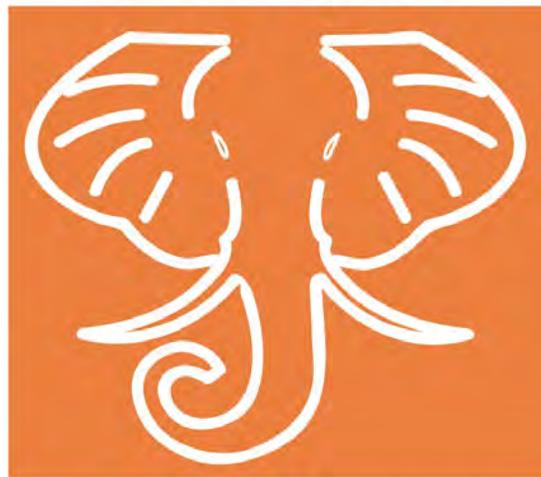


**Comments on fishery oceanography. Prepared for the Working Party on Fishery Oceanography of the Scientific Committee on Oceanic Research of the International Council of Scientific Unions**

International Council of Scientific Unions.  
[San Diego, Calif.] 1962

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SIO



WPFO 62-3  
15 August, 1962  
San Diego 6, California

TO: SCOR Working Party of Fishery Oceanography

FROM: W. M. Chapman

SUBJECT: Comments on Fishery Oceanography

For the past six or seven months we have been inquiring among practitioners as to the nature of fishery oceanography, its relation to other studies of the ocean, its foibles, what it may require from itself and from other disciplines of research, and what might be done about all of this, Uda has solicited opinion among Japanese, Philippine, Formosan, Korean, Thai, Vietnamese and Indonesian scientists to the number of 100, receiving useful replies (as of late June) from the first four groups. Cushing circulated inquiry among British workers both at home and abroad, and among New Zealand, Ceylonese, and Indian scientists, receiving as of late June useful replies from about 50 in Scotland, England, Ghana, New Zealand, Aden, Sierra Leone, India, and Ceylon. Davies circulated inquiries to workers in African countries, receiving replies from South African, Malagasy, Nigeria, and Ivory Coast. Rass has circulated inquiries among scientists in the Communist countries, but his replies have not yet been received here.

I circulated a long inquiry, a copy of which is attached hereto, to about 300 marine research workers in the United States and Canada. I have had about 150 replies to this inquiry, and they are still arriving. Uda has compiled the results of his inquiries into a digest in outline form, which is attached hereto. Davies has sent his replies in and they are attached hereto, Cushing has made an excellent analysis of the material in 46 of his replies, combining quotations from source and personal comment in a most useful fashion. I have had other comments directly from these gentlemen and a most useful synthesis of Russian opinion from Rass, all of which is attached hereto.

The volume of replies which I received from United States and Canadian workers has quite surprised me with its mass, variety and interest. As I read over the letters I was moved to reply in a number of instances to points of particular interest. My replies in some cases brought counter replies. I find it quite impractical to synthesize this correspondence as Uda and Cushing have done with theirs. My own views so much color my writing that a synthesis of so many other views by me would simply lose most of the flavor and value of the originals. Furthermore,

many of my contributors showed interest in receiving copies of what their fellow workers thought on these subjects. Lastly, my views and those of my contributors seem to fit rather well within the analysis Cushing has made of the replies he has received, and I see little point in doing over again with United States and Canadian material what he has done so well with his.

Accordingly, I am just duplicating and circulating the most pertinent material that I have received from all hands on this subject, together with a number of my replies, somewhat compressed and edited where that seemed appropriate. These are arranged roughly by date of receipt of the reply, as there seemed to be no more logical way in which to arrange the variety. From this mass of material the reader can draw his own conclusions. My conclusions are in this memorandum.

It should be noted that the views expressed herein are solely my own and my responsibility. They do not necessarily represent those of anyone in SCOR, ICSU, the United States Government, or any other person or entity. This is the case also with the contributions. Each contributor sent his material in with the specific reservation that the views were his, or hers, and not necessarily those of the institution worked for.

Perhaps the majority of contributors found the terms of reference set down by Dr. Humphrey for our work too confining for their thoughts and they often wandered widely from them in their replies. My reaction has been the same and my reaction will be similar.

Perhaps the first step is to examine the origins of the present working party. The immediate causes may be traced to the interaction between practitioners in the fisheries and oceanographic fields of research encountered in the course of establishing the Intergovernmental Oceanographic Commission during three inter-governmental meetings held in 1960-61.

The first of these was a "Preparatory Meeting of the Intergovernmental Conference on Oceanographic Research" convened by UNESCO in Paris, 21-26 March, 1960. The fisheries component of this meeting was nominal. Representation from the major maritime nations was drawn from the academic-classical oceanography sector and not from the fishery agency ocean research sector, except in the case of one country. In that case the director of the national fishery agency was present as an observer representing the International Council for the Exploration of the Sea and the International Commission for the Scientific Exploration of the Mediterranean Sea

and was not listed on the national delegation. Also present in observer status was the Director of the FAO Fisheries Division.

From the recommendations of this preparatory meeting arose the "International Conference on Oceanic Research", also convened by UNESCO, in Copenhagen, 11 to 16 July, 1960. At this meeting there was a somewhat increased representation from the fishery agency ocean research sector. I was not at this conference and can therefore give no first hand impressions. At least three fishery people who were at it left the meeting, as they told me, with the unhappy feeling that the fishery ocean research people were being run over by an impressively heavy steam roller manned by academic oceanographers, and they returned to their home offices to prepare better defences against the next encounter.

Pursuant to actions taken by the tenth General Conference of UNESCO, that organization established and staffed an office of Oceanography during this period and entered into agreement with the International Council of Scientific Unions (ICSU) that its Scientific Committee on Oceanic Research (SCOR) would be the official advisory body to UNESCO in respect of oceanic research.

The eleventh General Conference of UNESCO established the Inter-governmental Oceanographic Commission (IOC) in conformity with recommendations adopted by the Copenhagen meeting. IOC held its first session in Paris at UNESCO headquarters from 19 to 27 October, 1961. At this meeting representation from the fishery sector was larger than it had been at the previous two meetings, the fishery people had done their home work better in the preparation of positions in national delegations, and the above noted interaction became rather lively at times. For instance out of the eleven cooperative programmes recommended by the meeting for earnest consideration by such States as might desire to participate (Resolution 3) seven were primarily fishery-motivated.

It was, however, in the matter as to whom should provide scientific advice to IOC, and what should be the relations among IOC, FAO, WMO (World Meteorological Organization) and other interested agencies of the United Nations family, that this interaction became most spirited. It had been proposed that SCOR serve IOC as an advisory body in oceanography as it was already authorized to do in respect of UNESCO. This proposal was not adopted. Instead a very carefully worded Resolution (1) on "Relationship between the Inter-governmental Oceanographic Commission and other Organizations" was adopted, a copy of which is attached hereto.

This resolution recounted the broad nature of the statutes of the Commission in respect of oceanic research, the intimate relation between research on the ocean and its contained resources, the

desire of the Economic and Social Council of the United Nations that IOC take full account of the activities and interests of all organizations concerned with oceanography, the close relation between oceanography and fishery research and the fact that FAO had primary responsibility in the United Nations family in the latter field, the anticipated formation by FAO of an Advisory Committee on Marine Resources Research, the advisory relationship of SCOR to UNESCO and the great contribution SCOR had made to the development of international cooperation in oceanic research since its founding in 1957, and finally the anticipated formation by SCOR of a working group of experts in fisheries and oceanography.

Having recounted these things IOC, in the operative part of this resolution, postponed decision on advisory bodies and "Requests the members to submit to the Secretary of the Commission their views on the establishment of advisory channels to the Commission in all fields of oceanography, including fisheries oceanography, for consideration by the Commission at its second session."

One way of looking at this action, or the postponement thereof, was that it marked about an even standoff in power of the academic oceanographers and the fishery people in the national delegations to IOC. Since SCOR, in its energetic activity in promoting the development of international co-operation in

Oceanic work, had been the prime force in generating these three key meetings, establishing the Office of Oceanography in UNESCO, establishing IOC in UNESCO, and was the officially designated advisory body to UNESCO on oceanography, lack of action by IOC in this matter seemed to indicate that SCOR had not taken sufficient account of fishery-generated interest in its activities to date in carrying out its responsibilities, stated as follows in the Constitution of SCOR: "SCOR is a Special Committee of ICSU charged with furthering the coordination of scientific activity in all branches of oceanic research, with a view to framing a scientific programme of world-wide scope and significance". (The Year Book of the International Council of Scientific Unions, 1961).

Although the interaction between oceanography and fishery research thus indicated was brought to the forefront during the course of 1960-61 in these three intergovernmental meetings and otherwise, the sources of the interaction were numerous, complex, and in some instances subtle and most difficult to cope with. Some were of recent origin and some were older in their derivation than any of the representatives at IOC. It would seem desirable to take note of some of these. Presumably each member of the working party will have his own views on these factors. Mine are discussed under the following headings:

1. Academic - government;

There are at least two general sorts of scientists inquiring into the ocean who derive their funds, their direction, their responsibilities, their inspiration, and their interests from largely different sources. Liaison between the two groups is imperfect as to individuals and as to groupings of individuals. One may be called loosely the academic group and the other the fishery group.

The academic group is primarily associated with institutions of higher learning, National Academies of Science, National Research Councils, and the like, Its primary objective is simply the increase and diffusion of knowledge of the ocean and its contents. While it has relations with its particular national government, varying in type from country to country, it has its own international organization more or less separate from the national governments, first in the International Unions and Societies in different disciplines, and finally in the International Council of Scientific Unions (ICSU).

ICSU is composed of two sorts of members "National Members" and "Scientific Members." The former are nations represented by their Scientific Academies, Scientific Research Councils, or, failing these, by their governments. The latter are International Unions in particular disciplines of science. The former number 49 (as of 1961); the latter number 13; the combined number of nations whose scientists are thus represented in ICSU by these two sorts of members is 71. The Executive Committee of ICSU is composed from among its members under specific provisions of its statutes.

SCOR is a special committee of ICSU charged by it with the above noted responsibilities. It consists of 18 members, six of whom come from ICSU and twelve of whom come from the International Scientific Unions in indefinite proportions as provided for in the constitution of SCOR.

In this manner the academic oceanographers are provided with means of coordination and liaison among themselves at all levels. SCOR has furthered this in its particular field by stimulating the formation of National Committees of Oceanography to give it contact and liaison with the oceanographers within nations somewhat outside, or additional to, the above general framework.

Nothing of the sort exists on a world wide basis among fishery scientists. The greater part of oceanographic research done in the world in connection with fisheries is accomplished by scientists working as civil servants in government agencies whose prime objective and responsibility is not research but is the application of all knowledge from all sources to their respective fields of responsibility

in the general government. These head up in the National Governments in the Ministry of Fisheries, the Ministry of Food, the Ministry of Agriculture, Forestry and Food, the Department of the Interior, etc. etc. These governmental departments in turn are represented internationally by their respective Department of State, Ministry of Foreign Affairs, Ministry of External Affairs, etc., and at intergovernmental meetings their particular views are conformed within the position of the national delegation to it.

These ocean research people in government fishery laboratories have no world wide organization as do the academic oceanographers. It is a generally held misconception that they are united in some manner through FAO, but this is not so. The Fisheries Division of FAO is a minor part of that organization which is dominated by agricultural interests. Oceanography in FAO Fisheries Division in turn, is an activity within the Fishery Biology Branch of the Division, which is only one of three major branches of the Fishery Division. There is at least little feeling among ocean researchers in fisheries agencies that FAO has much to do with their field of activity.

These ocean research people in government fishery laboratories also do not feel that they have any representation in the ICSU apparatus. While many of them belong to International Union, they are government civil servants, whereas the ICSU apparatus is basically and purposefully non-governmental. Thus they feel no sense of belonging to SCOR or its National Committee's on Oceanography, or of being represented by them nationally or internationally.

Nevertheless, the amount of basic as well as applied ocean research which has been done, and is being done by researchers in these government fishery laboratories compares favorably in volume and quality with that being done by academic oceanographers. The support of both by funds essentially derived from government has increased sharply in recent years and each is showing appropriate, and not unequal vigor.

The ocean research people in government fishery laboratories have traditions and aspirations of their own which they view no more lightly than do the academic oceanographers view theirs. While they do not feel they have any good way to have those traditions and aspirations adequately represented in the ICSU apparatus, culminating in SCOR in the ocean research field, they do have reasonably good means of affecting these activities in the international field now through IOC, because representation at IOC is by national government delegations. Being an integral part of the national government these fishery people have a good, or better, opportunity to have their views reflected in positions taken by their national delegations at IOC as do the academic scientists,

who take pride in being non-governmental.

If SCOR, representing solely the non-governmental workers through being appointed sole advisory body in oceanography to IOC, were to gain dominance over the scientific activity of IOC, this single remaining facility of inclining the direction of international (and to some degree national) oceanography toward their traditions and aspirations would be lost to the ocean research people in government fishery laboratories. This they resist.

This is at least one of the root factors in the above noted interaction between the fisheries and oceanographic fields of research at the IOC level. The means for resolution of this problem are not at once apparent, but the existence of it is testified not only in the actions taken at the first session of IOC, but also running through the correspondence received both by Cushing and me on this matter.

It seems obvious that it is in the public interest that both of these groups, both of which work in the public domain upon public funds, should work together as effectively and as efficiently as is possible.

## 2. International - intergovernmental.

As used herein the term international organizations means agencies in the United Nations family, or deriving directly therefrom, whilst the term intergovernmental organizations means organizations that have been formed among governments by convention or other agreement outside the United Nations framework.

Heretofore the fishery ocean research workers have had their international research correlated primarily through intergovernmental rather than through international agencies. These intergovernmental fishery agencies are of three general sorts: (1) Those correlating research efforts among national fishery agencies, collating results, etc., merely as a means to further acquisition of knowledge and understanding of the sea and its contents, (2) those which do the same thing with the primary objective of the nations involved taking joint conservation measures, and (3) those which have their own scientific staffs and conduct their own research with a conservation objective.

The oldest of these is the prime representative of the first group, the International Council for the Exploration of the Seas, the mother of organized international oceanography. Research workers associated with ICES have an understandable pride in its history and traditions, in the ocean research which has been accomplished under its aegis and is currently being so done. They have high aspirations for the

contributions their planned future work will make to the general knowledge and understanding of the sea and its inhabitants.

Another much newer member in this field is the work in seas adjacent to tropical Africa under CCTA/CSA, the Commission for Scientific and Technical Cooperation by the States south of the Sahara.

In the second category is the International Commission for the Northwest Atlantic Fisheries, the Permanent Commission on Over-fishing, the International North Pacific Commission and the International Fur Seal Convention, as well as the International Whaling Commission.

In the third category is the International Pacific Halibut Fisheries Commission, the International Pacific Salmon Fisheries Commission, and the Inter-American Tropical Tuna Fisheries Commission.

These Commissions are all regional or are engaged in research in respect of particular fisheries with finite geographic bounds. They all have special areal problems. They are working rather well in dealing with international problems, sometimes of grave moment among the particular nations and industries involved. They, and the national governmental fishery agencies that have the particular responsibility, and the industries involved, do not look with favor on international agencies becoming involved in those problems for a variety of reasons. They have rigidly resisted FAO Fishery Division becoming so involved. Their inclination with the new IOC in UNESCO seems to be similar at this juncture. They incline to view it with suspicion.

These international fisheries commissions do a considerable amount of basic oceanography as well as straight fishery research. Their funds derive from the same government treasuries as do those of the international agencies (and the greater part of that supporting academic oceanography), but comes through different sections of the national budget. If a national budget has only so much money to be devoted totally to the support of ocean research, then this poses a problem.

These relationships among intergovernmental and inter-national agencies pose a problem different than the government-academic problem noted above, and not much easier to deal with. It forms another reason why FAO cannot readily provide the sort of liaison among fishery workers that SCOR-ICSU does among academic oceanographers.

It will be noted that this thread of thought occurs in the Cushing correspondence and so it has in mine, although two of the most pointed comments on this subject have been eliminated from the duplicated material provided herein upon the request of the correspondents.

3. UNESCO - FAO

At all three of the above noted intergovernmental meetings in 1960-61 interaction between members of the United Nations family in respect of IOC was animated. Although several specialized agencies were involved UNESCO and FAO were most deeply so. At various stages of the action there appeared to be a clear conflict of interest and responsibility. With this sort of jurisdictional problem, scientists on the outside can do little to cope, but it requires to be mentioned as one of the divisive forces in this situation.

The Economic and Social Council of the United Nations has an Administrative Committee on Co-ordination whose prime responsibility is handling situations of this sort. ACC in 1961 formed a sub-committee on Oceanography composed of representatives of UN, FAO, UNESCO, WMO, IMCO, and IAEA. This sub-committee has met twice and has mitigated the above noted situation. Also formal and informal arrangements have been made among UNESCO and FAO which have led even more strongly in this direction.

One special sort of problem in this field has not yet been solved. There exists in the United Nations the Special Fund whose field of responsibility is the funding of pre-development projects of reasonably large size in the Technical Assistance field using, primarily, the specialized agencies of the United Nations as executive agencies. It currently has two large projects in fishery development which . . . . . have a sizeable component of oceanography one in Peru, the other in Ecuador. FAO is the executive agency in both instances. Others are pending.

This would appear to be a field where the joint efforts of IOC, UNESCO, Office of Oceanography, FAO Fisheries Division and the World Meteorological Organization could be ideally and beneficently applied. The administrative means by which this might be accomplished has not yet been devised.

Comment on this FAO-UNESCO interaction was found in my correspondence. The Rass and Sears letters are cases in point.

4. Inshore - broad sea.

In the United States in particular there has been a considerable interaction between those ocean research people (both fishery and other) whose research interest lay in the littoral, inshore and estuarine areas, and those research people whose interest was in the broad open sea. This interaction became particularly vigorous two or three years ago in the early stages of the work of the National Academy of Science - National Research Council's Committee on

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Oceanography. The contention on one side was that the broad sea people were getting all the new money; the contention on the other side was that the broad sea people needed \$1,500 per day for ship time in order to have a platform under them and be in the same position as the littoral worker was when he stood on the beach, and thus they must have much more new money and old as well just to be in the equivalent position to work.

This ran rather broadly through the correspondence I received, and was not absent from the Cushing correspondence. It was pleasing to me to see that with few exceptions the views of the inshore people were not as vehement as they had been two or three years ago. This mitigation appears to derive from two sources: (a) the enthusiasm which the broad sea people have generated for ocean research has brought considerable new money to the inshore people also, and (b) as more becomes known of the broad sea and its contents the effect of what is transpiring offshore on the inshore conditions becomes more clear and desirable for the inshore people to know more about.

#### 5. Biology - physico-chemical

The marine biologists who are not connected with fishery research project have had a left out feeling. The International Union of Biological Sciences has no particular section for marine biologists. They feel often like small brother to the physico-chemical oceanographers. They have felt themselves to be neither fish nor fowl in several countries.

At the IOC there was a move put afoot to organize a marine biologists organization as a means, partially, of mitigating the interaction in the fisheries and oceanographic fields of research. Reference to this feeling runs through the Cushing correspondence and mine.

#### 6. Basic - Applied

One of the strongest currents running through my correspondence, and not absent from the Cushing correspondence, was the insistence that more funds must be allowed for basic research, that fisheries work was predominately applied research and as such should not have much of a place in the halls of science. Concurrent was the feeling that fishery oceanographers were so closely under the heel of industry that they could not work freely. Concerned as I have been for a number of years with research associated with tuna, sardine and other pelagic resources this did not ring true. The industry with which I have been associated for a number of years has been primarily interested in stimulating what academic people call basic research for the reason that that sort of research, on experience,

seems to produce usable results more frequently and more quickly than what is called applied research in the oceanographic field. In the sardine problem off the California coast, physical, chemical, biological, and fishery oceanographers have come jointly to so many dead ends that they commiserate rather than quarrel, and one is analyzing the other's data now in what is called the basic field because the applied research seems to have had little chance of application.

Yet this strain ran so heavily through my correspondence that I was constrained to reply in a number of instances setting these things out at more length. In most cases the correspondent replied that there had been a misunderstanding or otherwise avoided the issue. As a consequence, I formed the opinion that this division of opinion is mostly a conservation of shibboleth's out of the past held by workers more or less out of the main stream of recent developments, and thus of no great concern.

#### 7. Directed - Undirected

As an outgrowth of the above line of thought, it became evident that most of the basic applied argument was really concerned with directed versus undirected research. A case in point is provided in the program of the Inter-American Tropical Tuna Commission. In the fields of work on indicator organisms, pure descriptive oceanography, investigation of basic oceanographic processes, research on atmosphere - sea interaction, use of blood chemistry in racial work, investigation of the oceanography of tropical estuaries, that this organization has done much pioneer work. There is also no question in anyone's mind that the overall program of the Commission is tautly directed to the primary contribution). Thus there is provided a directed program of research which provides a good deal of freedom within definite limits for its investigators, and includes a large component of what is termed basic research.

Another case in point is the Bureau of Commercial Fisheries Biological Laboratory at Stanford where the program is to elucidate the relation between atmosphere, ocean, and fish on an ocean wide basis, working with three sorts of data: surface temperatures, barometric pressure, and wind direction, and stress. No one concerned expects this program to develop in any reasonable period of time knowledge or understanding which will be practically applicable to existent fishery problems in the area, so it might be called almost totally basic research into processes. But there is no question that it is directed research, as the POFI program under the same direction

when it discovered the Cromwell current and other such things in the Tropical Pacific.

If directed research is bad, then much fishery research on this continent is bad. I have never been able to convince myself that this is bad because I have seen so many excellent researchers in the academic field, who abhor the idea of directed research, yield to their work being closely directed by suggestion, example, and other more subtle forms of direction.

The feeling is nevertheless so deeply held in the academic oceanography field on this continent that no good researcher permits his research to be directed and resists the term with his life's blood. Accordingly I felt it desirable to emphasize this in replying to Professor Rass. Should either SCOR or FAO attempt to direct international ocean research the scientific community on this continent would rise in united wrath and smite them hip and thigh.

#### 8. Special discipline - broad team work

Running through my correspondence, and found in the Cushing correspondence, was a rather forlorn complaint that the individual specialized researcher was being swamped under the growing tendency in oceanography for complex team assault on oceanographic problems. Given the cost per day of keeping a research ship at sea, the cost of instrumentation, the cost of computer time, and the very complexity of the problems that are being encountered I do not know much that can be done about this except complain. As one of the framers of the EPOC "Cooperative Program of Study of the Eastern Tropical Pacific Ocean" which attempts to carry this team approach to a rather extreme degree, I cannot even, in good conscience, complain.

#### 9. Conservation - utilization

Running through the Cushing correspondence and my own has been the refrain that fishery science has been heretofore primarily concerned with conservation problems. Some point out that this is properly so and properly confines fishery science to the use of oceanographic information not its primary acquisition; others refer to it as a complaint, pointing out that fishery scientists have worked with conservation blinders on and thus been unable to discover the effect of the ocean itself upon their problems.

This has been, up to recent time, a valid complaint. On this continent in particular (not so often in Europe or scarcely at all until recently in Asia) the stimulus to ocean fishery research rose out of particular conservation problems. From this rose all of the international fisheries commissions in the Eastern Pacific, the International Northwest Atlantic Fisheries Commission, the Whaling

Commission, the Fur Seal Commission, the Fishery agencies of the individual states and provinces, and to a good share the Federal Fishery Agencies.

The fishing industries have been prime stimulators of this sort of research. The reason has not necessarily been an enlightened sense of public responsibility, It has more generally been a desire to acquire the scientific information that would prevent capricious regulation where conservation regulation was not required, and to obtain biologically sensible and practical regulations where they were required.

Running through both the Cushing correspondence and my own has been the theme that fishing industries should finance oceanographic research as do so many land based industries. There are several reasons why this does not take place and is unlikely to. One is that the fish of the sea are common property resources. If one husband them another who has not borne or shared the cost of husbanding will make the harvest. Another is that a very large part of high seas fishing is done by small individual enterprise for the basic reason that a fisherman operated and owned vessel produces at a lower cost per ton of production than a company owned boat. These small enterprises have no funds with which to sponsor research of consequential size.

A third, and substantial, reason is that until very recent time high seas fishermen have had no reason to believe that oceanographic research had been of any use to them, except to keep conservationists off their back. Running through the Cushing correspondence is the theme that the tuna fishermen of the United States and Japan have been greatly aided in the expansion by the fruits of ocean research. I am widely acquainted in the United States Tuna fleet and I do not know of a fisherman who holds that view. So near as I can find, the Japanese long-range tuna fishermen are not much more enlightened.

The basic research into the relation between wind, sea and fish that has been going on during the past ten to fifteen years now gives glimpses here and there that this picture is due for a change, but the picture is by no means yet clear and no one realizes that more clearly than the capable research men who are closest to the activities of these broad ranging fleets and searching avidly for breakthroughs. They trend ever more to broadly basic research rather than what is termed applied research, and it is they that industry is backing when it backs any sort of research at all.

Another factor that requires constant consideration is that some fishes are very sensitive to variations in the environment and some are not. Put in another way tuna are very sensitive and precise oceanographers and halibut are not. It is mentioned in both the Cushing and my line of inquiry that the International Pacific Halibut Commission has been able to carry out a quite successful high seas conservation program with very little attention to the environment. This is not so precisely true, because in the early days of its research it pioneered in studying the general circulation of the Northeast Pacific, but by and large the statement is correct as it was early learned that the environment did not grossly affect the abundance, distribution or availability of the halibut in the area under study. This, however, has never been true of the tunas.

#### 10. Helping industry - not helping industry

Running through the Cushing and my line of correspondence has been the theme that fishery oceanographers or scientists are too strongly industry oriented, directed, and attuned and that they would do much better to attend to science and let the fishing industry shift for itself.

This is a view also widely held in the fishing industry, not only on this continent but elsewhere in the world where I am acquainted. One thing the fishing industry and scientific community appear to be in substantial agreement upon is that when scientists do science and fishermen fish a good deal is learned and a lot of fish is caught, but when fishermen assay science and scientists attempt to show fishermen where and how to fish all hands should better have stood in bed.

There remains however the very substantial suspicion that enough knowledge and understanding of the relationship between wind, sea and fish is being accumulated that industry or government, as the case may be, can use this at least as one of the more <sup>valuable</sup> guide lines in developing fisheries where none, or very primitive, fisheries exist. Hinds in Aden and Longhurst in Nigeria, among others in this line of correspondence, hold this thesis. So do I.

This has been the basic thesis underlining the sponsorship by CCTA/CSA and the United States of the Guinean Year and Tropical Atlantic Program. It has been my hope, shared by others, that the International Indian Ocean Expedition can be made to yield much information useful to developing the high seas fisheries of that ocean to the benefit of the peoples living around it, who in many instances are desperately short of protein in their diet while it swims, dies and goes to waste a few miles offshore.

**11. SCOR - Non SCOR**

There has been a considerable expression in this correspondence that SCOR was exceeding its authority, if not actually meddling, in appointing a Working Party on Fishery Oceanography and that no good was likely to come of it. This ranges from puzzlement, as illustrated by the Sears letter, to a letter I was asked not to make public which ended "Sensum Societas SCOR Abolenda Est." There was, in fact, a division of opinion in SCOR at its fifth meeting as to whether SCOR could, with propriety and utility, delve into such an inquiry. I have dealt with this problem in my reply to Dr. Sears.

While SCOR may not be able to cope with this problem successfully because of built in difficulties, attempting to deal with it is not only its clear responsibility - there is no other world wide group of which I know which is able to come to grips with the problem on a world wide basis.

These, then, are some of the cross currents which have disturbed the international and domestic ocean research scene. Others could be listed at some length, such as the general desire to simplify the structure of international oceanography while not wishing to give up one's pet horse, the wide felt urge to decrease or abandon, all committees dealing with oceanographic problems except the one dealing with the particular problem in which one is interested, and the general human desire to keep one's own ox from being gored.

It is not within the purview of the Working Party to deal with most of these problems, even though they have been brought out in the correspondence we have received and obviously are the subject of a good deal of thought in the international ocean research community. To ignore them, however, would be bootless because it is in this context that our work lies.

SCOR established this Working Party to examine the four questions:

1. To discuss and define the subject of fishery oceanography.
2. To state what fisheries oceanography has accomplished.
3. To state what fisheries oceanography should be trying to accomplish.
4. To state what progress is needed in other sciences so that the aims set out in 3 can be attained.

To quote the letter of establishment: "SCOR chose the above terms of reference because its members noted that during the discussions at the meetings previously mentioned, there was much confusion concerning the nature, accomplishments, and aims of fisheries oceanography. On the

one hand the term was used to include all of fisheries science, on the other to denote a restricted use of a small part of physical oceanography. SCOR felt that before any attack could be made on the problems envisaged in the original working group suggestions, it was necessary to examine some of the basic considerations involved.

"SCOR felt that it could make a contribution by bringing together a small group of workers in diverse fields so that the different viewpoints could be recorded, discussed, exemplified and put together for the benefit of intergovernmental bodies, laboratories, and individual workers. Such action would assist further work by SCOR and other bodies."

It would appear to me that the present volume of correspondence does part of this expected task with adequacy - the recording and putting together, of different viewpoints, I doubt that any substantial expansion in viewpoints on these terms of reference we have gathered would be yielded if we increased the volume of correspondence by an order of magnitude.

At our meeting in Bergen we will have seasoned specialists among whom some have particular competence in oceanic meteorology, some in physical oceanography as applied to fish, some in fishery biology, some in non-fishery biology in its application to fisheries science, some in industry and industrial-scientist liaison, some in international and international organizations in the field, and some who are not unknowledgeable and inexperienced in the specialized Law of the Sea and its applications to fisheries and oceanographic research.

It would be my hopes that in the first three days of our meeting we could discuss amongst ourselves these four terms of reference, set down a conformed opinion from all these viewpoints, and where a conformed viewpoint among us on a point is not possible then to set down each viewpoint amongst us each illustrated by example. This I would like to have in order so that it could be submitted to the SCOR Executive at its meeting in Paris, beginning 17 September, together with the recommendation that this Working Party, having discharged its duties, be disbanded.

If time affords at Bergen, and the members of the Working Party are agreeable, I would like to use this opportunity to seek advice as to how the International Indian Ocean Expedition can be used to extract a maximal amount of fishery-useful information - not as a part of the work we are charged with but from personal interest.

It may well be that other members will similarly have suggestions for other topics that we can appropriately and usefully discuss. If so we can settle upon those at the inauguration of our meeting - when we settle upon the agenda.

There remains my personal views in respect of our terms of reference (letter from Humphrey, attached hereto), which are as follows:

1. To discuss and define the subject of fisheries oceanography.

The most wide spread reaction to this term of reference in the correspondence I have received have been: (a) there is no such thing, (b) if there is such a thing there shouldn't be, and (c) toying with such semantics is a waste of everybody's time, and is probably disruptive of the even tenor or progress in ocean research. Such attitudes are reasonably common also in the correspondence reported upon by Cushing. Almost invariably the writer then goes on to discuss and define his concept of what fisheries oceanography is, some times for two or three pages. In consequence we have, in toto, more expression of opinion on this term than the others, which is, of course, appropriate because if there is no such thing as fishery oceanography our task is soon done.

The history of languages indicates that it is not common for a term to be purposefully injected into a language and be adopted into normal usage; nor is it common for a term to be eradicated from the language because it is not a very accurately descriptive term or because quite a number of people do not like it. Words and terms creep into language through need to describe a new concept, and stay there through usage, or disappear through lack thereof.

I stand with the majority of my correspondents in not particularly liking the term fishery oceanography, not being quite sure of the concepts it purports to connote, not caring much for either of the two words that compose it, and rather wishing that it had not been borne. But there it is, and like Sette, I have no better form of words to suggest or replace it.

It is a curious thing that two of the better discussions of this term of reference in my correspondence came from two men to whom it was quite new and who have, at most, a collateral connection with the subject: (a) Dr. V. B. Scheffer, who is a mammologist, who has worked much with marine mammals for the past twenty odd years, and (b) Dr. G. S. Myers, who is a highly specialized, as well as competent, worker in ichthyological systematics.

Where the term arose I do not know. Sette says: "My acquaintance with it arose indirectly from Townsend Cromwell's serious probing for the avenue of oceanographic research that would contribute most significantly to solution of the fishery problems facing the organization with which he was associated - (first POFI and latter IATTC)" Since he has been actively engaged in this sort of research for upwards of thirty years this attests to its recent occurrence in American usage at least.

Wherever the particular term arose there is general concensus that the concepts it purports to describe were first put into practice internationally in a collective manner by the founders of the International Council for the Exploration of the Sea at the turn of the century, Hela and Laevastu (Fisheries Hydrography, 1962, p.15) quote from the first, 1902, report of the administration of ICES:

"- - - - it was seen from the beginning that the study of the physical conditions, of the chemical nature of the ocean waters, of the currents, etc., was of the greatest importance for the investigation of the problems connected with life; that on the other hand, the study of the floating organisms had particular worth for the solution of hydrographic problems, and consequently that a sharp line should never be drawn between these two main divisions - - -". One of Cushing's correspondents (Carruthers) says: "Persons belonging to I.C.E.S. should always bear in mind the initial view of that body which would have the definition run thus: "The distinction of the different water strata, according to their geographical distribution, depth, temperature, salinity, gas content, plankton and currents in order to find the fundamental principles for the determination of the external life conditions of useful marine animals".

There is some suggestion in correspondence and discussions that ICES may have deviated somewhat from this overall principle from time to time over the past sixty years, moving toward more emphasis of fish-connected matters and away from hydrographic matters. How that may stand I have no way of knowing beyond the great volume of data and research reports that have continually flowed from that organization over the years dealing with all aspects of the overall subject as defined above, and falling in the seven categories of publications supported by ICES. It may be noted that among this series is the "Bulletin Hydrographique" and that the Council describes the series "Annales Biologique" as follows in its official notice to authors: "A yearly record of data, arranged by areas and in summary tables and/or diagrams, of the composition of the stocks of fish of commercial importance in relation to the hydrographical and other factors" (underlining supplied).

Also the preamble to the Statutes of the Council as revised in 1950 (the most recent revision available to me) reads:

"The International Council for the Exploration of the Sea is charged with the execution of the programme for the international investigation of the sea, adopted at the Conference held in Stockholm (1899) and Christiania (1901) and subsequently modified at meetings of the Council, with the approval of the participating Governments.

"Its main functions are to encourage all investigations for the study of the sea and to coordinate the operations to this end of the participating governments."

"Its area of operation may be roughly defined as the eastern North Atlantic Ocean and contiguous or adjacent seas, including Greenlandic and Icelandic water."

I do not believe anyone in the world will disagree that ICES: (a) founded, in collective multilateral research form, the subject to which we have reference, (b) contributed, and is contributing, mightily to the growth of knowledge and understanding of the ocean and its content (particularly in its area of prime interest but also on a world wide basis in many particulars), and (c) during the first half of this century really had no competition of a major nature in this comprehensive field of research. It is only in the years since 1945, in fact, that the enormous increase in ocean research elsewhere has created, independently of ICES, other foci of research in this field having reasonably similar scope and comprehension.

At about the same period of time as ICES was being founded, a strong focus of fishery research was being generated on this coast at Stanford under Jordan, Gilbert, and others. Starting primarily in the systematics of North Pacific fishes, generally this led off in one direction, through Jordan, to the conservation activities exemplified by the quadripartite convention to conserve the fur seals of the North Pacific, and through Gilbert to the founding of extensive lines of salmon research in British Columbia and Alaska particularly. Out of this vigorous group came students who strongly influenced the trend of those events in the Eastern Pacific in particular, among whom two are of particular pertinence to this discussion.

Thompson's (W.F.) line of research and stimulation led through the founding of the California State Fisheries Laboratory, the establishment of the International Pacific Halibut Fishery Commission, then the establishment of the International Pacific Salmon Fishery Commission, the conversion of the School of Fisheries at the University of Washington into a scientific center, and at last the establishment of the Fisheries Research Institute in the University of Washington. This line of research vigorously stimulated, by precept and through students, the study of the result of man's activities on fish, particularly salmon and halibut. Because of the principal early problems in respect of the former lay in the fresh-water phase of existence, and the latter were sufficiently inert to variations in oceanic condition that these could practically be lumped into the "background noise" called natural mortality, this line of research did not lead to much high seas oceanography, except for the early investigation of the circulation of the Gulf of Alaska by T. G. Thompson and associates, supported by the Halibut Commission, in order to elucidate some aspects of the early life history of the halibut. This line of research did, however, stimulate greatly

the study of population dynamics. It drew not a little of its stimulation from I.C.E.S. sources and from the Russian, Baronov.

In the northeast of the United States another vigorous early focus of fishery ocean research was established under Henry Bigelow in his investigations, particularly from 1910 to 1925, of the Physical Oceanography, Plankton, and fishes of the Gulf of Maine, supported by the U.S. Bureau of Fisheries and conducted much along the ICES line, from which it drew much inspiration. The Pacific and New England lines of research were hybridized, in a manner of speaking, by Sette of the Stanford school being sent to New England by the Bureau of Fisheries in the mid 1920's to study variations in mackerel catches, among other things, thus bringing under study in the United States a pelagic commercial species of fish whose variations in abundance and availability could not be understood without close knowledge of variation in the physical nature of the environment. Another line of hybridization between these groups was established by the shifting of Herrington from Thompson's halibut commission in the North Pacific to New England in early 1930's, to take charge of the U.S. Bureau of Fisheries investigations in that area.

The California line of fishery oceanography was building well prior to World War II through stimulation in Sverdrup (who had come from Norway and the ICES atmosphere to head up Scripps), Sette (who had been sent back to the Pacific coast by the Bureau of Fisheries to head up its sardine investigations), and Clarke of the California State Fisheries Laboratory, another product of the Stanford school. This line of development was much slowed during the World War II, only to resuscitate with enormous vigor upon the cessation of war.

In the six years from 1946 to 1952 the foundation for much was laid. In California during these years were conceived and borne the CalCOFI program, the Scripps MLR Program, the POFI investigations in the Central Pacific, those of the Inter-American Tropical Tuna Commission, and the Institute of Marine Resources of the University of California. Revelle replaced Sverdrup in the directorship of Scripps and proceeded with remarkable energy to the stimulation of all ocean research everywhere (a line of effort leading through NASCO, IGY, SCOR, IOC, etc.).

In the North Pacific occurred an equally remarkable surge of this joint fish-ocean research, particularly at Nanaimo under the dynamic leadership of Needler and Tully. This was stimulated further by negotiation of the International North Pacific Fisheries Commission, and these in turn stimulated a vast increase of United States effort in that area through the Bureau of Commercial Fisheries Laboratory in Seattle. As well as being stimulated further by Japanese workers under INPFC.

In the same short span of years was established the International Commission for the Northwest Atlantic Fisheries, which was to stimulate ocean fishery research in that area and by creating hybrid vigor in the North Atlantic area through bringing ICES European and American workers to focus on the same problems.

POFI turned out to be an early and vigorous stimulant in this line of development. Aside from its contributions to fishery oceanography of the broad open sea, developing concepts, practices and scopes of thought not formerly exercised by American Fisheries workers, POFI exercised a most powerful force as a training center under Sette and his successors. Through this school came Schaefer, Director of IATTC; Kask, Chairman, Fisheries Research Board of Canada; McKernan, Director, U.S. Bureau of Commercial Fisheries; Murphy, Coordinator of CalCOFI; and at last Brock, Austin and Wilson to stimulate on behalf of the Bureau of Commercial Fisheries and the United States Government the Tropical Atlantic Program.

The establishment of the Inter-American Tropical Tuna Commission physically at Scripps reinfected that institution with a most virulent strain of the fishery research virus during its period of rapid growth during the 1950's under Revelle. To this has been subsequently added (on top of the Scripps Marine Life Program), the Bureau of Commercial Fisheries, La Jolla Laboratory under Ahlstrom, The Scripps Tuna Oceanography Research Program (supported by Bureau of Commercial Fisheries) under Blackburn in 1958, and Bureau of Commercial Fisheries, San Diego Laboratory under Howard in 1959. Into this net were drawn to a continually increasing degree from more purely academic oceanographic research Wooster and others at Scripps. It also led to much stirring in this field of research in Western Latin America.

These lines of forces centered on Scripps in California, POFI in Honolulu, and on Nanaimo & Seattle in the Northwest joined together in 1954 as the Eastern Pacific Oceanic Conference, of which Sette has been temporary chairman and Reid temporary secretary, since. This organization has no membership, no charter, no by-laws, no formal standing of any sort, and is an ad hoc meeting each year practically de nouveau. It grew out of a practice that the Sardine investigators from Nanaimo to San Diego had formed during the 1930's under which they all gathered together once a year just as scientists to compare notes (a practice they still carry on in the annual Pacific Sardine Conference). In 1950 the few tuna scientists then existent in the region (POFI and IATTC mostly) copied this procedure by having a Pacific Tuna Conference (since then also an annual affair). By 1954 the Tuna scientists could clearly see that their work required the most intimate cooperation and collusion with the physical oceanographers in the area and asked those scientists

to meet with them after the annual Tuna Conference, which that year was held at Scripps. At that inaugural meeting was formed (besides the EPOC), the plans for the great NORPAC synoptic survey of the entire North Pacific by Canadian, Japanese and United States ocean researchers, followed in subsequent years by the similar EQAPAC. of the tropical Pacific, and much else.

Thus EPOC has become a cauldron into which fishery, biology, geology, meteorology, physical and chemical oceanography and other ideas are thrown to be stirred around and boiled together under the fire of ever increasing interest in the broad open ocean and its living resources and support of inquiry about them. The clear lines of disciplinary distinction fade continuously year upon year, as investigators of mixed provenance and interest use the same ships on the same long voyages, the same computers to tote up the results, associate in the corridors of the same buildings, have a drink or two together at least once a year at EPOC, and gradually realize that it is the same ocean that they are studying.

Quite coincidentally elements of the California tuna industry have established active interests in the tropical, sub-tropical and temperate world ocean on a fully world-wide basis which has given at least a conjunction of industrial with scientific and governmental interest, although the cross connection of interest and activity have not yet become very intimate.

It was in this maelstrom of swiftly changing and growing ideas that the brilliant and serious young oceanographer Townley Cromwell had his scientific upbringing, and pondered continually what on earth it was that he as a physical oceanographer was doing that was useful enough to the fisheries, or likely so to become, that they should cause him to be hired and to see that his expensive work was reasonably well supported. In addition to mulling this over himself and with his associates he conceived that there should be held a seminar to bring together oceanographers and fishery scientists to discuss these matters and find out what fisheries oceanography was, if there was such a thing, and what it should seek to do. His brilliant career was snuffed out in an airplane crash (with Bell Shimada, another brilliant young POFI-IATTC product) as they were flying to join an expedition ship and before the seminar was arranged. It was eventually organized by Blackburn and held in San Diego in June 1959 in connection with the meeting of the Western Division of the American Association for the Advancement of Science under the joint sponsorship of the American Society of Limnologists and Oceanographers and the American Society of Ichthyologists and Herpetologists. The published collection of papers from the seminar was entitled "Symposium on Fisheries Oceanography." (California Cooperative Oceanic Fisheries Investigations, Reports, VOL. VIII, Jan. 1961).

So far as I know this was the genesis of the term fisheries oceanography in American usage in this part of the world. It was not originated or proposed; it grew because fishery researchers and oceanographers were working together so intimately . . . . .

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that it was convenient to have a term to describe briefly what they were doing together.

To illustrate what I personally mean by fishery oceanography as I discuss it in the following pages I can do no better than quote four or five paragraphs of Sette's letter of 9 March, attached hereto:

"In fact, I think the term "fisheries oceanography" itself is too restrictive (besides being ungrammatical). Fishing denotes predation by man and this should not be a necessary precondition for studying the living resources of the sea. I do not think the study of atmosphere or of molecular biology should be precluded if either holds promise for understanding the ever-changing environmental conditions governing the abundance, distribution and behaviour of any of the organisms making up the living resources of the sea, or any other attribute of these resources that might be significant to their use (actual or potential) or non-use by Man.

"If we knock out both words we are left with no term to express the concept we are talking about. Being unable to conjure up words that suit me better, I will go along with "fisheries oceanography" (but couldn't we dis-corrupt it to "fishery oceanography?") and try to tinker up Blackburn's definition to conform with my concept. As a first try, with reservation of future privilege to tinker further, I suggest:

"Fishery Oceanography - - the study of living resources of the Sea and of natural phenomena directly or indirectly influencing them in manner potentially or actually significant to their use by Man, including any information gathering needed for such studies.

"This is intended to exclude the study of the effect of fishing on a resource according to the classical density-dependent model but to include study of the density-independent influences on a resource even though the latter may be responding simultaneously to exploitation according to the density-dependent model. It is intended to exclude study of any organism that is not potentially a resource but to include the study of that organism if it is a significant part of the environment of a resource organism. It is intended to exclude studies of natural phenomena offering very remote possibility of being influential on the immediate environment of resources, (such as the topography of the backside of the moon) but include the study of phenomena once or twice removed from the immediate environment, such as the variations in atmospheric circulation, or perhaps the pulses of energy emitted by the sun, if they seem likely to significantly influence the conditions in, or movement of, the ocean waters containing the resource.

"This is a conceptual definition, laced with motivation. Operationally, the kinds of research and survey undertaken in fishery oceanography would depend on the state of the resource, its

nature, and the problem requiring solution."

I have two troubles with this concept:

(1) I do not conceive a fishery as being more than another predator, from the standpoint of the fish. Although the density-dependent and density-independent models are most useful tools for the population dynamicists they do not reflect much basic significance to the natural world, and are no more than particular glimpses of the generalized predator-prey relationship, which is a major and critical phenomenon in the ocean with which the fish must contend and continually adapt to, or perish, Thus I cannot leave this factor out of my definition.

(2) Additionally I do not know what a resource organism is in Sette's concept, as I have no idea whatever what living resources of the sea are potentially significant to Man. This requires no change in his language but must be registered as a caveat to the concept his language expresses to him.

I am not a competent grammaticist in the English language but "fishery" in this usage flows more easily and smoothly from my pen than does "fisheries" and I have adopted its usage not in any substantive sense whatever, but because to my tastes it improves the elegance of the language.

I do not like the word oceanography to describe the concepts involved in man's quest for knowledge and understanding of the sea as it does not accurately describe them. However it is not my wish to be in any sense an innovator or to disturb common usage in the language. Yet if Prof. Rass chooses to make a strong stand for the word oceanology, he will find one supporter in our Working Party.

With these comments and caveats I find Sette's definition quite concisely and succinctly expressing my thoughts on this subject with the elimination of one word "natural": so that the definition which presently suits me is:

"Fishery oceanography - The study of living resources of the Sea and of phenomena directly or indirectly influencing them in manner potentially or actually significant to their use by Man, including any information gathering needed for such studies."

When a tuna fisherman discovers a protuberance from the sea floor so situated as to aggregate tuna he calls this a tuna bank and keeps it secret as long as he can from some of his fellow fishermen. When an Admiral's submarine geologist discovers the same protuberance he calls it a sea mount and the Admiral requires him as long as he can to keep the discovery secret from his peers:.

In many ways it is fortunate that these two types of individuals have, from the standpoint of their separate motivations, coined quite different terms to describe precisely the same object, as it does not give rise to any competitive strains between them as to who thought up the term first, what it means, who has ownership, etc.

In this context it would have been a fortunate thing if those scientists who study the ocean and its contents from the standpoint of potentially or actually useful living resource had coined a new word to describe their activities thus motivated instead of cribbing a rather poor word from other scientists studying the same ocean and its contents from other motivations. But they did not do so and at this juncture we are stuck with the term fishery oceanography to describe this comprehensive activity.

What I mean by the phrase is set out above. If I have been more prolix than excuseable in coming to this point it is because it profoundly effects what I shall say under the remaining three terms of reference which we have been given to consider.

2. To state what fishery oceanography has accomplished.

It is a singular fact that both Cushing and my correspondents are so modest, or derogatory, in their statement as to the accomplishments of fishery oceanography. This is so in respect of those vigorously engaged in it as well as those inclined to look down long nostrils, unused to the smell of fresh fish slime, at practitioners of this discipline (and habituated to spelling science in caps).

As I have defined the discipline it has been remarkably productive when one considers that it is only about sixty years old, that it only began to flesh out in the past fifteen years, and that nobody has been calling it a discipline in this broad usage for more than about five years. I should like to jot down some of the types of things it has done that I think are most noteworthy, and it will be seen that most of them stem in concept back to the founders of the discipline in ICES.

a. The theory of population dynamics

Baranov, Hjort, W.F. Thompson, Michael Graham, Beverton and Holt, Schaefer, Ricker, and a good many other men who have gathered much slime on their clothes at sea with the fleets are great names in the history of the theory of population dynamics, and the production of mathematical models reasonably suited to the description of complex events observed about populations in the living world.

b. The Theory of conservation.

Built upon the work of three generations of fishery scientists who had gone to sea with the fleets 88 nations were able to agree on a definition of conservation in a conference as surcharged with power politics as an international conference can readily get, in the "Convention on Fishing and Conservation of the living resources of the high seas", adopted at the Conference on the Law of the Sea convened by the United Nations in Geneva in the spring of 1958. It reads:

"As employed in this Convention on the expression 'conservation of the living resources of the high seas means the aggregate of the measures rendering possible the optimum sustainable yield from those resources so as to secure a maximum supply of food and other marine products. Conservation programmes should be formulated with a view to securing in the first place a supply of food for human consumption."

- c. The theory and practice of multilateral use of common resources and international collaboration

One needs not read deeply into the post-Renaissance history of man to discover the international strife that has been generated by contests in connection with jurisdiction over high seas fisheries, using that in its broadest meaning. That the intergovernmental fisheries commissions alluded to above have led, one time after another, to the resolution or mitigation of these knotty human problems cannot be denied. It would be hard to recall other instances in human relations where scientists have done more to relieve political tension, and the international fisheries commission have not mitigated the problems given them through the excellence of their diplomacy, but through the excellence of the scientific research their staffs have done.

- d. Concept of homogeneous inter-breeding stocks or populations of living organisms.

Classical taxonomy has been annoyed with this problem since its infancy. Fishery population dynamicists have required to refine and delimit the concept before they could approach, much less resolve, the problems noted under the three headings above in order that they might have manageable units with which the conservationists could deal. In their need they have given this concept new dimensions.

- e. Procedures for measuring living parameters.

Under this heading may be put the various procedures for aging fish (scale and other hard part marks, statistical modes, ingenious marking of identifiable single specimens, etc.), for differentiating fishing from natural mortality (mathematical models, statistical procedures, mass tagging, etc.), for determining the relative success of brood years (sampling methods, etc.), for measuring the growth rates of individuals and brood years, for tracing migrations (through tagging, relative growth rates, morphometrics, blood antigens, etc.) and the other ingenious techniques that no other biological science has developed better.

- f. Primary productivity

In the search for methods of making greater use of the living resources of the sea measurements of relative rates of primary productivity are becoming one of the more useful tools irrespective of the lack of faith with which the scientists engaged in this form of research view their results to date (see Strickland letter). In the progress of this particular search for understanding and

knowledge the names of scientists employed by fishery agencies, such as Strickland, Thomas, Jitts, Gilmartin, Angot, Humphrey, Etc., cannot be ignored.

g. Energy exchange between trophic levels

It must be conceded that few branches of the discipline are less well understood than this one, but it must also be conceded that the work on Calanus and herring by scientists of the ICES relationship, and similar other activities in that area, are as promising and fruitful as any other work in this line being done in the biological sciences.

h. The circulation of water masses and its relation to productivity and fish aggregation

The work of POFI, IATTC, CalCOFI, POG, STOR, and Japanese fishery oceanographers, in the Pacific is notable in its contributions to descriptive oceanography, particularly of the mixed layer. The Cromwell current, Costa Rica Dome, upwelling in the Tehuantepec area, general circulation of the North Pacific and in the south-east Pacific (Peru area particularly), upwelling and downwelling at interfaces, and the theory thereof, the subtle processes of water mass change over broad geographic area and its result on fish movements (as in the Hawaiian area), are some of the effects produced by scientists working for fishery agencies that come to mind in this field of research. They can undoubtedly be duplicated by statements concerning the ICES area, and are in the process of being inquired into in the Tropical Atlantic under primarily fishery motivated research. In this category may be put also the still inconclusive but stimulating work on indicator organisms under prosecution in several fishery programs.

i. Relation of air to sea circulation.

The work of Bjerknes in relation with IATTC and the new work of Sette and associates at the Bureau of Commercial Fisheries Laboratory at Stanford are important examples that come quickly to mind.

j. Biological data.

The massive accumulation of data on the life histories of fishes, their inter-relationships, their ecological preferences and requirements, etc., is generally brushed aside as the routine accumulation of dull data, but these are the building blocks upon which progress in ecology, the biological description of fisheries, inquiry into the ocean's web of life, and the ocean's processes is built. The accumulation of these building blocks in the past sixty years has been of formidable size and it rightly accounts for much of the energy of fishery ocean researchers everywhere.

I think it would be useful for our Working Party to flesh out this crude, hasty, and incomplete outline of what fishery oceanography has accomplished to the end that this, in itself, would more clearly define what we mean by the term fishery oceanography and also to allay the apparently widely held misconception that fishery workers produce little of scientific merit as they study

the ocean, its content, its basin, and its air cover.

It would appear from the correspondence which Cushing and I, in particular, have had, that the negative view so widely held on the accomplishment of fishery oceanography has derived chiefly from the widely held view among scientists that the prime function of fishery science in respect of the ocean is to help fishermen find fish and catch them cheaply. It must be readily admitted that if this is the prime objective of fishery oceanography then it has not yet accomplished much. This is not to say that its results in this direction have been negligible nor that they will not assume prominence in this direction in the near future, but to date fishermen have not had as much practical benefit from scientific input to their methods of locating and catching fish as they have derived from their own traditions, personal experience, and ingenuity.

As one who has had much experience in the past twenty years in enlisting support from the fishing industry for fishery oceanography I have not found lack of progress in this direction much of a factor in the minds of fishermen or fishery industry executives, who seem to be reasonably happy with the progress and promise of fishery oceanography to date. As an executive of one of the larger fish companies in the world I am profoundly convinced that fishery oceanographers will not help the fishing industry of the world maximally by trying to do so, but will best serve humanity by simply learning how fish, ocean, and air are related together in their movements and processes. I used here fish as short hand for the living resources of the sea.

3. To state what fisheries oceanography should be trying to accomplish
4. To state what progress is needed in other sciences so that the aims set out in 3 above can be attained.

The third term of reference has been treated as fully as I wish to treat it presently under the discussions of the first two terms of reference; my discussion of the fourth term of reference is governed by the concepts so set down and by the obvious fact that fishery oceanography is a part of human activity and as such cannot be considered solely in a vacuum of science. Accordingly I propose to set down here some of the activities humans might take which would improve the ability of fishery oceanography to serve humanity more effectively.

Before doing so I wish to set out the conclusions from Uda's Methodological Paper No.8. FAO World Scientific meeting on the Biology of Tunas and Related Species, La Jolla, California, 2-14 July, 1962.:

"Future lines of tuna research are needed as follows:

- (a) Broad surveys of the circulation, of the distribution of biological, physical, and chemical properties, and of the distribution, composition and abundance of tunas.

- (b) More detailed fishery oceanographic, and experimental studies of some smaller scale features which are important to tuna ecology and reproductive potential.
- (c) Particular studies such as fishery oceanography concerning the effects of thermal domes, islands, banks, temporal variations, monsoon and trade winds.
- (d) Analysis of the year-class strength of tunas in relation to continuously collected data (statistical, biological and oceanographical).
- (e) Ecological and physiological changes to tunas in the course of migration or while on the spawning grounds, nursery grounds, or fishing grounds, in response to the oceanographic fluctuations.
- (f) Development of related instrumentation and methods for the exploitation of new fishing grounds (e.g. underwater observation chamber on the Charles H. Gilbert, specially designed BT, salinometer, current meter, somewhat like the GEK, for tuna fishermen's use, aerial scouting of tuna schools, specially designed fish finder including sonar for tunas, automatically recording buoys and improved communication systems).
- (g) Solution to the problem of damage to tunas by shark and killer-whales.
- (h) Studies of the long-term fluctuations and inter-related mechanisms of oceanic climate and tuna populations.
- (i) Produce improved fishery-oceanographic charts for tuna vessels (if possible, include weather charts).
- (j) Devise effective measures to prevent adverse effects of overfishing.
- (k) Establish reasonable restricted areas and seasons for tuna fishing based on the needs of the fish for spawning and nursery grounds.
- (l) Fishery biological and oceanographical studies to estimate evaluate and conserve tuna populations, in order to secure the maximum sustainable catch.
- (m) Permanent organization for scientific research and a conference (committee) for World Tuna Fisheries."

If the phrase living resources of the sea were substituted in the above conclusions wherever the word tuna occurs this would form a useful base for us to start from. Much of what I say below will simply be a formulation of these objectives in other words. My comments can be made under the following headings.

**A. International planning and joint activities.**

The organization of ocean research at the world-wide level is not adequate or suitable to meet the requirements of fishery oceanography.

(1) at the international level (to use this term as I have used it, restricted to the United Nations family) there requires to be an organization which is ocean directed and within which all of the specialized agencies of the United Nations that have to do with the ocean can bring their varied talents and abilities unitedly to bear upon ocean induced problems. In this should be represented the Office of Oceanography of UNESOC, The Fishery Division of FAO, The World Meteorological Organization, The International Atomic Energy Agency, The Special Fund of the United Nations, the Economic and Social Council of the United Nations EPTA Committee, IMCO, and all other sea-oriented agencies. Perhaps the present sub-committee on Oceanography of the Administrative Committee on Cooperation of ECOSOC is the proper vehicle for this correlation of United Nations activity in this field but it has not yet grown to that stage.

(2) at the world-wide intergovernmental level the placement of the Intergovernmental Oceanographic Commission organically within UNESCO must be viewed as a temporary and unsatisfactory solution to this problem on a long-term basis. The framework of IOC is well suited to handling those aspects of ocean research planning that require to be handled on a world-wide basis but its placement organically within any one of the existing land-oriented specialized agencies where it must play a subordinate position to land oriented thinking will not work in the long run.

(3) at the world-wide scientific level, as differentiated from governmental level, there requires to be an adequate fishery input into general ocean research planning and stimulation. The SCOR apparatus, with its National Committees of Oceanography, is well suited to this purpose but the mechanisms of how this might be done are not easy to think about.

(4) at the national scientific level, there requires to be an adequate fishery oceanography input into National Committees of Oceanography. Since most fishery oceanography is done by government agencies and most National Committees of Oceanography are drawn from the academic community, this poses a problem in many countries.

(5) the organization of regional activity on the intergovernmental level stands much in need of overhauling and some of this appears to be in imminent prospect. For instance, the several intergovernmental fisheries commissions in the North Pacific could stand some coalescing, and the same is true of the North Atlantic. On the experience of the past fifteen years it is suggested that these intergovernmental regional activities require to be kept clear of the United Nations framework so that governments can deal among themselves on strictly regional problems without kibitzing from other governments who are only mildly or not at all interested in those problems, and from international public servants. This leaves aside such regions as the Indian Ocean and south-west

Pacific where governments heretofore have been united to some extent under the aegis of FAO in the Indo-Pacific Fishery Council, and the West African area where the indigenous CCTA/CSA and the not yet viable FAO West African Fishery Commission appear to be aiming at the same objectives.

There is a strong theme running through the correspondence Cushing and I have had to the effect that there should be a vast simplification of ocean research organization and a thinning out of the structure, particularly of committees. This leaves aside the obvious fact that the set of scientists presently studying the ocean are about as independent a group of humans as exists and by and large will not work under dictation of policy from on high, and the other obvious fact that ocean research is growing so rapidly, becoming so large, and is involved in such complex and huge undertakings that it cannot proceed in that absence of government which is anarchy. Another form of governance is the representative form and this involves activity by those governed. If ocean research workers wish to have their activities governed in the way they want, then they require to give intelligent and continuous thought and critical inspiration to the forms of their governance. The responsibility and use of personal time that this envisions cannot be escaped.

#### B. Time-series measurements.

Much of oceanography to date has been done on the steady - state basis for the simple reason that the methods for understanding any other state were not available. But life, the ocean and the air are dynamic and their interrelations cannot be elucidated until the dimension of time is taken into account. Technology and funds are now approaching the level where this can be undertaken on a reasonable basis. This requires continuous monitoring of phenomena, the programming of data analysis by computers, the development and use of networks of moored buoys recording variation in time of various parameters in form to feed directly into computers, and the whole complex framework of acquiring knowledge and understanding of the dynamic nature of the ocean, its living resources, the air, and the dynamic interrelationships among these things. No other trend requires to be emphasized more to aid fishery oceanography.

#### C The Web of life

Energy enters the system from the sun and this is the primary source of energy that results in tuna being in a casserole at dinner or a bloater being on the breakfast dish. How this energy is fixed and how it is transposed from one trophic level to another is understood so poorly that one can only throw up one's hands in despair upon the consideration of it. Yet this understanding must be acquired if man is to conserve the living resources of the seas in the sense of that word as set out in the definition of conservation

in the "Convention on Fishing and the Conservation of the Living Resources of the High Seas."

D. The transport of chemical nutrients in the sea.

The whole business rests on getting the chemical nutrients from the vast reservoir of the deep ocean up into the photic layer so that they can be fixed in useable form by the plants. That this comes about by upwelling, turbulence, the diurnal migration of plankton and nekton etc., all hands know, but the processes by which this is done are not understood in such a way that the action can be usefully predicted. Upwelling is really a term of that large class of words coined to define for conversation purposes a reasonably restricted field of ignorance.

E. Several entities (Bureau of Commercial Fisheries San Diego Laboratory, U.S. Navy Hydrographer, Japanese Hydrographic Office) are currently putting out charts of surface temperatures for various sectors of the world ocean (see Johnson letter). These are not conformable in their present form. The technological means are now available to do this on a world-wide basis, with blow-ups of particular areas of interest, in a regular and relatively cheap fashion. No easily available parameter is so useful to so many persons using the world ocean as is this one. This is particularly true in fishery oceanography.

F. Air-Sea interface

In the correspondence much is said about the importance to all of what transpires at the air-sea interface, but there is not much being done about studying it. The field of work represented by operational studies of air-sea interaction alluded to in the Johnson letter is one particularly crying for attention.

G. Multiple species fishery population dynamic models.

While every predator-prey relationship with which I am acquainted with is a multiple-species matter and thus comprehended in (c) above, the special instance of this created by fisheries working simultaneously on many species (such as the big-ship modern trawlers) is one urgently requiring further theoretical as well as empiric inquiries.

These eight examples have merely been put forward as illustrative of the sort of things which fishery oceanography requires progress in so that the whole discipline can progress as rapidly as this period of history requires it to do. It is not at all intended to be exhaustive.

Once again I must emphasize that the opinions I have expressed above are only personal except as they may be illustrated in the extensive correspondence which follows, and that that correspondence is the expression of strictly personal opinion by the writer except where the contrary is specifically stated. The remaining caveat is that these thoughts are set down for the purpose of stimulating thought and criticism and not as a statement of comprehensive consideration.

Sincerely yours,

W. M. Chapman, Director

ANNEX V

RESOLUTIONS ADOPTED BY THE COMMISSION AT ITS FIRST SESSION

RESOLUTION I

RELATIONSHIP BETWEEN THE INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION  
AND OTHER ORGANIZATIONS

The Commission

Recalling that the Statutes of the Commission prescribe that the purpose of the Commission shall be to promote scientific investigation with a view to learning more about the nature and resources of the oceans, through the concerted action of its members,

Bearing in mind the very wide scope of oceanography and the many important fields in which scientific investigation of the nature and of the nature and of the resources of the oceans is pursued, in particular those concerned with fisheries of the world.

Bearing in mind further the interest and valuable work of many organizations, intergovernmental and non-governmental, world-wide and regional, in oceanography or directly related fields and that these organizations could contribute to the development and implementation of a well co-ordinated and integrated international programme in oceanography.

Noting that the Economic and Social Council, and its thirty-second session, expressed the hope that the Commission would take fully into account the activities and interests of all organizations concerned with oceanography.

Appreciating that oceanography and fishery research are complementary undertakings and that the Food and Agriculture Organization of the United Nations has the primary responsibility within the United Nations family for fisheries.

Appreciating further that the Food and Agriculture Organization plans to consider at its forthcoming conference the establishment of an Advisory Committee on Marine Resources Research,

Aware that the Special Committee on Oceanic Research of the International Council of Scientific Unions is now serving Unesco as an advisory body on oceanography and has, since its inception in 1957, contributed greatly towards the development of international co-operation in oceanic research.

**Aware also** that the Special Committee on Oceanic Research is in process of establishing a working group of experts in fisheries and oceanographic science:

1. Invites the United Nations and its Specialized Agencies and other intergovernmental and nongovernmental organizations concerned with oceanography in its various disciplines, to co-operate with the Commission to the fullest possible extent;
2. Expresses the hope that the Food and Agriculture Organization, the World Meteorological Organization and other interested agencies of the United Nations family will find it possible to designate members of their Secretariats to co-operate actively with the Secretariat of the Commission, the extent of such co-operation to be decided by agreement between these organizations and Unesco.
3. Requests the Members to submit to the Secretary of the Commission

Resolution I )cont'd)

their views on the establishment of advisory channels to the Commission in all fields of oceanography, including fisheries oceanography, for consideration by the Commission at its second session;

4. Requests the Bureau and the Secretary of the Commission, in the interim, to seek and receive the advice of those organizations which now advise Unesco on oceanographic matters and other intergovernmental and non-governmental organizations of a world-wide or regional nature, which could contribute to the development of international programme in oceanography.

5. Requests the Secretary of the Commission to submit to members, at least three months before the second session of the Commission, a draft report on the matters raised in 3 and 4 above.

\* \* \* \* \*

CONSEIL INTERNATIONAL DES UNIONS SCIENTIFIQUES - INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS. .Special Committee on Oceanic Research

Dear Dr. Chapman:

SCOR WORKING GROUP ON FISHERIES OCEANOGRAPHY

Early this year, SCOR received suggestions for the formation of two new working groups, namely -

"Location and Investigation of New Fisheries Resources" and  
"Oceanographic Estimation of the Size and Distribution of  
Oceanic Living Resources."

These suggestions are symptomatic of the increasing attention being given to the interaction between the fisheries and oceanographical fields of research. This attention has been evident at the many intergovernmental oceanographic meetings held in 1960-61, and particularly at the recent meeting of the Intergovernmental Oceanographic Commission.

SCOR has discussed these proposals for working groups over the past few months and decided at its recent meeting in Monaco to establish a working group on "Fisheries Oceanography" with the following terms of reference:-

1. To discuss and define the subject of fisheries oceanography
2. To state what fisheries oceanography has accomplished
3. To state what fisheries oceanography should be trying to accomplish.
4. To state what progress is needed in other sciences so that the aims set out in 3 can be attained.
5. To communicate the statements listed above, through SCOR, to interested laboratories and organizations

Additional items could be added by agreement with the Chairman, but there should be no overlap with the functions of bodies such as FAO, ICES, etc.

SCOR chose the above terms of reference because its members had noted that during the discussions at the meetings previously mentioned, there was much confusion concerning the nature, accomplishments, and aims of fisheries oceanography. On the one hand the term was

Humphrey letter (con'd)

used to include all of fisheries science, on the other to denote a restricted use of a small part of physical oceanography.

SCOR felt that before any attack could be made on the problems envisaged in the original working group suggestions, it was necessary to examine some of the basic considerations involved.

SCOR felt that it could make a contribution by bringing together a small group of workers in diverse fields so that the different viewpoints could be recorded, discussed, exemplified, and put together for the benefit of intergovernmental bodies, laboratories, and individual workers. Such action would assist further work by SCOR and other bodies.

On behalf of SCOR I ask you to take part in this project which will extend over a year and involve correspondence, attendance at a meeting (probably in Europe), and much thought. Your expenses would be paid by SCOR. Others who have been approached are:

Dr. Cushing, Lowestoft Fisheries Laboratory, U.K.  
Dr. Bjercknes, Department of Meteorology, University of California  
Dr. Davies, Oceanographic Institute, South Africa  
Dr. Popovici, Special Fund Project, South America  
Dr. Rass, Institute of Oceanology, Moscow  
Dr. Rollefson, Bergen Fisheries Laboratory, Norway  
Dr. Uda, Tokyo University, Japan

It is intended to ask relevant international bodies to nominate people to participate in the correspondence and the meeting.

I hope that you will find the thought of this work interesting and stimulating and that you will tell me that you are willing to participate. Yours sincerely, G.F.Humphrey, President of SCOR

\* \* \* \* \*

From D. B. Finn - copy sent to Dr. Chapman

Dear Dr. Humphrey:

Thank you for your letter of January 8, 1962 informing me of the last action taken by SCOR to establish a working group on fishery oceanography and of the final terms of reference approved.

It is unnecessary to tell you how interested we are in the matters under consideration, upon which my Division has expressed on many occasions the point of view of this organization. We will be very grateful if you can make the necessary arrangements to keep us informed of the activities of the group and, if already decided, the exact date and place where you plan to hold the preliminary discussions and the meeting. I have designated Dr. M. Ruivo as Liaison Officer for your working group, and I hope it will prove possible for him to attend its meeting and take part in its work.

We hope also that the book on "Fisheries Hydrography," of which Dr. Laevastu is one of the co-authors, now in the press, will be available in time for the meeting, because I believe it can offer a useful starting point and a very abundant documentation for the discussion of the points included under the terms of reference of your group. The approach of Dr. Laevastu to the problem reflects the point of view that has guided FAO Fisheries Biology Branch's action in the field of oceanography and its relation to fisheries research.

Dr. Finn letter (cont'd)

You were kind enough to ask for my comments on your project, and I would like to say that we believe it would be useful to discuss points two and three in the terms of reference of your Working Group in relation to the need to promote fisheries research in areas where little has been done hitherto. Thus we should be happy if the Group paid some attention to the problems of priorities in assigning funds, especially in developing countries, to fisheries oceanography, as distinct from other aspects of research on fisheries resources, such as study of the dynamics and behaviour and ecology of fish stocks. We would also be interested in the views of the Group on the context in which fisheries oceanographic studies are, in a variety of circumstances, to be carried out, and specifically whether a "fisheries oceanographer" is best regarded as a specialized member of a general "marine sciences" or "oceanographic" research unit, or (as we believe to be right) as a member of a fisheries research team which certainly would include biologists working on fish populations and behaviour, and also, probably, scientists of a variety of disciplines, concerned with the behaviour of fishing gear, operation analyses of fishing activities, and certain economic aspects of fisheries development and improvement problems.

I take this opportunity to inform you that the Director-General of the FAO has already taken the necessary action towards the formation of the Panel of the Advisory Committee of Marine Resources Investigations, approved by the 11th FAO Conference, and we expect that the first meeting of this Committee will take place in the first half of this year. Yours sincerely, D.B.Finn, Director Fisheries Division.

\* \* \* \*

INSTITUT DES PECHES MARITIMES DU MAROC, Casablanca 14 Juillet 1962  
Durban natal, South Africa

Cher Dr. Davies,

Je vous remercie de votre lettre du 4 Avril 1962 que j'ai rescue seulement la 9 Juillet.

Peut'etre est-il encore tempe de repondre a vos questions concernant l'océanographie halieutique("fisheries océanography")?

Je pense que le problems s'est posé tout naturellement en Afrique où les Gouvernements des pays nouvellement indépendants ont placé une grande confiance(on serait tenté de dire une foi aveugle) dans la recherche océanographique pour améliorer et développer l'industrie des peches. Il importe de ne pas les decouvrir, Mais je veux souligner, en passant, que l'océanographie n'est pas seule en cause; une fois que la poisson est débarqué il faut le conduire au consommateur sous-alimenté, sous une forme ou sous une autre, et il faut que celui-ci le mange. Dans ce domaine les résultats sont parfois paradoxaux et décevants.

J'aperçois une deuxième cause au développement de l'Océanographie halieutique, mineure mais il faut la mentionner: le désir d'obtenir plus facilement des crédits en faisant état d'application pratique. Un certain nombre d'organisations intitulées primitivement, par exemple,

F. Varlet letter (cont'd)

"Centre d'Océanographie" sont devenues au cours des dernières années:  
"Centre d'Océanographie et des peches."

En Cote d'Ivoire, pays que je connais bien, on a adopté un point de vue très fragmatique, en regroupant cote à cote, les laboratoires d'Océanographie physique et biologique d'une part, le service des peches maritimes d'autre part. Du point de vue administratif chacun est autonome, mais au stade des réalisations et des programmes, le travail est souvent commun. Les relations personnelles des chercheurs sont évidemment très facilitées par ce voisinage, et je considère qu'au cours des dernières-années le syst'eme a fait ses preuves.

Au Maroc, le problème s'est posé différemment, Il existe un "Institut des Peches Maritimes" qui a été créé sans au'on se soit rendu peut-être compte qu'il devrait s'appuyer sur une infrastructure scientifique complète. Actuellement notre problème est de développer cette infrastructure scientifique. C'est donc l'inverse de ce qui se passe généralement. Il faut aussi signaler que le développement de la peche marocains, trop acée jusqu'ici sur la sardine, dépend très largement de problèmes d'ordre économique, social, voire politique devant lesquels ;'oceanographe est désarmé.

Quant au bénéfice, sur un plan tout à fait général, que l'industrie des peches peut attendre du travail des océanographes, j'ai toujours pensé que LE CREN voyait juste quand il écrivait pour la peche en eau douce d'ailleurs: "Il y a loin de la découverte scientifique à d'accroissement du produit des peches; néanmoins, c'est en nous apportant quelques clartée sur les phénomènes naturels qui la science peut, à long terme, contribuer le plus au développement des peches.

Je vous prie de croire, cher Docteur DAVIES, à mes sentiments les meilleurs. Merci d'avoir pensé à me tenir au courant des activités de "Working group on Fisheries Oceanography".

F. Varlet.

REPORT FROM PROFESSOR UDA

A. Compiled report of replies for the inquiry on Fisheries  
Oceanography (20 replies from 100 inquiries)  
in Japan

- (1) Definition and Subject of Fisheries Oceanography
  - (i) Studies of oceanic processes affecting the abundance and availability of commercial fishes. Oceanography for fisheries use, mainly for the distribution and size of populations in relation to oceanic conditions. Interrelationship of the physical, chemical environment and marine life, especially biological behavior in relation to oceanic conditions.
  - (ii) Distribution, character and abundance of fishes or commercial marine life in relation to oceanic relation to oceanographic conditions. Interrelationship of the ecology, distribution of planktonic food organisms and hydrographic conditions.
  - (iii) Applied, practical science of the seas and oceans including the fields of fisheries and biology (e.g. migration, distribution and population size in response to oceanographic structure and its fluctuation). Oceanographic researches to stabilize and regulate fisheries production, especially on the factors controlling fisheries fluctuation and the formation of fishing grounds.
- (2) Accomplishments  
Mainly the contribution in the past is analytical, physical but few synoptic. New approaches could be expected - through contributions from other fields of industries in more advanced situation or in other way through self-producing contribution of fisheries oceanography.  
A lot of works on the distribution of fish-shoals, factors concerning the formation of fishing grounds such as "Siome" were presented in the past.
- (3) What should be trying to accomplish?
  - (i) Ecology and population fluctuation related to fisheries oceanographic conditions.
  - (ii) Environmental mechanism on the survival rate at early stage of coherent marine life.

- (iii) Fisheries oceanography to find unexploited resources
- (iv) Basic oceanographic researches to predict the oceanic processes related to changing population and fisheries.
- (v) Close association between the fisheries and oceanography, testing the proposed hypothesis from fisheries people by well planned oceanic surveys.
- (vi) Mechanisms concerning the effects of environments on the distribution, and abundance of fishes, with its fluctuation, prediction and control, esp. environmental norm on the changing recruitments.
- (vii) Studies of biological balance concerning marine production including plankton, fishes, whales etc. and their control as a whole.
- (viii) Microoceanographic, automatic observation at the fixed stations (including buoy station).
- (ix) Kinematical studies of migration, concentration of fishes
- (x) Development of instrumentation and (model) experiments for all concerned fisheries oceanography.

4. Progress needed in other sciences.

- (i) Ecology and physiology of marine fishes.
- (ii) Development of electronic instrumentation.
- (iii) Estimation of fish abundance by means of echo-trace.
- (iv) Automatic telemetering instruments.
- (v) Microbiological metabolism in the sea.
- (vi) Basic physical researches such as oceanographic fine structure, turbulence etc. in the actual seas and oceans.
- (vii) New designs and improvement of sampling devices, biological observation device and recorders.
- (viii) Development of new device for fish detector in the hitherto uncatchable, unexplored resources
- (ix) Well-equipped research vessels for fisheries oceanography.
- (x) Any other request from fisheries people.

\* \* \* \* \*

**Inquiry Reply B** Some of S.E. Asia Area

(I have got replies from following gentlemen, which need their permission to be in public of each original letter)

Reply from Phillippine, Taiwan and Korea . . . 6 letters still no reply from Indonesia, Thailand and Vietnam

Phillippine . . . Dr. Deogracias V. Villadolid, with the Assistance of MR. I. R. Ronquillo (Bureau of Commercial Fisheries) Dean and Vice-President, Araneta Univ, Rizal, Phillippine

Phillipine . . . . Professor Teodoro G. Megia, Head, Univ. of the  
 Philippines, College of the Fisheries, Port Area, Manila  
 Taiwan . . . . . Professor Chu Tsu-You, Dept. of Zoology,  
 National Taiwan University, Taipei  
 Korea . . . . . Mr. Bong Nai Lee, Central Fisheries Experimental  
 Station, Pusan, Korea  
 . . . . . Mr. Yang Jae Mok, President, Pusan Fisheries  
 Korea

(1) Definition

- (i) The specialized study of the various oceanic conditions which have direct bearing on increasing the efficiency of various fishing gears in particular fisheries thereby leading to an increase in fish landing, and at the same time, determining the limits to which the exploitation of fishery resources may be undertaken without destroying the breeding stock.
- (ii) The study of the marine environment - its physics, chemistry and biology - in relation to fishes and allied marine plants and animals.
- (iii) Oceanography in relation to fisheries. It deals with the oceans (or seas) as the environment of Marine Biological Resources, esp. local conditions in particular areas such as in estuarine, coastal and shallow waters and the upper layer of the oceans.
- (iv) A field of ecology, particularly deals with ecological study of an "eco/system" which would be formed on fishing ground.
- (v) Oceanography needed for cultivation or exploitation of fisheries resources, a science for the environment on the fluctuation in abundance and availability of organisms of commercial importance in terms of changes in their physical and chemical environments.

(2) Accomplishments

- (i) Fisheries oceanographical researches in Japan geared to increase the exploitation of fisheries resources, data collected by ICES in the past 60 years correlated fishing conditions in the North Sea, USA investigations correlated all their activities to explore the tuna fishery in the Hawaiian areas and menhaden at the Atlantic Ocean.
- (ii) Doing oceanographic research on a number of commercial species at certain fishing grounds.
- (iii) . . . . .
- (iv) . . . . .
- (v) It has become current tendency to pay more attention and even begin to try after the instruction of Fisheries Experiment Station or other similar institutions.

(3). Main subjects

- (i) (a) The study of plankton
- (b) Underwater detection of deep swimming fishes
- (c) Localities where there is mixing of oceanic waters in association with fish concentration
- (d) Relationship of primary productivity, fish productivity and oceanic conditions.
- (e) Oceanic conditions surrounding islands to determine relationship of upwelling and fisheries conditions.
- (f) A definite prolonged current caused by the prevailing wind correlated with fisheries.
- (g) Fisheries meteorology
- (ii) Survey plans; sampling principles and techniques, and analysis; and processing and interpretation of data collected.
- (iii) (a) Configuration of the oceans (depth, topography and nature of bottom)
- (b) Physical and chemical properties of sea water (distribution and variation of T.S.etc)
- (c) Movement of seawater (transport, mixing, wave, tides)
- (iv) Characteristic of Fishing grounds by oceanic conditions
  - (a) Where and when will make fish school
  - (b) Aggregation and dispersal of fish related.
  - (c) Fish behaviour to various artificial stimuli
  - (d) Marine meteorology related to fishing aspect and formation of fishing ground.
  - (e) Marine biology.
- (v) Oceanography applied to fishing industry to be developed so as to back up the industry
- (4) What should be trying to accomplish?
  - (i) . . . . .
  - (ii) Training of manpower to collect data basic to the prediction of the success or failure of our major fisheries.
  - (iii) (a) To make clear about how all the factors affect the production, distribution, migration and variation of the fauna and flora in the sea.
  - (b) To forecast the sea conditions for the use of the fisheries.
  - (iv) As a field of marine science, associated with fisheries biology.
  - (v) A larger scale international cooperative investigation or observation to gain mutual helps in getting clear and prompt discoveries of factors that are essential for the fishing industry,
- (5) What progress is needed in other sciences?
  - (i) . . . . .

- (ii) Weather forecasting and extraction of chemicals from our seas of industrial importance. Also pollution studies on river effluents draining into important bays and gulfs rich in fisheries.
- (iii) Marine ecology in biology
  - (a) Methods of measurements and analysis in Physical and Chemical Oceanography.
  - (b) Weather forecasting in meteorology.
- (iv) (a) The principal factor controlling the quantity of primary production.
  - (b) The method of population dynamics
  - (c) The convection as a stirring mechanism in the coastal waters.
  - (d) Deep sea current.
  - (e) Heat budget on the ocean.
- (v) In the study of ocean, those subjects such as physics, Chemistry, biology and geology are the essentials but a coordinative study on the results of the above subjects will be even more important.

\* \* \* \* \*

Oceanographic Research Institute, Centenary Aquarium Bldg. 2 West St.  
Durban, Natal, South Africa

12th February, 1962

Dear Wib:

This is really to record my own first thoughts on the terms of reference as outlined in Dr. Humphrey's letter of 23rd November, 1961. I may add that I have had the benefit of reading Dr. Cushing's letter of 7th February, 1962.

1. Definition of Fisheries Oceanography.

Fisheries oceanography is nothing but a blanket term like oceanography itself and may include any of the disciplines which are needed by fisheries workers to enable them to investigate their problems, for example the biological or environmental aspects of fish populations.

Work on the fish themselves would fall under the general heading of biological oceanography whereas work on their environment could include physical and chemical oceanography and meteorology.

So that any attempt to limit the definition of fisheries oceanography would in my opinion defeat the object of this exercise. Why not agree to define fisheries oceanography as including all the oceanographic disciplines, each one of which is used whenever required?

2. What Fisheries Oceanography has accomplished.

This is difficult. Whatever its accomplishments are it has had to work for them but the way things are going in oceanography it looks as though a lot more can be expected in relation to the effort put in, in the future.

3. What Fisheries Oceanography should be trying to accomplish.

Here I agree with Cushing that fisheries workers are the best judges of their requirements in relation to the physical, chemical, biological, and meteorological background to their problems. At the same time, however, it is necessary for there to be at all times an integrated effort on the part of fisheries workers and workers in other disciplines in oceanography. There should be no "class consciousness" - a fisheries oceanographer is quite as good as a physical oceanographer or any other oceanographer although there are times when fisheries oceanographers are relegated to an inferior position for reasons unknown.

4. What progress is needed in other sciences.

Oceanographic instrumentation, engineering, techniques, and oceanographic science in general, in order that the disciplines of oceanography can be advanced. A better understanding of fisheries problems would then follow.

I have written on these lines at this stage in the hope that it will be of some assistance to you and to provide something for the other members of the working group to criticize.

Yours sincerely, David H. Davies, Director

April 4, 1962

Dear Wib:

On my return from attending oceanography meetings in Capetown, I found that your general letter on fisheries oceanography had arrived. I am sorry that this letter did not reach you by March 1st.

As requested, I have sent copies of your letter with a covering letter of my own to eighteen different laboratories in Africa. I hope that there will be a good response.

I wonder how good the response has been to all the letters that have been sent out? As long as you are able to deal with them, they should provide valuable material, particularly as the opinions of many will be included who are actually doing the work as well as the ideas of those who direct it.

What follows is really a brief commentary on your general letter beginning with page 4.

I agree that the NASCO definition of oceanography is straightforward and satisfactory. If this definition could be extended by the addition of the word "scientific" viz, "the scientific study of the ocean, its boundaries and its contents" then we could dispense with the term fisheries "scientist" referred to on page 6 and use the term fisheries oceanographer in its place.

I consider the term "fisheries" to be preferable to "fishery" since the latter sounds too restrictive to me.

On page 4, paragraph 3, you state that the term oceanographer when used alone describes a person who studies natural processes - I agree, I feel that as there is likely to be more and more interference by man with natural processes in the ocean, we should accept that oceanography, including fisheries oceanography, should include natural processes and processes that have been interfered with by man.

I think that a blood biochemist working exclusively on the racial groupings of fish and the mathematician involved in model studies related to fisheries problems should call themselves fisheries oceanographers. The man who spends a part of his time working on population dynamics and another part on devising regulations, is, in my opinion, a part-time fisheries oceanographer. I don't believe that the drawing up or the enforcement of fisheries laws and regulations can be included under the heading of fisheries oceanography in spite of the fact that these activities may be completely dependent on each other.

Page 6, Item I - your first group defines very clearly what fisheries oceanography should not be viz. a sort of convenient cover for the manipulation of regulations to suit interested parties.

Group 2 describes the deplorable lack of harmony and respect which has developed between oceanographers and fisheries oceanographers. This has to be broken down completely in order for there to be an easy integration of effort between any or all the disciplines in oceanography which is necessary if reasonable progress is to be made.

Group 3 - I fully agree that this is the right approach to oceanography whether it be fisheries or any other.

Page 9, para.1. - I share your doubts to some extent as to whether there is a field of scientific inquiry finite enough to be called fisheries oceanography and agree that there is enormous breadth to this field of investigation but if an investigation can reasonably be linked with fisheries research why not call it fisheries oceanography?

I don't believe that one can go much beyond listing the accomplishments of fisheries oceanography in an abstract manner - the fact that there are populations of edible organisms in the ocean which man has been able to exploit is the reason for the existence of fisheries oceanography, and investigations in this field have stimulated or assisted a great deal of development in other fields of oceanography.

Page 9, para.2 - I think it would be wrong at this stage to sub-divide our consideration of fisheries oceanography to relation to pelagic, demersal, estuarine, etc. Let us rather confine ourselves to the broader treatment of the subject.

Page 9, para.5 - The possibilities of fisheries oceanography being able to alleviate the protein shortage in the diet of the vast numbers of people inhabiting tropical and sub-tropical regions are doubtless very great indeed. Certain of the agencies that provide funds for research may not readily support projects concerned with fisheries research but once they are related to the mitigation of human suffering due to dietary insufficiency there should be far greater scope for obtaining support.

I sincerely hope that these rather uncoordinated reactions will be of some use. With best wishes, Yours sincerely, David H. Davies  
14th May, 1962

Dear Wib:

Thank you for your letter of 23rd April, 1962 and the copy of your letter to Dr. Cushing both of which I received on my return from attending a regional meeting of S.C.O.R.-I.I.O.E. in Lourenco Marques.

I am glad to hear that you have had such a good response from marine science workers in the U.S.A. and Canada. The response from Africa in general has not been quite so good, 7 out of a total of 18 so far but replies are still coming in.

I am enclosing photostat copies of all replies received to date and since I have made the reason for seeking their opinions quite clear, there should be no objection to your using any material you may require for circulation among the members of the working group with names attached.

I have not mailed copies of this letter or the attached replies to other members of the working group and have added Dr. Ruivo's name to the mailing list. With best wishes,  
Your sincerely, David H. Davies, Director

\* \* \* \* \*

Replies received by Dr. Davies

DIVISION OF FISHERIES DEPARTMENT OF COMMERCE AND INDUSTRIES  
SEE-/SEA Directeur Van Visserye, Director of Fisheries  
Kusweg, Seepunt, Beach Road, Sea Point, Kaapstad/Cape Town 15/62  
Dear Dave:

SCOR WORKING GROUP ON FISHERIES OCEANOGRAPHY.

Further to our recent discussion in Lourenco Marques, I have some brief comment to offer in response to your letter of April 4.

Referring to Wib Chapman's exposition, I have no hesitation in stating my adherence to the "small and recent group" mentioned in para no.3, page 2 of the enclosure to your letter.

I do not propose to define "fisheries oceanography". As a fishery scientist I prefer to think in terms of applied oceanography and I consider progress in the basic disciplines of oceanography, particularly physical, chemical and biological, as a sine qua non for progress in fishery science.

Regarding the achievements of applied (or fisheries) oceanographers in South Africa, I believe we can claim to have shed some light on several problems connected with the distribution, abundance and availability of various species of marine fauna exploited by our fishing industry whose exports were valued at R40,000,000 last year. The latter figure speaks for itself and obviously demands an increased effort on the part of applied oceanographers.

It stands to reason, therefore, that oceanographic research, whether carried out by my institute or another, will continue to receive my active support, especially when such research may be reasonably expected to lead to results of significant value in relation to important fisheries problems.

I hope these few remarks will be of assistance to you. Kind regards,  
Yours sincerely, /s/Dup, Director of Sea Fisheries. . . .  
Duplessis...

Letters received by Dr. Davies Cont'd

SUIDWES-AFRIKA / SOUTH WEST AFRICA - Kantoor Van Die Office of the  
Fisheries Officer, Walvis Bay, 30 April, 1962

Dear Dave:

I am sorry that I could not give you an earlier answer on your letter of the 4th April, 1962, but I have had one of my spells of running around and, apart from Easter, wasn't home for quite a while. In any case, I will try and help with a few thoughts that might help, or might not, in your later assessment.

I feel that we must first of all understand that we have the science of Fisheries Oceanography but that there are no fisheries oceanographers. The name "Fisheries Oceanography" already explains what is expected and what should be done in this science. On the one hand we have the science of the fish and on the other hand the science of the oceans. These two must be studied individually, brought together and the influence of the one on the other must be examined. In other words, fisheries oceanography is not, or should not be, the science of a person, a fisheries oceanographer, but is really the science of a few people working together. On the one hand we must have the biologists who must obtain the information on life history, predators on and competitors of this species, the recruitment and mortality of this species etc.

Apart from the biologist we need chemists, meteorologists and physicists to study the physical and chemical properties of the ocean and the changes in the atmosphere as well as statisticians to assist with the analysis of all this data in relation to the biological data collected and so get an idea of the environmental conditions and their interaction on fish.

Fishery science cannot be described as the science of a person but of a group of persons all working towards one goal, that being a better understanding of the fish and its surroundings. These scientists must never give economy a thought. They should be there only to advise and the cost-per-effort type of information should be excluded from their activities. The utilization, in other words, should be left to other groups, perhaps economists in the employ of the same organisation or in the employ of industry.

It is easy for any ambitious administrator or director of a research institute to overreach himself and wander too far from the path of pure fisheries oceanography. If he keeps to the basic precepts of fisheries research he cannot go far wrong. Whether he is interested in pelagic or demersal fishes, the problems must remain the same if he divorces himself from the economics (apart from the economics of the research itself). He will always want to know how much fish there are, where they are, their movements, spawning and rate of growth, environmental conditions and all the other basic precepts of knowledge required before an institute can serve its Government or Board in the advisory capacity it was formed for originally.

I think that there is a danger that fisheries oceanography can easily become theoretical research with no direct value to

Fisheries, in other words, it can become too much oceanography and its value to fisheries might be very small. You will have to pardon me if I think that this, at the moment, might be happening with the Indian Ocean Research Programme. A lot of countries will do a lot of work, they will collect a lot of information but I doubt whether they will know a lot more about fish when they are finished. Of what value, therefore, working this terrific programme if the individual countries do not know any more of their particular problems than before the start of the programme. At the end of the programme, a lot of information would have been gathered about the Indian Ocean but is this knowledge of the ocean as a whole of such importance, I know that I am sticking my neck out but I feel that too much importance is given to the broader aspects instead of concentrating on the actual problems. I am not convinced that a knowledge of the ocean instead of a knowledge of a particular area is of such value to the fishery scientist. We do need to know the environmental factors of a particular area and factors that might influence conditions in this area, but whether we need to know again the conditions that might influence this area and further again ad infinitum, I very much doubt.

I feel, in other words, that fisheries oceanography should be directed to obtain as much information as possible on the specific fish species and the immediate environmental conditions, but should beware of purely theoretical exercises as well as economical influences directed from the Government or Board controlling the Research organization or from Industry who might or might not profit from results.

Whether you can use any of the thoughts that I put down here in relation to any of the terms of reference, I do not know. I feel that it is always very difficult to compartment thoughts into different categories. With kind regards. Johnny

\* \* \* \* \*

FEDERAL FISHERIES SERVICE, VICTORIA BEACH, Private Mail Bag 2529.  
Lagos, Nigeria

24th April, 1962

Dear Davies:

I answer your questions as to my views on the scope of fisheries oceanography and its relationship with the remainder of fisheries science frankly as a fisheries biologist accustomed to working in underdeveloped areas in the tropics where the fisheries are primitive and small and if mechanised at all are in a very early stage in their development; here, much more of our work is exploratory than would be the case elsewhere and we are trying to rationalise dimly observed biological phenomena in an environment of which we lack virtually all knowledge.

Here, we have no oceanographers and must perforce become our own. We cannot ignore the physical environment in which our fisheries occur, nor can we rely on outside assistance to give us adequate information on it - international or national oceanographic expeditions from sea-faring countries may work off our shores, but provide us with no more than non-seasonal basic oceanic structure.



reference No. 3 of Dr. Chapman's circular letter.

Fishery science has a definite aim and its connections with many branches of oceanography are sometimes very remote.

Fishery science is interested in biotopes and biomasses in relation to human industry and one cannot help feeling that much of the progress to date has been achieved by biologists; a more immediate contribution from physical oceanographers would be most desirable. Yours sincerely, J. deB. Baissac

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CENTRE D'OCEANOGRAPHIE ET PECHEES DE NOSY-BE

12 Avril 1962

Cher Docteur David H. Davies,

A la réunion du "SCOR Working Group on Fisheries Oceanography" à Monaco en Novembre 1961, Ms Humphrey et Chapman ont, seion votre lettre, montré l'ambiguïté du terme "Fisheries Oceanography", dont aucune définition n'est complète ni ne satisfait les différents membres de la grande famille océanographique.

J'ajouterai à ces remarques que le terme général d'océanographie a un sens différent en anglais et en français. En anglais, le sens propre de "Oceanography" paraît bien être l'étude hydrologique des masses d'eau et de leurs surfaces de contact supérieure et inférieure avec des milieux différents. En français, l'océanographie comprend toute étude scientifique qui touche à la mer et se divise en "océanographie physique" (qui correspond à "Oceanography" tel qu'il vient d'être défini) et "océanographie biologique" (qui groupe ce qu'on peut appeler "marine biology").

Que devient alors l'expression "Fisheries Oceanography"? Elle se traduit par "océanographie appliquée aux pêches" et, malheureusement; tellement imprécise d'ailleurs et prêtant à confusion que, chez marine Outre-Mer ont été appelés "Centre d'Océanographie et des Pêches", tel Nosy Bé par exemple. Car, et je crois que ceci est un concept encore très général, qui parle d'Océanographie songe à un type de recherche fondamentale (ou encore de base) et qui parle de "Fisheries Oceanography" songe au contraire à un type de recherche appliquée. Toute l'ambiguïté des termes repose sur cette distinction datant du début du siècle où la recherche fondamentale et la qui ne se recontraient pour ainsi dire jamais.

Nous savons maintenant que cette distinction est artificielle et l'on parle plus volontiers d'application de la recherche que de recherche appliquée. A mon avis, il n'y a pas de véritable "Fisheries Oceanography". Il y a une océanographie, au sens français du mot, qui est l'oeuvre des scientifiques océanographes, et, à côté, il y a l'application pratique des résultats scientifiques, opération conduite par les techniciens de la pêche. Mais il est faux de vouloir donner davantage d'importance à tel ou tel domaine de l'océanographie: l'hydrologie, la productivité marine, le plancton végétal ou animal, les stades larvaires, la biologie des espèces pélagiques ou benthiques sont tous des éléments aussi essentiels, ni plus ni moins, pour la connaissance des océans et, par voie de conséquence, pour l'exploitation par l'homme des richesses marines. Dès le moment où un scientifique se penche sur un problème maritime,

qu'il soit purement théorique ou au contraire orienté vers la solution d'un cet instant donc il participe à la meilleure utilisation par l'homme des ressources maritimes puisque celle-ci est fonction en premier lieu d'une meilleure prise de conscience des phénomènes et des interactions au sein du milieu aquatique.

C'est pourquoi, tout centre de recherches marines doit comporter un certain nombre de thèmes de travail essentiels. L'absence de l'un d'entre eux suffit à détériorer l'organisation rationnelle d'un programme de recherche; au lieu d'un travail d'équipe conduisant nécessairement à la compréhension de la masse océanique étudiée et à son exploitation judicieuse, on aboutirait à un ensemble anarchique de connaissances aptes à satisfaire le responsable d'un musée ou le rédacteur d'un dictionnaire mais totalement inapte à réaliser la nécessaire synthèse harmonieuse réclamée par les futurs exploitants du réservoir de nourriture qu'est la mer.

Cette nécessité des thèmes de recherche dans l'ordre de la chaîne vivante: hydrologie, productivité, et phytoplancton, zooplancton, stades larvaires, systémique et biologie des espèces animales et végétales) est encore plus évidente pour les organisations scientifiques qui travaillent à partir du pays où la pêche en est restée au stade archaïque de la tradition ancestrale que pour les pays surdéveloppés. En effet, le développement de la pêche dans les premiers pays ne peut reposer que sur l'étude scientifique de la mer sans qu'il soit possible de profiter des données léguées par les expériences effectuées à titre privé par des compagnies de pêche, pas de bateau capable d'affronter la haute mer, donc pas d'essais de pêche susceptibles de se pratiquer sur un rythme industriel, pas de connaissances sur le milieu marin en général; dans ces conditions, un éventuel Centre d'Océanographie commence vraiment dans l'inconnu et se doit souvent pour survivre d'apporter aux gouvernements locaux quelques résultats exploitables sur le plan pratique au bout de quelques 3 à 4 années de recherche seulement. Tendre vers ce but, pour les responsables scientifiques, n'est possible qu'avec la constitution et le fonctionnement d'une équipe d'océanographes travaillant en complète coopération sur les thèmes exposés ci-dessus.

Et c'est enfin à partir des résultats qu'ils obtiennent que peuvent se pratiquer des pêches expérimentales dans le but de que leurs recherches en apparence théoriques mènent à d'incontestables résultats pratiques.

Ainsi apparaît le rôle considérable des institutions océanographiques dans les pays d'Amérique latine, du Sud Est asiatique et, surtout, d'Afrique et de Madagascar. Non seulement celles-ci effectuent des recherches générales purement océanographiques, mais encore elles entreprennent des expériences pratiques de pêche en faisant appel, non plus à des océanographes, mais à des techniciens de la pêche se servant des résultats des précédents. C'est dans cette optique, et seulement dans celle-ci, que doivent être programmées les recherches des centres d'Afrique et de Madagascar.

With my very best regards. Truly yours, M. Angot

Dear David:

I received your letter re Fisheries Oceanography. I cannot make any comments as I have not had much connection with Fisheries Oceanography until recently. I was not aware that Fisheries Oceanography was looked down upon by other oceanographers as their institutes in England and Scotland, the ones at Lowestoft and Aberdeen, enjoy a high reputation.

The only place where I could comment is on the interaction between the sea and the atmosphere. The statement is rather vague about this and how investigation in this field would benefit the fishing industry . . . Yours sincerely . . . J. Darbyshire . . . Professor of Oceanography.

\* \* \* \* \*

OCEANOGRAPHIC RESEARCH INSTITUTE, Centenary Aquarium Building,  
2 W. Street, Durban, Natal, South Africa

### WHAT FISHERIES OCEANOGRAPHY HAS ACCOMPLISHED

#### IN SOUTH AFRICA

##### Definition of Area

For purposes of this brief memorandum, South Africa is defined as the Republic of South Africa and South West Africa (see map). The major fisheries of Africa are presently located in this area, and it is considered that fisheries oceanography has accomplished more in South Africa than in any other area of the African continent.

##### Principal Fisheries

The principal fisheries of South Africa are listed as follows together with the landings for 1961 in short tons:

1. The Pilchard or Sardine (Sardinops ocellata) Fishery - 821,531 tons
2. The Marsbanker or Horse Mackerel (Trachurus trachurus) Fishery - 43,937 tons
3. The Bottom Trawl Fisher, mainly Hake (Merluccius capensis) 123,723 tons
4. The Rock Lobster (Jasus lalandii) Fishery - 10,000 tons
5. The Line fish various, including Snoek (Thyrsites atun) Fishery estimated catch 40,000 tons
6. The Tuna Fishery - 500 tons.

With total landings of over one million tons per year, South Africa ranks about eighth among the fishing nations of the world - not far behind Canada but still well behind countries such as Japan, the U. S. S., the U. S. S. R., Norway, and Peru. The situation, in relation to South African fisheries is by no means static, however, and the tendency is for continuous development to be taking place.

The foregoing is merely an enumeration of the main fisheries of South Africa and the landings should provide some idea of the extent to which these have been developed.

### Fisheries Research

Active research in relation to sea fisheries began in South Africa at the beginning of the century when the first Government Marine Biologist was appointed. There followed a period of active investigation into the marine resources of the area near Cape Town and later extension to include the entire South African coast. A great deal of pioneering work consisting mainly of the collection and identification of marine flora and fauna took place in the early years. This was followed up commercial fisheries surveys such as the survey of the trawling grounds off Cape Town and the Agulhas Bank by state-operated vessels which in turn was followed by the commercial exploitation of these grounds by private enterprise.

By the end of World War II the flora/fauna enumeration and commercial fishing grounds survey phase of the activities of the Sea Fisheries Research Division was over and although exploratory fishing of various types has been continued ever since, a different approach to fisheries research had to be adopted.

Since the otter trawling fishery, the rock lobster fishery and the sardine/marsbanker fisheries were developing at an enormous rate, the need to know something about the stocks, their natural fluctuations and the reason for these fluctuations had become urgent. This was particularly evident in the sardine fishery which was developing very rapidly and the disturbing example of what had happened to the California sardine fishery was never far from South African fisheries scientist's minds.

As a result of this, immediate temporary restrictions were imposed on the sardine fishery for the purpose of arresting over-rapid development and, at the same time, an ambitious and comprehensive programme of fisheries oceanographic research was planned for the purpose of finding out something about the resources before irreversible changes could take place. By 1950 this programme was launched and has flourished ever since.

Since then a vast amount of information has been acquired in relation to the oceanographic factors affecting not only the pelagic fisheries but also demersal fisheries such as those for hake and rock lobster. In spite of this, the surface has hardly been scratched as far as a complete understanding of the resource is concerned.

It can be stated however, that Fisheries Oceanography in South Africa has kept a finger on the pulse of its fisheries and has enabled the authorities to follow a conservative but nevertheless thoroughly enlightened management policy which has permitted a steady and consistent development of commercial fisheries to take place simultaneously with the accumulation of new knowledge of the fisheries.

If this extremely healthy state of affairs can be maintained, and there seems to be no reason why it shouldn't then South Africa

can look forward to the steady development of its economic fisheries at a rate which will be determined by the research effort.

Signed - David H. Davies.

\* \* \* \* \*

Professor T.S.Rass. .INSTITUTE OF OCEANOLOGY ..Academy of Sciences of the USSR.. 8, Bakhrushin str., Moscow J-127, USSR

June 25, 1962.

Dear Dr. Chapman:

Please forgive my failure to reply promptly to your letter of December 25, 1962.

I am sending you, enclosed, the record of my own thoughts on the terms of reference as outlined in Dr. Humphrey's letter of November 23, 1961.

I am of opinion that the field of the fisheries oceanography may be considered generally speaking in two aspects: /lines/ - the aspect "from fish" and that "from the ocean". By the first one are defined the studies carried out by the fisheries scientific /exploratory/ bodies on their vessel according to a practically limited program, chiefly within exploited fisheries regions and adjoining ones. Naturally this work is determined and directed by Fisheries Division of FAO.

By the second one are defined the studies of the ocean as a whole according the oceanological programm of a more or less complete complex from atmosphere and oceanic bottom up to the fish.

It would be reasonable to carrying out these studies by all scientific vessels embracing the world ocean. The scope of these studies is determined and directed by SCOR.

In the inclosed text which is devoted mainly to this second aspect of fisheries oceanography I am trying to put down my own thoughts on the subject. I have consulted also with professor Leo A.Zenkevich, who approved my viewpoints.

As requested I am sending copies of this letter and additonal text to the members of the group, as also to Drs. Humphrey, Bohnecks and Wooster. Sincerely yours, Th.Rass, Theodor S. Ra\$\$

Some consideration on the Fisheries Oceanography on the whole and its Oceanographical approach in particular.

1. Definition of fisheries oceanography.

Fisheries oceanography may be defined as a part of oceanography in the broad meaning which is used directly for the survey, exploitation, estimation, development, conservation and increase of fisheries resources. This is the science dealing with the dependence of distribution, behaviour, migrations, reproduction, abundance of marine fish from the environmental factors. It gathers and joins data on biological, physical,, chemical, geological oceanography and marine meteorology effecting fish and fisheries/of Uda, letter to Dr. Chapman from 28.2.1962/.

Two approaches or aspects may be distinguished within the fisheries oceanography: that of fisheries properly and oceanographical one. Fisheries approach includes investigations carried.

out "from the object" /from the fish/, oceanographical one embraces those carried out "from the environment."

2. What is accomplished by the fisheries oceanography.

Fisheries oceanography has to find out the physical, chemical, geological and biological oceanographical parameters responsible for distribution, migrations, concentration and dispersal of food fish, as also for the evaluation of the relative population size and estimation of the fishing areas. . . . . All possible factors are taken into consideration, as e.g. bottom relief and deposits structure; temperature, salinity, transparency, movements and chemical peculiarities of the water masses; distribution and abundance of fish eggs and larvae, etc.

3. What the fisheries oceanography is destined for

Fisheries oceanography has to provide:

- a/orientation of the survey of distribution and abundance of fish according to the oceanographical aids;
- b/estimation of the relative size of the schools according to geological, hydrological and biological properties;
- c/prediction of distribution and abundance of fish populations based on oceanographical factors;
- d/suggestions concerning the possibility of introduction of commercial fishes or other useful organisms for enrichment of native fauna, based on the oceanographical premises.

4. What is necessary for accomplishing 3.

- a/Carrying out aimful combined biological, hydrological and geological investigation.
- b/Combined study and analysis of the materials procured in such way as to be reciprocally comparable and reciprocally corrected. Being a "border-land between fishery and oceanography, fisheries oceanography borrows from the fishery elements of survey of fish schools and from oceanography - elements of biological and physical oceanology which affect the distribution and abundance of fish.

Consequently to these two lines /aspects/there are two somewhat different approaches within the fisheries oceanography; "fisheries /or fish/" approach and "oceanographical" approach.

The main objective of "fisheries" approach is elucidation of dependence of commercial fishes environmental conditions. These investigations are carried out on the fisheries research vessels, which undertake survey of fish schools and obtain also the limited oceanographical features with which are associated distribution and abundance of fish/sometimes oceanographical data are obtained on additional vessels especially attached to/. These investigations are carried out mainly within the exploited fisheries areas and partly in the postulated areas of commercial abundance of fish. The main purpose of this is getting and broadening the information about the biology of the known commercial fish species or groups of species in the areas explored.

c Combined investigations of the ocean make up the basis of the "oceanographical line /approach/ of research, embracing broad areas of various biological productivity.

Investigations along this line are carried out on oceanographical research vessels which gather physical, chemical, geological and biological data arranged in the manner to be reciprocally comparable. These investigations have to be spread out on the whole Ocean /or broad area/, including exploited as well as unexploited fisheries areas, revealing the regularities in distribution and reproduction of life as a whole and creating a theoretical basis for fisheries line /approach, aspect/ of research.

Data concerning oceanographical approach of the fisheries oceanography are to be gathered during all cruises of oceanographical research vessels.

These data are as follows:

- a/bottom relief and - structure;
- b/temperature, salinity, optic and acoustic water characteristics;
- c/velocity and direction of water currents;
- d/O<sub>2</sub>, P, C, H<sub>2</sub>S and other chemical water characteristics;
- e/primary production of organic matter;
- f/Bacteria and Protozoa;
- g/phyto - and zooplankton;
- h/ichthyoplankton /fish eggs and larvae/;
- i/phyto - and zoobenthos;
- j/pelagic, bathypelagic and abyssal fishes;
- k/squids

At present most prospective main lines of research are supposedly those:

a/productivity in the boundary zones of different water masses /fronts"/, such as :cold and warm currents; currents and counter - currents, brackish and salt water masses, surface -and deep water layers /thermocline zone, upwelling areas etc./; this line of research is of utmost importance as there are as a rule accumulations of organisms within those boundary zones. The reason is that those zone represent often the boundary of distribution range for many organisms which accumulate here being weakening under influence of somewhat unusual conditions and becoming more accessible prey for attracted predators;

b/bipolarity /antitropical distribution/in the abundance and dispersal of life in the Ocean:

c/amphiboreal and amphinotal structures in distribution of productivity of the Ocean;

d/special combined investigations of some regions of increased organic productivity.

A broad program of combined oceanographical investigations embracing entire World Ocean should be recommended for evaluation of the world biological resources of the Ocean. It seems highly advisable to include collecting the data mentioned below into the program of international explorations which may be carried out on expedition ships, as also at biological and fisheries research stations.

The following data would be obtained during each season:

1/principal oceanographical background on most important environment factors /t°,S‰, O<sub>2</sub>, N, P, H<sub>2</sub>S/ as well as well as distribution of different water masses and "fronts", currents and a general scheme of circulation of oceanic waters;

2/quantitative distribution of marine plants and animals, to reveal the regions of dispersal and concentration of life;

3/data of primary production, production of phyto - and zooplankton, production of phyto - and zoobenthos, as parameters /sources, indicators/ to be used for estimation of possible final production /fishes!;/

4/quantitative distribution of eggs and larvae of fishes;

5/quantitative distribution of small fishes in the upper layers /up to 1000 m/ of oceanic waters;

6/distribution of fish - and squid - schools in the Ocean according to visual observations, and obtained by attracting fish with electric light /at nights/, as well as by echosounder and fish - location;

7/distribution of sea birds in the Ocean according to visual observations;

8/data on the diet of important oceanic school fishes; distribution and biology of main forage organisms /particularly calanoids, euphausiids and small fishes/.

Summarising all materials indicated in charts would be of much expediency.

All investigations recommended will be needed for finding out the regularities in the distribution of life in the Ocean. This will serve as theoretical basis for evaluation of biological resources of the Ocean, needed for prospective plan in broadening out their utilization by mankind.

\* \* \* \* \*

To: Professor Theodor S. Rass, Institute of Oceanology, Academy of Sciences of the U. S. S. R., 8 Bakhrushinstr., Moscow J-127, U. S. S. R.

August 10, 1962

Dear Professor Rass:

I appreciate your letter of June 25th. For your information, it arrived on July 25th, in contrast with the very rapid passage of your later letter.

The considerations you enumerate are most valuable because they provide a contrast to somewhat different viewpoints from which we in this particular area see these same situations.

I am quite sure that our views in California have been impelled in the directions they have taken because of our preoccupation in this area with oceanic research associated with tuna. In the first place, these fishes are so closely responsive to variations in the environment that a study of the one can scarcely be separated or distinguished from the other. In the second place, they are so far ranging in several instances that they lead us to a consideration first of very large sectors of the world ocean, and then shortly to a study of these same factors on a world-wide basis. Thirdly, we have had an exceedingly complex population dynamic problem arise locally over the last twenty-five years involving the California sardine and northern anchovy, together with variations in fishing pressure and oceanic conditions which we have studied long and hard. We are still studying without much light having yet been shed on causative factors or their interrelation. Also, we have had a straight, clear cut conservation problem arise in the last five years in respect of the yellowfin tuna of the Eastern Pacific which could hardly have been elucidated or properly dealt with except that the intimate relationship between variations in population strength and oceanic climate (both atmospheric and oceanic) had been reasonably thoroughly inquired into.

I am not sure how much these factors apply in other areas and with other fishes and other fisheries, but I am confident that they have compelled us here to a rather different feeling of the relationship between fisheries research and classical oceanology than is held in some other parts of the United States and in other parts of the world. Whether they have just forced us into the forefront of what will become general concern elsewhere, or whether we represent what will remain an aberrant offshoot from the body of fishery science, I cannot say at this reading.

From our own experiences, however, the following considerations arise:

1. The aggregation of tunas, and possibly year class strength in some instances, is intimately associated with variations in oceanic phenomena that appear effective over very broad oceanic areas and appear to be related also to variations in wind stress (not always the wind stress in the same oceanic area which is under fishery investigation). I would not care to be required to state what these phenomena are at the present time or what causal relations there may be between them and the fish. It is only that we have

a strong feeling from our progress here to date, and some acquaintance with Japanese research on tuna and the ocean on a much broader geographic basis than we have heretofore embarked upon, that one cannot really understand much about tuna without at the very same time knowing just as well, at least, what is going on in the upper ocean and the lower atmosphere over quite broad areas.

2. This has also led us fishery people from a study of steady state situations to a concentration upon elucidating the relationships among processes. While we have done much along this line, I would hesitate at this point if I were asked to tell you exactly in what direction our researches of this sort are leading us. The research of Mr. Gunnar Seckles at the Bureau of Commercial Fisheries Biological Laboratory at Honolulu on the relationship of seasonal movements of skip-jack tuna in that area with changing oceanic processes is a case in point. In the Eastern Pacific the geographic occurrence of tuna and perhaps even to some degree the success of the brood year, pulsates in an as yet not well understood manner or regularity with warming and cooling of the whole Eastern Pacific, which in turn is related to almost ocean wide mixed layer and atmospheric movements. The research of Dr. Jacob Bjerknes, in association with the Inter-American Tropical Tuna Commission, on the "El Nino" phenomenon is a case in point.
3. In the California Current Area there have been, from time to time, broad fluctuations in the abundance of the California sardine. In the late 1930's, the fishery produced upwards of three-quarters of a million tons per year; it now produces less than twenty-five thousand tons per year. One can assert that the population was over-fished; in the presence of vast quantities of data one has a good deal of difficulty in convincing oneself that this was the only, if even the controlling, factor in the decline in abundance or its staying low.

Coincidental with the sharp decline in abundance of sardine has been a very sharp increase in the abundance of anchovy in the area. One can postulate that the anchovy are competitive for sustenance with the sardine at some stage in their life history and that in some way they form a biological lid which prevents the sardine population from expanding again, as it perhaps did about the turn of the century when data were too sparse to tell exactly what was going on. But when one examines the voluminous data available on these matters here, one becomes increasingly uncertain as to what is going on.

The physical and chemical oceanography of the California Current Area in which this sardine-anchovy drama is being enacted is about as well known and steadily investigated, this as in any sector of the world ocean. Yet one cannot point one's finger at any oceanic parameter now being measured and say with any conviction that that is the one which is associated with these fishery phenomena.

At this stage in these studies, at any rate, we have the feeling that we must go back all over again and inquire into: (a) the full ecology of this sea area, as well as (b) bring rather considerable pieces of it ashore where it can be studied under controlled laboratory conditions both as to living, physical and chemical processes.

One has the utmost difficulty in drawing distinctions between the necessity for studies of living and inorganic matter and processes, and between upper oceanic and lower atmospheric processes.

4. In both of these sorts of fishes (sardine and tuna) the effect of the fishery on population abundance has been at least large. Because fishing effort is capable of being controlled, this brings us to a much closer contact with conservation thinking than is normal in much of the world.

Yet the fishery is only a special instance of the generalized predator-prey relationship, and the further we get along on the studying of this basically ecological problem, the less we are able to separate our thinking and investigating into "fishery" and "oceanography" compartments. The oceanic milieu simply cannot be divorced from these predator-prey relationships.

One could go on at considerable length detailing these problems, but perhaps it can be summed up something like the following: One can have a technician examining into T/S relationships off Peru, another technician measuring biological parameters of fish being landed in San Diego, and a third technician running a weather observation station on Christmas Island in the Pacific, all of them working well on specific research problems in their specialized fields and areas.

But somewhere the government or industry man who has responsibility for managing or directing man's activities as they affect, or are affected by, the abundance and availability of the fish resources in that geographic triangle requires to have a scientist, or a body of scientists, elucidating the relationships between all of these things, and such others as may be pertinent, to the end that he (the government or industry man) may know how to manage or direct, or what not to manage or direct.

I think that it is this scientist, or this body of scientists, to which we are increasingly referring as fishery oceanographers. And I suggest that the reason why we are having some difficulty in characterizing what we mean by those words is related to this concept being rather new, this type of researcher not being very numerous, and these sorts of considerations not being very broadly held in the world as yet.

While one requires to refer to the above matters with some diffidence and uncertainty because not as much is known as needs to be known for confidence, one can speak of the relation of these things in the international field, as between the Fisheries Division of FAO and SCOR, and as set out in your

covering letter, with much greater definiteness. The differences in thinking here are clear cut and decisive and can be set down as follows:

a. **FAO Fisheries Division**, while it does much that is useful and of which its staff can well be proud, has not heretofore been a factor of importance in the actual doing of fishery research work. This is done by national agencies and laboratories for the most part, and where it is done by several nations jointly, it is done through the agency of intergovernmental fisheries commissions (to several of which the U. S. S. R. belongs), rather than by any of the specialized agencies of the United Nations Family. In some instances, as in ICES, they are correlating agencies of national programs, with their objectives being generalized. In other instances, as in ICNAF, they are correlating agencies of national agencies with more or less specific conservation objectives. In other instances, as in IPHFC, IPSFC, and IATTC, the intergovernmental commission hires its own scientific staff, conducts its own research, and the governments involved take their actions in the light of the results of research done by the Commission staffs.

Heretofore substantially all of the fishery exploratory work has been done by national agencies and most particularly by the national agencies of a relatively few countries either for themselves or as technical assistance programs in the developing countries. In the international field this has been engaged in by FAO Fisheries Division in the EPTA program for a number of years, but these EPTA programs have been primarily concerned with the application of knowledge and understanding rather than the generation of such knowledge and understanding.

Very recently in the administration of fishery pre-development projects undertaken by the special fund of the United Nations in Ecuador and Peru, a larger element of oceanic research has been introduced into the FAO Fisheries Division activities, but in the bulk of such research going on in the world, that being done by FAO is quite nominal.

The reasons for this, quite aside from any policy or objective considerations, is clear. They do not have either the funds or amount of personnel adequate to the task, and I do not envision a time when they will ever will have. Both the U. S. S. R. and the U. S., for instance, have a dozen specific fishery laboratories, each of which has more funds and scientific personnel with which to study the specific problems assigned to them than the entire Biology Branch of FAO Fisheries Division has with which to carry out its world-wide responsibilities.

Furthermore, none of these national agencies and laboratories or intergovernmental bodies or commissions

has the slightest intention of permitting FAO Fisheries Division to determine or direct its researches in any manner whatsoever. So far as I know, FAO has, on its part, no slight inclination or desire to do this.

The maximum that FAO Fisheries Division can be expected to do in this field is stimulate, collate, and forward coordination and collaboration. I do not foresee any greater role for it in this field in the foreseeable future, but I think that to be a most important role in itself.

- b. The situation in respect to SCOR is even more clear cut. SCOR neither directs nor determines anything.

Its objectives and scope are set out in the first paragraph of its constitution, which reads: "SCOR is a Special Committee of ICSU charged with furthering the coordination of scientific activities in all branches of oceanic research, with a view to framing a scientific programme of world-wide scope and significance."

Furthering the coordination of scientific activity cannot be taken to imply directing or determining the scope of scientific programs. Should SCOR undertake the latter function, which I am sure none of its members or ICSU contemplates, then I have no doubt that in the present frame of thinking of the ocean research community its support would quickly vanish.

SCOR performs an invaluable function when it stays within the limits of its constitutional objective. It was rather involuntarily diverted from those objectives in the instance of the International Indian Ocean Expedition simply because in furthering the coordination of scientific activity in this area of oceanic research it succeeded in creating an enterprise which required at least some elements of direction and management. There was no mechanism otherwise available in the world which could handle this.

It was the Soviet representatives on SCOR and in IOC who first suggested that SCOR divest itself even of these minimal managerial and directional activities and return to concentration upon its proper constitutional objectives. I must say that I personally was in full agreement with the suggestions of the Soviet representatives in this matter and have been most pleased at the smoothness and dispatch with which SCOR has been divesting itself of these responsibilities as rapidly as the staff of UNESCO's new Department of Oceanography has been able to accept them.

- c. In the previous sections of this letter I have been referring to views which are rather widely held in this area. The remarks stated in this present section are strictly

my personal opinions which may, or may not, be shared by others and which in no sense are to be taken as being related to positions on this matter held by the United States government or anyone that I know of in SCOR or ICSU.

What has concerned me is that we do not have in the world any agency, body, or institution which can properly undertake in the field of fishery oceanography what I consider to be the splendidly stated constitutional objectives of SCOR. The constitution of SCOR is perfectly suited to enable it to further the coordination of scientific activity in all branches of fishery oceanography as merely a special case of oceanic research generally, but the composition of SCOR and the means of provenance of its membership has not heretofore made this practical.

I am not altogether sure that it is possible. SCOR is a creation of ICSU. ICSU is a creation of its national members and its scientific members. Its national members are the national Academies of Science, Research Councils, or lacking these, their governments. In no instance of importance that I know of is a vigorous fishing country not represented on ICSU by an Academy of Science or Research Council. The scientific members of ICSU are the International scientific unions, who are primarily composed of academic scientists. Essentially, ICSU's components are drawn from the academic community.

On the other hand, most fishery research in the world is done by governmental agencies of one sort or another. These agencies have definite responsibilities to specific government ministries or departments, who primarily are interested in the application of research and otherwise received knowledge and understanding to specific problems.

This bifurcation of provenance of scientists, money, and ships within governments has, in every national instance with which I am acquainted, led to more or less strained feelings, competition for funds, competition for personnel, competition for research objectives, etc., between the academic ocean research people and the government fishery department ocean research people.

The government fishery department ocean research people do not have any way to make their weight or opinions felt in ICSU because they have no direct representation there.

On the other hand, in many governments they do have quite satisfactory means of representation at the Intergovernmental Oceanographic Commission because there: (1) Representation is by national delegations. (2) The position of the delegation is that of the national government it represents. (3) The government fishery agency ocean

research people have as large a voice in most governments in the formulation of government positions as does the academic community.

I think that it was this factor, straight out, that prevented SCOR from being accepted as the official advisory body of IOC at its inaugural meeting. Without adequate representation on ICSU, or its committee SCOR, the government fishery agency ocean research people were not willing to permit it to be the only official advisory body to IOC, because of the important position which IOC may come to occupy in international ocean research and the effect that may come to have on national oceanographic budgets.

I personally expect to see much of this drama reenacted at the forthcoming second meeting of IOC because the problem is not much closer to solution than it was last year, and more government ocean fishery people are aware of the problems (noted above) this year than last year in Paris or previously in Copenhagen.

As a matter of fact, this is a very difficult problem to bring to satisfactory solution because on one hand the government fishing agency scientists cannot afford to have all international ocean research dominated by the academic scientists. On the other hand, the academic oceanographers cannot afford to have all international ocean research dominated by the government fishery agency scientists. The academic community as well represented on a world wide basis by ICSU, and the academic oceanographers are rather well served on a world-wide basis by SCOR. The government ocean fishery scientists have no satisfactory world-wide means of acting together. FAO Fisheries Division, as yet, does not form such a body because its role in fishery oceanography is slight.

It is not clear to me how this is to be solved. A step in that direction might be the World Oceanographic Organization, in which academic and government ocean research scientists could both feel at home, and to which physical, chemical, biological, meteorological, geological, and fishery oceanographers would all look for such coordination of their research on an international level as was beneficial to it rather than having these functions scattered through several specialized agencies of the United Nations, as is now the case. Perhaps the sub-committee on oceanography of the Advisory Committee on Cooperation of the United Nations Family will lead in this direction.

At any rate, it appears to me that a rationalization of these problems lies directly within the purview of SCOR's constitutional objective of furthering the coordination of scientific activity in all branches of oceanic research. I would hope that the efforts of our Working Party on fishery oceanography might aid it somewhat in

that task. I am sure that your letter and comments have furthered our ability to do so by clearly delineating some of the problems involved.

Please give my best regards to Professor Zenkevich and again accept my thanks for your work.

Sincerely yours, W. M. Chapman, Director

REPORT FROM DR. D. H. CUSHING

S.C.O.R. questionnaire

Method

1. The following letter was circulated:

"S.C.O.R. has set up a working group on fisheries oceanography, of which Dr. W. M. Chapman (of the Van Camp Foundation, California) is chairman. He has asked me to make an enquiry amongst marine research workers on the nature of fisheries oceanography.

Could you please answer the following brief questionnaire?

1. What is fisheries oceanography?
2. What has it accomplished?
3. What should it try to accomplish?
4. What work is needed from other scientific disciplines in order to advance?

Obviously each scientist will give a different answer; it is the range of difference which will be of interest. I am asking marine biologists and fisheries workers indiscriminately."

The circulation was extensive, going to some physical oceanographers as well as to biologists. To date about fifty replies have been received.

In the following analysis, quotations give sets from the answers to each question. Some small changes in wording have been made at one or two points to aid condensation and for the same reason some choice from the more extensive replies has been made.

My comments are of two sorts, summarizing and elucidating. In the latter function some of my prejudices have leaked out.

I have numbered the quotations and they are identifiable from the Appendix I. D. H. Cushing

Question 1. What is fisheries oceanography?

Quotation

"What fishery oceanographers do" (1)

"A wide discipline involving the study of the physics, chemistry, biology, geology, meteorology, cartography of the marine environment... The concept of fisheries oceanography therefore might be expanded to include study of the world ocean. In any case, the behaviour of the onshore water masses and the life they contain cannot be properly understood without a full understanding of the oceanic waters beyond." (2)

"A study of the physical and chemical properties of sea water, particularly as related to water movements of all kinds. The identification of water masses. A study of tides and tidal streams in relation to productivity and fisheries." (3)

"There is no such thing as 'Fisheries Oceanography'; there is fisheries research as one branch of marine science and oceanography as another. The bastard term "Fisheries Oceanography' is probably an invention of the overpaid incompetents at F.A.O. who wish to have a say in Oceanography which is not a subject within their terms of reference. Alternatively it is an invention of oceanographers who wish to get a bite at the Fisheries budget or Fisheries people who want a bite at the Oceanographers' budget." (4)

"A discipline based on geographical hydrology, which attempts to study fisheries problems." (5)

"I quote Wooster's short definition:-'Fisheries Oceanography is the study of oceanic processes effecting the abundance and availability of commercial fishes! "I however, prefer to put 'processes in the seas' instead of 'oceanic processes.'" Persons belonging to I.C.E.S. should always bear in mind the initial view of that body which would have the definition run thus:- 'The distinction of the different water strata, according to their geographical distribution, depth, temperature, salinity, gas content, plankton and currents in order to find the fundamental principles for the determination of the external life conditions of useful marine animals'. To concentrate my own views I would word it: '(1) To study water events and fish events side by side for long enough to detect apparent inter-relationships. (2) To pursue the latter by ever improved study of water conditions until it becomes possible to choose what water events (or causative meteorological conditions) stand out as the most likely to exercise determinative influence along the two lines which matter most . . . .the prediction of upgrowth fortunes from the brood stage and of availability to capture in the adult stage.'" (6)

"I personally define oceanography as all aspects of scientific study directly concerned with the oceans, including their margins and populations. Thus I include chemistry of sea water and sediments, physics and mathematics of waves, tides and currents, those aspects of meteorology which affect the oceans, those aspects and distribution of marine life, all aspects of productivity, oceanic survey and exploration, and such branches of engineering and technology which are directly concerned with solving the problems investigated by the other fields (e.g. the scientific investigation of ship motion and design, forecasting of effects of harbour works, disposal of wastes etc.) I have never personally used the term 'fisheries oceanography', nor do I propose to. However, when I meet it I take it to mean any scientific

- work covered by the previous definition which has a bearing  
on the fishing industry. (7)
- "Scientific planning of the seas and oceans." (8)
- "A study of fish and fishing." (9)
- "...any knowledge of the oceans which leads to an under-  
standing of the biology of fishes." (10)
- "Fisheries Oceanography embraces any and all aspects  
of the scientific study of the sea and its life which  
can contribute in any way towards the most natural  
exploitation of the fisheries.:" (11)
- "Study of fisheries and their marine environment." (12)
- " Fisheries oceanography is the completely integrated  
study of all aspects of chemical, physical and bio-  
logical phenomena associated with fish and fisheries." (13)
- "As I understand it, 'oceanography' is concerned with  
the physical and chemical properties of oceanic waters  
and with the factors which influence these properties  
and determine the movement of large masses of water.  
In other words, it is fundamentally concerned with the  
study of the physical environment of all fish." (14)
- "largely a waste of time, too often an irrelevant ex-  
tension of basic oceanography e.g. at Aberdeen, Lowestoft  
and Plymouth." (15)
- "Primarily, oceanographic investigations undertaken  
with the aim of increasing understanding of the natural  
conditions underlying established fisheries, or which  
can be expected to promote the development of new  
fisheries. Secondly, - the study of general ocean-  
ographical and marine biological work, a great deal of which,  
although not undertaken with an immediate fisheries objec-  
tive, will ultimately prove to have a bearing on fisheries  
problems." (16)
- "Fisheries oceanography then is the integration of our  
knowledge of the physical and chemical factors as they  
apply to the marine environment, and the biological  
factors as they apply to the marine environment, and the  
biological factors as they co-exist and inter-relate one  
upon the life span of the other, Our knowledge of these  
disciplines will never be complete, for Oceanography, like  
the objects of its study, is fluid and ever changing." (17)

"I feel only that fisheries oceanographers have the sole right to define their own subject." (18)

"Fisheries oceanography may be regarded as the study of the physics and chemistry of the oceans, and also of the distribution and inter-relationships of the living organisms therein, related particularly to the needs of fisheries." (19)

"A study of the effects of marine hydrography and meteorology upon Ceylon's algology and marine zoology." (20)

"Fisheries Oceanography is ... That part of oceanography which deals with the marine fish that man is interested in harvesting. Thus fisheries research is part of oceanography.

The primary aim of fisheries research is to help man to obtain the best regular harvest of fish. The study of fish by themselves is soon found to be inadequate for this and it is necessary to study them in relation to their environment. This means that fisheries research becomes involved in physical and chemical oceanography as well as the rest of biological oceanography." (21)

"The study, in particular, of those aspects of oceanography that bear on fish, per se, and the conditions under which they exist." (22)

"Fisheries investigations necessitate a study of environment of the fish and their food - that is of the water occupying particular fishing grounds, which by fluctuating seasonally and from year to year affect the fish maintained on that particular ground. Such investigations embrace almost every aspect of physical, biological and chemical oceanography. Since these changes over fishing grounds usually arise from incursions of water from other areas which are in turn brought about by fluctuations in the general circulation of the oceans, more knowledge of conditions, including winds over very wide areas indeed is sometimes, perhaps often called for. Thus the term 'fisheries oceanography' embraces almost every facet of oceanography and needs workers with a basic knowledge of varied scientific disciplines.

Investigations of fluctuations in environment over particular fishing areas which may affect the quantity of fish supported on the grounds include those of temperature which may affect the place and time of spawning; those in currents bringing planktonic food or carrying very young fish; those in the production of the microfauna and microflora in sufficient quantity at the right time and of the right size to nourish the early stages of the fish and as food for the bottom fauna providing food for the demersal fish." (23)

"Fisheries research is a branch of industrial research in which systematic investigations is applied to the economic problem of the fishing industry. Fisheries biology is the study of all aspects of marine animals of economic importance and of such other organisms as influence them for good or ill. Fisheries Oceanography is the study of all properties of the sea which influence the economic success or failure of fisheries.

Fishing is the only large industry which depends on hunting and has no fixed site for its operations. Also until recently the operators were all quite small so that the only possible way of financing fisheries research was by government alone. Moreover, the problems were even beyond the resources of any single government, so that inter-governmental co-operation has developed. I consider that large concerns such as Ross Group, should follow the lead of their land lubber colleagues and develop their own research departments.

None the less the nature of the fishing industry requires ~~-----~~ much that elsewhere would be done by industry must here be undertaken by government. It is essential that government should recognise and distinguish the several types of research which large industrial firms support in quite different ways.

Again, fisheries oceanography should not be confused with fisheries biology, but though they draw their inspiration from quite different basic sciences and attract different types of men to their study, they are economically inseparable and must always march together. (24)

Investigation of commercial fishes beyond the 100 fm line, especially tuna and Pacific salmon." (25)

"Living entities are affected by their environment so that fisheries - the economic aspects of fish and other aquatic species of commercial importance - are also affected by these conditions. Oceanography includes the study of such conditions in the sea so that fisheries oceanography is the study of those factors that have, or seem likely to have, an effect on the fisheries. This by the Oxford dictionary definition should be confined to the physical factors but as some of those are essentially bound with the chemical and in turn with certain biological aspects this strict definition should not be upheld. Therefore: Fisheries Oceanography is the study of any aspect of oceanography - physical chemical or biological - that could affect the fisheries through the natural environment of the living fish" (26)

"By fisheries oceanography I understand the study of those meteorological, hydrological and biological factors in the sea (whether in neritic or oceanic areas) which may affect the distribution and abundance of fish stocks of commercial importance." (27)

"Oceanography (including physical, chemical and biological work) as applied to fisheries i.e. covering the kinds of work carried out by research vessels operated by fisheries laboratories such as Lowestoft and Aberdeen." (28)

"A study of various factors in the oceanic environment as related to the behaviour, fluctuations in abundance and 'availability' of commercially important fish stocks or populations of other organisms useful to man" (30)

"Oceanography I take to be the study of the sea including the bottom and the sea/atmosphere interface, and as such it encompasses most if not all of the scientific disciplines. Fisheries are the means by which the natural plant and animal resources of the sea are exploited commercially. It thus follows, I think, that fisheries oceanography covers those particular investigations that are directed towards a rational and controlled exploitation." (31)

"Anything about the seas of the world remotely connected with fisheries: that means everything including geology and meteorology. Of course, some aspects of knowledge are closer to fisheries than are others, and if fisheries are what you are interested in then the closer are these aspects to fisheries the more they will interest you. But you can never be sure when something apparently right on the borderline of knowledge, as viewed from a fisheries position, will suddenly become of the utmost importance to commercial fisheries. It would be lacking in foresight to draw a line anywhere and say that on one side accumulated knowledge about the oceans relates to fisheries and on the other side, does not and never will" (32)

"Fisheries oceanography is the mapping with time and distance, of the physical, chemical and meteorological features of the oceans which might directly or indirectly affect the numbers of availability of food fishes." (33)

"Fisheries oceanography could be defined as  
(a) a study of the physical, chemical and biological factors of the fishing areas which are thought to influence commercially important species.

(b) This definition may be broadened to include factors of regions other than the fishing area (e.g. the deep sea) which indirectly influence the conditions within the area and/or to include species other than commercial species of the area." (34)

"The science encompasses all studies of the seas and the oceans that lie around them, especially the aspects that can be shown to or might reasonably be expected to affect the fruitfulness and catchability of commercial fishes and other valuable marine products. These aspects include the studies of water movements and physical properties that go to make up the marine 'climate' from season to season and of the 'quality' of the sea water in so far as its bearing on fruitfulness or catchability may be demonstrated or anticipated. This study of water quality is the chemical link between water and fish while the physical aspects make up the 'climate' of the environment. In these studies it may be necessary to study local (inshore and estuarine) environments as well as the open sea to take into account land-based effects e.g. river flow, pollution etc." (35)

"I would ... define fisheries oceanography as that part of oceanography as a whole which is likely to contribute something to the understanding of fisheries and to lead to improved management of fishery resources. ... Several explanations of the gaps in our knowledge have been offered, firstly, a failure on the part of hydrographers to work closely with biologists, leading to what has been termed 'hydrography for its own sake', rather than fisheries hydrography; secondly, insufficient effort on hydrography; fourthly insufficient sea time and poor instruments; and fifthly, the inability of biologists to indicate clearly what needs to be done.

....The tendency to divorce fundamental oceanography from fisheries oceanography seems to me to be based on the belief that it is better to have a slow rate of progress in the understanding of fisheries while a solid foundation is laid in fundamental work. This view can perhaps be justified if one is considering very widely based oceanographic studies with application in the field of defence, meteorology, navigation, shore protection etc., but in such a context, work on fisheries oceanography may well be given low priority and starved of money. I am not sure that, looking at the matter on a world wide scale, such an attitude can be reasonably maintained; additional food is badly needed, particularly home produced protein food, and the sea seems to be a convenient source of this which

should be exploited to the full. Rational exploitation must be based on long-term studies, of which hydrography is an essential part." (36)

"Fisheries oceanography is a study of the essential physical chemical background and the biological environment (though these cannot be strictly separated) on which each commercial fishery is based, As such, the study includes investigating such basic problems as primary productivity with all its dependent chemical and physical parameters and the production, distribution and crop of plankton. It includes studying the density and turnover of the benthos, and the spawning and factors influencing the survival of fish larvae. Also it must deal with the migration problems with young, adult and spawning food fishes, and finally it must at least include some biochemical investigations on the turnover of material from basic production to fish flesh." (38)

"Marine fisheries research is a study lying wholly within the larger field of oceanography. It starts with the fish and its intrinsic characters, such as morphology, physiology, ontology, behaviour, population dynamics. But to explain these it has to make substantial studies of the environment both living and non living. By this I mean as far as biology is concerned, ecological studies of predator-prey relations, food chains, competition and conditions of behaviour. In the non living field, the disciplines of physics, chemistry and mathematics as used in hydrography are of importance. Throughout the study of fisheries research however, chemistry, biochemistry, physics and above all, mathematics are relevant." (39)

"This means the gathering of as much information as possible about the physics, chemistry, biology and meteorology of the Gulf of Aden and Southern Red Sea, to provide us with a more extensive appreciation of the movements of pelagic fishes upon which our Fishing Industry depends and in turn a very important part of the economy of South Arabia." (40)

"A study of the oceans with the main object of obtaining a better understanding of the influence of various physical and biological factors on stocks of fish." (41)

"Assuming that oceanography is the general study of all conditions existing in the seas and oceans, then fisheries oceanography may be defined as the study of those factors existing in the seas and oceans which influence spawning, growth, behaviour, migration, feeding and catchability of fish." (42)

"The study of all the environmental aspects which affect marine animals which are of practical food value to man, and which can be caught or farmed." (43)

"A wide definition, fisheries being equivalent to fish, is the study of anything in or near the sea which might affect the fish. If fisheries are taken as being equivalent to fishing, then it is the study of anything in the sea which will help fishermen to catch fish now and maintain good catches in the future. I prefer the second definition and use it now." (44)

"those parts of oceanography which contributed to fisheries research starting from a consideration of stock." (45)

Combination of quotation and comment.

Oceanography is physical chemical and biological. Where does fisheries oceanography fit in?

A. It is an all embracing discipline

1. "any knowledge of the oceans which leads to an understanding of the biology of fishes;" or "the completely integrated study of all aspects of chemical, physical and biological phenomena associated with fish and fisheries." So "fisheries research becomes involved in physical and chemical oceanography as well as the rest of biological oceanography." The term fisheries oceanography "embraces almost every facet of oceanography and needs workers with a basic knowledge of varied scientific disciplines." Indeed, "it would be lacking in foresight to draw a line anywhere and say that on one side, accumulated knowledge about the oceans relates to fisheries and on the other side, does not and never will." A wide definition, fisheries being equivalent to fish, is the study of anything in or near the sea which affect the fish."
2. This very extensive definition is qualified in various ways:-
  - "which can contribute in any way towards the most natural exploitation of fisheries";
  - "related particularly to the needs of fisheries";
  - "upon Ceylon's alogogy and marine zoology";
  - "which deals with the marine fish that man in interested in harvesting";
  - "that have an effect on the fisheries";
  - "which may affect the distribution and abundance of fish stocks of commercial importance";

"which might directly or indirectly affect the numbers of availability of food fishes";  
"physical, chemical and biological factors of the fishing areas, which are thought to influence commercially important fisheries";  
"reasonably be expected to affect the fruitfulness and catchability of commercial fishes";  
"the essential physical and chemical background and biological environment on which each commercial fishery is based";  
"factors on stocks of fish";  
"of the Gulf of Aden and Southern Red Sea";  
"which contributed to fisheries research starting from a consideration of the stocks";  
"If fisheries are taken as being equivalent to fishing, then it is the study of anything in the sea which will help fishermen to catch fish now and maintain good catches in the future";

3. These qualifications are of profound importance because the search for knowledge is restricted; the sense of restriction in the second paragraph is quite opposed to the sense of extension in the first paragraph.  
"The tendency to divorce fundamental oceanography from fisheries oceanography seems to me to be based on the belief that it is better to have a slow rate of progress in the understanding of fisheries while a solid foundation is laid in fundamental work . . . I am not sure that looking at the matter on a world wide scale, such an attitude can be reasonably maintained; additional food is badly needed . . . "
4. I think that the opposition revealed between the first two paragraphs can be resolved. The first paragraph, advocating extension of scope, is really concerned with the ultimate scope of that body of knowledge which we are naming fisheries oceanography; the second, advocating restriction of scope, is concerned with where and how that body of knowledge is built up. Obviously Mr. Hinds will restrict his work to the Gulf of Aden and the Southern Red Sea, and most fisheries scientists do work on commercial fish stocks. But the scope of fisheries scientists is becoming more extensive. I am paid to work on herring's food, - which turns out to be a fundamental study of the nature of productive cycles.
5. Here I declare a prejudice - against the word "environment". "Le Milieu interne" of Bernard and the "fitting environment of Henderson are good meanings, far outside my prejudice. To divide the animal's world into two environments, external and internal, each with lots of factors, is of some value.

In population work, however, the vast majority of this stuff is irrelevant: we are interested in birth, copulation and death and perhaps a little travel. We must find the boundaries to migration, how the animals move and the pieces of necessary environmental knowledge are illuminated to the light of the basic pattern of where and how the fish live. The real point here is that the population is governed by relatively few sorts of factors and the individual animal is immersed in an enormous mass of factors to most of which it is unresponsive. To choose the relevant from the irrelevant is hard enough for the individual animal. The fisheries biologist should choose only the factors affecting the vital parameters of the population (including the boundaries to distribution). This is where the detailed knowledge of the stock's habitat becomes so useful. It is this detailed knowledge which may be called the environment: it is a complex of factors from which the few relevant to the population must be chosen. The environment is not a crude lumping of factors, nor is it what is left when fishing mortality has been estimated. The word has a very wide meaning and I think that its use often blankets the need for care.

B. It is a narrow discipline, a form of physical oceanography.

"It is fundamentally concerned with the study of the physical environment of all fish." It is "the study of the physical and chemical properties of sea water particularly as related to water movements of all kinds. The identification of water masses. A study of tides and tidal streams in relation to productivity and fisheries". Or it is "a discipline based on geographical hydrology, which attempts to study fisheries problems". The most precise form of definition is "to study water events and fish events side by side for long enough to detect apparent inter-relationships, To pursue the latter by ever **improved** study of water conditions until it becomes possible to choose what water events (or causative meteorological events) stand out as the ~~most~~ likely to exercise determinative influence . . . on the prediction of upgrowth fortunes from the brood stage and of availability to capture in the adult stage."

There is a prime virtue about this last definition which is the recognition of the need to tie the water events to the vital parameters of the population. There are two tacit implications, firstly that the two parameters mentioned are controlled physically rather than biologically and secondly that they are the parameters most likely to yield a relationship with water events. It is partly these implications which help to name the narrower fisheries oceanography, I think that the narrow definition arises when hydrographers have had to work in a society of biologists and have worked in some sort of isolation.

"Persons belonging to I.C.E.S. should always bear in mind the initial view of that body (1902) which would have the definition run thus:- 'the distinction of the different water strata, according to their geographical distribution, depth, temperature, salinity, gas content, plankton and currents in order to find the fundamental principles for the determination of the external life conditions of useful marine animals!'" There is a hint here of my prejudice -- that because there is an environment, it must have an effect on the population -- which is not necessarily so. But the more important point is that the first fisheries oceanographers saw the need to spread the search of knowledge as widely as possible.

### C. Conclusion

There appear to be three common definitions of fisheries oceanography

- embracing physics, chemistry and biology extending over the whole field of these sciences;
- embracing the same three sciences, but restricted to particular fish stocks, commercial fisheries or to particular areas;
- embracing physics and chemistry only in so far as physical events react upon the vital parameters of the populations.

They may be combined because all forms of oceanography are of necessary interest to the fisheries biologist; he needs and makes some parts of it as he studies the fish stocks and their dependencies; and effects on fish stocks, whether physical or biological, whether man-made or not, are only measurable in the vital parameters of the population. So fisheries oceanography is the study of the physics, chemistry and biology of the sea as they affect the vital parameters of the stocks of commercial fishes.

\* \* \* \* \*

#### Question 2.

What has it accomplished?

#### Quotation

- "I shall not attempt to answer this. It has accomplished so much." "Scientifically it has accomplished a lot, but perhaps rather less on the applied side." (2)
- "As it doesn't exist, it clearly cannot have accomplished anything.:" (4)
- "I don't know, but would say as an independent discipline not a great deal - unless it is assumed that the classical voyages made by the Discovery etc. were field exercises in fisheries oceanography." (5)

"Unfortunately lamentably little and very much less than hoped. The best results have applied to the availability aspect in respect of marketable adults. The Japanese have led, thanks especially to the work of Uda concerning the expected presence of tuna near the upwelling streaks. Then there has been the success of Devold in connection with the herring and its temperature environment. Eggvin's work on the position of the cold front off northern Norway has been important; and so has been recent American work relating tuna availability to wind conditions around Hawaii. The P.O.F.I. work in general around the Line islands has been of success in respect of water/fish inter-relationships - also to do with tuna.

I would place particularly high, however, the work of Tully in his explanations of the displacement of the arrival path of salmon to British Columbian coastal waters . . . . by using the airborne radiation thermometer. This meets the sternest need which is:- lots of looking at lots of water for lots of time, without lots of difficulty. I also esteem Kalle's simple correlations between herring availability and rainfall. Very praiseworthy also are the German studies explaining the changeover in the Baltic from pelagic to demersal fish. As making a particular appeal to me are the German investigations which connect the availability of redfish with meteorology in the N.W. Atlantic, and of particular value were the German researches connecting cold water overflow across the Arctic/ Atlantic banks with the presence or redfish on their lee side.

. . . .I am convinced that various correlations (on recruitment) to which the statisticians have seemed to deal the death blow, are not really dead. Rather do they need a helping hand . . ." (6)  
"It has accomplished an enormous amount in producing a background picture which would inevitably have been asked for by governments when questions cropped up on overfishing. It has produced many results of immediate practical value, e.g. a knowledge of oceanic currents has enabled the most likely places for tuna to be known." (10)

"A great deal of basic knowledge from all branches of Fisheries Oceanography has been obtained which is beginning, in those areas where sufficient work has been done (at present very few), to lead to a better conservation of the stocks of fish and, in some cases, to a prediction as to the state of the fisheries in a coming season. New fishing grounds and stocks of fish have also been discovered." (11)

"Present state of knowledge of especially the separate parts of the ecological set up and man's interference, but little integration of those parts as between the living organisms and the environment." (12)

"It has determined a lot of basic knowledge regarding such things as cyclic changes in the marine environment, the life

history and behaviour of fish and associated organisms, effects of fishing on stock etc., but at the present time there seem to be too many unco-ordinated lines of work which tend to result in isolated 'pockets' of knowledge which may or may not have correlative value with other aspects of the subject." (13)

"If I were asked what contributions valuable to fisheries had been made by physical oceanography up to 50 years ago - I would have said 'very little'. There were lengthy tables of salinities and temperatures, but very few biologists felt they were much the wiser. All this has changed dramatically since biologists began to look on the sea as the natural environment of the organism they were interested in. By co-ordination of physical and biological observation I would say that a flood of light has been thrown on the factors affecting the distribution of fish (all the work on indicator organisms, distribution of nutritive salts etc., etc.) (14)

"Very little: certainly not much more than we knew in 1903-08 when most of the work was done by biologists and few physicists." (15)

"Some basis for an understanding of the relation between the major established fisheries and the environmental conditions that govern them. Also considerable aid in the development of new fisheries . . . e.g. the deep water prawn trawling off Norway, spreading later to other parts of the world, the great clupeid fish meal industries off S.W.Africa and Peru, and descending again in the scale of magnitude, the cray-fishing at Tristan de Cunha and Gough Is. On the technical side also, fisheries oceanography begins to provide some real assistance to industry: short term forecasting, echo locations . . . ." (16)

"A good deal of information on this subject has been accumulated particularly from coastal regions." (19)

"Very little or nothing from Ceylon waters." (20)

"To ask what fisheries oceanography has accomplished is to ask what fisheries research has accomplished . . . ."

1. In the North Atlantic, the limits of distribution of cod stocks have been defined in terms of their temperature requirements and spawning migrations;

2. In the Norwegian Sea, the seasonal movements of herring and their variation from year to year have also been defined in terms of temperature, spawning and food supply;

3. In the northern North Sea, the relation between the distribution of herring shoals and the oceanic influx and its associated plankton has been described;

4. The oceanic distribution of salmon in the North Pacific has been related to temperature and food;

5. Knowledge of the distribution of tunas in the Pacific Ocean has been considerably increased and explained in terms of the major current systems." (21)

"Our knowledge of the events taking place in the seas is largely derived from the prosecution of oceanography by scientists primarily interested in the fisheries of their own countries. Several accomplishments can be listed which have arisen directly from this background of oceanographic knowledge which has been so far built up . . . Search for areas of upwelling as indicated by slightly lower temperatures and richer plankton in tropic water has resulted in the extension of the Japanese tunny fisheries far eastward into the Pacific and westward to the African coastal waters." (23)

"Such a simple and elegant solution was the extension of the mesh sizes of trawl nets to cope with overfishing. It is inconceivable that the industry would have accepted this solution unless it could have been backed by the assured knowledge that came from long years of patient and costly investigations.

Similarly, the study of the population dynamics of the North Sea plaice has provided a basis for economic and effective exploitation of the fishery. Fisheries oceanography has played its essential part in providing the fisheries biologists with accounts of the currents and the nature of the water in which these fisheries are conducted and in which spawning and transport of young stages occurs.

All the economic teleost fish have planktonic young stages which feed on other small animals or plants which drift freely in the plankton and are controlled by the biochemical status of the water. It is in these aspects of fisheries biology that fisheries oceanography pays its most profitable dividends. The advances are not spectacular . . . , but without this knowledge of the environment fisheries research would have to close down.' (24)

"Found out something of life histories of Pacific salmon and tunny." (25)

1. Provision of charts of the depths, bottom topography, type of bottom, tidal streams etc., on the fishing grounds.
2. Detection of water masses and the determination of their horizontal and vertical boundaries and their movements.
3. Research into methods of chemical and physical analyses that fishery biologists can then use or adapt to suit their own needs . . .
4. Knowledge of the temperature range of the water masses and the distribution of associated species of fish and their races, and the changes associated with long term trends.
5. The effect of the physical and chemical (including micro organic chemical) environment on mating and spawning of fish and the organisms that are the food of fish.
6. The effect of these factors on fish behaviour and migration.
7. The effect of temperature on hatching and development of fish eggs.
8. Physical drift of fish eggs and larvae and the larvae of food organisms.
9. Potential fertility of different water masses.
10. Provision of environmental data in mathematical form for use by fisheries biologists in their models." (26)

"demonstrate a correlation between some of these factors (such as temperature, salinity, primary production, plankton standing crop) and the distribution and abundance of fishes, usually as measured by landings . . . Fisheries oceanography has not so far been of much practical assistance in improving the catch of an existing fishery or predicting its future, or in guiding exploratory fishing for a new one." (27)

"So far, what it has accomplished is very little. Studies have indicated possible correlations between temperature, salinity, currents, etc., mostly as isolated factors, and availability of fish stocks." (30)

"Previous work in fisheries oceanography has resulted in the physical and chemical changes of some sea areas with time being sufficiently well known to be of use to fisheries biologists in the interpretation of numbers - or availability of food fishes or the food organisms, e.g. the circulation of ocean water resulting in persistent local upwellings and the associated planktonic abundance necessary to maintain permanent fisheries (33)

"Knowledge of all the stages involved in the relationships among fish, sea and catchability has grown to a stage when, by and large, scientific culture of fish stocks might be undertaken with success if only there were control of the 'climate'. Lacking this, it is only possible to conduct practical and economic production of fish within limits and one must therefore accept the only alternative, namely the practical management of fishing, subject to the prevailing oceanographic climate." (35)

"the state of knowledge of the population dynamics of land insects, birds and mammals is no more advanced than that of the most heavily exploited fish stocks." (36)

"The study up till now has given some attempts at more rational explanation in fisheries. It has helped to assess the more proper use of gear and methods of fishing. It has indicated possible new fisheries or how depressed ones might be resuscitated. It has indicated how newer fisheries might be developed." (38)

"Substantial progress in the following lines:-

1. Identification of fish stocks and forecasts of shoal movements for commercial processes;
  2. Establishing the dynamic characters of fish population so that optimum exploitation may take place;
  3. Methods of identifying and tracing shoals by the use of echo sounding;
  4. Success in transplantation experiments (Shad in the U.S., Plaice in Denmark, Mullet in Egypt, Salmon in Russia and New Zealand)."
- (39)

"Conservation; some gear (including a lot of fish detection); survey work.

It is pretty well true that all this has been achieved to date without any real use of most oceanographic subjects (hydrography, plankton etc.) e.g. the effective Pacific halibut re-

gulations are based on fairly complete ignorance of the fundamental biology of the halibut - and no worse for that. It can be argued that the Japanese Pacific tuna story would be just as useful based on 'fish at such and such a latitude' as on 'fish on such and such hydrographic feature' - and would have been established as quickly. At Bear Island a trawler can find cod more quickly with an echo sounder or a trawl as with a thermometer - even given that the 2°C story holds completely." (44)

"the more notable achievements ...can be found in those studies whereby the distributions of the arcto Norwegian cod stocks in the Barents Sea, the herring in the Norwegian sea and the tuna in the Pacific have been explained in terms of oceanographical factors. (It might be noted here that fisheries oceanography can throw up discoveries of fundamental importance to oceanography as a whole e.g.the Cromwell current)."

#### Combination of quotation and comment

In a sense the answers to the second question reveal the conflicts in the answers to the first. There is the extensive range of fisheries oceanography - "it has accomplished so much" - "a great deal of basic knowledge from all branches of Fisheries Oceanography . . . is beginning to lead to a better conservation of the stocks of fish" - "to ask what fisheries oceanography has accomplished is to ask what fisheries research has accomplished?" But the real point is that the restricted range of fisheries oceanography is that which has been achieved.

I list the achievements:-

On availability: "the expected presence of tuna near the upwelling streaks" - "the success of Devold in connection with the herring and its temperature environment" - "Eggvin's work on the position of the cold front off northern Norway" - "relating tuna availability to wind conditions around Hawaii" - "the work of Tully on the displacement of the arrival path of salmon to British Columbian coastal waters" - "Kalle's simple correlations between herring availability and rainfall" - "German studies explaining the changeover in the Baltic from pelagic to demersal fish" - "German investigations which connect the availability of redfish with meteorology in the North-west Atlantic" - "German researches connecting cold water overflow across the Arctic/Atlantic banks with the presence or absence of redfish on their lee side." - "a flood of light has been thrown on factors affecting the distribution of fish. . . ." - "in the North Atlantic, the limits of distribution of cod stocks have been defined in terms of their temperature requirements and spawning migrations" - "in the Northern north sea, the relation between the distribution of herring shoals and the oceanic influx and its associated plankton has been described"- "the search for areas of upwelling as indicated by slightly lower temperatures and richer plankton in tropicwater has resulted in the extension of the Japanese tunny fisheries far eastward into the Pacific and westward to the African coastal waters"

On new fisheries: "the deep water prawn trawling off Norway. spreading later to other parts of the world, the great clupeoid - - fish meal industries off S.W.African and Peru, and descending again in the scale of magnitude, the crayfishing at Tristan da Cunha and Gough Is." - "success in transplantation experiments (shad in the US., plaice in Denmark, mullet in Egypt, salmon in Russia and New Zealand).

On fisheries biology: "it has accomplished an enormous amount in producing a background picture" - "it has determined a lot of basic knowledge regarding such things as cyclic changes in the marine environment, the life history and behaviour of fish and associated organisms" - "the study of the population dynamics of the North Sea plaice has provided a basis for economic and effective exploitation of this fishery. Fisheries oceanography has played its essential part in providing the fisheries biologists with accounts of the currents and the nature of the water in which these fisheries are conducted" - "substantial progress in the following lines: -1. identification of fish stocks and forecasts of shoal movements for commercial processes; 2. establishing the dynamic characters of fish populations so that optimum exploitation can take place; 3. methods of identifying and tracing shoals by the use of echo sounding." - "conservation, some gear (including a lot of fish detection); survey work". "Sometimes fisheries oceanographers discover things of fundamental importance to oceanography e.g. the Cromwell current." This is one use of fisheries research.

Thus we have again the narrow discipline, embracing physics and chemistry only in so far as physical events react upon the vital parameters of the population. This is the study of availability in fisheries oceanography. There is also the wider discipline embracing all three sciences but restricted to particular fisheries; here are the contributions of fishery biology, including the necessary physical and chemical accounts of the ocean.

How extensive need be fisheries biology? "It is pretty well true that all this has been achieved to date without any real use of most oceanographic data (hydrography, plankton, etc.) e.g. the effective Pacific halibut regulations are based on fairly complete ignorance of the fundamental biology of the halibut - and no worse for that. It can be argued that the Japanese Pacific tuna story would be just as useful based on fish at "such and such a latitude" as on "fish on such and such hydrographic feature" and would have been established as quickly. At Bear Island, a trawler can find cod more quickly with an echo sounder or a trawl as with a thermometer. . ."

Both studies in fishery conservation and availability thus have clear limits beyond which it is needless to proceed. This, of course, means that more useful work can be done elsewhere - in fishery biology. In the North Sea since 1880, sole stocks have increased by 5-10 times and haddock stocks have decreased by 5-10 times. These are natural changes and it is no explanation to pick a convenient piece of environment in order to engineer a correlation, They

are basically changes in recruitment of which practically nothing is known. An immense amount of biological work is needed to understand this sort of change.

There is a current of discontent + "unfortunately, lamentably little and very much less than hoped" - "little integration of those parts as between the living organisms and the environment" - "too many unco-ordinated lines of work which tend to result in isolated pockets of knowledge which may or may not have correlative value with other aspects of the subject" - "Fisheries oceanography has not so far been of much practical assistance in improving the catch of an existing fishery or predicting its future, or in guiding exploratory fishing for a new one" - "So far, it has accomplished very little. Studies have indicated possible correlations between temperature, salinity, currents etc., mostly as isolated factors and availability of fish stocks".

No discontent is expressed at the conservation aspect of fisheries biology. It is directed mainly at availability studies and "environmental" studies. I think that the relative failure of availability studies is failure to realize a hope: Such situations are often transient and a combination of knowledge on availability would be needed for scientists to outfish fishermen. The failure of "environmental" studies is for me a properly scientific failure, associated really with a too facile use of the word "environment",

So far I have attacked the use of the word "environment" because in it is lumped the irrelevant as well as the relevant, and its use tends to gloss over the need to find the factors affecting the vital parameters of the population.

I now attack "short cut" methods. A short cut method is usually a correlation between, say, year classes and sunspots (Ottesal, 1960) This correlation is a good one over a vast number of years. Because the two variables are only linked distantly, we have not added to knowledge but only added to mystery. Such a correlation only becomes useful when we understand, brick by brick, how it works. There is, of course, a use in such a correlation but it is a minor one and its terrible power to mislead must be recognized.

### Conclusion

When we examine what has been achieved it is not surprising that the achievements are within the restricted range of fisheries oceanography applying all sciences to the fish stocks. There are three groups of achievements in studies of availability, in the discovery of new fisheries and the general study of fisheries biology. There is a tendency to put the narrow physical fisheries oceanography in availability studies.

It was pointed out that some conservation work needs no availability biology studies. Other work on conservation needs intense biological study. My own opinion is that the lasting achievements of fisheries oceanography are in the development of population models and in the biological description of the fisheries. In general availability studies (as opposed to the discovery of fisheries) have not yet taught fishermen how to fish.

\* \* \* \* \*

### Question 3

What should it try to accomplish?

#### Quotation

"(a) The maintenance of existing fisheries for the benefit of mankind, above all preventing overfishing (b) increase the productivity of existing fisheries by artificial means or by wise husbandry (c) discover new fishing grounds, both onshore and pelagic, which means exploration of the world's oceans . . . ." (2)

"Not too much . . . . I have found that the overall picture gained from hydrological studies in Lake Nyasa, although helpful in giving part of the background story, does not solve problems associated with particular fisheries. Even if oceanographic studies showed the possibility of a stock being present in a particular area they would not necessarily indicate its availability, which would depend on more purely biological factors . . . ." (5)

". . . seek simplicity . . . it is no good at all correlating fish with scores of complicated hydrographical sections. Nothing of real use will come to pass unless the non fish half of the correlation is easy to get. This is why I put my money on meteorology. Data on winds etc. can often be got all the time gratis . . ." (6)

"(a) to catch fish and the like more easily and more economically. (b) to ensure that x years hence there will still be fish to catch. While appreciating that individual fishermen are by human nature solely concerned with the first, I personally feel that the more fundamental of the scientists' tasks is the second; and that our real duty is to gain information on the lives, habits and development of the animal populations and the influence thereon of the oceanic environment." (7)

"rational exploitation of the sea" (8)

"to supply sufficient information necessary for the greatest possible exploitation of food and other resources from the sea." (10)

"in addition work (1) towards forecasting the areas of more profitable fishing and (2) towards a general increase in the productivity of the sea by experimenting along the various lines of underwater farming methods." (11)

"Future work should be orientated towards closer integration between the various disciplines involved so that the effort available may be utilized most efficiently to produce the essential data needed for conservation and prediction of stock, and where possible the controlled cultivation of economically important marine life.:" (13)

"the key position to be safeguarded if cooperative effort between biologists, physicists, chemists and mathematicians - and the more they can all get together the faster will things move." (14)

"biological, chemical and physical investigations should be linked together by insisting on no: one unaccompanied investigation - physical and chemical work should be accompanied by biological work and vice versa . . . I admit I see the problem as an application of physical and chemical methods to biology and this is not done by leaving the program to physical or chemical workers." (15)

"It should go on trying to improve our knowledge of the relation between marine organisms and their environment to the point where the optimum catch in a given sea area can be convincingly demonstrated . . ." (16)

"(a) a greater integration of our knowledge of all the different studies which have been made . . . (b) a joint effort (e.g. the I.G.Y) between all nations - a pooling of resources . . ." (17)

"Work out the subspecies and bionomics of our food fishes with special emphasis upon the fluctuation of their seasonal appearances." (20)

"the main aims should be to help towards the best use of the ocean's resources. Three specific aims are: (a) to understand the causes of fishery independent fluctuations in important fish stocks with a view to (i) forecasting then (ii) discounting their effects in studying the reaction of fish stocks to fishing and (iii) taking measures to eliminate them if possible, (b) to improve methods of predicting the times and places where fish will concentrate, (c) the discovery and assessment of new resources." (21)

"continued investigations of fluctuations in the water over fishing grounds, as facilities and improved methods become available. One aspect which seems to deserve further investigation is changes in the biomass (dry weight of organic matter) or plankton below unit area which the water occupying particular areas actually support. This, in conjunction with the size and kind of the organisms should give an index of the supply of food to pelagic fish and to demersal fish and to demersal organisms which provide food for the demersal fish." (23)

"Traditionally fisheries biologists have stated problems to which fisheries oceanographers have tried to find answers. Also traditionally, the oceanographers have had to rebel and say "enough, the problems already stated are so large that we must be left alone for a while to establish the answers required. Only too often this approach is not sympathetically appreciated by the biologists who want quick answers to satisfy the industrialists who in turn are pressing upon them. This dichotomy is likely always to remain.

With the knowledge we now have fisheries oceanography should be able to take the lead. There are many situations now to be recognized as potentially productive where a physical and chemical study could profitably come first. Such situations are:-

1. The equatorial Girdle current (Cromwell current):
2. The consequences of surface currents flowing over deep highly irregular bottom topographies;
3. "Upwelling situations over distant continental slopes"

"Progress has been faster on the physical than on the chemical side so that an increase in the proportion of effort on the chemical side is needed. Work on potential fertility has barely started and there is a great deal to be done on these lines and on the effect of mixing of water masses of different characteristics. Chemical analysis needs to extend more into the organic side as only then will many of the links be found between fish behaviour patterns and environmental factors." (26)

"My particular field of study of trace metabolites in phytoplankton is in its infancy. The whole field of algal physiology and nutrition needs to develop parallel to and in inter-relationship with studies on the physiology and nutrition of land plants . . . (29)

"Short cuts are permissible and often necessary but the powers that be must allow sufficient time for basic studies even though they may only be concerned with variations in the sexual appendages of some god-forsaken copepod." (31)

"Fisheries Oceanography must:-

- (a) complete the physical, chemical and organic distributional mapping of the ocean;
- (b) provide intensive local study of hopeful areas which would lead to the discovery of worthwhile new fishing areas;
- (c) provide information by the intensive study of fisheries which would lead to effective conservation recommendations, e.g. location of spawning grounds, forecasting of good and bad year classes." (33)

- "(a) find the basic factors influencing the biology of commercial species.
- (b) improve the accuracy of short and long term forecasting of fish populations;
- (c) investigate the possibilities of extending fisheries to species not caught commercially and to areas not fished;
- (d) to investigate culture and transplant methods." (34)

I have yet to find any substantial numbers of senior workers in fisheries who are unappreciative of the importance of maintaining a good proportion of fundamental long range work in fisheries laboratories . . . what is lacking in fisheries oceanography is the intimate knowledge needed to give us an understanding of the factors governing the movements and survival of fish eggs, larvae, juveniles and adults and of the food plants and animals on which they depend. An example is provided by the North Sea, where despite years of study which have given us a general picture of circulation, mixing, nutrients and bottom topography, we lack the sufficiently detailed knowledge of currents and tidal movements to enable us to understand the forces at work which result in the movements of adult herring to the same restricted spawning areas year by year and the redistribution of the larvae and young fish northwards into the nursery and feeding areas.

We need more and better and cheaper instruments for recording current speed and direction, temperature, salinity, light penetration, turbidity, oxygen, etc. We also need cameras and automatic samplers of fish larvae and fish food. We need cheap instruments to tell us

where our nets are working . . . we need improved instruments for fish detection . . . we need reliable and cheap instruments which can be supplied and used in numbers . . .

There is another weapon . . . international co-operation in the work at sea . . . too many people confuse sitting on committees and drawing up paper plans, with working." (36)

"In addition efforts should be made to make the brooding, culture and farming of sea fish a reality. By this I mean a substantial development of Shelbourne's methods married to those of Gross." (39)

"We require much information on the thermocline system existing at different seasons throughout the Gulf of Aden, and the influence of Red Sea waters in the Gulf of Aden, on meeting other currents which flow into the Gulf from the east. This complex is the main influencing factor on the movement of plankton and plankton feeding organisms on which our carnivorous fishes depend (40)

"More attention should be paid to new fisheries and those which might be developed e.g. Tuna in the tropical Atlantic, Sardinella off west Africa and Sebastes in the North Atlantic. (41)

"I would like to see an extension of (Studies) so that we can forecast the distribution (of stocks) in a particular season . . . a concerted effort to understand the effect of biological and physico chemical factors of the larval stage and hence on stock size . . . ." (46)

\* \* \* \* \*

#### Combination of quotation and comment

What should be accomplished is apparently a programme for fisheries research - "increase the productivity of existing fisheries" - "to catch fish and the like more easily . . . our real duty is to gain information on the lives, habits and development of the animal populations and the influence thereon of the oceanic environment" - "rational exploitation of the sea" - "to supply sufficient information necessary for the greatest possible exploitation of food and other resources of the sea" - "forecasting areas of more profitable fishing" - "to produce the essential data needed for conservation and prediction of stock" - "work out the subspecies and bionomics of our food fish" - "help forward the best use of the ocean's resources." This is very much the background to earlier answers.

Are there any significant directions of research?  
"data on winds etc. can often be got all the time gratis - "experimenting along the various lines of underwater farming methods" - "the application of physical and chemical methods to biology" - "to understand the causes of fishery independent fluctuations; predicting the times and places where fish will concentrate; discovery of new resources" - "changes in biomass" - "potentially predictive situations, where a physical and chemical study could come first: - the Cromwell current; the consequences of surface currents flowing over deep and highly irregular bottom topographies;

upwelling situations" - "organic chemical analysis . . . find links between fish behaviour patterns and environmental factors" - "algal physiology and nutrition . . . in parallel with studies on the physiology and nutrition of land plants" - "investigate culture and transplant methods" - "the intimate knowledge . . . to give understanding of the factors governing the movements and survival of fish eggs, larvae, juveniles and adults and of the food plants and animals on which they depend". "Need more and better instruments for recording current speed and direction, temperature, salinity, light penetration, turbidity, oxygen etc.,; cameras, automatic samplers of fish larvae and fish food, improved instruments for fish detection; reliable and cheap instruments which can be supplied and used in numbers" - "make the breeding, culture and farming of sea fish a reality, i.e. a substantial development of Shelbourne's methods married to those of Gross."

To me one of the most important items emerging from this section is this: - "closer integration between the various disciplines involved" - "cooperative effort between biologists, physicists, chemists and mathematicians; and the more they can all get together, the faster will things move" - "biological, chemical and physical investigations should be linked; I see the problem as an application of physical and chemical methods to biology and this is not done by leaving the program to physical and chemical workers" - "a greater integration of our knowledge; a joint effort (e.g. the I.G.Y.) between all nations - a pooling of resources" - "international co-operation in the work at sea". There is much more than lipservice to international co-operation here; it is a combination between nations and between disciplines. The form of combination is the concentrations of people in different disciplines on the same subject: physicists estimating stock densities and biologists estimating diffusion.

As a physical discipline, fisheries oceanography should: - "continue investigations of fluctuations in the water over fishing grounds" - "complete the physical, chemical and organic distributional mapping of the ocean" - "much information on the thermocline system throughout the Gulf of Aden."

The division between fisheries biologists and fisheries oceanographers (in the narrow sense) is referred to the latter saying: - "the problems already stated are so large that we must be left alone for a while to establish the answers required . . .; the biologists want quick answers to satisfy the industrialists". I do not believe that this is the reason for the division; very few fishery biologists have to supply answers to industrialists, they supply them to governments, for whom a right answer is better than a quick answer. Indeed the need for fundamental fisheries work is recognised: "I have

yet to find any substantial number of senior workers in fisheries who are unappreciative of the importance of maintaining a good proportion of fundamental long range work in fisheries laboratories" - "short cuts are permissible and often necessary but the powers that be must allow sufficient time for basic studies even though they may only be concerned with variations in the sexual appendages of some god forsaken copepod." I abhor short cuts; the use of a short cut means that the real relationships are unknown and so it is not worth making. But because research ships are expensive, short cuts are tempting, particularly in the so-called physical side of fisheries oceanography.

### Conclusion

This is an extensive and imaginative programme for fisheries research. There are three or four main lines, the analysis of fertility, the prosecution of fish farming, the analysis of year class fluctuations, the understanding of fish behaviour and the discovery of new fisheries. The mass instrumentation of observation and data processing was suggested. But the most important of all is the need for the welding of international co-operation and the establishment of mixed discipline teams. To me this last point means the abandonment of hydrography, chemistry or zoology: the team of all disciplines works on a single problem-herring stocks in the North Sea, salmon migration in the Pacific, the Deep Scattering Layer as an economic resource, the fertility of upwelling areas etc. The physicist takes part in fish measuring and the biologist is allowed to read thermometers. Then I think that the causes of decision between physicist and biologist will disappear, having been made clear.

\* \* \* \* \*

### Question 4

What work is needed from other scientific disciplines in order to advance?

#### Quotation

"Chemistry, physics, meteorology, physiology, biochemistry etc." (1)

"very few scientific disciplines that will not be ultimately involved if great advances are to be made." (2)

"Problems of fish migration . . . would involve studies in fish behaviour and physiology, and studies on nutrient cycles and food chains would take in almost the whole discipline of fisheries oceanography." (5)

"The fisheries oceanographer needs all he can get which seems to have a possible relevance, from the meteorologist, from the physicist, from the optics man, from the chemist and from the geologist . . . Success can only come of the manageable data . . . Can the Gordon Riley kind of correlation ever be worked on labour grounds? . . . I remain unashamedly convinced that hopes have to be pinned to some

- umbrella factors within the domain of meteorology . . . unmanned buoys will monitor conditions far and wide over the oceans and will radio their data back to the land based office . . . I am sure that meteorology must be laid under contribution 'to the last gap' so to speak. The alternative of lots of earnest little men building mountains of unmanageable data makes little appeal to me." (6)
- "A study of sea floor deposits by geologists. Temporal changes in nature of water masses and their circulation should be studied by meteorologists, physicists, geographers and mathematicians." (3)
- "Surely major advances in any scientific discipline will help fisheries oceanography either directly or indirectly?" (8)
- "Hydrodynamics and engineering studies of ships and gear." (9)
- "The scientific disciplines already engaged are physics, chemistry, zoology, botany, geology. There should be more oceanographical meteorology. The work needed is really an intensification of all these, rather than the introduction of other scientific disciplines." (10)
- "echo location, television, infra-red photography, bathyscape construction . . . pure research in physiology, animal behaviour." (11)
- "Improved methods of instrumentation; meteorology for the prediction of long and short term effects of . . . wind on residual current systems and tides; mathematics for the construction of models and theoretical systems . . ." (13)
- "sea going experience, some of it under commercial fishing conditions" (16)
- "Satellite weather research; thermonuclear heating of large quantities of water." (17)
- "Meteorology: to understand the inter-relation between atmospheric and oceanic circulation; long range weather forecasting and ice forecasting. Parasitology, as help in separating fish stocks. Genetics, to find and breed the most suitable races for fish farming. Electronics, to devise better instruments. Engineering to devise better gears for catching fish." (21)
- "Advances are likely to require the cooperation of workers with basic training or knowledge of a wide range of scientific disciplines . . ." (23)
- "fisheries oceanography is exceptional in that basic studies in physical, chemical, and biological (ecological) oceanography have attracted only a few workers in universities . . . Provide unfettered opportunity for gifted people to advance knowledge. Fetters produce sterility." (24)
- "Physiology and biochemistry of tuna, but not with British money" (25)
- "Biochemistry . . . the technique of micro analysis to find out what is in the sea, its source and its importance . . . and the establishment of the links between these chemical factors on the various behaviour patterns of the living organisms in the sea Electronics and mechanical engineering to devise simple yet robust and seaworthy instruments. Documentation. There is room for improvement in dissemination, classification, translation . . ." (26)

- "The rate of advance is probably more dependent upon the financial resources available than upon the use of new techniques." (28)
- "Ethology: effects of various environmental factors, individually and collectively on the behaviour of fish.
- Physiology: "optimum, inhibitive and lethal levels of various environmental factors, individually and collectively on different physiological processes in various stages of development of fish." (30)
- "Bigelow on Oceanography: Every oceanic biologist should therefore be grounded in the principles of geophysics and geochemistry; every chemical or physical oceanographer in some of the oceanic aspects of biology." (31)
- "Perhaps geology and meteorology could contribute more than they do at present, although both are rapidly coming into the general picture.
- Microbiology . . . has yet much to contribute and biochemistry is still in its infancy." (32)
- "The fish physiology associated with hydrographic conditions in a study of migration." (33)
- "The help of high powered mathematicians and computers to advance the understanding of the dynamics of water movement and mixing. At the root of the whole matter are the problems of cell growth and the dynamics and physical chemistry of nutrient absorptions from very dilute solutions." (35)
- "nature, occurrence and role of marine bacteria; life histories of individual species of phytoplankton; factors controlling growth of phytoplankton; photosynthesis rates under different conditions; grazing factors." (37)
- "Marine science should take more account of experimental physiological and biochemical work . . . borrow a great deal from marine microbiology . . . and need genetics." (38)
- "Biochemical racial analysis; the great quantity of organic dissolved carbon; the effects of growth factors" (39)
- "I do not know and doubt if many people can give a satisfactory answer." (41)
- "the pressing need for more biochemical oceanography . . . help from engineers, electronic and mechanical, to produce fixed stations to record temperature, salinity and current . . . in shallow shelf seas with strong tidal currents . . . Egg and larval studies require more knowledge about diffusion in the sea; we have a number of mathematical models, but need an experimentation technique badly. But more important we need resources in the form of manpower and cash. I get the impression that in many countries, fisheries oceanographers are not getting an adequate share of the national oceanographic cake." (46)

Combination of quotation and comment

Usually the question has not been answered - which must reveal a fault in the question. With one or two exceptions, each answer circles round some technique or approach which is already in use. This gives the lie to the immense scientific range of fisheries oceanography as it is at present practised. The real answer is the last one: - "I don't know and doubt if many people can give a satisfactory answer"; science is a body of knowledge and if we knew how to add to it, the addition would have already taken place. I do not mean that progress is blind but that advance takes place by making conceptual structures, independent of the technique or disciplines. These are the branches of the tree of knowledge. In fisheries oceanography they are often population models, with the diffusion of water masses or the absorption of energy built into them. In other words fisheries oceanography is nearly (not quite) as extensive as it can be, as ranging into other scientific disciplines.

### Summary

Fisheries oceanography is the study of the physics, chemistry and biology of the sea as they affect the vital parameters of the stocks of commercial and exploitable fishes. There is a narrower definition than this confined to the physical events reacting on fish populations.

In listing the achievements of fisheries oceanography there are three groups, availability studies, the discovery of new fisheries and the general study of fisheries biology. The narrow physical fisheries oceanography was put in amongst the availability studies.

In listing directions of future research, five lines were stressed, fertility, fish farming, year class fluctuations, fish behaviour and the discovery of new fisheries. Perhaps the most important suggestion is the establishment of mixed discipline teams; in this way the ancient division between physicist and biologist in oceanographical work will disappear.

### APPENDIX I

- |                                  |                                      |
|----------------------------------|--------------------------------------|
| 1. Dr. T.I. Shaw, Plymouth       | 17. G.C. Bolster, Lowestoft          |
| 2. J.W.S. Marr, N.I.O.           | 18. Dr. F. Evans, Cullercoats        |
| 3. Professor G.E. Newell, London | 19. Prof. E.W. Knight-Jones, Swansea |
| 4. P.M. David, N.I.O.            | 20. Dr. P. Deraniyagala, Ceylon      |
| 5. T.D. Iles, Lowestoft          | 21. J. Corlett, Lowestoft            |
| 6. Dr. J.N. Carruthers, N.I.O.   | 22. J. Ramster, Lowestoft            |
| 7. Dr. R.A. Cox, N.I.O.          | 23. Dr. H.W. Harvey, Plymouth        |
| 8. G.R. Forster, Plymouth        | 24. Dr. L.H.N. Cooper, Plymouth      |
| 9. P.G. Corbin, Plymouth         | 25. Dr. J.A.C. Nicol, Plymouth       |
| 10. Dr. F.S. Russell, Plymouth   | 26. Dr. J.H. Fraser, Aberdeen        |
| 11. Sir Alister Hardy, Oxford    | 27. Dr. R.H. Clarke, N.I.O.          |
| 12. A.R. Margetts, Lowestoft     | 28. S.G. Brown, N.I.O.               |
| 13. Dr. P.O. Johnson, Lowestoft  | 29. Dr. J.A. Mowat, Aberdeen         |
| 14. Sir James Gray, Cambridge    | 30. Dr. B.S. Bhimachar, India        |
| 15. Dr. A.J. Southward, Plymouth | 31. P. Foxton, N.I.O.                |
| 16. Dr. T. J. Hart, N.I.O.       | 32. Dr. D. P. Wilson, Plymouth       |

33. J. D. Riley, Lowestoft
34. M.R. Clarke, N.I.O.
35. Dr. R. Johnston, Aberdeen
36. Dr. H.A. Cole, Lowestoft
37. Mrs. Cassie, New Zealand
38. Professor J.E.G. Raymont, Southampton
39. R.S. Wempenny, Lowestoft
40. V.T. Hinds, Aden
41. V. Bainbridge, Edinburgh
42. G.B.G. Harrison, Ghana
43. J. Wickstead, Plymouth
44. J. A. Gulland, Lowestoft
45. J. C. D. Watts, Sierra Leone
46. Arthur Lee, Lowestoft



WPFO 62-4  
30 August, 1962  
San Diego, California

TO: Members, SCOR Working Party on Fishery  
Oceanography  
FROM: W. M. Chapman

SUBJECT: Volume II of Comments on Fisheries Oceanography

Volume I of Comments on Fishery Oceanography has already been transmitted to you. It was composed of general comments from me, other materials coming from other members of the Working Party, and other materials from persons outside North America. It was intended at the time it was being put together that all the materials in Volume II would also be included in it so that the preparatory documentation for our Bergen meeting would all be included in one handy volume.

After this work was well in progress through the typewriter it became obvious that the facilities available to me were not adequate to get the whole to the members in time for their inspection and study prior to our meeting. Accordingly the material was rather arbitrarily split into two segments of unequal size, the splitting being done at the point where the work was when the decision required to be made.

The unfortunate effect of this is that a clean break was not possible at that time. The present Volume II is composed of my original letter of 25 December, 1961 on this subject and about 100 pertinent replies which I received to it. All of the materials from United States and Canadian workers are included in it, but unfortunately so are several others that properly should have been included in Volume I, such as the correspondence with Cushing, Uda and Davies of the Working Party, and also exchanges of correspondence with workers in international agencies, such as Wooster (UNESCO), Holt (FAO) etc.

I have left out of this whole composite in Volumes I and II replies from perhaps fifty people that were either almost entirely personal, trivial, or not responsive to our task. I have left out numerous letters of an organizational nature among myself, members, Dr. Humphrey, and Dr. Böhnecke. Included, however, in these two volumes is all of the correspondence which has come to my hand which I considered to be pertinent to the task assigned to us.

It is, finally, desirable to again state that all of the opinions expressed by all of the writers of all this correspondence, including mine, is that of each alone, writing in his individual capacity as a scientist and does not necessarily represent the views

August 30, 1962

of his (or her) country, or the institution by which the person is employed. This is the condition under which I solicited replies. Some stipulated this again in their reply; others did so in following letters giving me permission to use their replies in the form I have done, and which I have not reproduced.

Sincerely yours,  
 VAN CAMP FOUNDATION  
 W. M. Chapman, Director

\* \* \* \* \*

## ORIGINAL LETTER

VAN CAMP FOUNDATION W. M. Chapman, Director 739 Golden Park Ave.  
 December 25, 1961

Dear

At its Monoco meeting in early November 1961, the Scientific Committee on Oceanic Research decided to appoint a "SCOR Working Group on Fisheries Oceanography" with the following terms of reference.

1. To discuss and define the subject of fisheries oceanography.
2. To state what fisheries oceanography has accomplished
3. To state what fisheries oceanography should be trying to accomplish.
4. To state what progress is needed in other sciences so that the aims set out in 3 can be attained.
5. To communicate the statements listed above, through SCOR, to interested laboratories and organizations.

The Working Group was to inquire as deeply and broadly into these subjects as time permitted and report back to SCOR at its next regular meeting, scheduled loosely at present as between October 1962 and March 1963.

Pursuant to this action Dr. George F. Humphrey, President of SCOR, has requested a group of nine persons to serve on this Working Group. These are Dr. Cushing, Lowestoft Fisheries Laboratory, U.K.; Dr. Bjerknes, Department of Meteorology, U.C.L.A., Los Angeles, California; Dr. Davies, Oceanographic Institute, Union of South Africa; Professor Adolph Bückmann, Institute für Fischereibiologie, Germany; Dr. Popovici, Special Fund Fisheries Project, Lima, Peru; Dr. Rass, Institute of Oceanology, Moscow; Dr. Rollefson, Bergen Fisheries Laboratory, Norway; and Dr. Uda, Tokyo University of Fisheries, Tokyo. He has asked me to serve as Chairman of the Working Group.

In his letter of request Dr. Humphrey said, pro parte "Early this year SCOR received suggestions for the formation of two new working groups, namely -

- "Location and Investigation of New Fisheries Resources" and
- "Oceanographic Estimation of the Size and Distribution of Oceanic Living Resources"

"These suggestions are symptomatic of the increasing attention being given to the interaction between the fisheries and oceanographical fields of research. This attention has been evident at the many intergovernmental oceanographic meetings held in 1960-61, and particularly at the recent meetings of the Intergovernmental Oceanographic Commission ----"

"SCOR chose the above terms of reference because its members had noted that during the discussions at the meetings previously mentioned, there was much confusion concerning the nature, accomplishments, and aims of fisheries oceanography. On the one hand, the term was used to include all of fisheries science; on the other, to denote a restricted use of a small part of physical oceanography. SCOR felt that before any attack could be made on the problems envisaged in the original working group suggestions, it was necessary to examine some of the basic considerations involved.---"

"SCOR felt that it could make a contribution by bringing together a small group of workers in diverse fields so that the different viewpoints could be recorded, discussed, exemplified, and put together for the benefit of intergovernmental bodies, laboratories and individual workers. Such actions would assist further work by SCOR and other bodies.---"

All of this transpired while I was on tour. I had been to IOC meeting in Paris and the SCOR meeting in Monaco. I continued on to the General Conference of FAO in Rome, then on down the East Coast of Africa to Cape Town, back up the West Coast and through Western Europe, arriving back on December 23, to find that Dr. Humphrey had initiated the above actions in my absence. My travel and work commitments for the next little while are such that it is necessary to get the work of this Working Group initiated at once if the time desideratum set by Dr. Humphrey is to be met.

Accordingly, this communication is being sent to workers in this field in the United States and Canada prior to hearing from other members of the SCOR Working Group or initiating any correspondence with them, in order that the process of thinking and comment on this subject matter can be put in train as expeditiously as possible. At the same time, I am suggesting to the other Working Group members that they invite comment similarly from workers in ocean research in their areas so that we can begin to have a broad body of opinion from the actual workers in this field to collate and form into a suitable report.

My timing desires are somewhat stricter than those set down by Dr. Humphrey. I would hope that the Working Group would have the bulk, if not all, of its work completed by mid-September, 1962, so

that a completed report, or a draft in advanced stage, could be available for consideration somewhat prior to the next meeting of IOC which will be in Paris at UNESCO House during the last week of September, 1962.

A preliminary time desire arises from a different cause. The General Conference of FAO in November approved the establishment by the Fisheries Division of FAO of an Advisory Committee on Marine Resource Research. Dr. Finn, Director of FAO Fisheries Division, told me in mid-December that he was proceeding with the appointment of this Committee as soon as possible with a view of having its first meeting in Rome in March.

It is obvious to all hands that the work of these two groups should be related in such a manner that FAO, UNESCO, intergovernmental bodies in this field (such as the International Fisheries Commissions), and the international community in general, can benefit most from the information and opinions that each brings forward. Accordingly it would be helpful if a considerable body of opinion in respect of the first four terms of reference of the "SCOR Working Group on Fisheries Oceanography" cited above could be in hand, at least from United States and Canadian workers prior to the March meeting of FAO's ACMMR.

With this in mind I would most deeply appreciate it if you would give solid thought to these first four terms of reference and give me your written reaction to them, and any related considerations that come to your mind, and have it to me prior to March 1, 1962.

I am asking that this response be made in your capacity as an individual scientist in this field of research and not as representing the opinion of your laboratory, agency or organization. Your observations will be kept confidential and will not be used under your name without your specific permission.

The reason for this stipulation is that a great many of the scientists to whom this is being addressed are employed by governmental agencies whose policy objectives in the field might not be consonant with the views of the individual worker most closely dealing with field and laboratory problems, and it is the view of this individual worker, who is closest in the chain of command to the problems in nature, that are most valuable to us at this stage of inquiry.

Perhaps the most reliable service SCOR can provide in this matter is to serve as a sounding board for the individual scientist in the field without the dampening effect of policy control upon their views. Exercising this same right of independent thought I wish to set down some privately held ideas on this subject of fishery oceanography that do not necessarily represent the views of my own organization or of SCOR, and for which neither is to be held responsible.

To begin with I am not at all sure to what the term "fisheries science" as used by Dr. Humphrey in the above citation refers. In casual conversations with him I was not at all sure that we were talking about the same thing although we were using the same words.

NASCO, the National Academy of Science Committee on Oceanography (which forms the national committee for the United States in SCOR) defines oceanography as the study of the ocean, its boundaries and its contents, and defines the term oceanographer as a person who engages in such studies. This seems quite straightforward and satisfactory to me.

In view of the fact that so far the activities of man do not bulk large in altering the natural processes of interaction among ocean, its boundaries and its contents (in gross) one may assume that the term oceanographer as used alone describes a person who studies natural processes.

The situation is not at all so clear when one refers to fishery scientists, and in what I have to say on this I am referring to practitioners of that art in the marine field.

Man does intend to affect the fish populations upon which he works, and in fact does affect them materially. The prime purpose of a good many of the dozen odd international fisheries commissions which operate in the world is to prevent the fishing operations of man on that particular species or group of species from lowering the abundance of that population or population complex below the level at which it is able to produce the maximum sustainable yield ad infinitum. This is also a prime purpose of many of the fishery agencies of the advanced fishing countries and their political sub-divisions (in particular the fishery agencies of the Maritime States of the United States and Provinces of Canada).

A prime originating source of what are called fishery scientists has been this field of population dynamics as applied to fishery conservation problems. It may be noted that it is generally necessary for these people to take account not only of the reactions of the fish and their natural environment but also the added predator man. It is a platitude in the profession that the fish are much easier to understand than the fishermen.

Is a blood biochemist who is exclusively involved with trying to determine racial groupings of fish by various techniques a fisheries scientist?

Is a mathematician who never sees a fish but is concerned with devising a mathematical model which his agency's data might reasonably fit a fisheries scientist?

Is a person who is concerned with keeping track of the changes fishermen make continuously in gear, its use, and vessels and their use in order to provide current estimates of fishing effort potential a fisheries scientist?

What about a fellow who spends part of his time in population dynamics, and another part in devising and applying regulations and measuring their effects upon fish and fishermen?

In the early history of marine fishery science at ICES (the International Council for the Exploration of the Sea) a prime purpose

was to study the ocean and the fish with a view to being able to predict the availability of fish in time and space.

In more recent times this branch of fishery science has received great impetus in the tuna fisheries of the world, in the great herring and cod fisheries of the North Atlantic and Arctic, in the booming anchovy fishery of Peru, etc.

An advancement of this line of research, and also of the conservation line of research, is leading toward the humanitarian goal of resolving the protein deficiency of people in developing countries and gives rise to the suggestions received by SCOR in the past year to establish two new working groups namely - "Location and Investigation of New Fisheries Resources" and "Oceanographic Estimation of the Size and Distribution of Oceanic Living Resources."

This trend is being much augmented by various Technical Cooperation Projects under bilateral and multilateral auspices designed to increase the yield of fisheries in particular ocean areas. A particular case of this is provided in the Special Fund of the United Nations. Its terms of reference require that work done with its funds be predevelopmental in the sense that its projects should lead in a reasonable period of time to production. It does not support oceanographic research as such, but nevertheless, its funds are becoming an important factor in promoting the growth of fishery oceanography (as witness an important component of its fishery Project in Peru).

These Technical Cooperation Projects are becoming most important in the world in their provision of funds for the training of fishery scientists and their useful employment, but their aim is primarily economic and is not aimed at science except as a tool to that economic end. At one end of its scale might be put the Special Fund Project for a Meteorological Station in India to correlate the Meteorological observations of the Indian Ocean Expedition, and at the other end might be placed the Fishery Officers in Aden, Somalia and Tanganyika, who are presently happy to get their primitive fishermen accustomed to using simple motors in their dugout canoes, tough steel hooks, and nylon webbing. The latter would resent being called fishery scientists, whom they rather hold in scorn. But in these Technical Cooperation schemes that spectrum from physical oceanographer to fishery officer appears to be continuous to the outside observer.

One might say that all fishery oceanographers are fishery scientists and that the difficulty is in telling what a fishery scientist is. Certainly a definition confined to persons studying natural processes is too confining to be useful in this field of activity. On the other hand a definition so broad as to cover the whole gamut of persons dealing with the development of sea fisheries would have no useful meaning as a description of a field of science.

Your views on this question would be appreciated.

It would appear to me, on the basis of conversations had in many parts of the world over several years that opinion on fishery oceanography, in that part of the scientific community that has given any thought to it at all, divides rather sharply into three dissimilar and at times incompatible fields as follows:

1. One group holds that there really is no such thing as fishery oceanography. Fishery scientists, if that term is appropriate, are concerned primarily with economic objectives of one sort or another to which the term science does not always quite apply. They incline to be pretty ignorant of physical and chemical, and often biological, oceanography and, in fact, of the ocean. Their basic training is often too shallow to permit them to understand these rather abstruse matters. Furthermore they are mostly employed by government agencies, often are more responsive to policy than natural truth, and often so closely responsive to pressure from some branch of the commercial fishing industry as to be unable to bring unbiased thought to bear on ocean research problems. At best they can be expected to do no more than advanced cook book type oceanography.

2. Another group holds that a more detailed knowledge of the ocean, its processes, and the interaction of fish to their environment is too critical a necessity for the development of knowledge concerning variations in the abundance and availability of marine fish populations to be entrusted to the oceanographers, (in the same framework as Clemenceau's famous remark that the conduct of war had become too important to any longer be entrusted to generals). Oceanographers, mostly being hired by academic institutions of one sort or another, are creatures of their ivory towers and not in tune with the practical results to be expected and needed from ocean research. If anything is to be accomplished in elucidating oceanic circulation in the detail required to understand fish movements, rather than the navigational patterns of sailing ships of the last century, it will have to be done by fishery scientists hiring young physical and chemical oceanographers relatively unpolluted by the thinking of the first group, to help them as required. And,

3. A perhaps small and recent group holds that the upper ocean and lower atmosphere are a closely interacting system affecting each other intimately, and affected by processes in the deeper ocean and upper atmosphere, as well as geostrophic forces, to the extent that the system as a whole must be studied much together, and that the fish populations are so intimately associated with the environment in which they live that their processes cannot likely be understood in any useful manner until the relationship between them and the other elements of the physical, chemical and biological environment is understood.

It would be safe to say that one or the other of the rather mutually exclusive first two views cited above is held by a good many ocean research workers in the countries whose nationals are doing most

ocean research currently in the world. This gives rise to a good deal of conflict, misunderstanding, and waste motion.

The conflict thus generated has numerous bases and effects. Among these are competition for money, trained men, and research ship time under the currently limited conditions of supply of each; the competition for fields of power as between old established fishery investigative agencies and the newer agencies and academic institutions in this field, etc.

All of this is no doubt natural, and much of it is perhaps inevitable, in a field of inquiry which is undergoing such a rapid and belated expansion on a world wide basis. Nevertheless these and other competitive conflicts appear to many to be so strong and numerous at times as to be disruptive to the orderly development of this whole field of inquiry. This was particularly evident in the series of intergovernmental meetings that led to the establishment of the Intergovernmental Oceanographic Commission.

One would assume that a purpose of SCOR, as an advisory body to UNESCO's Department of Oceanography, in establishing the "Working Group of Fisheries Oceanography" was to mitigate these disruptive influences in the development of world oceanography by the means rather uniquely available to it, that is, a full ventilation of different viewpoints on this subject among scientific peers actually engaged in the development of the field.

For my part, I quite frankly advocate the third point of view noted above but I quite realize that this is because for a good many years I have been primarily concerned with elucidating the relationships among ocean, atmosphere, and pelagic fishes (primarily the tuna's) in tropical and sub-tropical seas and with the primary objective of lowering the cost per ton of production of these food resources so that they may be more broadly and fully utilized by mankind.

Those of us who have been similarly involved with these fisheries are quite prepared to admit by this time that the fish we study are much better oceanographers than we are, and that if we are to become equal to them in this field we have to mount a much broader, more comprehensive, as well as detailed, attack on the problems of relationship of the whole environment to the availability and abundance of these fishes than we as fishery scientists by ourselves are able either to accomplish or secure finances to have accomplished.

For this reason we have, through many means for several years, sought the most thorough coordination of physical, and chemical, geological, and biological oceanographers and meteorologists with our work not only so that by united efforts we could cover more ground with the limited amount of ship time, skilled personnel, and finances available to all of us by united action but so that the "hybrid vigor" induced by a cross-fertilization of ideas among disciplines might see us on our way to understanding more rapidly.

To us of this persuasion it is most useful that the whole field

of ocean research proceed as rapidly, smoothly and swiftly as man can contrive and we do not much care if this is done in the name of fishery oceanography, astrophysics, or more efficiency in hunting submarines. Dealing with the swift, far-ranging fish of our primary interest we tend more and more to desiring understanding of the whole world ocean and its processes so that the processes of more localized ocean areas and their fish contents can be better, and perhaps more quickly, understood.

In setting out the above I know that I am not putting forward views held in many other fields of fishery thought and investigation, The demersal fishes of the continental shelf, so important to mankind's nutrition, particularly in the northern hemisphere, have been longer and more fully investigated than have the tunas and those studies have led to quite different, and in some instances much more localized and finite, inquiry patterns. The great fisheries of the estuarine habitat, such as oysters, clams, shrimp, seaweed culture, etc., have led inquiry in another direction yet. Fourthly, the anadromous fisheries for salmons, shads, etc., where the fresh water life history has such importance have led to other patterns of investigation and thought again.

Indeed the people investigating pelagic fishes are far from united in their thinking and approach to the ocean and their sorts of fish. The investigators of the great clupeoid fisheries go at things quite different than do the investigators inquiring into the tuna fisheries, Again the two large-scale investigators of tuna fishery matters, Japan and the United States, have tended to go their separate ways and to adopt diverse methods of investigation.

Whether, indeed, there is a field of scientific inquiry finite enough to be called fishery oceanography is a question moot enough for serious thought. When one considers what fishery oceanography has accomplished or should be trying to accomplish, can one yet put this down in abstract generalized terms or does this need to be considered in separate terms for different types of fishery oceanographic situations? If so what, precisely, are those?

I do not know of any investigators of marine resources who would hesitate in saying that they require much assistance from physical, chemical and biological oceanographers and meteorologists in getting at their own problems. In fact most with whom I have discussed this matter over the years have felt that the other, mostly academic, oceanographers were not properly carrying their weight. If this contention is to be supported, then what should these other sorts of ocean researchers be doing which would more satisfactorily complement the studies of the fishery workers? Again, is it possible to state this in abstract, general terms as related to Fishery Oceanography, or does this have to be broken down into separate considerations for problems of pelagic, demersal, estuarine, and other sorts of fishery situations?

Another dimension has been added to marine fishery research problems in the most recent years. As a generalized statement, subject

to all the faults of the ilk, it may be put this way: A shortage of calories is not a major problem on a world-wide basis for this generation or those immediately to come. The problem of human diet most general in its adverse effect on mankind is protein deficiency. Even more narrowly the problem is concerned with not getting sufficient essential amino-acids into the human diet. These essential amino-acids are found in proportions well suited to human needs in fish protein, as well as most meat proteins, but not fully or adequately in vegetable proteins.

A series of international studies and world-wide conferences in the recent past indicate that areas inhabited by 500,000,000 people are seriously affected by such dietary deficiencies, and that a figure of 1,500,000,000 people might be more realistic; that these are mostly in developing countries adjacent to largely undeveloped marine fishery resources of the tropic and sub-tropic world ocean; and that the fishery resources large enough to abate these dietary deficiencies may well be available in the reasonably adjacent ocean.

Is fishery oceanography a sufficiently well developed field yet to be able to contribute on a broad basis to this objective of mitigating human dietary distress? If so, how? If not, what is needed?

Perhaps this leads on toward the suggestions, mentioned in Dr. Humphrey's letter cited above, received by SCOR for the formation of two new working groups and is thus inappropriate to the present inquiry. On the other hand this is a very real and concrete problem which is developing rapidly in the world and it may be well for you to have it in mind when you respond to the four terms of reference cited above to which your attention has been directed.

In any event I want to assure you that in my humble opinion as one who has been involved in these ocean resource problems in various capacities over the past thirty years, and increasingly in the international aspects of them over the past fifteen years, that I consider the questions posed by SCOR through Dr. Humphrey important enough to occupy a good deal of my scarce time with during the next year, and I hope that you will feel sufficiently the same to give them your serious thought and us the benefit of it.

No nine men that I know in the world are sufficiently wise or experienced to satisfactorily resolve the issues that these four terms of reference give rise to (or which have given rise to them). If we have your assistance we may at least be able to shed some light upon them.

Looking forward to a reply from you prior to March 1, I remain, Sincerely yours, W. M. Chapman, Director

A Fishery Biologist

January 26, 1962

Dear Wib:

This is in reply to your 10-page missle that arrived the other day and which I have read with interest. First let me say that I don't feel that I have the scope to comment thoughtfully on all the points that you raise and on those that I do remark on, you must remember that my experience is somewhat less than global.

What is a fishery scientist? My definition is a researcher who, regardless of his specialization (blood typing, scale studies, taxonomy, growth) has a working knowledge of the methods and techniques employed in the study of the life history, ecology and vital statistics of fishes. Further, he must have a basic grasp of the concepts of population dynamics, both theoretical and as applied to fishery conservation problems. By this definition the four workers that you describe at the bottom of page 4 and top of page 5 might or might not be classed as fishery scientists depending on their overall grasp of the field.

The recent emphasis on studies of the air and ocean processes and their relation to biological populations is good. However, despite all this talk in the last few years, the fields of Oceanography and Fishery Science are still a long way apart. On the entire Pacific Coast from Alaska to Chile there are almost no scientists of Oceanographic training (primarily) who know anything about the biology of fishes and in fact most would be quite insulted if they were referred to as anything but pure oceanographers. On the other hand there are perhaps a half dozen scientists of biological training (again primarily) who have a fundamental understanding of Oceanography; I refer to persons like Sette, Schaefer and Murphy. We also have a large middle group of workers (some scientists and others not) who are of biological origin who, seeing all the money and interest developing in Oceanography have attempted to identify themselves with Oceanography (higher pay grades and prestige) for their own advancement. This has resulted in people who five years ago were botanists, now being botanical oceanographers. Other new categories are arising daily such as optical oceanographer and soon perhaps even taxonomic

oceanographer. Actually little has changed but the names, the faces and actual capabilities of these people has not been greatly altered. This will change as people who are truly competent in both fields develop. The point is that one should not be too critical of the accomplishments of fishery oceanographers as in truth it is largely a mythical category.

As you may have gathered my definition of a fishery oceanographer is a scientist who is sufficiently well trained that he has the ability to understand and utilize the basic data from both disciplines for his own research, which follows the line of thinking in your section 3. at the top of page 7.

Further, I believe that these people will come from the ranks of competent fishery scientists who become trained in the field of oceanography and not visa versa.

I have tried, in the preparation of the April program for Pacific Fishery Biologists, this year to bring in a few topics which will assist in the orientation of fishery workers in this direction. Yours sincerely, s/Gordon Broadhead

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The Florida State University, Tallahassee, Oceanographic  
Institute

January 29, 1962

Dear Dr. Chapman:

The following remarks represent my personal opinions on the broad subject of oceanography and oceanographers and are not intended to be taken as representative of my organization. Other members of the staff will undoubtedly air their own thoughts in separate letters.

As a member of several national panels and committees aimed at various problems of marine research, I have become convinced that there are a number of misconceptions, or, rather, sloppy and far too general ideas, prevalent among all marine scientists with regard to their area and the people involved in it. I believe that the question of "Fisheries Oceanography" is simply another example of this confusion which has been hurt rather than helped by the reports of the NAS Committee on Oceanography and groups related to it and generated by its pronouncements. Among the several bad features of the various efforts are the following major ones: (1) the lumping together

in "statistical" surveys of oceanographic manpower of everyone from the stockroom clerk to the investigating scientist with formal sophisticated university training in his field of interest; the too specific approach to an enormously broad area which has led to the proliferation of special interest groups all trying to push their speciality in competition with others rather than in cooperation; (3) the lip service given to training with no thought of curtailment of the activities presently too much emphasized by academically based marine groups which use up the time and facilities which should be devoted to training; and (4) the cry for communication and interdisciplinary cross fertilization which ignores the several existing facilities which could implement this demand if supported by all marine scientists.

Of the above, the first yields erroneous conclusions as to the numbers of various categories of workers which in turn leads - - - to confusion in planning future programs. We should carefully distinguish between technical level people (i.e., fisheries agents involved in routine tabulations or inspections), staff people (secretarial or clerical help in marine laboratories as an example) and the scientific community or individual scientists who are doing imaginative and basic research or are interpreting and designing applied programs. This will eliminate the confusion inherent in trying to lump all fisheries workers into a single too simple category of fisheries oceanographers. This last does disservice to the persons at all levels. All encompassing inventories also interfere with training in that they lead to such appalling mismatches; as training technicians in a graduate university department side by side and in the same curriculum with future research men. It also pushes aside one of the most pressing needs in American science; the professional career oriented technician.

The second problem cited stems from the too casual view of the NASCO group in particular, with regard to the areas of research which should be stressed in future programs. Two warring schools have sprung up in the U.S. and elsewhere separating the Deep Ocean man from the Shallow Water men. This is unfortunate since both deal with the same basic physico-chemical phenomena, differing only in the techniques and methods used to elucidate these basic phenomena. These factions cut across all lines of specialization (including fisheries research) to no benefit. Both views should be reconciled.

To meet dangerous problem is the third. Unless more marine scientists of all interests are produced, the problem of definition and classification will solve itself by extinction. I have lately made myself a bit unpopular amongst some of the marine science community by stating that the university marine groups should get out of "big deal" oceanography and start minding their obligations as faculty. The international, interstate, interdisciplinary cooperative efforts for bigger and better research into bigger and broader problems is dandy when applied to federal survey agencies (i.e., U.S. Geological Survey, U.S. Fish and Wildlife Service, U.S. Navy Hydrographic Office, and U.S. Coast and Geodetic Survey) or to non-university research organizations. They are inimical to the training of future scientists. Students simply can't be bothered with in most big deals. It's much easier to use full time people. Fisheries work particularly, should be approached in the broad international sense through federal agencies and industry. The needs of the eventual cooperative programs should certainly be placed before the universities, but the same programs should certainly present their requests for new people accompanied by such things as fellowships and summer appointments for students as per the new example of the Fish and Wildlife Service Graduate Fellowships. When programs speak of future objective or future accomplishments, they are actually talking about the education and training of the persons interested in the subject area. This leads us back to the first point and the need for programs at several levels including apprentice training for modern fishermen, secondary and junior college training for technicians, and university programs for imaginative and broadly prepared marine scientists. I would include here an indictment of the current trend toward "Oceanography" programs that produce Jacks-of-all Trades, but have failed to develop masters. It has always been impressive to me that the best marine scientists all received their education in Physics, Biological Sciences, Geology or Chemistry and not in interdisciplinary areas.

The last problem, communication and interdisciplinary exchange should perhaps be given greater emphasis. The one valuable contribution of international or national groups, or committees, or panels, is in helping to bring information together for the scientific community. They fail when they enter the area of planning surveys, expeditions or future lines of research. These last should be left to the individual scientists and organizations. There should be greater emphasis on national problems first until we know more about our own seas and shores.

The above remarks have only occasionally touched on fisheries specifically, but I believe that the problems of marine sciences in general are the primary causes of problems in various subdivisions. Many of these are simply problems of communication. As you noted in your general letter the same words don't always imply the same meaning to all nations or to all fields of specialization. Sincerely, Donn S. Gorsline, Associate Professor & Acting Director

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from  
VAN CAMP FOUNDATION 739 Golden Park Avenue  
San Diego 6, California

June 5, 1962

Dear Dr. Gorsline:

1. National Interest

My first comment goes to your last. I agree that greater emphasis should be placed upon our national problems first. The question then becomes what are our national problems.

The United States consumes about 400,000 tons of tuna (raw weight) per year now and it is expected that ten years from now it will consume about 800,000 tons a year (the market has been doubling at the rate of every ten years for forty years and is still proceeding at the annual rate of increase which would indicate another doubling in the same space of time).

The raw material for this comes quite literally from all sectors of the tropical sub-tropical and temperate world ocean where there are tuna in commercial abundance. Dependence will increasingly be upon the whole world ocean rather than particular sectors of it. This is mostly processed, distributed and sold by firms having their origins, major operations, headquarters, and tax paying base in California. They also have plants and operations either in being or in immediate prospect, either wholly owned or in combination of various sorts with other entities, in Mexico, Colombia, Venezuela, Surinam, Puerto Rico, Ecuador, Peru, Chile, Senegal, Sierra Leone, Republic of the Ivory Coast, Ghana, Republic of the Congo (Brazzaville), France, Italy, Tahiti, American Samoa, Fiji Islands, Hawaii, Trust Territory of the Pacific and Indonesia. Sites are being examined in the Indian Ocean. American flag tuna vessels fish for these companies in the Eastern Pacific from

Oregon to Northern Chile in regular fashion, and off West Africa.

These are national companies. While they sell their products regularly in thirty to forty other countries their prime service is to the American consumer. I assume their interest to be a part of the national interest. It is partially on account of them that the U.S. Bureau of Commercial Fisheries interests itself in the Eastern, Central and Western Pacific, the Indian Ocean and the Tropical Atlantic oceanographic investigations as well as being attentive to matters dealing with the ocean resources in FAO, UNESCO, Special Fund, and the newly organized Intergovernmental Oceanographic Commission.

To take a second, quite separate, example. Both as stated in high national policy and as felt by the plain ordinary American in the street, it is in the national interest to see that the peoples of the developing countries are better clothed, fed and, have their aspirations better attended to. Where the ocean fits into this is indicated in the following excerpts from the Report of the International Meeting on Fish Meal held under the auspices of FAO 16-25 March, 1961.

- "5. Fish can be processed to provide for man a high quality, easily digested and complete animal protein source by exercising good practices in the preparation, packaging and storage of such a product as fish protein concentrate
- "6. Calculated very roughly, it may be said that about one million tons of such fish concentrate will satisfy the annual dietary requirements of about 100,000,000 people in a population in having a normal spread of age."
- "7. Lack of adequate protein in the child's diet manifests itself in two ways - retardation in rate of body growth and, if continued over a period of time, possible irreversible impairment of mental capability. In adults, protein deficiency leads to lack of full physical vigor, including lowered resistance to disease, and sub-optimum mental attitudes. There was attempted at the meeting the estimation of how many human beings in the world now suffer from protein deficiency. A conservative estimate of at least 500 million was arrived at, made up perhaps four-fifths pre-school age children and most of the remainder pregnant and lactating mothers."

- "8. Vegetable proteins, as stated above, cannot fill fully the protein need in the human diet. Furthermore, the amount of land in the world suitable for growing them is limited and this limitation increases as the human population continues to increase and press upon the land as in the case, for instance, in considerable sections of southeast Asia. Animal protein production can be expanded only with great difficulty in several areas of the world, in some instances because the land cannot be spared from production of other needed human food stuffs, and in other instances because endemic animal diseases make the raising of live stock impracticable. Ultimately, despite any and all land-produced protein supplies, the resources of the sea must be more fully utilized."
- "9. Large populations of fish occur in the world oceans, often in reasonable adjacency to large human populations suffering from protein deficiency. Fish protein concentrates also can be readily and practically prepared, stored and transported from major centers of fish production to areas of high human need."
- "10. For these reasons it would appear certain that the need for fish protein concentrate in the world's human diet is great, urgent and should be capable of fulfillment. What value to give to the quantity needed is uncertain, except to say that it is to be expressed in terms of millions of tons of fish meal and fish flour per year."

Arising from these things, again, the Bureau of Commercial Fisheries validly deals with ocean areas far from our shores; Agency for International Development assists ocean research far removed from our shores; so does Special Fund, UNICEF, FAO, UNESCO, and IOC where the United States foots about one third of the bill.

To take a third separate example. The last war rather demonstrated to the United States Navy, or at least to me chasing around with it in the South Pacific, that war is liable to take the Navy in some peculiar places where even the land is not charted. The next war, if there is one, is likely to see the Navy everywhere where there is salt water and some places where there is not. Tell me where in the world is the U.S. Navy's interest in the ocean the greatest? Today it looks as if it would be more useful to the U.S. Navy to know more of the submarine geology of the Bay of Bengal than the approaches to San Diego, and I am glad they are having a look at it.

Other examples could be drawn upon ad nauseum, but in summation I contend that the interest of the United States in the ocean is as broad and deep as the ocean itself, and that there is only one ocean.

2. NASCO

I am very pleased when ocean researchers criticize NASCO and its report as well as its present work. I am strongly convinced that when the scientific community, and particularly administrators, are pleased by the work of such bodies as NASCO and SCOR that those bodies are not performing adequately their prime functions of critical inspiration. In a rapidly growing field such as ocean research the workers in it need to have their thinking shaken up on a pretty continuous basis. This applies no more to the University researcher who may tend to ivory tower seclusion than it does to the worker in government laboratories.

Researchers who become confused by such stimulants to the extent that their work is hampered rather than being stimulated and constructively inspired probably were not going to do much of earth shaking importance besides draw their salary check anyway.

3. Deep-water versus shallow water men.

One difference you have not noted between these two is that it costs the deep-water man about \$1,500 per day simply to have a platform to work upon in addition to the other costs that a shallow water man has. This requires bigger units of capital, supporting staff, money, etc., than the shallow-water man has to contend with.

These two sorts of men do not deal with the same sort of problems, There is no way in which the small along shore laboratory can deal with problems of ocean wide circulation, affect of wind variability on ocean current variability, vertical transport away from the effects of land, etc.

I think the expression that there are two warring schools in the U.S. composed of Deep Ocean and Shallow Water men and that this is attributable to NASCO does not square with the facts.

Prior to World War II we had no deep ocean men on this coast except at Scripps and the University of Washington and their small vessels did not get far from the beach,

Deep Ocean oceanography did not get started being financed with any adequacy in this part of the world before 1950 and is still in its infancy. I believe we were half a jump ahead of you people and never more than a half a jump behind New England.

What has happened to Deep Ocean Oceanography since 1950 is that it has grown rather sharply, and is due to grow more sharply yet. This was in response to national desire, need and interest. It was a prime reason for the establishment of NASCO to further this.

My criticism of NASCO is not this but that they have compromised too much here and there to be politically popular in the scientific community. The purpose of such organizations was NASCO and SCOR, in my view, it to stimulate the accumulation of knowledge and understanding of the ocean and its content, not particular segments or fringes of it.

From the surge which has been given Deep Ocean Oceanography the Shallow Water men have received benefits in more liberal support, understanding, appropriations, etc., than they were able to get for themselves and the growing pains are already beginning to be less wracking to them. I have been most pleased to see this changing attitude as reflected in letters received in this series from researchers whose primary concern is the estuarine conditions of the Middle Atlantic and Gulf Coasts. Their letters indicate that the new level of interest, funds, etc., is bringing them apparent benefits now in their enormously complicated problems, and the new understanding of the adjacent deep ocean is also benefitting their work.

#### 4. University, Industry, and Government Laboratories

I have yet to see any ocean research done by the fishing industry that was worth the money put into it and I never expect to. The deep-sea fishing industry does not own the resources it harvests nor can they. Without going into long-winded economic discussion I'll just say that this does not lead to investments in the sort of knowledge that is required to deal with the problems involved.

Federal and international survey agencies are jim-dandy for survey work; University laboratories ordinarily are not. Each man to his last. Ocean research does not consist solely of surveys even in a wide use of that term. University type people do not like to do survey's ordinarily and are not very good at them. Yet there are specific problems, not surveys,

in ocean research that empirically speaking are more competently handled by University types than by Government laboratory types, Again speaking empirically it looks as if where Government types and University types can work together (as we have done much in the Eastern Pacific and is now going to happen in the United States' Tropical Atlantic Program, , reasonably smoothly) it looks as if great results can be achieved.

Just because I have seen it work productively at Scripps and elsewhere I strongly favor the subsidization of University Professors to do what they want to do in studying the ocean, and not bothering them with things you want to find out specifically.

If University Professors or whole Institutions are such hogs for research money that they choke on it and have no time for students this is , of course, bad, but my observation is that this is a temporary phenomenon too, and we seemed to have passed the worst of this in this area.

However, your letter was most interesting, Thanks for your cooperation.

W. M. Chapman, Director

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THE UNIVERSITY OF BRITISH COLUMBIA, Vancouver 8, Canada  
Institute of Oceanography

January 30, 1962

Dear Dr. Chapman:

In reply to your letter of Christmas day, 1961, I regret that I probably do not have very much to offer that you have not already covered in your comprehensive letter. I think that the reason for this is that my career in Oceanography has largely been in the academic aspect and my contact with the Fisheries side has been rather peripheral. What I will do is: offer a few comments upon the observations which you make in your letter, with the idea that these may add statistically to your findings.

I am afraid that I rather react against the term "Fisheries Oceanography" in the same way that I react against the title "Scientific German" for a course at the University. The implication in the latter title is that there is a special kind of German language which is used by scientists, whereas

in fact the grammar is the same throughout the language and only the vocabulary has its specialized region. I do not believe that there is a kind of oceanography which is peculiar to Fisheries but that some aspects of Oceanography are of more importance to the Fisheries and less importance, whereas other aspects may be more important to the military or to the geologist, etc. However, this perhaps is just semantics.

Turning to page 6 and 7 of your letter, I would certainly subscribe to your opinion that the third view of Oceanography is the one which is the most appropriate. My experience of the Fisheries side of Oceanography has been that the people working in Fisheries have taken this same view. Perhaps I have been fortunate in this, I certainly could not subscribe to the first view which seems to me to be essentially the argument that since Fisheries scientists don't carry out Oceanography in any effective way then there is no such thing as Oceanography for Fisheries. This seems to be so illogical as to be not worth pursuing further. Nor would I subscribe to the second view that Oceanographers are unsuitable people to study Oceanography for the benefit of Fisheries. Scientists in general tend to pursue the studies that interest them particularly. If this means that an individual is studying some aspects of the oceans which do not appear to have an immediate application to the Fisheries this does not mean that he is an unsuitable person to study Oceanography for fisheries, it may simply mean that he is not available at that time. Under such circumstances it may be necessary to hire competent scientists without previous marine experience and turn them to applications in the marine field. Although I feel that a scientist with a backlog of experience in the marine field is probably best qualified to contribute, I do not think it is necessary to have a union card in order to be able to contribute worthwhile research; lots of people who now call themselves oceanographers came into the marine field after training and probably carrying out research in other fields first. The value of previous experience in the field is largely that it gives one some feeling for it, and as long as one does not permit oneself to become hidebound then I do not think that marine experience should be considered to disqualify a man from the study of the oceans for the benefit of Fisheries.

If I were called upon for a definition of "Fisheries Oceanography" I think that I would say that it is a study of any aspect of the oceans which is known to have or might possibly have some influence upon the fish populations therein, This definition seems to me to include pretty well all oceanography, as it is not easy to think of any aspect which clearly has no effect on the fish population whatsoever. Yours, sincerely, G. L. Pickard, Director

UNIVERSITY OF CALIFORNIA - Scripps Institution of Oceanography  
La Jolla, California

January 30, 1962

Dear Dr. Chapman:

Thank you for your letter dated 25 December 1961, in which you requested personal ideas concerning the scope and definition of Fisheries Oceanography. I shall try to answer some of the questions, although I am not a fisheries oceanographer, but one dealing with the physical environment, in which the fishes live. The ideas I shall put forward are strictly my own, and do not reflect those of other people or of this institution.

I shall answer the questions point by point.

1. To discuss and define the subject of fisheries oceanography

Fisheries oceanography should be defined to mean that part of oceanography, the main interest of which is centered upon the physiological, anatomical, genetical, ecological and other biological aspects of fishes, together with studies of the environment in which fishes live, provided these environmental studies are made with the primary purpose of fishes in mind.

Thus I would call a fisheries oceanographer one who:

- (1) deals with the physiology and genetics of fishes
- (2) deals with the ecology and taxonomy of fishes
- (3) explains the behavior of fishes in terms of the environment—on the other hand I would call one who
  - (a) devises population models, calculates fish distributions for the mere sake of the distributions, a statistician employed in fisheries oceanography.
  - (b) is interested in the marketing and canning problems, an economist employed in fisheries oceanography.
  - (c) describes the ocean circulation, temperature and sea level changes in connection with the atmospheric circulation, a physical oceanographer employed in fisheries oceanography.

A cooperation between these two main groups is essential, but I would only call the first three fisheries oceanographers.

2. To state what fisheries oceanography has accomplished

Not being a fisheries oceanographer, I cannot answer this question in detail. As a physical oceanographer, I have made frequent use of the hydrographic data collected by various fisheries vessels. I guess these same data have been useful in trying to interpret the distribution of fishes in

terms of their environment. This should be encouraged, but it should not be the only aim of fisheries biologists.

3. To state what fisheries oceanography should be trying to accomplish.

1. More emphasis should be placed upon the physiological aspects of fishes, particularly their food requirements, uptake, and metabolism. A biochemist with main interest in fisheries could do the job.
2. The diseases of fishes, their distribution, method of contacting etc., should be studied. Is it not that diseases can also reduce a large fish populations?
3. The food organisms themselves, and their requirements and fluctuations should be studied.
4. The genetic aspects of fish heredity should be looked into. Perhaps it will in some future time be possible to "breed" certain desirable strains of fishes.
5. The use of elementary statistics for statistics sake, and taxonomy for taxonomy's sake should be discouraged. These are necessary and valuable tools, but they should not be used as the endpoint of research. It may be desirable to modernise fisheries oceanography by putting more emphasis on the sciences of physiology, ecology and pathology, and less emphasis upon the purely descriptive arts.

4. To state what progress is needed in other science so that the above mentioned aims can be accomplished.

1. In biochemistry methods should be developed to obtain, identify, and manipulate minute quantities of organic material present in fish tissues.
2. In pathology the study of infectious diseases among fishes should be broadened.
3. In physical Oceanography there is need of direct current measurements, as well as theoretical work connected with the ocean circulations, which may determine where the eggs and larva are carried.
4. There is need in ecology to study the requirements and behavior of fish larvae, as well as to identify these correctly.

5. International aspects

Fisheries oceanographers should develop fisheries in under-

developed countries. Preference (in the beginning) should be given to those countries, where the natives are poor, but are able to read and write a little, as for example is the case on most Pacific Islands, Thus an ideal place to start this program would be in American Samoa and in the U.S. Trust Territory of the Pacific (Micronesia). Should the instruction of the natives prove, successful, the control of fisheries should be turned over to them, which would give them not only economic advantages, but also a moral booster.

There is dire need of developing fisheries among the once seafaring Polynesians and Micronesians. In some places, such as in the Society Islands, and the Marquesas Islands the natives who once ate fish and were healthy, now subsist on canned food and suffer from disformed or absent teeth, as well as of other nutritional diseases.

I hope I have answered some of your questions. Please excuse, if some of them sound rather elementary and idealistic, but I am not a fisheries oceanographer, so I am not an expert in this field. Sincerely yours, Gunnar I. Roden

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UNITED STATES COAST GUARD Commander International Ice Patrol, USCG Oceanographic Unit, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts

January 30, 1962

Dear Dr. Chapman:

Your air mail dated 25 December 1961, and postmarked a month later has been received.

It asks for my reaction to four terms of reference of a SCOR Working Group on Fisheries Oceanography. It asks that my response be made as an individual scientist and that the response need not represent the opinion of the Coast Guard Oceanographic Unit. It further states that my observation will be kept confidential and will not be used under my name without my specific permission. These observations follow:

1. Fisheries oceanography may be taken to mean oceanography (as defined by NASCO) as it is interrelated with protein production in forms which now or in the future may be exploited as "fisheries" to supplement other sources

of food for man.

2. No comment, What fisheries oceanography has accomplished would be best stated by the fisheries oceanographers, but presumably the important accomplishments would be the first steps toward the goals in 3 following.
3. a) Determination of the quantity and distribution of existing fisheries resources. b) Determination of the natural and man-made controls of such resources. c) Development of methods which may be used to manage these resources to increase their sustained potential as a source of human food.
4. Progress needed in other sciences would be best stated by the fisheries oceanographers from time to time as their efforts under 3 above define their needs for help from other specialties.

Comment on 3 above: b) represents such a vast field of effort by individuals trained in such a diversity of disciplines that it will be difficult to find a workably small group of individuals having a broad enough background to coordinate this effort intelligently and perhaps, therefore, it should be restated. From this it must be evident that I concur with your views set forth in your letter (beginning on page 7).

Very truly yours, Floyd M. Soule, Senior Oceanographer

\* \* \* \* \*

THE JOHNS HOPKINS UNIVERSITY Baltimore 18, Maryland  
Chesapeake Bay Institute

31 January, 1962

Dear Dr. Chapman:

This is in reply to your letter of December 25th with respect to the "SCOR Working Group on Fisheries Oceanography". Because of pressures of many other commitments, I do not have the time to speak as fully on the subjects listed in your letter as I would like. However, I am presuming you would appreciate some comment rather than none.

I note in the expression of your own thoughts on these subjects, as contained in your letter, you treated the first subject at somewhat greater length than the others. Since I have some

definite views as to what oceanography per se is, I will also deal more fully with the first term of reference than with the others.

In order to define the subject of fisheries oceanography it is first necessary to deal with the subject of oceanography. It seems to me that there has been an undue amount of argument about something that can be stated quite readily. Oceanography is not a science, it is a field of scientific endeavor. My definition is as follows: oceanography is the scientific study of the oceans, its contents and its boundaries. The key word in this definition is scientific. There are many endeavors, in or related to the oceans, its contents and its boundaries. I reserve the word oceanography to apply to scientific endeavors, the purpose of which is to increase our knowledge of the ocean as a complete system. Fisheries oceanography is then the scientific study of the marine fisheries resources including, but not necessarily limited to, the proper biological identification and grouping of the organisms comprising the fisheries resources, studies of life history and migration, studies of chemical make-up of the organisms, studies of the food chain leading from inorganic nutrients through the phytoplankton and zooplankton to the organisms making up the fisheries resources, and studies of the interaction between the physical and chemical properties of the marine environment and the marine biota with respect to the manner in which these inter-relations affect distribution, survival, and migration.

An oceanographer is an individual with a sound training in one of the basic sciences and a fund of knowledge peculiar to the oceans, who applies the scientific methods of his basic science toward increasing our knowledge of the ocean, its contents and its boundaries. A fisheries oceanographer then is one trained in one of the basic sciences with an additional fund of knowledge peculiar to the oceans, who uses the scientific methods of his discipline to increase our knowledge of that part of the contents of the ocean which constitute a food resource to man. On the basis of these concepts, it is generally possible to decide without ambiguity as to whether a given individual is, or is not, a fisheries oceanographer. The first question to ask is, is the individual a scientist, and second, does he apply the scientific method to the study of marine fisheries resources? The purpose of the fisheries oceanographer is to increase knowledge. Other

professions, the designation of which is not of concern to me here, must be responsible for the application of this knowledge towards regulation and management of the resources, or of undertaking the engineering task of improving man's technical ability to utilize this knowledge.

I admit that in some cases an ambiguity arises. For instance, one biochemist might study the chemical make-up of fish and the purpose of identifying sub-species or races or in order to relate some aspect of the life history of the organism to the environment chemistry, while a second biochemist may use the same techniques for the same fish in a search for some new product. Here the results of the studies of both these men might increase our knowledge of the sea and thus would be oceanography. Whether the individuals would be called fisheries oceanographers or not would depend on their purpose. If one of the goals of such studies is an increase in our knowledge of the marine fisheries resources, then the individual is, at least during that interval of time when he is working on this problem, a fisheries oceanographer. If an increase in such knowledge is not one of the goals of the investigator, then he should be satisfied to be called by whatever other designation he desires. Thus, in certain instances, the decision as to whether the individual is a fisheries oceanographer is a personal decision based upon personal purposes and goals. That is, of course, only true if the paramount conditions of scientific inquiry are also involved. In your discussion of these various points, as contained in your letter, you described the activities of certain individuals and ask whether these individuals are fisheries scientists, a term I am here equating to fisheries oceanographer. The decision rests upon the answer to the following questions.

1. Is the man a scientist?
2. Does the individual apply the scientific methods of his basic discipline towards increasing our knowledge of the marine fisheries resources?
3. Is one of the purposes of the individual's endeavor to increase such knowledge?

I do not feel confident to contribute materially to the second term of reference listed in your letter, however, I will make a try at the third. The ultimate goal of fisheries oceanography should be to supply sufficient knowledge of the marine

fisheries resources, including the interaction of these organisms with their environment, such that maximum sustained utilization of the marine fisheries resources may be realized to the benefit of all man. I want to emphasize that it is not the purpose of fisheries oceanography to accomplish such utilization, but only to supply the fund of knowledge required for proper regulation and management such that optimum utilization can be realized. It is also evident, I feel, that such a prime goal as stated above requires that the fisheries oceanographer be able to predict the effects of continually changing environmental conditions on the marine organisms and by implication he must also be able to predict the effect which external factors have in causing environmental changes. Thus, the areas of heat balance, of atmospheric oceanic exchange, and the chemistry of land drainage into the sea, are involved.

In general, however, the work of the fisheries oceanographer would start with the question of the interaction of the organisms with the environment. He would depend on other oceanographers to provide an adequate description of changes which are taking place in the environment, and of the relationships between these changes and the external causes for these changes. This brings us into the fourth term of reference.

In order to accomplish the aims set out in the third term of reference, it is necessary that the physical oceanographer progress to the point of completely describing the distribution of physical properties of the sea and the movements of water in the sea, including the pseudo-steady motion, the transient aspects of the motion, and the turbulent aspects of the motion. The physical oceanographer must further supply sufficient information as to the inter-relationships between these properties of the ocean and its motion, on the one hand, and the external processes which control the distribution of the physical properties and the character of the motion so that predictions can be made. The chemical oceanographer must supply a considerable increase in our knowledge of the major nutrients and of the trace elements of the sea. Particularly in inshore areas where sessile bottom organisms are an important contributor to the fisheries resources, geological oceanographers specializing in the processes of sedimentation must increase our knowledge of these processes sufficiently so

that changes in bottom conditions of importance to the success of the sessile organisms can be predicted.

I am thus saying that in order to accomplish the aims of fisheries oceanography, there must be considerable progress in the whole field of oceanography.

I hope these comments will be of some use to you and I would be interested in receiving any summary which you might make of the comments you receive as a result of your request for information from specialists in the field. Sincerely yours, D. W. Pritchard, Director, Chesapeake Bay Institute/. . . . .

\* \* \* \* \*

A Fishery Biologist

La Jolla, February 1, 1962

Dear Wib:

Fisheries oceanography, biological oceanography, acoustical oceanography, etc., ad nauseum. The word oceanography sure gets around, This reminds me of a story in which a group of Hollywood movie moguls is discussing a newly produced film. Everyone is of the opinion that the creation is lousy but they are not in despair at all because they practically all agree that a few well chosen words such as "super-colossal", "Gargantuan", "earth-moving", etc., will counter-balance the absolute quality, and therefore there is no point to worry about the box office returns. Madison Avenue methods are evident in science too.

Is there such a thing as fisheries oceanography? If we proposed a definition for the preceding it would not only have to encompass but also to integrate all branches of marine biology, all branches of physical and chemical oceanography and such subjects as geology and meteorology; and of course we could not leave out the various aspects of human endeavour connected with predation and disposal of the prey i.e. marine organisms which are the object of the fisheries. There is no doubt that I am talking about a number of subjects which present us with an enormous amplitude of our scientific pursuit. Now a question arises, if we assume that we have such a science as fisheries oceanography, do we have fisheries oceanographers? In my very own opinion the answer is no. There is a small number of very capable scientists, versatile in many fields, who can co-ordinate research in the various fields;.

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mentioned by me while attempting to define the mythical "fisheries oceanography". You see, I do not believe that there is such a thing as super-man (except in the comic strips, of course) and I do not believe that there is such a thing as a super-scientist. But I was talking about a small group of elite researchers. The problem of their training is of some interest. These scientists do not come from schools where fisheries oceanography is taught, practically all of them are biologists with considerable formal and informal training in oceanography and other disciplines and all of them have extensive scientific experience. There is no university course or textbook\* in fisheries oceanography, and this is not because this is a new science.

There are many scientists who very freely take advantage of the name fisheries oceanographer or something very similar, because to be an oceanographer (physical, optical, shallow water, perhaps even fresh water too - - limnologist sounds rather flat) is fashionable as well as profitable and also adds to their prestige. I do not take too dim a view of that fact because as they say "Money isn't everything but it's ahead of whatever is in the second place" and we know the members of the scientific world being human often show various traits of such things as vanity.

From your letter I have a feeling that the SCOR is not too sure about the existence of "fisheries oceanography". For example note the following part, "To state what progress is needed in other sciences so that aims set out in 3 can be attained". What are the other sciences? Are they referring perhaps just to some facets of the science of fisheries oceanography? Perhaps to such fields as physical oceanography, plant physiology, meteorology, biology etc.,? If we take that attitude would we not strip the science of fisheries oceanography of everything to find out that although there was lots of meat there was no skeleton under it. Further evidence that the SCOR is not convinced about the existence of the nebulous science of fisheries oceanography is in the composition of the working group of fisheries oceanography. The group consists of top notch specialists in their own fields,

\* I know of a book in a foreign language, the title of which happens to be "Fisheries Oceanography" but the title is misleading, so do not rush to buy the book or think about learning that language. On the other hand the subtitle is more elucidating, it reads: "Biological Basis of the Sea Fisheries."

all of which directly or indirectly are tied to oceans, their contents, and their boundaries, but why did they not include fisheries oceanographers? It is obvious that I am saying this with tongue in cheek. By the way since you have Rass I would not be surprised if a proposition were made to replace the name fisheries oceanography with fisheries oceanology.

Regardless of the way we define various terms the fact is that any scientist working with broad aspects of the life of a marine organism which is subject to predation by our own species has to take into consideration not only the spatial environment of the organism but also the fourth dimension, time, thus incorporating the temporal changes into the system. Of course, the mode of predation and factors connected with it cannot be left out. This type of investigation, carried out on such a broad basis, involves not a single scientist but a group of specialists and technicians and of course such an undertaking requires the best possible coordination.

For very obvious reasons my mind turns to the work carried out by our Commission. We do not call this type of work "fisheries oceanography" but, by Jove, we pack lots of various disciplines into our investigations. In my opinion, there is no doubt that only work of this type can provide us, and other scientists concerned with fisheries resources of the world oceans, with the required answers. Although I mentioned our own work I realize that similarly the team work of some other organizations has made equal or not unlikely greater progress in the line of their research of marine resources.

There is plenty to be done in the future. Some old avenues have to and will undoubtedly be followed. This is not only because the approach has proven itself to be definitely suitable but also because of the fact that in many cases it is essential to have continuous data in order to follow the presence or absence of any temporal variations. There is plenty of room for basic research, the type which is of no apparent value, the type no one wants to support. This type of research provides us with information which often is of great value in piecing together the jig puzzle of our scientific endeavor. While searching for new data we should not leave much of valuable information, gathered in previous years, somewhere in our files to gather dust and to be eaten by silverfish. I believe that a good deal could be learned from the data and the actual material collected over the past years. As we have to take time into consideration it is obvious that old data often cannot be replaced with new because this is physically

impossible. We should also be practical, it often takes a considerable amount of money to get the stuff in the first place.

Since I mentioned the problem of money I have decided to do some "ventilating" on that subject. I wonder where the money will come from to do some of the research by the scientists of various nations. Again because I am more familiar with the problem near home and because it concerns our organization directly here are a few of my own reactions on that subject. It seems to me that it is easier to get money for a new project than to carry on an old one, regardless of the past performance of the latter, or regardless of its value or necessity. Perhaps this is the partial reason for the coinage of the new word "fisheries oceanography". If I sound a bit bitter regarding money matters please do not be surprised because I am bitter. With all the technical aid to be given to Latin American countries our work did not merit a favorable consideration in the course of preparation of the budget. I see that I am slightly deviating from the intended subject of my letter but the deviation is not unintentional. As said before, however, money is not everything. It is true that to carry on research of such broad scope considerable sums of dollars, francs, rubles or other currencies are needed. But all these and all other, moneys of the world, no matter how valuable, have a limitation as far as procurement of scientists goes. It takes money to train one to be a scientist but it also takes time. Where will certain countries get scientists to carry on research on the location of new and the investigation of new and existing fishery resources? You may think that I am referring to certain developing countries. Well, my thoughts are like a homing pigeon and always turn home. Where the hell (remember this letter is confidential, so do not quote some of my naughty words) will you get enough trained people not only to carry out the research but also to serve on the various committees, working groups, panels, etc.,? Mind you this is not a criticism of the usefulness of various meetings and conferences or the participants. I am far from criticizing them because these undoubtedly have an important place in the progress of science.

There are rewards for scientists working in various aspects of marine sciences, and I am sure of that fact from my own experience, but I am talking about non-material rewards. Material rewards, however, enter into the picture too. If the science would be financially more rewarding obviously the scientists working for the sake of science would carry on anyway, but think also about the additional recruitment of the greedy types, who at the moment

are in more profitable professions. you know that such guys in order to get a salary increase would go out of their way and could make some significant discoveries. Really it is of no importance whether a given facet of research was carried out by an individual who did it for the love of science, for the love of money, or for the love of both. We are concerned with the quality of his work and not with his motives. When I think that my boss earns less than a mediocre physician it makes me mad; by the way the word "physician" could be substituted by many other professions. I know that many of the scientists in this country have to supplement their income from various other sources. A scientist who is doing plumber's work in his house in order to save money, is in my opinion, wasting valuable time. I do not expect that a scientist should be devoting his time entirely to science but I consider that the primary duty of a scientist is science. The people are natural resources and here we are discussing the problem of utilization of marine resources and I do not think we should neglect the utilization of human resources, although in some aspects to the dislike of many, with respect to the output of scientific manpower appears to be very effective - - perhaps too effective (I guess you are aware of the superb study "Education and Professional Employment in the USSR" by DeWitt). It gives me the creeps to think that on the whole no one here seems to be really concerned about the whole matter. They said that they would put special effort into space technology, but no one took them seriously. They say that they are making a tremendous effort to produce technical and scientific manpower of considerable magnitude and superior quality, but no one takes them seriously either. On the whole, I am slightly oversimplifying the entire problem which concern the scientific manpower. It is not only a question of numbers but numbers in the right categories. Well, I have strayed away from the main purpose of this letter. The problem of recruitment and utilization of scientific manpower, however, although it may differ from country to country, must exist in all countries.

Regardless of how the scientists are recruited there is a great need only for first caliber creative individuals with truly analytical minds but there are also many niches for properly trained technician-type scientists too.

I am sure that research of marine resources does now and will in the future involve not only cooperation of scientists of various countries either organized in the form of some permanent inter-

national commission or some transiently formed ad hoc international group. Therefore it is important that some more thought be given to standardization. I do not mean of the scientists - - although perhaps some times this would be in order too, but to the standardization of some of the methods, techniques, equipment etc.,

In many instances I have been referring to some problems in generalities which are even vague to you but, nevertheless, I believe that in all cases I can substantiate my statements with concrete examples. Of course, this does not apply to my "prophecies" which will be disproven or proven by the time alone.

I have a remark regarding your letter. Personally I would prefer to answer your questions without having your ideas before me, because it makes me go out of my way to try to avoid being influenced by your thoughts, which otherwise are of great interest.

Another remark is that perhaps you could discuss the problem mentioned in your letter with a group of people. There is, for example, a meeting of the Pacific Fisheries Biologists in northern California in April; I realize that this is too late for your deadline but perhaps really not too late on the whole. Of course, I realize that you are not going to limit your survey of opinions to biologists.

Thank you for asking me to give you some of my thoughts regarding the problems expressed in your letter. I hope that some of my ideas were of the type you requested, the others, not asked for, can be considered as a bargain. All the best, Sincerely yours,

W. L. Klawe, Hydrospace Scientist, currently engaged in Fisheries Oceanographic Research.

\* \* \* \* \*

THE UNIVERSITY OF KANSAS DEPARTMENT OF GEOLOGY, Lawrence

February 2, 1962

Dear Dr. Chapman:

Thank you for your letter of December 25, 1961, regarding the functions, problems and aspirations of the "SCOR Working Group on Fisheries Oceanography". As a teacher and a sometime worker with fisheries people I am grateful for your ideas and your considered synthesis of a difficult and important subject. I wish I were more qualified to contribute to your needs and efforts,

but my experience in these affairs is limited to work as a marine geologist and Recent paleontologist. Perhaps I am in one of the few fields of oceanography which would be least likely to offer constructive thought to your program.

Geologists as a whole probably have not been aware of the roles, if any exist, they could play in aiding the fishing industry. Perhaps there are some facets of our work that could be useful, particularly with the shellfish industry. I am sure that rates of sedimentation, changing shorelines and nearshore environments, the role of substrate control, the effects of clay minerals as nutrients catalysers (anion exchange), pollution by turbid rivers and other such "geologic" subjects are of more importance to productivity of oysters, scallops, shrimp, etc., than is generally appreciated.

If we knew more about the interaction across the sediment-water interface I might suggest a closer tie between interests of the physical oceanographer and the sedimentologist-mineralogist that you imply should exist between the interests of those who combine studies of upper ocean and lower atmosphere. All of course contribute to the study of the biological habitat.

Most marine geologists are not concerned with ecology of living organisms. This is unfortunate as it usually results in the omission of the changes and effects of substrate as a part of general habitat studies. I hope your group can be more far-sighted and insist on incorporation of such studies by geologists into programs dealing with nearshore and shelf areas.

In the meanwhile I will remain as an interested observer of the efforts of your group and convey those ideas which should interest and effect geologists to my colleagues. Sincerely yours,  
Richard H. Benson, Assistant Professor of Geology

\* \* \* \* \*

VAN CAMP FOUNDATION                      W. M. Chapman, Director                      739 Golden ParkAve.

Dear Dr. Benson:

I think the sedimentation-water interaction may be of more broad importance even than you anticipate, particularly in the tropics, and particularly near the great river outlets such as Amazon, Congo, Brahmaputra, Mekong, etc., not only in the manners you suggest but

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also in the relationship between the sedimentation rate, the depth of the photic layer, and the general effect of suspended material in the water on the photo synthesis process as well as contributed salts and the other things one thinks of at once. W. M. Chapman.

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CANADA DEPARTMENT OF MINES & TECHNICAL SURVEYS. Ottawa

February 2, 1962

Dear Dr. Chapman:

Your vigorous and comprehensive initiation of the work of your SCOR Working Group is a most admirable stimulant and with your drive and enthusiasm the group should contribute substantially to answering the questions on fisheries oceanography which were posed.

I read your thoughts with interest, and have prepared the attached comments, which I confess, are not as profound as your contributions or terms of reference require. However, as a modest contribution to what I am sure will be a broad and comprehensive flow of ideas from others better qualified than myself, here they are. Yours truly, W. M. Cameron, Director of Oceanographic Research

Comments on the questions posed to the "SCOR Working Group on Fisheries Oceanography"

1. Fisheries oceanography.

A study of the sea and its processes to better understand the dependence of fisheries resources on their natural environment.

Fisheries oceanography is a directed activity aimed toward a specific goal associated with fisheries. This is not to imply that fisheries scientists have no dependence upon, or recourse to, undirected research in oceanography, but rather that such undirected research should not be called fisheries oceanography.

The tendency of some fisheries scientists to include a broader field of oceanography in this definition is understandable. A great amount of oceanographic activity has been sponsored by fisheries research agencies in the past, and in the absence of comparable effort by non-fishery organizations, the fisheries groups have been obliged to spread their nets widely. However, with a greater interest on the part of non-fishery organizations, sponsored largely by defence research funds, the broader, less applied fields are being more intensively covered and "fisheries oceanography" can be more precisely oriented.

2. In terms of my definition above, fisheries oceanography has accomplished very little to date. Oceanography sponsored by or for fisheries organizations has done much to describe the oceanographic state but I do not feel that a proportionately sufficient volume of information has been derived regarding the "dependency of fisheries resources on their environment".

3. Fisheries oceanography should be trying to accomplish what its definition states: "to understand the dependence of fisheries resources on environment". Fisheries science should reach back from the fish to its environment rather than project forward from the environment to the fish. The correlation of fisheries with some (often any) oceanographic parameter has been dictated by the complexity and enormity of the more direct approach. This has been the fault of much fisheries research in the past - the urgency of the problem, and the pressures of industry have required the cheap and dirty answer, and investment in less hurried but more scientific approaches has suffered.

The recognition by some countries that oceanography, as a basic study, should be more vigorously pursued is a most promising development. If fisheries scientists were to look upon this effort, not as a competing demand on financial resources but as additional contribution to the study of the sea, they can look forward to relief from their investment in basic oceanographic studies, turn their effort to the more direct approach and emphasize the woefully neglected area of "fish-environment" research.

The analogy of the weather service may be forced, but is pertinent. When the importance of "weather in the sea" was first appreciated, the fishery research organizations were obliged to initiate a weather service of their own, whereas agriculturists had been able to depend on a weather service established by another agency for more general reasons. Whereas agriculturists have been able to study the influence of climate or weather on their plants and apply their findings to large scale climatic pictures drawn by another organization, fisheries scientists have spent most of their time studying weather and have had little or no time to get down to their explicit task.

The recent emphasis on oceanographic research is, in a way, the initiation of an oceanographic weather service, which though in the early stages of its development, should eventually assume this responsibility for all agencies interested in the properties of the sea,

4. (a) Physical, chemical, geological, and biological oceanography must progress much further before any hope of substantial contributions to fishery problems can be realized. Taking the Grand Banks fisheries as an example, what it required is a continuous and detailed synoptic picture of the whole Irminger, Baffin, Labrador, Gulf Stream complex similar in accuracy and scope to daily meteorological, thru-dimensional maps of the atmosphere. They should describe not only the parameters affecting density, but the non-conservative parameters of oxygen, nutrient salts and finally the planktonic parameters which are of fisheries importance. This type of descriptive service demands much basic hydrodynamic research and a revitalized and dynamic approach to the plankton problem.

4. (b) Simultaneously, and in parallel, fishery scientists must concentrate on the fundamental relationships between their fish populations and their physical, chemical, geological and biological environments. When oceanographic techniques are used in these studies they might be labelled fishery oceanography. From these studies will finally emerge more well-defined requirements which can be directed toward the oceanographers concerned chiefly with an understanding of the environmental parameters, and their eventual prediction in time and space.

\* \* \* \* \*

answer

VAN CAMP FOUNDATION W. M. Chapman, Director 739 Golden Park Avenue

Dear Bill:

Your letter particularly intrigued me and if I argue with you on a point of two it is because you have stimulated my thinking a little.

I am now two-thirds of the way down this enormous stack of correspondence resulting from my 25 December letter and yours is the first that has differentiated fisheries oceanography from other on the grounds of being directed research. This has been a reasonably good criterion in the past but when you jogged my mind about it I began to wonder whether or not this line is not beginning to break down around here, mostly out of necessity.

Certainly the work of Benny Schaefer's group is directed, as was that of W. F. Thompson's, tautly so and admirably so. Also it is producing the answers that were wanted when they were wanted. This is not due, however, to industry pressure from his Commissioners. I have been intimately associated with this project from its initiation and I can speak with authority. It is due to the nature

of the director and the problem - but he has not been pushed except by the problem.

I was also closely associated with POFI from its inception and often as an industry advisor. I remember only two instances when the industry used pressure. Once at the start the Washington D. C. authorities demanded that a large section of exploratory fisheries and another large section of fisheries technology be established. We resisted this, and won, on the grounds that Elton Sette had a big chunk of ocean to investigate and should be largely autonomous from Washington in doing it. While we watched closely what he and his boys did we did not push him. We only tried to keep Washington from interfering. The second occasion was when it was desired to wind up the more central Pacific work and move westward toward the Trust Territories. We desired that they move eastward toward the Marquesas instead, and won, but we did not pretend to tell them what to do or how to do it or when they should get it done. On a third occasion we got them additional money to extend their work north into the albacore area but they did not feel, nor did we, that we were pressing them to cut any fat pig in a hurry or tell them what to do.

As a matter of fact I do not believe anybody in the industry has felt at any time in the past ten years that anything of great practical importance to the industry was likely to come from the POFI work, but considered it a worth while investment in general tuna oceanography. Nevertheless, the industry advisors quite religiously attended the annual meetings at their own expense, gave advice where they could, helped get appropriations from time to time, and all felt rather proud of their association with the project until the Bureau dropped the Committee a couple of years ago. Certainly Gunnar Seckles work has had no pressure put upon it. There are not a dozen industry people who are more than casually acquainted with it.

Another example of undirected fisheries oceanography on a rather large scale is the group of projects known as CalCOFI off the California coast. These are supposed to be centered on a study of the California sardines but to tell you the truth nobody involved knows how to direct the assembled scientists as to what to do. . . . Quite a large number of approaches are being used at the same time to develop leads and we industry advisors are sometimes subjected to censure (often by scientists on other problems) for not cracking the whip and holding the boys' noses to the grindstone.

Whether rightly or wrongly we think we have got quite a bunch of bright lads at work that know what they are doing better than we do and if we provide them with money and a pretty free head they will do about as well as the next bunch.

I wouldn't want you to think we believe we are making any great progress in finding out what has happened with the sardine, but we are learning a fair amount about how the ocean runs in these parts and how a good many of the organisms conduct themselves in it.

Here is one example of the sort of thing you mentioned under 3. In CalCOFI (as in POFI) we had to do our own oceanography because nobody else would do it for us. This has, over the years, used a disproportionate part of the total funds we had available. We are now trying by several means to cut down the routine measurement of physical and chemical parameters to a minimum and get the remainder shifted over to more purely oceanographic types so that we can free more of our money for the fish and other biological research that is more properly our responsibilities. I may say that the industry has lobbied through special taxes on itself to partly support the Cal COFI work.

We have had for some years Blackburn's Scripps Tuna Ocean Research Program in progress for which we lobbied the funds. Progress has been slow, but the problems have been complex. I do not think any other industry fellow besides myself goes near this project, and Maurice feels that I neglect him. Certainly there is no pressure from industry of even the lightest sort, although there is from time to time from the Bureau of Commercial Fisheries, his immediate grantee. We do not generate that.

You, like so many of my correspondents say "and the pressures of industry have required the cheap and dirty answer." I have been in this racket on this coast for thirty years now and I cannot honestly say any industry fellow ever crowded me as a researcher for a quick and dirty answer. As a matter fact 99 out of 100 industry fellows I have been acquainted with on this coast have been dubious that anything either I or any other researcher was

doing had any practical connotation one way or another for his business, and mostly they were right. I think things have been different in British Columbia and Alaska in these last few years, but I am sure that I have given you an accurate picture of industry pressure from Puget Sound to the Strait of Magellan.

For the past fifteen years I have spent a great deal of my time stirring up industry people to prod their Senators, Congressmen and State legislators to raise dough for new fisheries ocean research and I am about ready to take off on another major campaign. But this is just exactly like getting my kids to weed the rose garden. The minute my back is turned they are off doing something else. They couldn't care less. I have gotten a good many worthwhile projects financed over the years only because of two things (a) the rest of the industry guys figured out some years ago that I was honestly trying to get something useful started, and (b) if they raised the money I would quite hollering at them for awhile. I do not realistically think I have made more converts in fifteen years than I could count on one hand, and I have banged a lot of drums on a lot of heads in that length of time.

Thanks for your cooperation, Sincerely yours, W. M. Chapman

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CANADA DEPARTMENT OF MINES & TECHNICAL SURVEYS MARINE SCIENCES BRANCH  
615 Booth Street, Ottawa, Ontario, May 29, 1962

Dear Wib:

If you send so lengthy and detailed a letter to each of your contributors as you did to me, I am amazed that you have covered two-thirds of your stack of correspondence. As far as I am concerned, I have no objections to your quoting my remarks and attributing them to me but I probably should amplify the second paragraph of my comments as to what I mean by "directed" research.

This is a term which I would tend to use in place of the word "applied" research, to differentiate it from non-applied research activity. I certainly did not intend to suggest that "directed" research is necessarily under the taut control or direction of a directing individual or committee, but rather that the research of the individual would tend to be directed or "oriented" toward answering a specific question associated with fisheries. Perhaps it is more a matter of why research is being carried out rather than how it is being done.

One would like to think that an oceanographer studies the sea because he wants to find out more about it. He should be encouraged to follow his own inclinations and interests irrespective of the particular facet of the marine environment which he finds interesting.

A fisheries oceanographer, on the other hand, might be expected to choose a problem which would seem to contribute directly to a better understanding of fishery resources. He would be expected to keep his efforts much more directly channelled, and when tempted to wander off into some interesting byway, would have to ask himself: "Am I going to contribute more to an understanding of fishery resources in this departure from my original approach than if I were to re-direct myself more specifically to my original purpose?"

As a matter of fact, I don't like the term "fisheries oceanography" I think of oceanography as covering a wide spectrum of various research specialties of which physical oceanography and biological oceanography are examples. I much prefer to think of the broad term "fisheries research" in which these various aspects of oceanography and other specialties have a part to play.

I had not intended to proceed to this length in amplifying that paragraph. My remarks may serve only to further muddy the waters. Yours very truly, W. M. Cameron, Director of Oceanographic Research.

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GULF COAST RESEARCH LABORATORY, OCEAN SPRINGS, MISSISSIPPI  
Controlled by the Board of Trustees Institutions of Higher Learning  
State of Mississippi, Sponsored by the Mississippi Academy of Sciences  
February 2, 1962

Dear Doctor Chapman:

This is a partial reply to your letter of 25 December 1961.

In the first place, I have some doubts about this designation fishery oceanography. When I started out some years ago, I thought I was a zoologist with some bent towards the marine side of things. Later on, I began to realize that people in my line of work were coming to be referred to as marine biologists. A few years later, and up to the present, the term biological oceanographer has taken over and now we are to become fishery oceanographers. Glory be! I have become many things and have never

changed my coat. However, I do not suppose it makes much difference what we are called. Anyway, in my following remarks I am equating fisheries oceanography to marine fishery biology.

First, I think you have to restrict the field. For example, during the past two or three years I have worked in collaboration with some medical school biochemists on the blood of fishes. This is an interesting question and some day some of these results may be taken into consideration by fisheries oceanographers when they are seeking to interpret some of the phenomena they observe. However, my medical school friends are certainly not oceanographers of any kind. They have no knowledge or understanding of the field and they were pursuing basic, physiological questions. They might just as well have been studying bats. So, I think that you must immediately exclude the biologist or chemist or scientist of any kind who comes to the sea temporarily, merely for material to add to the data of his own special discipline. This does not mean at all that some of this data will not be of value to the fishery oceanographer.

Secondly, we must exclude the technologists of all varieties who are concerned with the preparation, processing, preservation and distribution of seafood in all of its diverse details, ranging from the chemistry of proteins to refrigeration engineering. Similarly, the marine engineers and technologists who design and manufacture the boats and nets and docks and various other important requirements of the marine fisheries industry must be excluded. In a like manner, the instrumentalists who devise the working apparatus upon which all oceanographers depend must also be excluded. If such exclusions are not made, then we are soon lost in a morass and would end up including such people as the chemist who makes nylon, acrilan, etc. I could go on and mention many other groups which should be excluded from fisheries oceanography, although their efforts are extremely important to that field and are certainly auxiliary.

In spite of the basic and fundamental (pure science) nature of much of the data gathered by fisheries biologists, fisheries science is applied and utilitarian in its basic concept. This fundamental aim or duty of the fishery oceanographer, as I see it, is to tell when, where and what to catch for the benefit of mankind. This may not mean catching the most or the most abundant or the largest or the most economical. In a restricted sense, the fisheries oceanographers' primary service is to the fishery business itself, which depends so much upon the prejudice, whim and customs of the public that the term "optimum catch" has to take on a different aspect when viewed from that direction. But the distribution of seafood to the public is all handled through industrial channels so far as I know and the service of the fishery oceanographer to mankind is funnelled right through the

business world, which means no profit, no service, - or at least not for long.

A Fishery oceanographer is a biologist who studies the ecology of commercial and potentially commercial marine fishery populations.

You can see that I have made this definition short by including the all-inclusive term, ecology. But ecology is a useful term in that it takes into consideration all relations of the fishery populations to the environment, both organic and inorganic. That means that it includes the data of the meteorologist, climatologist and the physical and chemical oceanographer, as well as that of ethology and physiology, plus the data for analyses of the structure of populations, which are generally collected by the fishery population and not upon the physical oceanography of the sea, or the biochemistry of fishes blood, or the mathematics of populations. These gentlemen are coordinated and held together by a definite point of view and they are a class to themselves among all the various branches of study and science in the world.

It is hardly necessary to point out that a fishery biologist is not necessarily a fish man. The commercial and potentially commercial invertebrates can be studied in the same way as the populations of fishes and such students are also fishery biologists. (I suppose I mention this obvious matter because the author of a text on freshwater fishery biology once got furiously angry with me because I called his attention to the fact that he completely ignored the freshwater shrimp, crawfish and turtle industry of the United States. Nevertheless, I still think he had an erroneously rigid conception).

This is a beginning to an answer to your letter, and I shall try to come along with some more at some future date after I have done a little more thinking. With best wishes, Sincerely yours,  
Gordon Gunter, Director. (Second Gunter letter follows)

Dear Doctor Chapman:

I must take issue with the third paragraph on page 4 of your letter as follows:

"In view of the fact that so far the activities of man do not bulk large in altering the natural processes of interaction among (the) ocean, its boundaries and its contents (in gross) one may assume that the term oceanographer as

used alone describes a person who studies natural processes."

Your attitude is typical of high seas biologists, but I think you should change your view to some extent. The reasons are several and the first one is that some of the most productive fisheries of North America, and the world, depend upon the estuarine area which is rapidly being modified by the activities of man. In fact, I have been yelling for about twenty-five years now that the most important conservation problem in the marine fisheries of the United States does not concern the activities of the commercial or sports fisherman, but the changing environment caused by man in other unrelated activities. For instance, when you and I started in fisheries, the most important one in this country in terms of pounds produced and value was the salmon industry. You can remember when it was around one billion pounds a year. But this fishery is not consonant with dams, and we all know what happened. Today, the most valuable fishery in North America is the shrimp fishery and the most productive is the menhaden fishery. The later has produced over two billion pounds twice in recent years, including the last one, for the first time for any fishery in North America. Both of these fisheries are dependent upon animals which go through an estuarine phase of their life history in very low salinity water, and in fact they cannot survive without such areas. If you add to these fisheries the blue crab and the hardhead, or croaker, of Virginia waters, and the so-called "industrial" fish of our Gulf coast, you will see that a high percentage of the present fisheries of this country depend upon animals connected, during part of their life history at least, with the estuarine situation.

In addition, years ago I used to take a peculiar, and to me then unknown, scombrionid larva on the Texas beaches. A good many years later I realized that these were tuna larvae. Man does modify and change the environment of any beach or bay, and he is doing it at a great rate.

Therefore, I do not believe that man-made changes can be excluded from the serious consideration of fishery oceanographers. On the other hand, this does not change my ideas of what a fishery oceanographer is. He is not one of these water pollution boys who are a class to themselves, With best wishes, Sincerely yours. G. Gunter.

\* \* \* \* \*

answer

VAN CAMP FOUNDATION W. M. Chapman Director 739 Golden Park Avenue

Dear Gordon:

Your two letters were very refreshing. Do you mind, if I argue with you a little bit?

1. I, sir, am not a high seas biologist. I am a comparative osteologist specializing in ichthyological systematics and why in hell George Humphrey picked me for this job I do not know.
2. You have high lighted something in your first letter that has been bothering me subconsciously as I have gone over this mass of replies to my letter of 25 December. When you say that it is your understanding that the fundamental aim or duty of the fishery oceanographer is to tell when, where and what to catch for the benefit of mankind you are undoubtedly with the majority. However, I am beginning to wonder if you have not hit pretty close to the heart of my disagreement, and the controversy between "pure" oceanographers and fishery oceanographers.

When an Admiral plunks out a few million dollars to a bunch of oceanographers he does not ask when, where and how to catch submarines, because oceanographers by and large have no high earned reputation for catching submarines. Instead the Admiral asks the oceanographers to find out more closely about how the ocean runs, how sound travels around it under this condition and that, how the mixed layer is separated from the deeper layer and what this portends from the standpoint of bouncing sound off a thermocline, what sorts of noises the other inhabitants of the ocean make, and such things as that. Then he hires some people who are pretty good at catching submarines anyway, feeds them these new data to help them perfect their art, and turns them loose on that job.

I am an industry fellow. In particular I want to know how to catch tuna at a lower catch per ton of production than that I now have. Like the Admiral I already have a bunch of guys that are pretty good at catching tuna. I never was acquainted with any fishery oceanographer or fishery biologist who was very good at catching tuna by the ton steadily. Accordingly, I don't want to ask the fishery oceanographer when, where and how to catch tuna. That is not his line of work. I want him to find out how the ocean runs; how the tuna comport themselves in it, and adjust themselves to its changes; how the weather changes the way the ocean runs and the tuna comport themselves in it; how my activities are affecting the abundance and availability of tuna; and such questions as that. The answers I get I will feed to my people already well qualified in catching tuna in the hopes that by use of it they will catch more, more quickly, and thus more cheaply.

This may sound to you like splitting hairs, but I don't think it is. When scientists stay to science they are pretty useful, but when they start telling fishermen how to do things better you run into some funny things. When fishermen stick to fishing they often make a good deal of money, but when they start giving scientific conclusions based on their observations at sea they are usually horrible.

Your point about the changes in environments being caused by man particularly in the estuarine conditions around the Gulf, and indeed many other places in the world, I do not argue with because it is real, huge and as easy to do as making deserts. I do still contend that so far, however, man has fortunately not been able to change much the world ocean in gross. Sincerely yours, W.M. Chapman  
Third Gunter letter follows;

Dear Doctor Chapman:

Thank you for your letter of 7 June.

I understand that you are an ichtho-osteologist. As a matter of fact I have appreciated your work and wrote you on that subject many years ago. Nevertheless, your statement impressed me as being that of a "high seas biologist".

I know about fishermen because I have been involved with them for years, and I can tell you frankly that sometimes I would prefer to be categorized with them in preference to some of the biologists I know. By that I mean the commercial fishermen. God deliver me from the so-called sports fishermen and their attitudes.

Concerning our disagreement about Fisheries Oceanography I wish to state the following: You hold your job, and all fishery biologists hold theirs, for the simple reason that the powers that be think that you can show them how to catch fish cheaper and easier, while at the same time conserving the fish population. Who actually does the labor, is beside the point.

My mentor in graduate work, Doctor E. J. Lund, used to say about fisheries which I was trying to promote, "You can sell that stuff because it has a curb market value, but you can't sell pure science". There is no difference between pure and applied science, except that one will be applied now or soon we hope, but the other will be applied just as surely at some later time.

In spite of all of our talk and all of our work and in spite of the work of men like the late Thurlow Nelson, who could say that the oyster is the best known marine animal in the world, the oyster industry on the East Coast has been going downhill for a hundred years. Nevertheless we know enough to rehabilitate the industry and resuscitate it. Sociologically we are at least fifty years behind science in that field. Fishery biology is a practical science. Nevertheless, the sociological and political impedance to its proper application is so strong that its immediate application is hopeless, Therefore, I teach my students that it is a nice way to promote money and to learn some fundamental biology which will be applied some day.

I believe that all of us in the fishery business are in it for practical reasons, so far as people who put up the money are concerned. If some of us do not think so then we are in the same class as the boys in the superstition business who believe their own line of patter.

Go ahead and use my letters as you see fit. Sincerely yours,  
Gordon Gunter, Director

\* \* \* \* \*

answer

VAN CAMP FOUNDATION W. M. Chapman, Director 739 Golden Park Ave.

Dear Dr. Gunter:

Your correspondence is about as refreshing as it comes. It is nice to know that there is another unreconstructed bastard in the racket. While I am pretty sure, on purely empirical grounds and thirty years of hacking away at it, that your dictum on sociological and political impedance to the application of fishery biology being so strong as to make the situation rather hopeless is soundly based, I keep on hacking away at it, and so do you. If our students and scientists and great brains get it through their noggins that the problems of harvesting marine resources requires as much sociological, political and economic as scientific input, we might be further ahead.

Thanks for your cooperation. Sincerely yours, W. M. Chapman

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THE MARINE LABORATORY Institute of Marine Science of the  
University of Miami February 2, 1962

Dear Dr. Chapman:

I have read with interest the discussion which you sent to me, and I think there is no question in my mind that fisheries must embrace a wide field and not just those aspects of fish which give a dollar return. To give a single instance, Gordon Riley

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developed his mathematical model of phyto plankton productivity with far from adequate basic data. His attempt at a comparable model for the herbivore was based on much less adequate data and was increasingly less adequate. He made no attempt at the next step, a treatment of the carnivore model.

In fisheries, we have outstanding examples of a study of that fraction of the fish population which yields commercial returns. We know considerably less of the dynamics of the eggs, larvae and juveniles. No clear understanding can be reached of fish fluctuations until all parts of the model are complete. Obviously, all call for a knowledge of physical and biological environment conditions.

Clearly, fisheries must see the need for this wide attack and contain scientists who have had a sufficiently wide training to appreciate what is involved. We are endeavoring to give such a training here.

Since fisheries research depends on available money, the wide field of such research must appear to the grantors of money to reduce the direct attack on problems which will pay a cash return. The extent to which fisheries can meet this problem by leaving it to other agencies to handle the neighboring fields, is a problem which I can hardly attempt to answer here. I must emphasize that it is vital that the really wide field be studied.

Hoping that this is of some help and with best wishes, Sincerely  
Hilary B. Moore, Assistant Director

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THE BINGHAM OCEANOGRAPHIC LABORATORY YALE UNIVERSITY Box 2125  
Yale Station, New Haven, Connecticut, U.S.A. February 2, 1962

Dear Dr. Chapman:

I enclose a memorandum in response to your request for opinions on fisheries oceanography.

The work that your committee is doing seems very important to me and I hope that you will be successful in carrying out your objectives.

I have shown this memo to Dan Merriman. His opinions are essentially in agreement with what I wrote. He is very busy at the moment and is not able to reply to your letter extensively so that I think you might regard this memorandum as essentially a joint opinion from us both. Sincerely yours, Gordon A. Riley.

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YALE UNIVERSITY

MEMORANDUM Department Bingham Oceanographic Lab.

1. The only definition of fisheries oceanography that makes sense to me is an operational one, i.e., the application of oceanographic knowledge to fisheries problems. For example, if I were preparing a card catalogue, I would not file subjects such as upwelling or primary productivity under fisheries, but it is certainly the province of the fisheries oceanographer to investigate the effects of these and many other factors upon fish populations.

2&3. For the sake of brevity I would like to discuss these two items together. In my mind the things that fisheries oceanography should accomplish, and has already done so to a limited degree, fall into several distinct categories:

(a) It can shorten the labor of exploratory fishing in developing new areas of commercial promise. We know that a high level of primary productivity is necessary but not sufficient for a thriving fishery. Relatively quick and simple oceanographic surveys will delineate potentially rich areas, and exploratory fishing in those areas can then determine the feasibility of developing a commercial fishery.

(b) Fishery oceanography should be and to some extent is concerned with any kind of predictions that will allow fishermen to plan their operations in advance. Whether we are talking about year-class fluctuations of changes in patterns of distribution and migration, or long term variations in the stock due to natural causes, we need to bring all of the available oceanographic and meteorological information to bear in these problems.

(c) Fishery oceanography should take a hand in the development of regulatory measures designed to maintain the commercial yield, although admittedly we have not progressed far enough in basic understanding to be of much help in this respect. But it is obvious that we cannot determine accurately the effect of fishing effort on available stock unless we know something about the nature and extent of natural fluctuations in fish stocks. It is less obvious but worthy of consideration that fishing effort may have side effects by altering the balance of competition between commercially useable and nonuseable species. In short, such regulatory measures as have been instituted or advocated up to the present time are empirical stop gaps, and I hope that eventually we will be able to do the job better.

(d) Admitting that fish production is a complicated process involving biological relationships with all the rest of the marine community and subject to a variety of influences imposed by the physical and chemical environment, I think we can hardly fail to recognize the need for more thorough oceanographic knowledge on a broad front. There are perhaps a few segments of the field that the fisheries oceanographer can safely ignore, such as seismic refraction studies and the more esoteric aspects of marine geochemistry, but he can hardly afford to be unaware of progress in physical oceanography, marine meteorology, population dynamics, and various other subjects that are potentially if not immediately applicable to fisheries problems. Whatever the practical fisheries men may think of the "ivory tower group", they are in fact using a great many ideas and techniques that came straight from the tower, and they in turn have made valuable contributions to pure science, as, for example, the work of the POFI group on the equatorial current system. The real difference is simply that the practical fisheries man is to a large extent bound by inclination or circumstance to short term problems, while the man in the ivory tower is free to range further. Most of us in this group hope that our work will have practical utility some day, but we also feel that we ought to be spending a considerable part of our time on problems that are too complex to have immediate application or are, within the present knowledge of human needs, valuable only from the standpoint of pure science. One would think that the ultimate practicality of this point of view hardly needs to be defended, particularly among fellow scientists.

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FISHERIES RESEARCH BOARD OF CANADA. . . Biological Station  
St. Andrews, N.B. June 13, 1962  
Dear Dr. Chapman:

In reply to your letter of May 28 concerning your SCOR Working Group on Fisheries Oceanography, you have my permission to circulate my letter on the subject to your colleagues on the working group.

I have just returned from the Annual Meeting of ICNAF in Moscow. You will be interested to know that the Commission has advised IOC of its reaction to relevant IOC resolutions passed at its first session. Particular attention was directed to the Commission's environmental program scheduled for the Greenland area during the period April to July 1963. The Commission also expressed gratification that FAO was taking steps to con-

(Unfortunately Dr. Martin's original letter inadvertently follows this exchange)

vene a meeting of national and intergovernmental bodies concerned with oceanographic aspects of fisheries research. ICNAF is supporting the idea of collaboration in offering advice to IOC on fisheries aspects of oceanographic aspects of fisheries research. ICNAF is supporting the idea of collaboration in offering advice to IOC on fisheries aspects of oceanography.

I will look forward with interest to receipt of information on conclusions of your working group. Yours sincerely,  
W. R. Martin, Biologist

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VAN CAMP FOUNDATION W. M. Chapman, Director, 739 Golden Park Ave.

Dear Dr. Martin:

Thanks for yours of 13 June. I was particularly pleased by the report of activities by ICNAF in Moscow.

There are a good many people in our business who think that international cooperation in this fish and ocean research racket is impossible of achievement and perhaps undesirable if attainable. I have had a good deal of correspondence indicating such.

I, for one, hold strongly opposite views, being certain that such cooperation is both desirable, attainable - and, in fact, as inevitable as it is necessary, although data are sometimes hard to come by on this side of the question. I have sat through many sessions of the United Nations, its family of specialized agencies, and special conferences in the past fifteen years where considerable acrimony arose (I have even heard Canadian and the United States Chairmen of Delegation excoriate each other publicly in a way most embarrassing to me). The acrimony is usually well reported to the press. But what has always impressed me is that the representatives of eighty to one hundred nations, having the most diverse languages, habits, aspirations, and social and racial backgrounds, could sit in one room and accomplish as much as they do do. This is seldom noticed.

Of course, I am an incurable optimist, but your news from the Moscow conference adds a little fuel to the fire.

W. M. Chapman  
Director

FISHERIES RESEARCH BOARD OF CANADA. Biological Station St. Andrews,  
February 5, 1962

Dear Dr. Chapman;

I have given some thought to your Fisheries Oceanography letter of December 25, 1961. This reply offers a few points for consideration by your Working Group.

I consider fisheries oceanography to be the study of oceans in relation to fisheries. In Canada we employ physical, chemical, geological and biological oceanographers in the Fisheries Research Board to work on fisheries oceanography. Oceanographers working in these different disciplines are also employed by other Canadian agencies to study other fields of interest such as Mines and Technical Surveys and Defense.

In fisheries oceanography we are interested in the relationship of the ocean environment to fish and to fishing. Our first interest is descriptive oceanography. We are then interested in obtaining sufficient knowledge of the environment and its relationship to fish to predict environmental changes and their effects on the abundance and availability of fish in time and space. In some cases we hope to go even farther and manipulate the environment and fish to man's advantage. This might involve ploughing, upwelling, fertilization, cover, predator- parasitization- or pollution-control, stream clearance, or fishways. It might also involve the planting or transplanting of existing or new strains of species which are of interest to man - - . Assessment of costs and effects determine the feasibility of such actions.

The needs for fisheries oceanography vary with the objective. In anadromous and inshore fisheries we can visualize manipulation as well as prediction of the environment and fish populations. In offshore demersal and pelagic fisheries we are mainly concerned with prediction studies since manipulation would probably be prohibitively expensive.

The objective may differ in other ways. In some cases the goal is related to the growing world need for animal protein. In other cases we are more concerned with reducing the costs of fishing in order to maintain high production with satisfactory economic returns to the fishing industry.

To date we have just scratched the surface. Even in descriptive oceanography we find that most work has been done from the surface down. Since most fisheries occur on bottom, there is need for more intensive studies of the ocean floor. We are beginning to

make predictions about the changing environment, but there is much to do. We have inshore waters. A great deal of research is needed to assess the possibilities for such manipulation.

With so much to do, and such a limited number of oceanographers, we must be very selective about research projects. It is better to have thorough work on a limited number of projects than superficial, intelligence-service studies of a large number of projects. Concentrated effort in selected areas is advocated.

Efficiency can also be achieved through co-ordination. Improved communication, co-operation and planning will enable us to consider priorities, fill gaps and avoid duplication to achieve more efficient use of the limited men, money and materials available for fisheries oceanography.

Fisheries oceanographers must work closely with other fisheries scientists and with other oceanographers in order to select high priority fisheries projects and make best use of all suitable vessel and shore facilities.

One of the greatest needs is the training of oceanographers. University departments of physics, chemistry, geology and biology should be encouraged to help. Establishment of Oceanographic Institutes at Universities is a useful method of achieving this end.

May I conclude with a word of caution against moving too quickly in international organization of fisheries oceanography. Current interests in an International Association of Biological Oceanographers (under IUBS), the Working Group on Fisheries Oceanography (under SCOR) and the Advisory Committee on Marine Resources Research (under FAO) could lead to duplication of effort. With limited numbers of fisheries oceanographers, there is also a danger that they will be spread too thinly over many international agencies.

In our oceanographic work in ICNAF we are busy with preparation for a symposium on the effects of the environment on fisheries, scheduled for Halifax in May 1963. I hope that our fisheries oceanographers won't be unnecessarily diverted before then to other jobs in international oceanography.

Best wishes for a profitable working session on fisheries oceanography. Yours sincerely, W. R. Martin, Biologist

VAN CAMP FOUNDATION    W. M. Chapman, Director 739 Golden Park Ave.  
May 28, 1962

Dear Dr. Martin:

It appears to me that you Canadians are going at ocean research, and that connected with fisheries, in a somewhat more orderly and logical fashion that we are doing the same. Your letter sets this out the most clearly of those that I have had from Canada, and I am particularly glad that you could take the time to set down your views.

I note also a rather general feeling among Canadian workers (included in your ante penultimate paragraph) against moving too rapidly in international oceanography. We down here have, I know, taken the opposite tack but out of necessity rather than any strong desire. Our interests have become so broad so rapidly that we incline to be as much at home in the Atlantic or Indian Ocean as in the Pacific, and in working with the new efforts out of Lagos, Abidjan, Zanzibar, Cochin, etc., as we do those out of Ensenada, Callao and Valparaiso. It being one ocean, and we interested in substantially all of it, there seems no alternative to working as much as possible with Russia, British, Japanese, Dane, French, Norwegian, German, or whatever scientists as much as we can whether we like each other or not, if only from the standpoint of sharing and conserving the enormous amount of money, ship-time and trained talent demanded to do the needed tasks. This really requires some international organization. The only new thing in this line really is the Intergovernmental Oceanographic Commissions.

The International Association of Biological Oceanographers was an idea that occurred to Anton Bruun during the IOC meeting last fall. He conceived it as a necessity to provide some sort of rallying point inside the huge International Union of Biological Sciences, for those biologists interested principally in marine problems. I have heard no more of this since Anton's unfortunate and untimely death last fall. Whether it is to be pushed or not I do not know. At any rate International Unions of any sort do not seem to put an undue burden of time expenditure upon the constituents.

The SCOR Working Group on Fisheries Oceanography is a group of only nine persons set up for a specific purpose and for a specific short period, a year or at most eighteen months. The specific purpose is the examination of the four criteria set down by the President of SCOR and set out in my letter of 25 December. While its members might be reappointed to examine :

another problem when this one is handled, it is strictly an Ad Hoc group, there is no reason to think its composition would be the same next time, and I do not know of any plans to assign any new topic to it after this one is in hand. It can't very well duplicate with any other outfit because I do not know of any other set up to examine these matters.

The Advisory Committee on Marine Resources Research of FAO Fisheries is a horse of a different color. Although its membership will change from time to time it is considered more or less to be a permanent and continuing group. It is to be a group of experts independent of government who in their individual capacities can give FAO Fisheries technically competent advice on the Marine Research Programs in which it is involved. It is, as I understand it, designed to give critical inspiration as only independent experts can to bureaucracies and will in some respects fulfill for FAO Fisheries some of the functions the Fisheries Research Board (and old Biological Board) has long served for you, that NASCO serves for the United States oceanographic effort, and that SCOR is intended to perform in the international oceanographic scene.

Certainly the latter will have no function in the international organization of fisheries oceanography. FAO really has no one on its home staff who could be called an oceanographer since Taivo Laevastu went to the University of Hawaii. Dr. Finn conceives ACMRR as being a service function for FAO Fisheries and not for the whole international scene.

SCOR Working Group on Fisheries Oceanography may possibly have some effect on organizing international thinking concerning fisheries oceanography, but I doubt it. I think really any effect we will have will be in stimulating thinking about it and jarring some thinkers about it out of comfortable, well-worn ruts. Certainly we will have precisely no effect on the international organization of fisheries oceanography. We will be gone from the scene before that subject could be broached.

I never caught an International Union really organizing much of anything. What Anton's idea was last fall was to quell a small insurrection of fishery types against domination by physical-chemical oceanographers in SCOR and in IOC. I never felt that this had a ghost of a chance of working in the first place. International Unions are primarily composed of academic types where as most marine fisheries research workers in the world are government employees. Accordingly, you couldn't quell a riot led by the latter by organizing the former..

So far as I know nobody is trying to organize fisheries oceanography on an international scale. That would be a hard side of the street to work. All we hired out to do in this Working Group was to find out what fisheries oceanography was. After reading

about two hundred detailed analyses of this written by practitioners of the art I can tell you about two hundred and ten things that it is, none of which you would be likely to agree with completely. However, we will raffle this around some and see what sense we can make of it.

Thank you for your cooperation.

W. M. Chapman, Director

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UNITED STATES DEPARTMENT OF THE INTERIOR Fish & Wildlife Service  
Bureau of Commercial Fisheries, Washington 25, D. C.  
February 5, 1962

Dear Wib:

Although I did not receive a copy of your letter of December 25, 1961, Laurie McHugh let me see his. I feel rather strongly about the four points listed by the SCOR Working Group on Fisheries Oceanography, and am taking the liberty of replying herewith. As has no doubt been obvious to you for some time, these points involve some of the basic problems of the relation between fishery biologists on the one hand and physical oceanographers on the other. My individual comments on the four terms of reference are as follows:

1. We have not considered "Fisheries Oceanography" to be a separate discipline. For working purposes, we have adopted the NASCO definition of oceanography, which is broad enough to include a very large part of our research in the marine field. As a matter or personal opinion, however, I think a distinction can be made and should be made between physical oceanography and fishery biology. I like to think that they bear the same relation to each other as meteorology does to agriculture. It is significant, perhaps, that at one time the Weather Bureau was a part of the Department of Agriculture. The physical oceanographer deals with quantities that can be accurately measured and forces whose inter-actions on the whole can be accurately predicted. The fishery biologist, on the other hand, deals with living organisms, not the least among whom are the populations of people who exploit fishery resources. Through such organizations as the American Institute of Fishery Research Biologists to which we both belong, fishery science is achieving status as a profession on its own. Although I favor the intensification of cooperation between oceanographers and fishery biologists, I firmly believe that each have their own mission to fulfill and their own professional status to maintain.

2. It seems almost redundant to elaborate to someone like yourself the accomplishments of fishery biologists and oceanographers in cooperation. I would merely mention the substantial achievements of the Pacific Halibut Commission, some of the remarkable facts discovered about the oceanographic migrations of salmon by the International Pacific Salmon Fisheries Commission, the fantastic increase in the knowledge of the marine life of the salmon achieved by fishery biologists and oceanographers of Japan, Canada, and the United States working under the auspices of the International North Pacific Fisheries Commission, the great discoveries of Dr. Sette and his successors at Hawaii in the field of interaction of tuna distribution and oceanography, the discovery of the influence of currents and other oceanographic variables on the survival of haddock on Georges Bank, the tremendous advances under the International Council for the Exploration of the Sea. Some solid accomplishments have resulted from these advances in knowledge, such as the restoration of the Pacific halibut fisheries, increase of yield of the Fraser River sockeye salmon fisheries, knowledge of the extent of seaward migration of North American and Asian stocks of salmon, increase in yield of Georges Bank haddock through mesh regulation.

3. From the standpoint of man, the ocean is a machine which is capable of transforming basic nutrients into useful food. Oceanographers and fishery biologists working together should attempt to harvest the products of this machine in the most efficient manner possible; or, in other words, to achieve the greatest possible sustained yield of desirable fish flesh.

4. In general, I would say that other sciences have outstripped fishery biology. Rather than progress in them, we need more application of their disciplines to our own problems. I am thinking of such disciplines as physiology, biochemistry, higher mathematics, nuclear physics, immunology, etc. Sincerely yours  
Ralph P. Silliman, Acting Assistant Chief, Division of Biological Research.

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NATIONAL SCIENCE FOUNDATION, WASHINGTON 25, D. C.

February 6, 1962

Dear Wib:

As promised a while back, I enclose my thoughts on Fisheries Oceanography as it pertains to your SCOR Working Group. With best regards, Sincerely yours, John Lyman, Associate Program Director for Earth Sciences (Oceanography) Enclosure follows:

1. Oceanography is the scientific basis of seamanship. Therefore, fisheries oceanography is the scientific basis of fishing

operations at sea, involving study of both the catches and the methods.

2. Fisheries oceanography has in many cases told the fisherman how many fish of a given species and age are available for exploitation; where to look for them strategically, either on the basis of topography alone or considering water temperature and other environmental influences; how to find them tactically with echo-locators; how to arrange his gear so as to capture more of the desirable kinds with less damage to young ones; and how to direct his course to market so as to stay in colder water with less deterioration of his fare. In the case of anadromous fish, it has through selective egg-collection produced populations of faster-growing fish. It has through transplantation built up populations of desirable species in new areas.
3. Fisheries oceanography should continue studies of the kinds in (2) above and should pursue all useful leads with the ultimate aim of enabling the fisherman to land the maximum yield of fishery products with the minimum expenditure of labor.
4. The term "other sciences" is not appropriate, since oceanography is not a science but science. The fisheries oceanographer has to keep up with developments in communications, radiation biology, underwater detection, isotope geochemistry, genetics, hydrodynamics, and chemical analysis, to name only random examples of pertinent fields. It follows that virtually all scientific progress will be of ultimate tangible benefit in application to fisheries.

\* \* \* \* \*

VAN CAMP FOUNDATION W. M. Chapman, Director 739 Golden Park Ave.  
Dear John: May 28, 1962

Yours is a fresh approach, as your approach usually is. When I first read it I thought to myself that this is not really the way things are but perhaps a logical scheme for the way they should be. Then I got to thinking further and wondering if it is precisely the way things should be. At that point I still am.

Thanks for your cooperation. W. M. Chapman

\* \* \* \* \*

NATIONAL SCIENCE FOUNDATION

DearWib:

My tongue may have been a few millimeters sideways when I wrote you on February 6th; still, I have no objections to your duplicat-

ing and circulating the remarks on fisheries oceanography. As I grow older I become less and less patient with sacred cows; they draw too many flies.

The other day I was reading an interesting book called "Fishing in Troubled Waters" by some old reprobate whose name I forget. Why don't you write a book about your adventures some day? With best regards, Sincerely yours, John Lyman, Associate Program Director, for Earth Sciences (Oceanography)

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CALIFORNIA ACADEMY OF SCIENCES, San Francisco, California  
Garth Murphy, Coordinator of Marine Research, California Co-Operative Fisheries Investigations Scripps Institution of Oceanography, La Jolla, California February 6, 1962  
Dear Wib:

I find it very difficult to respond to your letter directly; instead it seems more natural to comment more generally in two directions, hoping the comments are pertinent to your problem.

The first area that strikes me is brought to mind by your comments on the ivory tower types. Oceanography is not the only discipline that goes into fisheries so the comments may apply generally. I think we must strive to build up three general classes of scientists.

- 1) The first of these are the ivory tower people. Their function is to teach. This in itself forces them into some sort of balance because they recognize only too well that their final evaluation is based on their students. These people do research on whatever they choose, whenever they choose. This is a safety valve we must have. They are the people presumably most able, and in the best position to follow their hunches, and really develop significant advances. They may not, but society tries to maximize their opportunity by choosing the best available and putting the minimum of boundary conditions on them.
- 2) We need a second group which should be as, or nearly as, able as the first. They have a few more, but still reasonably flexible, boundaries on their activities. Within these boundaries, the research they do is just as basic, just as fundamental as that of the first group. By boundaries I mean, e.g., Ahlstrom would probably not be allowed to swing his whole lab to the Indian Ocean no matter how brilliant an idea he might have with respect to tuna there; he himself might be encouraged to follow up on it, but not at the expense of disrupting the Calif. Current System research. Presumably this second group are well enough trained and prestigious enough

to communicate fully with the ivory towers, and either trained or socially oriented enough to communicate fully with group 3.

3) This last group of people are those who carry our applied research in the strictest sense of the word. They are people who communicate with and work directly with industry. Their primary responsibility is to exploit for the direct benefit of the public the knowledge and understanding developed by groups one and two. They must be just as competent as the others but must be so oriented socially that they derive more satisfaction from working with people than things. They are the people who built the bomb which was made possible by the work of the ivory tower people. They might do almost anything - the boundary condition being that they are turning out something tangible in terms of society.

One may ask why the intermediate group (group 2). There was no such group in the development of the bomb. Well, in instance of the bomb, the need of our society was glaringly before everyone. Most of societies needs are not, and so group two serves as a communication link; it can communicate our needs into the ivory towers, and put the findings of the ivory towers, when applicable, into the hands of the third group.

At the risk of blowing my own horn I enclose a reprint that I think is an example of such communication. I was acquainted with all the theoretical work; I knew society had a problem with ponds and reservoirs. All I did, was improve Sverdrup's equations a little, show how they applied in the instance of one set of published data; and indicate how they might be applied in a practical way to management problems. Assuming the suggestions are correct and worthwhile the way is now open for a management research project to show how the concepts can be directly exploited for better fishing.

In addition to this exceedingly vital communication function, group "two" also develops basic research results of its own, within its own rather liberal boundary conditions. In operational terms I think we (in fisheries) should keep the ivory tower ivory, even encourage it to be more so, and see that it is well financed. The bureau of commercial fisheries biology labs should be encouraged to occupy the group 2 role. State labs, exploratory fishing, etc., should be encouraged to fill the third category. And, we should not try to mix things, except a little, in group 2. We should stop trying to influence the ivory tower except through the scholarly contact with group 2, and we should stop looking down our noses at the applied people.

There is, of course, a problem in arriving at a balance among these groups. I won't comment except to remark that an ivory tower occupant that tries to swing everything to his way is indulging in two bit politics; and is in fact trying to direct research.

Now, on to the SCOR working groups first three questions. The first task seems to be to put fisheries science into some sort of coherent context, and I lean towards the concepts of ecology - a branch of biology which has become respectable and has overcome the excesses of the categorizers of the 20's. If we state the objective of marine ecology as, "To learn the physical, chemical, and biological rationale of the distribution and abundance of marine organisms;" we have also stated the objective of marine fisheries ecology. It is a specialized segment of marine ecology only in that its ultimate objective is to understand species likely to be useful to man, though many other organisms may be considered, in fact have to be considered, in converging on the objective, and because it must directly consider the workings of one additional highly specialized predator - man. Finally, fisheries ecology should consider problems in a time span nearer to decades than millennia.

If the above is satisfactory, we can forget about the term "fisheries oceanography", and substitute environmental oceanography, and immediately get away from the industrial onus (I have set aside group 3 workers - they need not be considered further in this context). Environmental, or ecological oceanography, can then be defined as oceanography that leads towards understanding the distribution and abundance of marine organisms, and variations in these parameters, on a time scale of decades. I think this is an academically respectable, and practically satisfactory boundary condition. It tends to exclude much, but not all, of the work of the earth scientists, geophysicists, etc.

I believe I have already answered question 3.

Question 2 is difficult to answer. One could refer to the symposium on fisheries oceanography published in the last CalCOFI report. Concrete, positive accomplishments, are difficult to list. Primarily I think this stems from the newness of the science. But, there have been enormous accomplishments in a negative sense. For example, Benny has not produced much tuna with his oceanography, but he has learned enough to feel reasonably confident that the changes in the yellowfin population are the works of man and not primarily some environmental change. Conversely, CalCOFI, has learned that

there have been enough changes paralleling the decline of the sardine to induce great caution in ascribing the changes in the sardine to the effect of man. If both groups are correct the contributions has been substantial - in the one case the ground was cleared for appropriate action - in the other, inappropriate action was forestalled.

I hardly know where to begin on question four. We need to know so much. Probably the most glaring need is long range weather forecasting for even if we understand the effects of changes in the ocean environment on the species that interest us most, we can't maximize the public benefit unless we can predict. Our greatest needs from other fields seems to be then, first, a more predictive knowledge of the effect of changes in wind stress on the ocean circulation.

Phrasing this another way, we need to understand the unsteady state at least as well as we presently understand the "steady state". Second, we need to have some way of anticipating these unsteady states in advance.

I hope these thought are of some help. Sincerely, Garth I. Murphy

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FISHERIES LABORATORY, Lowestoft, Suffolk 7th February, 1962

Dear Professor Chapman,

I haven't received yet a copy of your questionnaire multilithed to 310 marine research workers; please could I have a copy?

A poll of this type is useful in scanning opinion. I am not sure that mere opinion in science is of any greater value than it is elsewhere. To be more precise, the facts required by fisheries research workers from fisheries oceanography will not be obvious to marine scientists who do not work in fisheries.

Terms of reference (Humphrey, 23 Nov. 1961)

I Definition of fisheries oceanography

Those parts of physical oceanography and biological oceanography which contribute to fisheries research. Fisheries research is concerned with numbers of distribution. For the first, the main oceanographic problem is diffusion and for the second it is diffusion and fine structure of currents.

(a) Physical oceanography

For example

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- (1) The measurement of water currents in detail and on large scale - not as an average condition, but in particular cases. This information can be used in the definition of fish stocks, in studies of migration, in studies of stock mixing.
- (2) The estimation of diffusion as it affects the measurement of abundance of plankton population in time. This information affects our knowledge of stock and recruitment problems, feeding and aggregation problems - most of the basic problems of fisheries research.
- (3) The measurement of irradiance and the estimation of vertical mixing in the sea to understand the starting of plankton production. This information again affects our knowledge of stock and recruitment, migration of pelagic fishes and the dynamics of feeding fisheries.

I have chosen three examples in which I myself am interested. Others might choose turbulence as it affects the sensory channels used in migrations, the estimation of trace stinks as migrational signposts.

(b) Biological oceanography

Biological oceanography includes the fundamentals of fisheries research, being the study of oceanic ecology: the basis of all ecology is population dynamics which is the hub of fisheries research.

Here I choose again three examples:-

- (1) The charging of upwelling areas in terms of living material at all trophic levels, particularly the upper ones. This means little more than a proper sampling programme; I would not want  $C^{14}$ , chlorophyll or any nutrient observations (unless used in conjunction with the quantity of nutrient per living cell).
- (2) The comparison of an upwelling area with other oceanic areas using the methods of population dynamics to find the quantities produced at each trophic level - as opposed to a selected fraction

of the quantities there at the time of sampling.

- (3) The study of "fish" catching in the dispersed phase in mid ocean. By "fish" I mean any living organism not caught with conventional plankton nets. The technique is essentially the Japanese one with long gill nets or very long pelagic lines, but the object is to find what is in the ocean apart from small surface plankton, and fish last caught by Prince Albert of Monaco or the Kontiki expedition.

Again, this is only what has attracted me as I write.

## II. Achievements of fisheries oceanography

Here I should restrict myself - the Meteor expedition set out to find gold, not phosphorous. In a broad sense, the recent exploitation of upwelling areas in the Benguela current, Peru current and in the Pacific Equatorial Counter current are exercises in fisheries oceanography. In a narrower sense, there is a developing discipline in which oceanographers and fishery scientists work together - like the Japanese in the Kuroshio, the Americans in the Pacific Equatorial Counter current, the Norwegians in the oceanic herring investigations and the British in their Barents Sea cod investigations. In a sense these are fringe investigations, in boundary or near boundary conditions; but the point is that each investigation leads to further knowledge of the biology of a fish stock.

It must be admitted that the achievements of fisheries oceanography are not great - but then nor are the achievements of oceanography as a whole. There are three reasons why fisheries oceanography has not developed rapidly.

- (1) The quantity of hydrographic information required by the fisheries research worker is enormous. For example I am interested in herring in the North Sea: I would like detailed current information at a variety of depths, closely spaced horizontally, each month for the last twenty years. The instrumentation for this would have been expensive: alternative methods such as analogue computers are nearly ready but not quite. In any case, they would require at least one detailed survey to establish the technique.
- (2) The quality of hydrographic information required is often sophisticated. I have pointed out how essential a study of diffusion is to fisheries research workers. The Joseph and Sendner equation is of great use to a moron like me; until this was published three

years ago the problem was unmanageable. Much information required by fisheries research workers is beyond the reach of physical oceanography at the moment.

(3) Because the problems are extensive and very expensive, nearly all oceanographers have been tempted to use short cuts. For example, all the complex interactions of populations in the sea have been summarized by saying that a given area is rich because there is a lot of phosphorus in the sea. The correlation is valid but to me it is not worth the machine it is calculated on until we know properly how it works in terms of the populations. Then we could use it properly and with subtlety.

III. What fisheries oceanography should be trying to accomplish

To provide physical and biological information for me (and other fisheries research workers) to use. The point here is that the fisheries research workers, however incoherent they are, are better judges of this than physical or biological oceanographers, who often work in fields far removed from fisheries research.

IV. What progress is needed in other sciences

Here I am stuck because I am not sure whether the sciences referred to are those already part of physical and biological oceanography (which I have certainly referred to by implication) or whether they are outside these: meteorology, climatology, acoustics, etc.

I shall enquire among marine research workers in the U.K. etc., on what they think fisheries oceanography is: I exclude Australia and Canada from your list, Humphrey and Cameron reporting directly. In particular, I shall get the views of Hickling's fishery officers and I shall ask Deacon how to spell "science". I should point out that we often take a sour view of Royal Commissions - their purpose is often to shelve something awkward.

I have only one thought about how the group should work - we should wait until we see what each of us thinks about the term of reference. Yours sincerely, D. H. Cushing

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VAN CAMP FOUNDATION W. M. Chapman, Director 739 Golden Park Ave.

Dear Cushing:

We made it, and neither or our fathers were the wiser for a long enough time to avoid retribution. But it was an experience I have never forgotten, and the technique of looking only one stop ahead when faced with a task of impractical size, which engraved

itself on my mind that afternoon, I have used many times since.

Your point in respect of physical oceanography having heretofore been concerned primarily with description of steady state ocean condition and explanations based on equilibria models is, I am sure a key one. All segments of ocean I have dealt with have been in a bad state of disequilibrium (some worse than others) and this is what fish and the people studying them require to contend. Since I am mathematically illiterate I would not know a disequilibrium model if I stubbed my toe on one, and I am not certain that the term is even grammatically correct, but I do not think tuna sense things more than a few hundred yards away at the most or are any more acquainted with average ocean conditions than am I.

To the best of my knowledge nobody has a very good way worked out to even make a reasonable guess about volumes of vertical transport, or vertical current strength, yet nothing has been more apparent in the last few years than that vertical transport is the key to whether a chunk of tropical ocean, at least, is desert or verdant pasture.

Also I am not as sure as I was thirty years ago just what is being transported vertically that is so useful to the phyto-plankton (and fish). The boys tell me that phosphorus in biologically useful form is never a limiting factor in the southern California area, but wide variations in all biological events here still transpire nevertheless.

There is no really good methodology I know of for sampling the life in any area of ocean very well, from a bucket full to a bay full. The Japanese gill nets and long-lines are no better than others and worse than most through high specific selectivity. Small mesh nets are never small enough to get the smallest, and bigger things move (or are shoved) out of their way.

There is a form of ocean economics in which I have been trying for a long while to get somebody interested in with no success and I am beginning to think that my terminology is faulty and scary because economics means dollars (or pound sterling) to scientists and that is a nasty term, like spit.

A good many years ago I had occasion to work on the stomach contents of fur seals from the Pribilof Island herds, and in a moment of absent-minded curiosity (having some pretty good figures on how much food per day per unit weight fur seals consumed and how much weight of fur seal there was in the herd) I ran up some calculations on what weight of living resources this herd was taking

from the Northeast Pacific each year. Of course later research showed that the size of herd we then thought we had was somewhat inflated, and there were other gross inaccuracies. But nevertheless when all was said and done the fur seal herd of the Pribilof Islands was eating a weight of produce per year from this sector of ocean greater than that taken by the fishermen of the United States and Canada from the same area, despite the importance of those fisheries to those countries. Moreover the fur seals were in no apparent competition with the fishermen. They did not at all eat the sorts of things the fishermen were catching, nor did they interfere with the fishery.

I merely point this out as one of many examples that could be mentioned that indicates our ignorance of the internal economy of the ocean. In listening in on the discussions of the basic productivity boys at the Pacific Science Conference last year in Honolulu it was not clear that they were very sure what they were measuring or whether they were measuring it in comparable ways. I could not help but comment that as poor as the state of their art seemed to be, they were miles ahead of those of us working at higher trophic levels except for a very few stocks of a very few species which we were considering as if they lived in splendid isolation because, for instance, we did not have even good models for handling populations dynamics problems arising from a trawl fishery affecting simultaneously a dozen species of fish in an important way.

Dayton L. Alverson is playing around with a mid-water trawl with a mouth 35 ft by 46 ft that shows some interest as a sampling device.

I am an incurable optimist. I can't help but feel that we are just on the edge of beginning to find out something about the ocean and its contents. The analogue computer, and variations, has given us such a jump ahead. Now if we get a moored buoy that will stay moored and start feeding time series of several parameters into the computer we will jump ahead a giant's stride, again - and this is only a short time away. Perhaps with all the new money being put into the ocean research we may be able to drain away a few bucks to set up establishments ashore where we can have a few pieces of controllable environment so we can begin learning to what in the ocean the plants and animals are responsive. One of the reasons I want to get to Bergen is because I want to see Gunnar Rollefson's new facilities against the day we can build something of the sort here.

If SCOR had any idea of employing this Working Party in the sense of the Royal Commission to shelve something awkward, Humphrey sure did a hell of a poor job appointing shelvees. And I give him and them the credit that you are a cynic. W.M.Chapman

MINISTRY OF AGRICULTURE, FISHERIES AND FOOD Fisheries Laboratory  
Lowestoft, Suffolk, England 14th May, 1962

Dear Professor Chapman:

Thank you very much for your original letter (25th December, 1961). There are two papers on the Calanus/ herring relation in the North Sea:

1. Cushing, D.H. and Burd, A.C.(1957) "On the herring of the southern North Sea". Fish. Invest. London, II, 18(7).  
Burd, A.C. and Cushing, D.G.(1962) "I Growth and Recruitment in the herring of the southern North Sea: II Recruitment to the North Sea herring stocks". Fish, Invest.London, II, 23(5)  
This paper was given at ICES in 1958.

A third paper dealing with mixing rates and timing of the fisheries was given at ICES in 1961; I am now re-writing it for full publication. I will not give a summary of the whole thing.

The quantity of Calanus increased sharply in 1950; it remained high till 1955, decreased in 1956, bounced up in 1957, fell in 1958-60 and rose again in 1961. A clear relationship has been found between the mean length of three year old fish and the density of Calanus averaged for the three years growth. Recruitment to the adult fisheries has taken place partly at three and partly at four and is related to the size of the herring; so a clear relationship emerges between percentage recruitment at three years old and the average Calanus density.

The increase in growth rate has had other effects on the fisheries themselves. During the early fifties recruitment to the Scottish fisheries increased by five times, virtually generating a new sort of fishery off the Scottish coasts (Parrish and Craig, 1958). There is a heavy fishery east of the Dogger Bank on immature herring (100,000 tons + per year), which started vigorously in 1951 (E. Bertelsen and K, Popp Madsen, 1953); when the same year class reached the adult fisheries, some changes were found - the rate of maturation increased somewhat and the spawning seasons tended to shorten a little (Cushing, paper to ICES Herring Symposium, 1961). Three fisheries were expanded:-

1. Between Sandettié and Ruytingen Banks (Straits of Dover)
2. On the immature herring grounds east of the Dogger in 1950;
3. Off the Scottish coasts in 1952.

In each case a small fishery expanded by perhaps five or ten times, due to an influx of fish larger than expected for their age.

STANFORD UNIVERSITY, Stanford, California, Natural History Museum

Dear Wib:

Your letter of December 25th last, regarding the "SCOR Working Group on Fisheries Oceanography" is rather unexpected, because, as you know, I am one of those cloistered professors whose duties prevent more than occasional participation in the fitful but nearly continuous intercontinental, interocean fluttering of the big-wheel oceanographic fraternity. I have learned - most recently as a member of the Planning Committee of the New York Oceanographic Congress - that the members of this fraternity seem inclined to doubt that anyone not free enough of scheduled work, or well enough heeled by the ONR of NSF, to take off at short notice for Woods Hole, or Lima, or Paris, or Dakar, or Bombay for another committee meeting, can possible have any useful thoughts on oceanography. Yes, I am surprised, and a bit flattered.

First, as a systematic ichthyologist (erstwhile) you should know that a great deal of what you say or repeat from others, and most of what you and SCOR apparently want, involved primarily the solving of a problem in plain taxonomic classification. You wish the content, methods, boundaries, interrelationships, and goals of fisheries oceanography (and its components) set forth in a sensible, clarified, usable manner. That is a problem in taxonomy, and if solvable, will require a taxonomic approach. However, I do not refer to pigeonhole taxonomy. I mean a systematic approach, in the phylogenetic sense, which emphasizes phyletic interrelationships, ecological relationships, biogeography, etc., - all translated into terms necessary in applying the study to a segment of human endeavor instead of to, let us say, a family of fishes.

However, in biological taxonomy you have an established core and point-of-reference, evolutionary relationship. You can point out "true relationship" by means of anatomy, homology, etc. That is, the systematist looks at it from the evolutionary point (therefore the holdfasts) from which you view the problem.

Numerous viewpoints are possible, and the taxonomy will be different for each. In each, to carry the comparison further, what is homology (true relationship) and what is analogy (false similarity) will be different. Therefore you face a much more complex problem than the biological taxonomist, for you must first establish exactly what you expect to get out of the clarification

classification) of the subject - in this case an exceedingly amorphous subject, whose boundaries are exceptionally fuzzy, and which is viewed in quite different ways by the people concerned with it.

The problem is similar to the classification (or taxonomy) of Science, or of Biology. I have concerned myself with the classification of Biology, and especially of Taxonomic Biology (Systematics) which is a very similar problem. Is a statistician employed to help solve a problem in the relationships of two populations of insects a Systematist? Or even a Biologist? (You will recognize the similarity of this question to some that you ask.) My reply is that the man is what he is and that is the prime information that is needed. Whether he is to be labeled a Systematist, a Biologist, or a Whatnot is just as unimportant as the question of whether to label two fish populations as Species, or Subspecies, or Races, or Whatnots. What we are after is the biological characteristics of the populations, not what to label them! Labels mean nothing. They are mere names, like Pete or Jim or Lulu. We do not judge people, or handle them, by their names except in a phone book or directory.

I believe that any definition you adopt of "fisheries oceanography" will of necessity be fuzzy and usable only in the most general sense, for the subjects included or excluded so broadly overlap other segments of not only Oceanography, but also Chemistry, Physics, Biology, Geology, Economics, Engineering, Navigation, Sociology, Business, etc., that in many (perhaps in most) instances it will not be possible to say how much of each should be assigned a definite place in fisheries subjects. For the very word fisheries goes in part far beyond any science or definable segment of human endeavor.

The point is that human endeavor, like the populations of organisms, did not evolve for the benefit of classifiers. Each is inherently unclassifiable except from very narrow points of view (in Systematics, the evolutionary point of view) - which necessitate that any classification used must be to a great extent arbitrary and not useful from a different point of view.

**Examples:** The mere taxonomic classification of several families of fishes will not tell me (of and by itself) what fishes I will find in the Bay of Fundy. You need also a geographical (faunal) classification to show that. But the first had to be built before the second was possible. The mere taxonomic classification of men into those who are employed as fishery biologists and those who are not will not tell me who knows most about the

fisheries of the Bay of Fundy. A geographical classification, and then a further breakdown by specialties, would be necessary. Moreover, even that might fail, for the man who knows most about the fisheries of the Bay of Fundy may be a high-school teacher who was never employed in any fishery endeavor, or has never published a paper on the subject. Is he a "fisheries" man or isn't he? Really, it makes no difference. He is he! That's the important point.

However, it seems to me that decisions as to the boundaries of "Fisheries Oceanography" and as to the content of that subject ought to be possible, if the SCOR-WOGOFO can first agree as to viewpoint from which they wish to operate. Without such an agreed viewpoint it seems to me that such a clarification will be beset by varied and in part irreconcilable differences of opinion.

Also, in view of the nature and the broad spread of the fisheries field (which, as you note, cannot be encompassed in toto even by the term Science), I think it must be agreed that:

1. Oceanography and Fisheries Study are two distinctive lines of work, which although in part overlapping or merging, must be recognized as having largely different objects.

2. The two fields are (like most fields of endeavor) most easily and usefully defined by their objects.

3. Persons whose work encompassed both fields, or who are employed in one field to work in part or whole on the other, must recognize their own dual purposes, and must use care, when speaking for one or the other or both, not to muddy their thinking or conclusions by confusing the two. (The latter is a common human failing).

4. The same caution is necessary, I would think, in fishery biologists or scientists, whose scientific work should be independent and objective even if they happen to be working for a public or private organization with an official viewpoint or policy. (This is a mere parenthetical statement).

5. Part of the difficulty of delimiting "fisheries oceanography" lies in the delimitation of oceanography. Is, for example, the increase of production of protein foodstuffs for human beings one of the objects of oceanography? More specifically is one of the objects of American oceanography the well being of the fish-

ies industry? These are practical questions which perhaps oceanographers would prefer not to answer in detail but which they tend to accept and use in pleading for funds.

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My own field is quite definitely fish classification or systematics, which we are attacking at Stanford not only by morphological means but also through behavioral, physiological and biochemical means. Thinking along this line, I can see many approaches to problems and thinking concerning matters brought up in your letter.

For example, although many fishery biologists would object to the idea, a large part of what marine fisheries biologists have been doing and are still doing is clearly taxonomy in its modern sense (for example, racial delimitation, etc.,) or closely related to taxonomy (studies of the growth, migrations, etc., of natural populations), as Taxonomy is viewed today by biologists. Of the two groups that Dr. Humphrey mentions ("Location and investigation of new fisheries resources," and "Oceanographic estimation of the size and distribution of oceanic living resources") it seems obvious that important segments of each are composed of things done by taxonomists. Taxonomists locate and investigate species. And if they do not estimate the size (sometimes they do), they do try to investigate the distribution of species.

From that point of view, the two proposed new working groups are each concerned with a job that is in some important aspects taxonomic. Is this overlapping understood?

In regard not only to these two suggested working groups, but also to points no. 3 and no. 4 of the five propositions handed by the Monaco meeting to the SCOR-WOGOFO, I would insist that taxonomic exploration and study is obviously a necessary part both of oceanography and of fisheries work.

To a great many fishery biologist, this conveys a picture of a group of museum zoologists using a "fisheries cloak" to get more little specimens to go on museum shelves. In part the picture is correct. In part, however, it is not, or need not be. I agree with your preference for viewpoint no. 3 (on p. 7 of your letter) and a basic part of any deeper study of the dynamics of sea organisms must be knowledge of what is there and what they are.

However, I think that plain old-fashioned exploratory fishing is an important part of any attempt to study the resources of the sea,

and exploratory fishing need not wait for all the little fishies in the museums to be "worked up" to achieve some important practical results. The little specimens should be saved, and put in museums, but a lot of the most important results are obvious the moment the trawl hits the deck.

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My final thought is that your attempt to taxonomize "fisheries oceanography" (i.e., find out what it is) can be successful only if you use, as your prime taxonomic character, the objects of the persons and groups concerned. If you can define a series of objects in a general but sensible way, you can achieve some sort of results by using the objects as yardsticks. But to try to define groups and then find out what their objects may be is, I think, hopeless.

Maybe the above will help to stir the pot. Best wishes! Yours,  
George S. Myers, Professor of Biology, Curator of Zoological Collections

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VAN CAMP FOUNDATION      W. M. Chapman, Director    739 Golden Park Ave.

Dear George:

As Mazie points out it is a world of coincidences. Horatio Rosa was in to dinner last evening and we talked about you at some length. This morning son Thomas, whom I have employed this summer to put the mass of paper which surrounds me in some semblance of order, discovered yours of 7 February which was interlarded with other things. Pardon my slowness in acknowledging its receipt.

As you quite well realized what I was trying to do with mine of 25 December was to stir thinking and discussion. Being a firm believer in hybrid vigor arising from cross breeding in thought as well as corn I sent that letter to a broad spectrum of people interested in the sea and its inhabitants. The result exceeded my expectations in volume, variety and interest. Rather than let so much good thought go to waste in my files I am multilithing the lot, where permission is granted, and sending them around to my colleagues so that they, as well as I, will have some flavor of the thinking on this subject on

this continent at least. If I do not hear to the contrary from you I will include your thoughtful letter.

Some things developing in tuna research will undoubtedly warm the cockles of your heart. One of our prime concerns in this field presently is just the plain taxonomy of the tunas and their near relatives. Collette, Gibbs and others are making pretty good progress on this and I expect will probably pretty soon have it well in hand. But now comes the horrendous problem of sub-populations (whatever you want to call it) on a world-wide basis. This is very difficult, will be enormously expensive and time consuming, but requires to be done because so many aspects of the fishery have become world-wide.

Another matter that has caused me some quiet satisfaction has arisen in local tuna work. For a variety of reasons, not pertinent to this discussion, it has become desirable to riddle out some of the behavior patterns of the large sharks and the porpoise in the area of the local tuna fishery. Of course, the boys found out first that they could not put names to either the sharks or porpoise in the Eastern Pacific. Accordingly, they are starting back at the first and subsidizing some straight taxonomy.

I do not think that this is at all exceptional of what is coming to us. The intensification of inquiry into the ocean and its contents is going to stimulate taxonomy very greatly as you are already seeing occur. I am referring to taxonomy in the broad sense you use. Now we are to learn the value of the resources we have in George Myers, Carl Hubbs, Leonard Schultz, and the ilk who have labored mostly out of intellectual curiosity and are to find their work and that of their students of growing practical use. Do not hesitate because your activity is becoming economically useful.

On another subject I find it interesting that you and Elton Sette came to exactly the same view of fishery oceanography, although using different words. Elton refers to it in terms of motivation, you in terms of objectives. Lo mismo.

Thank you much for taking the time from your busy rounds to give us the benefit of your thinking. Like so much of human endeavor this Working Party is plodding along rather blindly toward objectives indistinctly discerned, and you have helped us on our way some. Sincerely yours, W. M. Chapman. Director.

Pacific Oceanographic Group, Nanaimo, B.C. Canada 7 February, 1962

Dear Dr. Chapman:

Thank you for your thought provoking letter of December 25 re terms of the "SCOR Working Group on Fisheries Oceanography."

I have listed below a number of comments which I feel should apply to the organisation of Fisheries Oceanography. I am not sure how directly they apply to the terms of reference quoted by you, but they are a direct outcome of my personal experience in oceanography and as such reflect both good and bad points of the organisation for which I am at present working (viz. the Fisheries Research Board of Canada).

1. The solution to any problem of such biological complexity as Fisheries Oceanography (as opposed to purely physical or chemical problems) can only be obtained by teams of scientists from a number of professions (e.g., bacteriologists, algologists, biochemists, chemists, etc.,) working together in the same laboratory in the same subject. This requires unselfish persons who are prepared to sink their egotistical ideas for one authorship publications in exchange for the satisfaction of a comprehensive, fully substantiated, multi-authorship treatise which encompasses all the variables within the area studied. The literature is scattered with bits of information which are desperately hard to properly evaluate because of the many variable circumstances which were not measured by the author at the time of his particular observation.
2. Practical applications must never be an initial consideration to the undertaking of a piece of research in Fisheries Oceanography. If practical application precedes the design of an experiment in Fisheries Oceanography, the scope of the experiment is immediately limited. The precedence of practical application over experimental design finds its place among engineers building bridges, for example, but in Fisheries Oceanography it should be derived from an interpretation of the data obtained.
3. As a corollary to (2) financial assistance for research should not be channeled through organizations directly interested in utilizing data obtained for personal profit. This is a very difficult chain of events to break under a democratic system of government.
4. Inter-communication between persons in the same and different countries should be greatly increased at the level of actual

field workers and not among armchair scientists. (One of the greatest disappointments in my life was to hear a talk by a brilliant scholar. The man had spent so much time lecturing on his views that his critical appreciation of experimental results was greatly impaired).

I hope these comments are of some use to the wider problem in which you have become involved. Yours sincerely, T. R. Parsons

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VAN CAMP FOUNDATION W. M. Chapman, Director 739 Golden Park Ave.  
May 29, 1962

Dear Dr. Parsons:

I believe that you are the first of my correspondents who has come out flat footedly to say that practical application must never be an initial consideration to the undertaking of a piece of research in Fisheries Oceanography. One would want to fiddle around a little discussing what practical application meant, and whether the confining adjective initial was necessary, but as a general dictum this one merits more consideration than a lot I have seen and I would hope that administrators in particular would take note of it.

Your corollary that financial assistance for research should not be channeled through organizations directly interested in utilizing data obtained for personnel profit is one that I firmly believe in but am willing to admit there may be exceptions to.

I have been serving on the California Marine Research Committee for the past two years and have been more or less closely acquainted with its work for fourteen. This Committee is composed of fish canners, union leaders and at least one representative of organized sportsmen. It has at its disposal funds running from \$100,000 to \$200,000 per year derived from special landings taxes which the California industry had the legislature put upon it for this specific research purpose. The Committee does no research itself. It works with and through the California Cooperative Fisheries Investigations, a completely informal group organized by it, consisting of its Director (Murphy) and the heads of the Federal, State, and University of California (Scripps) Laboratories involved in this area of study (Ahlstrom, Radovic and Isaacs). These organizations are throwing well over a million dollars per year into the common pot. The Marine Research Committee uses its \$100,000 per year, rather a small part of the total to lubricate the cooperation amongst these entities and make particular grants to other agencies, such as the California Academy of Sciences, Hopkins Marine Station of Stanford University, etc. While there is a quite free exchange of views between the industry fellows on the Committee (an official body appointed under law by the

Governor) and the scientists, and the Committee people have the whole say about their \$100,000 per year, still in practice the Committee allocates its funds precisely, or nearly so, as the scientists as a group recommend to it.

This is an unusual group and does not quite fit into your category anyway, but I point out that there may be gray areas around your corollary worthy of examination. In my humble opinion, although I have inveighed against it occasionally during the time, the Marine Research Committee has done a pretty good job of stimulating general inquiry in the California Current area over the last fourteen years and we hope to rather improve the record over the next fourteen. Yet these men have an interest of a personal profit nature in the results.

Your corollary actually runs in two directions. both of which are difficult to deal with in our democratic system of government. The first, which I think is what you are primarily concerned with, is the director indirect direction of research by people who do not know enough about the problem or likely means of solving it to direct anything to do with it. This is not exclusively a fault of industry folks but is often apparent in administrators and in budget officers who tend to stray beyond their immediate responsibilities. It may even be taken as a part of the general problems of communication between scientists and the lay public. As John Isaac puts it, society should pose problems to the scientist and let the scientist alone to solve the problems. He opines that a major part of the difficulty is that society does not ordinarily know well enough what its problems are in any particular field to pose it in a sensible fashion.

It cannot be put in these simple terms. Society, to over use the abstract terms, does not know enough about the resources which the scientist can bring to bear on a problem to state the problem ordinarily in a manner that appears sensible to the scientist. Often enough the scientist does not understand, or ignores, all of the non-natural force aspects of the problem to the extent that the scientist cannot postulate the problem in a form that seems sensible to the lay public.

Translating those matters into the field of our responsibility, marine research, it appears to me that there is not sufficient feedback between the scientists and the interested and intelligent members of the effected public to assure the most efficient operation of the one or the most effective question formulation

by the other. I for one would incline to be somewhat more lenient than you are in your corollary. I should like to see some competent persons make an objective study of how different forms of liaison between those doing and those financing marine research have been used in democratic societies and what has been the success or failure of the form relative to the others. If this has been done I do not know of it.

The second part of your corollary, although you do not mention it, has to do with conflict of interest. I believe general practice in the countries having democratic systems of government is clearly to the effect that conflict of interest is inimical to the interest of the State. I have not run into this in any marked degree in relations between the fishing industry and research laboratories in my own experience, and I have always attributed this to the general belief among fishery entrepreneurs with whom I have been acquainted that research, like motherhood and conversation, are things that all conservation industrialists should generally favor but not get too excited about as it is unlikely to materially effect the current Profit and Loss Statement of the Company.

In a related field I have not thought this to be always, or generally, the case. I refer to International Fisheries Commissions that have the ability to shape conservation regulations and thus effect the P. and L. statement of fishing companies. In my book a direct conflict of interest contrary to the public good can well arise in such instance if a Commission member has a financial stake in a company doing business in the regulated species. Thanks, Sincerely yours, W. M. Chapman, Director

\* \* \* \* \*

PACIFIC OCEANOGRAPHIC GROUP, , Nanaimo, B. C.  
10 June, 1962

Dear Dr. Chapman:

Thank you for your letter of May 29.

I was very interested in the extensive comments contained in your letter. I agree with some of them but would like to point out that my own statements were made with little elaboration in order to lend them a degree of emphasis. This is not a retraction but one would have to study a case in point (such as the one you cited) in order to know how best to apply one's ideals. Yours sincerely,  
T. R. Parsons

9 February 1962

From an old friend who is an excellent marine zoologist, inclined to view the world with a jaundiced but benign eye. At this point in this line of correspondence I found a touch of levity welcome and include this series for that effect with some editing)

Dear Wib:

I really liked your Christmas news-letter - it was stirring. I was especially moved by your antipenultimate paragraph (it was you who taught me to count backwards on my fingers to discover the anti(1)-pen(2)-ultimate(3)), where you, with self-effacing modesty, state "I want to assure you that in my humble opinion . . ." (italics mine.)

But your letters, you should either preface with an abstract or finish with a "summary and conclusions." Must be that you are getting old and garrulous. I can remember little notes you wrote to Foster about Lloyd Royal never left any doubts about your conclusions.

However I shall be succinct:

1. Fisheries oceanography, defined: "That branch of marine science dealing with the utilization of the seas as a food resource." Considering that I have never heard of fisheries oceanography before, I think this is most neat and precise.

2. Accomplishments of fisheries oceanography to the present; This I cannot answer - or claim my share of its fame - for I'm just a poor wayfarin' marine biologist in love with warm Pacific Islands and brown Pacific people.

3. Aims of fisheries oceanographers: With my slight observations of and contacts with this group, I would put their objectives thus, in order of importance: 1) answering your letter, 2) lobbying for bills and funds, 3) preparing proposals for grants, 4) holding conferences. And, if they are with the government, this all being the fluff on a solid bedrock of daily, weekly, semi-monthly, semi-annual and annual reports. Should they have any additional time (this being doubtful) or inclination (this being even more doubtful) I suppose they could study the oceans and the fish therein - but, really, such an objective is too trivial to mention.

4. Progress needed in the other sciences to accomplish the aims of No. 3: This is much more difficult . . . . .

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I can't answer this, for you make me feel embarrassed and Victorian. You don't suppose that I should organize a team of physical and chemical oceanographers to help me collect snapping shrimp, do you? Would that keep me from looking at my feet and stammering when I meet modern scientists from Scripps?

I'm sorry I can contribute nothing more to your effort - I guess I'm just an old-fashioned naturalist. After all, I trained under Kincaid and worked when the prime requisite of an oyster biologist was to navigate the passage behind McNeil Island in the fog.  
Aloha,

\* \* \* \* \*

VAN CAMP FOUNDATION      W. M. Chapman, Director      739 Golden Park Ave.  
June 13, 1962

Dear - - - -:

For some little time I have been debating as to whether I should slug you on your large snozzola or congratulate you on being the only addressee of my letter of 25 December to view it in proper perspective. Since I do not wish to be a party to inflating your ego by congratulating you on anything, and I cannot reach you, this has been something of a dilemma. I have rationalized it as being all my fault any way on two grounds: (a) I did not do any better a job than your mother did at teaching you manners, and (b) if I had wanted a serious answer I should have written to --- in the first place.

I am not asking your permission. Either you send me a more serious reaction or in this goes, and it will serve you and the snapping shrimps right. In any event that sentence "Would that keep me from looking at my feet and stammering when I meet modern scientists from Scripps" is a classic and must stay in.

If I ever show up in ----- again it will be strictly in line of duty. The plain fact is that I actively dislike your island paradise. I disliked it the first night in 1942 when the Navy offloaded me there in a blackout; and I have seen nothing more attractive about it either by day light or after the lights were turned back on. If the missionaries had not gone anywhere in the South Seas they may have remained tolerable. Sincerely yours.  
W. M. Chapman, Director

\* \* \* \* \*

Reply

Dear Wib:

Well, at least I have found a way to get a letter out of you - my most important advance in all the years since 1943!

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Before I go into the trivalities of the questionnaire, I would like to launch into something vastly more important - your attitude about Hawaii and the Pacific Islands.

Really, I think, it ill-behooves a person who has emerged, like Grendll from the foggy fens of the Columbia, and passing successively through the rains of Puget Sound and the misery that is called Alaska, and finally settling - God help him - in that land so far removed from all that is good of Western Civilization (tell me, did Spengler ever visit California, or did he merely foresee it?) to do more than feel heavenly repose when visiting our islands - he should be glad for the respite, however short, and yet sad with the thought that he will have to return again to Danté's innermost circle.

Your attitude confirms, however, my hypothesis. You know how tastes can be cultivated: for example, the esquimaux delight in raw blubber and consider the odor obtained from washing with urine as delightful, Germans find putrescent milk products, as Limburger cheese, a delight. More to the case, while I was in Thailand I bought a bowl of pig intestine - lower bowels, to be more specific - soup, which the Chinese consumed with gusto in spite of the fact that it smelled like pig - - - tasted like pig - - -, and contained pig - - -. Correspondingly, I suppose one could like southern California.

So I will overlook your attitude, ignore it like one does leprosy in Thailand, or homosexuality in one's colleagues in the English department. And I will not discuss it again, for fear of embarrassing the both of us.

Now, about the questionnaire - I have only a vague recollection of it, but I did like it. In fact, I thought I saw some parallels between it and Parkinson's essays, except you were more subtle and showed greater restraint. The place you really gave the humorous intent away - and that quotation I can still remember was where you wrote, "in my humble opinion."

But as I recall I answered it as soberly and seriously as I could, and I don't quite understand your aspersions ("if I wanted a serious answer . . .").

On the other hand, if you publish a private communication without permission, I'll have you before the courts of the land!

Give my love to Mazie, and tell her that as always she has my sympathy and commiserations. Aloha.

\* \* \* \* \*

THE UNIVERSITY OF BRITISH COLUMBIA, Vancouver 8, Canada 9 Feb.1962

Dear Dr. Chapman:

I enjoyed reading your memorandum in regard to Fisheries Oceanography.

My idea of Fishery Oceanography is that it is an attempt to establish correlations between the activities of fish populations and the features of the physical environment (physical, chemical and geological). This implies that following the establishment of correlations there should be an attempt to explain the correlations on basic principles. This involves the results of researches in physiology and animal behaviour. The fishery oceanographer can either collect the oceanographic data himself or have others do the investigations but he must work out the correlations. I think it is the duty of the fisheries oceanographer to indicate, where necessary, the information required from the physical oceanographer. The same procedure applies in the case of physiology. (A fisheries scientist is not necessarily a fisheries oceanographer).

For example, there is an International North Pacific Fisheries Commission which is studying the fish and fisheries of the North Pacific. In regard to the salmon, they wish to know among other things, where the young salmon go on reaching the ocean and why and how the mature salmon return to the place where they lived as young. The physical oceanographers are doing a good job in defining the ocean movements and other phenomena. The physiologists have not got far with their work to date. For example, why do the sockeye salmon start moving toward their natal streams at the beginning of their fourth years instead of two years as do the pinks. What factors are involved? Endocrines, sight, response to current? What is the cycle of biochemical events in the bodies of the fish that dovetail with the cycle of physico-chemical events in the ocean and bring about the migration? Obviously the fishery oceanographer or fishery scientist cannot unravel all the factors involved in the cycle of events but he should know the problem and direct physical oceanographers and physiologists to attack it and work out the correlations and explanations.

According to my thinking the task of the working group should not be too difficult if the group does not become involved in a lot of side issues. My very best wishes to you and your committee in the work. Sincerely, W. A. Clemens

\* \* \* \* \*

February 9, 1962

Dear Dr. Chapman:

Enclosed are my comments with reference to oceanography. As my training has been in fresh water fisheries my knowledge of oceanography is scant, though my work has been concerned with salmon and tuna.

1. I feel that fisheries oceanography should be concerned with studying the direct effects of oceanographic features on specific fish populations taking into account population dynamics in addition to other traditional fisheries studies which involve the interaction of fish to their environment. To properly achieve this goal we need a new type of researcher. A person that can be considered primarily an oceanographer who instead of specializing on plankton or marine bacteria has specialized on studying the relation of specific fish populations to their environment. This problem seems to be similar to that of fisheries limnology.

2. Fisheries oceanography has accomplished only a limited amount of work. Its primary accomplishment probably has been in recognizing the fact that a proper understanding of oceanography is vital to the proper management of marine fisheries. I think this is as true for salmon as it is for tuna. I don't mean that this is all you need to know to manage a fishery but one of the many factors necessary to the understanding and management of the resource.

3. Fisheries oceanography should study the effects of the oceanic environment upon the fishery resource, specifically with view to contributing knowledge necessary for proper movement of the fishery. This should be the role of a fishery oceanographer employed by a governmental agency.

4. To obtain the above we need increased understanding of the physical, chemical and biological environment. This work should be pursued by oceanographers who have specialized in the above fields. However, the biological oceanographer should realize that a proper study of biological oceanography includes all elements of the biota (population dynamic included) and not just a single element of the food chain.

I hope this may be of some assistance to you, Sincerely yours,  
Edwin B. Davidoff, Scientist

WORLD LIFE RESEARCH INSTITUTE 22022 Center Street Reche Canyon  
Colton, California 9 February

Dear Wib:

Thank you for the opportunity to comment on some of the items included in your lengthy letter of 25 December.

There are several areas in which you asked for comments which I consider to be beyond my area of competence. However, I have some convictions regarding our present fisheries oceanographic approach which I would like to pass on to you for whatever, they may be worth.

As far as the nomenclature of various fisheries scientists is concerned I don't think it matters what you call them or how you classify them just as long as you clearly define your terminology. Moreover, there has been a steady trend in science to break through some of these artificial boundaries and more and more we are beginning to realize and appreciate the integration of disciplines. I am personally convinced that fisheries scientists in the past have been much too narrow in their approach to their own problems. The real break-throughs are going to come in the future in these inter-disciplinary twilight zones.

As you well know our research has been primarily concerned with toxic marine organisms as they relate to the future utilization of marine protein food reserves. We have also been interested in the development of new pharmaceutical and other organic chemical constituents from marine products. Consequently, my views are quite biased.

If the free-world is to meet the competition of the future they are going to have intensify their efforts in such areas as marine ecology and food chain studies. Our present efforts are much too meager and far too superficial. There needs to be a much greater understanding as to the relationship of algal productivity to that of fishes and their resulting organic chemical constituents.

We now know that toxicity in marine organisms is far more extensive than was previously suspected. Moreover, there is a growing amount of experimental evidence to indicate that toxicity cycles in the ocean may be controlled and purposely triggered - if a nation should desire to do so. This is an area that is deserving of much more careful consideration than it has received to date.

An enormous amount of material has been written about the vast untapped protein food reserves of the sea. Much of this material

is completely meaningless. They will expound at great length about the carbohydrate, fat, and protein values but over-look the "incidental" point that these substances may contain violent neurotoxins which make many of these materials unsuitable for animal or human consumption. I think that it is time that the fisheries people begin to take a more realistic view of some of the long-term problems facing them in any attempt that is made to greatly increase the utilization of fisheries products. We need to intensify our efforts in the direction of obtaining more fundamental knowledge of the interaction of fishes to their environment.

I would certainly urge that UNESCO give some serious study to this matter of toxicity in marine organisms. This is a problem that is going to take on very meaningful proportions in the future utilization of marine products in underdeveloped areas of the world. The points that you have brought out on p. 8 of your letter I would most heartily endorse.

There is one item on p.9 that is worthy of comment and that is fish protein versus vegetable protein. Vegetable proteins can provide a perfectly adequate diet as has been adequately demonstrated by the studies conducted at Harvard, Loma Linda University and elsewhere. However, very little effort has been directed toward the use of marine plants and their proper place in the diet of underdeveloped countries. Although it is true that the Japanese and Scandinavians have done considerable along this line I believe that much more could be learned by conducting more fundamental research along the line of marine plants and human nutrition. Our research efforts in the past have been much too narrow and far too limited.

The problems which you have mentioned are certainly of tremendous international significance and will require an enormous amount of effort from many directions. I am certain that my comments have not been of much help, but perhaps they are slanted in a little different direction than most of the replies that you will be receiving. Thanks again for the opportunity to comment.

Hope you had a pleasant trip to Honolulu. We went on to Wake Island where we did a lot of diving for poisonous fishes.  
Best regards, Bruce W. Halstead, M. D. Director

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UNITED STATES DEPARTMENT OF THE INTERIOR Fish & Wildlife Service  
Bureau of Commercial Fisheries, San Point Naval Air Station  
Seattle 15, Washington 8 February, 1962

Dear Dr. Chapman:

Thank you for your letter of 25 December 1961. In spite of questions raised in the letter I conclude that SCOR has decided to accept "fisheries oceanography" as a useful concept. SCOR has, for example, asked for a statement of "what fisheries oceanography has accomplished", implying that "fisheries oceanography" is now in our language. I quite agree with your statement on page 8 that "it is most useful that the whole field of ocean research proceed as rapidly, smoothly and swiftly as man can contrive and we do not much care if this is done in the name of fishery oceanography, as astrophysics, or more efficiency in hunting submarines." Semantics aside, may I offer some private opinions on your four points of inquiry?

1. Discuss and define the subject of fisheries oceanography

Fisheries oceanography is a science and its general methods are those of other sciences. Following a design or program, the fisheries oceanographer (a) makes observations, especially counts and measurements, (b) organizes and classifies his data, (c) makes certain deductions, especially as to cause-and-effect relationships, (d) insures in one way or another that the results of his work will be open to review by other scientists and (increasingly today) by science-interpreters. As a step beyond c the scientist is often asked to predict, though perhaps as often the burden of prediction is left to the manager or production officer who is responsible for applying the findings of the scientist.

Fisheries oceanography is the study of the oceanic environment of living resources. "Oceanic environment" means the ocean, its boundaries and its contents. "living resources include the marine organisms useful to man. Conventionally, these are the "marine products of commerce": the seaweeds, shellfishes, and miscellaneous invertebrates, fishes, marine turtles, marine birds, and marine mammals. However, noncommercial uses of marine products, --- namely, as objects of beauty and recreation -- are growing in importance to world citizens for whom the every day struggle simply to exist is not a problem.

Fisheries oceanography is not fisheries science and it is not oceanography but is a sum which is greater than these parts. The fisheries oceanographer studies living resources with the image of the sea in mind. He studies the sea with the problems of distribution and variation in plant and animal populations in mind. He would not, for example, concern himself with theories of atoll formation or wave dynamics unless he were to foresee some practical application of his findings. While I would be among the first to defend pure research, I do think that a "fisheries oceanographer" should devote his major effort to pre-developmental research. This should be part of his job description.

In thinking about a definition of "fishery oceanography", it may be helpful to ask ourselves, "How and why did this field of science originate?" When fishery biologists found that they could not understand population fluctuations solely on the basis of catch statistics and from examination of organisms detached from the sea and laid on the deck of a vessel, they looked to the environment for further clues. They looked first for changes in the food chain and were soon obliged to explore the energy budget, mass movements, and chemical contents of the water itself.

Does "fishery oceanography" have subdivisions? I think not, Its reason being is its collective approach to the truth, an approach to the truth, an approach made possible with the help of traditional sciences such as chemistry and physics. It is a subdivision of a still larger science: oceanography. Oceanography has been belittled as a catch-all science or concept no more useful than would be, let us say, a "terrology", - - a blend of geology, geophysics, geochemistry, physiography, seismology, vulcanology, mineralogy, petrology, and other earth sciences. Nevertheless, perhaps you will agree that "oceanography" (or "oceanology" as the Russian put it) is here to stay. The closest relative of fisheries oceanography is fisheries limnology.

2. State what fisheries oceanography has accomplished. - - - As you know, I am little acquainted with fishery resources with the exception of marine mammals. The world stocks of marine mammals can be very roughly estimated as follows (in thousands):

- (a) Cetaceans protected by international treaty...400 to 600,
- (b) Other cetaceans, mainly the smaller ones ...2,000 to 5,000
- (c) Sea otters. . . about 30
- (d) Pinnipeds, of which about 15 million are pelagic ... 15,000 to 25,000
- (e) Sirenians, dugongs . . . . . 10 to 50
- (f) Sirenians, manatees . . . . . 10 to 50

The studies by J.W.S.Marr on macroplankton in the vicinity of the antarctic convergence are useful to whalers ("Euphausia superba and antarctic surface currents/ an advance note on the distribution of the whale food", Norwegian Whaling Gazette, 1956, p.127-134). Certainly most of the world production of baleen whales is dependent upon these plankton stocks.

The studies reported by Taylor, Fujinaga, and Wilke of water temperatures off Japan show that fur seals tend to concentrate in places of water mixing. ("Distribution and food habits of the fur seals of the North Pacific Ocean . . .U.S.Fish and Wildlife

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Service, 1965). As a result, pelagic sealers (now operating for research purposes only) hunt 100 to 200 miles off shore, whereas along the American coast they hunt much closer inshore.

3. State what fisheries oceanography should be trying to accomplish  
Fishery oceanographers might profitably:

(a) Catalog the known oceanic living resources according to species, location, numbers, mass, availability, and present value.

(b) Where fisheries are important, catalog the characteristics of seawater such as chemical content, temperature, and degree of mixing, in order to identify the important limiting factors in fishery production.

(c) Add continuously to items a and b by planned exploration.

(d) Study methods of manipulating fishery stocks by deliberately altering the environment, -- especially by imposing to-called "biological controls" in the sea. For example, could the dogfish population in Puget Sound be reduced by introducing a more aggressive and, at the same time useful, species which would occupy the same ecological niche? At what strategic places in the ocean could dikes, canals, or breakwaters be constructed so as to bring about new currents and temperatures to the benefit of a local fishery?

(e) Search for places where organisms are being "wasted" and figure out how to save them. For example, do guano deposits represent the highest value obtainable from the small schooling fishes of the Peru Current?

4. State what progress is needed in other sciences so that the aims in 3 can be attained. -- I have no well defined thoughts on this point, There are, of course, a number of fields in zoology which ought to be getting more attention. For example, the taxonomy of cetaceans is poorly organized, and to improve it would require field exploration, anatomical study, and the training of taxonomists.

May I say in closing that I hope fishery oceanography as a science will move closer toward, and draw increasing strength from, the United Nations FAO and UNESCO. Sincerely yours, Victor B. Scheffer, Biologist.

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VAN CAMP FOUNDATION W. M. Chapman. Director, 739 Golden Park Ave.  
Dear Vic:

I cannot say that I am satisfied yet that the term fisheries oceanography or oceanographer merits a place in the language and I find

it a mark of your broad viewpoint that you, a mammologist, would put forward one of the most succinct and persuasive arguments justifying it.

One of the pleasures of this otherwise drudging task is gaining correspondence contact with old friends that I do not see as much any more as I would like to do. I hope Beth and the kids are well. Lewis is a navigator-bombardier with SAC, lives in Lincoln, Nebraska, is married and has a few months old son. Jane is married and has a son a little older than the above. Her husband is a Coast Guard Officer and they have lived in Long Beach since his graduation from the Academy. They are going to Hawaii for their next tour of duty in the late summer. Alan is finishing his first year of graduate work in marine biology at UCLA. Tommy is finishing his freshman year at UCLA. Johnny is in junior high school and playing pony league baseball. Kathy is a spoiled brat but brought home straight "A's" last report card. Mazie and the old man are alive and kicking.

Thanks for your cooperation, Sincerely yours, W. M. Chapman

\* \* \* \* \*

San Diego, California

February 12, 1962

Dear Wib:

I may have been as puffed up as a poisoned pup when I received an epistle from the Van Camp Foundation but the very weight of it deflated me. I hope you don't object to my lazy approach to the problem but your letter was so massive that dissection was the only answer.

1. To discuss and define the subject of fisheries oceanography. I think that the definition of "fisheries oceanography" is a fine problem in semantics and that you will receive, no doubt, as many different answers as there are people with different kinds of axes that need grinding. In fact your letter anticipates this problem by enumerating some of the possible definitions and at the same time casts a vote for the definition you prefer. In my opinion "F.O." is merely the study of the fish resources, realized or potential, and their relationship to their environment, chemical, biological, physical, what have you. If one needs to study sunspots and how they affect the catch of sardines in Southern California then one is working in the field of "F.O.". By the same token exploratory work to determine commercial distribution, feasible grounds, depth distribution, etc., where a potential hake fishery might be developed is also working in fisheries oceanography. Probably there are very few or no fisheries oceanographers, per se, but only people working with, on, or concerned with some facet of what you term "F.O.".

2. To state what fisheries oceanography has accomplished. The answer to this no doubt depends on the definition of 1. For instance look at pages 6&7 of your letter - depending upon your definition one could elaborate at length. My field of experience is much more limited than yours but I feel that fisheries oceanography should have the laudable goal of production. In this case or sense I think that "F.O." has a long way to go - it needs to know the facts, sir, before it can go out and help that fellow that is looking for tuna, etc. One's thoughts do not have to stray too far afield to think of the tremendous amount of information that is needed before you can give the fishermen any positive help. I believe we know only a fraction of what we need to know to help our own California fishermen that work the tuna business - and lord knows we have accumulated a fair amount of information on the yellowfin and skipjack. But when you consider what Mario Pyretic, the Zuanich brothers, Anton Missetich, Lou Brito, and the fellow that invented the brine spray system did to lower the price per unit of tuna produced we in the fisheries field know that we have not even come close to matching their achievement.

3. To state what fisheries oceanography should be trying to accomplish.

Briefly fisheries oceanography should be striving to elucidate the definition in statement 1. Its back to semantics again. Define it and you have an idea of your goal. I believe that it should be the accumulation <sup>of</sup> those facts which will enable us to understand the processes in the sea, atmosphere, etc, that have a cause and effect relationship with the living resources of the sea. At the same time a considerable amount of information needs to be gathered on the various fishes which are at present of economic importance and a start must be made on those that are potentially important. It is just as important to know our biological subject as it is to know the physical processes that create and constantly change the environment that the biomass has to make a living in. They go hand in hand.

4. To state what progress is needed in other sciences so that the aims set out in 3 can be attained.

Your statement implies that fisheries oceanography is a science - is it really? In my opinion it is merely an amalgam of the various disciplines and techniques needed to understand the oceans and their fish resources. The real need is for coordination of the scientific manpower that is available for the study of the sea (and the money it takes to do the job).

Is a blood biochemist who is exclusively involved with trying to determine racial groupings of fish by various techniques a fisheries scientist? YES

Is a mathematician who never sees a fish but is concerned with devising a mathematical model which his agency's data might reasonably fit a fisheries scientist? YES

Is a person who is concerned with keeping track of the changes fishermen make continuously in gear, its use, and vessels and their use in order to provide current estimates of fishing effort potential a fisheries scientist? YES

One might say that all fishery oceanographers are fishery scientists and that the difficulty is in telling what a fishery scientist is. Certainly a definition confined to persons studying natural processes is too confining to be useful in this field of activity. On the other hand a definition so broad as to cover the whole gamut of persons dealing with the development of sea fisheries would have no useful meaning as a description of a field of science.

The conflict thus generated has numerous bases and effects. Among these are competition for money, trained men, and research ship time under the currently limited conditions of supply of each; the competition for fields of power as between old established fishery investigative agencies and the newer agencies of the United Nations family; competition among governmental agencies and academic institutions in this field, etc.

Now we are getting down to the substrate-crass materialism - the definition of fisheries oceanography is apparently the one that will secure the most money. Quite possibly that is how that romantic name \$\$\$\$\$\$\$\$ oceanography \$\$\$\$\$\$\$\$ got tacked onto fisheries in the first place.

Regardless of the description one gives to fisheries oceanography great caution should be used in this business. Should there be only one avenue of approach - I am thinking of the Japanese approach - many people knock it - its not scientific - they are lousy oceanographers, their fisheries people don't know a thing about physical environment, etc., etc. The Japanese may not know their oceanography, per se, but brother they know fish have a pretty good idea how to find out where they are and how to harvest them. I don't think you can deny that they have developed some tremendous fisheries in the past few years in the Bering Sea, Pacific, Indian, and Atlantic Oceans. In the interest of narrowing the gap between the protein demand and the protein supply I think they have done a pretty good job -- of course I realize that their approach to the problem-exploratory fishing - was not sophisticated but it worked. Never - I realize you have not - know a winner. All I am trying to say that fisheries oceanography

graphers, God bless them, should not get their collective heads so high in the sky that they no longer can smell the sea breeze. Every tool that can help the machinery run should be used in the field of fisheries oceanography if we are going to solve this problem of greater yield from the sea. Frank Alverson

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VAN CAMP FOUNDATION W. M. Chapman, Director 739 Golden Park Ave.  
Mr. Frank Alverson

Inter-American Tropical Tuna Commission  
Scripps Institution of Oceanographic  
La Jolla, California

June 5, 1962

Dear Frank:

I was particularly impressed by your letter. One of the things I was attempting with this gambit was to reach down under laboratory Directors and find out what the people who are doing the work were thinking about. The result has been richly rewarding and your letter is a perfect example of it.

I do not knock the Japanese Empirical way of putting two and two together and starting a paying fishery. As you say, it has worked. I do point out to you that the Japanese long-range fishermen have not worked blindly in so doing. Their familiarity with, and use of, rather simple but effective oceanography parameters in guiding their fisheries surpassed the sophistication of our fishermen by a considerable degree.

I believe that it is generally overlooked that the comprehensive system of fisheries education which has been in use in Japan for upwards of thirty years has had a profound effect upon the development of their entire complex fishing industry. It is not noted that not only the fisheries scientists and administrators in Japan are products of this educational system, but to an increasing degree the skippers of their larger craft, their trade association executives, and the executives in their industry are also coming from it. Accordingly, they have in their whole apparatus a heavier sprinkling of personnel that understands the usage of fisheries oceanography than we have and are thus capable of adopting new understanding of the ocean to their daily operations more rapidly than our people can. I believe this is a major reason why they remain the dominant high seas fishers in the world.

On the other hand it has seemed to me that in the period since the war we have developed a deeper and more basic curiosity about the subtleties of relationships among ocean, atmosphere and living resources which in the long run will be more productive of useful fisheries information than the doings of the Japanese presently will be. Perhaps this is because I am not sufficiently acquainted with present Japanese methods and results.

I agree with you that we do not have much with which to point with pride to our fishermen as to how we have helped them yet, but I am not so sure we are far away from that. It is a big ocean and it has not been fifteen years since the serious inquiry into the living resources in the tuna area of it began.

Thank you much for your cooperation, W. M. Chapman, Director

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UNITED STATES DEPARTMENT OF THE INTERIOR Fish & Wildlife Service  
Bureau of Commercial Fisheries, Biological Laboratory, P.O.Box 6121  
Point Loma Station, San Diego, California

February 12, 1962

Dear Wib:

This is in response to your letter of December 25 in connection with fishery oceanography. I think what you are really trying to accomplish is to ascertain if those of us working in "this" field really know what we are about. Nevertheless, at the risk of exposing my ignorance, I will attempt to put my thoughts on paper.

In my initial thoughts on the subject of defining fishery oceanography, I tried to be exclusive but soon found that it was almost impossible to derive a definition in restricted terms. As much as I dislike the result, I am afraid that what I have to say is couched in generalities.

First, insofar as the fish is concerned, if one is truly to know this animal, I do not see how he could exclude biology, serology, taxonomy, population dynamics, or other related fields. Nor, under "environment," do I see how one could exclude chemistry, physics, meteorology, or geology. Often I have thought of this particular matter and have tried to be more precise and limiting, but the more I study "availability" problems, the more I am coming to realize the cosmic nature of fishery oceanography. There just isn't one neat little package to tie up and attack. Frankly, I feel that the "fishery oceanographers", especially those looking at both the fish and environment, are sometimes unreasonably maligned. One is hard pressed to name another field of research that crosses so many disciplines - and those of a theoretical bent might well be advised that, were not some of us "applied" scientists, if this is what they wish to call fishery oceanographers, putting their findings to use, their research funds might some day suffer from acute deficiency.

I will not attempt to discuss Item 2; I think the record speaks for itself.

With reference to Item 3, as to what fisheries oceanography should be trying to accomplish, I would list the following (in keeping with my broad definition of fisheries oceanography, this list also is broad in nature; if one were to get specific at this point, he would be at it for the next couple of weeks):

- (1) Locate new fishery resources
- (2) Define new resources
- (3) Determine distribution in time and space
- (4) Predict occurrence of all resources in time and space
- (5) Determine maximum sustainable yield of each resource and of the ocean as a whole.

Your Item 4 is one part about which I shall remark only in part. I feel neither qualified nor inclined at this point to discuss it at length. One field, however, that needs emphasis at this stage in our ocean studies is that of air-sea interface problems. If one would count the scientists today actively engaged in research of the air-sea boundary, he certainly would not need an adding machine - we have a fair number of oceanographers, a larger number of meteorologists, but the "meteorologists" are few and far between.

Another person who feels quite strongly on this point is Dr. Namaias of the Extended Forecast Section of the U.S. Weather Bureau. At an informal gathering of oceanographers and meteorologists at Rancho Santa Fe in 1960, he suggested that someone on this coast establish a lab to look at boundary features operationally; that is, researches into these ocean-meteorology problems as they are happening. I am inclined to agree with him. For instance, the north central Pacific presently is in a period of abnormally warm water over a large region. Similarly 700 mb charts of the U.S. Weather Bureau are showing highly anomalous conditions in the upper air picture over the central north Pacific. It may be that the heavy rainfall in southern California is associated with these phenomena. They may, of course, be coincidental but a further "look see" seems warranted and, if we had an outfit looking at this operationally and they needed additional observations, they could be obtained before the picture had disappeared.

Another project about which I have thought a bit is that of ocean temperatures on a world-wide basis. Because of feedback mechanisms, between the ocean and atmosphere, sea temperatures at any one point on the globe might well be related to temperatures 180° away. I am aware of four organizations preparing current temperature charts over large regions - our laboratory, Japan, Hydro and NAMWEP. None of these charts are truly comparable. It might be worth considering world temperature charts on an operational basis.

I have obviously been rambling here toward the end but I am confident that you can separate the wheat from the chaff. I hope some of this may be of value to you in determining what the consensus is with respect to fishery oceanography. Very truly yours,  
James H. Johnson

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VAN CAMP FOUNDATION W. M. Chapman, Director May 29, 1962  
Dear Jim:

Please pardon my delay in answering yours of 12 February. As you know I was away much longer than I had originally expected this spring.

The trouble is as it used to be about the weather. A great many talk about finding out what is going on at the air-sea interface but not many seem to be doing a great deal about it. Certainly Dr. Namais is correct when he says that it would be a most useful thing for a team to be having a look operationally at boundary conditions while they were still going on.

It was some idle speculation about several seemingly unconnected things going on in salmon, tuna, the Eastern Tropical Pacific, and the jet stream segment of the upper atmosphere during the El Niño year of 1953 that led eventually to Sette's present laboratory being set up to have a look all in one piece at the North Pacific and adjacent South Pacific in respect of two or three air-sea parameters at least. This is only a crude start of course on the sort of thing you have in mind and Namais is talking about. It has taken a long time to get that laboratory established and its financing is not adequate yet.

One of the things I had in mind in suggesting to the Marine Research Committee that it ask the National Academy of Sciences - National Research Council for the loan of its Committee on Oceanography for the purpose of examining the needs of the west coast states in respect of the ocean was to examine into some of these interdisciplinary matters.

My opening gambit in this game is the last paragraph of Resolution 3 adopted by the Intergovernmental Oceanographic Commission at its first meeting last fall, which reads: "Requests the Secretariat to initiate the preparation of a comprehensive programme for world ocean study through the most effective means he deems appropriate."

I intend to goose IOC, Wooster, SCOR, Humphrey, et al, about this innocent little paragraph from time to time until something gets done about it, and I consider one of the necessary ingredients to be the idea you put forward.

Obviously, at any rate, IOC Secretariat could be of some use in rationalizing the reduction of current temperature charts by Japan, Hydro, USNAMWEP and you to a comparable basis.

Thanks for your cooperation, W. M. Chapman, Director

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UNIVERSITY OF CALIFORNIA Department of Zoology, Los Angeles 24,  
February 13, 1962

Dear Dr. Chapman:

I have read through your long letter on fisheries oceanography with considerable interest. I find that my own views in some places coincide with those that you express and others differ to some extent. Let me express my views here as succinctly as I can.

First of all, I think we are in pretty good agreement on the directions in which fisheries science should work, that is, toward the production of maximum sustained yield fisheries of all kinds allowing the maximum exploitation by man, and yet maintaining the protection of the basic stocks involved. I am not particularly exercised over definitions of fisheries scientists. What we need is to judge from what specialities information must come to solve the particular problems at hand. I am quite sure that the contributing sciences will be different from fishery to fishery, depending on many things, whether or not the species concerned is pelagic or an estuarian form or any of a number of other factors. In addition to these basic applied problems, I am quite sure that we must also gain strictly basic research information about the ocean. This will ultimately lead to many new insights of practical importance which cannot be predicted in any way now. It seems to me that we must allow the basic research wheel to turn and we must realize that basic research in an effort to make it produce new information of utility. This, I think is true of basic research in almost any sphere. The ideas are apt to come from the most insignificant bases. Hence, like yourself, I would strongly stress that basic research of every sort which contributes to our knowledge of this ocean world which surrounds us all is absolutely necessary for the continuing development of fisheries in the long run. It is also of absolutely essential importance to the development of every other facet of oceanography. I am not concerned about whether or not a fishery scientist in Japan operates in a different fashion from a fishery scientist in the United States. It seems to me that the major question here is simply one of communication. We must let them know what we are doing as we must let everyone who is working in this area know what everyone else is doing, and this is the primary responsibility of those who would seek to create faster progress. I see utterly no reason for us to attempt

to standardize methods, as a matter of fact, I feel that this would be positively detrimental. It is good science it seems to me to have people go off in their own directions using their own intellects and bases for interpretation, as long as these ideas are then used to fertilize the minds of others who use different methods and vice versa. Therefore I would not try to influence anyone other than by passing on the fruits of various researchers around the world to him.

As far as what a fishery scientist is, I think this is largely semantic. There is the great and relatively sharp break between the basic researcher whose work is not intended at the moment to have practical application and the applied worker whose work is pointed toward the solving of a specific problem with information already at hand. The latter is a technologist in many cases and may be assisted by the basic researcher from time to time, however it is probably not a good policy to lean on the basic researcher for information to solve specific problems. I really see no need for further classification. A blood chemist can be a fishery scientist if he is applying his blood chemistry to such problems or anyone else can be a fishery scientist if he is doing the same thing. The basic researcher may be a fishery scientist is he is doing basic research in that area. He however, should not have the onus of being required to produce a practical result.

To sum up my feelings on this matter, I think we are in need of communication at several levels. First of all there is great need for the study on a basic plane of the sea and its interaction with both the floor beneath it and the atmosphere above it and concomitant study of its environs. This is the basic sphere. Then there is great need for translation of the results of this study into the area where they can be used by the fisheries biologist. This is a most difficult area for communication to operate. It is one of the greatest lacks in American science today. Our scientists produce much information and relatively little of it is absorbed and applied by people who are looking toward a directly practical result. It seems to me that the interpreters of science, particularly of oceanography, are not

numerous enough. Within the field of application of information to practical problems, communication is needed between the various divergent schools such as those you mention. I would certainly not try to change people's ways of thinking and make them uniform but would merely attempt to disseminate information as uniformly as possible between these various schools. I think another area that is very important is the next step below this which comes directly from the results of the practical

or applied fishery worker in which one attempts to transmit his information to the practitioners or fishermen and processors. these people must realize the importance of what has been found by the whole structure of science behind them. I realize that it is extremely difficult sometimes to get across such information to people in the uneducated groups such as one finds in some of the more primitive parts of the world, but the educational process can go on if it is tailored to their capacity.

I think that's about it from here. Sincerely, Kenneth S. Norris,  
Assistant Professor of Zoology

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VAN CAMP FOUNDATION W. M. Chapman, Director 739 Golden Park Ave.  
May 29, 1962

Dear Ken:

Your thinking is so similar to my own that I could find little or nothing in your letter with which to take issue, but I did find you using "basic" and "applied" in a way I used to do and which I do not believe I do any more - or seldom. The reason, I believe, is that I do not any longer have a very clear idea of what is basic or what is applied in fisheries research. Let me give an example or two.

1. Anchovy-hake: I have been following sardine research on this coast actively for thirty years and even have been involved in it mildly a time or two, and written a paper or so on sardines. All I really know about sardines is that in my younger days the fishery extended along the whole Pacific coast from Baja California to British Columbia and yielded upward of 700,000 tons a year, and now it is reasonably well confined to the area south of Point Conception and 20,000 tons per year is a fair catch.

I think the reason for all this was an over heavy fishery during a series of poor year for recruiting sardines due to that expression of my ignorance called ocean climate. But from the copious data I must admit the proof of this is by no means clear. Also I must admit the variations in ocean climate which I thought were beneficial to producing strong year classes has been gone through in recent years and while many more larvae were produced - no surge of the stock took place.

There has been much debate among the scientists more directly involved in these studies than I as to why the sardine decreased but there has been a surprising uniformity of opinion about why they do not come back as one good theory after another bit

the dust, shot down by cruel observation. The opinion that is growing uniform is a rather querulous uncertainty about our knowledge of anything about the sardine among the people who have worked on them longest.

Accordingly we have spread our shots very widely, as is customary under such conditions, and just started out investigating the California Current area rather generally hoping that promising leads will develop but assured at any rate that we will learn a good deal about this piece of ocean and its contents. This, I believe, all hands would admit to being pretty fully basic research that the whole program has come to even though it is still called a sardine program. It is loosely overseen by a group of hardnosed businessmen, labor leaders and sport representatives who are appointed by the Governor for this purpose and are supposed to be the epitome of pressure-types for quick and dirty answers. They (I am included) are perfectly agreeable to this present approach.

But the researchers are also coming to more and more uniform opinion that there is some connection between what happened with the sardine, hake and anchovy populations in the same time interval in the same ocean area, and that these changes may be causally linked in some obscure manner. Put bluntly: the hake population grew enormously while the sardine went down and the anchovy population did more. It increased in size almost as much as the sardine decreased. Is it possible that the ecological conditions have changed so that the very large hake populations and the enormous anchovy populations together or separately operate as biological "lids" through which the now small sardine population cannot break, despite a good brood year or two, to go on toward its former size.

It is a rather wild hypothesis, and it is not mine, but as Murphy, Isaacs, Radovic, Ahlstrom and their boys chew over the data this way and that, it becomes real enough to them to be worth testing. But how does one do this? Only by manipulating the hake and/or the anchovy populations. Observation techniques are not so good that every hake or anchovy is marked in its fall, but they are good enough so that substantial changes in any of the major fish populations in this area can be measured with a probable error of reasonable size and cannot go undetected.

Nobody has the sort of money required to conduct such a huge experiment even though it is challenging. The money has to come from the sea if it is to come at all. But hake are not a commercial fish in any sense of the word on this coast.

A few ton are caught and sold, but more are thrown over the side as complete waste and fishermen consciously avoid concentrations of them. A complex of laws called conservation so inhibit the fishery for anchovy that nobody knows if they can form the base of a real commercial fishery. But if hake and/or anchovy can be landed for a price of \$12.00 per ton, fish meal can be made from them which will sell on the world market in any reasonable amount. Sufficient demand can be generated to make drains on the populations sufficient to cause measureable changes in abundance. At such prices it is obvious that fishermen will have to catch very large volumes per unit of effort to make wages.

Can this be done? At first blush the industry to a man says it cannot and that the whole business is ridiculous.

But in southern California quite aside from a quite remarkable assembly of marine scientists capable of monitoring all or most variables of such a mammoth experiment we have a remarkable assemblage of industry talent from fishermen through processors through salesmen and the financial talents that go with skilfully run enterprises large enough to work on a world wide basis. Van Camp's sells marine products regularly in thirty five countries and produces them in nine. StarKist is about the same. The smaller companies have their talents through the exercise of which they survive. We are involved in instructing savages all over the tropical world how to initiate modern industrialized fisheries. Why can't we exert these talents on resources on our front doorstep and have a go at it at least?

So I am in the process of grading industry to build fisheries they do not really wish to build and have no faith in, that are presently against the law, large enough to cause a measureable effect on very large pelagic fish resources, with the objective of testing a shaky hypothesis held by a number of competent scientists whose only real brief for it is they have not got a better one, aided and abetted by the State authorities up to and including the Governor.

Is this a project in grasping, heartless commercialism; applied gear research and exploratory fishing; applied sardine research; or basic experimental ecology? If one, or the other, at what point does the change over come - especially when it is actively ramrodded by a group of simon-pure scientists who would rather like to be doing some applied research on sardine but have pretty well given it up as an impractical approach?

## 2. Air-sea interface interaction

You refer to this as a field for greatly needed basic research. I do not, I want people to stop talking about it and start working on it because I think I can apply the results, before they are cold on paper. Elton Sette is sitting up in the sardine loft at Stanford with a competent oceanographer, mathematician and meteorologist on senior staff, supporting staff, IBM computer availability, and about 8,000,000 surface temperatures and barometric pressures from the Pacific north of 20°S. latitude trying to riddle out what has been going on between sea and water over this enormous expanse during the past thirty years. This is pointed to with pride by the Bureau of Commercial Fisheries - as a bona-fide, gold-plated project in basic oceanography, and oceanographers around and about generally agree.

Basic, hell; I'll guarantee we will be making important money out of these research results a year before they are ready for publication, and right at the moment I can't tell you which of three or four ways we will use them first in. And this is only one small aspect to air -- sea interaction we would like to see the exploration of going forward more rapidly.

3. Internal Waves: People have been talking about internal waves for some time. Gene LaFond and his boys have been trying to riddle these out with some degree of rigor for some years. While I have not kept closely up to date on progress (I believe most of the work is classified) what I do know of it makes it look as if it is getting more complicated all the time instead of simpler - a rather normal tendency for this sort of research.

Why Gene's Admiral's are subsidizing this research you can guess as well as I. I think they see some very practical results to come from it and from that standpoint it is applied research. But it is by no means the putting together of known facts; it is a delving into the very pulsating heart of the ocean to discover the causes of its deep-seated rhythms so that eventually they may be predicted.

There is little doubt in my mind that tied up in these internal waves and their possible tripping and breaking on the edge of the continental shelf and on sea mounts is part of the story of tuna aggregation, and the rhythms (presently otherwise unaccountable) for why they aggregate in readily catchable surface schools at one time, and are otherwise hardly available commercially in the same area although present there. Relationships to the variable occurrence of other kind of fish in other major fisheries are likely also to be established as understanding of internal waves and their effects on the ocean is gained.

By every concept of the fine young scientists who are engaged in this particular work they are happily engaged in basic research. I have talked with them on this score. Yet from my standpoint their work is of such practical concern that if we had a couple of million bucks of loose research dough I would pass over an awful lot of what is called applied research to plunk it on this for more immediate return. Other examples of this sort could be given ad nauseum.

A hundred years ago basic and applied were good adjectives with which to differentiate types of research. If one looks at the time interval between the development of the concept of the storage battery or the electric motor and the sale of these practical instruments on the market you find the reason why. That time interval simply does not exist anymore in any field that I know. We are not very agile people in our industry but we are no longer nipping at the heels of people doing research in basic oceanography. In more fields than one we are keeping as close track as we can of what the basic researcher is doing, making the best guess we can as to what we think he is likely to come up with eventually, and investing ahead of his results as a gamble.

You will, then, wonder why big fishing companies like ours do not invest in basic research as does Bell Telephone, DuPont, General Electric, etc., and I will tell you. Our resources are too small in proportion to the size and complexity of the ocean problems we face. We do not own the resources, or much of the means of production, nor do we have any controls prior to our purchase of raw material. These are in the public domain and that is where the research requires to be. But we do aid and abet the researchers in this domain to the best of our ability, because whatever is discovered and newly understood about the tropical, sub-tropical and temperate world ocean and its contents is likely to be grist for our mill.

Yet running through these letters is a strong vein, particularly against applied research and a touting of basic research. I just do not think this has been thought through in modern terms. I wonder if we are not thinking more of the difference between team research and individual research, or some combination of these or other concepts of the modern scene? I am sure we are not talking about the dilettante who just wants to fiddle around and be called a scientist, preferably on public or foundation funds. This type of bird is pretty rare these days in my experience, although I hear from friends in fund dispensing agencies that the species is far from extinct and tends to develop great powers of mimicry and adaptability of other sorts in the struggle for existence. Also I am sure we are not talking about the fellow with some

scientific education up to the baccalaureate level that an administrator hires to rustle up some information designed to keep irate sportsmen or commercial fishermen off his back after he has formulated a particularly stupid regulation for sociological, economic or political purposes. These folks are seldom engaged in anything dealing with what I would call research, and since I worked at that last for a few years in my youth I know something of it.  
Sincerely yours, W. M. Chapman, Director

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Bowdoin College Department of Biology Brunswick, Maine,  
Dear Dr. Chapman: February 15, 1962

Your interesting letter of December 25 reached me, of course, some time ago, and since then it has been given concentrated attention from time to time, and other time has been devoted to the questions you raise. I fear that I have not arrived at answers satisfactory to myself, let alone to scientists generally; but with the feeling that many contributions examining the problems in slightly different lights may contribute to a truly rational discussion of the questions, the following is submitted with considerable trepidation. It is refreshing to think about such broader issues from time to time, as one moves along in one's own field of endeavor.

The fisheries oceanographer is one who deals with marine species of economic importance, either directly or indirectly important, as follows: He has an appreciation of the application of all pertinent oceanographic data to his problems, and he works with, thinks about and writes about fisheries problems as one who views the fishes and their environment as a continuum. He is capable of applying mathematics, advanced instrumentation and the vast body of oceanographic data to his problems where they apply then, but his ultimate concerns, his central theme; at least this is a significant body of his work.

His work will be considered as pure basic research, although he will be frequently called upon to lend advice on problems of economic and very material concern, and he will be interested in applying his own data and that of others to such problems. While his immediate work will always be within limited areas, he will be approaching the work with the broadest possible view. Under the best of conditions he is capable as a technician, as a statistician, as a taxonomist; in any event he appreciates the contributions of all these to his work as a scientist, and he often applies the work of all three to his own work as a research scientist.

Fisheries oceanography is that science practiced by such men as just described, of whom there are too few, and whom are too swiftly

assigned to administrative posts because of their rarity. The laboratories contributing most to fisheries oceanography will include oceanographers of many specialties upon their staffs, and will not necessarily be dealing with marine organisms per se as a major effort. They will include facilities for working with marine organisms, preferably in the natural environment. In briefer terms, a fisheries oceanographer is one approaching the study of marine organisms from a broad oceanographic base, and whose contributions serve to improve the state of the fisheries. I would cite Sir Alister Hardy and Dr. H. B. Bigelow as two approaching the ideal.

Fisheries oceanography has contributed most in regard to productivity studies and in regard to the migration of fishes, especially the herrings of Europe. The work presently being done at the Edinburgh (Scotland) Oceanographic Laboratory under Mr. Glover strikes me as an excellent example of fisheries oceanography in these connections.

Fisheries oceanography should be preparing for a time when knowledge of the seas will be so complete that the distribution charts of fishes over the seasons of the year will be as accurate as those of ocean currents; it should be working toward increasing predictability of catch. The development of accurate seasonal fisheries maps, similar to weather charts, is an end in view of fisheries oceanography. These would however be useless were it not for considerable concern already extant in re fertilization of marine waters to increase the productivity of the sea. Fisheries oceanographers must be concerned about pollution problems, about the important problems of atomic wastes, about poisonous plankton blooms, about the total picture of man's utilization of the sea.

The clarification of relationships between oceanographic data and fish distribution should be a continuing process at many oceanographic laboratories.

The kind of progress needed in biology is a greater realization that life does not go on in a vacuum - that the responsibilities of those studying whole life cycles of animals and plants are as great in physics and chemistry as in biology. Unfortunately, most of us cannot be excellent in all fields, so unceasing cooperative endeavor is a great need. A schism between the sciences cannot exist in oceanography for the most productive work; traditional lines have been cut across. This is very important in fisheries oceanography.

An important area for advance must be increased presentation of educational opportunities that view the oceans from the standpoint of preparation in all the natural sciences. Availability of distinguished lecturers from research laboratories is an important contribution that such laboratories are making, as exemplified by the Woods Hole Oceanographic Institution.

Application of instrumentation have reduced the trial-and-error factor in fisheries; gear research in relation to vessel construction and ship behavior have increased markedly the predictability of catch. Increasingly we are able to appreciate the factors accounting for orientation of fishes and other marine organisms in relation to the environment. Increasingly cooperative endeavor of fisherman and oceanographers are elucidating problems of distribution and migration. Perhaps the area least explored and that offering the greatest challenge to accurate study is that of the life cycles and behavior "at home" of marine organisms, Facilities for this area - underwater vehicles, oceanographic ships, photographic methods - are rapidly being improved.

Fishery oceanography is the application, then, of the oceanographers' data to the fisheries; it includes an appreciation of the ecology of fishes and other organisms in the sea. It is the culmination of cooperative endeavor by many scientists studying the oceans in their entirety. It is a science more demanding of team research than many others.

The problem of mitigating human dietary deficiencies through fishery oceanography lies very largely in the overcoming of traditional prejudices as to what one eats. Exploratory fishing is an important aspect of this, as of fisheries oceanography generally. The increase of food supply will be a long-term outcome of the development of fisheries oceanography. Bringing marine organisms into markets where they will be purchased for food is not an unimportant problem in regard to improving diets.

The fisheries oceanographer will be able to write at several levels; he will describe the results of his research which are contributing in scientific journals, he will not be put off by requests to write about his work at a "popular" level. Whether in a research laboratory per se, or in a teaching university, he will consider himself a teacher to an important extent, and he will appreciate the importance of starting others out in the field that he has helped create.

All of which thoughts are, I fear, more random than you would like; I hope they will help.

Please remember me to Dr. Humphrey. I had the pleasure of meeting him in Australia last year. Sincerely yours, James M. Moulton, Associate Professor

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UNIVERSITY OF HAWAII, Honolulu 14, Hawaii, Department of Zoology  
February 15, 1962

Dear Wib:

So far I have found time to read only the first part of your long epistle of December 25, 1961 -- I suppose this was intended to be a Christmas present?

Regarding your first point, I think it is highly unfortunate that the term "oceanography" has been forced into such an all-inclusive connotation by the so-called oceanographers who are neither ichthyologists nor fishery biologists. I would define the term "fisheries oceanography" rather narrowly, as will be apparent below. I would much prefer the term "fisheries science," which is more meaningful to me and which would include not only fishery biology per se but also aspects of oceanography, mathematics, and other disciplines applied to the study of fish and fish populations.

If fisheries biology is to be included in oceanography, does that make me an "oceanographer"? Of course not, I call myself a fishery biologist. I might even call myself a fishery scientist if I were trying to be impressive.

That brings us to what is a "fishery scientist." I would say it includes any scientist trained in any discipline, who is spending most of his research time attempting to solve problems associated with fish or fisheries. It is sort of a generic term which should be made more specific in each individual case. Thus dealing with fish populations, you might have a fishery biologist, a fishery statistician, a fishery oceanographer, or even a fishery gear technician. In dealing with individuals (as opposed to populations), you might have a fish behaviorist, a fish taxonomist, a fish physiologist, a fish immunologist, or what not. These people might be all classed as fishery or fish scientists, but the specific designation is more edifying. . . . I trust I have added to the confusion. . . . I will comment on the other points at the next opportunity. Sincerely yours, Albert L. Tester, Senior Professor and Chairman

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UNITED STATES DEPARTMENT OF THE INTERIOR, Fish & Wildlife Service  
Bureau of Commercial Fisheries, Biological Laboratory, West Boothbay Harbor, Maine

February 15, 1962

Dear Dr. Chapman:

I welcome the opportunity to comment on the SCOR terms of reference concerning fisheries oceanography. In recent years, I have participated in a number of official and quasi-official meetings at which the definitions and objectives of fishery oceanography were discussed. It is my opinion that definitions, per se, become less important the more they are discussed. The constant bickering of attempts to separate "applied" and "basic" research serves to exemplify this fact. Definitions are certainly a necessity, but we must continually guard against any obsession to define. Definitions are unlikely to change the efforts and/or direction of scientists engaged in "marine research."

My comments on the terms of reference follow, and I hope they will contribute towards a resolution of the problem.

1. Definition of fisheries oceanography: I have generally accepted the concept of three basic disciplines in oceanography - biological, chemical, and physical. (A fourth discipline-geological-I consider as a sub-division of physical oceanography). These disciplines are not all-exclusive, rather, each discipline influences the others, and it is impractical--indeed impossible--to divorce one from the other. The "type" of oceanography merely designates the area of emphasis. This same consideration is applicable in the various sub-divisions of each basic discipline.

Fisheries oceanography, a sub-division of biological oceanography, is a science directed towards the gathering and understanding of information vital to commercially important marine populations; the information may concern commercially unimportant populations or any of a number of sub-divisions of either physical or chemical oceanography.

2. What fisheries oceanography has accomplished. Through studies of life histories--in the broadest sense, ecological relationships, population dynamics, etc.--fisheries oceanography has continued to provide a wealth of facts about fisheries populations and, in general, contributed to the growing knowledge of oceanography.

Examples of applied accomplishments in marine fisheries of the world are not numerous, but the usual scope of fisheries research is not conducive towards this end. The outstanding examples result from long-term, well-financed research efforts.

3. What fisheries oceanography should be trying to accomplish  
As a new science, fisheries oceanography should continue to provide background information about marine populations and oceanography, towards an eventual goal of attaining knowledge that will enable an interpretation of changes in fisheries populations and result in improved utilization.

4. Progress needed in other sciences. The immediate needs of progress--as evidenced by the demands of fisheries oceanography for more and more specialists (i.e., physiologists, microbiologists, etc.) --lie in the more basic aspects of biology and related physical and chemical sciences. Our present knowledge provides "What" an animal did or did not do, and the "why" is the knowledge we need to add. Coupled with this biological need are synoptic observations of the physical environment. The need for specialists does not preclude the need for "general practitioners" to assimilate and utilize the multitude of facts from the several sciences.

Bernard E. Skud. Laboratory Director.

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NATIONAL ACADEMY OF SCIENCES National Research Council, Committee on Oceanography, 2101 Constitution Ave. Washington 25, D. C.

February 15, 1962

Dear Wib:

Your letter of December 25 poses some difficult questions. Personally I feel poorly qualified to answer any of these questions but I appreciate the opportunity to express my personal views.

I am glad to see a SCOR Working Group on Fisheries Oceanography formed even if under duress. The chairman and the group have my sympathy.

Although I'm not quite sure what a fishery oceanographer is, I have come to feel that as a group they are somewhat thin-skinned. I think this is particularly evident from the defensive maneuvers of FAO at the IOC meetings. I was mildly shocked at the assertion that SCOR members were not responsive to the needs or aware of the complexities of fisheries oceanography. In my opinion, an analysis of the backgrounds and interests of SCOR members will demonstrate a strong association with the fisheries scientist.

To me, the essential feature of the marine sciences (and their application) is the absolute necessity for close cooperation and inter-disciplinary programs. I hope that SCOR's Working Group on Fisheries Oceanography will strengthen this interrelationship rather than focus attention on fiddlerences--either imagined or real. Best wishes. Sincerely yours, Richard C. Vetter, Executive Secretary

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OREGON STATE UNIVERSITY, Corvallis. Oregon, School of Science  
17 February 1962

Dear Dr. Chapman:

With reference to your letter of 25 December regarding the formation of a SCOR "Working Group on Fisheries Oceanography," I have the following comments:

As you intimate toward the end of your letter, commercial fisheries activities are strongly influenced by economic and social factors affecting consumption of fish and fish products. SCOR's concern is more with location of resources and a better understanding of the factors controlling their distribution and abundance. If "fisheries" are like any other commercial and industrial activity, as I believe they are, then both supply and demand must be taken into consideration. Thus we may regard the location of fisheries resources and an understanding of processes controlling their abundance as closely allied to prospecting in other natural resources such as petroleum, mineral ores, or forests. The proper approach, then, is one of practical considerations for the biology and economics of, in this case, a renewable resources. Scientists interested in "basic" science are not very enthusiastic about such an approach. This is obviously the reason why agricultural colleges, the USDA and the Bureau of Commercial Fisheries (and the field survey groups in the minerals industry) are doing most of the cataloging. It should be noted that some of these organizations are conducting some very important basic studies, but that is not their prime responsibility.

Your three categories of opinion on fishery oceanography (p.6) are very well taken. We can readily identify individuals belonging to group 1) and 2). Until recently, as you will be able to judge from the enclosed reprint, my personal thinking has been mostly allied with the first group. Lately, and partly as a result of your letter, I have come to feel that the third way of thinking promises to be much more fruitful for everyone.

The biological program of the Department of Oceanography, here at Oregon State, is developing along just such lines as you suggest for your third category. However, when it comes to nekton, we are interested in all of the swimming creatures, not just commercially valuable species. Moreover, our approach to the study of the oceans must ignore most of the economic considerations, because, with a small staff, we must put our entire time into investigations of the environment and the entire pelagic and benthic community to do the job at all well.

Therefore, I believe that your category 3. is the answer to the third aim of your group, "to state what fisheries oceanography should be trying to accomplish". Is there any group, presently active in the United States capable of carrying out this mission? I think not. We really are divided into more or less ivory tower and dook book oceanographers.

The most valuable contribution your Group can make is to formulate the desirability of a basic approach to a practical investigation.

So-called fisheries investigations have tunnel vision. All they can see are hake, or salmon, or albacore. They have limited funds and are subject to political winds blowing out of Washington. This must be true, because they work on not only economically valuable, but on politically valuable species. I have the feeling that this is true not only in the United States but throughout the world. The ICES seems to have accomplished the most with a basic approach to a practical subject, but they are woefully undermanned.

A fisheries oceanographic investigation should strongly resemble any one of the better oceanographic institutions throughout the world, It should have the following structure, with regards to staff; meteorologists interested in wind fields and solar insolation, physical oceanographers interested in currents, heat budgets, and general circulation, chemical oceanographers, interested in nutrient elements and in trace metals, biologists assorted by trophic level, i.e., primary production, secondary production, systematists for important taxa, a general ichthyologist interested in deep sea forms, ichthyologists interested in particular families; economists of the theoretical type, and an instrumentation specialist.

As for aim number 4., "to state what progress is needed in other sciences", it seems to me that the cart is before the horse. The "other sciences" are way out in front. Fisheries people need to broaden their horizons and realize that the real break-throughs are achieved by working on a very broad front, with theorists and field people working together. To use a modern analogy, what is really required is something like "operations research". The Rand Corporation is a private brain trust employed by the Air Force to tell them how to fight the next war. At the moment we are just plodding along in fisheries; what we need is a Rand Corporation to tell us how to manage and harvest our fisheries. Sincerely yours, Hervert Curl, Jr., Assistant Professor Biological Oceanography  
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VAN CAMP FOUNDATION W. M. Chapman, Director 739 Golden Park Ave.  
June 7, 1962

Dear Dr. Curl:

Down this way we are most interested in the way in which you people at Oregon State are setting about your business and we are expecting big things of you.

In the industry down here we do not expect fishery oceanographers to even be able to recognize a commercial species if they see one and we are getting more of that opinion daily. Telling what is

a commercial species is really the business of industry and not of science. Demand can change quite rapidly, or can be upset quite rapidly by supplies from some other part of the world. Science requires consistent application to lines of research. It cannot be turned off and on like a water spigot and it cannot react quickly as the market place must.

It is quite true that we have tropical tuna programs, albacore tuna programs, mackerel programs, sardine programs and those are all for species that have steady commercial markets. This arises from two reasons (a) you have to have some point to rally around to get research money from the Congress or from budget officers of any sort and (b) there are specific things that fisheries administrators not industry people require to know about fish in their charge.

But I believe that our joint investigations in California Current area, all done in the name of commercial fisheries, are about as generalized inquiry into a sector of ocean as you people in Oregon will be able to put a foot for awhile. Another branch of our "commercial" fisheries research effort down here is support of Sette's Stanford Laboratory which is relating variations in surface temperatures and barometric pressures in the whole Pacific North of 20°S. latitude to variation in current strength in the mixed layer and, perhaps eventually, to variations in the yields of major fisheries in the whole North Pacific. We have also been involved from the start in the generalized POFI work out of Hawaii. We have had some small part in stimulating the multi-agency, multi-nation Tropical Atlantic research program of the United States Government of which you will hear more. We have had our part in helping to design the EPOC "Cooperative Program for Investigation of the Eastern Tropical Pacific Ocean" a copy of which is attached for your background information.

Down here we are no longer so well divided into ivory tower and cook book oceanographers as we were a generation ago. I may say that this is due more to the pressures that the ocean has put upon all of us rather than to training in our youth or natural inclination. Our methods of working together and scratching each others backs are somewhat informal and I am afraid would be viewed in Washington, D.C. occasionally as being unorthodox. Our only excuse is that the loose system, or lack thereof, serves us pretty well.

We do not have any formal group that can accomplish fully the mission I had outlined in my third alternative. However, the varied group that put together the EPOC PROGRAM I sent to you is available in its parts, and, informally associated, will put this program afoot and carry it out. Our CalCOFI group in the California area

is a reasonably formal group that can turn in a broad job of this sort reasonably well also. But I put forward the third alternative merely as a goal toward which a good many of us down this way (and in some other parts of the world) think we are heading and should head.

We are attempting to get the National Academy of Sciences - National Research Council to lend the west coast states its Committee on Oceanography to assay what are the needs and responsibilities of the West Coast States in the adjacent ocean. We have not yet been able to get the Governor of Oregon to go along with this request, but are hopeful that he will see the light soon.

In our crude way we have been groping our way toward "operations research" down this way for sometime in our ocean research associated with commercial fisheries, perhaps starting somewhat ahead -- if moving more slowly--than the Rand Company and the Air Force. But we aren't quite so well heeled, nor can we order each other around with any success. On the other hand neither the Rand Corporation or the Air Force has fought a war yet and I am not sure that in our plodding way we aren't making fair headway in our business too.

Your letter and viewpoint was interesting and useful. As a matter of fact the response to mine of 25 December was so voluminous, varied and interesting that instead of trying to synthesize it as yet, I am, where permission is granted multilithing the whole and circulating it to my colleagues for their background information prior to our meeting. This is one case where it seems to me that the raw data will be more useful than the conclusions to be drawn therefrom. May I use your letter in this fashion?

Thanking you for your cooperation, I remain, Sincerely yours.

W.M.Chapman, Director

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\*INSTITUTE OF MARINE SCIENCE  
Alaska

University of Alaska, College,  
February 19, 1962

Dear Dr. Chapman:

Your letter of Christmas Day was sent on from Texas A&M and has just reached me here, where I am enjoying a new and stimulating job.

Not only was it the longest letter arriving this week, but quite the most enjoyable. After each reading, it becomes more interesting and challenging. Unfortunately, I will be leaving for a fairly long trip in a few day's time and, if a reply is to meet your deadline, it must be written now, even if your letter does not so get the consideration warranted.

It seems to me that, taken as a whole, the terms of reference and your very searching comments on them raise two issues, one is largely a question of semantics and thus none too relevant, the

other - what can, or should, be done to study more effectively fish and fisheries - is obviously of profound practical importance. I hope your committee skims over the former and devotes its time to constructive thought about the latter.

As you say, NACSO's definition of oceanography is quite adequate; it is not too restrictive, and that alone commends it. If we accept it, then 'fisheries oceanography' might be described as "the study of all aspects of the oceans from the viewpoint of a fish or a fish population." The purist may note here that the subject is oceanography (the study of the oceans) and the narrowing term fisheries (those aspects relevant to a fish). Clearly, the connotation fishery (fisheries) scientist' is quite different. Science, with all its breadth is the subject, fish (fisheries) the restrictive term. Thus, I would opine that all the types you list on p.4-5 could claim the title 'fisheries oceanographers.' But does this really matter? Is the issue what a man studies, or the relevance and application of his results? For example, is the chemist studying the properties of silicones to be dubbed an automotive engineer because of his contribution to car paints? In seeking too close definitions, you may be in danger of embroiling yourselves on the time-honored argument about what is 'academic' and what is 'applied' research; what constitutes 'science' and what 'engineering' (vide the philosophy expressed on p.4 of your letter) - and this can become a time-consuming business.

The cynic, with some justification, may point to a particular current significance of the term oceanography. If often not closely defined, oceanography is, at present, a fashionable and lucrative subject; a sentence including the term attracts attention, a budget or a proposal claiming oceanographic implications expects support. See, for example, how Humphrey is carried away in this direction in his call for an "oceanographic estimation of the size and distribution of oceanic living resources. What, in the name of etymology, can an 'oceanographic estimation' mean? I hope that in your search for definitions, the committee do not forget entirely such words as aquatic, marine, ecology, etc., which have better established usages.

Personally, I do not think there is any justification whatsoever (unless purely political) for attempting to raise the status of the term fisheries oceanography to the extent of defining a discipline or a discrete field of inquiry (see top 0.9). Indeed, many of the more distinguished scientists working in Oceanographic Institutes, refuse to see themselves as oceanographers; they prefer to remain physicists, chemists, geologists, biologists, etc., who happen to have current interest in marine problems. This point was brought out forceable during a recent attempt to form a new and exclusive society for oceanographers and during the discussions of a joint ESA-ASLO Committee on which I served last year.

However, if one is to follow the SCOR terms of reference, it must be assumed that 'fisheries oceanography' means something. Let us

suppose that this is the study of the oceans from the fishes' viewpoint or as a dynamic environment for the fish. For many years, it has been conventional to associate with each fisheries laboratory, a hydrographical unit comprised of men who were predicated to expressing the environment in simple physico-chemical parameters that could be readily collated with observations on the fish. These were called hydrographers, not oceanographers; the latter term has tended to imply some reliction of practicality - and indeed, how was the biologist to place the demersal fish in the oceanographer's discussion of the boundaryless ocean of infinite depth? I suspect such people were at a disadvantage and still are, because of their narrow terms of reference. They did a good job in evaluating mass water transport, circulation over fishing grounds, annual and seasonal anomalies in basic (though possibly irrelevant) variables such as salinity, temperature, density and those dissolved chemicals more easily measured. But, if asked what they have contributed to the understandings of fish populations and fisheries, one has to answer relatively little. Potential progress has come more from those workers who, for the present purpose, we may have to call 'non-fishery oceanographers.'

The straight answer to what fisheries oceanography should be trying to accomplish is liable to be trite! However, it seems to me that applied fisheries is a classical example of where pseudo-technology has outstripped basic knowledge. Taking the piscocentric stand, we ask how does the ocean affect the fish? To answer this, we use as parameters the variables measured by the oceanographer for quite different purposes, even to the extent of measuring exactly the same factors as part of most fishery research programs.

True, nowadays, some index of organic carbon fixation is sometimes added, although questions on the relevance of this often elicit alarming remarks from fishery biologists. The urgent need, then, is some constructive program to determine what are the conditions and variables in the oceans that are relevant to the behavior of fish and the fluctuations in fish populations. Occasionally, a constructive cry is heard from a Lucas or a Collier. But, nevertheless, the same routine of sampling continues, just in case, after 50 years and many megabucks it may prove useful, It is, of course, all too easy to be critical - and I would blame the system rather than the individual scientists.

Question 4 again begs the issue, what is fisheries oceanography and what is left outside in other sciences? It would seem that progress in science in general, and marine science in particular, is adequate - at least, new ideas and techniques evolve far faster than the scientist can comprehend them. The issue, rather, is how can we ensure that such progress is brought to bear on fishery problems. This, in my opinion, is the key issue before your committee.

At the serious risk of overgeneralization - there are many many exceptions - one might try to mention some of the things that are wrong:

1. Fishery research throughout most of the world - and specially in America - is almost exclusively an in-house program conducted by Federal or State agencies, This is clearly reflected in the attendance at I.C.E.S., I.C.N.A.F, F.A.O., symposia, etc., and it must lead to a lack of communication with the main body scientific. Equally, the civil servants are seldom well represented at the meetings of the so-called 'learned societies' - or if represented, rarely report their problems or findings. Also, they seldom seem to engage in information-seeking visits to universities and non-federal research institutes.

2. By far, the majority of fishery research workers were trained as biologists - usually to the exclusion of any sophistication in the exact sciences. True, there is now a policy to attract physical and chemical oceanographers into the Bureau of Commercial Fisheries, but as a result of tradition, it may be a difficult policy to implement. There are lots of attractive jobs for the competent physical, chemical or, for that matter, biological oceanographers in universities, in industry, and many other agencies not predicated to fishery work. Naturally, the majority are loathe to subserviate their special talents to a service function. Justifiably, they may prefer their direction to come from one of their own kind than from someone trained in biology or wildlife management.

3. The non-biologist who aligns himself with fishery problems is immediately at a disadvantage when compared with his colleagues who elect otherwise. If he joins an in-house program, he is likely to be starved of equipment and faced with a degree of isolation. If he stays outside, he is starved of research funds. By their terms of reference, the generous sponsors of marine science, NSF, ONR, NIH, AEC, etc., cannot finance applied fishery research - or at least, are not inclined to do so. As a result of this - or possibly also because of 2 above and other contributory reasons - the know-how and initiative of the oceanographers in fishery laboratories is, on the average, noticeably of a lower standard than in the non-fishery marine institutions. Further, it is my experience that eligible students finishing their doctorates, will almost invariably seek an opening in an oceanographic institute and only resort to the Service as a final expedient.

Where may the solutions lie?

1. Less trade unionism and better communication: Each time governments put their fishery scientists together, they should call also a selection of people with other specializations and interests. One has in mind briefing sessions in theoretical physical oceanography, activation analysis, biophysics, isotope methodology, cellular physiology, information theory, etc., etc.

2. It should be insisted that fishery workers explain and define their problems to other scientific bodies. (It is interesting here to note how Koczy and Idyll attempted this in Proc. Gulf and Carrib. Fish. Inst. 10, 1958, and the response they elicited from Curl in Limnol, Oceanogr. 5, 1960).

3. Fishery research funds should be made more plentifully available as grants-in-aid(not as contracts) for these organizations not predicated specifically to applied fisheries. If cynical, it is

none the less true that research effort follows available support fairly closely; the recent upsurge in oceanography bears evidence to this.

I hasten to say that personally I have always had excellent relations with the Federal agencies involved with commercial fisheries, both previously in Europe and since I have been in the States. From time to time, we have spent their money - I hope to fairly good effect. But, I believe there is room for much improvement in communication and liaison. Possibly, your committee can devote some thought to this - it might be more profitable than listing once again all the measurements that can be made in the sea.  
Sincerely yours, K.M.Rae, Director, Institute of Marine Science.

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THE MARINE LABORATORY . .Institute of Marine Science of the University of Miami. .1 Rickenbacker Causeway. .Virginia Key, Miami 49, Florida  
February 20, 1962

Dear Wib:

Thank you for your letter of 25 December which I recieved 29 January. Your letter stirred up mixed feelings and touched cords of well known but partly supressed memories. The latter because it reminded me of the time when I worked for the Board of Fisheries in Sweden and actively participated in the work and discussions of the ICES. Consequently the theme is only too familiar but I never found any satisfactory solution to all the questions you raise. Even though Clare Idyll and I wrote a paper on a similar subject and I still underwrite most of what I wrote at that time, I will add a few considerations and summarize once more my ideas along the following lines.

1. To discuss and define the subject of fisheries oceanography. I believe it is a very confusing term because of the increasing use of the term oceanography for the total field of the study of the ocean. In the ICES the term fisheries-hydrography was used in order to determine the work physical oceanography employed in fishery science. In the American language oceanography has mostly been used for non-biological oceanography and sometimes only for physical and chemical oceanography. Consequently, in order to be consistent with the more wide spread usage of the term oceanography, fisheries oceanography should cover all oceanographic phenomena influencing fisheries. This means we have to forget the old usage of the term oceanography and include also all biological work pertinent to fisheries.

I believe it is just as important to define also the term fishery science as I have found many different uses are used and people will talk and discuss several problems using this term but actually they are talking about different matters. I would define fishery science as follows: the science describing and studying all processes and techniques that affect the catch of fish and its economical implications.

Therefore we can also define fisheries oceanography as the oceanographic research carried out with the purpose of satisfying the needs of fishery science.

Fishery science is an applied science but as all such research may lead back to basic oceanographic research, sometimes the fundamental problems have to first be attacked before results applicable to fisheries can be obtained. Sometimes the problems raised are such that we do not have the necessary knowledge in order to be able to state the problem as an oceanographic one. In your letter, you still, in some respects, seem to be of the opinion that oceanography equals physical oceanography and there is also a discussion about the usefulness of the physical and chemical determinations for fishery research and you also mention the Ivory Tower of physical oceanographers. I believe, as I have pointed out earlier, that many times the problem should be stated exactly by the biological

oceanographer before the physical oceanographer can find physical processes which may explain these biological ones. Many fishery problems are explained by fishery scientists as being caused by physical phenomena when there may be a biological explanation just as probable and perhaps more correct. I am especially referring to the large and complex problem of long term variation of the stock of fish such as the Icelandic, Swedish, and Norwegian herring. My explanation for this variation is that we can just as well assume that the decline and recovery is caused by the resistance of a specific species and consequently would fall under genetics more than physical oceanography. A young species may have a great deal of resistance to all factors attempting to restrict its spreading but after several generations, the species may decay and consequently the stock of fish decrease. When a new mutation arises, a new resistant species may develop and the stock will again increase. This question just discussed and similar ones have very often crumbled the waters of communication between physical oceanographers and fishery biologists, the latter representing the main part of fishery scientists.

2. To state what fisheries oceanography has accomplished/.

According to my definition of fisheries oceanography, the question is too broad to be satisfactorily answered in a letter. Population dynamics, productivity studies, interrelationship of physical state of water masses and their productivity, organic matter and metabolics and their influence on the stock of fish, and fishery biology studies with special emphasis on fish behavior are part of fishery research. Most of them, of course, deal with basic problems and many excellent results have been obtained, far too many to give a complete account in this letter. Also here I believe the old definition of physical oceanography and its application to fisheries is behind the question. If this is the case, then I would say that very little has been accomplished which is of real importance or a major breakthrough for fisheries, but why should it? Before we know the behavior of fish, their direct dependence on physical parameters, and their adaptability to physical parameters, very little can be done by a physical oceanographer. It is about the same as if a deer hunter should ask a meteorologist the best way to hunt deer.

3. To state what fisheries oceanography should be trying to accomplish.

The answer to this question is partly contained in general terms in what I have written up to now but I will add a few statements.

The most important discipline seems to be the study of fish behavior in its broadest sense (including ecology and ethology). These problems have to be studied in the laboratory as well as in the sea. We must try to think as the fish do and not try to explain the reaction of fish to environment in anthropological terms. Therefore it is important that, together with the field studied, the environment is studied as fish are also dependent on other

organisms. This must also be investigated.

The fish population, its dynamics, and studies of the life history of fish must then be added to the research program. Consequently we will end up with a large field which coincides in most respects with the program of a basic research institution in oceanography.

A marine biological station and an institution of fisheries oceanography are only different in one way. The latter studies edible fish and the former does not care if the studied object is economically important.

At the present time we are just at the beginning of the studies of fish behavior. It will be a long time before we get results that the fisherman already knows and sometimes has known for a long time.

Throughout the world fishery research is mainly supported by governments and only a few private investigations are carried out. The private investigations are usually supported by economically interested industries and are initiated by gains they hope to make from the scientific results.

Sometimes a government is not prepared to pay for the total research and therefore fishery councils and international organizations have been created (ICES, FAO, and other organizations in the Atlantic, Pacific, Indian Ocean). Very good results have been achieved by some of them such as the herring research in the North Sea and the salmon research in the North Pacific.

To give a patent solution as to how each of these large fisheries should study their problem is impossible because it will be determined by the species under investigation but of course all oceanography will be involved including physical sciences, chemistry, life history, behavior, and population dynamics.

It will be excellent to have an institution concerned with fisheries oceanography in close contact and working together with oceanographic institutions. In addition they may also be closely aligned through meetings and conferences with similar institutions from other countries. In this way the units will not become too large, will work effectively, and exchange of ideas will automatically follow. Therefore the FAO, UNESCO, and other international organizations should create smaller units according to areas and arrange meetings between them for united purposes.

4. To state what progress is needed in other sciences so that the aims set out in 3 can be attained.

This question is partly answered in number 3. I would emphasize here that in order to make any progress we have to first study the biology of fish and their mentality before we can succeed in studying the environment and its influence on fish in order to increase the output of proteins from the ocean and/or reduce the price.

5. To communicate the statement listed above, through SCOR, to interested laboratories and organizations.

This is your problem but since you have also made it mine, if you would like you may incorporate this letter in your answers as a special statement, or you may even forget that I have written. I know I have communicated my ideas in a rather fragmentary manner and I am quite sure that people in closer contact with the problems and having more time to penetrate these questions more thoroughly, will arrive at more exacting conclusions.

With my best wishes and regards, Sincerely yours, F.F.Koczy

\* \* \* \* \*

STATE OF OREGON, Fish Commission of Oregon, Research Laboratory  
Astoria, Oregon February 20, 1962

Dear Sir:

It appears that the union of fisheries biologists with the oceanographers has resulted in fishery oceanographers, and the result has been an improvement. Both areas have information that is not fully utilized without being combined. The name is not important as long as complete cooperation is maintained.

Of course, since I am employed by a state agency, I would like to maintain my identity as a fisheries biologist and obtain oceanographic data that may be applied to the species that I am studying. This probably places me in your Group I. However, I do not believe that any segment should jealously guard its sphere at the expense of complete understanding of at least the commercially important species whether they be tuna, salmon, or groundfish. I would align myself with your Group 3.

Because of the great expense involved in obtaining and outfitting a vessel for oceanographic work, the Fish Commission of Oregon has not been able to enter this field of investigation, but the research staff has felt the need for this information very strongly. In general there has been a serious lack of oceanographic information in the area between Cape Flattery and San Francisco. Now that Oregon State University has become involved in oceanography this gap has been partially filled. I would particularly like to see studies of the food chains and currents over the continental shelf in order to understand the effects on salmon and groundfish. Probably because of the international aspects, the tunas have caught the imagination of many people who control the purse strings, and studies correlated with tuna and other pelagic species are gaining momentum. However, many fishermen are harvesting species not involved with long migrations or international problems. This segment of the fishing industry does not attract much attention from fishery oceanographers, yet the species being harvested undoubtedly have as critical areas in their survival in the ocean as tunas.

I believe that data collected by fishery oceanographers should be correlated as soon as possible with fleet activity to insure

a more efficient harvest of the various species. These data are also necessary to the management agencies to combine with other life history and catch data for better management agencies to combine with other life history and catch data for better management of certain fisheries, primarily those over the continental shelf. Duplication should certainly be avoided and all agencies should strive for complete cooperation.

I have a feeling that I have not met your questions squarely, but sitting on the side lines watching fishery oceanography develop, it is difficult not to be a little jealous and wish that I could have that type of information to apply to the species that I am studying. I do not believe we can successfully manage any fishery until we can measure the effect of the ocean environment on the species involved.

I hope that you have had a good response to your letter and that all of the answers combined will provide the information you require. Very truly yours, s/Alfred E. Morgan, Aquatic Biologist.

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UNITED NATIONS EDUCATIONAL SCIENTIFIC & CULTURAL ORGANIZATIONS  
Place de Fontenoy Paris 7<sup>e</sup>, France 21 February, 1962

Dear Wib:

I have been reading with great interest the accumulating correspondence concerning the SCOR working group on fisheries oceanography, including the recent letters from Cushing and Davies. Of course, I don't agree completely with them which is not surprising since I tend to look at the matter as a physical oceanographer rather than as a fishery scientist.

It seems to me that the note on "Fisheries Oceanography" I published last year in the Reports of the California Cooperative Oceanic Fisheries Investigations is pertinent to this discussion, although it was prepared for a somewhat different purpose. Therefore I am taking the liberty of sending it to the members of your group, as additional fuel for the fire.

Sincerely, /s/ Warren Warren S. Wooster

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FISHERIES OCEANOGRAPHY Warren S. Wooster, Scripps Institution of Oceanography, University of California, La Jolla, California

In considering how to summarize the oceanographic aspects of the papers we have just heard, I found my thoughts falling into several categories - - the definition and goals of fisheries oceanography, current practice in this field, and the success of this approach.

Some may feel that fisheries oceanography is nothing more specific than the broad assemblage of problems being studied by oceanographers working for fishery laboratories. The interests of marine fisheries scientists and those of oceanographers overlap in so many areas that almost any marine research can be included in a suitably broad definition. But unfortunately such

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broad definitions have little operational value.

One might speak, however, of a somewhat restricted area of marine research which could be called ecological oceanography. This deals with the relationship between the ocean as a physico-chemical environment and the populations of organisms inhabiting it. A special case exists in which the populations consist of species of commercial interest. This point of view leads to the following definition:

Fisheries Oceanography -the study of oceanic processes affecting the abundance and availability of commercial fishes.

Obviously populations of commercial fishes are affected by other than oceanic processes. In particular they are subject to the pressure of an aggressive non-environmental factor, the fisherman. Much of fisheries research has resulted from the fear that this pressure was excessive and would soon lead to decimation of the stock; thus it has concentrated primarily on the dynamics of the populations involved. The working hypothesis of the fisheries oceanographer, on the other hand, is that variations in apparent abundance are due primarily to changes in the environment. These changes must be described and understood before the role of man can be properly evaluated.

The relationship is traced out in a model which started with the observation that significant changes in the atmospheric pressure field occur from place to place and from time to time. These changes lead to variations in the stress applied to the sea surface by the wind. It is now generally believed that the major near-surface circulation of the ocean is wind driven, so that the changing wind stress causes changes in the velocity, depth, breadth, transport or other characteristics of the surface currents. Furthermore the processes whereby the surface layer is refertilized with nutrient elements from below appear to be either directly wind-produced (for example, wind stirring and coastal upwelling) or secondary effects of the wind-driven circulation (for example doming or ridging).

The near surface circulation may affect directly the distribution or abundance of organisms at all trophic levels. In addition, changes in the intensity of the refertilizing processes are reflected in the time and space distribution of primary production. This in turn affects production in the next higher trophic level, and so on, with assorted time and space lags, to the desired fish. At each step in this line of reasoning, refinements and complications are involved, but the basic theme of the model remains:

"Changes in the wind field lead eventually to changes in the success of fishing."

The goal of investigation of this model is often considered to be prediction. Certainly if one could forecast accurately the changes in abundance, distribution and availability of fish, this would be of great economic significance. But, conceivably,

a useful prediction could result from the blind statistical treatment of a large number of variables, rather than from a fundamental understanding of the interplay of the pertinent atmospheric, oceanic and biospheric processes. It is the acquisition of this fundamental knowledge which is the scientific goal of fisheries oceanography.

Current practice in fisheries oceanography has concentrated on documenting and trying to interpret the changes in the marine environment. One of the leaders in this field in the United States was the late Townsend Cromwell, who originally proposed this symposium. His first important work, in Honolulu, was a study of wind-induced upwelling along the equator. Subsequently, the Honolulu group has examined the mechanisms of surface enrichment near the Hawaiian Islands and to the north. At Scripps Institution and the Tuna Commission, there have been studies of coastal upwelling, oceanic fronts, and of processes such as those Cromwell labelled "doming" or "ridging". Dr. Sette and his colleagues have been examining past weather and the marine climate, looking for long-term changes related to those in the fisheries. All of these investigations have been facilitated by the presence of certain conspicuous features or discontinuities. As Henry Stommel has suggested, studying the oceans resembles dissecting a lobster - it is easier to do at the joints.

What has been the success of fishery oceanography in recent years? Certainly in the Pacific it has had no dramatic impact on the commercial fisheries. And if the goal be considered prediction, very little success can be recorded. Yet the fund of basic knowledge of the ocean has increased tremendously. The near surface circulation and the distributions of properties such as temperature, salt and oxygen have been much more adequately described. The theory of wind-driven circulation is well established. The variations in time and space of coastal upwelling are recognized, and other important surface-enriching mechanisms are known. In short, the general scheme by which atmosphere, ocean and biosphere are interrelated is taking form, and we are ready to formulate and test hypotheses having bearing on important and specific problems in fisheries science.

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UNIVERSITY OF CALIFORNIA, Santa Barbara, University, California  
Department of Biological Sciences February 22, 1962

Dear Dr. Chapman:

This letter replies to yours of December 25, 1961. I support the views that you express: the essence of which seem to me to be that with respect to fisheries we are dealing with ecological problems that require the organization of a diversity of kinds of knowledge for their solution. Some comments on the specific points follow:

Point I. A definition of fisheries oceanography could be "that body of knowledge and methodologies necessary to understand and manipulate marine fisheries, in a scientific manner." Such a definition

must be quite elastic, within it a fisheries oceanographer would presumably be a person, operating at a sophisticated level, whose primary activities are rather directly concerned with the gathering, organization and dissemination of the knowledge and methods of fisheries oceanography. ("Part-time," "indirect," or "amateur" fisheries oceanographers would generally be trivial to define, as would be too close attention to the definition of "rather directly.")

Point 2. Beyond the factual and technical contributions already made, the present realization that many diverse areas of science and economics, more often "pure" than "applied" must contribute to the successful development of fisheries oceanography seems to me an outstanding accomplishment.

Point 3. Fisheries oceanographers should be working to complete and disseminate the understanding of fisheries oceanography.

Point 4. All progress in other sciences that contributes directly or indirectly to the understanding and manipulation of a fishery would seem obviously desirable. A corollary of this would seem to be the search for and training of more persons with the imagination and capacity to comprehend, develop and utilize relevant material in other sciences. (The tendency, while very human, of groups working in different areas and with different objectives to unconstructively criticize each other is damaging to the "cause" and should be discouraged as much as possible).

Note: The above comments recognize that the adjective "fisheries" implies a focus of attention on individual fisheries. While a fishery has its obvious economic aspects, the point should be stressed that its study is in essence a massive exercise in ecology with significant underlying relationships to evolutionary mechanisms.

I wish you and the committee all success in your interesting endeavor, and hope to learn more of it at the Tuna Conference this July. Sincerely, John Cushing, Chairman, Dept. of Biological Sciences

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NATIONAL RESEARCH COUNCIL CANADA, Atlantic Regional Laboratory  
Halifax, N.S. February 22nd, 1962

Dear Dr. Chapman:

This will acknowledge your letter of December 25th, 1961. There are many much more closely associated with the fields of oceanography and of fisheries than I am who can express more informed opinions in reply to your letter. Over several years I have carried out detailed analyses of sea water and lately I have been investigating the proteins of cod skin and the composition of seaweeds but this in no sense makes me either an oceanographer or a scientist in fisheries. Your difficulty appears to be one of semantics. Philosophers have long recognized the necessity of close definitions of words. The definition of oceanography as the "study

of the ocean, its boundaries and its contents"requires clarification as to whether this applies only to the water or to all that is within the ocean. Presuming the latter, the scope of the discipline, if it may be called such, is very wide, - so wide in fact that it permits the inclusion of many scientists, like myself, who have contributed to knowledge applicable in oceanography or fisheries due entirely to overlapping interests. The situation is comparable with that in agriculture.

The science of fisheries thus will include knowledge contributed by zoologists, botanists, physiologists, chemists, economists, and oceanographers in the restricted sense now current. It would seem quite legitimate to recognize such a field of knowledge although comparatively few investigators are devoting their full time over years to its problems.. Personnel of the fisheries research station in Canada can be so classified even if they be primarily engineers concerned with the design and operation of freezing, salting or canning plants, or primarily biochemists concerned with the proteins of fish muscle or the sterols of fish blood. The relationship becomes more distant in the case of a plant physiologist who is studying the culture of phytoplankton.

If you admit the broad definition of oceanography it must ipso facto include all contributions to the subject of fisheries although contributors at present need not be considered oceanographers for practical purposes. Investigations of populations, migrations, distribution, and ecology of fishes may be considered pertinent to fisheries, - likewise the study of the physiology of fishes and the nutritional value of fish or fish products. But what of the plants of the sea? By definition these are included in the scope of oceanography and probably of considerable importance in the cycles of the feeding of fishes. Hence in some respects they do enter the science of fisheries.

Semantics apart, of course there are many investigators contributing to the scientific knowledge of fisheries who may be loosely called scientists in fisheries and they belong to many recognized scientific disciplines. This will include contributions to fish as human food and we now have a three volume treatise on the subject.

With increasing monetary support for the broad field of oceanography your committee should be able to prepare a statement to emphasize those areas which require investigation as a guide to the placement of financial grants and to the younger scientists who are entering this field, They will have their own ideas too!  
Yours sincerely, E. Gordon Young/

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WOODS HOLE OCEANOGRAPHIC INSTITUTION , Woods Hole, Massachusetts  
February 23, 1962

Dear Dr. Chapman:

This is in reply to your letter of December 25 on the subject of "fisheries oceanography". My field is the study of marine

phytoplankton, hence I am neither an oceanographer nor a fisheries biologist. However, I have participated in studies involving the use of phytoplankton as food for marine animals, including commercial bivalves, and because phytoplankton is the basis of all fisheries, perhaps my opinion from this point of view will be of some value to you.

The terms "fisheries" and "agriculture" seem to me more or less analogous in that both represent large scale human efforts that need and use results from the theoretical and practical branches of biology and from the earth sciences, as well as from engineering, etc., down to marketing and sales analysis. I think "fisheries oceanography" should refer to a much smaller set of activities; but even so, no simple restrictive definition is possible or desirable. The unifying concept, which makes the term "fisheries oceanography" valuable, at least politically, is that human food in certain quantity can be obtained by one means or another from the marine waters of the earth; the body of knowledge relevant to the organisms involved and to their relationship to each other and to the environment is the subject matter of "fisheries oceanography".

It seems to me that a breakdown of "fisheries oceanography" is necessary at the present time to make individual programs of manageable size. The division along ecological lines such as you mention in your letter (page 9) "into separate considerations for problems of pelagic, demersal, estuarine, and other sorts of fishery situations" appears to be the most straightforward and should lead to no more difficulties (e.g.; competition between branches) than any other method of division. I do not imply by this recommendation of division that I think the body of knowledge is actually partitioned; my own point of view is much like yours as expressed in your third alternative, on page 7 of your letter. It seems to me that the practical problem is to get individuals trained in various disciplines to apply themselves to problems that are fundamental to "fisheries oceanography."

This brings up the final and most important matter, the "purpose" of fisheries oceanography. It is perfectly plain that increased production of food and commodities is not man's most important problem. That problem is basically to keep the number of individuals small enough so that the earth's productivity and space will provide for them indefinitely at a level they find tolerable. It is self-evident that two billion starving people are at least twice as good as four billion starving people. It is not evident on any grounds that four billion people, even well fed, would be "better" than two billion. Before we supply food to the undernourished peoples of the earth we owe it to them and to ourselves to provide knowledge and incentive for lowering the population by means other than war, famine, and disease.

It may be the biological destiny of Homo sapiens to eat up the earth or blow up the earth - or both, in equence. Man has been a destructive ecological force up to the present; for the most urgent practical reasons as well as aesthetic ones our major conscious efforts should be devoted to reversing this tendency. I think this is a necessary (but not sufficient) condition for the continued success of mankind.

The purpose of fisheries oceanography is to enable us to understand the living resources of the seas and to contribute to mankind's efforts to live within the biological budget of the earth. I think it is the duty of individuals in positions of influence to further the ends stated above and to use all opportunity to make the nature of the problem and of the solution widely known and politically accepted.

You further remarked at one point that there is a serious deficiency of specific amino acids in the diet of many persons. It occurs to me that this is an excellent opportunity to utilize amino acids produced by chemical synthesis or through biosynthesis by fungi, bacteria, or algae, acting if possible upon organic matter not otherwise useful. This method might be easier, though no doubt less tasty, than putting the burden on fisheries. I hope these remarks are of some use to you.  
Very truly yours, Robert R. L. Guillard

Reply

VAN CAMP FOUNDATION, W. M. Chapman, Director, 739 Golden Park Ave.

Dear Dr. Guillard:

I do not know enough about human nutrition problems to speak sensibly about them, so what I know say may be in error. My colleagues tell me that the prime nutritional shortage in the world is not calories, of which there is an abundance, but of some of the essential amino-acids. I believe they say those containing the sulphyl radical. These are available in an animal protein and are in good balance (from the human nutritional viewpoint) in all fish protein. One or two of these have been synthesized, but in such a costly fashion as to not be practicable for human nutrition yet, and others have not yet been successfully synthesized.

The following citations from last years FAO World Meeting on fish meal are in point.  
"6. Calculated very roughly, it may be said that about one million tons of such fish concentrate will satisfy the annual dietary requirements of about 100,000,000 people in a population having a normal spread in age."  
7. ". . . there was attempted in the meeting the estimation of how many human beings in the world now suffer from protein deficiency. A conservative estimate of at least 500 million was arrived at, made up of perhaps four-fifths pre-school age children and most of the remaining pregnant and lactating mothers."

8. "Vegetable proteins, as stated above, cannot fully fill the protein need in the human diet. Furthermore, the amount of land in the world suitable for growing them is limited and this limitation increases as the human population continues to increase and press upon the land as is the case, for instance, in considerable sections of South-East Asia. Animal protein production can be expanded only with great difficulty in several areas of the world, in some instances because the land cannot be spared from production of other needed food stuffs, and in other instances because endemic animal diseases make the raising of livestock impracticable. Ultimately, despite any and all land-produced protein supplies, the resources of the sea must be more fully utilized."

9. "Large populations of fish occur in the world oceans, often in reasonable adjacency to large human populations suffering from protein deficiency. Fish protein concentrate also can be readily and practically prepared, stored and transported from major centers of fish production to areas of high protein need."

10. "For these reasons it would appear certain that the need for fish protein concentrate in the world's human diet is great, urgent and should be capable of fulfilment. What value to give to the quantity needed is uncertain, except to say that it is to be expressed in terms of millions of tons of fish meal and fish flour per year."

While the more drastic cure to this problem you cite, that of decreasing (or holding steady) the world human population, may be the only solution in the end, my travellings around the world leave me feeling that this is wholly impracticable at this stage of world society. On the other hand it does look to me to be quite practicable to materially mitigate this world protein deficiency with tools and knowledge at hand, or nearly at hand. In this oceanography can and will play a major role, and your phytoplankton work also.

Thus whilst I would not care to try to break into the limited market for planned paternity pills, I am prepared to have a go at getting fish protein concentrate shoved down throats that need it. In my humble opinion if we paid as much attention to the nutritional requirements and desires of the human populations of the developing countries as we do to those of cats, dogs, chickens, cattle, swine and even trout in the industrialized countries may be my big kids would not have to serve quite such long hitches in the Armed Services, and even my tax bill might begin to level off. Thanks for your cooperation, Sincerely yours, W. M. Chapman, Director

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U.S. NAVY ELECTRONICS LABORATORY, San Diego 52, California

23 February, 1962

Dear Dr. Chapman:

Your long letter discussing programs, etc. of fisheries for SCOR was waiting for me when I returned from a cruise to the south.

It seems to me most of the points of discussion are covered in the EPOC report. Although the EPOC report deals mainly with the Eastern Central Pacific the principles and present types of study contained therein would be applicable to other areas. Thus, I do not see what to add to the discussion from a physical oceanography standpoint.

I have been towing the thermistor chain off the end of Lower California looking for fronts which turned out to be rather weak at this season. I did find the scattering layers were especially strong there and they seemed to have vertical oscillation corresponding to the internal waves recorded by the chain.

Another point of interest is the distribution of organisms that we have been observing on recent dives with the bathyscaph off San Diego. There seems to be a strong layer of small Hake (*Merluccius productus*) at a level of 100 fathoms or more at this time of year.

I am enclosing two copies of a short note on the NAGA Expedition, It seems to me, being a physical oceanographer, that programs relating the physical properties of the water to the biological populations are the most important. To pursue this further I expect to participate in the parts of the Indian Ocean Expedition that cover the upper regions of the Indian Ocean which appear to be the most accessible potential fishing areas.

Regards, E. C. LaFond

#### OCEANOGRAPHY AND FOOD

E. C. LaFond\* Head, Marine Environmental Studies Branch, U.S. Navy Electronics Laboratory, San Diego, California . . . . .

The people of Southeast Asia, already burdened by an exploding population whose food-growing space is being reduced through conversion of rice paddies into urban areas, are turning increasingly to the sea for additional food. Even though fishing in parts of the adjacent waters is already intense, it is believed that modern science can find ways to exploit still further the resources of the sea.

The Naga Expedition\*\*sponsored by the International Cooperation Administration(ICA)was established as an exploratory program to survey and develop the marine food resources in the Gulf of Thailand and the South China Sea. Under the leadership of the Scripps Institution of Oceanography and in cooperation with representatives of Thailand and South Vietnam, a program for an oceanographic and biologic study of these two bodies of water was arranged in order to determine the food-producing capacity of both. Scripps personnel, officers from the Thai Navy, scientists of the Thai Fisheries Department, students and teachers attached to Chulalongkorn Univeristy, and technical personnel from the Oceanographique Institut Nhatrang of South Vietnam were among those who participated in the expedition.

\* Former senior scientist on the Naga Expedition

\*\*Hindu serpent-genii of the waters

To study the physical properties and life processes of the ocean, members of the cooperating agencies made a series of cruises in the RV Stranger (Figure I) a well-equipped Scripps Institution oceanographic vessel. The cruises utilized a network of oceanographic stations established throughout the Gulf of Thailand and the South China Sea. Water samples were collected for the determination of salinity, oxygen, and phosphate. Nets were towed through the water to collect plankton, and dredges were towed along the bottom at some locations to collect pelagic (open-sea) and benthonic (deep-dwelling) organisms. Numerous valuable data covering the entire annual life cycle were collected on the 10 cruises made in both bodies of water.

#### LIFE CYCLE

How was the marine food potential of the Southeast Asia region studied? Since the important fish-producing areas were not clearly defined, they had to be sought principally by indirect methods, i.e. by locating and mapping environments likely to produce food for fish and other valuable marine life.

A study of the food supply of marine animals involved a study of its life cycle. The cycle begins with nutrients, one of the factors needed by plants in the process of photosynthesis. The nutrients are water soluble and consist chiefly of chemicals, such as phosphates, nitrates, and silicates, plus a few trace elements and vitamins. These plants provide food for the small marine animals (zooplankton which include the larvae of most fish). Zooplankton, in turn, are eaten by larger animals (which include the adult forms that are of primary interest as human food). All of this living matter eventually dies and is decomposed by bacterial action. The resulting nutrients are redissolved in the water (especially in the deeper layers of the sea), thus completing the life cycle. "If anyone of the steps in this cycle could be singled out and its areas of concentration determined," the scientists of the Expedition reasoned, "then potential food-producing areas could be established." Since the concentration of nutrients is the key to the whole life cycle, finding these areas became the basis for the procedures used by the Naga Expedition in the Southeast Asia area.

#### ECONOMY OF THE SEA

The major supply of marine plant nutrients flows from the land into the sea through river drainage and runoff. This process is analogous to fertilization. Some of the nutrients spread out temporarily on the surface of the sea, but most find their way to the bottom layers. The runoff observed in the Gulf of Thailand is extensive.

The vertical movement of water is a powerful factor in introducing nutrients to the zone of light penetration (euphotic zone) where the plants are found. To gain a fuller understanding of the factors involved in the regional sea-life economy, the pertinent vertical water movements of the area were classified and observed.

. . .Fronts: The leading edge of a border separating unlike water masses is called a front. Fronts can occur not only between water masses of different salinity but also between those differing in other properties, such as temperature. These fronts raise water of higher nutrient content to the surface. In addition, the fronts tend to concentrate floating fish food in adjacent areas.

. . .Wind Mixing: The storms indigenous to Southeast Asia were found to be severe enough to mix the surface layer with water from considerable depths. Such mixing and churning of the water may raise nutrients up from the depths.

. . .Convection: Convection currents, set in motion whenever the surface water layer becomes heavier than the layers beneath (either through evaporation or cooling), also bring nutrients up from the depths. This condition was observed during the winter in the northeast part of the Gulf of Thailand.

. . .Shoals: Observation revealed shoal borders to be favorite fishing grounds. Here, nutrient replenishment may be effected through the vertical circulation and turbulence created when water flows over a shoal.

. . .Islands: Off the leeward side of islands, the subsurface water layers may rise to higher levels through eddying and limited upwelling, thus furnishing a method of localized nutrient replenishment. This process was noted in the western part of Thailand.

. . .Upwelling: Surveys by the Naga Expedition in the Southeast Asia locale showed that nutrients were brought almost to the surface by near-shore upwelling. Here the twin factors of coastal orientation and persistent wind direction combined to make upwelling a principal source of nutrient replenishment.

-----RESULTS-----From the data gathered, combined with a knowledge of regional wind direction and speeds, it was possible to establish the most probable current or motion patterns in the Southeast Asian region. It was determined that during the summer, when southwest monsoon winds prevail, the current flows northward up the South Vietnam coast in the South China Sea, and a large clockwise eddy forms in the upper Gulf of Thailand. In winter, when northeast winds prevail, the circulation nearly reverses, with a southward flow off South Vietnam and a counterclockwise eddy in the upper Gulf. The other seasons, transition periods between the extremes of summer and winter, have variable circulation patterns. A description of the principal areas where upwelling was found follows.

. . Southwest Monsoon Upwelling: The strongest and most persistent winds in Southeast Asia are the summer southwesterly monsoons. These blow the surface water away from the coast on the west side of the Gulf, and cause the colder, higher-nutrient water in this region to well up to a subsurface level of less than 20 meters, but not completely to the surface. In this region,

however, other factors, such as the impinging of currents on islands and strong winds, are also capable of forcing the nutrients to the euphotic zone.

During the early part of the southwest monsoon season, wind action off the South Vietnam coast was such as to induce surfacing of the lower sea layers. This causes colder patches of surface water to develop off the north coast of South Vietnam. Later in the season, the upwelling zone moved somewhat south and offshore. This was observed to be a region of high organic production. The careful delineation of this phenomenon is important for the development of fisheries in the South China Sea.

. . . Northeast Monsoon Upwelling: Evidence of upwelling on the northeast coastal sector of the Gulf appears in winter, when northeasterly winds prevail. This creates another seasonal area of high nutrient content, with resultant planktonic production. A fish tagged in the summer upwelling region on the west side of the Gulf was caught on the east side during the winter upwelling. The fish was probably following the food supply, or region of upwelling.

A significant discovery of the Naga Expedition was a water-mass boundary near Paul Obi, between the waters of the Gulf of Thailand and the China Sea. This boundary, caused by temperature differences, showed an abrupt rise in temperature just north of Paul Obi. Here, for miles, the water was very turbid from a concentration of plankton. This proved to be a zone of high organic production.

Scientists of the Naga Expedition theorized that upwelling should occur off the Thailand coast in the Andaman Sea. Although not studied, the area was postulated as an upwelling zone for two reasons: in winter, the monsoon winds, blowing from the northeast, should displace the coastal waters seaward and cause upwelling; and the zone is a vital fishing area worked intensively by local fishermen. These men, by trucking small boats across the narrow peninsula, fish in the Andaman Sea in winter and in the Gulf of Thailand in the summer.

#### SUMMARY

Though many factors unknown to science still exist in the life cycle of the marine organisms that are moved by sea motion and subjected to environmental hazards, scientists of the Naga Expedition found a strong planktonic concentration at the edge of the Gulf of Thailand. This was in accord with predictable nutrient-distribution and circulation patterns. Upwelling of deep, cold, nutrient-rich waters, which influences distribution and abundance of plankton, was found to follow the changing seasonal wind system. The species of plankton inhabiting the Gulf of Thailand showed discrete and meaningful patterns of distribution. Still other relationships will no doubt evolve with further analysis of the data.

Through oceanography, the Expedition began a practical course of action to identify the marine resources and increase the food supply. In the opinion of the Asian and American scientists who participated, the program was so well conceived and executed that it can serve as a model for similar expeditions in the future.

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UNITED STATES DEPARTMENT OF THE INTERIOR Fish & Wildlife Service  
Bureau of Commercial Fisheries Biological Laboratory, Beaufort,  
North Carolina February 26, 1962

Dear Wib:

The length of your travels is only matched by the length of your letter, but I was glad to hear from you. As with everyone these days, we are bogged down with budgets, meetings, committees, publications, etc., and I have not been able to give consideration to the subjects in your letter that they deserve. I will, however, be glad to give my first impressions and in most cases will agree with your statements.

In the first place, what is a fishery scientist? I think he is a scientist who is working or presumes to be working on problems primarily related to fish and, most important, wishes to be termed a fishery scientist. Of the east coast more so than on the west coast, we find many scientists working on fishery problems more or less by chance. They may be trained as chemists, physiologists, biologists, animal behaviorists, etc., they may have been employed for years by a fishery agency and have worked for years on fishery problems, but still consider themselves as chemists, physiologists, marine biologists, etc., rather than fishery scientists. These are essentially the same types as given in your letter as blood biochemist and mathematician. It appears to me that they are fishery scientists if they wish to be, but it would be their prerogative as to what they label themselves. The same situation must prevail in the field of medical science which can include everything from physiotherapists, lab technicians, M.D.'s, researchers, etc.

Titles may not be too important and may change to suit individuals and situations. For example, since oceanography is now popular and profitable, we have many oceanographers who were something else a few years ago. It might be possible to restrict the term "fishery scientists" to those scientists who are studying the effects of man on fish populations, methods of regulating the populations to produce the maximum sustainable yield, and prediction of availability in time and place as implied in your letter, but it is doubtful if this would solve the question entirely.

I believe a fishery oceanographer is a person who is applying the methods, techniques, and oceanographic data in pursuing fishery research. In this regard you may be interested to hear that at a meeting I attended recently in New York, the oceanographers stated jointly that oceanography is a supporting science and that oceanographers should supply service data to other disciplines.

I was interested in the three views on fishery oceanography which you presented (pp.6&7). The first two views are similar to those I have heard expressed many times in relation to research in general and reflect the difference of opinion between the staffs of academic institutions and employees of government agencies. In fishery research we certainly are in need of oceanographic data regardless of who obtains it, but I'm afraid we will wait in vain if we expect the classical oceanographer to get it for us. These first two mutually exclusive views are really expressions by two groups about who should do the work. The third view is actually an opinion of what should be studied. I believe there is enough information available at present to support the third view from a fishery scientist's standpoint.

On p.8, Para.2, you have set forth the methods you have used to produce the results you desire - namely, the coordination of several oceanographic sciences to obtain the most information with the facilities and funds available. You mention that other fields such as the study of demersal, estuarine, and anadromous fisheries do not hold your view and their efforts have led to different inquiry patterns. This is true for past investigations especially where manpower and funds were limited. Much of this has come about, however, because the most could be accomplished with the funds available by the method used. For instance, anadromous fish research usually began on the spawning grounds, demersal fish with statistics and population dynamics, and oyster research with better spat collectors. Up to a point these studies produced the most results in a short time and were undoubtedly necessary before studies could be expanded.

At the present time at this laboratory we have projects on marine and anadromous fishes and crustacea, and have reached the point where oceanographic data are vitally needed to help understand and solve the problems. These data, for our projects, are particularly needed from the river mouths through and including the estuaries and the ocean, particularly the continental shelf. Based on past experience it is doubtful if the academic oceanographers will obtain the data we need, and we will attempt to obtain them through the Bureau's oceanographic program. As yet, however, the Bureau has not formulated policies or programs for oceanographic research.

In the meantime Bert Walford has attempted to coordinate an Atlantic Shelf program, and we have been participating in the preliminary meetings. We have hopes that if most state and federal agencies having an interest in the shelf will cooperate in carrying out a program in such detail that it will in general satisfy the needs of geological, physical, and chemical oceanographers and fishery biologists, we may get what we need. I can't help but feel that each of these disciplines and each type of fishery need the same general information, but perhaps in different detail for each, plus data specifically needed for each.

In answer to the four terms of reference:

1. I believe fisheries oceanography is the application of oceanographic methods and techniques and data to the study of fisheries problems.
2. You are in a better position than I to know the answer to this question, since the tuna investigators appear to be the only ones with enough funds to mount an oceanographic study. Offhand, however, I would state that accomplishments by fishery oceanography are the discovery of the deep equatorial countercurrent in the Pacific, and the prediction of abundance and distribution of tunas in the Pacific.
3. Fisheries oceanography should determine the interactions between oceanographic factors and fishery dynamics.
4. Need a critical review and study of the parameters being measured in oceanography. Laboratory studies are needed to determine the specific requirements of nutrition and environment for organisms, to determine what parameters are necessary and the accuracy requirements. We hear arguments regularly, calling for accuracy to 0.1 ppth., 0.1 ppm., or 0.1°F., when little or no factual data are available at any level of accuracy.

I hope this brief rambling will be of some use to you. I would be pleased to receive a summation of the replies to your letter.  
Sincerely yours, Gerald B. Talbot, Laboratory Director

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UNITED STATES DEPARTMENT OF THE INTERIOR Fish & Wildlife Service  
Bureau of Commercial Fisheries, Washington 25, D.C. Feb.27,1962  
Dear Wib:

This is in reply to your letter of December 25, 1961, requesting opinions concerning the subject of oceanography and fishery science.

Considering definition of the terms "fishery scientist" and "fishery oceanographer" one might follow this line of reasoning: There are many kinds of fishery scientists; these are the experts from those branches of science which are necessary in the study of fisheries. One might draw a parallel in the field of petroleum scientists. Petroleum chemists, petroleum geologists, and petroleum engineers all might be grouped together as petroleum scientists because they work in a common field, petroleum. Yet each could change to another field and retain his basic profession. Likewise, fishery scientists could include chemists, physicists, biologists, micro-biologists, biochemists, and many other specialists. Even fishery research biologists with good educational background are not completely tied to fisheries. They might easily become entomologists or general zoologists.

We have often said that an oceanographer is a person who was trained first as a scientist in some disciplines such as geology, physics or chemistry, and who later specialized in that part of his field which applied to studies of the sea. He then broadened his knowledge to cover other disciplines which are required in oceanography.

A fishery oceanographer might be a person initially trained in any of several sciences who specializes in studies relating to fisheries of the sea. A few of these persons who have broad enough interest<sup>s</sup> in the oceans and gain knowledge of several disciplines, will become known as fishery oceanographers. Others who remain in their specialty will retain their identity in their original discipline even though they happen to be working in a field of fisheries or oceanography. Therefore, there will be many scientists working in the general field of fisheries oceanography who will be known as chemists, biologists, or mathematicians, etc., but relatively few who will be known as fishery oceanographers.

Next, in answer to your question concerning the accomplishments in oceanography, I would like to comment as follows: Fisheries scientists or fisheries oceanographers have traditionally looked for quick solutions; bypassing tedious, long-term, basic research necessary for complete understanding of factors affecting fishes in the sea. They have made what seemed like logical assumptions, applied imperfect methods, and hoped that a solution could be reached without going to more time-consuming research and development required to produce full factual knowledge.

Such an approach occasionally succeeds, but more frequently fails because the assumptions are wrong, the methods of population analysis inadequate, or for some similar reason. Then the workers have been forced to begin over again, often by searching for basic knowledge which they should have sought the first time. Some fisheries oceanographers have lost their reputation because of these failures. Others, perhaps the lucky ones, have achieved excellent reputations because of their successes.

The motives for a program designed to produce a quick solution are understandable, for we all want to find answers as quickly and as cheaply as possible. In the long run, however, this is a dangerous policy for it encourages overestimation of our skills and under-estimation of cost and time to do the job. Furthermore, the probability of success is so low that the risk involved is too great. It would be far better to promise less speed, and greater cost, but better probability of success.

Considering the state of the art, I believe that fishery oceanographers have accomplished much, but accomplishments should not be measured in terms of quick solutions to major problems, but rather in the good progress on phases of research which are beginning to provide the background needed for solutions of major problems.

Research must continue as long as fish from the sea are needed by man. By way of comparison, I would wager that the U.S. Department of Agriculture will conduct research on corn as long as farmers raise corn. The accomplishments of agricultural scientists are not measured in terms of whether or not they have solved all of the corn problems, but rather whether or not they have solved one or two parts of the general corn problem.

Fishery oceanography should have as its goal the expansion of the knowledge of the sea and its fisheries so that some day, with complete knowledge, we can manage all species which man uses. However, we do not have to wait for that goal to receive some benefits for our research. Before going very far we should find much knowledge which will improve the accuracy of our assumptions upon which biometrics are based. This will give us a better approximation of populations and should result in a working hypotheses which could be tested by application. We should not be fooled into thinking that this is a final conclusion, but should expect to make major modifications when later information becomes available. Gradually, during a period of years or perhaps decades our facts should become more accurate which would reduce the range of error in our estimates.

I hope these views and thoughts will be of some help in the most difficult task which has been given to the SCOR Working Group on Fisheries Oceanography. Best personal regards, Sincerely yours, John B. Glude, Chief, Branch of Shellfisheries. . . .

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UNITED STATES DEPARTMENT OF THE INTERIOR Fish & Wildlife Service  
Bureau of Commercial Fisheries, Biological Laboratory P.O.Box6121  
Pt. Loma Station, San Diego 6, California February 27, 1962  
Dear Dr. Chapman:

It is gratifying to know that a group is at work to clarify the standing of the fish end of the business. In the light of the memo by Dr. McHugh last March and a recent letter by Dr. Ahlstrom I had felt that the fish end was to be given the place of the retarded child in the scientific household and kept out of sight when visitors came.

Regarding the subject of fisheries oceanography. I have always considered the term oceanography misleading. It came into use after the other principal sciences were established, and it seems unreasonable to use the term in the generic sense as one does "biology", "geology", etc. The biologists are the worst offenders with their attempts to be included in the physical sciences by calling themselves biological oceanographers, a pitiful ruse at best. After all what is wrong with being a marine biologist? Unfortunately, the tide was stronger than this shoveler for those people have been allowed in the SIO catalogue so the title must be valid.

Well, this means that fisheries oceanography too is a valid subject. It follows that oceanography, as used here, has the same meaning as it did in the preceding. This means that one is talking about a fisheries biologist (biology being necessarily understood) who possesses special training in the marine environment. Therefore, it follows that the subject of fisheries oceanography deals with the relationship of organisms (biology) with special reference to those of economic importance (fisheries) and the marine environment (oceanography). The difference between fisheries oceanography and biological oceanography then depends upon the concept of

economic importance. When "fisheries" is used in this sense it becomes difficult to gather meaning from such a combination of words as fisheries science. For this implies a special branch of science on a scale equal to that meant when one speaks of physical science or biological science. For this reason, it would be best not to use this combination at all, and refer to the blood biochemist and the mathematician as such or call them fisheries mathematicians, etc., to indicate the better side.

In the past, fisheries oceanography has given tremendous impetus to the development of instrumentation and sampling technique. For example, the studies of productivity in the English Channel in the 1920's and the North Sea investigations pioneered oceanographic research. With the advent of A.S.W., military investigations have taken the lead, at least financially, in this country. On a world wide basis, however, fisheries oceanography is still of major importance in supplying the need, techniques, finances, and manpower for marine investigations.

We do surpass the military in our long range objectives. It should be the purpose of fisheries oceanography to relate the observed physical parameters and phenomena of the sea to biological processes. This will lead to the ultimate goal of the intelligent utilization of the living resources of the sea and, at the same time, produce several desirable side results. It will stimulate related investigations of a basic nature, It will provide important coordination for marine research if or when the military centered investigations begin to decrease. It will relate man to another facet of his environment. A philosophical result to be sure, but nonetheless an important, if not the most important, result of oceanographic research.

In order for fisheries oceanography to proceed at an optimum rate, it needs communication with other sciences more than any particular breakthrough in any particular science. Along this line one might include the security conscious military. Access to their store of technological development is certainly desirable.

One last thought, marine research is in for a boom. Whenever a boom occurs there is organization and regulation, Research carried out by teams is fine, but creativity seldom results.

Sincerely, Frank. J. Hester, Fishery Biologist (Research)

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VAN CAMP FOUNDATION W. M. Chapman, Director 739 Golden Park Ave.  
Dear Frank:

When you say that creativity seldom results from team research you are saying the same thing that almost all independent researchers say in all fields. I wonder if it is true. I am beginning to doubt it. People also abhor Big Science. Yet Big Science, conducted primarily by teams, is, it seems to me, creating quite considerable new thought and understanding not

only directly from the team, but by stimulating individual thinkers and doers in a secondary way. I hope at least, that my feeling is correct because I really see no way to get at basic understanding of the ocean and its contents except by team approaches for the most part. The units of capital are too big to use single scientist approaches; the problems are too complex and on too large a geographic scale to permit an individual approach.

One of the more encouraging facets of the marine research boom to an old goat like myself is seeing it attract in new young fellows like you, Dick Whitney, Jim Johnson, and the ilk who bring fresh ideas with them.

Sincerely yours, W. M. Chapman, Director.

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UNITED STATES DEPARTMENT OF THE INTERIOR Fish & Wildlife Service  
Bureau of Commercial Fisheries, Biological Laboratory, San Diego,  
California  
June 4, 1962

Dear Dr. Chapman:

Of course you may reproduce my letter. I cannot say that I regard it with pride, however, I am sure that it is not incriminating.

I would like to add a bit about Big Science. My first letter was rather hastily written having just returned from a cruise and trying to meet your deadline. It is true that the units of capital are big. This is an example of Technology excelling in commanding funds. Exploring the Indian Ocean or putting a man on the moon will be a wonderful achievement but the achievement will be technological.

I am alarmed by Big Technology in the form of Fisheries Oceanography. As in business the level of the decision rises with the funds available and sometimes results in decisions that are not completely realistic. For example, we now have 10 million for research vessels for the Bureau but can not get \$50,000, for a small vessel that would be useful. See what I mean? Sincerely yours, Frank J. Hester, Fishery Biologist (Research)

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INSTITUTE OF MARINE SCIENCE, Port Aransas, Texas      The University of  
Texas      February 27, 1962

Dear Dr. Chapman:

We are circulating your letter among our staff. My reaction is to emphasize your item 3 especially (A) the understanding of the role of Fish + Yields in whole Ecosystems and also (B) new 20th century devices for getting lbs/acre data (instead of catch/unit effort data) for real understanding of stocks and their variation. There needs to be a granting agency to supply funds in this area. U.S. Fish & Wildlife Service keeps all its funds.

May I suggest de-emphasizing #1 on definitions and #2 on looking backward. Both lead to nothing but wasted energy. Sincerely yours, Howard T. Odum, Director

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environment in terms that are meaningful to those who need such knowledge. I will give two examples of what I mean:

- a. The tuna fishermen are interested in the Eastern Tropical Pacific but who, except someone trained in oceanography, can make use of the elaborate, beautiful colored figures in "An Oceanographers Description of the Eastern Tropical Pacific", by Wooster and Cromwell, which contains only three pages of description.
- b. In contrast, I cite the detailed analysis and interpretation of the BT data in the Gulf of Thailand with which you are familiar. I believe that many persons connected with different phases of fisheries problems could be taught to make similar useful data analyses and interpretations from both BT and hydrographic station data. Individual BT observations and masses of published hydrographic station data are meaningless unless they are translated into terms which fit the needs of each particular fisheries group. This means that some oceanographers must be induced to write not for oceanographers, but to meet specific fisheries needs. At the present time such writing is only done when subsidized by a fisheries agency. One reason why this situation exists is that descriptive oceanography has been down-graded over the past few years to such a point that it is almost impossible to recruit anyone to do this type of work. It will, therefore, require either upgrading of higher financial rewards for descriptive oceanography, in order to recruit into this field the number of students that are needed.

3. Fisheries Oceanography should be trying to accomplish the following:

- a. Describe oceanic environment.
- b. Relate fauna to environment.
- c. Relate variability of fauna to variability in environment.
- d. Engage in, or follow closely, all research related to the ocean-atmosphere interchange with the hope of making environmental forecasting possible.
- e. Work hand-in-hand with the fisheries scientist working in population dynamics with the hope of forecasting and controlling the availability of fish.
- f. Learn how to communicate oceanographic information in a form understandable to those who need it, on all levels, even if this requires publication of material in several forms.
- g. The problem related to pelagic, demersal and anadromous fisheries are sufficiently specialized, that no single group can encompass them all. I prefer to see problems attacked by environmental groupings, rather than by species. I believe this is the planned approach to the fisheries of the Eastern Tropical Pacific. The success of this program will depend on how well the specialists communicate with each other.

- h. On the international scale, "practical" oceanography and biology should be developed on a level that under-developed countries can understand. The discovery of new fisheries may be beyond the means of most small<sup>o</sup> or under-developed countries, but improved boats and gear, with basic instruction concerning the oceanographic and biological processes which contribute to fish abundance, could vastly increase the fish catch of under-developed countries and the world's supply of protein.

Gene LaFond's work in India is an outstanding success in this field. I do not think our Naga Expedition has been equally successful - - we collected a lot of good data, brought it home, and are now preparing to publish the hydrographic data and charts of the physical properties. I do not think we taught the Thailanders enough - - they should be doing the analysis, under our supervision if necessary. But unless they do the analysis work themselves, they will be unable to carry out a program of their own in the future.

4. More cooperation and better communication among scientists and all others involved in various aspects of fisheries problems has a higher priority than any specific new research aim among the various disciplines. I believe, one of our problems is that specialists bog down in details, This may be satisfactory when communicating with specialists in their own field, but wholly unsatisfactory for communicating with those in other fields. For example, I believe the pertinent facts concerning the 1957-58 warm period, brought out in the Rancho Santa Fe conference, could be summarized in possibly three pages. Yet two and one half days (162 Text pages) were spent presenting and discussing details of the phenomenon, leaving insufficient time for relating the facts to cause and effect, (16 pages of discussion, and 6 pages of Editor's summary). The idea behind the conference was a splendid one. Such conferences might prove fruitful for the discussion of fisheries problems, if we specialists could learn to summarize and communicate only pertinent facts in understandable form to our colleagues of different disciplines.

I hope these remarks will be of use to you, Sincerely yours,  
Margaret K. Robinson, Associate Research Oceanographer.

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FISHERIES RESEARCH INSTITUTE University of Washington, College of Fisheries Fisheries Hal No. w, Seattle 5, Washington, Feb.27,1962

Dear Wib:

I have your long letter of December 25 in which you ask for my comments with respect to fisheries oceanography, I have some comments, most of which will pertain to item No.1 of the matters referred to the SCOR Working Group.

First I believe that we have a common problem which will remain with us indefinitely, that of obtaining the maximum sustained production from the living resources of the ocean. We start with

exploiting the stocks now known to us and eventually will exploit all of the living things which can be used. The problem of essential amino acids which you mentioned is an immediate and urgent aspect.

We must approach this problem with what we now know and what we are now doing and deal with it stock by stock. The research needed ranges from that which will assist in making the best day-by-day decisions to major long-continuing investigations of the productive processes of the sea.

The problem then is a pragmatic one of devising the most effective breakdown of objectives which people may grasp and pursue.

I state the objectives as follows:

1. To find and harvest aquatic resources
2. To regulate specific stocks under exploitation for maximum sustainable productivity.
3. To control natural processes by means other than regulating catch.

Doing these things requires a vast amount of knowledge, ranging from geophysics to refrigeration engineering and to studies of cultures of primitive tribes. Therefore, we must start by recognizing that obtaining the maximum sustained production of living resources of the oceans goes far beyond studies of or in the oceans.

This brings us to a definition of fishery. I am not happy with the applicable definition of fishery from the new Merriam-Webster, which is "the technology of fishery, a branch of knowledge concerned with the methods and economic of fishery and the utilization and preservation of fish resources". I much prefer to paraphrase the definition of engineering and define fishery science as a science by which the living resources of the waters are made useful to man for food and other purposes.

In this respect, I separate fishery science from other sciences much as engineering is separated from the branches of physics and chemistry upon which it is based. For example, the classification of fishes should in my view be called ichthyology, a branch of zoology, not fisheries science. (Knowledge of the taxonomy of the genus Pinus is only remotely useful for providing shelter!).

The definition of oceanography has been made by NASCO, and I concur in its direct simplicity - the scientific study of all aspects of the oceans, their boundaries, and their contents.

It follows that when fishery is attached to oceanography, the two terms together restrict the meaning of each, perhaps as follows: fishery oceanography is the branch of oceanography concerned with making the living resources of the oceans useful to man.

Other considerations will restrict its meaning further. Fishery scientists have been greatly concerned with populations and their rates of change because of the need to regulate certain stocks. In the broad sense of oceanography, such studies of oceanic populations would be included but to include all fishery

scientists in the category of fishery oceanography would bring in many who are not concerned with the oceans.

On the other hand, oceanographers concerned with living resources have been almost wholly preoccupied with the open sea - not with the continental shelf areas where the bulk of our fish are now produced.

Therefore, it seems to me that, if a new category is to be designated as fishery oceanography, it will mean to most people the scientific study of the processes which produce the living resources of the high seas. Defining it as something else will accomplish little because common usage will fix the meaning.

Stating what fisheries oceanography has accomplished or should be trying to accomplish follows routinely from the definition of the term, and I shall not attempt it.

With respect to the two new working groups being considered by SCOR, I have these comments.

1. Location and investigation of new fishery resources in my view includes estimation of the size and distribution of fishery resources.
2. Fishery resources is such a convenient and commonly used term for all of the living resources of the waters that we should specifically define it as such and use it in the interest of simplicity. "Oceanographic" estimation of the size and distribution of oceanic living resources is unnecessarily and vaguely restrictive.

Thanks for the opportunity to comment. Sincerely yours, /Bill  
William F. Royce, Director

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UNITED STATES DEPARTMENT OF THE INTERIOR Fish & Wildlife Service  
Bureau of Commercial Fisheries, Biological Laboratory 450-B  
Jordan Hall, Stanford, California February 27, 1962

Dear Wib:

Your letter of December 25, 1961, poses a very difficult question - in fact, quite a number of them - to answer. Certainly when confronted by the list of illustrious persons on the working group, I feel somewhat overwhelmed. I doubt if my few comments will be of much assistance, because, due to my own vocation, they will probably be diametrically opposite to most of those that you receive. Having made my apology - which according to the book one should never do - I will proceed.

There seem to be two general problems. The first is a matter of nomenclature. What do certain words mean? Should one define them by a system as they ought to be used or should one attempt to form a logical system from the common usage that has arisen? I personally favor the latter. However, assuming that this can be done, this is really not the important problem. The second problem, i.e., "what can and should these persons and these disciplines, so defined, contribute to knowledge and man's general

welfare?", is the prime consideration.

Turning first to the matter of definition, it seems to me that there are two general fields being considered, oceanography and fisheries. These are not two independent fields, but overlap to a great extent. However, there are areas of activity in each that do not touch on the other. Examples in oceanography are easy to quote, and in fisheries one might point to fishing techniques, methods of handling and storage aboard ship, fisheries statistics, etc.,

Now it is not necessary that everyone working in the field of oceanography or fisheries be classified as an oceanographer or a fishery scientist. Under the broad definition of oceanography by NASCO, and incidentally THE OCEANS by Sverdrup et al., there are scientists such as marine geologists, marine chemists, marine biologists, marine geochemists, and marine physicists or physical oceanographers. The title of oceanographer has come through common usage to refer usually to the latter category of physical oceanographer. I would prefer this usage although it runs contrary to the broad definition of oceanography.

Similarly, in answer to two questions that you pose at the bottom of page 4, you would have a fisheries biochemist and a fisheries mathematician, The person who is concerned with keeping track of the changes fishermen make continuously in gear, its use, and vessels, etc., I would not classify as a fisheries scientist but as a fisheries technician. Also there would be fishery biologists and, I believe, the recommendations recently made to the Civil Service Commission by a group of fishery biologists in this area for a further subdivision into Fishery Research Biologist and Fishery Management Biologists are a good approach which would help resolve your question at the top of page 5.

Where does all of this place the term "fisheries oceanography?" You may have gathered that I believe this has become too much of a catch-all term which takes in more territory than it should or was intended to cover. (I might insert here that my feelings on this derive mainly from conversations on the subject with Townsend Cromwell, who may have been responsible for originating the phrase. However, they are my own and may not necessarily reflect what he had in mind.)

To my mind "fisheries oceanography is the conduct of research or investigations in oceanography which is directed toward the solution of fisheries problems." Here I would generally restrict the use of oceanography to its non-biological phases, preferring to use the term fisheries biology for these. However, studies of the biological environment, e.g., elements of the food chain, should probably be included. Note that the above definition does not require that biological or fisheries measurements be made in conjunction with a given study. For example, a set of current drogue measurements might be designed to study the horizontal mixing characteristics in a known spawning area under different wind conditions. In order to get a sampling of wind conditions that might occur over a large number of years in the spawning area,

it might be necessary to take observations during a period near the spawning season but at a time when egg or larval observations would be of little value. However, these results could be applied to predicting the diffusion of eggs and larvae. So much for definitions!

In accordance with the above there is just as much need in the field of fisheries for research in fisheries oceanography as there is for that in fisheries biochemistry, fisheries mathematics, fisheries statistics, or fisheries pathology. Fisheries oceanography should be the natural outgrowth of cooperation of physical, chemical, and biological oceanographers and meteorologists with fishery biologists in their studies. It requires that the oceanographer be aware of and sympathetic toward the problems confronting the fishery biologist.

Usually the oceanographer should be working in the same integral unit or organization that is responsible for the fisheries research, but this is not an unbending rule. In return, the fishery biologists supervising the research should be sympathetic toward the problems confronting the oceanographer in his own area of research.

I am in agreement with your Attitude 3, given at the top of p.7, that fisheries oceanography makes its contribution by the elucidation of the characteristics of the physical, chemical, and biological environment and their relation to fish populations. I believe that the plan of our research here at BCF Biological Laboratory, Stanford, is a good example of fisheries oceanography.

This has not attempted to answer all of the questions you posed, or to discuss all of the "terms of reference" to be considered by your working group. On some items I do not feel competent to comment, and on others I have formed no definite opinion. I hope, however, that my few comments may be of some value. Sincerely, J.F.T.Saur, Oceanographer.

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UNIVERSITY OF WASHINGTON, College of Fisheries, Seattle 5, Washington  
February 27, 1962

Dear Wib:

I detect in your letter of December 25 evidence of a frustrated systematist who has given up classifying fish but is now classifying scientists. May I add another category to the three listed in your letter. This would be category 4 whether it is an order, family, genus, or species, I would define it as that group of hydrographers who consider that the observations of fish abundance and distribution are unnecessary since all problems in the oceans can be solved through study of current systems and water chemistry with an occasional dip of a plankton net.

The principal problem involved in defining the various fields seems to be partly one of semantics, but on the other hand in this fuzzyness of nomenclature between fisheries oceanography, oceanography, etc., is evident a lack of clarity in thinking. This is shown in the various statements quoted in your letter such as "oceanographic estimations of the size and distribution of oceanic living resources"

as well as in the term "fisheries oceanography" and again in the term "fisheries science."

In the interest of clarity I believe that the definition adopted by NASCO which defines oceanography as the study of the ocean, its boundaries and its contents, and defines the term oceanographer as a person who engages in such studies is certainly satisfactory but under these circumstances we must be careful to distinguish between an oceanographer who embraces the entire field as defined by NASCO and the physical or chemical hydrographer who is primarily concerned with the study of ocean waters and currents. I also believe that we should be careful to distinguish between the terms biological oceanographer which would include all biologists engaged in the study of the marine environment, the planktologist who is involved in the study of the biology of the plankton and the fishery biologist who is primarily studying the biology of fish. Continued use of the term oceanographer to designate the one who is a physical hydrographer or a chemical hydrographer or a planktologist will certainly confuse the issues.

When one tends to become more specific in defining the field of fisheries biology or fisheries science it becomes extremely difficult to define limits accurately for any particular field. Probably, most other fields of oceanography, which I use here in its broadest sense, would be much more confined than would fisheries science which overlaps so many areas including economics, and politics as well as all phases of biology and many fields of mathematics. It would be difficult to designate this field by a collective terms such as fisheries science because as you indicate in your letter much of it is not science.

The problems outlined in your letter are identical in many respects with the problem now faced by the American Institute of Fishery Research Biologists in the committee which is at present considering educational standards. At the moment I am trying to involve Frances Clark in an argument concerning educational standards which correspond to a rather feeble bachelor's degree in biology. I cannot agree that this would, as she seems to feel, prepare anyone for "work in fishery biology".

I am attempting to clarify my own thinking in this field and have not been able to find anyone outside of W.F.Thompson who seems willing to engage in constructive discussion of this subject. However, I believe that we should drop such terms as "fisheries oceanography?" Because of the all inclusive meaning of the word oceanography, "fisheries oceanography" would be quite meaningless and I am certain that most people who are talking about "fisheries Oceanography", if there is such a field, are talking about the field of hydrography or the study of the ocean currents and chemistry and the physics of the ocean as applied to the study of the distribution and abundance of marine fishes. For this field, if we can distinguish it from the rest of hydrography I would suggest the term of "fisheries hydrography". Although, it is I believe, stretching both the meanings and use of the words in using them in this manner.

Would it be possible to distinguish the scientific aspects of fisheries with sufficient clarity to designate a field of "fisheries science" opposed to what might be called "fisheries management"? In terrestrial work we hear much about game management and this usually designates the political operations in formulation and enforcement of laws for the management of hunting and hunters. Possibly the use of such a term to include similar areas in the marine field which would incorporate political operations would permit us to include all other work (blood chemists, mathematicians and fisheries economists) in the field of "fisheries science". Under such a classification then, I would suggest that "fisheries biology" would be a branch of "fisheries science" which would include all phases of biology related to fish and fisheries.

Whether or not it would be possible to distinguish such a field as fisheries hydrography it would be I believe a moot question, since this would refer only to a particular type of program in which hydrographic observations were made in connection with a fisheries program and would be difficult to distinguish in many respects from another program where fisheries observations on the abundance and distribution of fish were made incidentally to the collection of hydrographic data.

I do not believe that there can be much question that the simultaneous or near simultaneous observations of hydrographic conditions and of the presence and abundance of fish are necessary to develop relationships between fish and hydrography with any degree of efficiency. Over a long period of time, wide spread hydrographic programs coupled with independent observations of fish may eventually develop the knowledge that we require in the marine environment but the fundamental requirements of scientific method demand that measurements of variables which are to be related must be made simultaneously. It would be just as senseless to measure the head length on one series of fish from one location and the total length on another series from another location or taken at a different time to obtain the basic relationship between the two measurements. This however, is a matter of good planning and I believe that the closeness of the relationship between the observations that are taken depend upon the quality of the planning that goes into a program and the scientific ability of the people that are doing the planning.

Under these definitions the blood chemist trying to determine racial grouping in fish would probably come under the definition of a fisheries biologist. A mathematician who is devising mathematical models for fisheries would certainly be a fisheries scientist, or at least he would be involved in the field of fisheries science as would a person whom, I presume, would be a skilled statistician who is keeping track of the changes fisherman make in gear and in evaluating the effects of such changes.

On the fringes of this field we would expect to find technicians primarily concerned with routine observations who might be skilled in particular techniques but who would not be involved in either the development of methods or in the analysis of data of any complexity. These I do not believe would be classifiable as scientists and we probably would have to designate another category of workers in this field which would be considered in general terms as technicians or if their work was specifically concerned with fisheries they would be fisheries technicians. These would be comparable with the technicians used in all fields of science who are not considered to be scientists.

I doubt if we need concern ourselves with whether or not to include economists or lawyers in the field of fisheries science, since the economists themselves would, I am sure, have no desire to be included preferring to maintain their identity as economists. In the same way, the lawyers who are taking an active interest in international law as it is concerned with fisheries on the high seas, would I am sure have no desire to be designated as fisheries lawyers.

Turning now to the four subjects that were of special interest in your letter. I believe that the discussion above would shed some light, as to my thinking on the subject of fisheries oceanography. I do not believe that this is a specific term but involves all phases of study of the ocean so that the term fisheries oceanography would be just as general and would involve all phases of the study of the oceans which would have any relationship whatsoever to fisheries. This should be more specifically designated as fisheries hydrography although I do not care for the separation of the subject of hydrography into specific fields such as this but prefer the term fisheries science as a term to designate the study of marine fisheries.

To state what fisheries oceanography has accomplished is a job that I would not wish to undertake in a letter, since this cannot be discussed intelligently without a complete review of the entire field of marine fisheries oceanography.

To state what fisheries oceanography should be trying to accomplish would require first that you define this area in terms of the more specific definitions that I have given above. Are you speaking of fisheries hydrography or are you talking about fisheries science including development and conservation?

A more specific definition of terms is also required in question number 4.

The fisheries people in the northwest are at the moment involved in outlining the fisheries problems that face us in this area and in developing a broad program to study these problems. I happen to be chairman of this committee that is composed of representatives of each of the Pacific coast states and the U.S. Fish & Wildlife Service. We hope to have something concrete set out in the relatively

near future. Perhaps, when this program has been outlined its contents will be of some interest to you in answering questions two, three and four, at least with respect to the Northeast Pacific ocean.

I was happy to receive your letter and to see that these problems are of widespread concern. It is a strange thing that a very general characteristic of many scientific research programs is incomplete or improper definition of objectives. As a matter of fact, in my experience I have encountered many programs that have no well defined objectives. This of course is supposed to be a characteristic of pure science but in fisheries work, it is a luxury we can ill afford and I believe that in view of the immensity of the problems involved in all phases of study of the oceans that development of oceanographic programs without specifically defined objectives should be discouraged. It is encouraging, therefore, that you are involved in developing and clarifying objectives in this field.

I hope that my thoughts expressed above may have contributed something. Best regards, Sincerely, R. Van Cleve, Dean

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August 30, 1962

TOKYO UNIVERSITY OF FISHERIES, TOKYO, JAPAN, Michitaka Uda. . . .

Dear Dr. Chapman,

I appreciate your kind and encouraging letter (Jan.26) and have had the benefit of reading letters from Drs. Cushing, Davies and Wooster(with his reprinted paper).

I am arranging to make inquiry to many scientists in Japan who are working so many aspects of oceanography on the terms as you suggested in early decade of April as a first step, and next at the end of April to get answer from some selected marine scientists in the South East of Asia. On April 6 we will have Symposium on Fisheries Oceanography at Tokyo University of Fisheries by the sponsorship of the Oceanographic Society in Japan and the Japanese Society of Scientific Fisheries.

I am working actually as its coordinator on that inquired problem. We will soon establish the Japanese Society of Fisheries Oceanography.

The following is my rough thoughts on the terms of reference as outlined nicely Dr.Humphrey's letter(Nov.23,1961).

1. Definition of Fisheries Oceanography

Fisheries Oceanograph in a broad meaning is the applied and synoptic oceanography required for the fisheries use. Fisheries Oceanography in a narrower, more concrete meaning is the oceanography for the exploitation, development, utilization and conservation of fisheries resources and afford the forecasting means of fisheries fluctuations.(Refer to O.E.Sette,1961). Or the Oceanography of environmental conditions affecting the abundance and availability of fisheries resources(refer Wooster,1961).

Fisheries Oceanography gathers and joins biological, physical, chemical, geological oceanography and marine meteorology all in relation to fisheries and extends all over the areas of world oceans to the depth of any kind organisms inhabiting useful to Man.

2. The Main Subjects of Fisheries Oceanography

- (1) Oceanographic aids to find out distribution, concentration and dispersal of fishes or other useful livings.
- (2) Oceanographic means to estimate the relative population size and to evaluate the fishing areas.
- (3) Oceanographic researches to develop the prediction of (1) and (2) - -in the changing seas and oceans.
- (4) Oceanographic contribution to increase productivity and produce or develop fishing grounds.

3. What Fisheries Oceanography has accomplished?

Hitherto we have made a lot of studies of environment itself. Records of oceanographic factors were gathered in the past long years in correspondence to the fisheries and vital statistics. Recently encouraging results are remarked on the correlation between the fluctuations of marine biota and the oceanic climate. We have already advanced knowledges of the optimum temperature for some important commercial fishes and the favourable oceanic conditions for distribution

and localization or concentration of fishes. Oceanography have aided very materially to exploit and discover new fishing grounds, and to increase the efficiency of fishing with the contribution to tremendous yield in recent years.

4. What Fisheries Oceanography should be trying to accomplish?

Fisheries Oceanography should aim to challenge the changing seas and oceans and biological consequences of the changes at the various trophic levels, especially environmental requirement critical for survival of fish larvae etc. We should bring together fisheries biology, especially population dynamics which tell us how a fish population reacts to fishing in a steady environment and Fisheries Oceanography which can afford the relative population strength of a fish population or the prospect of their trends in a changing environment.

5. What Progress is needed in other sciences?

Long term fluctuation of oceanic climate and fish population with the interrelated mechanisms of them could be solved by the well-coordinated surveys cooperated of all interested countries and organizations.

Oceanographic instrumentation and related engineering techniques, and experimental studies on the sea and in the laboratory should be promoted. The joining of related sciences is the key to solve the problem.

I would like to present some detailed plan in future, if opportunity be given. I have written above short note, hoping it will be some reference to develop your ideas. Yours sincerely, Michitaka Uda, Tokyo University of Fisheries, Tokyo, Japan,

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UNIVERSITY OF CALIFORNIA, Scripps Institution of Oceanography, La Jolla, California

March 1, 1962

Dear Wib:

My comments on the first four terms of reference of the SCOR Working Group on Fisheries Oceanography, as given in your letter of December 25, 1961, are enclosed. You are welcome to attribute them to me by name although the organizations I work for should not be held responsible. I may want to use some of this material in another context but probably not in quite the same form or for some time.

I shall be very interested to hear more about the proceedings and findings of the Working Group. Sincerely yours, Maurice Blackburn

FISHERIES OCEANOGRAPHY

I. Discuss and define the subject of fisheries oceanography

Fisheries oceanography is any kind of oceanography applied to the study of organisms useful to man. It comprises much of the biological, physical, and chemical parts of oceanography, but normally little of the geological part; it makes special demands upon marine biology and meteorology. As applied to a particular organism(or group) its most usual form is that of the intensive study of the part of the ocean where the organism lives, but it may include the study of adjacent parts which affect the organism indirectly; it may even include oceanographic

work having no apparent connection with the organism at all, but considered to be capable of yielding results, techniques, or ideas applicable to research on the environment of the organism.

Fisheries oceanography does not include the investigation of the useful organism itself (its population units, their growth, reproduction, trophic relationships, vital statistics, etc.), which is fisheries biology; but it can have no application, and therefore no existence apart from general oceanography, unless such studies are made. On the other hand there can be programs of fisheries biology without corresponding effort in fisheries oceanography, but they tend to be ineffective unless the effects of human predation on the organism are of greater practical significance than the effects of the environment. Where both kinds of work exist there is normally a close working relationship between the two groups of investigators; the task of relating environment to organism may then be attempted by fisheries oceanographers or fisheries biologists or both, and some workers may participate in both programs in a way that partly obliterates the distinction between them.

There is no feature of fisheries oceanography that prevents it from having as much "good science" content as any other kind of oceanography. There is at any time an ill-defined limitation of some kind as to the scope or breadth of the subject, but this is true of all kinds of oceanography; in practice even pure oceanography is limited at any particular time, by fashions and personal interests. Within the presently widening scope of fisheries oceanography there is no necessary limitation as to intensity or depth of research.

Of course not all fisheries oceanography is as free as it should be in these respects, but the present tendency is for the freer programs to grow more than the others in number, size, and influence. To be of optimum service to science and industry such programs should be diverse in content, with research activities ranging from the closely applied to the supporting fundamental. If a program is too heavily weighted towards the applied end it is unlikely to attain sufficient understanding of the phenomena it describes; and unless it is well diversified it may suffer when changing socio-economic circumstances alter the research needs of the industry, as so often happens in fisheries work. The specific kinds of applied and fundamental research will depend on the particular interest man has in the exploitable organism (see 2 below), and the judgment of the scientists concerned as to how this interest can be advanced through oceanography.

## 2. State what fisheries oceanography has accomplished.

In this and the next section it is convenient to recognize the possible objectives of research on exploitable resources (organisms or groups) to which fisheries oceanography may be applied. There are the following five objectives: a and b tend to lead to c, which tend to lead to d or e:

(a) Creation of a resource, by introducing an organism to a

new environment;

(b) Discovery of a resource;

(c) Appraisal of a resource, by describing and understanding the population units and their features and the ways in which they are affected by factors intrinsic and extrinsic to the resources;

(d) Prediction of some kind about the resource, generally its distribution, abundance, availability, or quality; and

(e) Control of the resource, generally to maintain or increase the harvest that may judiciously be taken from it, either (i) by regulating human predation or (ii) by altering some other part of the environment.

Objectives (a) and (e) (ii) are so rare in marine fisheries biology that there is little or no associated oceanographic effort; this situation could change, however (see 3 below).

Researches with objective (e) (i) might seem to require little assistance from oceanography, and frequently request none; in fact the popularity of such work in fisheries biology has been responsible for some loss of contact between fisheries biologists and oceanographers, as in whale fisheries and some demersal fisheries; even the problem of effects of environment upon brood-strength has been side-stepped in some of this work, by direct measurement of broods at pre-exploitable stages of known age. In other cases the effects of environment have demanded recognition and direct study, as in the recent warming of the eastern Pacific which altered the distribution of salmon and yellowfin tuna; the result with the salmon was that a system of fishery regulations was jeopardized, whereas with the yellowfin the changed distribution indirectly made the resource more susceptible to fishery pressure. It is also noteworthy that changes in the California sardine resource, which were originally ascribed to excessive fishing, are now attributed at least as much to the environment. It is becoming more generally believed that effects of environment on a well-exploited resource warrant study as well as the effects of the fishery; the former to be predicted and the latter to be controlled, with the success of the control somewhat dependent upon the success of the predictions.

This leaves (b), (c), and (d) - discovery, appraisal, and prediction - as the objectives of fisheries biology to which oceanography could have made some contribution.

In the field of discovery the contribution probably has not been great. Little exploratory work was attempted with the aid of oceanography until after World War II, and even then many of the newly found resources were located empirically, as the older ones had been. How large a part oceanography played in the discovery of oceanic tuna resources by Japan is not clear; similar discoveries were made by the United States in mid-Pacific with the aid of oceanographic observations and models, but they did not prove attractive to United States fishermen. The empirical method has had its failures, notably in the search for oceanic herring resources in the Norwegian Sea; the resource was eventually found by an application of science and technology in which oceanography played some part, but the use of science was probably the

decisive factor.

Fisheries oceanographers have been quite effective in facilitating the appraisal of resources, especially by making repetitive observations on ocean properties, features, and processes for comparison with those of the resource, and thereby permitting successively better explanations to be given about the state of the resource. Our present understanding of connections between resource and ocean may still be deficient, but great progress has been made in the past 60 years in spite of wars and depressions, ever-inadequate facilities and staffs, and intermittent doubts in many minds as to whether the effort was worthwhile. Notable accomplishments have included the work relating distribution of Antarctic whales to complex distributions of biological and chemical properties of the ocean, the analysis of water mass changes in the English Channel which practically extinguished a herring population and enlarged a population of sardines; and the United States and Japanese work on the significance of areas of divergence and convergence, in relation to exploitable biota and their prey. A feature of these investigations has been the increasing sophistication of hypotheses, step by step as the simpler ones proved deficient and better ones became possible through advances in pure and applied oceanography. In general the emphasis has shifted from ocean properties to ocean features and processes, and even the properties have been considered in more varied ways. For example, temperature measurements in fisheries oceanography are probably as important as an ingredient in current measurements as they are on their own; and there is recognition of the fact that a large standing crop of zooplankton may signify an abundance of enemies instead of, or as well as, an abundance of food. Another change has occurred in the geographical scale of some of the investigations, with the growing recognition of dependence of local changes on distant events - even events in the atmosphere half an ocean away, as in the North Pacific.

With regard to prediction, very little of lasting practical value has been accomplished. Occasionally it has been thought with good reason that a certain relationship would have predictive value for some feature of the resource, but it almost every instance it has eventually broken down. The failure of the correlation between salinity and sardine brood-strength in California, based on acceptable oceanographic theory and backed by a seven-year series of observations, is a case in point. The effort continues because of the great potential value of forecasting to fishermen, who need to harvest resources more efficiently, and to fisheries biologists and managers, who are responsible for conservation: changes in the environment complicate both free fishing and restricted fishing by altering or redistributing the exploited population units, as mentioned above.

In much of this application of oceanography to fisheries problems, the effort has merged almost imperceptibly into pure or fundamental research which might not otherwise have been done. This will be apparent from examples already given. One oceanographer has concluded

that basic research has been the main accomplishment of fisheries oceanography:

"What has been the success of fishery oceanography in recent years? Certainly in the Pacific it has had no dramatic impact on the commercial fisheries. And if the goal be considered prediction, very little success can be recorded. Yet the fund of basic knowledge of the ocean has increased tremendously. The near surface circulation and the distribution of properties such as temperature, salt and oxygen have been much more adequately described. The theory of wind-driven circulation is well established. The variations in time and space of coastal upwelling are recognized, and other important surface-enriching mechanisms are known. In short, the general scheme by which atmosphere, ocean and biosphere are interrelated is taking form, and we are ready to formulate and test hypotheses having bearing on important and specific problems in fisheries science."

The quotation and most of the above-mentioned examples were taken from a "Symposium in fisheries oceanography" published in California Cooperative Oceanic Fisheries Investigations, Reports, Vol. 8, pp. 19-74, 1961.

3. State what fisheries oceanography should be trying to accomplish.

This should be obvious from what has already been said. Fisheries oceanography should try to improve its accomplishments in its special field of making useful organisms better known and more available to man, and here there is a great deal still to be done. It should also maintain and, if possible, improve its contribution to basic human knowledge about the ocean and its contents: it needs this knowledge and cannot count on obtaining all of it from other sources, and it has special opportunities for obtaining some of the knowledge which virtually oblige it to do so as a service to science.

Regarding applications to fisheries biology and the fishing industries, five fields have been noted in which fisheries oceanography could assist: transplantation, exploration, appraisal, prediction, and alteration of environment. Activity in the first and last is virtually nil; there has been some rewarding activity in the second field and a good deal in the third; much has been attempted in the fourth field but practically none of it has been successful.

Opinions would vary as to the fields in which future efforts should be made. Many might agree that the status of transplantation experiments in the sea is too slight to warrant much help from oceanography for the present; that oceanography should assist as required in the search for new resources; that the oceanographic contribution to appraisal of resources should be maintained, and greatly increased in any direction that seems likely to facilitate useful forecasting; & that more serious consideration should be given to the possibilities of improving living resources by modification of the marine environment.

It is almost impossible to be more specific as to what should be done in fisheries oceanography, either at the present time or in the future.

end. One can point from experience to a need for certain kinds of information that fisheries oceanography will probably have to obtain for itself with the aid of new or uncommon techniques and methods of operation. It seems, for instance, extremely important to measure apparent abundance of the exploitable organism at exactly the same times and places at which oceanographic measurements are made; at present, it is usually impossible to do this except by conducting oceanographic work and large-scale fishing from the same ship, which is inefficient, but the picture would change entirely if techniques such as sonar could be depended upon to identify and give the approximate abundance of the fish. Another type of operation that could result in more comparable series of observations on resources and environment, especially with migratory fish, is to have an oceanographic vessel working around a fishing fleet. Neither of these methods is new or free from difficulties, but both merit further attention.

It would also be useful to make more detailed studies of the distribution and abundance of fish and food-chain organisms around ocean features such as eddies, domes, fronts, and islands; much has been speculated and inferred about such occurrences, but good series of observations are few. Similarly, there is room for much further inquiry into the way in which pelagic populations and communities maintain themselves in current systems, and the circumstances in which they fail to do so.

These matters lie at the heart of fisheries oceanography. There are others which could be investigated in other branches of oceanography or in marine biology and meteorology, and some of them are mentioned in 4 below.

It may be supposed that further investigations such as these will enhance the possibilities of useful routine forecasting. Even so, such forecasting will probably not become a reality unless means become available for collecting and transmitting oceanographic information from many parts of the ocean. Fisheries oceanography has therefore a special interest in the development, testing and maintenance of unmanned instrumented stations, preferably moored ones, and should increase its participation in and support of that work; it can expect the cooperation of other users of the same kinds of information. Obviously these devices could also contribute much to our understanding of the ocean by providing long time series of observations for analysis.

Accomplishments such as those discussed will require more effort and a higher quality of effort than most fisheries oceanography programs have yet been able to muster. Perhaps the quality is the more important, and there is rather general agreement among leading fisheries oceanographers that this could be attained by closer association and more frequent exchange of ideas and information between biological oceanographers, physical oceanographers, marine biologists, experimental biologists, and possibly others; it would help even more if individual biologists knew more about physics and physicists more

about biology, and so on, The need for larger scientific staffs is obvious: as one writer has said, "Oceanography serves fisheries science in much the same way as the biology, geology, physics and chemistry done on land serves agriculture and forestry. But the ocean biologists, geologists, physicists and chemists are spread much thinner over the water . . ." If staffs were larger, the more experienced investigators would have more opportunity to obtain insight by working over collected data, making experiments, or merely thinking about their problems.

An improvement in quality of fisheries oceanographers would probably justify as increase in quantity. There may be severe limits to the size of the effort that can be justified for fisheries oceanography alone, but so much of the work would have other applications that it could probably grow much larger without becoming unprofitable to society as a whole.

4. State what progress is needed in other sciences so that the aims set out in 3 can be attained.

It is hard to be specific about what is actually needed; fisheries oceanography might make much further progress with the fund of scientific knowledge it already has, if it operated in some of the ways suggested in 3 above. Further progress is certainly desirable in several directions in parts of marine science that are not strictly fisheries oceanography, although they overlap it, and some of these are listed briefly as follows:

In fisheries biology and marine biology there is a need for further work on the physiology of exploitable organisms and those in their food chains (or similar organisms that may lend themselves more readily to such studies), to answer the general question of how and why they behave under specific external conditions; special interest attaches to the mechanisms of aggregation, migration, and dispersal of fish. Another special requirement in marine biology is for measurements of rates of production of animal material at various trophic levels, and information about what limits them, comparable to much of the work accomplished in the last decade on marine plant production.

In marine biology and physico-chemical oceanography more work is needed to identify the chemicals and physical properties that control marine plant production, and to establish their distribution in the sea.

In optical oceanography, apart from possible applications covered in the preceding paragraphs, it would be helpful to know more about the relation of water transparency to particle concentration (a possible measure of biota in some situations, e.g. on unmanned stations).

In physical oceanography and meteorology the greatest need is probably for more information of almost any kind about vertical motion in the sea; and for more detailed studies about the influence of winds and solar radiation on the upper layers of the ocean; moored stations offer much prospect as a source of observations, but there may be a need for theoretical studies to show where and when the observations should be made.

M. Blackburn, March 1, 1962

UNITED STATES DEPARTMENT OF THE INTERIOR Fish & Wildlife Service  
Bureau of Commercial Fisheries, Biological Laboratory 2725 Montlake  
Boulevard, Seattle 2, Washington March 1, 1962

Dear Wib:

As requested, these are strictly my own thought regarding the questions posed in your letter of December 25. To begin, the various views of the subject remind me of the old rhyme about the three blind men describing the elephant; the one who grasped the tail felt the animal was like a rope, the one who grasped a leg was of the opinion that the elephant was like a tree, etc., Similarly, most people in marine research probably have hold of the same animal, but we tend strongly to view it according to our own situation and problems.

For some time now, my feelings of the primary needs in fisheries oceanography(whatever this is) have been influenced by the problems we face with the INPFC. Here we are confronted with the need to know the quantitative abundance and distribution, migrations, origins and population dynamics of the salmon at sea. The need for information has its roots in the desire to manage, for human gain, the stocks involved. As you have pointed out, the requirements here are apt to be different than in another situation.

I am not at all certain that "fisheries oceanography" is a very real term to me. I view the problems as being essentially fisheries problems, and one gets help from any useful source for their solution. Large areas are likely to be of a nature that would permit them to be studied for purposes entirely separate from fisheries, if one wished to do so. The results are often quite valuable from a purely, say, physical oceanographic standpoint. It will be difficult to define a limited field of science that will fit the terms of fisheries oceanography. Rather, I would prefer to view the subject from the standpoint of the questions we are trying to answer. It is then possible to define fairly well the branches of science that are pertinent to the solution.

This avoids the first questions. I suppose that I would define fisheries oceanography as the science of oceanography as it pertains to marine fish and fisheries. The principal aim is the solution of fisheries problems and the scientists specializing in disciplines other than the study of fish and fisheries would be involved for the purpose of shedding light on fisheries problems.

Under this definition, I am not an expert as to what has been accomplished on a world-wide basis. In matters of direct interest (INPFC), we are only now getting a reasonably good idea of the circulation in some of the more critical areas of the North Pacific Ocean and Bering Sea. The first look at the system has hinted that the distribution of salmon is intimately associated with the characteristics of the ocean. We have not proceeded to the point that this is useful in determining the distribution and abundance (or

growth or death) of salmon. It seems to give some definition of migratory paths.

We need to know the detail of the ocean and fish distribution.

To obtain these we first need means of describing the circulation and distribution of properties with a good deal more exactness than is now possible, and we need far better tools and methods for locating, censusing and sampling fish at sea. Having achieved these, I'm not sure at the moment which way the path would lie.

I will be very interested in seeing the definitions which your committee develops. Sincerely, Fred Cleaver, Chief, Marine Investigations.

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UNITED STATES DEPARTMENT OF THE INTERIOR Fish & Wildlife Service  
Bureau of Commercial Fisheries Biological Laboratory . . . . .  
Stanford, California March 1, 1962

Dear Dr. Chapman:

The following is a response to your letter of December 25, 1961.

Having come fairly recently into association with fishery people and oceanographers, I am not keenly aware of the first distinction between the view of different groups on the subject of fisheries oceanography. Having, further, worked at a laboratory where the philosophy of approach is very nearly expressed by item 3 on page 7 of your letter, I find this view a natural one to take.

It appears to me that the concept of fisheries oceanography reflects a trend which is, and has been, spreading through many fields of science. It is a logical consequence of growth; an awareness that the close-up examination of a subject in minute detail must be supplemented by a broad perspective. Man has tended to divide the phenomena of nature into segments: physics, chemistry, biology, etc. Now he is beginning to put the segments together. The crash programs arising from the expediencies of national emergencies gave momentum to the team approach, which inherently tends to soften the boundaries between disciplines. The team approach is basic to interdisciplinary problems. But in the evolution of a mature interdisciplinary science, there is something more. Some of the workers begin to shift their base of reference from strictly one of the component sciences until it overlaps the other in some degree.

Fisheries oceanography needs fishery oceanographers whose interest and ability enables them to work from a broad base of reference. It also needs fishery biologists, physical oceanographers, etc., with more restricted areas of interest.

I certainly do not think that fisheries oceanography covers too broad a scope to be defined. The trouble starts if one tries to draw too fine a line at the boundary of a field which, by definition, transcends boundaries. The question to be asked during the planning stages is whether a given program is likely to produce results that,

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among other things, will contribute materially to the aims of fisheries oceanography. What are these aims? In general terms they are the same as in many fields: (a) observation, (b) understanding, (c) prediction and (d) control. Because fisheries oceanography is an applied science, the last two items are the payoff. But progress toward the payoff depends on the first two items.

A final comment in definition of scope: a person trying to understand (and predict) the effects of environmental influence on abundance of a fish population must, at present, work with catch data. The fact that he may need to account for economic factors in analyzing his data does not transform his research from a "scientific" to an "economic" status. Nor does the fact that his results, if successful, may be useful to fishery economics. His success would also contribute to the understanding of fish and the ocean and thus advance our general level of knowledge. And there is growing recognition that the latter is also beneficial to human welfare. Sincerely yours, L.E.Eber, Meteorologist

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THE MARINE LABORATORY, Institute of Marine Science of the University of Miami, 1 Rickenbacker Causeway, Virginia Keys, Miami 49, Florida  
March 1, 1962

Dear Dr. Chapman:

The questions and problems of fishery oceanography brought up in your letter of December 25, have been of much interest to me for a long time. However, my ideas and opinions in this area are radical and subject to severe criticism by those with more conventional view points, especially those steeped in Fish and Wildlife theories and carried away with the impossible doctrine of "maximum sustainable yield" and other such foolishness (as I see it).

I don't know what qualifies me to have ideas and opinions on these matters, much less to put them into writing; and I may be all wrong. But I've been interested in marine biology and ecology for over 25 years, and I do think that anyone who hasn't worked in or at least been interested in marine ecology for some time isn't qualified to express himself very vociferously.

If the estimate is correct that only about 1% of the world's food supply comes from the sea at the present time (99% from the land) then it is obvious that the sea's contribution is negligible and that it wouldn't matter much if all the sea's fisheries ceased. Probably the world's food supply varies annually more than 1% anyway. And if the estimates that the sea's contribution can be no more than doubled or quadrupled (in its present form) in the future, then it seems to me that we are concerning ourselves with a source of rather negligible importance. Furthermore, when we examine some of the basic problems underlying the sea's fisheries, pessimism as to their solution, elimination of the major roadblocks, would seem to be insurmountable.

In the sea we are pursuing wild game. Consider for a moment how many people the earth would support if we had continued to do only that on the land. Furthermore, we are extremely particular as to what form of seafood we will eat. We are so high up the food chain, so high on the proverbial hog, in our seafood demands, that it is obvious that we will never get much in the way of quantity out of the sea until we change this tradition. What are the prospects of doing so and what are the concomitant problems? These, it seems to me, are important questions.

I feel that I must pass over the question of definition of fisheries oceanography. In the first place I don't think it can be defined very well, and in the second place, I don't think that has much to do with the real problems of food from the sea. All oceanography is fisheries oceanography in a broad sense. Just as there is no "pure" research in the sense that the ultimate goal of all research is to enable man to modify or use his environment in the interest of his own welfare. One of our troubles is that much of what we regard as "applied" research simply isn't applicable - - - such as determining the maximum sustainable yield of a given species of marine fish. Even if it could be done (and it can't) the data would be quite useless.

Concerning problem 2: I don't believe that fisheries oceanography, in the narrow sense, has accomplished much of anything, I don't think it ever will until its goals are defined, and that has never been done. I suppose that fisheries oceanography is best represented in this country by the Fish and Wildlife Service. If you ask an administrative official of this organization what his organization has done for the fisheries (or for anyone or any group) he has extreme difficulties in providing a straightforward answer. Where the interests of the public in general and the fisherman are opposite, the Fish and Wildlife cannot say which group they are trying to help. But Fish and Wildlife itself cannot be blamed for this absence of a goal or policies. Their funds depend upon their throwing some sort of conservation scare into congress or congressional constituents and these are usually trumped up for the purpose. Otherwise, Fish and Wildlife would hardly have any support. And Fish and Wildlife cannot do anything that is obviously in disregard of the interests of sports fishermen. For the sports fishermen dictate what Fish and Wildlife can do, in the final analysis, and sports fishermen are blithely unscrupulous. Nearly all our politicians are sports fishermen; nearly all our businessmen are sports fishermen . . . . . They outnumber commercial fishermen by 10,000 to 1, and I suspect that's conservative. And every sports fisherman is his own ecologist; he's an authority. When he sees a trawler haul aboard a netfull of fish, he knows why he caught fewer than grandfather used to; so let's outlaw trawling. And even if he doesn't know that that's the reason, let's outlaw it anyway, just in case. Under these circumstances, what can we expect of Fish and Wildlife? I don't think we can expect

much of anything; I think we might as well forget Fish and Wildlife Service as a source of research and fisheries policies.

It seems to me that in the formulation of a research program in fisheries oceanography, we need to take this fact into consideration. The seas are constantly gaining in basic fertility at the expense of the land as a result of the rainfall drainage from the land and the dissolution of nutrient salts, especially nitrates and phosphates. It seems inconceivable at the present time that man will ever remove organic matter from the sea containing as much in the way of combined nitrogen and phosphates as rapidly as these important salts are draining into the sea in another form. Not until we do so will we be reducing the basic fertility of the sea by utilizing marine organic matter. One of our goals ought to be to regain from the sea as much of this loss as possible.

With a goal such as this it is obvious that the vast majority of our fisheries are not worthy of consideration. Of the fin fishes, probably only the clupeids will support a really important fishery. Instead, we must look lower down the food chain than most species are and this means invertebrates and small fish. We need to tackle some relatively simple technological problems of learning how to process mixtures of organic matter obtained from the sea, both plant and animal, and produce an acceptable form of food. At the same time, we must take into consideration both economic problems and the power of tradition in food preference.

At the present time, fishermen catch as many fish as the public will buy at a price at which the fishermen can afford to catch them. The public won't eat much fish in most parts of the world. How are we going to get them to do so? Probably our assumption should be that this economic problem is bound to solve itself in the future when the land simply will not produce adequate food.

A second form of fisheries oceanography research should be toward the cultivation and control of inshore marine populations, and hence productivity. We need to learn to steer inshore marine productivity toward a direction of optimum usefulness to us. Before we can do this, we must study the general ecology of the sea all over the world. When we have done that, and have begun to learn of the interrelations of marine plants and animals, we may then be able to establish large, controlled areas. We will need to define marine habitats all over the world and to locate similar habitats. We will need to transplant various organisms from one habitat to another in order to fill in missing links in the food chains within the controlled areas. We will need to develop genetically improved lines, but probably not of the species we now utilize. We have no sound basis as yet to decide what species needs to be controlled genetically. Marine ecology is something more than "energy flow" through "ecosystems". We've done enough generalizing in this respect and need to get into the details and determine what influences what and how we can influence both.

(In my opinion the most valuable work Fish and Wildlife has done was the marine transplanted program under Dr. Hugh M. Smith from about 1879 until the 1890's. After some signal successes, they dropped the program completely for reasons I have never understood).

Another form of fisheries research needs to be done on land, and that is a detailed, critical, and fearless analysis of all our fisheries laws and regulations. When we look behind them, it is easy to see that the majority of these regulations with which our fishing industry is hamstrung were promoted for some reason other than conservation, although virtually all of them were promulgated as conservation measures. It is remarkable how few arose from honest (is asinine) conservation interests. It is also remarkable how naively we apply land conservation principles to the seas. Nothing is more revealing than the assumptions underlying Fish and Wildlife's "maximum sustainable yield" research program and fisheries "management" policies.

Time does not permit me to suggest research programs needed in related fields as an aid to the utilization of marine organic resources, although I feel that this is the most clear-cut solution of any facing us. I am afraid too that I have stated my ideas so briefly as to leave them in a rather cryptic condition, and that I have not taken up a number of the questions in your letter. Sincerely yours, Harold J. Humm, Associate Professor of Botany, Duke University (On sabbatical leave, 1961-62)

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VAN CAMP FOUNDATION Dr. W. M. Chapman, Director, 739 Golden Park Avenue, San Diego 6, California May 23, 1962

Dear Dr. Humm:

I enjoyed reading your stimulating letter. We need iconoclasts. I think you and I would enjoy a bull session together because I disagree quite thoroughly with about half to two-thirds of what you have to say.

Take for instance man's supply of food. What is in short supply in the world is not calories but some of the essential amino-acids. These are not available from vegetables and are so far incapable of economic synthesis. They are present in good balance in all fish. Fish is a material source, either primary or secondary, of these in man's diet as a whole. When I say secondary, I am thinking of the role of fishmeal additions in the diet of chickens, cattle and swine. George Borgstrom's analysis of the role of fish in mankind's diet would be interesting to you.

Again, the Japanese for many years and the Russians now also, are utilizing essentially everything retrievable from the ocean. As an American you are used to the term scrap fish. In West Africa and around almost the whole of the Indian Ocean as well as Asia that term is unknown. Any fish is food and is eagerly sought as such.

Also the Bureau of Commercial Fisheries of the Department of the Interior is in no sense dominated by the sportsmen. Neither is it dominated by the commercial fishermen. In long association with it I say it is serving the public interest in its proper field of activity about as well as any other public agency and better than most. I would hate to see that statement get back to McKernan. It would destroy the effect of a lot of crabbing I do at him myself. Nevertheless, as an industry fellow I can list for you a sizeable number of things the Bureau has done, and is doing, that are useful to us. Furthermore, the whole tone of the outfit has been changing over the past six years in a direction most pleasing to me, as one constituent.

I question the statement that the seas are constantly gaining any material basic fertility at the expense of the land, if you will allow me to substitute the words world ocean for seas, The chemical composition of the world ocean changes about as rapidly as that of human blood, and for the same reasons.

My wife doesn't like to eat organic matter and neither do the kids. In consequence I get served food that ordinarily tastes, looks and smells pretty good, which keeps me fat and happy. When folks change their ways we will have a go at canning mixtures of organic matter for public sale. Until then we will probably stick with tuna, and such odds and ends. Incidentally, the use of tuna in the world doubled the past ten years, which is not too bad.

Maximum sustainable yield is by no means a figment of the Bureau of Commercial Fisheries' tortured mind. It was the accepted goal set down and agreed to by eighty eight nations at Geneva at the Law of the Sea Conference in 1958. It can be measured and set out with a reasonable probably error. It is providing a useful goal in a good many fisheries of considerable importance.

Sincerely yours, W. M. Chapman, Director

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STATE OF MAINE, DEPARTMENT OF SEA AND SHORE FISHERIES, State House  
Augusta, Ronald W. Green, Commissioner March 2, 1962

Dear Dr. Chapman:

My reply to your letter of December 25, is a little past the deadline, but I had wished to discuss this request with several of the biologists in our department and it did prove to be rather difficult to get them together all at one time. I realize that you requested my personal reaction to your comments but I felt I wished to consult with them also.

My general comment is that I agree with you, In fact, some of the things that we, as a department, have done in the past would indicate that agreement. Our marine biologists are designated under the State Personnel Department as marine resources scientists.

With respect to your terms of reference I would offer the following:

1. Delete the term fisheries oceanography and substitute

fisheries science, Oceanography as a study of the ocean appears to differ considerably from the specialized studies of the fisheries scientists.

2. Fisheries science has frequently been compared to agricultural science in terms of problems, accomplishments and direction, usually to the disadvantage of fisheries science. I think we can say that in general the natural science aspects of the more important commercial species have been pretty well outlined and that now we are primarily concerned with the second of three steps, that of ecology.

3. The third step is the answer to your question #3, what should fisheries science be trying to accomplish. The answer to this would seem to be the manipulation and control of the environment in order to control the yield of these commercially important species or any other species which are selected for such management or control.

4. It seems to me that the principal need in other sciences is progress in the fields of sociology and psychology. It is axiomatic that fisheries scientists have more difficulty with people than they do with fish or the environment of fish. We constantly pray, therefore, that those who will utilize fisheries science will be more receptive to communication. A secondary problem, relatively minor, is the need for the development of adaptation of more adequate research tools. In fisheries science maybe it is only a need for salesmanship, both for more adequate fisheries research funds and for communicating and applying the results of this research to those who will be using the information.

I feel there is a great need for better inter-science communication. Possibly the enclosed mimeographed material outlines my thoughts on this problem. Very truly yours, Robert L. Dow, Research Director

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Social Problems of Fisheries Research  
By Robert L. Dow, A.S.M.F.C. 1958

The Commercial fisheries and fisheries research create problems that we call "social problems". The term "social problems" is a biological expression which means, when it is translated literally, "Please go away and don't bother me."

There are two kinds of social problems. There are those that appear when fish and shellfish resources are used commercially and there are those that develop among researchers who are doing work on commercial fisheries problems. Which of these is the more disturbing is hard to tell. Maybe you'll want to answer that question for yourself, but I hope you'll wait until I have described them for you before you make up your mind.

No matter what kind it is, a social problem is nothing to fool around with. Usually it's a serious matter. At times, however, it's a convenient device. If a researcher wants to buck a question along to someone else and get himself off the hook, he calls the question a social problem. Some researchers will also tell you that the easiest way to end some arguemnts among their associates is to say, "Well, after all, it's a social problem."

In order to understand social problems and their function, behavior and position in society, we need to know something of fisheries research and how it operates.

Definitions are unprofitable ventures at times--their only purpose is to cause confusion and misunderstanding. Therefore, I am going to make use of simple illustrations and tell you a story about the state of Maine. I'm making these illustrations simple not so much out of consideration for you as to keep me from becoming confused.

There is only one place in this country, including Alaska, where Canada is due south of the United States. The fact that Canada is also north, east and west of this same area need not cause any confusion for in that part of Maine we have a bird called the whiskey-jack and he's not confused. At least I don't believe he is and he does research too. Anyway he spends all his time running around in the puckerbrush collecting. That's why I think he must be doing research work, although I am not quite certain what kind of research he's doing and I guess he isn't either.

Anyway, this bird collects all kinds of things; big things, little things, but mostly shiny things. When he's made a good collection he takes it home and hides it in a good safe hiding place--a sort of bucolic file. Then he goes back out in the puckerbrush and collects some more. And that's all he does. He doesn't use any of these things he's collected except maybe once in a while he trades some of them with his friends for items they have in their collections.

That's the way we do fisheries research. Of course, I think we're much more advanced, culturally that is, than this bird. We collect things, too, especially shiny things, but after we consolidate them and send them out to all our friends and competitors so that they can see what good collectors we are. And they do the same thing for us.

But we're not going to operate like that anymore. As soon as we can get our program set up electronically and can finish filling our file we're going to weigh and measure them. And we expect to come up with some pretty interesting results. Maybe there will not be anything important about fish and shellfish but we think we'll learn a lot about fisheries research, how researchers operate and why they don't like social problems.

Now that we've considered fisheries research it is time to look at both species of social problems and what causes them. First of all, we have social problems in fisheries reaseach. In

discussing these problems in 1956, Hildebrandt observes that they exist in Holland.

"Fisheries have," he said, "on the other hand, lagged behind (agriculture) even though scientific research has been increasing in importance, here, too, in latter years. It is still often the case, however, that scientific research into fisheries is conceived exclusively in terms of biological research. This is understandable, for for many years this was the only form of scientific research into fisheries that took place in any country."

In fisheries research then, we have a built-in peck-order type of social problem. Having been first to get there the biologists have latched on to a virtual monopoly of fisheries research. Even today other scientists enter the field at their peril. Except in a hand-me-down fashion, there has been little cooperative effort among scientists of different faiths.

The ability of natural science researchers of different faiths to work together on a common problem has been well demonstrated by the geological-biological investigations carried on in Maine for nearly a decade. These men learned each other's language so well that frequently, in unguarded moments, the geologists could have passed for biologists and the biologists sounded like geologists. I hold no brief for accoustical harmony, but I do believe that in the case of geological-biological cooperation an entirely new approach to fisheries problems was mutually opened up by these specialists. Not only did their efforts contribute to a greater understanding of the geological-biological interrelationship in the marine environment but they also uncovered and brought into perspective evidence of critical chemical, sociological, legal, hydrographic, and psychological influences upon the biological and economic well-being of the fisheries. It is, I think, highly significant that the Fish and Wildlife Service has recently published a biological paper by a geologist.

At this point, I would like to discuss the other type of social problem, the problem which often is a basic part of the commercial fisheries complex. Here again illustration will perhaps serve the best to describe this species. I have purposely selected an example from one of our geological-biological investigations because I feel that it is appropriate to use as an illustration the results of work done in what would normally be an area of high inter-science competition. In brief, by overcoming the social problem of research rivalry we can, perhaps, bring out more clearly the character and extent of the several types of social problems associated with legal, sociological and psychological factors and their impact upon biology and economics. In one of the reports appeared the comment:

"Interpreting Medomak Cove in the light of pH is complicated by the fluctuating pH records, varying from a low of 3.1 to a high

of 7.5. A glance at the horizon formed by the marine blue clay (as indicated by the Test Pit Studies) will readily explain this variation. In portions of the cove the clay sediment is found below that of Mya occupation. Excessive digging in the area for Mya and marine worms has caused this phenomenon, resulting in poor sub-surface drainage. Consequently any organic decomposition in these pockets which would tend to lower the pH is virtually locked in and cannot be distributed or carried away by the retreating tides."

What are the implications of this observation? Let us work backwards for then we'll know where we have been. Unfavorable biological conditions in Medomak Cove influence the economy of the fishery as an end product. These conditions were caused by an unfavorable chemical environment which became possible from interference with the former hydrography of the area. Changes in hydrography are attributable to geological changes which were induced by man's activity. The way man has behaved has been determined by several social factors. Among these factors are: (1) confidence or assumed confidence that a so-called conservation law no matter what it may be will of itself take care of all conservation problems; (2) the habit of harvesting by traditional methods unsuited to the sediment characteristics of the area, and (3) the attitude of individual irresponsibility toward a public resource.

This is not an isolated example, but one which is typical with some minor variation of the entire Maine soft clam fishery and likewise, I believe, of many public resource fisheries. On the basis of employment and landed value this fishery has been in the past second only to the lobster fishery among Maine's commercial fisheries. In some respect the two fisheries are in sharp contrast.

The decline in importance of the clam fishery can be traced to biological factors. However, important biological failures resulted directly from social and economic problems. Aside from several technological and quality shortcomings, the clam fishery may be said to be in fairly good condition economically. Declines in supply in recent years have been shown to be the result of (1) an increase in the number of predators and (2) an increase in mortalities associated with the harvesting operation.

Economic factors probably had nothing to do with the increase in predators but they definitely had something to do with other mortalities. Residual population losses from breakage and burial have been compounded by the rapid increase in demand for Maine clams which since 1949 has amounted to nearly one hundred and twenty per cent. As price has gone up the level of abundance at which diggers can profitably fish has declined. This condition has resulted in more and more frequent harvesting, which in turn, has widened the volume gap between growth and mortality. In other words, in terms of volume the growth rate of survivors has failed to equal the numerical

loss to the residual population from harvesting.

The troubles of the lobster fishery are largely economic, but those economic problems are the direct result in recent years of biological and technological problems. Increased landings of 377% between 1836 and 1957 as well as annual fluctuations in production can be accounted for on the basis of economic factors alone. However, the current high level of production has posed biological and technological problems, which, in turn, have adversely affected the economy of the fishery. Problems which the industry neither has solved nor clearly understands.

What then is the role of fisheries research in all its aspects when problems comparable to those I have just cited continue to bedevil the industry? I think all of us who are actively engaged in fisheries research have too carefully avoided attempting to answer the question, "Why?" We have been altogether too content to explain "what" has happened rather than try to account for the "why" of its happening. Correction of the difficulty will require an even greater concentration of effort.

Fisheries activities carried on by government including education, marketing and enforcement will neither assist nor benefit the industry unless those activities are based on the results of research. Moreover, to be truly effective, research should be so broad in scope that it will cover all pertinent fisheries problems and not merely a selected few.

Encouragement must be given to specialists in fields other than biology to participate actively and cooperatively in investigations. It cannot be assumed that biologists can do all of the research that needs to be done or that problems which biologists are unable to undertake are not worthy of investigation and of importance to the fisheries. The successful application of the results of biological or technological research may be impossible because someone did not consider the need of solving a sociological problem.

The rocky course of haddock management in Sub-area of the Northwest Atlantic was made possible by failure to augment the biological program with an economic and sociological investigation of the fishery, and the application of a workable management program was delayed for several years largely because experienced enforcement officers were not consulted on the enforceability of proposed regulations.

The question of what effect dragging has upon the bottom and upon other species is a problem which has been kicked around for several centuries. From the excellent appraisal by Bob Lunz and his associates at Bears Bluff one must interpret the problem initially as having been a political problem. With the advent of biological research in the fisheries, I assume that the problem was transferred to biology. In more recent years it would appear from the evidence of studied disregard that higher echelons of administrators and bio-

logists have succeeded in reclassifying it as a social problem. And being a social problem is no longer a fit subject for fisheries research since legitimate fisheries research should be, by tradition, concerned only with biological investigations.

Most of us are disturbed by social problems in one way or another. We're disturbed because we don't know how to solve them or because they interfere with the orderly application of the results of biological and technological research. We'd like very much to get along without these social problems. Then, there would be no sweat, no tension, no thinking--just complete mental relaxation, a working environment which anyone would consider to be desirable.

What are we going to do about social problems? Ignore them as we have in the past? Turn them over to a psychiatrist? Or leave them to the economists? The work of economists, by actual practice, has almost always been done independently of that conducted by biologists and other researchers and, as a result, the greatest possible progress in the understanding of fisheries problems has not been realized. What has taken place might properly be termed "fractured" research - a fragment of this and a fragment of that.

In commenting on this development Schaefer wrote in 1957.

"Attempts to systematize some of the significant biological and economic facts bearing on this problem have been made by a number of persons in recent years . . . the main result has been a considerable advance in our understanding of the biological and economic principles involved. There is, however, a fairly large degree of confusion, resulting from the biologist's inadequate consideration of economic principles, and, in part, from economists' failure to fully consider the properties of a self-renewing resource . . ."

I believe another weakness of the economic research done in fisheries has been the failure to realize that frequently fishermen will continue to fish even when operating costs far exceed income. Some fishermen will fish either from choice or from lack of other employment as long as someone will extend them credit. This practice in many respects is analogous to the grub-staking of prospectors.

In further discussing fisheries economics Schaefer observed:

"In a fishery which is a common property resource, where anyone who wished to do so is free to enter, new operators will be attracted to come into the fishery so long as the average cost is less than the average return . . . so that in the unrestricted common-property fishery the effort will grow until it reaches (the point) where average costs equal average return and the net economic yield is zero".

An economist through training and experience in more "ideal" economics often fails to appreciate the less sophisticated operations of the small fishermen whose existence is not only sub-marginal economically but in many respects is comparable to beach-combing. In many remote areas fishing is the last opportunity for employment.

The importance that any specialized category of research plays in the problems of a fishery will vary from time to time and from place to place. It is, therefore, impossible to particularize with respect to what should or should not be investigated and by whom. Several possible solutions suggest themselves. The increasing awareness by biologists of the need for research support by economists and sociologists might lead one to recommend that all biological investigations be placed under the supervision of an economist and that all economic investigations be directed by a biologist. But then -- what about geologists, engineers, psychologists, teachers and all the other specialists whose assistance and advice may be especially valuable?

A second possible solution would be to delete the modifiers: "biological", "geological", "economic", and the like from the terms "fisheries research" and "fisheries investigation". A third possibility is based on the premise that perhaps the greatest need in fisheries research is for generalists -- nebulous characters who would occupy the no-man's land between the fisheries and the specialists.

Their role would be particularly valuable in analyzing what the real problems of the industry are since the specialist has the occupational disability of assuming his specialized field will always have paramount application.

More times than not the problems of the fishery do not require the immediate attention of the specialist but rather that of one who is sufficiently experienced in several fields of science so that he is capable of correlating information from those several fields and applying it to the problems of the fishery.

And finally a word of warning to biologists. Our position is becoming increasingly dubious.

In recent years I have been forced by desperation to associate with economists. I have observed a gleam of increasing intensity in their eyes. Relatively unjaded by fisheries research they are young and vigorous, and they have not yet had their intellectual ears battered and buffeted by the frustrations, complexities and contradictions of the commercial fisheries. And close on the heels of the economists is the whole array of specialists. Unless we look well to our tactical deployment the economists, and the economists all by their lonesome, will become the new dynasty in fisheries research. Then the cycle will be repeated and we'll be right back at the same old stand again. If we can't join them, we'd better go underground. References: "Economic Research Into Fisheries", A.G.U. Hildebrandt, January 1958... "An Ecological Study of *Mya arenaria* L. in Medomak Cove, Maine," Treuting, Herbert R. Jr. A thesis submitted to the Graduate Faculty of Rutgers Univ. in partial fulfillment of the requirements for the degree of Master of Science, 1950, pp. 28-29... "Some considerations of Population Dynamics & Economics in Relation to the Management of the Commercial Marine Fisheries," Milner B. Schaefer, Jan. 1957. "Is Shrimp Trawl Net Destructive to Marine Life?" Beard Bluff Laboratory, June 1956, South Carolina.

UNIVERSITY OF THE PACIFIC, Pacific Marine Station, Dillon Beach,  
Marine County, California March 2, 1962

Dear Wib:

It is my impression that much of the justification for expenditures in oceanography is based on the notion that such knowledge is necessary to meet our increasing needs for food and other resources from the sea. The Indian Ocean program, for example, appears to be primarily for developing fisheries resources for the "underdeveloped nations. Because of its expense, oceanography must have some justification, whether economic or for national prestige.

I do not think that biology and fisheries can or should be separated; if they are, fisheries is more the loser than biology. Of course, in this compartmentalized day and age, we must emphasize some field of interest, sometimes reluctantly, in preference to other fields, but that is no reason to consider ourselves breeds apart. Of course, I am in nobody's sense of the word either a fisheries biologist or a fisheries oceanographer. I try to be an invertebrate zoologist, but there is little time left to me even for that. The essential thing is to maintain a broad interest even while in a narrow field(not always an easy parlor trick).

I am not much taken with semantic hassles, especially since I have become concerned about the schools and have tried to read some of the stultifying polemics on the subject in the book part of the Saturday Review. So, it might perhaps be of more use to you to make some effort to think who the great "fisheries oceanographers" might be -- or at least those who have contributed to the subject.

Nobody founded this branch of human endeavor as a science or field, so the earliest names that come to mind cannot really be considered the "founders". Thus we are thinking of the people whose work did most to bring things together. People like Viktor Hensen of the North Sea plankton, Karl Mobius of the German Fisheries Commission and William Herdman of England come readily to mind, along with C.J.G. Petersen of Denmark, Knipovich of Russia and, I suppose Nansen of Norway. I sort of doubt that any of these worthies would quite meet current qualification of "fisheries oceanographer" , even without a definition. But all of them were well-known zoologists at one stage of their work, and several were significant contributors to oceanography. Probably the biggest name of this vintage was Johan Hjort.

Maybe we ought to adopt the technique of the conservative rightists and refer to fisheries oceanographers as Hjortists or some such. In our day, Sir Alister Hardy is probably the most eminent practitioner of this solid European tradition. To suggest names of our colleagues in the U.S.A. might cause some hard feelings, and I am not sure where this document will wind up, so let us "except present company".

Anyhow, all of these eminent worthies came up through zoology or natural history. I am not aware of any examples of the

other way around. It would seem that it may be easier for biologists to learn a little oceanography than for oceanographers to learn a little biology. I am not sure just why this should be. Yet a good deal of our squabbles at the present time about using the ocean as a radioactive dumping ground would be beside the point if the oceans were azoic, and from time to time we get a bit of an impression that the occurrence of life in the seas is considered a rather messy complication by the physical people. These fellows seem to forget that they are organisms also.

Yet, again, we must point out that had it not been for the magnitude of our fisheries program, the formidable challenge to physical oceanographers passed by the events of the last decade in the eastern Pacific Ocean would probably have not been realized. In some ways, the organisms control the limits of physical oceanography (except when oceanography is considered simply a branch of geophysics and in that case maybe we ought to ask geophysicists studying the ocean to consider themselves "marine geophysicists").

Of course, we have all sorts of technicians, as you have pointed out, who are really not concerned either with oceanography or biology, but some branch of catching, processing, or marketing fish. In this respect, the field is not different from a number of others, such as entomology, I don't think anyone really worries about the status of crop-dusters, pest-control men, and, for that matter, bee-keepers - as entomologists, any more than we consider the fellows who work in lumber mills or market lumber to be foresters.

What I seem to be saying is that you can't be a fisheries oceanographer without first being a biologist. The field of fisheries oceanography is accordingly the specialized field of a type of biologist, not a branch of algebra or oceanography. I would think it inadvisable to codify the matter and set up criteria that would limit recruitment of future workers. You may be aware that the wildlife people have been concerned about standards and that one group is suggesting that membership in the Wildlife Society be limited to those with appropriate years of experience and level of academic initiation. To do this, it would be necessary to blanket a lot of present members in or kick them out of the society. I hope something like this - on an international scale - doesn't get started in fisheries.

The basic problem is that as in classical zoology, our schemes of classification are simply what we think we understand about nature and we must be willing to make changes as new information develops. Most branches of human thought that are actively being pursued are amoeboid in shape and area - it is when the boundaries become well-defined and difficult to cross that they become moribund and attractive only to antiquarians. Sincerely yours, Joel E. Hedgpeth, Director.

AGRICULTURAL & MECHANICAL COLLEGE OF TEXAS, College Station, Texas  
Department of Oceanography and Meteorology March 2, 1962

Dear Dr. Chapman:

This concerns your letter of December 25th, 1961, in which you asked some questions about fisheries oceanography. I found this letter to be very interesting, It presents a difficult problem.

Some days ago I sent you copies of a reprint, under the title of "Oceanography - A Definition for Academic Use." Some of the ideas presented in it might be pertinent to the problem which you posed. If there is a field which might be defined as Fisheries Oceanography one could probably approach a description of it by first agreeing upon a definition of oceanography itself, and then discussing the meaning of the modifying term 'fisheries'.

If one were to follow the definition of Oceanography which I presented in the paper mentioned above, he might then state that the modifying adjective 'fisheries' would imply the following things. 1) That the oceanographic work is done by a person who has a good solid background in fisheries science, 2) that he maintains contact with that science, 3) that he in his program of graduate studies, takes advanced courses in fisheries, as well as in his primary program in oceanography. 4) That he does research which combines his knowledge of oceanography and of fisheries science.

My beliefs about oceanography are very similar to those which you expressed on the 7th page of your letter. I do not think that there are different kinds of oceanography. There are simply approaches to this field from the various points of view and emphasizing the various pertinent techniques from the different backgrounds fields. In other words, the various phases of oceanography come through a combination of oceanographic specialization with specialization in other fields.

Specifically, with reference to your problem, it seems to me that a major question lies in the relation of 'fisheries' to 'biology'. This is something which I do not have the background to discuss. Possibly fisheries is a branch of biology in general, If so fisheries oceanography would be a branch of biological oceanography. An alternative to this might be that fisheries science is a different science which may be taken instead of biology. If this is the case we might have to define a new phase of oceanography for people who enter it through a background in fisheries.

I would be very much interested in the report which will be produced by your group. You face a difficult problem and one in which there is quite a difference of opinion from individual to individual. However, I do think your effort is well worthwhile and wish you the best of luck in it. Yours very truly, Dale D. Leipper, Head of the Department

UNITED STATES DEPARTMENT OF THE INTERIOR, Fish & Wildlife Service  
Bureau of Commercial Fisheries, Biological Laboratory P.O.Box 6121,  
Pt. Loma Station, San Diego 6, California March 2, 1962  
Dear Dr. Chapman:

I hope that I am not too late in expressing my opinion on the interesting questions you raised in your letter of January 25. We returned only last week from our 35 day cruise on the Hugh M. Smith. Your letter deserved more careful thought that I could give it in the rush of trying to catch up on my desk-work.

My friends are probably tired of hearing me quote a definition offered by one of my professors at Iowa, who facetiously defined statistics as "Those professional activities engaged in by statisticians". When he condescended to be a little more specific, he felt compelled to stress that this was from his point of view, and that his definition might not include the work of people who were used to thinking of themselves as being statisticians. When it comes to defining fisheries oceanography or even fisheries science, I'm not sure we can do much better than his first definition.

In my mind, I am accustomed to thinking of oceanography as being the counterpart of limnology. I don't know of any fresh-water fishery biologist who would call himself a limnologist on the basis of his work with fishes. As far as I know, the term "fisheries limnologist" has never been used. This may be the basis of the limited definition of oceanography that the oceanographers themselves have been using to close their clan to biologists. On the other hand, if I attempt to define limnology, I find myself thinking over what work has been done by the people whom I have been accustomed to thinking of as being limnologists - and this certainly does include some work on aquatic invetebrates, and if it does this, why shouldn't it include some of the work on vetebrates? I would have to admit that in the final analysis there is probably no clear reason for not including fisheries work in the definition. It would be particularly easy for me to accept some of the ecological work, and once that was done I probably would be forced to go all the way and include even some taxonomic work as well. It is an unusual taxonomist who is not interested in zoogeography. From this it is a short but significant step to a study of causes. It is this step that for the marine ichthyologist puts the work in the realm of marine ecology. Marine ecology is an all encompassing science which when it includes fish in the chain of interest is, in my opinion, synonymous with fisheries oceanography.

This definition of fisheries oceanography would exclude all those whose objectives do not include study of the oceanic environment as it affects fishes, or the study of fishes as affected by the oceanic environment. Man is undoubtedly a part of this environment, so I would include under this condition the studies of effects of

fishing intensity on the stocks of fish.

I would not include as fishery oceanography any survey work whose objectives might be simply to locate exploitable concentrations of fish by exploratory fishing, because it doesn't satisfy my requirement of an ecological approach. Thus, in my opinion, Dr. Humphrey's first proposed working group responsible for "Location and Investigation of New Fisheries Resources" would not be doing oceanographic work if their approach is only exploratory fishing. The second group would only qualify if the distribution of oceanic living resources were to be related to features of the environment.

I think this should be the objective of fishery oceanography to study the ecology of marine fishes so as to be able to explain their distribution and availability, their behavior, and their abundance, and to predict changes in each of these which can be related to physical, chemical, and biological features of the environment.

There is motivation for a broader definition of oceanography which we probably need to recognize, and that is that the term is receiving public recognition. Of more practical importance than this is the increasing use of the term by the congress. All of us would probably be willing to admit we were oceanographers for the benefit of this group. I think it is for similar reasons that we have become "fisheries scientists" instead of "fisheries biologists". Nowadays, anything with science in it is acceptable and has great prestige, while a biologist is still apt to be thought of as someone who runs a trout hatchery someplace. Perhaps all of us <sup>who</sup> can get away with it should call ourselves "oceanographers" and "scientists" if for no other reason than that it might help us get our job done. I'm probably getting cynical with age.

I hope that these ideas will be of some use to you.

Sincerely yours, Richard R. Whitney, Fishery Biologist (Research)

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AUKE BAY BIOLOGICAL LABORATORY, Auke Bay, Alaska, March 5, 1962

Dear D. Chapman:

I am pushing delay to the extreme in responding at this date to your letter, of 25 December, 1961, which asks for comments on the SCOR objectives. This is also written at home sans secretary or typewriter so as to not let anymore time slip by.'

Your letter filtered down several levels to my desk and it is now my opportunity (approached with misgivings) to discuss the four terms of reference you presented on fisheries oceanography.

The general subject has been thought about and discussed extensively in some form or other around this laboratory since it was organized several years ago. In response to your letter a last minute review brings the interesting consensus that there are no serious disagreements with the position you take on page 7. In

fact, we strongly approve of your philosophy.

Probably because I am a farm boy in origin I view the harvest of the organic products of the oceans as just another category of crops. In the matter of terrestrial crops disciplines including geology, soil sciences, hydrology, agronomy, biology, meteorology, etc., etc., meet and are required to "integrate" in the ultimate problems of agricultural production.

Fisheries oceanography, will require no less of a synthesis of disciplines and I cant feel any dismay at the prospect. It can only strengthen the program while if we try to confine fisheries oceanography to a single discipline it will be a superficial jack-of-all-trades.

A real danger we may be skirting too closely is that of trying to specify in detail the course of fisheries oceanography in the years ahead. In any field of our culture one can look back only five or ten years and note that present major accomplishments were not anticipated. The important factor was that the means for the research and development were at hand.

Our current probings into the wilderness of fisheries oceanography must be adequately equipped and supported with men and supplies. But, I doubt if we even get out of camp if we wait around for complete master plans that try to specify in advance where we are going and what we are going to find.

I think we worry too much about duplication. No two situations are identical and if more than one agency or institution is working in similar areas their common knowledge grows much more rapidly than if they were alone.

Any group having sole proprietary rights to an area of research is almost certain to succumb to decadence after its first accomplishments. I'm merely making a pitch for prudence in master plans for fisheries oceanography.

Apparent duplication may prove to be just what's required to stimulate achievement. Taking note of the astronomical sums our society spends on amusing itself (and I enjoy being amused as much as the next fellow) the cost of replication in ocean research is a pittance and hardly worth entertaining as a determining factor.

Living on the shore of this great ocean area that extends around Alaska it is very painful to feel the urgent demands from many directions to get out and study it and to be frustrated by lack of funds and equipment.

Fisheries Oceanography has the major problems of tooling up in many directions. And there is no clear answer to exactly what for. My preference would be to just start out on comprehensive "fish stocks - total environment" surveys and these would immediately point out profitable directions for further work.

This is probably our best compromise since it keeps our hand in the ocean against the time when our land production of protein

will not sustain our country.

The shot gun approach of placing oceanographic tools in the hands of the lowly as well as the mighty and recognizing the needs of local agencies and institutions as well as those of national reknown will yield big dividends. Both the small truck gardens and the vast wheat ranches are needed in producing agricultural crops and I think the production of marine crops will be analagous.

Sincerely yours, William A. Smoker,

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STATE OF CALIFORNIA DEPARTMENT OF FISH AND GAME 722 Capitol Avenue  
Sacramento 14, California March 7, 1962

Dear Dr. Chapman:

In reference to your inquiry of December 25, 1962, I am very happy to be able to comment upon the four points listed in your letter. In general I have agreed with your philosophy and feelings on the matter. There are a few areas of differences and I have commented on them appropriately; in some cases in generalities that apply to all four points and in others only to specific conditions mentioned.

Item I. To discuss and define the subject of fisheries oceanography. I am perfectly happy with the term oceanographer as used to describe one who studies the ocean, its boundaries, and its contents. Fisheries oceanography, to me, would imply a greater specialization dedicated or directed toward the specific study of the oceanographic phenomena as it relates to the behavior of the fisheries organisms under investigation.

For example, oceanography in its broad sense can be a study of all of the ocean and its contents. It can be more highly specialized and deal strictly with the organisms and the physical phenomena surrounding these organisms. Under question, a fisheries oceanographic study would be designed to gather physical, chemical, and other processes, but would be more or less limited to an area associated with effect upon the species being studied.

Item II. As undoubtedly you will be obtaining answers to :What has fisheries oceanography accomplished?" I will answer only for those specific studies that have been conducted within the sphere of my own researches. These are in the area of the soupfin shark. the California trawl fishery, the California shrimp fishery, and the international dabbling with the transplantation of salmon to Brazil and a species of fish from Brazil to California.

- a. The specific oceanography of the area surrounding the soupfin shark indicates its preference for waters of certain conditions during part of the year, and its bi-sexual differentiation into waters of other conditions during part of the year, Thē results are related to the oceanographic conditions and are associated with other biological factors such as food abundance and wave shock

ecology, which in turn are related to oceanography as well. It was interesting to watch the relationship between the organism and its vitamin content develop over a period of time. This was biological, but the fishery itself operated strictly with practical oceanographic understanding.

b. In the trawl investigations we were able to associate the distribution of certain species of bottomfish by time and space. These were related to temperature and other oceanographic conditions. There is considerable information relative to their embryological and sub-adult distribution associated with oceanographic conditions. However, specific studies of the particular species should be conducted to tie all the conditions together. This would partially cover the issue raised by Question 3.

c. In the California shrimp fishery a closely correlated relationship between the habitat oceanography of the shrimp and its distribution became evident during the investigation. An intensive ecological study was made on a shrimp bed off Morro Bay and the detail of the organism's relationship with its environment was established. Using this information as a base, habitat locations that met the conditions up and down the coast were then plotted. As sea time was limited, we selected the promising areas where shrimp would probably be found. On the exploratory cruises it was possible to go almost directly to all of the discovered shrimp beds on that first cruise. This is a specific testimony to exactly what fisheries oceanography can accomplish in the way of development of resources.

d. Salmon to Brazil. When I was with the FAO in southern Brazil the Brazilian Director requested that I study the possible importation of fish that might be adaptable to that country. The available data showed similarities between southern Brazil and California in the environmental conditions on land and at sea. The oceanography, current systems, and estuarine conditions indicated that the potential was quite feasible for salmon. It is being followed up by the Brazilians but unstable political conditions have caused some "atraplhacao"(impediments). The mutual international relationships of the cooperating countries can be benefitted both politically and sociologically by studies of fisheries oceanography. Item 3. To state what fisheries oceanography should be trying to accomplish. The examples given above are those of development of answers to specific problems, and to the accomplishments that a hand-in-hand fisheries oceanographic study can produce. They are small-scale operations; however, even large-scale operations are nothing more than a series of small-scale problems tied together. With the unraveling of the woof and the warp a pattern becomes apparent. Fisheries oceanography in its broad sense should attempt to determine the interrelationships of the organisms in the ocean with conditions therein. This is usually more likely to be done on those species specifically subject to commercial exploitation.

However, a broader understanding of the total biological complex in its entire environment is necessary to basic understanding of even the commercial species.

In a limited sense, however, the objectives of the study determine the extent of its coverage, and these objectives and their potential should be clearly delineated in any prospectus.

The broad weather processes are factors in any study. Information of this nature should be compiled with thought given to its application in a wide variety of programs that have use for it. A broad basic plan of weather data should be organized. So should a similar program on physical oceanography. These would contribute to many studies conducted on the various specific fisheries, and would eliminate the need for much "replowing of the same ground". The same good organization of programs would apply to the fisheries efforts so that all collected data would be of complimentary use to other studies whenever possible.

If organized in such a broad manner, application of some or all of the data could be expected from all studies conducted. As things are now, results of specific studies are often only applicable to the problem at hand. Meanwhile the data might be just the "key" needed by some other worker in a similar or dissimilar field. Science is professed to be "organized knowledge", but sometimes its practice is pretty "disorganized".

Item 4: To state what progress is needed in other sciences so that the aims set out on Item 3 can be obtained.

Other than organization of systemized knowledge mentioned above, probably most needed in science is detailed instrumentation for determining the three-dimensional behavior of the physical oceanographic processes in the ocean. Present methods of obtaining such information are so grossly expensive that it cannot be obtained when needed for many investigations, or is limited to certain objectives. The necessary data will have to be obtained simply -- it will have to be obtained in quantity -- it should be related to time, place and need. Macroclimate and microclimate data would have specific application.

Likewise, large phenomena occurring throughout the ocean would have to be correlated with the little anomalies associated with the distributional behavior of species. The relationships of the oceanographic processes, and the recruitment of survival of organisms should be studied more adequately. The biological techniques will have to be speeded up. Mass studies cannot be conducted with minor techniques not satisfactorily geared to quantitative measurement. Dissemination of data will have to be prompt, widely distributed, analyzed, and used cooperatively.

Much information will have to be ground into fine powder and the dust needs be assembled into the proper form and cast and shipped to those requiring it. The artifacts then can be segregated into their size, power, and temporality. ---Amen---Sincerely yours, W. Ellis Ripley  
Assistant Chief, Marine Resources Branch

UNIVERSITY OF CALIFORNIA, Scripps Institution of Oceanography,  
La Jolla, California

March 8, 1962

Dear Dr. Chapman:

Response to your letter of December 25, 1961 is difficult. Although I have been on the periphery of the fisheries field for several years, I feel singularly unqualified to comment in a very general fashion on the points you outline. In respect to the definition of the subject of fisheries oceanography, I feel only SCOR can do that. The definition would vary with what they might be trying to accomplish.

In respect to what fisheries oceanography has accomplished to date, once again I feel unqualified to respond. I am not overly familiar with the literature in the area. My experience with the STOR program and the ATTCgroup leads me to believe that, as field approaches, these might serve as models for long-range investigations.

My feeling in respect to item 3 is that the prime aim of fisheries oceanography should be directed toward understanding of the fish themselves, rather than the ability of man to catch them. Knowledge of life cycle, breeding habits, feeding habits and food organisms at different stages in the life history, metabolic efficiency, and ecological relationships with other organisms are all areas in which much fundamental knowledge is desirable. If the need to "farm the sea" arises, knowledge in the above areas and in genetics and physiology of the food organisms will be essential. Even in the absence of such a stringent necessity, the knowledge gained from such research would permit much more intelligent estimation of populations, suggest reasons for fluctuations in population size, and perhaps indicate when and how controls on fish catches might be limited.

As to information from other fields required to accomplish the above, several things become obvious. First is strong interdisciplinary exchange between the fisheries's scientists and physical and chemical oceanographers. Obviously, many of the areas outlined above will fall in the sphere of interest of other areas of biology as well. Thus, physiology of diving, energy metabolism, etc., can all help to achieve a better understanding of the fish themselves.

The best evidence I can give in support of the arguments advanced above is the terrestrial farming situation. Increased crop yields through use of hybrid stocks, chemical fertilizers, and crop rotation came about through knowledge of the biology of the crops themselves. Beef cattle, sheep, and swine have been subjected to the same careful scrutiny to give maximum yields through judicious breeding, controlled feeding, and use of antibiotics.

I realize that most of what I have said is not directly applicable to the framework of your letter. I can only plead ignorance of the whole area of fisheries science, except in the most superficial sense, and hope that my comments indicate that I have given the problem some thought, Sincerely yours, W. L. Belser

UNITED STATES DEPARTMENT OF THE INTERIOR-Fish & Wildlife Service  
Bureau of Commercial Fisheries - Biological Laboratory, Stanford  
Dear Wib: March 9, 1962

This is in response to your letter dated December 25 requesting comments on the five-item term of reference given to the SCOR Working Group on Fisheries Oceanography.

1. To discuss and define the subject of fisheries oceanography. Generally, when a new term enters into the vocabulary of technical language, it is precisely defined by the first user and, as long as subsequent users adhere to the original definitions, difficulties in understanding do not arise.

The origin of the term "fisheries oceanography" appears to be shrouded in mist. My acquaintance with it arose indirectly from Townsend Cromwell's serious probing for the avenue of oceanographic research that would contribute most significantly to solution of the fishery problems facing the organization with which he was associated -- first POFI and later IATTC. In addition to searching his own mind, he proposed a seminar to bring together oceanographers and fishery scientists for discussion of this area. His untimely death occurred before a seminar was arranged. It was eventually organized by Maurice Blackburn and held at San Diego on June 17 and 18, 1959 as two sessions of the AAS Western Division meeting under the joint sponsorship of ASLO and ASIH. The published collection of papers from this seminar was entitled "Symposium on Fisheries Oceanography.: (California Cooperative Oceanic Fisheries Investigations, Reports, Col.VIII, Jan.1961).

In announcing the Seminar and inviting participants, Dr. Blackburn defined the term as: "any kind of oceanography required for the appraisal or exploitation of any kind of organism useful to Man." In summarizing the Seminar, Warren Wooster defined it as "the study of oceanic processes affecting the abundance and availability of commercial fishes." This indeed is a characterization of the papers presented at the symposium, but definitely more restrictive than Blackburn's. And, in my opinion, Blackburn's is too restrictive.

In fact, I think the term "fisheries oceanography" itself is too restrictive (besides being ungrammatical). Fishing denotes predation by Man and this should not be a necessary precondition for studying the living resources of the sea. Oceanography implies operational restriction to the Sea. I do not think the study of the atmosphere or of molecular biology should be precluded if either holds promise for understanding the ever-changing environmental conditions governing the abundance, distribution and behaviour of any of the organisms making up the living resources of the sea, or any other attribute of these resources that might be significant to their use (actual or potential) or non-use by Man.

If we knock out both words we are left with no term to express the

concept we are talking about. Being unable to conjure up words that suit me better, I will go along with "fisheries oceanography" (but couldn't we dis-corrup it to "fishery oceanography"?) and try to tinker up Bläckburn's definition to conform with my concept. As a first try, with reservation of future privilege to tinker further, I suggest:

Fishery Oceanography--the study of living resources of the Sea and of natural phenomena directly or indirectly influencing them in manner potentially or actually significant to their use by Man, including any information gathering needed for such studies.

This is intended to exclude the study of the effect of fishing on a resource according to the classical density-dependent model but to include study of the density-independent influences on a resource even though the latter may be responding simultaneously to exploitation according to the density-dependent model, It is intended to exclude study of any organism that is not potentially a resource but to include the study of that organism if it is a significant part of the environment of a resource organisms. It is intended to exclude studies of natural phenomena offering very remote possibility of being influential on the immediate environment of resources, (such as the topography of the back side of the moon) but included the study of phenomena once or twice removed from the immediate environment, such as the variations in atmospheric circulation, or perhaps the pulses of energy emitted by the sun, if they seem likely to significantly influence the conditions in, or movements of, the ocean waters containing the resource.

This is a conceptual difinition, laced with motivation. Operationally, the kinds of research and survey undertaken in fishery oceanography would depend on the state of the resource, its nature, and the problem requiring solution.

Generally speaking, in areas of undeveloped resources it would consist of describing the average physical, chemical and biological structure of waters and their circulation both horizontal and vertical, in the several seasons of the year, and the topography and character of the sea bottom and shorelines, all with view to identifying the potentially productive areas and the mechanisms involved in their productivity. In areas of developed resources, the at-sea work would be directed toward monitoring significant departures from average conditions, identifying their causes and ultimately predicting them. The at-sea work might often need to be supplemented by experimental and analytical work in the laboratory on the environmental requirements of organisms, their physiological and ethological responses, etc.

Still generally speaking, fishery oceanography for the most part would deal with the upper layers of the ocean, in which the primary organic production takes place and where most resource organisms live, and, incidentally, where most of the physical, chemical and biological properties are subject to rapid change in time and space.

Its geographic scope might be very local, as in an estuary, or very broad, as in the study of perturbations in ocean-wide circulation systems.

From the above, it is quite obvious that my concept of situs and subject matter of fishery oceanography is almost as broad as those of oceanography itself and differs from it only as to motivation. Here, even, the distinction is not clear. At the research or "expedition" level the personal motivation may be simply "wanting to know", while the fishery motivation resides only at the level of providing the opportunity for persons or groups of persons to satisfy their "wanting to know".

So it all boils down to the simple idea that fishery oceanography is the oceanography that gets done because Man's utilization of biological ocean resources, or his desire to use them, raises questions that oceanography has not answered, and is not likely to answer, without direct or indirect intervention by the resource users. Generally these will be tougher questions than the free-wheeling, academically supported, oceanographer usually undertakes to answer; and are likely to require long-sustained teamwork rather than spurts of individual effort. Many of the fishery-inspired questions require, also, continuity of observation through long periods of time.

Perhaps the remark Henry Stommel included in his book on "The Gulf Stream" is germane here. He wrote:

"Many catastrophes of an economic kind, such as the failure of the rice crop in Japan, or of a certain fishery, or years of unusual numbers of icebergs in shipping lanes, are attributed to fluctuations in ocean currents. Very little is really known about such fluctuations. It takes years of careful and expensive observation to produce even a very crude description of them. The scientific programs of our oceanographic institutions are not geared to long-term problems of this kind; there is much pressure for novelty, much temptation to follow the latest fad, and a persistent though erroneous notion that all worth-while problems will eventually be solved by some simple, ingenious idea or clever gadget. A well-planned long-term survey designed to reveal fluctuations in ocean currents would be expensive and time-consuming. It might even fail, because of inadequacies of the tools we have at hand. But until this burdensome and not immediately rewarding task is undertaken, our information about the fluctuations of ocean currents will always be fragmentary."

2. To state what fisheries oceanography has accomplished.  
Here I shall comment only in U.S. -based activities. Under my definition of it, fishery oceanography accomplished much of the "modern" oceanography that was done on the Atlantic Coast of this country prior to the establishment of the Woods Hole Oceanographic Institution.

Bigelow's "Physical Oceanography of the Gulf of Maine," "Plankton of the Gulf of Maine" and "Fishes of the Gulf of Maine" were based almost entirely on sea work done from vessels put at his disposal by the old Bureau of Fisheries. And his monographs so well covered this piece of the ocean that practically all the oceanographers at the new WHOI immediately went on to bluer sea areas. According to my recollection, Redfield was the only one who continued a substantial effort in the Gulf of Maine as he studies the relationship between the circulation and the life-cycle of certain plankton organisms in the Gulf of Maine. More recently, fishery oceanography was resumed here and on the shelf waters south of Cape Cod directly by the Bureau of Commercial Fisheries and indirectly through contract with WHOI.

On the Pacific Coast, T.G. Thompson and associates' early investigation of the circulation in the Gulf of Alaska was inspired and supported by the International Halibut Commission. That organization needed to know whether the halibut spawn and fry were drifted. At Scripps, under the directorship of Sverdrup, fishery oceanography was well under way in collaboration with the California Department of Fish and Game and the U.S. Fish & Wildlife Service before the war. After the war it was resumed at Scripps' MLR program, again in collaboration with F&G and FWS. It has now documented events in the California Current area through more than a decade with comprehensiveness and continuity unmatched anywhere except perhaps in the Japanese coastal and off-shore area where much of the work also is fishery inspired and supported. POFI's program, entirely with fishery motivation, defined the equatorial mid-Pacific tuna resources and the oceanographic mechanisms involved; and in so doing, led to the discovery of the Cromwell Current. Similarly it defined the Central North Pacific albacore resource and the oceanographic mechanisms operating there. More advanced kinds of fishery oceanography are being continued at the Bureau of Commercial Fisheries Biological Laboratory at Stanford and are throwing light on the more subtle aspects of mid-ocean climate and circulation and the fluctuations thereof. Fishery oceanography practiced by the Inter-American Tropical Tuna Commission and by the Scripps Tuna Oceanography Research has defined and, to a considerable degree, elucidated a number of major oceanographic features underlying basic productivity in the eastern tropical Pacific. The activities of POFI, IATTC and STOR, in the aggregate, have laid to rest the old notion that: "The tropical ocean is a biological desert." Indeed, it appeared from their work that the equatorial zone around the world, with its special mechanisms for vertical circulation and the rapid turnover in its biotic cycles, may rival the better known and more intensively exploited temperate ocean in its basic productivity, if not in its yield to Man.

NORPAC and EQUAPAC are novel examples of an international effort

where those in fishery oceanography and those in "just" oceanography joined forces to produce semi-synoptic charts of the physical, chemical and some biological properties over larger sea areas than ever before covered.

Fishery oceanography practices by western European countries, Canada and latterly by USSR may have had an equally or more productive history, but I will leave the recital if this to better-qualified persons.

3. To state what fisheries oceanography should be trying to accomplish.

In general:

a. Participate in oceanographic survey programs to insure that the mensurable biological properties are mapped for the several biological seasons of the year. Such properties include (1) oxygen (2) topography of the compensation level, (3) productivity ( $C^{14}$  uptake), (4) standing crop of phytoplankton (Chlorophyll A), (5) of microzooplankton, (6) of mesozooplankton, (7) of macrozooplankton.

b. Participate in establishment and maintenance of networks of deep-anchored, unmanned, instrumented, oceanographic and meteorological stations to insure that such networks include stations strategically placed to provide monitoring of the environment of significant ocean resource areas, and are instrumented to measure biologically significant properties.

c. In furtherance of the above, (1) establish international standards for biological measurements, (2) develop instruments for measuring biologically significant parameters

In particular:

d. Study areas as dynamic systems wherein the physical, chemical and biotic interactions operate as factories for producing organic matter.

e. Study special situations associated with concentrations of marine organisms, such as current boundaries, eddies, convergences, oceanic fronts, oceanic islands, sea mounts, etc.

f. Study special processes for recharging the upper mixed layer with essential nutrient salts, such as seasonal overturning, upwelling, ridging and doming, shearing, foci of horizontal and vertical divergences, etc., and how they vary with time under direct or indirect influence of meteorological perturbations of short and long periods.

4. To state what progress is needed in other sciences so that aims set out in 3 can be attained.

By and large, the physics, chemistry and biology of the ocean have been studied in the steady state and the theories employ the equilibrium model. There needs to be developed observational and analytical techniques applicable to states of disequilibria.

Especially needed for solving resource problems is information

which might be gained in the laboratory by applying the techniques of experimental zoology to determine the physiological and ethological responses of marine organisms to those elements in the ocean environment that may be thought to govern their distribution, migration, reproduction, mortality and aggregational behavior.

5. To communicate the statements listed above, through SCOR, to interested laboratories and organizations.

I suggest that there is special need for inter-communication among fishery oceanographers and other marine biologists leading to standardization of methods of measuring and reporting the biological parameters listed in 3a. This need might best be met through a series of working group meetings, first at the national level, then the regional level and finally at the world level.

Please note that I have not fully used the 30-day grace period I claimed. With best regards, O.E.Sette, Laboratory Director.

Dr. Sette reply to a letter from Van Camp Foundation  
UNITED STATES DEPARTMENT OF THE INTERIOR, Fish & Wildlife Service  
Bureau of Commercial Fisheries, Biological Laboratory, Stanford  
March 16, 1962

Dear Wib:

You may find the enclosed excerpt of interest and pertinent to your SCOR Committee on Fisheries Oceanography, Best regards,  
O.E.Sette, Laboratory Director

Excerpt from Annual Report of the Fisheries Research Board of Canada 1960-61, p. 124.

"Oceanography for fisheries is a study of environments and of the fundamental processes in the oceans that related to these environments. The cycle of life in the sea is an intricate process and fish are one of the products. In order to live in the sea, the fish require oxygen for their respiration processes, and food for their survival and growth. Also, required is an environment suitable to the species. The sea is, in the main, always in motion, and it thus provides transportation, both in the vertical and horizontal for fish eggs and the non-swimming larvae. Thus fish are subject to the vicissitudes of currents or lack of currents in the sea, of its temperatures and saltiness, of its poverty of food or its plenty. The cycles of fish abundance or the variations in availability are related in one way or another with the many variables that enter into the cycle of life in the sea. The energy that is transformed into growth in the sea is received in a given area from all directions, north, east, south, and west; through the air-water interface at the surface; and from the mud-water interface at the bottom. This means that real understanding of the biological problems of the fisheries can only develop from a knowledge of the large scale ocean processes. Hence the progress of fisheries oceanography will depend not only on specialized studies

of specific species and areas, but by an expanded program of the oceanography of the larger ocean processes."

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UNITED STATES DEPARTMENT OF THE INTERIOR Fish & Wildlife Service  
Bureau of Commercial Fisheries North Pacific Fisheries Exploration &  
Gear Research 2725 Montlake Boulevard, Seattle 2, Washington

Dear Dr. Chapman:

March 12, 1962

I approach your letter of December 25 with some reluctance -- not from a lack of courage to express opinions, which will no doubt conflict with those of your other contributors, but from a feeling that I cannot adequately express them in time available. Regardless, I shall jump in with both feet if for no other reason than to demonstrate that a diversity of opinion does exist. If you have already resolved the questions at hand and are waiting for a flow of votes to confirm your ideas, then perhaps the following can swing the tide toward what we consider a rational approach to fisheries oceanography. You can dismiss all this as nonsense by classifying the author as irrational and therefore not capable of presenting a rational case.

In answering your questions I am attempting two goals: (1) to present honest answers, and (2) to provide an answer which equals in size the latter received.

1. The definition of fisheries oceanography. Of the four questions asked, this will obviously receive the most varied answers. In my opinion the question is really of little importance, and I doubt that the reams of paper (to which I shall add) will contribute anything to the field. It will in all probability only confirm your suspicion that no two people are talking about the same thing.

My definition is derived from a simple dissecting of the words "fisheries" and "oceanography." Oceanography, the scientific investigation of oceans, does not in itself constitute a single science but is a complex, that is, oceanography does not stand alone (at least, not yet) as a particular science. To me, oceanography is physics, chemistry, geology, meteorology, biology, etc., as applied to studying the oceans. The adjective "fisheries" indicates that these particular sciences are directed towards an understanding of existent ocean animal resources which are or have the potential of being harvested. Under this definition fisheries oceanography would seem to be an assemblage of sciences which can be applied directly or indirectly in achieving a fundamental understanding of fisheries (I use "fisheries" in the broad sense to include all marine animals). The key to my definition is the word "fisheries" in that it directs the scientific endeavor towards a particular portion of the spectrum of oceanographic studies, that is, ocean resources. Heaven forbid, but there seems to be a faint odor that fisheries oceanography as I have defined it has some applied objective in its broad concept!

There are many oceanographic projects underway which are providing information to fisheries, but a large number of these would not fall under oceanography. This does not intimate that the programs are not of considerable value, but merely that these scientific endeavors are not directed towards or designed with the intent of providing answers

needed for better understanding of fisheries. For example, it is easy to demonstrate the value of a general oceanography survey designed to provide descriptive data on current patterns to fisheries, but it would take a long stretch of the imagination to bring the MOHO project under my definition.

The fisheries officer or agent who lends support to fishermen in such matters as where to fish, or perhaps even how to use an outboard motor on a dugout canoe, is excluded by definition, although in all likelihood he may be an extremely important cog in making fisheries oceanography pay off. People in this group who may have little or no scientific training can play an important role in dissemination of information obtained from more sophisticated research programs, If there is to be any real value to mankind and those responsible for exploiting fisheries are to be sensitive to the value of fisheries oceanography, there must be a chain which allows information to feed back to the fisherman.

2. What has fisheries oceanography accomplished? Here the cheese becomes more binding and my statements perhaps more irritating. I should like to divide this question into two categories: (a) what has fisheries oceanography accomplished and contributed to development of fisheries themselves, and (b) what has fisheries oceanography accomplished and contributed to the field of science? I, for one, do not believe that fisheries oceanography as practiced in this country (especially by government agencies) has been particularly effective in making any contributions which have been of value to fisheries (there are some exceptions to the case). In many instances certain aspects of work perpetuated under the cloak of fisheries oceanography have actually been detrimental to a progressive attitude towards development of the U.S. fisheries.

Unfortunately, many of the "biologists" enter the field brain-washed with the idea that they have been trained to manage fisheries, that this means they must recommend regulations, Conservation (to them) means: decrease the harvest, minimize the effort, and preclude efficient fish catching devices. All too often I hear from fellow colleagues something like this: We must hurry up and regulate some particular new fishery before it gets large and economically wealthy and thus in position to assemble political resistance to regulation.

There are but a few good, concrete examples which indicate that fisheries oceanography has benefitted fishermen. Fisheries and fishermen seem to go on their way, carrying out their activities, unaware and uninterested in the bulk of fisheries oceanography work being conducted around them.

I think that this lack of accomplishment in our country results from: (1) a rather narrow myopic attitude toward the science of fisheries oceanography (by many biologists), (2) many of our programs have not been sufficiently thought out to provide any fundamental answers to fisheries, and (3) and probably the most important, governmental agencies

generally consider that fisheries oceanography should deal with control and management of resources--and not expansion, diversification, development, and understanding the resources.

In this country we have not attempted to understand the community of organisms and resources available, their overall distribution in time and space, nor processes controlling distribution, numbers, or behavior. As a result of our heavy emphasis on management and control, an attitude has developed among much of industry that most of the ocean's resources are over-harvested and that there is little opportunity for expansion and development.

In spite of this, fisheries oceanographers in some areas have made good contributions to the knowledge and understanding of fisheries resources. Because of the stress on management, there has been some excellent work in the field of population dynamics and life history.

3. What should fisheries oceanography be attempting to accomplish?

Of course, this will depend upon the definition one has stated for fisheries oceanography. By my definition, fisheries oceanography should be attempting to provide facts which will help us to understand marine resources. Here we need a much broader understanding of the resources. If fisheries oceanography beyond the realm of population dynamics and rational use of resources is to make a real contribution to mankind (and one must assume it can), the studies undertaken should provide facts to those responsible for harvest. These facts should include descriptive information on what resources are available, how they are distributed in time and space, what factors cause them to express certain behavior patterns, how the animal community or certain facet thereof reacts to non-conservative environmental features, and finally, what techniques, methods, and fishing patterns will allow efficient and lasting use of the resources. This would seem to require the following program:

(a) A study of the use and effectiveness of existing sampling devices and development of new devices which are or could be used to quantitatively sample the ocean nekton. This seems an extremely important field and one that has been grossly neglected. There is little doubt that the biological oceanographer is now groping about attempting to understand distribution of organisms without really effective quantitative sampling devices.

There is the problem of differential susceptibility of almost every organism to most sampling devices now used, and even a problem of differential susceptibility of the same organism at different times of the year and different stages of its life. This difference in susceptibility of organisms increases as we go up the trophic levels. I refer to it as the animal's coefficient susceptibility (to a particular sampling device). We will have to resolve many of these problems before any quantitative studies of either inner-or intra-organism abundance can be objectively evaluated. With the larger nekton we have the problem of merely designing systems of capture. If we are going to describe the distribution of organisms

in time and space, we certainly must get busy and develop tools which can accomplish this.

(b) There needs to be an increase in general surveys of ocean resources. You can call this exploratory fishing or any other term that suits you. It seems almost pathetic that we should discuss attempting fundamental understanding of fishes and their environment if we do not effectively make a census of the distribution and abundance of our resources.

We can speak in glowing terms of the benefits of understanding aspects of non-conservative ocean properties as related to fish distribution, but this is only a sham if we do not attempt to determine the real distribution of fish themselves. Symptomatic of all current fisheries oceanography programs attempting to establish such relationships is that they are more effective at monitoring water properties than they are the fish (especially at the higher trophic levels).

One can take Dr. Ahlstrom's approach and say the simplest method of measuring fish distribution is to sample them during their passive stages. This does provide an essential part of the picture, but one does not have to be in the business long before realizing that the distribution of eggs and larvae are seldom analogous to distribution displayed by adults, and that the oceanic properties to which the young may be sensitive may differ considerably from factors which direct adult behavior and distribution.

I am convinced that one of the basic contributions the Bureau can make to the field of fisheries oceanography is a more adequate survey of our resources. Unfortunately, I do not think that you have supported exploratory fishing in this country very enthusiastically.

I suspect this attitude is largely a hangover from the rather unfortunate experiences and attitudes which developed in the Bureau during the initial period when exploratory fishing was formulated. Thinking back, I would generally agree that we jumped into the business in a rather haphazard manner, that the embryo was nursed by people who had little or no training for such work, and most important, there was almost a complete void as far as leadership was concerned.

During the past ten years there has been a considerable maturation of our group, upgrading of academic training, and a realignment and direction of our approach to fisheries oceanographic problems. In my opinion, the hard core of workers that exists on the West Coast (in exploratory fishing) are well trained academically and have a more progressive and imaginative outlook with respect to marine explorations than any group in the country (we are biased, of course). Regardless of who does the work, the problem of resource survey and distribution of fauna in time and space is really one of the most important "firsts" which must be accomplished. We cannot really hope to have sophisticated analysis of resources trends if we do not know how they are distributed in time and space.

(c) Intensify physical and chemical oceanographic observations. It is obvious that we need considerable programming of oceanographic research which seeks to provide descriptive information on changing physical and chemical features of the ocean. Such oceanographic surveys need to be integrated closely with biological programming. The data thus may be used by fisheries workers in interpreting distribution, abundance, or behavior patterns, (presuming the biologist can uphold his part of the program and measure these). They also could be of value in planning further fisheries explorations. Here one needs to assume considerable caution with respect to planning explorations as related to environmental features. For example, general fisheries explorations need not be conducted in areas having high primary productivity to produce good results. In the fisheries business one cannot overlook the fact that harvest of a resource is governed by economics and that a produce of high value may be dispersed through an area of considerably low productivity and still make contribution to the economic welfare of an area.

(d) We must expand fish behavior studies. Studies of this type are in their infancy and appear to have considerable promise. I refer to the work of the type that Dr. Magnuson and Gerry Howard's group have initiated.

(e) Instigate more work of a basic nature as to the more subtle relationships between the ocean, the atmosphere, and the interaction of these systems.

I shall not attempt to comment on your question 4 because by my definition, fisheries oceanography includes all sciences which are required in understanding ocean resources. I suspect we do not need to worry too much about advancements being made in the fields of chemistry, physics, and mathematics. The demands on these sciences for military and industrial uses will keep them ahead of the pace we can set in the field of biology.

General Comments: - - I am under the impression that there is a great deal of confusion in the minds of the vast horde of fisheries biologists as to just what oceanography outside of fisheries biology contributes to our understanding of resources. The word oceanography has become a magic wand to many who see it as a panacea to all their problems, especially financial. There is no doubt that many have pulled themselves to the bosom of oceanography for no other reason than it is the popular and academic thing to do. They are not quite clear how it will resolve any of their particular problems, but they do know that it appears to be the winning team at the present time. I think this is rather unfortunate, especially for the biologist, because his confusion has in some instances led him to abandon his own field of endeavor to cling to a number of new sciences for which he has only a cursory feeling. These people will get little out of the expanding oceanographic program other than monies.

Those who understand that the expansion and development of fisheries oceanography offers only more tools and more windows to peer through, and that these tools must be handled correctly, will be able

to enhance their research programs, The answers will not be easier, but will require the integration of more talent and a consideration of broader concepts. The value of fisheries oceanography to fisheries can be greatly enhanced if we understand the limitations and value of research in these allied sciences, but not if we cling to the contemporary illusion that all problems are solved by praising Allah, Kennedy, and oceanography. Sincerely, Dayton L. Alverson,  
p.s. I think I achieved my first objective but failed in #2. 50/50

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UNITED STATES DEPARTMENT OF THE INTERIOR Fish & Wildlife Service  
Bureau of Commercial Fisheries Biological Laboratory, 2725 Montlake  
Boulevard, Seattle 2, Washington March 15, 1962

Dear Dr. Chapman:

I am in a very unfortunate position--not only is this reply to your query on fisheries oceanography late, but also, your letter was left behind in Seattle. Thus, here I am in the middle of the Pacific Ocean up to the ears in water, but unfortunately, only up to the toes in salmons, and I can only remember several of your questions.

First, I think we should look at the field of oceanography. It is, of course, striving for acceptance as a science. However, because it is such a blend of so many sciences, people are reluctant to dignify it with a specific name, and prefer to group its work with extensions of several other recognized sciences; thus, resulting in the all inclusive title of marine science. This is not fair, because what are the criteria necessary to establish a new science? Is it not the existence of natural or physical phenomena of sufficient scope and complexity to require special study, new approaches and methods not available in existing science? The fact that it benefits mankind directly, indirectly, or at all, is not a necessary condition.

Now, what makes oceanography such a mixture that one tries to mask it under the title of marine science? First, the ocean is at present relatively inaccessible and it is expensive to conduct cruises. Thus, everyone attempting to justify the expense tries to do as much work as possible in the various fields -- biology, geology, chemistry, etc. Second, but perhaps as important as the first, we know so little about the ocean everyone is trying to interrelate his own work before he completely understands it himself, In other words, everyone is grasping at straws, looking for boundaries, thresholds, and drastic changes.

Its becoming very obvious that there are no sharp boundaries in the ocean--only transition zones; that the surface layer has a definite seasonal cycle and the intermediate and lower layers have relatively permanent characteristics. Of course, there are fluctuations, but we are gradually defining the basic oceans.

Oceanography is passing through a descriptive phase into one of a geophysics category. This is a good, necessary and logical sequence of events. One might even say the exploratory phase is over. A good

descriptive oceanographer no longer wants more hydrocasts; he wants observations to the bottom, direct current measurements, knowledge of depth of motionless level and barotropic flows, etc. (Likewise, the biologist no longer wants more samples, but replicate samples over a twenty-four hour period). But one should be cautious. The exploratory phase has given us some knowledge of the ocean and we have made some gross and perhaps some erroneous conclusions, but with advances in theoretical studies, the descriptive phase will dominate again, and blossom out into a predictive phase. This is the end result we all are looking for, but which certainly is impossible with our present tools.

I have covered two of the three aspects of ocean studies I consider important--geophysics and physical, descriptive or plain oceanography. I distinguish between these two because it is not likely an individual would be interested in both aspects. A geophysicist does not have time, under present conditions, to go to sea or tabulate data; I dare say he abhors the real ocean and prefers infinite, rectangular or triangular oceans that conform to his mathematical gymnastics. This work does not aid natural studies, but provide basic tools. However, the oceanographer must recognize the useful tools from the absurd ones and bring the real ocean into focus.

I can imagine the same procedure occurring in meteorology --- man predicting weather from several reporting stations, and gradually increasing the number of stations until the forecasts became more complex and perhaps more erroneous. Then, he reverted back to more theory and finally reached the present state of the art, where meteorology is accepted in its own right and the field is dominated by meteorologists, not physicists or mathematicians, I think oceanography will follow the same pattern.

If I recall correctly, the serious study of the weather began by the French in the late 1900's after the complete destruction of a naval task force by a sudden storm. And it is obvious today that the science enjoys its present popularity because of the air and space age.

Today oceanography is realizing most of its support from the Navy as a result of interest in anti-submarine warfare. Certainly fishing interests are accomplishing oceanographic work and dollar for dollar, accomplish one hell of a lot more than the Navy contracts. My budget probably wouldn't keep the Hydrographic Office in pencils and paper clips.

The point I'm trying to make here is that the terrestrial weather affects the crops and animals and the oceanic environment effects the phytoplankton, zooplankton and fishes. Yet, the agronomist or wildlife biologist doesn't require a meteorologist on his staff, because the weather is reasonably known and can be predicted. Perhaps some day so will the ocean.

Now, forgetting the digression on meteorology, since fisheries biologists are interested in the real ocean it is not the theorist, but the oceanographer they must be allied with. I don't mean the data collector or the data plotter, but the oceanographer who wants

to know what is going on in the real ocean. Who questions the tools he has to work with, and researches or encourages research into more adequate ones. Thus, marine biology is the third aspect of ocean studies and fisheries biology is a part of this group.

Too many biologists think that oceanography will be a panacea for all the problems in fisheries and expect too much from the oceanographer and too much from the ocean in the sense of boundaries or 'fences' for their populations, I refer back to the previous discussion of terrestrial crops and animals which grow or roam over considerable expanses of the earth.

We also are approaching the ocean problem backwards by saying that so many fish were caught here and none there; thus, is there anything in the ocean that would indicate the reason for the zero catch? In some cases there is and some cases not. But in many instances the negative result is only the result of trying to assess a population of fish by a certain type of gear.

For example, we are trying to find relationships between gill net catches of salmon and ocean conditions. The gill nets extend to a depth of 20 feet and we have evidence salmon exist at depths of over 200 feet. Obviously, we must be able to determine the entire population at any one station not just the net catch.

It should be clear that not only the oceanographers, but also the biologists have their problems. There is more than enough work for both, and it is almost impossible for one person to attack both problems except in a superficial manner and we have enough of this type of work at the present time.

We need time and cooperation, but first of all, time. Look what has been accomplished in the last five years. We had only fragmentary knowledge of the North Pacific Ocean. It required a shipboard crew of at least 6 watch standers and several chemists as well as a laboratory staff six months and sometimes a year to process data before it could be analyzed. Today, with salinometers, data can be processed as soon as it is taken and IBM procedures permit tabulation of the more laborious calculations within a day or two after the cruise ends. A present Navy instrument suite calls for a probe which, while being lowered, feeds data directly into a computer providing instantaneous data, computations and compilations. When perfected, this will do away with sea-going technicians, chemists, etc. In poorly-charted or-known areas an oceanographer may be required to interpret the data, but in regions more completely understood, specific fronts, water masses, etc., could be easily identified or categorized so the biologist or fisherman could find them.

I realize that many other advances have come as a direct result of your efforts and can understand your questioning why fisheries must contribute so much to the advancement of a separate science and my only answer to this is that oceanography is a very competitive, almost hostile field, Everyone wants to discover something, but no one wants to do the work. Everyone wants money, but doesn't want to be responsible for accounting for it. Everyone downgrades the general tedious

oceanographic field work that provides insight into many of the present breakthroughs. For example, Fofonoff's work on ocean transports would have little meaning without the supporting data to show that it bears some relationship to the real ocean.

At this point, I feel that I have rambled on long enough and must stop before a major rewrite is necessary. However, you asked for solutions as well as opinions. I think coordinated ocean surveys with observations extending to the bottom of the ocean are the only answer and the next step forward. But unless truly coordinated, they would be a waste of effort. I personally believe that as great a triumph as NORPAC was it was only about 50% effective without considering the fact that observations only extended to 1000 meters. Ocean surveys will show the oceanographers how much or how little he really can explain about surface movements and sub-surfaces features. During this period the biologist should expand efforts on determining populations by visual and sonic methods and perfect electrical, net or other techniques to capture the plankton and fishes. Then we will be able to consider predictions which I assume is our present goal.

I feel it a mistake to make an oceanographer out of a biologist or vice-versa, and the lack of understanding, sympathy or cooperation that exists is mainly due to a reluctance by each to admit to the inadequacies of his tools and methods. Time, and research will serve to close this gap, but I think oceanography, the study of the ocean as it exists, has a place in science and will survive. Sincerely, Felix Favorite

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FISHERIES RESEARCH BOARD OF CANADA Head office in Ottawa (Under the Minister of Fisheries, Biological Station, St. Andrews, N.B.

March 26, 1962

Dear Dr. Chapman:

Your letter of last Christmas day reached me at a busy time and became side-tracked as a result. Now I am replying well beyond your deadline but I cannot completely disregard the request of an old and admired friend. You will find my comments characteristically naive and brief, This may have advantages in view of my bad timing.

Fisheries oceanography is a study of the principles controlling the exchange of energy within the sea with the object of directing man's utilization of the organic constituents. The study includes physical oceanography, hydrography, plankton and productivity studies, fish life histories, population dynamics, etc., and impinges upon geology, meteorology, and even astronomy. I would not include engineering except as an incidental.

The definition given above is much broader than the usage at our station--it would include all we are doing and beyond--where, for convenience, the term covers the application of physical oceanography to various biological studies.

As workers generally we have not progressed far in meeting the requirements of the definition. We have completed a lot of useful background description and we have explored some theories. In some situations we have satisfactorily applied knowledge to production. We can explain phenomena but it is only rarely that we can predict with confidence. Is it too much to say that it is only by faith that we can consider ourselves closer to a comprehensive explanation of production or productivity? The situation seems to call for more information, more effective compilation (although good progress is being made) more imaginative hypotheses, and more physical resources available to use in testing them. It remains to be seen if we will be smart enough to test the right things, Good luck! Sincerely,  
J. L. Hart, Director

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DAVID MILLER LETTER Re: ur December 25, 1962

March 26, 1962

Dear Sir:

A definition, if it is to provide any useful purpose, must necessarily be simple. Although many workers are astute in their observations of living processes they are often confused and misled in the mere observation of words. If we must be defined, define us that we may understand what we are. Next, let the definition be sufficiently broad so as to avoid the exclusion of those who apply other disciplines, such as mathematics, physics, chemistry, etc., to fisheries problems. If NASCO's definition of oceanography is satisfactory and useful, let us call one who engages in the study of fishes within the confines of the oceans a fisheries oceanographer and let it go at that.

What indeed has fisheries oceanography accomplished? In point of fact, little, nor are the fisheries oceanographers wholly to blame. Early biological oceanography was largely descriptive in tone, and I might add, inspired in scope. Unfortunately the relative completion of descriptive biology on land was reached long before the oceans received popularity or endowment and descriptive work waned and was replaced by an ever increasing emphasis and homage to the physiological and biochemical aspects of life. Now, the observant naturalist is gone. And, at a time when the first and major task ahead is a description of the resource, if a resource is the mundane category under which the marine fishes must be considered. Emphasis in this field must return, and perhaps with it, respectability.

The bulk of fisheries oceanographers in this country are wards of the federal government. Among these men are a surprising number who feel that much basic descriptive work is yet to come. Further, they realize that the Federal Government does not and will not support this type of work within their own organization. Although high level administrators pay ever increasing lip service to basic research they do not in fact support it. Federal programs are almost wholly based on the temporary solution of industry imposed problems. Few, if any, are basic and long range in scope. There is here a pool of well trained, competent, and experienced (if disenchanting) scientists

whose usefulness is worthy of someones serious consideration.

It is extremely difficult for a person, such as myself, to begin to consider what fisheries oceanography should be trying to accomplish. More often than not the individual worker sees but a few problems beyond his current work. Often he must complete current investigations to determine the logical direction of his next step. This leads me to a profound scepticism of the ornate "master plan:. As with defining the field, I believe only the most flexible outline possible, Above all, the plan should not rest on a utilitarian base.

Let us not be dedicated to gorging a hungry world on fish. Let us study fish, not fisheries. I have witnessed, at first hand, the parasitism of two separate and distinct scientific organizations by their own non-scientific supporting services. Too late the individual scientists, upon whom the entire organization has been built, find themselves bound hopelessly in an unsympathetic administrative framework originally designed to serve them. Let us not become similarly enmeshed in an inflexible and unsympathetic "plan for progress".

Relative to my own work, which is the early life histories of marine fishes, I find an alarming lack of basic descriptive work, and little interest in the provision of funds to support it, This basic work must come first since the ultimate consideration must be given to the interaction in space-time of all species with each other and with their physical surroundings. Fundamentally then we must first know all the parts, then how they function as a whole, and then we may be in a position to predict, control, and regulate. To study in great detail any of the parts divorced from the whole puts us in the position of the blind men and the elephant, each of whom is hopelessly lost in trying to discover the nature of the whole from an isolated part. Admitting my inexperience in dealing with as broad a concept as you have proposed for my consideration, logic would compel me to appeal for a descriptive study of all fishes in all oceans. At the very least, such a survey would provide a firm footing for succeeding efforts.

I would have little concern for progress in related sciences at this time. What, for example, can we intelligently ask of them at this time? From the point of view of an outsider their house appears to be in better order than our own.

My apologies for being tardy in answering are humbly offered.

I am deeply interested in the opinions of others in the field in the above matters, as you are, and would hope to be made aware of them at some future date. Very truly yours, David Miller

\* \* \* \* \*

VAN CAMP FOUNDATION W. M. Chapman, Director 739 Golden Park Avenue  
Dear Mr. Miller:

To relieve your mind this Working Party is not aiming at producing definitions of anything that will restrict or inhibit the thinking or activity of anyone working in ocean research directed at fishery problems, nor are we in any sense dreaming up any master plan of ocean research of this nature. As near as I see it at the moment

we are serving some useful purpose as a sounding board against which widely separated workers in this highly diverse field can bounce ideas and complaints. What may come out of this I am as yet unable to see but from the replies I have had it is perfectly apparent that there is a lot more serious thought being given to these matters by the workers themselves than I had anticipated, and in my book it is a good thing in itself to lay this out on the table where folks can have a look at it.

As a former comparative osteologist interested in the broader aspects of ichthyological phylogeny you can well imagine that my sentiments rest with you. It is the general feeling amongst those who support research that the field of vertebrate osteology was reasonably well exhausted about 1890, at the time when a great many of the deep sea forms of high phylogenetic interest had not yet been discovered.

I am not quite as discouraged as you are however. I seem to feel that we are getting McKernan and Company, the Departmental Budget Officers, and the Bureau of the Budget types slowly convinced that there is something to fisheries work of a more long term nature than discovering the best material out of which to construct lobster pots.

It must be kept in mind that quite a number of generations of slaves held quite a number of bloody revolutions at various parts of the semi-civilized world prior to the concept of general emancipation being recognized. For your information even the study of fish eggs and larvae is assuming a certain indefinable aura of respectability in these parts, to the point where Ahlie Ahlstrom is getting a little more appropriations this year, and Reuben Lasker may even get some facilities with which to inquire into the physiology of the ilk before he trips over his flowing white whiskers and breaks his pick.

It may also be that the labors of agents provacateur such as this SCOR Working Party may speed this process.

Thanks for your cooperation. Sincerely yours, W. M. Chapman

\* \* \* \* \*

SMITHSONIAN INSTITUTION UNITED STATES NATIONAL MUSEUM, Washington 25, D.C.  
February 4, 1962

Dear Dr. Chapman:

I guess that you have given up hope of ever getting a reply from Waldo L. Schmitt to your stimulating letter of December 25, but this is it. It is not the only over-due answer that is being expected of me. I have been pretty well occuppied with a number of things that had to be done first. . . . .

1. Oceanography as a word, and as a recipient of generous support these days to my mind as you use it, gives the wrong impression and should not be linked in the way you do with fisheries. In such juxtaposition "oceanology" might be better. Charlie Fish urged use of oceanology, years ago because for years

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past, oceanography by the dyed-in-the-wool oceanographers has been restricted to physical oceanography, but in more recent days in the course of selling it, in search of financial support, they have dragged in a lot of other "things" because they listen well when "oceanography" goes before the appropriating powers.

Fishery biology should be the term. After all that is what you are concerned with. Oceanography as such supplies more the physical data descriptive of the physical environment in which your fishes and other marine animals find themselves.

The biology of any group of organisms encompasses all knowledge that can be dug up about it, life, environment, ecology, physiology, and a lot more. Why throw over a fine, respected, and long honored, all inclusive, term, for some small part or phase of it (such as physical oceanography).

Ecology is but a part of biology. From literature, though, you can easily get the impression that ecology is the be all and end all of biological science. It has become a "happy" term for getting support for often working projects for which you cannot get support under the correct label.

Don't you remember that Shelford once put forward the hybrid title, "Bio-ecology?" (What the heck, say I).

Cleave to Fisheries Biology. It is honest, even if, as it appears, it is not so popular. But it does take in all the other disciplines and lines of investigation that bear on fisheries and marine life and living resources of all degrees and kinds. Even collecting, and catching fish is well a part of biology, for it concerns populations, and also conservation.

2. I have said it before, and many times, the history of fisheries research is a long list of incomplete and unfinished investigations. In my humble opinion, one of the best and most complete "jobs" ever done in this field was Will Thompson's North Pacific Halibut study. What was not carried through, through no fault of Will's, was the working up of those wonderful, and directly comparable plankton hauls, other than for halibut eggs and larvae. (Banner did something on the mysids and euphausiids)

In this connection when you get them compiled, I would appreciate a copy of the listing of fishery accomplishments. There have been a number, most recent and outstanding perhaps, in development in the Pacific Skipjack.

3. & 4. To my mind these are inextricably interwoven. You know me, maybe not too well, but with all the millions being spent in oceanographical, and all other types of marine research and investigations, how many real, substantial, dependable, and up-to-date monographic works on groups of animals, large or small, or on the biology of particular species can you reach for on any library or laboratory book shelf?

There are an ungodly lot of little scattered papers but where are the really definitive, up-to-date works. Fowlers bulletins (U.S.N.M.) on the Philippine fishes, are not revisions or momographs, even so I've heard considerable criticism of them. Also a fairly recent survey of the parrot fishes, but why can't we arrange to have carefully consider-

record and reviewed in manuscript form by other experts before publication) monographic works?

Why? Because you can't get the money over a sufficient length of time for a conservative, serious, not making a head-line project. It takes time, some years of careful, earnest, conscientious, intelligent, understanding study in order to produce a worthwhile taxonomic-systematic monograph.

Priority should be given for a real working up of the fishes of the world by competent ichthyologists, or students with the right temperament and potential.

I have nothing against exploratory fishing operations, They are fine, and have been wonderfully rewarding. But the shrimp in the Gulf of Mexico, we knew that they were there in the old Portugas days of 20's and early 30's. If our qualitative collections could have been worked up, and been published upon; and studied by a fishery biologist for indications of potential fisheries, we would have had those great fisheries in operation years ago. No? And if the old Albatross collections in the North Pacific had been worked up and scrutinized for commercial possibilities in proper fashion, we could have led the Japanese to the American king crab fishery instead of being dragged into it by their enterprise.

There is still a wealth of important, useful and valuable information locked up in systematic collections everywhere. Johan Hjort once told me of the Norwegian shrimp fishery that was a result of his investigations. They turned up in his nets and, man of foresight that he was, the realization of the use that could be made of them more than justified the cost of running his vessel and laboratories; the Michael Sars, wasn't it?

Systematic collections need to be worked up, and if studied analyzed and evaluated for possibilities with foresight, vision, and some imagination, might then pay off the effort.

We who gather in, store, and curate specimens, and report on them when we can, usually piecemeal (I'm one of them) never are vouchsafed the time, often not the necessary facilities, and equipment, and last but not least even essential service, help, but especially, not the undisturbed time, for quiet serious study without a lot of other demands often routine, being made of us.

More systematic-taxonomic workers of competence are needed in permanent jobs with more time, support (help and financial) than is available for long-time studies (and monographs properly done are long time, other life time studies).

We need a "register" of the known species of animals, In the Museum we did make a small start (in Decapod Crustacea) but have never had time help and money to continue it. But I cannot expatiate upon it here today. I have a brief case full of urgent matters beside me on the table here at home; Monday I'll be back at the old grind in the Museum.'

Look in on us at the Museum next time you are in Washington. I'm at the "office: usually from 10-6, but would appreciate a little advance notice so that I can get you a couple of decent sandwiches; I have a hot plate, makings and trimmings for a pretty fair lunch. Rm. 324, Natural History Bldg. as you know 10th & Constitution-xt313, or leave message at xt457. Good luck best wishes. Sincerely, Walter R. Schmidt

FISHERIES RESEARCH BOARD OF CANADA, Head Office in Ottawa, (Under the Minister of Fisheries,) Biological Station, Nanaimo, B. C.

August 9, 1962

Dr. W. M. Chapman  
Van Camp Foundation  
739 Golden Park Avenue  
San Diego 6, California, U.S.A.

Dear Wib:

I am chagrined terribly to find that I have so long delayed replying to your very interesting communication of June 1st, re "Fisheries Oceanography", which you remind me is the second letter on the subject addressed to me, I must take your word for this, and that I do most readily, though I can find no trace of the epistle in my files and cannot recall ever receiving it. Of course, with "retirement" no doubt comes the possibility of lack of memory, and that sort of thing, so I will not lay myself open any further to any subtle scurrilous slurs or innuendoes from you.

I am a bit puzzled as to why you should expect any profound and shattering reverberations from me on the subject in hand, for I am only a humble biologist. But since you have asked for it, I shall unburden myself and you can take it or leave it - as I know you will anyway.

In the first place, I dislike immensely your subject, namely "Fisheries Oceanography", just about as much as I detest the term "Fisheries Biology", for, in my opinion, oceanography is the study of the ocean in all its aspects, of which the fish therein are but a part, albeit a small part in many respects. It is my firm opinion that while oceanography should embrace both physical and biological aspects, the oceanographers must first concentrate on the physical features and achieve as complete and thorough understanding of ocean conditions, the variations - seasonal and from year to year - and the causes thereof. Great strides have been made in recent years and great advances will be forthcoming in the next few years in our knowledge of water movements, temperature and salinity conditions and changes as brought about by weather, current influences, etc., but until the general picture is clearer, attempts to correlate the oceanic conditions to biological forms, other than in a very broad and general way, must be mere postulations, In other words, the physical oceanographers have a fairly long way to go yet before their findings can be intimately connected with biological phenomena.

On the biological side, much has still to be revealed concerning the reactions of plants and animals to marine conditions, their limits of tolerance to environmental conditions, their respiration, food assimilation, habits, transportation or locomotor activities and the like. We must know how they behave, how they react to the fluctuating ocean conditions, Studies must be carried out in the laboratory and under "field" conditions in order to get the necessary basic understanding.

The purpose, of course, of investigating the ocean and its fluctuating conditions is to "set the stage", as it were, for determining their effect on the development, well-being and final production of the various species of fish resident therein, We may not know yet

which factors in the ocean are most limiting, that is, which ones have the most influential fluctuations, but by studying the most obvious ones and relating them to the fish, we can get some idea of their significance and can get "leads" as to the importance of others. I am perhaps too "old fashioned" in feeling that a thorough study of basic oceanography in all its ramifications is essential before we can select any one factor as of paramount importance. I am much impressed by the recent studies made on primary production. These investigations are becoming most illuminating and are showing us the importance of factors that had been given little attention in the past.

I know that to study oceanography for its own sake, without any particular direction or purpose in application, seems to many to be a wild goose chase, a waste of time and too energy consuming. Yet to direct oceanographic work along specific lines, in our present state of ignorance, can also be an utter waste, by following the wrong leads, "barking up the wrong tree", etc. The present tendency is to be too anxious to get results for application, to get immediate solutions to problems, to capitalize too soon on impressions or opinions.

And now, having "shot my bolt" for further basic oceanographic work, may I just say that we must soon change our ideas regarding the ocean and its food resources. We must get away from the idea that certain species, e.g., halibut, salmon, herring, tuna, must be conserved and developed at all costs, without regard to other species that may be exploited much more effectively though they are not popular at the present time. Why, for example, should we close wide areas of the North Pacific to groundfish fishing just because there would be a danger of catching too many small halibut. The total poundage of other flatfish might greatly exceed that of the halibut and meanwhile these other species are being wasted, as a protein food source.

I could go on and on and refer to the utterly ridiculous cost, at the present time, of catching and processing fish. We must change our ways in fishing, in regulating, in processing, and modify greatly our ideas of ever achieving a sustained yield in any particular fishery or arriving at an "optimum" sustained yield management policy for any ocean fishery. Salmon may be one exception, but even here our ideas must be brought under review.

But these phases are far removed from "Fisheries Oceanography", so I will cease my chatter. I am sure there will be nothing new in the above to add to your long list of ideas, but you do have my opinion for what it is worth.

All of the best, Wib, and if you happen to be at home or in your palatial office in early October, I might look you up. We expect to be visiting at Encinitas for a couple of weeks or so, October 1-15, prior to heading for the Orient and thence to Europe by freighter. Would just like to see you and say "hello".  
Sincerely, R. E. Foerster.

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**FROM:** Dr. George A. Rounsefell, Laboratory Director  
U.S. Dept. of Interior, Biological Laboratory, Galveston, Texas

Dear Wib:

Your letter of December 25, 1961 (received on January 29, 1962), requesting an opinion concerning the definition and role of fisheries oceanography, arrived at a time when we were implementing our expanded shrimp program, and I am afraid that it got on the bottom of the pile. On rereading your letter I note that you placed a time limit, since expired, on the date of a reply.

Even though the time has expired, I will give you my opinions for what they are worth. Having always been more or less an "otherwise thinking man," I usually find that my ideas are seldom those of the majority.

I am, and have always been, puzzled by the loose use of the term "fisheries oceanography;" this can be extended to "fisheries mathematics," "fisheries biology," ad infinitum. To me, oceanography is merely one of several tools that in certain instances may be useful in solving some fishery problem. At the outset before the military entered the picture, oceanography tended in large measure, to justify its operations on the service it could render the fisheries, as exemplified by the voluminous reports on oceanography published by the International Council.

No one can deny that general descriptive oceanography was of some value to the fisheries. However, in nearly every instance in which oceanography in the past has been helpful in the solution of specific fishery problems, the work has been carried out by the fishery agencies themselves. This was true of POFI and even true of Georges Bank which is in close proximity to several well-known oceanographic laboratories.

It would appear from the information contained in your letter that having suddenly grown greatly in stature the oceanographers now look upon fisheries as a showpiece in the window that can justify any number of projects, almost anywhere. To a slight degree there may be some justification in this attitude, but one cannot correlate fish with variations in the environment without concomitant and equally precise information on fish. It seems to be a case of whether or not the tail wiggles the dog.

On land we have meteorologists making weather observations available for a multitude of purposes, but the meteorologist does not attempt to include horticulture and stock raising as his special province. If oceanography can be justified on a sufficiently broad base, that is fine, and the data will certainly be used where and when applicable. However, I see no reason why the gatherers of oceanographic data should attempt to encompass everything in the sea. The oceanographers should ponder on the fact that in 1961 over twenty-one percent of all United States fish catch was from the coastal waters between Pascagoula, Mississippi, and Port Arthur, Texas -- a 300-mile stretch of shoal shoreline. Practically all of these are fish reared in the shallow protected estuaries. This was over three times the total United States tuna catch from all waters!

We are at present making regular concomitant oceanographic observations and fishery collections over an 800-mile stretch from the Mississippi Delta to the Rio Grande out to sixty fathoms (over 100,000 square miles). This is using oceanography as a fishery tool.

If fisheries are swallowed by oceanography, I am not at all certain that these observations would be those chosen by the oceanographic fraternity who doubtless have their own ideas on where and when they wish to operate.

In a sense this is similar to the present separation of church and state. We are not at all opposed to oceanography, sometimes we find it useful, but not all oceanography, nor even a large share, is applicable to fisheries. I do not doubt that there are many cogent reasons for doing a great deal of oceanographic work that has only the remotest application to fisheries, and we should not try to discourage this. Why not let each group perform its function as it sees fit. When oceanographers can supply some useful data, I am sure fishery scientists will be grateful.

**FROM:** Dr. Harris B. Stewart, Jr., Dept. Asst. Dir., Of. Oceanography  
U. S. Dept. of Commerce, Washington 25, D. C.

Dear Wib:

You asked for my ideas on what your Working Group might accomplish and for my general thoughts on fisheries oceanography in your last letter, so I pass them on to you.

Personally, I am quite disturbed by the schism that seems to be developing between the fish boys and the rest of the people involved in oceanography. The cause for this - as far as I have been able to ascertain - is primarily the personality conflicts between the more outspoken protagonists of each group. To me this is utterly ridiculous and every effort should be made to correct this. Here, then, is the prime task of your group.

To my way of thinking, the terms "fisheries science" and "fisheries research" are all inclusive and cover not only oceanography but fish biology in all its ramifications, gear research, catch techniques, statistical catch studies, canning methods, marketing, the international biopolitical aspects, and so on, from conception to consumption. "Fisheries oceanography," on the other hand, like "military oceanography," is merely oceanography done primarily to who is paying for it, rather than to a special genre of oceanography.

They were fisheries-supported oceanographers that first found and worked on the Cromwell Current. They were military-supported oceanographers that did the first sediment studies on Georges Bank and fisheries-supported oceanographers who did the later sediment work in that area. Who cares who supported it? The geological work was good geological geological oceanography regardless of whether it was fishery oceanography or military oceanography.

FAO seems to be afraid that the IOC will "take over" the oceans. Nothing could be further from the truth. Oceanographic research carried out by fisheries-motivated scientists is a contribution to our knowledge of the seas - the real end result - just as the work of a militarily-motivated scientist is.

It is time the whole oceanographic community stopped acting like a bunch of four-year olds and spent less time going to meetings and writing reports on meetings, and more time working together on oceanography per se. Merely by appointing your SCOR working group, George Humphries is in effect widening and perpetrating this split between fish folk and non-fish folk. Your report will have to be handled properly. It should not be a compendium of all that fisheries oceanography has accomplished and presented as though to prove that fisheries-motivated oceanographers are worthwhile. Everybody knows this already, and the tone that you were trying to prove something would merely widen the incipient rift. Rather than stress what the fisheries people have done, and in so doing point them out as a separate group, I would like to see you stress what oceanographers have done and are doing that will shed light on problems related specifically to fisheries. Let's keep the split restricted to the areas where problems exist, and not include in the split the oceanographers who are working on the problems.

The true oceanographer is interested in finding out what goes on in the ocean and why. He doesn't care if the Fisheries Research Board of Canada or the ASWEPS program picks up the tab. Please try to heal the rift rather than drive in another wedge. The fish and non-fish people need each other too desperately to perpetuate any rift. Emphasize the things that bring us together, not the things that tend to separate us.

This may sound a bit Pollyanna-ish, but I am dead serious. There is too much to be done and there are too few people to do it. We have got to learn about our oceans, so let's work to smooth out the FAO-UNESCO hassle, let's squash the outspoken bifurcationists, and let's get cracking on the job at hand. Keep the fish vs non-fish separation at the application level. Keep the oceanographers out of it.

These, of course, are my feelings as an oceanographer and not as an employee of the Coast Survey. You may quote me if you wish. Sorry to have taken so long to answer your letter, but a December request with a March deadline automatically gets shunted off into the hold-basket.

Good luck with your SCOR Working Group. You have an opportunity to do a real service to oceanography. My best wishes for your success.

**FROM:** R. A. Ragotzkie, Associate Professor  
University of Wisconsin, Madison 6, Wisconsin

Dear Dr. Chapman:

I offer the following comments to your letter of December 25, 1961 concerning the "SCOR Working Group on Fisheries Oceanography." If this reply is too late to be of any value to you, I am sorry.

You express some doubt as to the accepted meaning of fisheries science or fisheries oceanography and its relation to oceanography as a whole. To this I would reply that all of these terms, including physical and other branches of oceanography, refer to applied science or problem areas. Progress in any one of them is made by a person trained in the fundamental disciplines (biology, physics, chemistry) who has some skill with the tools mathematics and verbal language and who has interest in the problem area in question. To define fisheries oceanography is not practicable and is an essentially useless aim. Given a competent scientist in any fundamental discipline with interest in fisheries (interpreted in the broadest sense) and you will have a fisheries oceanographer. Lacking competence in a fundamental science, the worker in fisheries oceanography is a technician only.

Fisheries oceanography presumably has two aims: (1) to learn about life in the sea or the satisfaction of human curiosity, (2) to increase the world's food supply or the satisfaction of human hunger. These aims are compatible in that progress in either will lead to progress in the other. Progress will be accelerated when more really competent scientists are convinced that this is an important problem area and one that needs their attention. The success of our air and space explorations has resulted from this very process. The difference in sophistication between fisheries research and space research is the best indicator of the needs of the field of fisheries science in terms of scientists and financial support.

These are rather vague statements and do not solve your immediate problems. However, it is my feeling that far too much effort is being expended on building fences between problem areas, viz. physical oceanography and fisheries science, and not enough into attracting the best scientists into the fisheries field. This will cost a great deal of money and will not be accomplished overnight.

To take a favorite example: you cannot expect a physical oceanographer to go "all out" to solve a fisheries problem unless he is genuinely interested in it. Too often the fisheries person asks for a set answer for a physical problem that is only partly solved. His criticism of the vague and, to him, useless answer is often unwarranted, and usually stems from a lack of appreciation of the complexity of the problem he has posed. These difficulties cannot be solved by arbitration or diplomatic activity between the fields. Rather there must be more scientific understanding and more interest on both sides.

Item 4 in the terms of reference in your letter will take care of itself if fisheries oceanography can boast of a good complement of first class scientists. They will already know where to turn for help and where more basic research is needed, to further the aims of fisheries oceanography.

There is no question, I believe, but that support of fundamental research is in the long run the best investment possible. In the same vein, the enlistment of the best scientists available is the best insurance for progress in a particular field.

**FROM:** Dr. J. L. McHugh, Chief, Division of Biological Research  
U.S. Dept. of Interior, Fish and Wildlife Service, Wash. D.C.

Dear Wib:

I am sincerely sorry for the long delay in replying to your letter of December 25, 1961, (Don't you even rest on Christmas Day?), requesting my views on fishery oceanography. This delay was neither intentional nor conscious on my part, it came about through a bureaucratic comedy of errors, the details of which I will not bore you with, but the like of which I am sure you can easily imagine by recalling your own periods of government service.

I am not sure that this rather hurried reply will be particularly useful, but I hope that some of my ideas may contribute to the important task of your committee.

1. What is fishery oceanography?

Oceanography as it applies to fisheries is, of necessity, a very broad subject. To me it embraces all phenomena that influence the physical, chemical, or biological characteristics of the oceans and their living resources. Under this definition it is immediately clear that a great many disciplines are involved. To name these disciplines and their subdivisions would be to make a list of almost all the sciences and their special branches, and one might include some of the humanities as well. I like to think of fishery science as the very broadest kind of ecology, including the meteorological sciences, the physics and chemistry of the waters, the biology of the animals and plants of the sea, and some freshwater, terrestrial, and aerial organisms as well, the geology of the ocean shores and bottom, and various other things such as the engineering aspects of ship design and operation, instrument design and function, and so forth. It is important in my mind to recognize also the role that man plays in fishery ecology. It is recognized widely that he influences the abundance of marine animals directly, by fishing, by killing organisms he regards as pests, or by protecting those he finds desirable; or indirectly, by polluting the waters, building bridges, dams, or breakwaters, reclaiming marshland, dredging channels, and the like. It is much less widely recognized that he exerts more subtle influences upon the economy of the sea by his peculiar ways

of doing things. Thus, economics and social-political forces are important elements in fishery ecology, and these subjects deserve far more attention than they now receive. I would say that their effects are more often misinterpreted than judged correctly, and when they are invoked for purposes of conservation, as when fishery laws are formulated and enacted, more often than not the effects are quite different than what was intended. In the United States, particularly, where fishery laws and enforcement are the prerogative of the individual states, some ridiculously provincial ideas hold sway and in most cases the fishery laws contribute to the sad economic state of the fisheries by making it impossible to harvest the resources for maximum economic yield. These things all influence the abundance and distribution of fishery resources, and, thus are among the complex of forces that interact to produce the dynamic entity that is the ocean.

## 2. What has fishery oceanography accomplished?

This is not an easy question to answer. One view might be that oceanographers are just now on the verge of making solid contributions to fishery science. We have learned a great deal, it is true, about the distribution, abundance, changes in numbers, and kinds of fishery resources that live in the world's oceans. We have learned a little about why the distribution and numbers of fishes change from season to season and from year to year, but only very little. For the most part, our knowledge of these phenomena is still pretty much speculation, and many attempts that have been made to detect the underlying causes have been pretty feeble efforts. We do not even have a very good idea at the moment how large a harvest the oceans can yield on a sustainable basis. The wide divergency of opinion at the recent Conference on Fish in Nutrition illustrates the primitive level of our knowledge, and the very general statements that finally came out of the conference show that no one was willing to place a firm figure on potential yields. Obviously, we need to know a great deal more about oceanic productivity, food chains, and the like.

One might, on the other hand, develop a strong argument to the effect that, despite the feeble effort that has gone into fishery oceanography to date, we have learned a surprising amount about the ecology of the oceans. Much of our understanding has been reached by inductive methods, but such methods are widely used in science. But I think that anyone would conclude that the knowledge we need to have far outweighs that small amount now at our disposal.

## 3. What should fishery oceanography be trying to accomplish?

At the moment, I would state this only in general terms. My objective would be to understand the relationships between the following phenomena:

- a. circulation of atmosphere and oceans,
- b. distribution and change of physical and chemical properties of the oceans

- c. configuration and composition of oceanic shores and bottoms,
- d. distribution, abundance, migrations, and rates of birth, growth, recruitment to the fishable stocks, and death of marine organisms, and
- e. the role of man.

I would like to understand the dynamics of these interactions well enough so that I could determine and control the optimum yield from oceanic fisheries, forecast changes, understand the trophic levels at which the greatest yield of protein can be achieved (consistent with aesthetic values or economics) and be able to manage the fisheries to achieve this level of yield, and alter conditions in the direction of greater sustained yields. If I could do these things to some degree, I believe I would be able to say I understood something about the oceans.

4. What progress in other sciences will be necessary if these objectives are to be attained?

I think the answer, in general terms, is included in what I have written already. In physics, chemistry, and engineering, I think the main problem is to apply what we know already to the solution of the complex problems that the oceans present. Instrumentation is perhaps the most important immediate problem. In biology, of course, we need to go a long way yet in certain neglected fields as they apply to the ocean. Behavior, physiology, genetics, interactions between species and between races, disease, and factors influencing survival are just a few of the things we need to understand. We really do not know what the environment of a marine organism is, in the sense of knowing or understanding what factors influence the organism, although we talk glibly about studying the organism in its environment. A careful blending of laboratory and field work is necessary for this purpose, and a much more imaginative approach than heretofore. In studying the effects of pollution and other man-made environmental changes, more attention should be paid to the sub-lethal effects of man's activities.

Although I am not familiar with the field, I would judge that much more original mathematical research should be done on the dynamics of marine populations. This would include investigations of the mathematics of predation, of food competition, of interactions between stocks at different levels of abundance.

The economics and social-political aspects of fishery oceanography need much more attention. The question of social-political influences upon resource abundance and utilization is perhaps one of the most difficult and most neglected of fishery problems. It requires detailed study, education, and some radical changes in political philosophy and action.

I have not given adequate attention to this fourth question, and am not sure that my answer is very useful. Perhaps I can do a better job later, when I have had more time to think.

**FROM:** Dr. Carl N. Shuster, Jr., Director, Marine Laboratories  
University of Delaware, Newark, Delaware

Dear Dr. Chapman:

I have read your interesting letter of December 25, 1961 several times; in several cases you practically answer your own questions, but I will add a few more comments to those you have given.

1. Fisheries Oceanography and Biological Oceanography can be viewed as having relationship comparable to that of the Medical Sciences to the Biological Sciences. Fisheries Oceanography is largely an applied science, concerned with sport and commercial fisheries.

2. Accomplishments of Fisheries Oceanography. You have listed several accomplishments in your letter; other examples could be added, such as the Pacific halibut fishery investigations and "Some scientific aids to the oyster industry" (T.C. Nelson. 1957. American Scientist, 45 (4) :301-332).

3. What Can Be Done:

- a. Applied Research: Inventory of marine species and their utilization; development of fisheries methods; development of management, as in the use of artificial reefs to localize most fishing areas; "breeding" new and better stocks of commercial species; better manage trash species; etc.
- b. Basic Research: Biological oceanography, which includes: studies upon the environment as well as the biology and ecology of species; natural history of species; primary productivity and community metabolism (as Odum, H. 1960. American Scientist. 48 (1): 1-8); systematics, genetics, etc.

4. Progress Required:

- a. Better-trained government scientists.
- b. More and better research facilities, including shore installations and laboratories as well as vessels. These facilities should be provided to institutions of higher learning and the fisheries programs intimately associated with academic programs.
- c. Adequate financing.

Comment on 4. Generally speaking, the reason fisheries oceanography has not gained an "ivory tower" status is because fisheries researchers are, more often than not, second rate. Their

second-rate nature is due to a kaleidoscopic mixture of low salaries, inadequate training, lack of adequate research facilities, lack of ability, intelligence, or initiative, etc.

In the ideal situation, fisheries oceanographic programs should be directed by superior scientists with sufficient Ph.D. level assistants to do the enormous amount of work that should be done. The lack of extremely well-qualified directors and assistants in fisheries oceanography is one of the major bottlenecks to advancement of the science.

The need for modern research facilities is obvious. Most fisheries programs are equipped with second-rate material, housed in second-rate facilities. A quick comparison between fisheries oceanographic facilities and those of medical research centers and NASA (National Astronautics and Space Administration) should suffice to make this clear.

**FROM:** Dr. Elbert Ahlstrom, Laboratory Director  
Bureau of Commercial Fisheries, La Jolla, California

Dear Dr. Chapman:

My reply to your letter is somewhat episodic rather than comprehensive. I have delayed replying in the hope of furnishing you a more carefully constructed answer. I cannot foresee any lessening of my work load in the next few months, so I will have to settle for the following:

1. Discuss and define the subject of fishery oceanography

I will begin with an obvious statement: the principal problem of fishery biology is population dynamics. "Population dynamics" is, in a sense, a catch-all phrase, because it encompasses so much of fishery biology -- subpopulation studies, physiology, behavior, growth and longevity, recruitment, catch and effort studies, yield per recruit, etc.

The reason for investigating population dynamics is to gain an understanding of fluctuations in the distribution and abundance of exploited fish populations in order to maximize man's use of these resources.

Not all aspects of population dynamics can be included under fishery "oceanography." Much of our fishery data for any species, such as the sardine, are obtained from activities of the commercial fleet: catch statistics and localities, age, and length composition of the fish caught, catch-per-unit of effort, etc. Traditionally, such data have been used to construct density-dependent models of how fish populations react to fishing.

When we wish to investigate density-independent influences on a resource, we have to go to the ocean. It is then that we get into the field of "fishery oceanography."

The above, of course, is an oversimplification -- but the approach is used to point up the fact that not all areas of fishery biology can rightly be considered to fall under "fishery oceanography." Very few areas of technology will come under the blanket of fishery oceanography.

2. To state what fishery oceanography has accomplished

Dr. Sette has summarized this so excellently in his letter to you that all I need add is -- I concur with his summary.

3. To state what fishery oceanography should be trying to accomplish

The oceanic environment is a complex, intricate medium that is always in motion, always changing. There are major features about which perturbations occur, such as the major circulation pattern in the oceans, enrichment processes (upwelling, convergence, turbulence), etc. Fishes are affected by perturbations in their everchanging environment -- by changes in temperature and salinity of the water, by variations in the strength of ocean currents and countercurrents, by the presence of an adequate food supply or its lack, by increase or decrease in parasites and diseases, competitors and predators (including man). Some of the factors are physical or physico-chemical, others are biological; all for convenience, can be grouped together as environmental.

The environment can be considered to be the immediate habitat, but this in turn is affected by larger scale oceanic processes, by atmospheric circulation, and by energy from the sun. Hence the necessity of coordinating environmental studies within a larger frame.

Fishery oceanography is attempting to obtain a real understanding of fluctuations in abundance and availability (distribution) of important marine fishes -- an intimate knowledge of the relation of each to its eco-system and to large scale oceanic processes.

The primary objective of the ecosystem approach is to make possible a more complete understanding of the relation between fish populations and their environment. Studies of an ecosystem can become diffuse unless the research is kept fish oriented, and has as its core problem the understanding of the population structure and dynamics of fish populations. For some species (temperate tunas, for example) the studies may have the more limited objective of understanding variations in distribution (availability), for other species such as sardines, the more complex problem of fluctuations in population abundance. Of prime importance is the need for understanding the factors responsible for fluctuations in success of year broods, for this problem is at the heart of population dynamics.

In the California Current system, one area of research deals principally with the trophic level of filter feeding fishes. What relations exist between competing fish populations? More specifically for us, is the size of the sardine population

controlled in part by the anchovy population? This brings up a basic problem -- can a population be studied by itself without reference to other fish populations? Is it profitable to investigate a population, in vacuo, so to speak? The problem is basic because this latter approach has been the usual approach to population dynamics. I think there can be little doubt that the trophic level approach is essential if we are to gain an understanding of the population dynamics of pelagic marine fishes.

The primary need for studies of fishery oceanography can be simply stated: more limited approaches have not solved the really basic problem in population dynamics, despite the elaboration of sophisticated models of how fish populations react to fishing. The difficulty results from the fact that fish populations react to other things beside fishing -- things in the variable environment (including other species of fish).

There are several operational stages in investigating the oceanic environment (as for example in the eastern Pacific).

1. Area-wide surveys. The initial broad look -- semi-synoptic coverage of temperate and tropical regions of the eastern Pacific by multi-vessel survey cruises designed to map broad oceanic features (temperature and salinity distribution, currents), productivity, and gross distribution by marine organisms. Surveys to be repeated at different seasons.

2. Unmanned recording buoys -- listed separately because of need of developmental research and research planning. The area-wide surveys cover the areal dimension -- recording unmanned buoys would cover the temporal dimension. The ocean is a dynamic medium, and the proper understanding of dynamic processes require time-series data.

3. Habitat (ecosystem) studies -- smaller-scale, detailed, fish-oriented investigations of the environment, utilizing a variety of disciplines in order to understand the interaction of fish populations with each other and with features in their environment -- in order to gain an understanding of factors controlling fluctuations in abundance and distribution of fish populations.

4. Large-scale oceanic processes -- the major circulation patterns, temperature distributions, etc. as these effect the environment of ecosystems and in turn are affected by atmospheric circulation; the interaction of ocean on atmosphere as well as atmosphere on ocean.

4. To state what progress is needed in other sciences

In physical oceanography, theories should deal with the dynamic ocean rather than the equilibrium state.

Moored buoys -- development of instrumentation and adequate mooring methods. Incorporation of biological sampling

into moored buoy programs. It should be possible, for example, to develop an instrument for sampling plankton at regular intervals -- utilizing the method of preservation of the Hardy plankton recorder and the sampling techniques of the plankton pump. The critical component would be the power source needed for the periodic operation of the pump during the several months between maintenance calls on moored buoys.

Laboratory or experimental studies -- physiology, behavior, genetics, bio-chemistry, etc. dealing with such problems as rearing of marine fishes, effects of environmental factors on survival, energy requirements, etc.

The above examples are given to show that progress is needed in many areas. The list is far from exhaustive.

**FROM:** Dr. Peter Larkin  
Bureau of Animal Pop., Botanic Garden, High St., Oxford, Eng.

Dear Dr. Chapman:

Thanks for your voluminous letter requesting comment on the task before the committee on fishery oceanography for the S.C.O.R.

My comments herewith:

1. Defining fisheries oceanography should be the least of all worries, unless its more serious than defining a fisheries oceanographer. Everyone would agree that knowing about the environment of fish is essential to a science of fisheries. I don't know anybody who is doing oceanographic work that (not who) would be classified as useless to fishery oceanography.

As a matter of argument, I don't like the expression any better than say "insect meteorology" (essential to understanding locust outbreaks) or say "bovine politics" (the effect of lobbying in Washington on cow populations). But that's details.

2. What has fishery oceanography accomplished? Rephrasing the question as "what has an understanding of oceanography contributed to the objectives of fisheries science," an answer is -- the whole history of work on the North Sea and the North-east Atlantic is a fine example, providing a basis for why fish occur, when and where they do, and explaining some of the major fluctuations in abundance of some species. The same can be said, perhaps, of much of the oceanography in Japanese fishery areas, particularly those north and east of Japan. There are many other examples, but these two are perhaps the best or at least the most traditional.

3. What should we be trying to accomplish? More and better (of two above).

4. What progress is needed in other sciences to achieve aims?

a. Better instrumentation - a major point. We need better ways of collecting vast quantities of data.

b. Better data processing-instruments are available, but biologists don't use them to the extent that they should. Devices such as Fortran and Autocode, which facilitate programming for non-mathematicians, automatic data plotters, analogue computers should be recruited to a greater extent.

c. Fundamental research in fluid dynamics. I suspect this is needed, but I speak from ignorance.

d. Fundamental research in fish physiology. The understanding of hormone functions in relation to tolerance and preference of various environmental factors.

e. Miscellaneous. Almost all work in oceanography and fish may prove useful. The suggestions in c and d above reflect my own uninformed appraisal of the fields, which are most far behind.

I hope this short note may contain something to use to you. We will look for a copy of your final report in our library.

**FROM:** Dr. M. B. Schaefer, Director  
Inter-American Tropical Tuna Commission, Scripps Institute  
of Oceanography, University of California, La Jolla, Calif.

#### 1. What is fishery oceanography?

I should define oceanography as the study of the ocean, its contents, and its boundaries. For convenience, this broad subject is often subdivided by traditional scientific disciplines, into physical oceanography, chemical, oceanography, and biological oceanography. Another type of subdivision is, however, also appropriate, that by particular components of the ocean and its boundaries. Thus we speak also of submarine geology, of marine geochemistry, of marine meteorology, each of which involves the combined application of more than one of the traditional scientific disciplines to the properties and processes of some part or component of the real ocean. Mathematics, is, of course, the handmaiden of all.

Fisheries oceanography, like submarine geology or marine meteorology, involves an interdisciplinary approach to one component of the sea - its living organisms, a share of which are harvested by man. I would, therefore, define fisheries oceanography as "the study of the sea, its contents, and its processes, with a view to understanding the living organisms which are, or may be, harvested by man."

#### II. What should fisheries oceanography be trying to accomplish?

Fisheries oceanography should be trying to attain an understanding of the living organisms of the sea which are, or may be, harvested by man, including the various physical, chemical, and biological processes and properties which influence their

distribution, abundance, and behavior. Such understanding should lead to assessment of the fishery resources, prediction of their geographical and temporal variations, and provide the basis of improved means of harvesting them. This involves both studies of the ocean at large, and detailed research on particular features.

### III. What has fisheries oceanography accomplished?

In some regions of the sea, at least, a fair start has been made toward understanding some of the large scale features of the circulation and distribution of properties which importantly affect the abundance and distribution of the commercial fish stocks. One may cite as examples:

1. The California current system.
2. The general circulation and distribution of properties in the Eastern Tropical Pacific.
3. The region of the Peru Current.
4. The North Sea and North Atlantic.

There has also been made, in some instances, significant progress on understanding in some detail the variations in the oceanic circulation, which affect the fish populations, and predicting their effects on the fisheries. For example:

1. The relation of the cod near Bear Island to the location of the intermediate waters of certain temperatures.
2. The relation of yellowfin tuna to the temperature regime in the Eastern Pacific near the ends of their range, and the meteorological causes of variations of the sea temperatures. The relationship of skipjack and yellowfin tuna to areas of high basic productivity, and the physical processes (upwelling, doming, etc.) which cause high basic productivity.
3. Variations in abundance of skipjack near the Hawaiian Islands in response to variations in the temperature and current regime in that sea area.

Less progress has been made on understanding the causes of variable survival of young fish, on identifying the properties of the sea which fishes use as guides in their migrations, and on understanding the ecology of marine communities. It is my opinion that progress on the first two requires more study of fishes under controlled laboratory conditions to provide clues as to what we should be measuring in the sea. The last item demands a broader approach in the study of community ecology in the sea, that is the collection and analysis of data respecting the abundance, behavior, and interrelationships of all of the important organisms composing the biosphere in particular oceanic areas, rather than the study of only a few selected species.

### IV. What progress is needed in other sciences so that the aims of fisheries oceanography may be attained?

The several scientific disciplines which are applied to the sea in the study of fisheries oceanography - physics, chemistry,

biology, and mathematics, are, in general, adequately developed for our purposes. There are, of course, some particular aspects of them where further progress could provide better tools for the fishery oceanographer. For example: Turbulent motion in the sea, on both small and large scales. The physics of the air-sea boundary. Chemistry of organic compounds, especially important trace metabolites, in the sea. The physics and chemistry of carbon dioxide in the sea and atmosphere. Genetics of marine organisms. General properties of inter-specific associations (competition and predator-prey relationships). Mathematics of stochastic processes applicable to biological communities. However, I do not believe that we have, at this time, any great restrictions on our progress due to lack of development of these sciences. We are much more handicapped by the lack of means of applying the tools already developed, or which can easily be developed, to the problems of fishery oceanography.

What is needed are competent, imaginative scientists, of broad interests to apply their talents to the problems of fisheries oceanography, and funds to support their costly work at sea, and in the laboratory. Our research in fisheries oceanography if it is to make significantly more rapid progress than at present, requires a different scale of scientific planning and execution by at least an order of magnitude.

**FROM: Dr. Mary Sears**  
**Woods Hole Oceanographic Institution, Massachusetts**

**Dear Dr. Chapman:**

I think the reason I never answered your letter of December 25 is that it left me utterly confused. I had been under the impression that SCOR was primarily concerned with basic research in oceanography and that FAO was responsible for the practical or applied science of fisheries biology and/or oceanography. Without the background for this new major shift in emphasis for SCOR, it seems difficult to come up with any very strong opinions on items 1, 3, 4, and especially 5. Item 2 is well known generally and certainly by your Working Group.

Indeed, I begin to wonder whether a "tug-of-war" may be in the offing with the publication, apparently with the blessing of FAO, of the book, "Fisheries hydrography; how oceanography and meteorology can and do serve the fisheries" by Ilmo Hela and Taivo Laevastu. Perhaps this even reiterates the mission of FAO.

Since I have not been involved in and have no way of knowing what is going on at international levels, I do not feel that I could contribute anything very significant at this time.

**FROM:** Dr. W. M. Chapman, Director  
Van Camp Foundation, Division of Van Camp Sea Food Company,  
739 Golden Park Avenue, San Diego, California

Dear Dr. Sears:

I think that your understanding has been a generally held one: that SCOR was primarily concerned with basic research in oceanography and that FAO was responsible for the practical or applied science of fisheries biology and/or oceanography. I would amend that to say that FAO has had, to now, a quite limited relationship with oceanography (I believe Taivo Laevastu was the only employee who could be termed an oceanographer prior to the initiation of the Special Fund, FAO-administered, Peru Fisheries Project; Laevastu has left FAO and has not been replaced), and fisheries biology has never been more than one third of the field of activity of FAO Fisheries Division, with fishery oceanography in the organization being included within fishery biology section.

But there are other international, intergovernmental, national, and industry organizations in the world who have a deep interest in the ocean, and its resources, knowledge concerning them, and understanding of them. As examples of each of these categories (several could be picked in each) are the Special Fund of the United Nations and UNICEF; U. S. Bureau of Commercial Fisheries Association, and All Japan Fisheries Society.

With the formation of IOC in UNESCO there did begin a tug of war between UNESCO and FAO over jurisdiction in this field among the United Nations family of specialized agencies (others such as WMO, UNICEF, IARA, were more than peripherally involved also).

It would not be appropriate for me to attempt to state the feelings of others in this matter. I can only state mine. That is: there is only one ocean; what is basic to one interest is often applied to another (and vice-versa) and very frequently the difference between one and the other is an element of time (which seems to be diminishing in length); there is no such dichotomy as you note in the real world; the relation between ocean, atmosphere, basin, and living resources is so intimate, dynamic, and interchanging as to make understanding in respect of one element impractical, if not impossible, without pretty good understanding of the others; the resources of money, ship-time, and particularly of professionally competent personnel are too short in supply to find out what I want to know as rapidly as I want to know it. As a businessman, a professional fishery scientist, and as a very ordinary citizen of California, the United States and of the world it is in my selfish interest that these resources of money, ships, and men be used as effectively and efficiently as possible to achieve greater knowledge and understanding of the ocean and its contents as rapidly as possible. If I can do anything to remove an impediment to that achievement, or prevent such an impediment from arising, I am prepared to do it within such limits of time and ability as I have.

These things have appeared to me as such impediments, or as possibly becoming such:

1. The bureaucratic contest between UNESCO and FAO.
2. The unevenness of viewpoint in respect of the ocean among other agencies and individuals concerned with the living resources of the sea.
3. A latent, occasionally erupting, and rather wide-spread antagonism between fishery scientists and physical oceanographers which occasionally has been quite harmful to the progress of research within several countries, was infecting the international scene, and gave possibility of impeding the work of IOC.
4. The inadequate input of fisheries science in SCOR.
5. The inadequate input of oceanography and fisheries science in FAO Fisheries Division.
6. The growing need for an international agency that could deal with ocean problems with some unitary viewpoint (which in my view neither UNESCO or FAO will ever be capable of doing).
7. And some other odds and ends perhaps more irritating than important.

While I state the above purely as my own viewpoints, a good many of them seem to be shared by a fair number of other people in this and other countries. Much of this came to a head preceeding and during the first meeting of IOC last October in Paris, and it produced feelings and actions which were not conducive to the smooth progress of ocean research. SCOR at its November meeting in Monaco, directly after IOC, felt that the appointment of a Working Party, not to deal with the whole subject matter involved but with fishery oceanography along certain definite lines which the President laid down, might aid in smoothing over some of these possible difficulties. I agreed, and the next thing I knew, George Humphrey had appointed such a Working Party with me as the convener.

I do not know whether we will be able to contribute much to the objectives outlined above, but we are at least going to give it the old college try. I can only report that the interest shown in our inquiry so far has been more wide-spread and active among ocean researchers than I had anticipated and, accordingly, the project has become interesting. I am beginning to think it may turn out to have been of some use.

I have not interpreted this at all as being any sort of a new major shift in emphasis for SCOR. The preamble of the Constitution of SCOR reads: "SCOR is a Special Committee of ICSU charged with furthering the coordination of scientific activity in all branches of oceanic research, with a view to framing a

scientific programme of world-wide scope and significance." I think it plain that this objective has at all times encompassed research dealing with the living resources of the sea and that the objectives of this Working Party, if successfully carried out, will contribute a little to coordination of scientific activity in these fields, if only by relieving stresses that might have diminished such coordination.

**FROM:** Dr. Michael Waldichik  
Biological Station, Fisheries Research Brd. of Canada  
Nanaimo, B. C.

Dear Dr. Chapman:

Please accept my apologies for being so remiss in submitting a statement to you apropos of the terms of reference of the "SCOR Working Group on Fisheries Oceanography," as given in your letter of December 25, 1961. I drafted a few ideas in a moment of inspiration shortly after receiving your letter and set them aside for later consideration. Having become very fully occupied with field work, etc., in the first few months of the year, I missed your first deadline of March 1st. Your second letter of June 1st, however, prompted me to review what I had written previously and a revised draft is submitted herewith.

You may use my comments in any way you wish, with or without acknowledgment of source.

Thank you for permitting me to give some personal opinions on the important subject of Fisheries Oceanography.

**FROM:** Dr. Michael Waldichik

#### On Fisheries Oceanography

My basic training has been in the physical sciences, chemistry primarily and physics secondarily. I have been exposed to the other physical earth sciences - geology, geophysics, geochemistry - as well as the biological sciences in an attempt to integrate these disciplines into an understanding of the broad and general field of oceanography. This has led me to some inquiry into the fascinating field of the relationship of life in the oceans to its environment.

Not being a biologist, I regard a fish from the viewpoint of a physical scientist. It is an animal, and as any other of that kingdom, it lives in a delicately - poised balance with the other organisms of the biological community and with its environment. A slight shift in the balance, whether it be natural or man-made, can prove to be disastrous. A fish, then, is dependent on its surroundings for its food, its protection from predation, its shelter from the harshness of parts of its environment. its guidance during migration and, in short, for its

general well being. Alter any of its environmental conditions from the optimum to which it has evolved or adapted, and you impose a stress on it.

Fish are no different from land animals in that they have evolved to withstand the very special conditions which prevail in their habitat. Just as one would not expect an elephant to adapt to and thrive comfortably in the bleak Arctic wastes, which are called home for the reindeer and polar bear, so one cannot reasonably expect a tropical tuna to feel at home in the frigid waters of the arctic char. The arctic fox and the lemming can find sustenance in the desolate and barren tundra of Canada's northland. They not only survive but sometimes occur in large numbers. There seems to be an analogy in the oceans where some specialized fishes find food in the vast deserts of the sea. They differ from species in more productive environments by their behaviour patterns. The swift, far-ranging tuna, which often frequents the desert-like areas of the oceans in its quest for food, differs in its behaviour from the Pacific salmon or from some of the bottom fishes which migrate very little and usually have an abundant food supply at hand.

Fisheries oceanography, if such a profession indeed exists, attempts to bridge the gap between the two older disciplines, fisheries biology (if this term again is legitimate) and oceanography. Those scientists who find themselves in the invidious position of being called fisheries oceanographers ultimately follow one of two courses: (1) attempt to find statistical correlation between certain oceanographic events and fisheries trends, or (2) drift back into more basic studies of the marine environment or of the animals which dwell therein. The first course can prove extremely unprofitable after much frustrating effort. Statisticians will agree that correlations of some sort can be found for almost any two series of events. It is the understanding behind any such correlations, if indeed some truly exist, that we are often lacking. Oceanographers working on the problem of relating the marine environment to the fisheries generally come to the conclusion that inadequate knowledge is available about the basic oceanographic processes. They usually end up by studying more intensively the physical oceanography even at the risk of being accused of dereliction of their duties to fisheries science. Biologists entrusted with the problem of relating fish abundance and migration to environmental characteristics often drift back to studies of basic population dynamics.

The problem with fisheries oceanography is that the two disciplines which it attempts to wed have not yet matured sufficiently to satisfactorily consummate the marriage. It is in the same state that biochemistry was at about the middle of the last century. Neither biology nor chemistry had advanced sufficiently to contribute to the required understanding of the chemistry of living processes. We require the "ivory tower" approach for some time yet to come for a better understanding of the fish in all their aspects - physiological, behavioural, etc. - and of the environment in its ever-changing intricacies.

Only after a large number of the existing problems in these two fields are solved can we begin to hope to relate them. This may still be some years in the future.

We know that certain basic characteristics of the environment are related to the number of different fish species and to the densities of these species. Thus the upwelling areas along the west coasts of continents in both the northern and southern hemispheres are occupied by rich fisheries. This is a function entirely of basic productivity, where high nutrient concentrations arising from upwelled waters combine with other favourable factors, such as sunshine, temperature, and water stability, to give rise to high concentrations of phytoplankton. Thus the pastures of the sea determine the ultimate numbers and size of the grazers and other animal groups along the food web. For this reason, perhaps, basic productivity studies should be considered to be very near to this vague bridge known as fisheries oceanography, although I know that such studies are rarely regarded as that.

Relationships can be found for a host of events, the success or failure of a fishery related to the success or failure of the rice crop, for example (which has in fact been done in Japan). Others have gone so far as to relate success of a fishery to sun spots and solar cycles. This again has met with a measure of success in Europe.

In British Columbia, the success of the sockeye salmon run has been shown to be directly proportional to the Fraser River discharge occurring when the smolts migrate to sea. Whether the large river flow, per se, has had a favourable effect on the salmon young themselves in the river or whether the river discharge is merely a manifestation of favourable or unfavourable meteorological conditions is still unknown. Moreover, the significant effect of river discharge on the sockeye could occur in the Strait of Georgia where the young probably feed for a considerable time after entering the estuarine and marine environment. A further correlation has been found in British Columbia between the success of a given year class of pink salmon and the temperature of the surface water in the Strait of Georgia during the early marine stage of this species. Summer seawater temperature has been closely and inversely correlated with subsequent abundance of the adult pinks. No doubt, relationships exist through some tortuous and complex series of events. However, it is the understanding of the why and wherefore of these events rather than recognizing their existence which is important.

Most so-called fisheries oceanography has a strong physical-oceanographic slant. It may be pursued from the point of view of certain physical processes in the sea or from the point of view of marine features. For example, circulatory processes as a result of varying geostrophic forces have been related to changes in fisheries. Temperature changes in the sea have often concerned scientists studying those fisheries, such as albacore and Atlantic cod, where the fish is known to have a fairly

sharply-defined temperature range. At various times in the past, attempts have been made to relate abundance of fish to water salinity. Atmospheric pressure changes, as they affect geostrophic winds and ultimately oceanic circulation, have been studied as possible causal factors in fisheries fluctuations. One of the more promising advances in prediction of both the Hawaiian skipjack fishery and the California sardine has been in studies of rate of change of conditions - temperature, advection, etc. Rather than compare the year-class strength with the absolute conditions that prevailed during a given life-stage period of the species in question, the year-class strengths have been related with reasonably good results to the rate of change of conditions during that period.

The second physical oceanography approach toward contributions in fisheries-oceanography is the elucidation of features. These may be "domes," as known to exist in subtropical waters off the west coast of Central America and in divergent regions such as the core of the Alaskan gyral or intrusions occurring off the coast of British Columbia during some years. They may represent regions of concentrations of fish or of their food, which ultimately attract fish.

The most profitable approach to fisheries-oceanography has been what one might consider the incidental approach. A study is made of the basic processes in the sea, their time and space variations, and the effects at the air-sea boundary which may be influencing these processes. When cause and effect in the chain of physical events are understood, then we can move to the biological implications. By and large, most of the significant relationships between the environment and the populations of living organisms have been discovered in this way, and not by the direct approach where relationships *per se* are sought. The latter often proves to be sterile and of little ultimate value.

Profitable fisheries, by our present methods of fishing, can only be carried out in areas of fish concentration. Fish tend to concentrate at certain boundaries, whether these be sharp physical boundaries, such as the water-bottom interface and a river mouth, or somewhat more subtle boundaries, such as those existing between water masses. It is up to the physical oceanographer to define some of these boundaries and it will be up to the fisheries oceanographer to interpret them in terms of fish concentrations.

As an assist to fisheries science, oceanographers should be able to: (1) define the marine conditions that will lead to large or small fish populations; (2) predict changes in the environment which will affect fish production in a given way; and (3) give fishermen and fisheries administrators a clue on the time that fish will choose to migrate into a particular area, as in the case of the anadromous fishes running up the various rivers for spawning. Oceanography has not yet advanced to the stage of development of meteorology. Yet it has been

said sometimes that although meteorologists are expected to make reliable weather forecasts, they are not expected to predict when the geese will fly south. Consequently, the time is probably still a long way off when oceanographers can reliably predict when the sockeye or chinook salmon will run to a particular river.

One of the avenues of marine investigations where fisheries biologists and oceanographers have successfully collaborated, particularly in Europe, is in prediction of sizes of year classes of fish, especially herring. Anadromous, pelagic, and demersal fishes are subjected to the vicissitudes of nature from the time the female spawns to the time the progeny matures. But the most critical period for survival is during the egg and larval stages. The various stages of the fish in its life history are subjected to many environmental stresses, chronic and acute. While the chronic stresses may slightly influence the size of individual fish and year-class strength, it is the acute stresses which may drastically reduce the total number of fish. Thus, the extremes in conditions of the environment as they affect the survival of fish would appear to be much more meaningful than average conditions. Some of the extreme year-to-year fluctuations of sizes of stocks of Atlantic herring are no doubt related to large-scale shifts in the important North Atlantic current systems which affect basic productivity on the nursery grounds of the herrings.

As time goes on, and world populations increase, there will be a greater demand for protein to feed the billions of additional humans. Some of this protein will no doubt have to come from the sea. The world-wide fin fisheries will probably reach a maximum sustainable yield in not too many more years hence. There must be a move to expand the production of protein by in-shore farming of invertebrates, particularly oysters, clams and mussels. These resources are far from being fully developed. With at least one step in the food web eliminated, these filter-feeding organisms can produce protein much more efficiently than most of our commercial fin-fisheries. The oceanographer must be relied on to help solve some of the problems connected with shellfish culture. These include the transmittal of oyster diseases in the sea, which has had such devastating results along the Canadian and U. S. eastern seaboard, the prediction and prevention of shellfish toxicity, and evaluation of best marine conditions for shellfish propagation.

Finally, increased industrialization of maritime nations will lead to problems of acute and chronic pollution of coastal marine waters. Above all else, this contamination of the sea will pose a threat to our important commercial and sport fisheries. It will become more and more the responsibility of the oceanographer to evaluate coastal marine processes in order to provide sound advice on proposals to discharge industrial and domestic wastes into the sea so that our fisheries are not endangered. This is probably in the realm of fisheries oceanography although the person connected with such work should hardly be termed a fisheries-oceanographer.

In summary, I would say that the term, fisheries scientist, means to me a biologist with some technical training for applying tools of his profession in studying the many aspects of fish populations. For that reason, I do not consider myself a fisheries scientist, although I work a Biological Station of the Fisheries Research Board of Canada and the terms of reference of my work in marine problems of pollution have to do with protecting fish from pollutants. The term fisheries biology is rather vague for most people; I think that it implies mainly to studies of population dynamics in the fisheries.

The time is probably still premature to officially set up a separate subject of inquiry known as fisheries oceanography. The field of oceanography has been already segmented far enough into physical, chemical, geological, and biological oceanography. I am sure that most physical scientists working on marine problems, whether they have to do with fisheries or not, would prefer to be referred to merely as oceanographers. The biologist working on oceanic plankton may prefer to be called merely a marine biologist, although there are those whose scope of research embraces the zoogeographical aspects of marine organisms and they may be rightfully labelled as biological oceanographers.

There would seem to be serious shortcomings in pursuing investigations within very narrow limits to elucidate particular relationships of fisheries with conditions occurring in the marine environment. Instead, inquiry into the nature of the oceans and of their contents should proceed along parallel courses in the various fields of endeavour with adequate cross-fertilization along the way to produce the fullest possible scope of knowledge. Out of this vast array of data should emerge the information that can relate the affairs of the fisheries to those of the environment.

Ocean research has already elucidated some of the more obvious effects of the environment on marine life. Many of the more subtle effects are still only vaguely defined. The subject of ocean conditions affecting the success of year classes of various fishes has been one of a great deal of conjecture and speculation. More basic information from the various supporting disciplines will eventually bring fisheries oceanography out of the realm of speculation and give it the stature of a science.

The opinions given above are my own and do not necessarily represent those of the Fisheries Research Board of Canada or of any of its other employees.

FROM: Dr. Michael Waldichuk

Dear Dr. Chapman:

Thank you for your kind words and enthusiasm concerning the comments given by various correspondents on the subject of Fisheries Oceanography.

I should like to clarify a few points which you questioned in my contribution. There is no quarrel with your comments because I agree generally with what you have said. But there has been a shortcoming in my attempt to write down my thoughts lucidly, inasmuch as they are obviously subject to misinterpretation.

With my very limited knowledge about fish migrations, particularly about the tunas, I only wanted to say that the different species have adaptations suitable for the particular environment where they are found. I used the tunas, which may be a poor example, to illustrate the point that certain fishes are adapted for a life of "browsing on the ocean range" where the choice "pastures" may be scattered. This is not to say that food is necessarily scarce in the territory they cover. Although they may travel through the ocean deserts, they probably do not feed there. They undoubtedly seek out the oceanic oases to gain their sustenance. This may be an entirely wrong notion also on my part. However, I think it is true (I attended one tuna conference, where some of these points were mentioned) that tuna are known to make speedy and extensive migrations. It seems to me, if I recall correctly, that it is not uncommon for some species of tuna to make trans-Pacific migrations in one season.

Of course, Pacific salmon are also known to make long sea migrations. I was really referring only to bottom fishes on page 2, paragraph 1, of my note when I said "...which migrate very little....", although halibut are known to venture far afield from their spawning grounds. Generalizations are always dangerous! However, I was trying to speak about relative distances and speeds in comparing migrations of these two groups of fishes, - the tropical and semi-tropical commercial species versus the temperate ones.

You have certainly stated the historical course of any scientific inquiry succinctly and, as far as I am concerned, correctly in (c) of your letter. However, I wonder if we have reached the stage intellectually where we can be more purposeful and dig deeper in our research on fisheries oceanography. This is an era, of course, when the advancement of science is phenomenal and the time required for development of knowledge is greatly compressed, when compared to scientific developments in previous centuries. Nevertheless, because of many difficulties involved in explorations of the sea, the marine sciences are still essentially fighting their way with bows and arrows in an atomic age.

Perhaps the present intensive effort in oceanography may continue and increase in the next decade or two so that we may be closer to a realization of a successful and fruitful merging of oceanography with fisheries investigations than I had dared to hope in my first note to you. The migration, distribution, concentration, and dispersion of fishes are probably influenced through a complex maze of relationships between physical and chemical characteristics of the aquatic environment, including basic productivity (food supply), and the physiology, response to environmental changes, biochemistry, and ethology of fishes. Perhaps a program of study on fishes in the laboratory and in the sea should parallel oceanographic investigations in order to provide the maximum benefit from the latter for fisheries research.

You may alter or amend the statements given in my first note to conform with what I have stated here, if you wish.

**FROM:** Dr. Denis L. Fox, Professor of Marine Biochemistry  
University of California, La Jolla, California

Dear Wib:

Your reminder of June 1 is on hand, and, while I had by no means forgotten your earlier treatise - like overture for suggestions, I had not concluded any far-reaching ideas to suggest to you, largely because my areas of research are not very directly associated with the important area of fisheries oceanography, but also because other responsibilities claimed a priority of my time.

There is, however, one zone of general contact, I have long believed. And while it doubtless will not be new to you, I will introduce it for the further thinking and possible planning of those directly concerned there whom you have called the Working Party.

My concern is with those parts of the great marine biochemical cycle which involve the elaboration and ultimate use of organic leptopel, i. e. organic matter in colloidal or other finely particulate subdivision, suspended in the water, thus constituting a source of nutrition not only indirectly for phytoplankton (through bacterial intermediary metabolism) but directly for countless filter-feeding planktonic or nectonic animals; many of these depend to a far greater extent upon inanimate organic matter than upon living organisms for food.

All are familiar with the far greater numbers and relative concentrations of innumerable species of invertebrate and vertebrate animals in regions of high organic matter productivity, e.g. whether in jungles, swamplands or grasslands, than in frozen areas or in arid desert country. The same general rules apply to marine areas; where the cycle of organic matter is intensive, the standing crop of leptopel is high, and the animal-pyramid will be substantial and highly varied as to over-all content and

seasonal abundances. And in mid-oceanic areas, where there is a paucity of this fine "puree," the whole biochemical cycle will reflect greatly reduced intensity.

Great seasonal abundances will occur in fishes and other animals in Arctic regions when the spring thaw releases particulate organic matter held in "cold storage" by ice-packs over the winter.

Briefly, then, with the above kinds of premises in mind, I should recommend the serious exploration of seasonal abundances of organic leptopel in widely spread areas believed to hold promise of high seasonal occurrence of various commercially important fishes. Where high values are observed, in mg of suspended organic matter per liter, experience should show corresponding high populations of phytoplankton, copepods, euphausiids, and other invertebrates, as well as prey and predacious fishes.

The leptopel parameter surely should be useful, and as readily determined in mg/L, as is phosphate, nitrate, and other micronutrients in mg/m<sup>3</sup> for phytoplankton.

Moreover, this leptopelic index should be obtainable both by the "stream-sampling" and the continuous integrative sampling approaches. The former would involve the quantitative oxidation of all particulate organic matter collected upon inert, inorganic powder (e.g. MgO and celite), as published by ourselves, and since by others, while the so-called integrative or continuous collection could be appreciated by the mooring of colonies of sedentary filter-feeding animals, e.g. the California mussel, for which we have many growth-rate data, in areas of favorable or of poor organic productivity.

I have recommended this latter approach for several years. But it has not yet been tried, to the best of my knowledge. I would expose colonies of small mussels, two to four mm in length, in little wooden crates, bearing adequate screen on upper and lower surfaces to permit free flow of water. The crates, say six inches square, could be attached in a continually immersed position, to a mooring raft. Monthly or bi-monthly inspection would involve the collection of the exposed colony for measurement, and its replacement by another colony, involving new animals of the same original size. We know what these animals eat, how fast they filter, and how fast they may be expected to grow at shoreline conditions (S.I.O. pier). Hence, the growth-rate of the outpost pioneers could be compared with the progress of their relatives at nearly optimal feeding conditions. The survey should be relatively easy, practical, and directly informative, since basic stores of raw material favorable for this typical detritus-eating filter-feeding class should reflect the general economic level of supply for various other species, whether themselves also detritus feeders, herbivores, or at the carnivore status of the pyramid.

This is a hurried reply, and concerns a topic with which you doubtless are already familiar. However, I should be more than happy to discuss any details further with you at any time which might suit your convenience.

With apologies again for my tardiness, due to other areas of responsibility . . .

**FROM:** Dr. Albert Collier, Director  
A. & M. College of Texas, Bldg. 311, Fort Crockett  
Galveston, Texas

Dear Dr. Chapman:

Of all the thoughts stimulated by your letter, I would set down the following:

Item 1. Personally, I regret the time and effort presently spent on the game of "semantic" oceanography; some of the most productive work in the fields of oceanography and fisheries science was done by the early pioneers without a thought given to labels.

At first glance "fisheries" oceanography would appear to be either applied "biological" oceanography or applied "physical" oceanography, depending upon who is doing the looking. Without a satisfactory definition of "fisheries" oceanography it is going to be difficult to deal with items 2 and 3, so for my own purposes I shall consider as a definition the "description" of "fisheries hydrography" given by Hela and Laevastu in their recent book.

Item 2. In a word fisheries oceanography has contributed to the technology of sea harvesting. It has contributed to an increase in the efficiency of locating, capture, and transport of sea products and continues to assist programs aimed at expanding fishing grounds.

Item 3. Since fisheries oceanography under the broad terms of Hela and Laevastu includes the entire realm of fisheries science as an applied branch of marine ecology, we should expect that this science would look to the maintenance of the fishery resources as well as the efficiency of their utilization. We have not been very successful in this respect. It is my feeling that we are not going to be successful until the pure biologist can provide many new data on the critical needs of the individual animal with respect to its environment. Completely new approaches are needed before the fishery biologist can offer the hydrographer (or oceanographer) meaningful questions.

Each year brings new pressures on fisheries all over the world, and in America we are faced with such episodes as the loss of salmon production, the failures of the California

sardine, the eastern oyster, and how it appears that the Gulf shrimp industry is in trouble. This should be ample justification for re-examining research of the past twenty or thirty years with a view to finding new approaches. SCOR could do much in this area.

Item 4. The paucity of information on the physiology of commercial species is a serious stumbling block to an adequate understanding of what the critical factors in the environment might be. The need for a thorough knowledge of the nutritional requirements is obvious, but other than information gained from stomach examinations, what do we really know about fish nutrition? With exception of some important work being done on hatchery salmon, very little indeed. An aquatic animal is largely dependent on its chemo-sensory mechanisms for growth and survival, but here again we have insufficient information to interpret the capabilities of these organ systems in terms of environmental factors.

In only a few cases do we have sufficient information on the subtle biochemistry involved in the maturation of gonads, the spawning process, the hatching of eggs and metamorphosis of the immature to even begin assaying the environment for external regulating mechanisms.

So much for the animal as an individual. We are also faced with finding new approaches to the study of the animal in aggregates. This is being studied to some extent as fish behavior, but largely as a matter of increasing efficiency of capture by man. It should also be studied from the point of view gaining information useful in the development of conservation practices. For this purpose, I would propose that SCOR recommend the establishment of an international behavior study center. With such scope, some bold and large scale tank studies would be feasible. The tanks (or lagoons) would be one mile long and 0.5 mile wide. One could visualize large artificial lagoons under shelter. These should be equipped for temperature and salinity control, underwater photography, side and bottom ports for direct observation, an observation submarine, sonar devices, a complete sampling system to provide suitably randomized samples for chemical analysis, and irrigation type pumps for rapid exchange of water.

Such an institution should be located where water can be drawn from the ocean near the surface or from a considerable depth as required. It should provide laboratories and personnel for every basic scientific discipline. The fisheries of the world are certainly worth one such center.

We are familiar with the cruise type oceanographic survey. It would be gratifying to see more of the concentrated studies such as those being done in the North Sea. Again, there seems to be an opportunity for an additional international program: the establishment of oceanographic study areas to be studied intensively rather than extensively. These might be called "expanded hydrographic stations" and would be areas ten

miles on a side. The chief characteristics of these studies would be that they would be very thorough and at frequent intervals. These might be at key points in a conventional net work of oceanographic stations, but would have assigned to them a special team of investigators. These areas should be located near established laboratories and equipped with vessels especially fitted out for the job. Emphasis should be on recording equipment of all types for physical, chemical, and biological observations. One of these areas should be near the behavior center suggested above, and then one in each major type of ocean.

I hope these thoughts will be useful. If they are sufficiently helpful to justify circulation, you have my permission to include them as my personal remarks in your booklet.

**FROM: Mr. Tamio Otsu, Supervisory Fishery Biologist (Research)  
U.S. Dept. of Interior, Box 2830, Honolulu 12, Hawaii**

Dear Dr. Chapman:

I wish to apologize for your having to write me a second letter regarding my views on the subject of "fisheries oceanography." The first letter, dated December 25, 1961, was first seen in April when I returned from a lengthy cruise to the South Pacific. Since that letter called for a deadline of March 1st, I decided to let the whole matter rest, particularly since I had never before given this question much thought, and also because I was certain that you'd be getting replies from the hundreds of others to whom you had written.

In my opinion, and in the opinion of at least a few of my colleagues, "fisheries oceanography" is a field primarily concerned with increasing the efficiency of ocean food harvest. It is therefore restricted to studies of oceanic processes which are related to fisheries problems. Since we are now giving definitions, I should like to give my definition to some of the other terms. "Fisheries science" involves the study of the dynamics of fish populations, and the ultimate goal of this science is to attain the level of optimum sustained yield from the fishery resource under study. But in order to study the dynamics of fish populations, a biologist is required to amass considerable amount of background information on the biology and life history of the fish. He needs to have information, for example, on the age and growth of the fish in question. A biologist working on age and growth problems would therefore be working in "fisheries science." A blood biochemist studying blood groupings in fish to ascertain subpopulations would be working in "fisheries science" since the results of his study would have direct application in studying population dynamics. In other words, any scientist whose work has either direct or indirect relation to the aim of fisheries science would be classed a "fisheries scientist."

In order to fully understand the population dynamics of a fish population, particularly with respect to abundance and/or availability of the fish, and of their fluctuations, the fishery scientists would need to look into the oceanic environment of the fish for features which may be related to such fluctuations. Oceanographers study the dynamics of the ocean system. Those studies of the natural processes in the sea which might possibly affect the abundance and/or availability of the fish would come under the field of "fisheries oceanography." An oceanographer who examines the ocean with the aim of finding some relation between it and some fish populations, is a "fisheries oceanographer," and also a "fisheries scientist." A fisheries scientist may or may not be a fisheries oceanographer, but a fisheries oceanographer is a fisheries scientist.

I would prefer to look at a fisheries oceanographer as some biologist, who during his career develops considerable interest in, and becomes quite knowledgeable in oceanography, and who uses this knowledge as a tool in furthering fisheries science. However, fisheries scientists on the one hand and oceanographers on the other, working in a fisheries laboratory quite independently of each other, but with awareness of the major fisheries problems, may in effect achieve the goals of a fisheries oceanographer.

I look at fisheries oceanography as a very broad science which encompasses a wide variety of scientific and technological disciplines, serving as a coordinated team, dedicated to solving the problem of increasing the yield of ocean food resources. And yet, I do not believe that its definition should be so broad as to include all scientists studying the oceans or studying fish. This term should be restrictive insofar as including studies which pertain to both fisheries and oceanography.

Please regard this as nothing more than a personal letter.

**FROM:** Mr. Joseph L. Reid, Jr.  
Scripps Institution of Oceanography, La Jolla, California

Dear Wib:

This is in response to yours of June 1st. I look forward to seeing the results of your query of last December if they are to be made generally available.

I believe that merely all oceanography - possibly all - is fisheries oceanography in the sense that whatever contributes to understanding the ocean is likely to contribute to understanding the fisheries.

In this sense, a great part of the accomplishments of oceanography can be counted as accomplishments of fisheries oceanography. It is true that frequently direct fisheries support has been limited to programs that later views consider too small in scale: it is also true that the earliest larger-scale oceanographic expeditions were mounted by countries with fisheries interests. The work of the Challenger expedition in the nineteenth century did contribute to general oceanography and to fisheries oceanography, and it surveyed non-fisheries areas as well as fisheries areas of the ocean. There can be little doubt that part of England's motivation resulted from her long history as a fishing nation. Helland Hansen and Nansen, who are still cited as contributors to physical oceanography, would not have eschewed the name of fisheries oceanographer.

Fisheries oceanography should be trying to see that the study of the ocean in general is pursued and supported, since it is only from a general understanding of the ocean that the many particular fisheries problems can be viewed in proper perspective. The wider the separation of fisheries oceanography from the general field, the slower will be the progress in each.

I believe, therefore, that fisheries oceanography should not try to remain in a separate compartment, and that we should resist all efforts by other oceanographers to put them there.

These thoughts may not be original -- I hope they are not unique. In any case, good luck in your survey, and I look forward to hearing what others have said.

**FROM:** Dr. C. P. Idyll, Chairman, Fisheries Division  
The Marine Laboratory, Institute of Marine Science of  
the Univ. of Miami, Miami 49, Florida

**Dear Wib:**

Please accept my apologies for the delay in answering your letter on "Fisheries Oceanography." By the time I got it, your deadline had passed. I thought from the way your first letter read that it would not be useful to you to answer thereafter. On receipt of your June 1st letter, however, I have set down the following:

In producing a definition for fisheries oceanography, the task will be simplified if we regard oceanography as a scientific pursuit. We thereby eliminate engineering and many of the mechanical aspects of catching fish which intrude themselves into a definition embracing all men engaged in the study of the ocean and of fish stocks.

We can then define oceanography as studies of the ocean and its inhabitants, employing the principles, disciplines, and procedures of science, including observation, deduction, and

controlled experiments. Then, an oceanographer is a scientist engaged in such an activity.

These definitions differ slightly, but significantly, from those quoted by you, that "oceanography is the study of the ocean, its boundaries, and its contents" and an "oceanographer as a person engaged in such studies," by requiring that the studies be based on scientific procedures and that the practitioner be a scientist. It eliminates the difficulty that under the other definition are included "fishery officers in Aden, Somalia, and Tanganyika" who are encouraging native fishermen to use outboard motors, steel hooks, and nylon webbing, and who are obviously not fishery oceanographers.

The next step is to define fishery oceanography. I find this difficult because I doubt the existence of studies which are immutably "fisheries oceanography" or not "fisheries oceanography." There is no branch of science called "farming meteorology," or "picnic meteorology," nor is there "warfare oceanography" or "navigation oceanography." A science serves a special purpose when the information becomes useful. This may be sooner or later; it may be applied the day it comes out of the calculating machine, if the research program which produced it was designed to fill a recognized gap in knowledge; it may be applied generations later, as other parts of the puzzle are assembled so that the usefulness of the older data is at last clear. Any argument as to whether a certain program of oceanography is "fisheries oceanography" seems to me as sterile as attempts to make a permanent distinction between "basic" and applied research. Some kinds of research are clearly applied since they were designed from the beginning to solve a specific practical problem; some kinds of oceanography are clearly fisheries oceanography, since they are designed to describe some part of the living space of a particular stock of fish. But the most basic of research overnight may become useful, and be applied to the solution of the most crass economic problem -- perhaps to the chagrin of the scientist who may feel soiled by this brush with the economic world. In the same way oceanographic research carried out for the "purest" motives may suddenly be applied to the fuller use of an economic fish stock, and the work becomes fisheries oceanography. Hence, my definition of fishery oceanography is the scientific study of the ocean which is applied to the better utilization of ocean fish stocks. The fishery oceanographer is the scientist who performs such work.

Of course, by these definitions, oceanography may change from "non-fishery" to "fishery," and the oceanographer become a "fishery oceanographer" long after he has performed the work -- and perhaps against his will. By this definition the blood biochemist, and the mathematician of your examples are fishery oceanographers, and so are the men providing estimates of fishing effort and regulating the fishery, so long as they use the disciplines and methods of science in their work. The fishery engineer designing boats and gear, and the "master fisherman" raising the productivity of primitive fishermen are

not fishery scientists.

We can now consider the accomplishments of fisheries oceanography, meaning the scientific study of the ocean applied to the better utilization of fish stocks. Many fine and useful studies could be listed, and to their sum would make a voluminous and impressive record. There is no doubt that fishery scientists have scored triumphs in the North Sea studies, in the waters off California, on the Grand Banks, in the North Pacific halibut grounds, and in many thousands of other big and small contributions to the knowledge of the ocean and its contents which have been applied to the utilization of fish stocks. But if the contribution seems large by this measure, it seems small in relation to what we must know urgently. It can be said of any field of endeavor that its accomplishments are inadequate compared with its potential, and this is clearly true of fisheries oceanography. Fortunately, we appear to be on the verge of immense progress. Any branch of science must await the development of suitable techniques and tools; fisheries oceanography has progressed rapidly in this field in very recent years, so that we can look forward to accelerating accomplishment.

Fisheries oceanography should be trying to gather knowledge leading to the more efficient and rational use of exploitable fish stocks of the sea. Fisheries is ecology, the scientist seeking knowledge of the fish stock and of the environment occupied by the stock. Fisheries oceanography should therefore be attempting to describe the fish stocks, particularly their responses to environmental changes, and the changes themselves. The cause and effect relationship between environmental changes (including predation by man) and the size and character of the fish stock is the final aim of fisheries oceanography.

What is urgently required is more careful planning of fisheries oceanographic research. This includes a clear understanding and statement of the objectives, an experimental design which fulfil these objectives. There is too much haphazard collection of data which cannot in the end be used, or which at best would have been more useful if its application had been thought through beforehand. There is also far too much attempt at justification of ocean studies on the basis that they are required for the advancement of the fisheries without any actual attempt to design them for such a purpose.

Although oceanography has been called here "a scientific pursuit" it is not a separate science. It is, instead, the application of the traditional sciences (biology, chemistry, physics, geology) to ocean problems. Therefore, "progress needed in other sciences" is a meaningless phrase. In solving the increasingly complex problems of the ocean, we need as keen minds and as sophisticated apparatus as we can get, as fast as possible.

FROM: Dr. Allan C. DeLacy  
College of Fisheries, Univ. of Wash., Seattle 5, Wash.

Dear Wib:

Your December letter regarding a "SCOR Working Group on Fisheries Oceanography" has been at my elbow for months. My tardiness in replying is not consistent with my attitude toward the project you have undertaken. I think it most proper and strictly necessary that some overall assessment of purpose, progress, and planning be made for the benefit of those organizations and individuals who wish at least some loose guidelines for their activities. Those not interested in guidelines should find in your group's work at least a stimulus to their thinking, and assistance in clarifying their own objectives, whatever they may be.

I am going to comment mainly on your points three and four. Not that the other points are unimportant, but it seems to me that establishment of an objective is the way to start. With the objective identified, one can suggest methods of approach and determine what progress, if any, has already been made toward realization of the objective. I am not too concerned about what name or names should be adopted and applied to the disciplines or interdisciplinary areas which are involved in attaining the desired objective.

The crucial objective for fisheries-oceanography is to provide explanations for the fluctuations in at least the major marine fisheries. The fisheries scientist can or should be able to recognize changes in fish abundance, but he will never be able to fully identify the causes for these changes unless he has broader data than can be acquired from catch statistics, age analysis, or any other study of the fish themselves -- including stomach analyses and even an appreciable knowledge of the fluctuations in abundance of key food organisms.

Unless the fisheries agencies know why fish abundance is changing, the concept of a maximum sustained yield will remain merely a dream. By teaming with oceanography, fisheries has some reason to hope that sufficient understanding of environmental factors can be attained to afford reasonable explanations of changes in fish abundance. With such knowledge at hand, there can be some prospect both of estimating the magnitude of biological resources in the sea and of determining the effect of natural and imposed factors on the total attainable yield from the important ocean fisheries of the world.

It is self evident that fluctuations in the abundance of fish cannot be explained, or properly related to environmental factors, until appropriate criteria for recognizing fluctuations are established. A large proportion of fisheries work has been and is devoted to the establishment of such criteria. This type of work must be continued and extended. Not only should attention

be given to species inadequately studied at present, but the possibilities of interaction also need to be explored. That is, from the supranational viewpoint, it is not enough to know, for example, that the North Atlantic herring can support a maximum sustained yield at a given level, but one would also want to know whether a maximum herring catch is compatible with maximum production of halibut, cod, etc. Fisheries-oceanography should not become directly involved with regulatory actions, but fisheries-oceanography should be able to provide data which will not only permit reasonable estimation of maximal tonnage of marine food products but will also allow those who must formulate regulations to gain a fair idea of the compromise in total tonnage which is likely to accompany any efforts to secure a maximum sustained yield in one specific fishery. A long step toward understanding the interaction of the fisheries will have been taken when the factors which influence fish abundance and catch have been thoroughly delineated.

I think that the summarizing statement which the Working Group will put together should take pains to show that the interchange of ideas and information between fisheries and oceanography is not uni-directional. If it is likely that fisheries stands to make great progress as a result of effective coordination between fisheries and oceanographic programs, there is also much to think about in your statement that "the fish we study are much better oceanographers than we are." Participants in fisheries-oceanography programs should witness a dissolution of any initial imaginary barriers between their interests and find that the collation of appropriate data is mutually beneficial. Whether a fisheries-oceanographer becomes recognizable as a distinct employee type is much less important than that we get on with the amalgamation which must take place if early and rapid scientific advances are to be made in the field of fisheries-oceanography.

**FROM:** Mr. Stewart Springer  
Duke University Marine Laboratory, Beaufort, N. Car.

Dear Dr. Chapman:

This response to your letter of June 1st will comment only on Item 3. of your terms of reference -- that is -- to state what fisheries oceanography should be trying to accomplish. I expect that already you have received comments pointing out that fisheries oceanography is a bastard term, that oceanography is easily defined if no attempt is made to involve its many applied phases, and that fisheries science refers to applications of a series of disciplines to a single practical goal.

Fisheries oceanography is an applied field and as a composite must draw on the findings of a series of specialists. The most important contribution of fisheries oceanography would be to provide more numerous and better points of contact and

cooperation between specialists in various fields to solve practical, general problems of fisheries.

To reach an ideal situation, two things seem needed. The general principles dug up by specialists need to be put in forms that are understandable to a generalist in fisheries. Secondly, generalists in fisheries must somehow relieve themselves of prejudices favoring some particular specialty as a source of the essential ingredient in the solution of all practical fisheries problems.

In your Christmas letter you mentioned the cook book oceanographers. I would like to reverse some of the implications and suggest that better cookbooks are needed from oceanographers. Better cookbooks are needed from all the other specialists as well. With a wider availability of good interpretive cookbooks, we might find that generalists in fisheries would make consistently better application of available knowledge to practical fisheries problems.

It would help also if specialists could accomplish the almost impossible task of wiping off their sneers for the values of findings of specialists in other fields. Perhaps eventually the top specialists of one kind or another could be relieved of the necessity suddenly to cope with problems requiring experience and competence over a wide area.

The responsibility of the oceanographer is to make his findings or his determinations understandable to a generalist in fisheries science who should select and apply these.

**FROM:** Dr. S. J. Holt, Chief, Fisheries Biology Branch  
Food and Agriculture Organization of the United Nations  
Viale delle Terme di Caracalla, Rome, Italy

Dear Dr. Chapman:

In your capacity as convenor of the SCOR Working Group on Fisheries Oceanography you have sent enquiries to a large number of scientists concerning their understanding of what fisheries oceanography is or should be.

I thought that at this stage you might be interested to know the definition which we would propose to adopt for our purposes in our Program and specifically, as a starting point for discussion of this subject by the FAO Advisory Committee on Marine Resources Research when it is convened. We have for some time been acting on the assumption that fisheries oceanography is defined more or less as formulated below, the basis for our view being not so much a very broad enquiry, but from our contacts with scientists who appear to regard themselves as fisheries oceanographers, with scientists who appear to regard themselves as fisheries hydrographers, and with those who have discussed

such matters in, for example, regional fisheries bodies, and in connection with the formulation and execution of FAO programs. The exact words of the version below are those of Dr. G. L. Kesteven, who has recently completed a draft for a Manual in the FAO Manual series on Fisheries Biology. This draft is being used as a basic text for training courses in Australia. Dr. Ruivo and I think his formulation is excellent and put into concise language our review of the matter, while necessarily taking for granted definitions of other words contained in the definition of fisheries oceanography, words which are commonly used in scientific discussions and not too badly perverted by persons wishing to apply personal definitions for ulterior purposes. The definition is as follows:

**"Fisheries oceanography is the occupation of oceanographers, who, within fisheries programs:**

- 1. Maintain liaison between fisheries biologists and oceanographers by:**
  - a. Interpreting oceanographic data and theory for the fisheries biologists;**
  - b. Making demands on oceanographers on behalf of fisheries biologists.**
- 2. Plan and carry out special projects of oceanographic research on behalf of research programs in fisheries biology.**
- 3. Collaborate with fisheries biologists in:**
  - a. Their search for, and analysis of, relationships in our fish stocks planned, with environmental components, and**
  - b. Their development of methods and systems of prediction of the dynamics of these stocks."**

The members of your working group might be interested in this definition. Incidentally, we were a little surprised to learn from Dr. Kesteven that he was not among the persons whose opinions you had asked on this matter. If you think it would be useful, we should be quite happy to look at the list of names you have compiled, and eventually we could advise the names of other scientists who might well be able to contribute to your study.

**FROM: Dr. W. M. Chapman, Director  
Van Camp Foundation, Division of Van Camp Sea Food Company  
739 Golden Park Avenue, San Diego 6, California**

**Dear Sid:**

Your letter of June 27th arrived just as the Tuna Meeting was getting under way, and I have not had time to draw a full breath since then until now.

I have not personally solicited opinion on the Fishery Oceanography questions posed by Dr. Humphrey as terms of reference of our SCOR Working Party from anyone outside of the United States and Canada, except the members of the Working Party which Dr. Humphrey selected. I solicited much opinion from about three hundred such persons in the United States and Canada and received useful opinions from about a third. This has proved to be all the work load I can handle on this subject. I am in the process now of collating and reproducing these replies for circulation to the Working Party and will send you a copy when this is completed.

I had informed the other members of the Working Party of my actions respecting workers in the United States and Canada and suggested to them that they might want to do this elsewhere in the world, and in doing so suggested areas that they might wish to cover so that we would have world opinion on the matter reasonably well covered without overlap. Dr. Davies and Dr. Uda, at least, have done this, and have sent in reviews and copies of replies they received. I have not yet heard from others. I believe Australia was in Dr. Cushing's area. While I have not heard from him directly on what he was doing in this respect, I did hear from Pannikar when I came through India that Cushing had made inquiries of him. Thus I suppose that Cushing will inquire of such persons in Australia as he feels to be needed for his purposes. This, at any rate, is why I did not inquire of Dr. Kesteven.

The definition of fishery oceanography and fisheries oceanographers which you quote from Dr. Kesteven would appear to be considerably more restrictive than is shaping up from correspondence I have had so far in respect of these points.

1. Fishery oceanographers of this continent are not considered to be confined to persons inclusively engaged within the fisheries program.
2. In this area, at least, fishery biologists do not successfully make demands upon oceanographers. The way they get the physical oceanography they need done is either to work in close coordination with physical oceanographers or do it themselves. By either means one comes out with a man knowing a good deal about both fishery oceanography problems

and perhaps it is this product which may be called a fishery oceanographer.

3. We do not consider that fishery biologists and oceanographers are exclusive groups having a chasm of experience and aspiration between them that Dr. Kesteven's definition would contemplate.

Nevertheless, Dr. Kesteven's definition is a useful one to consider along with the others we are collecting. Accordingly, I am forwarding copies of your letter with this reply to other members of the Working Party.

The Tuna Meeting turned out to be a most useful one. Horatio will be bringing back the details soon.

**FROM:** Dr. S. J. Holt, Chief, Fisheries Biology Branch  
Food and Agriculture Organization of the United Nations

Dear Dr. Chapman:

Many thanks for your letter of July 16th concerning the definition of fisheries oceanography. I have only just seen this on my return from a short leave, and the points you make are well taken. My comments on them respectively are, however:

1. I think a fishery oceanographer must in practice be considered as someone working within a fishery program. The others are merely oceanographers interested in fisheries problems, which is another matter.
2. Kesteven's definition does not say that the fishery biologists make demands upon oceanographers, but that the fisheries oceanographers make demands on behalf of fisheries biologists. His definition also does not say anything about whether they are successful in this.
3. The replies to your questionnaire which Cushing has compiled do indeed seem to show a very big gulf between fisheries biologists and fisheries oceanographers on the one hand, and non-fisheries oceanographers on the other. All my experience of the last few years tends to confirm this view. There is, indeed, a big chasm both in experience and aspiration. Although the chasm can be bridged by understanding; it cannot be closed, because indeed the divisions of experience and interest will continue.

**FROM:** Dr. Richard A. Barkley, Chief, Oceanography Program  
U. S. Dept. of Interior, Box 3830, Honolulu 12, Hawaii

Dear Dr. Chapman:

It is flattering to have you solicit my opinions on fisheries oceanography, not once, but twice. The enclosed report, which was written to meet a March 1st deadline, will explain but perhaps not excuse my lack of response to your first letter. At the time I did not believe, and I still do not believe, that my opinions can be of any great value to you, especially when one considers the rather short period of time I have spent in the field of oceanography, and the still shorter time spent in considering oceanography in relation to fishery problems. Still, for what they may be worth, you are welcome to my comments and free to quote from what follows.

Whenever the discussion gets around to definitions, I think of the way in which the definition of gravity must have changed after Newton's work, and then after Einstein's. I believe that definitions of any but the broadest categories are little more than working hypotheses, subject to change depending upon their purpose and the state of knowledge in a given field. Therefore, when I am asked for a definition, I must in turn ask what the definition is intended to accomplish. By the same token, lists of accomplishments in a field such as oceanography applied to fisheries will depend upon definitions, as will a statement of aims for future work.

Any perusal of the history of science will reveal that the majority of all fundamental advances came about in ways which the wisest could not have anticipated. For example, there was a time when mathematics lacked the notions of "rate of change" and "function," although certain branches of mathematics were then in a highly sophisticated stage of development. At that time no one could have anticipated the most elementary results of modern physics, which depends so heavily upon the concepts of a function and rates of change. It therefore seems to me that attempts to anticipate fruitful fields of research are apt to be, at best, thankless endeavors, except in a very short-term sense. This is somewhat less true of oceanography, which depends upon other sciences, than it is of the more fundamental disciplines like chemistry and biology. Still unanticipated advances in our knowledge can easily make such deliberations seem quite useless.

Yet there remains the problem of getting something done to advance what you call fisheries oceanography. I believe that there is much that could be done, but that research scientists are not the ones to do it. What is required is a type of engineer, who can take the results of scientific research and apply them to practical ends, with economics as his guide and the techniques of engineering as his tools. Let the researcher solve his little puzzles as he will; this is what he will;

this is what he will probably do anyway, and by doing so he is contributing the knowledge which the engineers will need in their work.

If there is a lack of fundamental information for engineering applications, I cannot believe that the solution is one of trying to make engineers out of researchers. It would be vastly better to make sure that there are enough scientists trained and interested in oceanography and in fisheries, and insuring that they and their training are of the highest possible caliber. The best scientists will inevitably tend to pick the most rewarding problems, so that one first-class man can often accomplish more of value than a platoon of the less talented could.

If research is left in capable hands, with adequate (not necessarily lavish) financial support, we can turn to the problem of applying engineering techniques to the problem of harvesting the oceans. In this case the objectives are more manageable; the problem is one of obtaining the maximum economic yield from the resources at hand, or potentially at hand. If the analogy between farming and man's use of the seas is valid, it would seem that we are just emerging from the stage of foraging for food where we find it, and that we can anticipate that to some extent the oceans will begin to be "farmed." This is a commonplace observation, but I think it will prove valid. It would seem promising to try to select breeding stocks, diversify "crops," and mechanize the work as much as possible. We should consider (as has been done, to some extent) the economics of harvesting the apex predators as compared to sources of protein nearer the base of the food chain. Perhaps a combination of yields from land and sea would be best in some cases, such as raising cattle food in the oceans, or feeding the products of the earth to "domesticated" fish. As on land, we may find productive and marginal areas in the oceans which can be made to yield what we desire, instead of "weeds." This is presently the case in the Philippines, I understand, where shrimp are grown in salt water ponds.

Brute-force techniques are not apt to be effective in dealing with the oceans as a whole, but our puny efforts may be effective if selectively applied. Certain types of circulation systems tend to concentrate nutrients in some areas of the oceans, as in the eastern tropical Pacific. Perhaps we could develop means, in such areas, to modify conditions slightly and thus increase productivity. Man-made changes in what Stommel refers to as the "joints" of the oceans could produce significant effects in the ocean nearby out of proportion to the amount of effort involved, and these are probably the areas where engineering effort should first be applied.

In closing, I might add that I am more or less committed to the third school of thought, cogently described on page 7 of your December letter, although there are elements of

both the first and second schools in what I have written above. I am entirely in sympathy with your efforts to bring some order out of the sometimes chaotic efforts to relate oceanography to fisheries, and feel that we can best get at these relationships by looking at the entire ocean-atmosphere-biota system as a unit. Let me, however, make a plea for diversity, both of research interests, and of research methods. Too great a unanimity in our approach to these studies would worry me more than considerable controversy and conflict would, because we would then be almost certain to miss some good opportunities for important discoveries.

FROM: Dr. J. Laurens Barnard, Beaudette Foundation for Biological Research  
1597 Calzada Road, Santa Ynez, California

Dear Dr. Chapman:

I am so glad that you wrote me again. Your first letter arrived here months ago and was logged in while I was away, but when I returned, your letter and others somehow had been lost, perhaps swept away by a janitor. We knew that one had come from Van Camp Foundation. I called Terminal Island cannery but they had not heard of Van Camp Foundation, suggesting Stokeley's-Van Camp. I called your Chicago offices but they also could not supply me with information. I am happy now to be able to apologize for my negligence in not answering your first letter.

My discussion of your four points must have its frame of reference based on my stubborn support of basic "climb the mountain" research and revulsion at the constant bothering of the basic workers with questions "What good is it?" But I have an enormous appreciation for technological research. I am an idealist in my belief that basic exploration should precede application, feeling that more effort should be expended in compiling the "blue book" from which technologists can obtain their sources, ideas and background information. But things don't work that way: the technologists are always ahead of the scientists in their press for a better way of life; they are more romantic and less orthodox and because of economic pressures are able to support trial and error methods in a more grandiose way. I always like to think, however, that Thomas Edison's work could have been more routine had he been supplied with a blue book replete with the properties of all earthly substances, formulated by the curiosity of the basic researcher. Because he did not have such a compendium, he had to contribute to one himself, and that is the case today in all technological research. I have deplored the fact that scientists could not fully explore and experiment with the great American forests before they were decimated and I worry about our exploitation of the sea before we have begun to put together a really decent picture of its natural ecology. Hence I am a strong supporter of the basic research explorations and experiments regardless of their potential economic value.

Definitions: Fisheries oceanography can be nothing but totally encompassing in our era. There is no known property of the sea that is not influential on marine vertebrates to some extent and most properties of the atmosphere, many of the terrestrial, and many factors outside our planet have effects which must be measured and understood. I cannot envision much progress in the understanding of fisheries without taking a broad view and bringing together the talents of both the technologist and the scientist and the hybrids between them. But I don't think that the primary stimulation and the major monetary support can come from the technological side because all the commercial fishery companies in the world couldn't borrow enough money to support the encompassing research needed. The commercial interests will have to use their research money at the product end - better processing, better distribution, advertising, education and stimulation of governments (i.e. the people) to provide the research funds for the understanding, control and conservative exploitation of marine resources. The old adage, "a dollar of basic research today will provide 100 dollars to the economy in the next 50 years" seems most appropriate to fisheries today.

I realize that those who use the term "fisheries oceanography" want it to mean something definable. I can make it something moderately restrictive only by imagining a giant marine research institute with 2,000 scientists and employees divided into numerous departments, one of which was entitled "Department of Fisheries Oceanography." Who would be its staff and what would they do? The staff would comprise scientists no less well educated than any other department. They would be initiating projects on their own, enlisting cooperation of specialists in other departments; they would have some projects running on a team-research basis and have other individuals permitted to work entirely along on any project they cared to. Some individuals eventually would find their projects unsuitable to the Fisheries Oceanography department and they would move to another department to continue their line of endeavor. Other individuals in other departments would find their research developing along lines more suitable to fisheries oceanography and move to that chain of command to carry out their ideas. Not all persons working on fishes would be assigned to Fisheries Oceanography, for their would be a separate department of Fish Taxonomy, a separate department of physiology with many ichthyologists engaged in special researches, etc. But here in Fisheries Oceanography would be concentrated most of those individuals concerned with any problems having to do with fishes that are now commercially important or have some promise of being so, provided those problems have "scope." "Scope" is that abstraction applied by academic committees when reviewing the plans of a doctoral candidate for his dissertation. A dissertation must demonstrate its contribution to an understanding of natural laws and as the small part it will pay in such understanding is formulated, the observer-writer must be looking at the whole picture to determine the sensibility of the work he is doing.

Hence the fisheries oceanographer would not duplicate the commercial landings analyses already made by government workers although he might use their results. He would not engage in the technological problems of canneries or marketing but would start at the other end of the scheme and work towards the landed product.

An important part of the staff of the Department would engage in the putting together of the pertinent pieces of information being published by all the other types of oceanographers not engaged in studies of fisheries. These persons would form a loose committee of individuals who initiate team programs to fill in missing links that would be needed to round out any fishery picture from pieces studied by others.

Contributions: Believing that the concept of fisheries oceanography is new (post War II) I don't think we can credit it (as a discipline) with most past accomplishments. Of course, many post scientists would today be called fishery oceanographers but I don't think they thought of themselves in that light. Most certainly C. G. Joh. Peterson and J. Schmidt would today be called such but I feel they probably didn't conceive of such, being too busy to care. Perhaps Davis fits even better the ideal and may have considered himself as such. Mendel may have founded genetics but one can hardly call him a geneticist except in retrospect. I feel it only fair that the accomplishments of fisheries oceanography should be tallied after it has been recognized as a discipline. No doubt witch doctors practice some excellent psychology but are scarcely psychologists. Perhaps this view smacks of over-organization but it also forces the modern specialist to prove himself and his discipline and not to shine in the light of borrowed past accomplishments. Hence, the contributions in fisheries oceanography are still too fresh to merit historical perspective.

Goals: Fisheries oceanography era should be compiling the basic blue book of fish and fishery ecology. They should be able to put together the individual and related stories of each fishery in terms of its history, its size, the effects of mankind, its optimal rate of production, its migration, yearly and cyclical habits,

its influence on other fisheries, its future potential and its conservative management, as well as a host of other factors. Its scientists should imagine they were going to contribute to a comprehensive book concerning the individual fishery.

The enormous amount of oceanographic information needed presently has been well catalogued in the NAS reports and almost all of it could be justified as an expense to our people on the fishery improvement basis alone. Almost all oceanographers and marine biologists could be labelled fishery oceanographers for purposes of justification of the NAS program. Parenthetically, I feel that the NAS program over-values the need for ships and is much too skimpy on support of personnel and analytical laboratories. The bulk of biological materials collected by present USA oceanographic vessels goes unanalyzed.

I think more long-term programs such as the Tuna and the Sardine studies are warranted. The results of these have been most fascinating to this invertebrate zoologist although I cannot evaluate their "usefulness" to the immediate economy or whether their monies have been managed efficiently.

Our country needs to stimulate oceanography in general by providing more full time research professorships and positions in research "centers," so relieving some of our excellent research oriented academicians from "pile driving" responsibilities better left to teacher specialists and administrative specialists. Loss of research men to administrative posts should not be caused by their being attracted to better pay. I confess I have yet to see the scientific organization which couldn't benefit from having a few superb research men assigned to research and drawing better salaries than their chief administrative officers.

Progress in other sciences: Progress in general marine invertebrate taxonomy seems most essential, for the analysis of gut contents of fishes has been hampered by the lack of specialists and the lack of identification of the individual food components. Most certainly a great deal of value is to be extracted from knowledge of the food of fishes and other fishery members. We are especially weak in the USA on the Thorson type of invertebrate larval studies which would help greatly in studies of fish food and the availability seasonally of not only larvae but planktonic and benthic adult prey.

Sea-bottom mapping, such as bathymetry, sediment types, and benthic communities has been sorely neglected, always lagging far behind water analyses. Our country could well afford to support a U. S. Biological Survey patterned after but improved over our U. S. Geological Survey, in existence for many years.

The whole shallow water organic budget needs lots of attention and justifiably lies largely in the field of fisheries oceanography for I conceive that the word "fisheries" should eventually be replaced by some ingenious term synonymous with "organic matter."

Essentially we are looking for ways to improve our utilization of organic matter-in the sea. Today it is largely concentrated in fishes and crustaceans, the word "fishing" having been generalized to include almost any type of animal

(and occ. plant) harvesting. Probably the future will find us by-passing fish, as much as we by-pass deer on land, for the top herbivores and carnivores are far too wasteful sources of organic matter. They are energy depleters, we will have to harvest and farm the fish's food and the foods' food!

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FROM: Howard H. Eckles, Assistant to the Science Adviser, United States  
Department of the Interior, Office of the Secretary, Washington 25, D. C.

Dear Wib:

I have not replied to your letter of June 1 and your previous request for information on fishery oceanography because I did not feel that I had worthwhile contributions to this subject, over and above those you have received from Elton Sette and many others. I realize that it has been somewhat impolite of me not to reply to your request, and at this time I will attempt to give you a few thoughts on part of your questions. I do not have any objection to your including this in your compilation of replies to your request, however, on the other hand I do not regard the contribution as a large one and for this reason you may not wish to include it.

I would like to comment on your question number one "to discuss and define the subject of fishery oceanography" by adding a bit of information which other contributors may not have furnished. I would recommend as a matter of policy that fishery agencies take strong leadership in the field of biological oceanography. This means hiring oceanographers directly on their staffs and developing a team of physical oceanographers and biologists to attack problems of oceanic productivity which lead to discovery and efficient harvesting of fishery resources. I contrast this with the policy which has been followed on the part of some research organizations, which is to obtain oceanographic services through cooperative arrangements of one kind or another where scientists of different organizations work on common fishery problems. I do not mean that there has not been good progress on cooperative programs, but by comparison I believe the best progress has been made when oceanographers and biologists have been assembled on the staff of agencies with a fishery mission.

To be partly facetious, I believe an oceanographer becomes a fishery oceanographer when he dedicates himself to discovering attributes of the ocean which bear on biological and hence fishery production. That is, he has a keen interest in fish as an end product of his research. Success in these endeavors seems to be enhanced when the pay check of the oceanographer comes from the agency responsible for fishery research.

In response to your question number four which is "to state what progress is needed in other sciences so that the aims set out in number three can be attained," a much better understanding of the biological and environmental requirements of marine organisms is required. Much time has been spent taking oceanographic observations to support fishery investigations without a clear understanding of whether or not the most important parameters are being measured. Fish populations may be responding to many factors about which we have no knowledge at the present time. In this regard, I believe we need much more emphasis on taxonomy of all marine species so that we will know the identity of the critters we are studying. This effort should be paralleled with research in the laboratory and at sea on physiology of all life stages, response to environmental variables, and on behavior of marine organisms in all aspects.

Concerning your item number five "...communication through various agencies..." you are a master at communication as evidenced by the task you are undertaking at the present time. It is my hope that you will be successful in this endeavor and that a much closer meeting of the minds between the so-called physical and biological oceanographer will be reached because of your efforts.

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FROM: J. D. H. Strickland, Fisheries Research Board of Canada  
Biological Station, Nanaimo, B. C.

Dear Dr. Chapman:

I have returned from Europe to find your letter reminding me that I had not replied to your letter of December 25th.

This is one of the oversights arising from putting a letter aside for careful consideration later and then losing it in the wash! I am truly sorry about this as I agreed very much with your approach and your own views on the subject.

However, I gather you have had enough replies and I can get away from under this again by referring you to the reply by Tim Parsons of my group here in Nanaimo. We see pretty well eye to eye on most things and you can assume my reply would have been on the same lines.

My major interest, which is the marine food chain, especially at the early levels, is now suffering from the fact that practically no outfit the world over will devote a businesslike coordinated program of research to this problem. A simultaneous attack is needed by phycologists, chemists, biochemists, plant physiologists, microbiologists, invertebrate zoologists, etc., etc. Without magnifying this into a bureaucratic empire, it should be possible to furnish the background and facilities for a multidisciplinary approach with some coordination and common interest of approach. We are trying to do this at Nanaimo, with some gratifying results, but the effort is still much too small.

We are at a stage where some of us know quite definitely that we really have hardly a clue as to what is going on in the food chain. A very serious start must now be made on the mechanisms of the basic steps in the food chain before we tear around the world's oceans measuring phosphorus chlorophyll a C-14 uptake and what-have-you. Without this all we will do is fill up imposing but dreary masses of data records and kid the powers that be that we are working and send the people who should be doing useful work around the globe talking about it to each other. The position is getting positively farcical but there are few signs of change.

A prize example is in the number of imposing and seemingly plausible mathematical models of the food chain that are bandied about, the basic assumptions of which are gradually being shown to be quite incorrect.

However, enough of this and my best wishes for your endeavors. I hope I may see you some day for a talk on this subject.

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FROM: A. D. Welander, University of Washington, College of Fisheries, Seattle

Dear Dr. Chapman:

I am sorry not to have answered your letters earlier. The delay is due more to lack of inspiration and what I would regard as a suitable answer to your questions than to any other cause. I am also a bit puzzled by the use of the term "Fisheries Oceanography." Hence, I doubt that any of the material below will be of much help to you.

In order to adjust my thoughts regarding terminology, and to define Oceanography, I have briefly outlined some of the topics below for my own benefit.

### Oceanography

- I. Biological Oceanography
  - A. Systematics (Classification, Distribution, etc.)
  - B. Ecology (Radioecology, animal behavior, life history, etc.)
  - C. Economics
  
- II. Chemical Oceanography
  - A. Chemical precipitation methods
  - B. Radiochemistry
  - C. Economics
  
- III. Physical Oceanography (tides, currents, geology, etc.)
  - A. Currents, tides
  - B. Radiation
  - C. Geology
  - D. Economics

With this sort of an approach it became obvious to me that Fisheries reaches in and makes use of almost every category listed above. This would indicate that the terms Oceanography and Fisheries Oceanography are synonymous. Thus, even though I am prejudiced, I cannot quite accept "Fisheries Oceanography" as a separate branch of Oceanography.

It would be difficult to state what "Fisheries Oceanography" has accomplished without a great deal of research and search in the literature. My general impression has been that Fisheries Research with it's attendant broad ramifications has added a lot of "muscle" to many aspects of Oceanography, and, perhaps, has been the backbone of its support. Fisheries scientists were early aware of the needs of a comprehensive knowledge of the ocean in order to gain complete knowledge of the habits, the life histories and systematics of fishes. Probably more than any other one group, Fisheries scientists have done more to coordinate the biological, chemical and physical disciplines of Oceanography. Any other approach would be too narrow and incomplete to get the job done.

It would seem logical that any statement of what "Fisheries Oceanography" is trying to accomplish would include a reference to the efforts of Fisheries Scientists to correlate and coordinate all the knowledge available from the various disciplines of Oceanography so that we can better understand fish migration, spawning, mortality, behavior, etc. In general, we are interested in all factors that affect the abundance, distribution and relationships of fishes and we have found by hard experience that many factors are involved. I would say that, for the benefit of

economy and for obtaining information on a broad front, any oceanographic expedition should try to gather as much data in the three main disciplines as possible. There is a tendency today to omit or reduce "biological time" during the period at sea which I deplore as doing only two-thirds of the job at best.

Ships and expeditions are expensive, but with a look at Japan, Russia and other nations it would seem that this is a very necessary expense. Further, when compared with the price of a rocket and the money we spend on outer space, the price we should pay for oceanographic vessels to enable us to obtain Biological, Physical and Chemical data of the oceans, especially in the areas near our shores that effect our economy. We also need the manpower, equipment and space so that the data obtained can be synthesized and analyzed and communicated to interested laboratories and organizations as quickly as possible.

We are beginning to make use of I. B. M. techniques in the synthesis of our data. Perhaps a standard program can eventually evolve which would be useful to scientists in all countries. We are beginning to use librarians who are specialists in our scientific disciplines thus easing the ever-increasing burden of scanning the scientific literature. These and other methods should be fully utilized to enable us to get information to interested parties in suitable form as well as rapidly.

As you can see these thoughts and opinions are rather general. The pressure of other matters and precluded any serious thinking of almost any sort in spite of the fact that I am supposed to spend most of my time doing just this. In regards to the radiological sciences as they fit into the Oceanographic picture relative to Fisheries research, radiation techniques should form a very valuable tool, especially in the biological aspects of Oceanography. I would include in this, irradiation techniques, using X-rays and other sources of radiation, as well as the use of radioisotopes as tracers in the qualitative and quantitative analyses that can be made with so much greater accuracy than by any other known methods. The outline on page one indicates where the radiological sciences might fit in the general scheme.

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FROM: Phil M. Roedel, Manager, The Resources Agency of California Department of Fish and Game, Marine Resources Operations, California State Fisheries Laboratory, Terminal Island, California

Dear Wib:

You said in your letter of June 25, transmitting the December 25 communication on fisheries oceanography, that a fudge factor existed in your July 1 deadline for comments. On the chance that the factor still exists I have this to offer.

Before I can comment on fisheries oceanography I must first define what the term fisheries scientist means to me. My concept is conditioned by many years in state service and may by this time reflect the belief of our Personnel Board---but I try to be objective.

A fisheries scientist is one who (a) holds at least the bachelor's degree in the biological sciences (this area as defined by the college in question), and

(b) is engaged in studies, requiring academic training for their successful pursuit, of fish and fisheries, be they sport or commercial, freshwater or salt. I will now take exception to point (a). I have in mind a man who does not hold a degree (though he is working toward one) but who is a better fisheries scientist today than many I know who on paper are better qualified. He is a *rara avis* to be sure, but in this business today we cannot afford to let good men slip through the cracks on technicalities.

Now, what are studies requiring academic training for their successful pursuit? These run the gamut from the highly sophisticated efforts of such men as Schaefer to the man responsible for habitat improvement work on a trout stream. This latter you may say, as others have, is management, requiring only cook-book application of techniques which could be learned quickly without taking up the time of our crowded halls of higher learning. So we once thought, and put all our inland eggs in a managerial basket, a basket into which anyone with a high school diploma and some will to work could fit. Within a couple of years, those responsible for proper improvement of streams and such things were raising a great fuss over the inability of non-professionals to do the job. Manager class or not, they let positions stay vacant until a reasonably competent biologist came into view. Today, a degree is prerequisite for all inland work save in hatcheries.

Obviously, you can slice this spectrum occupied by my fisheries scientist into many little compartments and restrict the term to, say, the top X-th percentile going toward Schaefer. I just don't happen to do so. Radovich, with whom I've been discussing this, does, and I have suggested to him that he transmit his views to you. (He did not get a copy of your original letter.)

By my definition, then, all the men on my staff who hold the title "biologist" are fisheries scientists. Some of them are very good indeed and some you would like at times to propel toward the door. At least one is highly competent in the field of population dynamics, another in systematics, another in mathematics. Each makes his contribution in accordance with his talents and abilities toward the solution of problems facing fisheries science.

Ideally, the fisheries scientist would be well-trained academically in biology, he would have taken mathematics into calculus, be familiar with a foreign language, been interested enough on his own to take electives in sociology and economics, and he would have done at least a year's graduate work in the field of fisheries. You don't find the combination very often.

You asked a series of questions as to whether certain people filled the bill as fisheries scientists: a blood biochemist, a mathematician, a man concerned with keeping track of changes in fisheries gear and vessels, and a part-time population dynamicist.

I would say the fourth would be so considered, the first and third might be, the second, not. If the blood biochemist came into the fisheries picture because of a particular interest in fisheries and simply is in the arena of blood biochemistry because that is the niche he best can fill, he's a fisheries scientist. If, on the other hand, he is just selling his wares in whatever market is available, and couldn't care less whether that market was involved with fish or Chihuahuas, he doesn't make the club. Similarly, the third man might get into his work through a fisheries scientist position (we have a biologist doing not dissimilar work), or he might be a fisherman hired to do this specific task for a fisheries scientist. The mathematician you define falls, for my money, into the category of the blood biochemist peddling his wares.

Your fourth man, the population dynamics-fisheries regulations chap, fits my definition of a fisheries scientist. He may, however, be moving along the trail which leads to the fisheries administrator. Here I place that group who do such things as run herd on research, devise regulations, and explain, or attempt to explain, programs and goals to plain administrators, industry and sportsmen. Fisheries administrators most often are ex-fisheries scientists.

The fisheries oceanographer is to me a highly competent fisheries scientist who is concerned with all that goes on in the sea and the atmosphere in his attempt to understand fisheries problems. He must obviously be skilled in such fields as physical oceanography and the higher levels of mathematics and possess the ability to think big. While I list him as coming from the ranks of the fisheries scientists, there is probably no reason why he couldn't come from the files of physical oceanographers. I have not met too many of the latter breed, but at least one of them fits the bill.

You remark on page 6: "One might say that all fishery oceanographers are fishery scientists and that the difficulty is in telling what a fishery scientist is." So far as all fisheries oceanographers being fisheries scientists is concerned, I have left the door ajar for people from other disciplines, though I suspect your definition is for all practical purposes correct. And I have the concept I stated as to the minimum requirements one must have to be a fisheries scientist. Granted there are the usual gray areas, but the definition has been workable so far as I am concerned. More nebulous is the point at which the fisheries scientist becomes a fisheries oceanographer.

I certainly agree with the third of the three schools of thought you describe, and my definition of the fisheries oceanographer is that of the man competent to carry on such studies.

Your first group hits pretty close to the truth so far as many who fit my definition of fisheries scientist are concerned. But that does not mean that fisheries oceanography fails to exist. Groups one and two are pretty much mutually exclusive, but groups two and three are not. My fisheries oceanographer would doubtless want, as Blackburn does, a physical oceanographer on his staff. No one is master of all fields, and certainly our CalCOFI experiences show more than an element of truth in the ivory tower concept.

I do not believe that things are crystallized enough at this point to say that fishery oceanography is yet a finite field. Perhaps it will distill from the mass of comments you have received. I imagine these run the gamut, but with enough of them a consensus should emerge, one which should encompass the various situations you mention. Certainly here the tuna and sardine people see a joint need for the approach held by your third group. Our people concerned with demersal and shellfisheries are equally interested though not as far along the road. So is the salmon group, bound though it now is by the immediacy of grave problems in our rivers.

On looking back at this, I find I may have given the impression that in my mind the crowning glory for a fisheries scientist was to become considered a fisheries oceanographer and a member of a select and esoteric cult. This is not the case. A goal should be, however, to interest and train a sufficient number of good biologists to carry out such studies on a far broader scale than now exists.

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FROM: John Radovich, Marine Biologist, The Resources Agency of California, Department of Fish and Game, Marine Resources Operations, California State Fisheries Laboratory, Terminal Island, California

Dear Dr. Chapman:

Phil Roedel asked for my definitions of Fisheries Oceanographer and Fisheries Scientist so that he might include them with his. However, my views were divergent enough from his, that I thought it best to send you my views separately.

To me, the term Scientist connotes a person with the ability to synthesize data into a working hypothesis regarding certain phenomena, and then test the hypothesis. He must have the ability to organize his thoughts creatively.

Many people who possess titles such as Marine Biologist, Aquatic Biologist or Fisheries Biologist are not what I would consider Scientists. Perhaps we should call them Fisheries Technicians. They have the ability and training to perform routine tasks associated with fisheries research programs, such as: sampling and measuring fish, reading scales, counting and sorting plankton, making hydrographic observations, and even cook-booking some life history projects. They would probably possess an A.B. degree or even an M.S.

A Fisheries Scientist would be more apt to have an M.S. or Ph.D., but the degree is not as important as the persons actual abilities. The scientist is the type who might be able to run a major fisheries program. He would have a thorough understanding of fisheries, including fundamentals of population dynamics, a working knowledge of economics, oceanography, ecology and other related fields. I would not classify a Geneticist who is working for a Fisheries Scientist on a fisheries problem as a Fisheries Scientist. The same could be said for a physiologist, taxonomist or even a Fisheries Oceanographer.

I feel that a Fisheries Oceanographer is an oceanographer who is working on an oceanographic problem which is pertinent to a fisheries problem.

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FROM: B. M. Bary, The University of British Columbia, Institute of Oceanography, Vancouver 8, Canada

Dear Dr. Chapman:

Thank you for your reminder of June 5th. I am glad to have an opportunity to add a note to your enquiry of December, 1961.

Is there any real basis to a definition of a "fisheries oceanographer" or a "biological oceanographer?" They are general appellations that have "just growed"; they mean something to those concerned, and will almost always cause indignation to someone when applied by somebody else to himself! This sounds facetious, perhaps, but I say it with your views on Item 3, P. 7. (letter of December 1961) in mind.

It seems almost impossible to delineate boundaries or define particular fields in ocean research except in general terms. There is inter-dependence in considerable degree and too much that is fluid in the subject, apart from the medium.

Specialization in the study of one group of animals (or plants) whether fish or plankton in general, or species or other defined group in particular, may involve the application of some general oceanographic (physical/chemical) information or data. Usually these data are obtained at second hand---and often are not even concurrent with the biological data concerned. In these circumstances there appears no cause to name the investigation "fisheries oceanography" or "plankton oceanography." Studies in this category seem to me to be in the general field of marine zoology---or marine botany.

On the other hand, where a concerted effort is made to collect concurrently, and to analyse, data on physico/chemical properties of the environment and on the constituent organisms, be they fish or plankton, and the study is attempted of all aspects in relation to each other, perhaps then the biologist would be justified in labelling himself a "biological oceanographer" with leanings towards fisheries, or zoo-plankton, or phytoplankton or what-have-you.

It seems to me, firstly, that the study of marine organisms cannot be attacked in isolation from their environment as many aspects of the biological, physico-chemical features of the sea are interdependent; secondly, environmental data must be collected concurrently with biological data. Organisms cannot be understood in their entirety unless associated with the environment as it exists at the time the study is made. Preferably the studies should be made in the field, at least initially, in order to define the problems more precisely.

An oversimplified diagram of the interdependence in the marine environment of fish, plankton and physico-chemical properties is indicated by the triangle: -



Included in the implications of such a diagram is that solutions to problems of distribution, many ecological relationships and much of the study of populations are to be sought for in the interactions of naturally occurring communities, their populations, constituent species and organisms, with other groups or organisms of their own or different kinds and with environmental factors. With a broadened comprehension of these interactions, isolated facts, e.g. of a more purely zoological content, may well drop into place as into a jig-saw. It would seem a necessity, however, to make a concerted effort towards determining inter-relationships in an overall approach of the "plankton-fish-hydrography" type than to try to determine each for itself and in isolation from the other two.

The above remarks are not meant to deny the proper place of zoological, botanical or physico-chemical studies. These provide the essential, basic constituents necessary to any advances in the more applied fields contained within ocean research. But it seems in ocean research that the zoological etc. advances in themselves usually do not constitute advances in the oceanic fields, unless supported by, or unless they can be integrated into, the broader picture "plankton-fish-hydrography." On the other hand, a foreseeable outcome of such a field study of inter-relationships is a series of investigations of the reactions of organisms to properties of the sea (as yet unknown), and through these reactions, on the occurrences and distributions of species or populations. That is, research of a more fundamental nature in bio-chemistry should develop as a result of an integrated field study, the results of which, in turn, can be re-applied to explain in detail particular situations existing in the sea.

Thus at present there appears to be a need (in my view, an urgent one) for correlated, integrated investigations of fish-plankton-hydrography, rather than investigations of one of these three parts (or sections of one part) in isolation, or in distant, second-hand relationships to the others.

In such a context oceanography may be subdivided in a general way into "physical" "chemical" or "biological," and these may be subdivided if one so wishes. As an alternative to defining such fields, the breadth of particular interests can be stated specifically, not covered by a blanket term of little meaning.

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The following is a series of replies received to my letter of December 25, to which I did not receive the writers' permission for reprinting at this time. The contents of some of these letters are pertinent to our Working Party. With respect to the anonymity of the contributors, each letter has been edited without a change of tenor.

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Dear Dr. Chapman:

I thank you for your Christmas message, which arrived just in time to ruin my New Year. Having just finished it this afternoon, kind friends are clustering round my bedside to resuscitate the reader after his epic ordeal. Pray excuse me a few hours.

Later: Convalescence for a week is my fate, and strict instructions to no more mail from California! "My written reaction" comes with deep apologies for no encouragement whatever.

1. What was it all about?
2. Progress in any sense of the word already has more than enough committees to encircle it and one so abstruse and long indeed as the one proposed, should, I suggest be avoided at any cost. At any cost at all! The most capable anonymity of this letter is due to my not being the director of our Institute. I apologize deeply.

Reference the mints of our present day endless tower of organization. Have you ever considered the "catch per unit effort" aspect? You will have no trouble bringing to mind a dozen marine stations that did sterling work in the past with perhaps just two men in each. And now, in their place, are great buildings with, in one place I know, a staff of fifty. Do you think fifty times more useful work is done? If not, then what is the remedy? Believe me, I remain sincerely, a well wisher of knowledge. . . . .

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Dear Dr. Chapman:

I wish to offer you my apologies for the letter which I sent to you recently.

Of your Christmas day circular I was not even an addressee, and it was only due to a friend showing me a copy that I read it. I rashly penned a reply and posted it before I considered my actions.

My sarcasm and presumption were both most objectionable, and I am heartily sorry for both. It is much better for me to apologize for these things late than never to do so.

I do apologize to you now, and most sincerely I now remain . .

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FROM: Dr. W. M. Chapman, Director  
Van Camp Foundation, Division of Van Camp Sea Food Company  
739 Golden Park Avenue, San Diego 6, California

Dear \*\*\*\*\*:

Please pardon my slowness in acknowledging the receipt of yours of January 28 and February 6. I was out in the Indian Ocean area from early January to late April, which put me behind in everything.

Your letters intrigued me. A person who holds such violent opinions must hold some useful, perhaps positive, ones also. Since I was not at fault in the first instance in sending you a letter from California, yet took the blame, I will now even things out by sending you one asking for your positive ideas.

The Working Group on Fisheries Oceanography had a very good reason for being, although not necessarily under that heading, examining that subject, or composed (or led) as it is.

I take it from your original letter that you are a strong proponent of the small marine station as the ne-plac-ultra for investigating the ocean, with liaison amongst them through private correspondence, private visits, and the scientific literature. As one who has worked in such, I am a very poor team member. I insist on working solo myself; my every instinct and feeling is with you. The trouble is that the world has passed on beyond us in its hurry, whether rightly or wrongly.

Unfortunately, there are major ocean and ocean resource problems that cannot be satisfactorily attacked on this scale, or, if that is not strictly true, are felt by the generality of those wishing answers to problems, in terms of at least decades rather than generations, to be incapable of effective attack by such means. While as an individual scientist I am with you, as a person wishing more rapid understanding of the ocean than those facilities can achieve, I am with the latter. Whether these views are correct or not, the United States, U.S.S.R., Japan, U.K., Canada, Germany, and some others are expanding their ocean research sharply and increasingly overlapping sectors of the world ocean. Their efforts are getting larger and the problems they are finding and tackling are also increasing as to number, size, and complexity. Whether they like each other or not, they are finding it increasingly desirable to pool efforts.

Two forces are adding to these tremendously. The first and largest is the huge amounts of money the Admiralties of the major maritime powers are throwing into ocean research in connection with anti-submarine warfare. In this country, at any rate, a substantial amount of this is diverted into academic institutions for basic research, giving them vigor and forced growth not anticipated fifteen years ago and not particularly relished by all. The second, and older, and smaller but still sizable factor is the rapid rate of growth of long range fishing, protein deficiency problems, and other problems connected with ocean food resources.

The first force generated the ocean research part of IGY. The Academic oceanographers particularly, and predominately those infected by the Navy bug, saw to it that there was an appropriate amount of ocean research in IGY. They liked the way this worked well enough that they tried by several means the continuation and better development of the international cooperation in ocean research efforts which IGY had initiated. The best instrument to develop from these proddings was the Special Committee on Ocean Research organized under the International Council of Scientific Unions. I do not think that anyone concerned with SCOR believes its organization, composition, methods of work, or financing is at all satisfactory or finalized. But there is no question that SCOR has served a useful function in stimulating international cooperation in ocean research.

But its own successes grew beyond its ability to cope with them. It began rather vigorously stimulating a means within the United Nations family to carry on. This resulted in the establishment of the Intergovernmental Oceanographic Commission within UNESCO, international politics reared its ugly head, and the Academic Oceanographers ran full head into fish people at the same time.

I do not wish at this time to argue the merits of the cases or to explain their origins, but will simply state two facts: (1) FAO Fisheries Division had visions of the new UNESCO Department of Oceanography dominating everything to do with the ocean in the United Nations family to its disadvantage. This was a jurisdictional fight which had other overtones from the competitive relations between FAO and UNESCO at higher levels, having nothing to do with oceanography or fisheries, (2) Fisheries ocean research in the world is considerable and of some status, vigor, and ability regardless of feelings elsewhere. Its practitioners have pride in their work. They are mostly employed by government. Their work internationally has been organized rather largely outside the Academic structure of ICSU or the United Nations structure of FAO, through other intergovernment organizations, primarily international fisheries commissions, including the International Council for the Exploration of the Sea, the International Commission for the Northwest Atlantic Fisheries, the International North Pacific Fisheries Commission, the Inter-American Tropical Tuna Commission, etc.

The fisheries ocean research people did not have any high regard for FAO in many quarters and would just as soon it stayed out of their business. But if it became a contest in the international structure between the fish people and the Academic oceanographers, they were prepared to side with FAO to the extent necessary to bring the Academicians into reasonable line and prevent their absolute dominance of the international ocean research scene. This fight between the fish people and the Academic oceanographers ran deeply and had rather solid historic roots in several countries, including yours, mine, Russia, Japan, and France to my personal knowledge.

The conflicts inherent in these forces arose at the Copenhagen meeting, where the IOC organization was shaped up. The protestations of the fish people were rather brusquely pushed aside. This had the result of submerging the fish peoples' interest but antagonizing them. They came to the first IOC conference last fall not well organized, but somewhat better prepared.

The scrap headed up over whether or not the SCOR was to be the sole advisory group to the IOC. The fish people said no. SCOR, they said, had no fisheries component worthy the name and was incompetent to advise IOC exclusively on ocean research matters. But the fish people had no alternative to offer. They had no group comparable to SCOR from which advice at this level was to be drawn. FAO was intending to establish an Advisory Committee on Marine Research Fisheries for its own in-house, and perfectly valid, purposes. This might be able to perform the same function in the fishery field as SCOR was doing in the academic field. But it was not established at the time of the IOC meeting (and is not yet) and nobody knew for sure just what sort of body this might turn out to be (nor do they yet). The upshot of this scrap was that its resolution was postponed for a year. IOC did not appoint SCOR to be its advisory committee but agreed to consider the matter anew at the 1962 meeting.

I have oversimplified this brutally and used terms which may induce semantic difficulties, both in the interest of brevity. My purpose has been to merely indicate that (1) there is such a thing as international oceanography, (2) it is of large size and growing rapidly, (3) as with all doings of groups of men, some sort of governance is required, (4) where public funds of these magnitudes are involved there will be governance either by the governed or, if they are incapable, imposed by the purveyors of the funds, (5) in international ocean research there are basic conflicts among those engaged in doing the work and those desiring to govern the work, (6) those conflicts are sufficiently deep-seated that they could disrupt the smooth and efficient increase in man's effort to increase his understanding of the ocean and its contents, and (7) in my view, at any rate, it is desirable that (8) not occur.

Not being appointed the exclusive advisory body to ICC was recognized by SCOR as indicative of something more serious than it had originally sensed with the fish people, and at its Monaco meeting directly after IOC it took the matter under advisement. The President of SCOR, Dr. Humphrey, felt that the proper way to react was to get some greater fisheries input into SCOR, but not to do so in a manner that might exacerbate the FAO-UNESCO scrap, which was only partially the fisheries-academician scrap. He felt most strongly that SCOR should do what it could to smooth over all of these fissures and bring a greater unity amongst the scientists inquiring into ocean processes to the end that this inquiry might move forward as effectively, efficiently, and swiftly as the entire scientific community could contrive. He thought that this could be best forwarded by SCOR appointing a Working Party on Fisheries Oceanography having definite terms of reference (those set forward in my letter of December 25), and having a definite short life of about a year (although capable of reorganization or reappointment as another Ad Hoc effort if that seemed desirable at the end of its short period of life).

At IOC and before, and still, I was on the ocean resources side of this scrap. Whatever I do I like to do with what small vigor and ability I have. Accordingly, I was active at IOC. Dr. Humphrey asked me to come to the SCOR meeting at Monaco. I did. I found myself completely in agreement with Dr. Humphrey's views, as set out above, and so opined. United States delegation, and thence on tour down along the African coast of the Indian Ocean arriving home the day before Christmas.

Here I found that Dr. Humphrey had asked me to be Convenor of the Working Group. I had no particular qualifications, I had no guide lines upon which to proceed, and I had precisely no time at all to devote to the activity.

On the other hand, I share every sentiment of SCOR for doing anything reasonable to forward the effective inquiry into ocean processes as rapidly as can be done and the avoidance of any controversies in the scientific community that might impede this. Having agreed with Dr. Humphrey's method of approach, I could not in good conscience refuse to assist it. Having no time, I hastily wrote a letter on December 25 and left it with my secretary to get out after my departure. I fed her back addresses as I traveled. We sent it to about three hundred and twenty five ocean researchers of all sorts in the United States and Canada, and I sent information copies to my Working Party colleagues in other countries but only as information copies to them as to how I was proceeding in my bailiwick. I sent it to no others abroad, so your reading copy came via one of my colleagues and was not intended for you.

I do not yet know whether this approach has been the correct one, but upon my return home in late April I found a huge stack of responses of a serious nature from a wide variety of ocean researchers of high and low estate. They indicate a wide and serious concern with these problems in the scientific community on this continent at least - a sufficiently depth of interest that I am prepared to put in a good deal more time on this project than I had originally intended or more than I can afford.

It is a curious thing that the only intemperate reply I had was from you, to whom I had not addressed a copy. I do not know you or your work. I do not know what ax you may have to grind. It has even occurred to me that a good portion of this fisheries-oceanography-flap may be due to other cases of the same sort, honest differences of opinion amongst fair minded persons growing out of lack of communication.

At any rate, I have spent this amount of time setting these matters out to you overhastily because your two letters taken together led me to think that you might have some practical and positive thoughts on these matters that might be useful to us. If so, I would like to have them. A copy of my letters of December 25 is attached. Keep in mind that its sole purpose was to stir comment and thinking. This it has done.

To put this letter in terms of tuna purse-seining, sometimes when you set blind on a wild flipper you get nothing; other times you get a hundred tons. I was rather interested to see what a blind set on this wild flipper might produce.

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Dear Dr. Chapman:

Fisheries Oceanography appears to me to be a title coined to take advantage of funds made available for oceanography, or more properly, oceanology.

A quotation from H.L. Sanders et al., *Limnology and Oceanography* Vol 7 No. 1 page 77 is to the point.

"The naive practice in applied fisheries biology of studying a commercial species in complete isolation from its biological environment can never lead to an understanding or even an insight of the problem. No species in nature lives in a biological vacuum. Broad, detailed and many-dimensional community investigations represent the only practical approach to a proper understanding of applied fisheries problems."

I think that there is only biological oceanography to be carried out by biologists working on life in the oceans, or physical oc - by physicists, etc.

Having denied the existence of fishery oceanography, there is little to say on accomplishments. Work done by fishery agencies on ocean research is a different matter. This does not sanction a new term. The agency might be studying any one of several sciences and probably should be. An established oceanographic agency cannot help but do work of interest to those whose main concern is with fishery resources. It is ridiculous to rechristen the staff "fishery oceanographers" if the agency comes under the administration of or receives its main finances from a fishery agency.

Those interested in the fishery resources of the world should support "broad, detailed, and many dimensional" investigations by competent scientists.

As to what scientists, we in fisheries research have allowed a confusing terminology to arise - "fishery biologist." Those in ocean research have used the loose term "oceanographer." In general, the fishery biologist is a zoologist who has acquired the necessary competence in mathematics to analyse the data available to him. An oceanographer is a scientist who has learned enough seamanship to gather his data from the oceans.

From the above it is obvious that the term "Fisheries Oceanography" is a catch-all title. From your letter it appears that "Marine Fisheries" is the topic under consideration. For its study, biologists of many specialities, physicists, chemists, engineers, meteorologists, and mathematicians are required. The prefix "Fishery" and the suffix "oceanographer" can be added if they are paid with fishery funds and if they gather their data at sea. The terminology, of course, is superficial.

Joint planning of ocean studies is needed to avoid duplication and to insure collection of data required by individual investigators. Present projects should be expanded at a reasonable rate as new scientists and technicians are employed to undertake new studies.

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FROM: Dr. W. M. Chapman, Director  
Van Camp Foundation, Division of Van Camp Sea Food Company  
739 Golden Park Avenue, San Diego 6, California

Dear \*\*\*\*\*,

Please pardon my delay in acknowledging receipt of yours of March 4. I was on tour in the Indian Ocean area from early January until late April, which has put me behind in my work.

Some comments arise. The quotation you give from Sanders seems peculiarly naive and dated. People in this part of the world studying the living resources of the sea have not operated in such a narrow frame of reference for a long while.

As usage appears to be shaping up in this correspondence, fisheries oceanography has been with us for a sufficiently long time that it is not required as a handle with which to acquire new appropriations or to climb up on a band wagon. As a matter of fact, some acquaintance with the field would indicate that funds raised in response to problems involving the commercial fisheries, and not for purposes of oceanography or oceanology in the sense you appear to use those terms (or leaning upon them), are contributing more to the elucidation of problems in physical and chemical oceanography, not to speak of general biological oceanography, than the return flow in a good many sectors of the world ocean.

You note that joint planning of ocean studies is needed to avoid duplication and to insure collection of data required by individual investigators.

Down this way we have looked with some envy at some of the fields of science more lushly financed than ours where duplication is a rather normal and valid part of the investigatory process. It appears in many aspects to be a most efficient way of proceeding. We have been engaged with rather meager funds in inquiring into such complex problems that we have had to plan carefully not only to avoid duplication but to attempt to see that the major variables are touched upon at all.

Another difference in our approach that has developed has been team work in which the individual investigator does not sit in an ivory tower ashore waiting for data to be collected for his study but goes to sea with the rest of the boys, collects data for all as well as himself and in the process gets that feel of the sea which we believe a prerequisite to understanding much that goes on in the sea.

Thank you for your cooperation.

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Dear Wib:

We have been very slow to answer your letter of December 25. There has been a good bit of discussion and confusion and some expression of views. In spite of all this, the views given here are my own, although they are doubtless colored by views of others here and although some of those you wrote are leaving the reply to me.

In general, we agree, almost to a man, with your third point of view (top of page 7 of your letter). We also are unimpressed with the need to define "fisheries oceanography," "fisheries oceanographer," or indeed "fisheries scientist." At this station some of our most interesting and effective people have come to us from diverse disciplines and no background of interest in fisheries.

I believe that the proposed Working Group, though a pleasant and profitable intellectual exercise and contact for the members, will be largely a waste of time and that the proliferation of international bodies attempting world-wide organization of oceanography should be discouraged. My view is not that the subject is unworthy of as much clear and imaginative thinking as possible, but rather that such a group cannot produce valuable generalizations at this time. Apart from the problem of recognizing the views of such a diverse group, there are some basic doubts about its mission.

Regarding the first term of reference, it is actually undesirable to define "fisheries oceanography." Definitions and labels tend to separate and limit activities of agencies or individuals, not to foster cooperation and development. Any finding by oceanography, in the widest possible sense, which can contribute to solution of a fisheries problem, is, in my opinion, "fisheries oceanography." Research in this category might run all the way from biology to abstruse theoretical physics. We do not want either to put limits on "fisheries oceanography" or to separate it from the general body of oceanographic research. The limits of the oceanography worth of fisheries support must be determined in each case by including anything which can contribute to the solution of the particular fisheries problems under investigation. No individual or group is in a position to define general limits now or to predict what may eventually be found useful. I do not believe a field with such broad and changing ramifications can be defined. If it is, the definition would have some nuisance value by building fences; it would have no foreseeable advantage. What is needed is understanding of the objectives of each fisheries research project, and encouragement and use of whatever "oceanography" (or any other scientific activity) can make a contribution.

Regarding the second term of reference, this would be a long and difficult job even with an acceptable definition of fisheries oceanography and impossible without one. Taking physical oceanography alone, it would be necessary to assess its contribution to the numerous and diverse lines of fisheries research. The assessment would be difficult and subjective because background knowledge of the environment, though essential, is often unrecognized as being so. To make such an assessment one must imagine where we would be with no oceanographic knowledge. I think the futility of such an effort is obvious. The knowledge of the

environment is essential, and we cannot understand or predict all the ways in which it does and will contribute. All that could be done objectively is to describe the more definite and obvious cases which are probably only a small part of the whole and still smaller part of the potential.

Regarding the third term of reference, this depends, of course, on the elusive definition of "fisheries oceanography." Even with a definition, the contributions of oceanography to the solution of fisheries problems vary so much from case to case and are so difficult to predict that any statement must either be so broad and general as to be nearly meaningless, or be extremely lengthy, diversified and tentative. It must, above all, not be made restrictive.

Regarding the fourth term of reference, this is clouded by the difficulties and vaguenesses of the first three. I doubt whether any valuable prediction can be made and whether it would have influence if it could be.

It might be said in support of the work of the Working Group that the definitions and statements it produces might help promote oceanography for fisheries purposes. This, too, I doubt. The most effective promotion would probably be by requests for oceanographic work associated with established fisheries programs or requirements, not by a generalized approach.

I think that any attempt to plan or coordinate oceanographic work on a world-wide basis now is premature. Oceanographic activities will continue for a long time to be planned and supported on the basis of national requirements. Neither oceanography itself nor its organization within countries have in general reached the stage where effective world-wide planning can be done. Too much attempt in this direction can cause waste effort and even harm by turning too many resources into regimented channels and leaving too little for the many lines of exploratory research which are still needed. It is, of course, necessary to broaden our studies of oceanic circulation to look eventually at oceans as a whole but the state of knowledge and the problems themselves differ from region to region and pro tem the most effective approach is at most ocean-wide. Such international coordination of oceanography for fisheries, as is now feasible and desirable, would probably be done most effectively in association with international organizations responsible for solution of fisheries problems (e.g., ICNAF or INPFC).

Perhaps this is a fine example of Bernard Shaw's apology for a long letter because he did not have the time to write a short one. All of the above words may just confuse the issues more. With a bit more thought a shorter and clearer letter might be written. I would enjoy discussing the subject with you personally.

Many here join me in urging you to visit us. We would certainly gain. We might also offer you some opportunity for productive discussion. I really mean this invitation. I have only one condition - you must come when I am here.

FROM: Dr. W. M. Chapman, Director  
Van Camp Foundation, Division of Van Camp Sea Food Company  
739 Golden Park Avenue, San Diego 6, California

Dear \*\*\*\*\*,

Please pardon my delay in answering yours of March 16. I was on tour in southeast Asia and around the Indian Ocean the first part of the year and did not get back until late April, which has put me further behind in my work than is even usual.

Your letter was strangely disturbing to me. I know why this is. For a good many years I have looked to you as one of the extraordinary people of our profession whose interests, personal feelings, and wisdom had long gone beyond the boundaries of the profession and surveyed with a degree of equanimity the full field of human endeavors in a more humanistic vein than is normal to scientists. Since I have some failings along this line myself, I had long felt a degree of informal thinking camaraderie with you which was perhaps overestimated. When I read your letter, I found myself in rather basic disagreement with you. Since I think so highly of your views generally, this has caused me to reexamine my own with some care to see where I may have flipped.

Where I was perhaps most disturbed was in your ante-penultimate paragraph where you state your thought that any attempt or plan to coordinate oceanographic work on a world-wide basis now is premature.

In looking back, I see that whilst running at full speed around the world, I have fallen rather subconsciously into a contrary view out of quite selfish interests. For a good many years I have looked after some aspects of the California Tuna industry's interest in the outside world, primarily those concerned with access to the resource, i.e., Law of the Sea and Ocean Research. The transition through Director of Research, American Tunaboat Association, to Director, The Resources Committee, and now to Director, The Van Camp Foundation has merely served to simultaneously sharpen and broaden my viewpoints whilst I remained for twelve years writing and working from this same desk.

Out of professional necessity, I have been out in the world much and actually know my way around in a number of world capitals with greater familiarity than I do in my home town, San Diego, a few blocks inland from the water front. This gradual loosening of ties with home problems has undoubtedly affected my general views. I find myself thinking of my duties as a member of the ocean off California in much the same way as I think of the problems of ocean research in Indonesia and in West Africa, where I have advisory responsibilities in respect of ocean research. That is, I think of the home district problems, as I tend to think of these other problems, as more or less localized aspects of a general problem dealing with the world ocean.

This may well be a premature point of view, but it has been forced upon me by the responsibilities of my professional work. The Van Camp Sea Food Company, of which the Van Camp Foundation is a division, has production operations presently in Long Beach, Terminal Island,

San Diego; Ecuador; North, Central, and South Peru; Puerto Rico; Sierra Leone; Ivory Coast; Indonesia; soon in the Trust Territories of the Pacific; American Samoa; and Japan, either solely owned or in various combinations with other entities, and having a good solid look at several prospective operations in the Indian Ocean area. It sells its products regularly in about thirty-five countries. Thus my already cosmopolitan proclivities have only been exacerbated by association with this company.

We are interested in the world ocean. Whatever is learned about it and its inhabitants we may be able to turn to profit for our stockholders, if you wish to use the crassest commercial outlook, or with the use of our broad technical competence we may be able to serve humanity better by providing it with more abundant supplies of reasonably priced protein foods, if you should wish to take the more humanistic view which actually occasionally drives some of us. While our primary interest is primarily in the tropical, subtropical, and temperate zones of the world ocean, I don't think anyone will quarrel about a statement to the effect that these sections of ocean are able to be understood only along with understanding of what is going on in the rest of the world ocean (and lower atmosphere, at least).

This, at least, is the excuse I use for being interested in ocean matters on a world wide basis, but being acquainted with my own frailties, I put them forward only as excuses that I have thought up to cover my activities which I would probably have undertaken anyway under another set of excuses had that been necessary.

Let me, then, note some of the problems that I run across in this wandering around:

1. There is a limited amount of ocean research money, trained man power, and research ship time available in the world totally which is much less at the present time than is required for attacking the whole world ocean in a massive assault on our ignorance in respect of it. All three of these elements are increasing in volume rather rapidly but not more rapidly than our curiosity about, and need for, new knowledge and understanding of the ocean.

When a big international operation, such as the Indian Ocean Expedition, is put afoot, it ties up so much of the total world ocean research talent, ship-time, and money that it puts strains on ocean research programs either planned or in being elsewhere in the world.

It would seem desirable to have a look at such major enterprises from the standpoints of (a) effective use of talent, time, and money in the broad spectrum of ocean research, (b) whether that is the place or problem most needing work, (c) the competitive effect on other programs. It is quite obvious that no one person or no one entity of any sort is going to dictate the allocation of talent, time, and money on a world-wide basis. Still, it does seem reasonable that if there had been some thinking done by competent experts on what is needed on a world-wide basis, the individual pieces which such extensive programs comprise might fit into place with less rancor and more effectiveness.

Single nations may think they can escape the effects of such large enterprises by seclusion and this was so in the Indian Ocean Expedition to a good extent. But it will not be possible with large schemes now under consideration for the North and Central Atlantic and Pacific. As the boys say, there is no place to hide.

Nations such as the United States, U. S. S. R., Japan, and Britain, which have ocean wide interests, almost require to involve themselves in all of these schemes to some extent. They all have the same limitations of money, men, and time. They thus find it desirable, if not mandatory, to do more and more work and planning together whether they like each other or not.

The Russian scheme put forward at the IOC-Bureau meeting in April was a quite logical extension of what had gone on at IOC in October of last year. It is so far reaching in its use of men, money, and time that it is only one short step away from planning on a world-wide basis.

Accordingly, it seems to me that some attempt to plan and coordinate oceanographic work on a world-wide basis is not only not premature, but it is inescapable and is going on presently on such a large piece-meal basis that it can only be effectively continued by having a look at the world ocean, and the research work in it, as one whole.

2. You folks and we in southern California by devious and several means have succeeded in getting fisheries and physical-chemical type researchers working together with enough peace, and productive cooperation and coordination that we occasionally forget that the schizm between these two which existed a number of years ago was deep and real, and adversely affected the ability of both groups to work and to get financial support for their work.

This vigorous schizm still exists in much of the world. I will not specify as to places. You do not have to look very far to see it going on. I see it in Europe and the Far-East in just as sharp outline as you see it closer home. I do not think that anyone will disagree that activity designed to lessen friction, rancor, and ill-feeling between fisheries and physical-chemical oceanography types is likely to be a useful exercise whether done on a regional basis as in EPOC, or on a world-wide basis.

3. I take it as accepted fact that the United Nations and its family of specialized agencies are here to stay, like labor unions, strong federal power, the income tax, the purse seine, and other such things which did not loom large when I was a boy in the Northwest. One may rail against them, but there they are, and they must be dealt with.

International bureaucracies are no less empire builders than any national bureaucracies. Competition among them is as heavy, bitter, and tooth-for-tooth as is life in the jungle, even though clothed in more subtle terms.

The formation of the Intergovernmental Oceanographic Commission in some form or another was inevitable, in my view, as an outgrowth of the forces mentioned in (1) above. Its placing within UNESCO unleashed bitter stresses in the U.N. family, affecting FAO most strongly, but others as well, which was not in the best interests of the ocean research community. It is quite possible for you to ignore or look beyond this sort of thing, but our interests are so broad that we cannot. We have an equality, or nearly so, of interest as a nation in UNESCO and FAO. It is not to our total interest to see one crowd the other out, or to have them engage in bickering amongst themselves, which is disruptive of the work of either.

Furthermore, when this scrap took the turn that looked as if it might freeze into concrete in the international scene, the fisheries-physical-chemical oceanography scrap alluded to in (a) above, some of us thought we should deal ourselves in for a few hands to see if this could not be mitigated.

4. You express the view that such international coordination of oceanography for fisheries as is now feasible and desirable might be done most effectively in association with intergovernmental organizations responsible for solution of fisheries problems (e.g., ICNAF or INPPFC).

This suits reasonably well your position in the north Atlantic and north Pacific, but it does not suit our position in the tropical Atlantic, tropical Pacific, or northern Indian Ocean at all, because there either are no such organizations there or they are not sufficiently broadly based or financed to accomplish the task (I think I could make a reasonable case that the latter is the case with you too, and that you could not do without the supporting research financed by your Navy much more early than we could dispense with that financed by the United States Navy).

To the extent that these things are true, our practical desires are divergent. I don't think that they really are very much, but this whole subject could stand a cool looking at.

5. There is another factor that may or may not be of much importance. Halibut, plaice, cod, and other demersal fishes do not seem to measure variations in the ocean climate with quite the refinement and delicacy that the tunas do. The older, international fisheries organizations of the northern hemisphere, having been involved originally and primarily with these more stolid fishes, do not seem to have the same rapport with physical and chemical oceanographers that we tuna people have.
6. There are the broad problems of really geophysics which Professor Kort wishes to attack with the scheme Russia put forward at the IOC Bureau meeting in April, and will certainly emphasize at the full IOC meeting in September.

I am not competent to say whether this is a problem most needing attack now, or whether this is the cheapest way to get at the solution of it, but it does seem to me that there is no real way to tackle a circulation problem of this sort on a scale which will not involve a very considerable share of the world total of money, men, and time presently available for high seas research. Accordingly, I do not see how such a problem can even be thought about sensibly unless there is some world-wide planning going on somewhere. I could go on at considerable length if this Sunday afternoon were longer, but without making much more impression I suppose. At any rate, I have set down some of the things that color my viewpoint.

I think one could fairly say that there is at least a small body of thought in the world which would regard this Working Group on "Fisheries Oceanography," or SCOR itself, as not being indispensable. I made the mistake of agreeing with George Humphrey that I thought such a Working Group might contribute enough to mitigating some of the problems noted above to be worth the trouble. Accordingly, I could hardly back away when he asked me to be the convenor of it, although I had no time whatever for the work that would be involved.

I set out to find out what would be the reaction in the United States to such questions and, when Dickie backed out, extending my inquiry on the same basis to Canada. What I did was draft a letter stating pretty much my own views and send it to about three hundred and twenty-five Canadian and American toilers in this vineyard. Then I took off for the Indian Ocean.

I was amazed at what I found in the mail upon my return. One has the feeling that dozens upon dozens of people have been thinking seriously about these questions for some time with no good way to express their views and that some way or another I succeeded in pulling out the bung and letting the thoughts flow freely. In any event, the results have been so remarkable that I am going to multilith those of the letters that I have permission to do and send the lot around together to my colleagues to see what may be made of them and to give them more use than simply gracing my files.

I will be guided by your reply.

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Dear Dr. Chapman:

Thank you for your letter of December 25, 1961 (postmarked January 26, 1962). I was very pleased to know that you think well enough of me to ask for my opinion on the topic of fisheries oceanography. I am sorry that I was unable to answer by March 1 as you had requested, however, in addition to having been on the mainland, I also was on an oceanographic cruise earlier this year. Rather than preparing an essay on fisheries oceanography, I will briefly relate my own experience in the field in the hope that it will still be of some use to you. This, not having been without success, may have some bearing on the questions you have posed.

First some generalities! Serious workers in science, regardless of what medium they choose, be it nuclear physics, chemistry, or ornithology, must have a guiding philosophy directing their life and work. This is not "having a lot of fun doing what one likes" but the effort involved in delineating and tackling problems. It is fun in the sense of meeting a challenge, much as that of a mountaineer tackling a mountain and then mastering the peak. By and large, when a scientist says he is doing what he likes, he means that he is doing what he feels he ought to do in order to solve a problem. He may be willing to put up with 95% drudgery in order to enjoy the satisfaction of having gained insight or new understanding.

The significant event of our time is the rising tide of man. He is changing the face of the earth; and this often in violation of ignorance of the laws of nature with the consequent adverse effects. The exploding populations are making ever greater demands upon our natural resources, both those which are limited and those which may be renewable. The nomad's method of making a living, essentially searching for his needs and then harvesting, be it wild animals, gold, or high seas fishes, are no longer adequate to supply man's needs. Therefore, to help man adapt to his rapidly changing environment, to help him control his environment, and to help him exploit his environment for his needs without committing suicide, man must learn and understand the laws of nature. Thus science has changed from the activity of a rich man's son or man of independent means, to one which is an essential part of modern society. A scientist, trying to gain insight into the laws of nature, is performing an essential service.

After this lengthy introduction, I will briefly describe my niche in fisheries. Soon after my arrival, it became apparent that I should ask myself what I, a physical oceanographer, was doing in fisheries organization. I decided that I should describe the physical environment, emphasizing those properties and parameters which may affect the biota.

Being associated with the group who were concerned with the fishery, it soon became apparent that the methods, parameters, and properties traditionally associated with the biota did not correlate with the seasonal and annual variations in the availability of biota. I therefore decided to study oceanographic processes, without any application in mind, still believing that the changes in the fishery were associated with changes in the environment.

In general, the atmospheric climate plays an important part in determining the distribution of the flora and fauna on continents. In analogy to this, I decided to study the "oceanographic climate" of the region, believing that it would have a similar effect on the distribution of the biota in the sea. Here, by climatic is not meant average conditions of temperature and salinity, but the seasonally repeating processes in the ocean.

This approach, as you know, led to the discovery of new parameters which correlated with the availability of the fish. The occurrence of the fish is associated with the type of water, the summer advection period, and can be predicted on the basis of the time of the initial heating. In addition to the right type of water, the dynamic conditions

in the environment must be favorable. Although these results do not provide understanding of the linkage mechanism between fish and the physical environment, they point towards a new avenue of approach in this particular problem of fisheries oceanography. As pointed out in my paper, the results show that the new parameters which contain the first and second derivative with respect to time, probably reflect the same environmental changes which also affect the biota ..

The new approach, the climatic study, also led to a new way of presenting time-sequence data, in this case, the characteristic heating curve. The shape of the curve reflects oceanographic conditions which, as mentioned above, affect the availability of biota in general. These varying oceanographic conditions may also affect the distribution of the mixed layer and thermocline which is important to the military. Thus, the new way of presenting time-sequence data, the heating curve reflecting oceanographic conditions or the climate, may have applications beyond the fishery. Conversely, an investigation of oceanographic processes if undertaken for some other application, may be of use in fisheries problems.

Longer period changes in the environment which affect the occurrence of the fish also became apparent which may involve the Pacific wide circulation. If these are to be understood, studies in regions removed from the area of immediate interest and also at depths in which the fishes of our interests do not live will be required.

Finally, as the result of my climatic study, we have also looked a little at the salinity boundary separating the North Pacific Central from the transition water of the California Current Extension. Here we find that not only bird flocks and fish schools are sighted along the boundary but also other major predators and mammals. This illustrates that in order to understand the life history, behavior, and reaction to the physical environment of an important food fish, one should not neglect looking at other species. It may be simpler to discover the ecological significance of the salinity boundary, for example, by looking at an animal which may not be important as a source of food.

In summary, I am pleading for an unfettered or unconstrained approach to fisheries oceanography, forgetting for the moment the immediate problems of the fishing industry, and permitting a scientist to come to grips with the fundamental problems of this difficult subject in his own way by seeking understanding rather than application. My experience has shown that in addition to the traditional properties in the sea, the fisheries oceanographer should also look at environmental processes, the time rates of change, and accelerations. This may reveal a new class of parameters which can be associated with the biota. Further, environmental studies should not necessarily be confined to the area of the fishery only, and the commercial fish should be studied as part of the whole community. This requires investigations of other species and forms of life in the sea besides the fish of commercial interest.

By defining fisheries oceanography one sets a boundary around the area of investigation which is the very thing I am pleading against. I suppose, however, that this is necessary in order to attract scientists and financial support to this problem area. My compromise definition is

as follows: Fisheries oceanography concerns the study of the multiple interactions in the oceans, physical, chemical, geological, and biological, which may lead to an understanding of the life history, distribution, place in the biological community, etc. of present and potential food fishes (animals) in the sea.

Although I am not qualified to comment on what fisheries oceanography has accomplished, I cannot help but think that it has yet a long way to go when one considers that fishing is by and large still done in nomadic fashion as contrasted with the exploitation of many others of our resources. On the basis of my experience, I think that there has been too much emphasis on immediate solutions to one or other fishing industry problem which had led to superficial fisheries or oceanography surveys rather than scientific investigations. This emphasis has also had the by-product effect of making the field unattractive to many capable scientists.

Here I should point out that I distinguish between fisheries oceanography - scientific research, and fisheries oceanography - engineering (the application of scientific results to fisheries problems and management). Although my letter has dealt with the former aspect, I am not against the latter but want to stress that we must know before we can apply. Generally, as scientific research progresses, applications become apparent and the scientist is usually happy to point to them and help to get them going. However, a scientist's primary objective is to gain knowledge and this is in the direction in which pressure should be applied.

As to reference term 4, progress in other branches of science is so far ahead of fisheries oceanography that this is, at the present time, not as important as a change of emphasis from surveys of the distribution of fish, temperature, salinity, etc. to a study of the forces and processes which determine these distributions. This means a change from the exploratory approach in geobiology and geophysics to the experimental approach, as I am attempting to do in my proposed trade wind zine investigation.

To conclude, having come to grips with some of the fisheries oceanography problems, I am confident that the long range potential of fisheries is tremendous if fisheries oceanography is conducted in line with my definition.

This biased account, along with all the other biased accounts should make a very interesting report to SCOR, and I am looking forward to seeing a copy.

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Dear Dr. Chapman:

Many thanks for your colorful letter of May 10, 1962 with the enclosure.

As to the subject of the enclosure of your letter, I might start with commenting your views. You may add me to your "recent group" of your point 3 (p. 7 of your comments). I would also like to put some of your carefully expressed and partly hidden questions and doubts into a direct form: Is a report of opinions and definitions of a rather artificial term really necessary? Maybe you have in mind a report which deviates from the subject of the questions and is more of a technical-scientific nature--e.g. formulating an approach for estimation of marine fishery resources. With such an approach, I would come along. I do not see how a "spiritual exercise" with answers to four dialectic questions to define one term can help anybody. To the contrary, I know that SCOR has irritated many ICES people and will surely irritate more with the "answers" to the four questions. An expressed opinion is very rarely objective, as you pointed out yourself. It is extremely difficult to balance between the "official" opinions of ones boss, ones type of work and ones personal feelings.

As you have indicated, you will not be satisfied with my answer "We have already defined, described, and answered the questions in our book" -- so I will try to put down some condensed, somewhat more positive, thoughts on the questions, besides the negative remarks above (and from my point objectively).

1. I quite agree with you that "fisheries or fishery oceanography" does not make much sense. Why not use a sixty-year old term - fishery hydrography. Hydrography has meant, in ICES, physical and chemical oceanography including, of course, sea-air interactions. Then fisheries hydrography would mean the application of hydrography to fisheries problems. It would try to investigate and explain the relations between the environment and fish behavior (in a wide sense) and the use of this knowledge in various services to fisheries (prediction of abundance of given time and area, migrations, year class strength, etc.) as far as environmental changes are responsible.
2. The second question is out of sky. I am sure that you agree with me that it is not possible to make people wise on a subject with a few sentences, where books and lots of experience are necessary.
3. Again, direct answer to this question is unrealistic because with certain exceptions, the fisheries problems are local and/or regional of nature as you also mentioned. I do not think that one should try to tell the people what they should do and accomplish. If someone, to whom a task is given, does not know what he should accomplish, he should be fired. Some general approaches could, of course, be emphasized. One of them is your point 3 of which I am a whole-hearted supporter. Another related group of problems concerned with forecasting and synoptic services

exist in ICNAF and ICES area. The people concerned know well what they should accomplish, and why should an outside group try to tell it to them.

4. Considering the nature of the first three questions, I get a feeling that one should not look for progress and help from other sciences in first hand, but what people need is either to follow the literature and developments in their field of activity, or they should go back to the school again and gain a broader education in oceanography if they want to know about it. If "there was much confusion concerning the nature, accomplishments, and aims of fisheries oceanography" then the confusion was surely caused by people themselves who had little or no idea about the subject but wanted to speak up.

As you see, my letters become nearly as long as yours though not so "meaty." I do not think that it is of any help to you. However, you are welcome to extract any or no parts of this letter for your circular, but if you extract, please "translate" it into proper English. I am, of course, in pure curiosity, very interested to see the opinions of other people. I have not heard anything about the FAO's advisory committee either--this was kept a kind of secret from me.

With general reference to the ideas in the present letter and to some marks of others, I am inclined to finish with

CETERUM SENSEO SOCIETAS SCOR ESSE ABOLENDA

FROM: Dr. W. M. Chapman, Director  
Van Camp Foundation, Division of Van Camp Sea Food Company  
739 Golden Park Avenue, San Diego 6, California

Dear \*\*\*\*,

Your letter of May 16 was most appreciated and had the distinction of being the first in this series to end in a Latin sentence.

We Californians will wrestle you any day of any week for money, marbles, or salt in ocean research, and be glad you have found the strength. One of the proper forums for such engagements in the Eastern Pacific Oceanic Conference which will be held in the Northwest this winter. Hope you can make it.

I have no idea at this writing what form the report of this Working Group will take, but we will try to make it a stimulating one as to content.

That SCOR has irritated many ICES people, as you say, in the past perhaps indicates that it is performing a useful function. Quite a good number of the friends I have working in ICES (or more properly in ICES work) feel that ICES can do with a good deal of irritation if this would serve to job it on to new and better things.

I am not prepared to subscribe yet to your : CETERUM SENSEO SOCIETAS SCOR ESSE ABOLEND. International, as well as all other bureaucracies (as well as most people) require to have turpentine dashed on their tender parts from time to time to be kept in motion mentally as well as physically. If SCOR performs this function conscientiously, it has a reason for being, in my mind, and there are some other things that it has done and can do that need doing which no other body appears to be doing or inclined to do, such as stimulating budget officer types to shell out some dough for ocean research, getting scientists from different institutions to measure things in comparable ways, finding out what oceanographers are measuring when they say they are measuring salinities, looking at the world ocean as one good sized pond, etc.

Furthermore, your dictum is contrary to the motto of the sovereign state of California, to wit: NON ILLEGITINI CARBORUNDUM, which roughly translates, "Don't let the bastards wear you down."

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Dear Wib:

Many thanks for your letter of May 22, 1962. I do not wish to waste your valuable time with this letter so please do not bother to answer it. As you know, I like arguing for arguing's sake, and am at times insistent with my views but do not expect that others accept them. I agree with Schopenhaur: "Einer kann in sich selbst Recht haben; aber wenn sein Rect ist nicht anerkannt-er hat kein Recht, weil ein unanerkanntes Recht ist kein offentliches Recht."

First, I would like to reflect on ICES whom you seem to believe does not do the right things. ICES does its work quietly and profoundly and without propaganda about it. Some people, who have tried to disturb its work, have been pushed gently aside. These people are sour on it and try to blackmail ICES, especially in SCOR. I guess you have met such people. The last Newsletter of NODC (if it can be called so, because it does not contain any news) is nearly entirely devoted to a very small old activity of ICES. However, ICES does many more and better things. You might know that ICES has established an oceanographic-meteorological-fisheries reporting and forecasting service, which you find desirable also for tuna fishery. In this service (four nations collaborating at present) oceanographic data and data on fish occurrence are reported in codes in addition to meteorological reports to certain laboratories where weekly national forecasts for fisheries are issued. As you might know, nearly nothing has been written about this work.

I do not see any possibilities of getting anywhere by irritating some scientists by forcing definitions and ideas upon them. If a scientist does not have fantasy and ideas himself in his own field - he is no scientist. I think that if a man who thinks to be a specialist in one field (e.g. biochemistry) wants to dictate action and definition in other fields (e.g. oceanography) this man must have some serious complexes.

I know that you will not take the remarks above personally, because they do not apply to you. I quite recognize and support your mission and see an urgent need for it and even reasons for irritating scientists - i.e. to get the scientists to attack and solve problems which promise application in the practice and for which there is a request from the industry or public. Very often scientists are carried away with their fantasies to minor details (which sometimes is also necessary) and avoid attacking greater problems which are difficult and less rewarding. Although one has to recognize "scientific freedom," one has also to recognize the "obligations of science." I am sure you agree with me that the basic need for "coordination in marine science" is to bring the "producers and consumers" of information together and try to find a common language for marine biologists and oceanographers. It could be done, e.g. by detailed listing (but not in general wide terms and nice words such as - investigation of the content of the sea) of the problem for which there exists a need for answer in the practice and to show the possible way to attack the problems. This also includes the old problem - the marine biologists should formulate exact questions to oceanographers and be insistent to get the answers.

I have nothing further to say about the other international organizations into whose thirty backyards I have had a good look during the last six years. The frontpiece of these organizations is often carried by men with power complexes but without their own ideas and knowledge. I assume that you, yourself, are following the good advice you gave to me - to not let yourself be bothered by them.

Still I am with you when you would attempt to bring some "fisheries scientists" to the real problems of the industry - both short-range and long-range ones.

As Cata was insistent and finally obtained results (Praeterae senso Cartaginem esse delendam) so am I insistent:

CETERUM SENSEO SOCIETAS SCOR ESSE ABOLENDAM

I quite understand you when you do not yet wish to subscribe to this demand, because you have now an ideal opportunity to try to irritate and job SCOR itself on to new and better things.

WPFO 62-5  
2 October, 1962  
San Diego 6, California

**TO:** SCOR WORKING PARTY ON FISHERY OCEANOGRAPHY  
**FROM:** W. M. CHAPMAN  
**SUBJECT:** FINAL COMMENTS

As with everything concerned with this project I was not prepared for the interested reception which the first two volumes of these Comments on Fishery Oceanography has had. We ran off four hundred copies of these first two volumes. Through an accident of mailing arising from our haste to get them out prior to the Bergen meeting two copies of Volume I were mailed to several people, which left us short of that Volume. Now there has risen a demand, particularly from University, Laboratory, and Agency libraries, which has completely exhausted our supply of Volume I, and very nearly used up our supply of Volume II. Accordingly, it would be most appreciated if those who accidentally got two copies of Volume I would send back their extra copy, and that anyone not wishing to keep either Volume would send back both so that we could redistribute them to people and institutions who wish to save them for reference purposes.

Pursuant to the desires of the Bergen meeting there is presented herewith the third and terminal Volume of this series. It includes an account of what transpired at the Paris meeting of the SCOR Executive Committee and the Intergovernmental Oceanographic Commission, the report of the Bergen meeting, the report on this subject submitted by SCOR to IOC, the resolutions adopted at IOC, (in their provisional form still subject to editing), material received from Dr. Uda, Dr. Popovici, and Professor Bückmann too late to be included in Volume II, and an index to volumes I and II most kindly prepared by Dr. Joel Hedgpeth, Director, Pacific Marine Station, University of the Pacific, Dillon Beach, California.

After the conclusion of our meeting on Friday I stayed behind to prepare the finalized report for mimeographing. Dr. Bjerknes joined me latter to assist in making the changes the group had left in our hands. I remained the rest of the afternoon to assist the secretaries in Dr. Rollefson's office interpret my hieroglyphics and when they had

completed their work and had thirty copies ready I took these in hand and returned to the hotel, taking advantage of Mr. Aase's kind offer to mail another one hundred copies to me in Paris as well as send copies to other members of the Working Party.

Upon reaching my hotel I found that a numerous contingent of Englishmen had arrived for a trade exhibition that was to start the next morning and I was without a bed to sleep in. There being a plane leaving for Oslo in an hour I quickly packed and went to Copenhagen for dinner and the night. The next day I proceeded to Hamburg, where I was most pleasantly shown around over the week-end by Herr Moeklinghof, Drs. Meyer-Warden, Sahrhage, Krefft, and our colleague Hempel, who was considerate enough not to run me up and down any more mountains.

I arrived in Paris late Sunday night and went Monday morning, as requested, to the meeting of the SCOR Executive Committee at UNESCO. There was a considerable gathering and the thirty copies of the report that I had were quickly exhausted. Unfortunately, the one hundred copies of the report sent on by Mr. Aase did not arrive while I was in Paris, presumably being held up somewhere in French customs. Accordingly, no other copies of our full report were available to the IOC meeting aside from the thirty copies I had brought with me and distributed at the SCOR meeting. I believe, however, that all of the national delegations having strong fishery contingents at IOC had a copy of our full report available to them.

When my turn came I presented our report, reading out pertinent sections of it, including our recommendations. Although it is to a large extent duplicative I attach hereto the summary of our report which SCOR submitted to IOC as information paper 33, so that members may see where the differences lay. This was chiefly in our recommendations, which were not transmitted to IOC. Our report was not discussed during the course of the IOC plenary sessions.

Nevertheless, several of the national delegations with strong fishery contingents who had received copies of our full report were active in the IOC deliberations and a reading of the resolutions emanating from this second meeting of the Intergovernmental Oceanographic Commission indicates that a reasonably satisfactory consideration was given to our recommendations.

We had suggested the ultimate desirability of having an organization devoted solely to ocean problems standing independently among the specialized agencies of the United Nations family. Dr. Uda, as a member of the Japanese delegation, submitted a resolution to Working Group number 2 proposing the establishment of a World Oceanographic Organization, but upon being informed by the Chairman that it was not pertinent to the work of that group withdrew it. He discussed the matter further with the Chairman of IOC who suggested that the matter be set aside for latter consideration by the Bureau of the Commission and the Consultative Committee. It was discussed by the Bureau after the IOC meeting was concluded and is presumably to be discussed by them further at their next meeting. At least the subject is not dead.

We had noted that continuous attention required to be given to liaison between intergovernmental fishery commissions and regional organizations on the one hand and the international agencies dealing with ocean research on the other hand in order that the scientific work undertaken under both sorts of regimes would go smoothly and efficiently. In resolution 7 dealing with the International Cooperative Investigations of the Tropical Atlantic provision was made for interested organizations to be invited to attend the meetings of its Coordination Group in the role of observers. In resolution I provision was made for intergovernmental organizations active and interested in oceanic endeavors to participate in sessions of the Commission as well as appropriate meetings of subsidiary organs of the Commission, without the right to vote. In resolution 15, on advisory channels to the commission, it was provided that the Bureau and Secretary of the Commission should consult appropriate intergovernmental and non-governmental organizations of a world-wide and regional nature on international programmes in oceanography. In resolution 6, dealing with International Synoptic Investigations of the Atlantic and Pacific Oceans north of 20°S, the Secretary of IOC was requested to ensure, in consultation with pertinent advisory bodies, the future development of programs of synoptic international investigations of the large scale dynamics of the oceans as affected by the ocean-atmosphere interaction, and the formulation of plans for the further stages of such investigations and in this resolution mention was made of investigations of this sort made by ICES, ICNAF, INPFC, and IPFC. Resolution 13, was devoted solely to encouraging member states to participate in the ICNAF environmental programme.

We had recommended that SCOR reconstitute its membership so that fishery oceanography and marine biology may be better represented for the purpose of improving SCOR's ability to serve the whole scientific

community concerned with the ocean. Presumably this matter is under consideration by SCOR.

We had recommended that a committee be formed consisting of not more than fifteen members for the purpose of advising the IOC on the scientific aspects of ocean research, the composition of which should be drawn on approximately an equal basis from SCOR and from FAO's Advisory Committee on Marine Resources Research. Resolution 15, established SCOR as the advisory body to the Commission on the broad scientific aspects of oceanography and established an IOC advisory body on fishery oceanography to be composed of the thirteen members of the FAO Advisory Committee on Marine Resources Research, augmented by two members from countries not members of FAO, to act as the advisory body to the Commission on fisheries aspects of oceanography. Advisory duties were assigned to these two advisory bodies in other resolutions.

We had recommended that in the prosecution of its broad international cooperative programs in oceanic research IOC use the existing machinery of regional commissions and organizations to the extent that it finds practical and appropriate. This aspect was approached in the several resolutions noted above under improved liason and in addition the Rules of Procedure of IOC were amended to provide that intergovernmental fishery commissions and regional organizations could provide items for inclusion on the agenda of future meetings of IOC.

We had recommended that SCOR, IOC, and ACMRR give particular and continued attention to liaison among marine meteorologists and other ocean research workers. This was dealt with particularly in resolutions 2, 4, 5, 6, 7, 10, 12, 14, and 16.

We had proposed a definition of Fishery Oceanography. Resolution 5 deals with fishery oceanography in the Indian Ocean and recalls that the SCOR Working Group on Fishery Oceanography's broad and inclusive definition of Fishery Oceanography requires a close cooperation between the fishery and non-fishery oceanographer and points out the mutual advantage if close cooperation is achieved. Fishery Oceanography is further alluded to in Resolutions 2, 14, and 15.

We had pointed out the high desirability of the speedy collection and dissemination of synoptic oceanographic data. Resolution 14, originated by Dr. Uda, deals satisfactorily with this matter. Resolution 4 recommends to the director of Indian Meteorological Center

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the construction and dissemination of semi-monthly, sea surface isothermal charts for the Indian Ocean for two years beginning 1 January, 1963.

Other of the matters we discussed were dealt with in other resolutions and actions by the Intergovernmental Oceanographic Commission. One has the feeling that whether our activities had, or had not, any influence on these matters a satisfactory beginning has been made in attending to the fishery aspects of oceanography in the international field overseen by the affected specialized agencies of the United Nations family. I have the feeling, however, that the measure of our labors of this year on this subject will not be these short term reactions but will, instead, be reflected in the longer term reactions that rise from the thinking we have been able to stir in the scientific community through the circulation of each others views.

At any rate, it has been fun and I wish to thank all of you who took the trouble, time, and interest to collaborate in these endeavors, as well as SCOR for having made it possible.

With best wishes, I remain,

Sincerely yours,

VAN CAMP FOUNDATION

W. M. Chapman  
President

WMC/reb

p.s. 6 November, 1962

" Subsequent to writing the above Dr. Lyman, Professor Uda, Mr. Brock and I gave an evening symposium on the Paris and Bergen meetings to the Eastern Pacific Oceanic conference at Lake Wilderness. Later the pertinent resolutions from the Paris meeting were presented by the United States delegation at the U.S. - Japan Tuna Conference in Tokyo, 9-14 October with what is hoped will be results helpful to Japanese fishery oceanographers. A copy of the report of Committee I of that conference is appended hereto for the information of the Working Party. Appended also is a late reply from Dr. Rechnitzer, who has been ill, and a recent letter from Dr. Humphrey, President of SCOR, authorizing on behalf of SCOR the distribution of the full report from our Bergen meeting"

p. p. s.

It has been three months since I promised you to promptly reproduce and circulate our terminal report and comments on fishery oceanography. While I am apologetic for this long delay I put forward these extenuating circumstances.

After the conclusion of the Intergovernmental Oceanographic Commission meeting in Paris I flew directly home and assembled most of the attached manuscript for the attention of my reasonably patient secretary, Ruth Babcock, before dashing off to the EPOC conference outside Seattle, Washington. The evening that meeting concluded several of us flew to Tokyo as members of the United States delegation to the U.S. - Japan Tuna Conference.

The day after the conclusion of that conference I flew to Manila for a brief reconnaissance of the Philippines with the intention of going on to the Tenth Meeting of the Indo-Pacific Fisheries Council at Seoul, Korea. Upon desiring to proceed from the Philippines in this manner I discovered that there was a cholera epidemic in progress in those parts and that my cholera shot had expired. The upshot of this was that for the next six days I saw more of Manila, Zamboanga, San Jose, and environs than had been intended, and arrived back in Tokyo as the IPFC meeting in Seoul was concluding. Accordingly I returned next day to the United States instead, stopping enroute for a long week end in Honolulu where I was able to talk with various colleagues involved in ocean research at the University of Hawaii and the Honolulu Biological Laboratory of the Bureau of Commercial Fisheries. Mr. John Marr, Hawaiian Biological Laboratory, BCF, kindly sent me the papers from the Seoul meeting.

I had not been home long enough to greet my family when I learned that the Department of State felt it might be a good thing if I participated in a United States observer delegation to attend the inaugural meeting of FAO's West African Fisheries Commission. Accordingly after eight days at home, where I had time to work a little more on this manuscript amidst other meetings and attending to accumulated correspondence, I was off to Tunisia with stopovers enroute in Washington, D. C. and New York.

The meeting in Tunisia unexpectedly lasted only one day, a pleasant precedent in international meetings, and I returned home with stopovers in Rome, Paris, Bonn, Copenhagen and Reykjavik. While all of this wandering has delayed completion of this chore well beyond its appointed time, it has yielded material for some added comments in, or peripheral to, the group's field of interest. Among these are:

1. Indo-Pacific Fisheries Council

The IPFC at its tenth meeting adopted two resolutions particularly pertinent to this subject:

Resolution III. "The Council:

Being aware of Resolution #12 of the Intergovernmental Oceanographic Commission, having to do with the investigation of the Kuroshio and adjacent seas, and Recognizing the importance of such studies to fishery problems,

- 1, urges interested Member Governments to participate actively in such investigations, and
- 2, directs Technical Committee I, through its Fishery Oceanography Sub-committee, to participate in and facilitate the planning of the study, and
- 3, requests the IOC Secretariat to explore the possibility of convening through SEASCO, planning meetings for the Kuroshio study."

Resolution IV

"The Council having received from Technical Committee I a report of its work during this session, resolved to adopt and approve this report.

"The Council in particular approved the Committee's action in appointing Standing Sub-Committees for Fishery Oceanography and Stock Assessment and noted that the Sub-Committees for Rastrelliger, Hilsa, Chanos, Fish Culture in Rice Fields, and Shrimp and Prawn had not been reestablished, and that it did not propose that Panels should be set up."

The action which Technical Committee I had taken respecting fishery oceanography is embraced in its resolution on the subject, which follows:

"Being aware of the importance of fishery oceanography in the study of fishery problems, and, Recognizing the relative lack of fishery oceanography in the IPFC region and, Further realizing the importance of closer communication between fishery workers and those engaged in general oceanographic studies, There shall be appointed a Standing Sub-Committee on Fishery Oceanography which shall function as follows:

1. The Sub-Committee shall facilitate the growth of fishery oceanography in the IPFC region by

- (a) pointing out to member governments the assistance in the solution of fishery problems
  - (b) encouraging the participation of Member Governments in oceanographic expeditions.
  - (c) Soliciting information from, and making suggestions to Member Governments concerning particular oceanographic observations which would be of value to the fishery programmes of the Member Governments, and
  - (d) facilitating the exchange of oceanographic information between member governments.
2. The Sub-Committee shall act for IPFC in relation with FAO, IOC and/or any other international, national or private institution, in order that,
  - (a) Member Governments are kept informed in detail of oceanographic expeditions in the IPFC region which are of interest to fishery biologists,
  - (b) fishery biologists are afforded opportunities of participating in the planning of oceanographic expeditions so that maximum benefits will be achieved in relation to fishery problems; and
  - (c) fishery biologists are afforded opportunities to participate in such expeditions, so that ancillary observations of fishery significance may be made,
3. The Sub-Committee shall facilitate the training of fishery oceanographers, particularly with respect to
  - (a) arranging their participation in oceanographic expeditions for the purpose of gaining experience in field methods; and
  - (b) arranging their participation in the analysis of data for the purpose of gaining experience in analytical and interpretive methods, and
  - (c) informing Member Governments of training courses, seminars and symposia in marine sciences, which may be held in the IPFC region.
4. The Sub-Committee shall facilitate the availability of oceanographic data to Member Governments by
  - (a) Acquainting Member Governments with the facilities of existing data centres; and
  - (b) encouraging Member Governments to deposit copies of their oceanographic data in the data centres."

December 15, 1962

2. Special Fund of the United Nations

The Special Fund of the United Nations arranges for, and aids in financing, pre-development surveys. It provides matching funds to the requesting governments on approved projects. Its projects are ordinarily for a four year term, or at least are long term. It ordinarily designates one of the specialized agencies of the United Nations as the executing agency. It ordinarily does not deal with projects of less size than those requiring \$250,000 for their execution. Five projects having a substantial component in the field of fishery oceanography have been authorized to date by the Governing Council of Special Fund. These are:

(a)	Ecuador	Fisheries Institute	\$693,000
(b)	Peru	Marine Resources Research Institute	\$790,500
(c)	India	Fisheries Training Inst.	\$610,300
(d)	Nigeria	Fisheries Survey in the Western Region	\$564,000
(e)	Chile	Fisheries Development Institute	\$1,448,700

The designated executing agency for each of these projects is FAO.

The Peru project has been underway for something over two years. It is this project with which Dr. Popovici is associated. Its accomplishments are already considerable, as will be indicated to the scientific community from the published reports which are beginning to flow from its scientists, and will shortly be of major proportion.

The Ecuador project got actually underway about a year later and is just getting its work nicely initiated.

The Nigeria and Chile projects have just had Directors appointed and will be gathering together staff and getting underway.

The India project is underway already by the Indian Government but details are still being settled with the executing agency that are required before the project gets fully underway.

A number of other projects of a similar nature, some of them larger than these initial projects, are in a stage ready to be submitted to the Governing Council or being prepared by countries in various parts of the world for submission to Special Fund staff for study.

This includes projects in the Western Pacific, Southeast Asia, Northwest Indian Ocean, Gulf of Guinea, Southwest Atlantic, Caribbean Sea, Gulf of Mexico, and at least two in the Eastern Tropical Pacific off Central America. What will be the fate of each of these projects cannot, of course, be prejudged. To put each into suitable form is a time-consuming process. Finding lead scientist-administrators to operate them is not easy, nor is the locating of other senior, experienced personnel.

Nevertheless \$4,106,000 of new money has been allocated to fishery pre-development studies under this program in the past three years and it would appear likely that somewhat more than this will be allocated to additional projects of this sort in the next three years. This will have at least three effects on fishery oceanography work on a world wide basis (a) tightening up an already tight world market for experienced personnel in this field of work, (b) expanding materially the knowledge and understanding of the world ocean and its living resources, and (c) training local personnel in the developing areas in this sort of work.

### 3. West African Fisheries Commission

The inaugural meeting of the West African Fisheries Commission got hung up on a political hook and adjourned before any substantial work could be undertaken. The issue was the right of Portugal to attend a meeting of the Commission as a member. This issue probably can only be resolved by the General Conference of FAO adopting a change in its constitution. The General Conference will not meet until November 1963. Whether it will modify its constitution cannot be prejudged.

In the meantime a hiatus of sorts is left in the governance of the high seas fisheries of the area. The Statistical Committee of the International Council for the Exploration which would ordinarily attend to the collating and reporting of the fish catches in the area by its members, at least, in 1961 decided to withdraw from that task in deference to the West African Fisheries Commission which was to begin its work this year. Thus in the face of rather rapidly increasing fishing in the area by the fishermen of a variety of nations of not only African but also European, American and Asian countries there is no international body specifically responsible for keeping the biologically useful statistics of catch and effort that may be required in future years to elucidate population dynamics problems, FAO Fisheries Division collates fisheries statistics primarily of a trade nature.

This problem is perhaps most urgent in the case of the tropical Atlantic Tuna Fishery. CCTA/CSA in early 1961 had requested the Secretary-General of the United Nations to take the necessary steps preparatory to the establishment of a West African Tuna Commission modelled after the successful Inter-American Tropical Tuna Commission which for the past twelve years has dealt with similar problems in the Eastern Pacific. The Secretary-General had passed this request along to FAO. The matter had rested there pending the establishment of FAO's West African Fisheries Commission. This summer the FAO World Meeting on the Biology of Tuna and Related Species adopted a resolution asking the Director - General to call a conference to deal with the establishment of such a Tuna Commission. This matter lies in abeyance also as a result of the break up of the inaugural meeting of the West African Fisheries Commission.

#### 4. International Council for the Exploration of the Sea

As noted above, ICES had rather withdrawn from the Tropical Atlantic although its cognizance runs to the equator under its present charter. On the other hand Dahomey, in West Africa, has become a member of ICES and the Republic of the Ivory Coast has made application to ICES for membership. Aside from those of Japan, it is chiefly the fishermen of ICES members who are expanding high seas fisheries of the area. Whether ICES will be prepared to step into the gap left by the temporary incapacity of the West African Fisheries Commission will be a matter to watch.

#### 5. ACMRR

The Advisory Committee on Marine Resources Research of FAO which, with two additions, will function as the advisory body to the Intergovernmental Oceanographic Commission on fisheries aspects of oceanography (see Resolution 15, p.39) has been appointed and will hold its inaugural meeting in Rome, beginning 28 January, 1963.

#### 6. Comprehensive Programme for World Ocean Study

Perhaps the most far reaching resolution adopted by the Intergovernmental Oceanographic Commission at its second session was Resolution 2, (page 26), calling for the preparation of a general

scientific framework for the Comprehensive Study of the World Ocean. A number of international bodies will be considering this subject during the coming year. The IOC advisory body on fishery oceanography (ACMRR plus two) will consider it at its meeting in late January. SCOR will consider it at its meeting in Halifax early April, 1963.

A reading of this resolution will indicate that the main matters of concern to the Working Party on Fishery Oceanography are covered by the guidelines IOC set down for the preparation of this general scientific framework. I am sure that any specific suggestions on these matters would be welcomed on behalf of ACMRR by Dr. Mario Ruivo, FAO, Fisheries Division, Viale delle Terme di Caracalla, Rome, Italy and on behalf of SCOR by Dr. George F. Humphrey, President, C.S.I.R.O. Cronulla, Sydney, Australia.

7. National Academy of Sciences/National Research Council, U.S.A.

Dr. Harrison Brown of the California Institute of Technology has accepted the position of Foreign Secretary, NAS/NRC. As the original Chairman of the NAS/NRC Committee on Oceanography Dr. Brown's energy and ability has had a considerable impact on world ocean research. These same traits give evidence of further achievements along the same line in his new responsibilities.

The Office of Foreign Secretary has under review through one of its committees the matter of how it can best implement a continuation of adequate and effective fishery oceanography among the coastal countries of the Indian Ocean after the termination of the International Indian Ocean Expedition.

Additionally in early November the Office of the Foreign Secretary caused to be held in Miami, Florida, a meeting of specialists to consider ways and means of effectively enhancing the conduct of ocean research in the Latin American area, both Atlantic and Pacific. The broad selection and competence of the attendees from all of the Americas insures that this meeting will have a profound effect upon the future course of ocean research in that area.

8. Institute of Marine Research, University of California

In the course of our deliberations the Working Party had noted that one of the difficulties in liaison between classical oceanographers and fishery oceanographies was that in large part the former were associated with institutions of higher learning whereas for the most part the latter were employed by governmental agencies

for the doing of particular investigations. The former could move with a higher degree of freedom into programs of international ocean research (such as IIOE, ICITA, etc.), than could the latter. This, and other differences in employment, attitudes, aspirations and budgetary provisions for their work gave rise occasionally to some interaction which was not necessarily conducive to the smooth and efficient expansion of ocean research.

It has at least been the case in the United States that fishery scientists interested in, and capable at, fishery oceanography have for the most part been employed by government fisheries agencies that had specific tasks to perform and that ocean fishery scientists interested in the open ocean and its resources have not been numerous, relatively, in Universities in the United States. This has been in the process of ameliorating in recent years as the U.S. Bureau of Commercial Fisheries, and some other governmental fisheries agencies, have initiated the issuance of grants, fellowships and research contracts in fisheries to Universities.

An important step in this direction by a University was taken this fall by the regents of the University of California when it appointed Dr. Milner B. Schaefer, hitherto Director, Inter-American Tropical Tuna Commission, as the Director of the University's Institute of Marine Research.

IMR is a University-wide organization. Although headquartered on the campus of the Scripps Institution of Oceanography it maintains laboratories at the Berkeley campus also and has maintained work on the campus of the University of California at Los Angeles, as elsewhere. It is able to draw upon the full resources of the University of California in the fulfillment of its own research objectives which are as broad as its name, inquiry into the more efficient and effective utilization of the resources of the world ocean.

The high reputation and drive of Dr. Schaefer is expected to attract research scientists of the highest calibre to the Institute and form it into a vital cog in such investigation on a University level. In these short months the ferment is already actively at work.

## 9. IOC Secretariat

One cannot help but admire, and comment upon, the energy and ability with which the staff of UNESCO's Office of Oceanography is attacking the all but impossible series of tasks which the Inter-

governmental Oceanographic Commission assigned to them in the twenty-two resolutions adopted at its second session. If there were ever five scientists who required, and deserved, the sympathetic assistance of their principals these are they. The Director was in Miami in November for the above noted meeting on Latin American ocean research; I ran into Dr. Takenouti hard at work in an office in New York on Indian Ocean problems; Dr. Parson's was preparing for a liaison trip to FAO in Rome in December; Dr. Fedorov was putting together reports; Dr. Howell-Rivera was busy in Latin America; progress was going forward on the selection of a fishery oceanography coordinator for the International Indian Ocean Expedition; the budget was being defended at the UNESCO General Conference; relations both ways with their colleagues in the Biology Branch of FAO's Fisheries Division were on a basis of wholesome cooperation that one could not have reasonably anticipated as short a time as a year ago. Despite the effective way in which the work of the office was proceeding one must call attention again to the need expressed in the penultimate paragraph of Resolution 22 (page 45).

#### 10. International Union of Biological Sciences

The International Council of Scientific Unions has undertaken the support of IUBS's International Biological Programme. This will have a major component in the marine field concerned with the mechanism of the fixation of solar energy and its transfer between trophic levels and different habitats. Because of the complexities of the task it is unlikely that this program will get off to a quick or flashy start. My estimation of it is that the leadership which is being attracted to it has got the staying power to make this program into a substantial contributor in this line of fundamental inquiry which was one of the principal concerns of the Working Party.

It has been just ten days short of a year since I found myself on Christmas day of 1961 with the task of getting the work of this group under way. It has been a most interesting, if overly-active year. Once more I should like to use this final opportunity to thank all of you and our collaborators for the excellent cooperation which has been forthcoming, and to use the season to wish you all: a Merry Christmas and a Happy and Prosperous New Year.

As you will all understand the comments and statements above are only mine and do not necessarily represent the thinking of any other person or entity.

Sincerely yours,  
VAN CAMP FOUNDATION  
W. M. Chapman, President

October 14, 1962

## APPENDIX I

Bergen, 14th September 1962  
Norway

Dr. George F. Humphrey, President  
Special Committee on Oceanic Research  
International Council of Scientific Unions  
C.S.I.R.O.  
Cronulla, Australia.

Dear Dr. Humphrey:

Attached you will find a report of the meeting of the SCOR Working Party on Fishery Oceanography held in Bergen, Norway, 10th to 14th September, 1962.

You have previously been provided with two volumes of Comments on Fishery Oceanography derived from various sources. It is the intention of the Working Party to incorporate this attached report with some additional materials received this month in a third volume of Comments on Fishery Oceanography.

Having done this the Working Party considers that it will have discharged its responsibilities and respectfully recommends its disbanding.

Sincerely yours,  
/s/ W. M. Chapman  
Convenor

\* \* \* \* \*

Report from  
SCOR Working Party on Fishery Oceanography

The SCOR Working Party on Fishery Oceanography was appointed by the President, Dr. George F. Humphrey, pursuant to action taken by SCOR at its Monaco meeting in November, 1961.

In a letter, dated 23rd November, 1961, to the members, Dr. Humphrey stated:

"Early this year, SCOR received suggestions for the formation of two new working groups, namely -

"Location and Investigation of New Fisheries Resources" and  
"Oceanographic Estimation of the Size and Distribution  
of Oceanic Living Resources"

These suggestions are symptomatic of the increasing attention being given to the interaction between the fisheries and oceanographical fields of research. This attention has been evident at the recent meeting of the Intergovernmental Oceanographic Commission.

SCOR has discussed these proposals for working groups over the past few months and decided at its recent meeting in Monaco to establish a working group on "Fisheries Oceanography" with the following terms of reference:-

1. To discuss and define the subject of fisheries oceanography.
2. To state what fisheries oceanography has accomplished.
3. To state what fisheries oceanography should be trying to accomplish.
4. To state what progress is needed in other sciences so that the aims set out in 3 can be attained.
5. To communicate the statements listed above, through SCOR to interested laboratories and organizations.

Additional items could be added by agreement with the Chairman, but there should be no overlap with the functions of bodies such as FAO, ICES, etc.

SCOR chose the above terms of reference because its members had noted that during the discussions of the meetings previously mentioned, there was much confusion concerning the nature, accomplishments, and aims of fisheries oceanography. On the one hand the term was used to include all of fisheries science, on the other to denote a restricted use of a small part of physical oceanography. SCOR felt that before any attack could be made on the problem envisaged in the original working group suggestions, it was necessary to examine some of the basic considerations involved.

SCOR felt that it could make a contribution by bringing together a small group of workers in diverse fields so that the different viewpoints could be recorded, discussed, exemplified, and put together for the benefit of intergovernmental bodies, laboratories, and individual workers. Such action would assist further work by SCOR and other bodies.

On behalf of SCOR I ask you to take part in this project which will extend a year and involve correspondence, attendance at a meeting (probably in Europe), and much thought. Your expenses would be paid by SCOR. Others who have been approached are:

Dr. Bjerknes, University of California, U. S. A.  
Dr. Chapman, Van Camp Foundation, San Diego, U.S.A.(Chairman)  
Dr. Cushing, Lowestoft Fisheries Laboratory, U.K.  
Dr. Dickie, Fisheries Research Station, Canada  
Dr. Davies, Oceanographic Institute, Durban, S. Africa  
Dr. Popovici, Special Fund Project, South America  
Dr. Rass, Institute of Oceanology, Moscow  
Dr. Rollefsen, Institute of Marine Research, Norway  
Dr. Uda, Tokyo University of Fisheries, Japan.

It is intended to ask relevant international bodies to nominate people to participate in the correspondence and the meeting.

I hope that you will find the thought of this work interesting and stimulating and that you will tell me that you are willing to participate."

Dr. Dickie was unable to serve because of prior commitments. Prof. Dr. Adolph O. Bückmann, Director, Institut für Fischeribiologie, Hamburg, was subsequently added to the Working Party by Dr.Humphrey.

During 1962 there was considerable correspondence among the members of the Working Party on the terms of reference set down by Dr. Humphrey in appointing the group. Members additionally solicited the views of workers in marine science to the number of more than 500 in various countries, The correspondence which thus resulted has been gathered into two volumes of Comments on Fishery Oceanography. These have been distributed to members of SCOR and to members of the scientific community who contributed views to the Working Party, as well as some few others who were interested in the subject.

The Working Party met in Bergen, Norway at the invitation of Dr. Gunnar Rollefsen, the Director, Institute of Marine Research, from 10th to 14th September, 1962. Members of the Working Party who attended were:

Prof. Dr. J. Bjerknes, University of California, Los Angeles, Calif.  
Dr. W.M.Chapman, Van Camp Foundation, San Diego, California  
Dr.D.H.Cushing, Fisheries Laboratory, Lowestoft, England  
Dr. DavidH.Davies, Marine Biological Association, Durban, Natal  
Union of South Africa;

Dr. Gunnar Rollefsen, Institute of Marine Research, Bergen  
Norway

Prof. Dr. Michitaka Uda, Tokyo University of Fisheries, Tokyo  
Japan

Prof. Dr. Bückmann was unable to attend because of illness, but sent in his stead Dr. G. Hempel, Institut für Fischereibiologie, Hamburg, Germany, who participated fully in the deliberations of the Working Party. Dr. Theodore S. Rass, Academy of Sciences, Moscow, U.S.S.R. and Dr. Popovici, National Institute of Marine Resources, Lima, Peru, were unable to attend the Bergen Meeting because of previous commitments.

The Working Party was assisted in its work at Bergen by the following observers, : Prof. Dr. Trygve Braarud, University of Oslo, observer from the Norwegian National Committee of SCOR; Dr. Jens Eggvin, Institute of Marine Research, Bergen, observer for the International Council for the Exploration of the Sea; Mr. Roy Jackson, Director, International North Pacific Fisheries Commission, Vancouver, British Columbia, Canada; Prof. Dr. Håkon Mosby, University of Bergen, observer from the Norwegian National Committee of SCOR; Dr. T.R. Parsons, Office of Oceanography, UNESCO, Paris, France. Dr. Birger Rasmussen, Institute of Marine Research, Bergen, Norway; Dr. Mario Ruivo, Fisheries Division, FAO, Rome, Italy; and Mr. W.C. Tait, International Atomic Energy Agency, Vienna, Austria.

After a first day of general discussion the Working Party considered the definition of Fishery Oceanography. It is defined as follows:

Fishery Oceanography is the study of the living resources of the sea using those aspects of oceanography (including biology, physics, chemistry, geology, and meteorology) that affect their abundance, availability, and exploitation.

Objectives of Fishery Oceanography include:

1. The assessment of the distribution of living resources of the sea;
2. The prediction of the abundance in time and space of presently used living resources of the sea;
3. The estimation of the maximum sustainable yield of presently used individual living resources of the sea;
4. The estimation of the exploitable production of individual stocks under natural and man made conditions and of the living resources of the world ocean as a whole;
5. Investigation of means of increasing the exploitable production of the living resources of the sea and means of

- protecting them from natural and man made disaster; and
6. The prompt publication of these findings.

The Working Party did not have time in which to adequately describe what fisheries oceanography has accomplished. Attention is directed to the letters of Davies, Cushing, Uda, and Sette, in particular, in the two volumes of comments on fishery oceanography, to much else include in the other correspondence in those volumes, to the letters from Uda and Bückmann attached hereto, and to the excellent historical account of Norwegian Fishery Research by Rollefsen in "Havet og våre Fisker" published by J.W.Eides Forlag, Bergen, Norway, and obtainable in English translation at the Institute of Marine Research, Bergen.

Much discussion was entertained on the subject of trends of inquiry that might be emphasized to further the objectives of fishery oceanography. This discussion is summarized as follows:

1. Much advantage can be expected from a more extensive and continuous inquiry into the dynamic and thermal relationships between atmosphere and ocean, not only in local areas of investigation, but on a wider regional basis as soon as means for doing this are perfected. Intensification of operational research in interaction at the air-sea interface is required per se and also for the purpose of studying the variations in the marine biota, to the end that the effect of departures from normal in the atmosphere can be followed in their effects on the ocean and its marine life.

It was noted that prediction of events in the ocean, even months ahead, from an intensification of study in relation to atmospheric phenomena is not presently promising, but that an intensification of such studies in the present can be expected to be fruitful, at least in aiding in the elucidation of past events.

2. To aid in efforts as outlined in (1) synoptic charts of atmospheric pressure and its deviation from normal are needed and should be available to workers in fishery oceanography quickly at regular and brief intervals. The international organization that is to represent the interests of fishery oceanography should seek contact with the World Meteorological Organization (WMO) with the aim of obtaining meteorological services as outlined above on a world-wide and/or regional basis.

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3. WMO and its regional subdivisions would also be able to supply quickly the observations of sea surface temperature gathered by radio from the world ocean in either tabular or map representation (examples: North Atlantic maps distributed by the Marine Division of the British Meteorological Office and the U.S. Naval Hydrographic Office; North Pacific maps distributed by the Japanese Meteorological and Fishery Agencies and by the U.S. Bureau of Commercial Fisheries Biological Laboratory of San Diego).

Attention is drawn to the experimental work of Tokai University, Japan, in drawing information by radio from vessels at sea and re-broadcasting to ships at sea at five and ten day intervals by facsimile chart the collated information of several meteorological, oceanographical and fishery parameters and, moreover, to the experimental daily charting of bathythermograph traces in the North Atlantic by the U.S. Naval Hydrographic Office. It should be particularly noted that ICES since 1959 has had a sub-Committee working on the organization of telegraphic communication of observations serving fishery oceanography. An international code for this purpose has been devised and adopted by the Council in 1961. Experiments with the use of the coded messages have been carried out by the Institute of Marine Research, Bergen.

The desirability of exploring the extension of these communication techniques on broader scale and to other parameters is stated. Amongst these may be considered storm surges, wave and wind conditions, depth of mixed layer, salinity, plankton volume and other appropriate primary productivity index, catch per unit of effort in certain wide-ranging fisheries, variation in location of water mass boundaries, etc.

like, so that sturdy, simple, cheap dependable instruments of this nature can be put into broader use.

There is required the development of instrumentation for the quantitative assessment of living resources in different habitats and at different trophic levels. Attention is directed particularly to concentrations of organisms in the scattering layers in various parts of the world ocean.

The work being done in several areas on production of a cheap, sturdy, dependable buoy from which several meteorological and oceanographic parameters can be continuously recorded is pointed out as a field requiring even intensification of present effort. The high desirability of developing instrumentation for the continuous recording of biological parameters on such installations is emphasized.

7. Attention is directed to the great, growing, and continuous need for intercalibration studies of instruments, methodology and techniques in all of these fields of measurements between individual workers, laboratories and expeditions to the end that resulting measurements will be fully comparable on a world wide basis.

8. Much additional attention must be given to taxonomic studies in all divisions of the biota but particularly at present to phytoplankters, zooplankters, fish and fish-eggs and larvae. The production of comprehensive well illustrated monographs is a desideratum.

9. Emphasis requires to be given to studies of the principles of the mechanism of biological productivity in the sea. Both theoretical and experimental studies in this field require to be broadened and intensified. It is noted that much of the experimental study required cannot be practically done in situ but will require to be undertaken in laboratory and that there are few places in the world where adequate facilities for undertaking laboratory experiments in this field are available except of a most primitive sort which, for the most part, are not suitable for such work.

10. Lying at the base of much frustration in the elucidation of fishery problems is a profound ignorance of the physiology of the key organisms. As an example it is frequently hypothesized that the success of year classes, and the resultant success of the fishery, is dependent upon events during the first stages of the fish's life even, in some instances, during the first hours

after spawning or of hatching, In the absence of detailed knowledge of the physiological requirements of the very young larvae little progress can be made in this vital area of understanding. For this work, again, laboratory facilities of a higher order of sophistication than most which are presently available will be required, as well as teams of specialists in different disciplines.

11. The center of fishery oceanography is understanding the factors affecting the abundance of populations under study. This boils down to understanding the factors affecting recruitment, growth, and mortality. Much progress has been made in the field of population dynamics, but the present simple models require development.

Two directions are possible. The first is the extension of Riley's methods to evaluate the transfer of energy between trophic levels and the establishment of the links between these levels. The second is the development of the models evoked by Beverton and Holt, Schaefer and others to take into account the biotic and abiotic factors in the environment. Ultimately the two approaches will combine.

At the same time is needed a combination of field and experimental work to test and retest such models in order that they may be perfected and adjusted to different sorts of populations and conditions. What is wanted, in fact, is the development and application of concepts in dynamic ecology to these vital problems of recruitment, growth and mortality as they affect the populations under study.

12. It was repeatedly noted that the complexity of the problems involved in fishery oceanography increasingly call for a team approach to their solution in which specialists from different disciplines would be required working in close collaboration. Attention was directed to the growing role of behavioral, or even fish psychology, research as an element of such teams.

Aside from this brief summary of aspects of fishery oceanography requiring intensification, the reader's attention is directed to the voluminous correspondence in the volumes of Comments on Fishery Oceanography and particularly to the letters from Uda, Rass, Cushing, Davies, Sette and Blackburn included therein.

The Working Party, lastly, turned its attention to problems involved in liaison among workers in fishery oceanography and the rest of the scientific community investigating the sea and the atmosphere.

The necessary breadth of the field of fishery oceanography as noted in the definition given above requires the closest possible liaison between workers in it and among them and all other investigators of the ocean. The Working Party considered these needs at several levels.

A. Within the United Nations family of specialized agencies.

The Working Party discussed the genesis of the Intergovernmental Oceanographic Commission, the sub-committee on Oceanography of the Administrative Committee on Coordination of ECOSOC, and the relationships among UNESCO, FAO, WMO, IAEA, etc. While realizing the fiscal and diplomatic difficulties involved it was felt that the high desirability, from the viewpoint of the different scientific disciplines involved in inquiry into marine problems, of preventing any splitting of those disciplines, and the equally high desirability of continuously simplifying the machinery for liaison among them, lent emphasis to the ultimate desirability of having an organization devoted solely to ocean problems standing independently among the specialized agencies of the United Nations family.

B. Intergovernmental regional, or particular fishery, commissions and organizations.

It was realized that governments require, and probably will continue to require, commissions or organization of a regional, or geographically and politically restricted, nature quite outside the United Nations family, to attend to particular problems occurring among them growing out of high seas fisheries of common concern. It was noted that continuous attention must be given to liaison among these and the international agencies in order that the scientific work undertaken under both sorts of regimes will go smoothly and efficiently. It was also noted that continual attention should be given to the possibility of simplification of such intergovernmental apparatus. It was suggested that the time might be approaching when some coalescing of this structure might be profitably considered.

C. Scientific advice to the present Intergovernmental Oceanographic Commission.

The Working Party reviewed the interaction on this question between various elements at the First meeting of the Intergovernmental Oceanographic Commission and Resolution I of that meeting. It was informed by the observer from FAO that FAO Fishery Division would announce the establishment of its Advisory Committee on Marine Resources Research during the course of the forthcoming second

meeting of IOC, and it was told the proposed composition of ACMRR. It considered the broad field of responsibilities which SCOR had aside from its advisory responsibility to UNESCO. It considered the broad field of responsibilities which ACMRR would have in its relations with FAO aside from fishery oceanography as herein defined.

Accordingly it adopted the following recommendations:

1. That SCOR reconstitute its membership so that fishery oceanography and marine biology may be better represented for the purpose of improving SCOR's ability to serve the whole scientific community concerned with the ocean.
2. That a committee be formed consisting of not more than 15 members for the purpose of advising the IOC on the scientific aspects of ocean research. The composition of the Committee should be derived from the Scientific Committee on Oceanic Research of the International Council of Scientific Unions and the FAO Advisory Committee on Marine Resources Research approximately on an equal basis.
3. That the above recommended joint scientific advisory committee to IOC invite the intergovernmental fisheries commissions and regional organizations to send observers to participate in its meetings and keep them informed of its activities.
4. That in prosecution of its broad international cooperative programs in oceanic research IOC use the existing machinery of such regional commissions and organizations to the extent that it finds practical and appropriate.
5. That SCOR, IOC and ACMRR give particular and continued attention to liaison among marine meteorologists and other ocean research workers.

The Working Party on Fishery Oceanography extended particularly warm thanks to the Institute of Marine Research, Bergen, to its Director, Dr. Gunnar Rollefson, and to other staff-members, for the cordial welcome, the fine facilities provided, and the excellent atmosphere in which its deliberations could be conducted, all of which lent pleasure as well as effectiveness to the meeting in Bergen.

## APPENDIX II

NS/IOC.INF-33,  
Paris, 18, September 1962  
English only

UNITED NATIONS EDUCATIONAL  
SCIENTIFIC AND CULTURAL ORGANIZATION  
INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION

Second Session

Unesco, Paris, 20-29 September 1962

SUMMARY OF REPORT OF SCOR WORKING GROUP ON FISHERIES  
OCEANOGRAPHY

The Secretary,  
Intergovernmental Oceanographic Commission  
U.N.E.S.C.O.  
Paris

Dear Dr. Wooster,

During the First Session of IOC it was announced that SCOR would appoint a Working Group on Fisheries Oceanography.

This Group was appointed, has met, and has presented its report. This report is now being considered by the SCOR Executive and I enclose a summary of it for your information.

Yours sincerely,

/s/ G. F. Humphrey  
(President)

9. Emphasis requires to be given to studies of the principles of the mechanism of biological productivity in the sea. Both theoretical and experimental studies in this field require to be broadened and intensified. It is noted that much of the experimental study required cannot be done in situ but will require to be undertaken in a laboratory and that there are few places in the world where adequate facilities for undertaking laboratory experiments in this field are available.

10. Lying at the base of much frustration in the elucidation of fishery problems is a profound ignorance of the physiology of the key organisms. As an example it is frequently hypothesized that the success of year classes, and the resultant success of the fishery, is dependent upon events during the first stages of the fish's life even, in some instances, during the first hours after spawning or of hatching. In the absence of detailed knowledge of the physiological requirements of the very young larvae little progress can be made in this vital area of understanding. For this work, again, laboratory facilities of a higher order than most which are presently available will be required, as well as teams of specialists in different disciplines.

11. The center of fishery oceanography is understanding the factors affecting the abundance of populations under study. This boils down to understanding the factors affecting recruitment, growth and mortality. Much progress has been made in the field of population dynamics, but the present simple models require development.

Two directions are possible. The first is the extension of Riley's methods to evaluate the transfer of energy between trophic levels and the establishment of the links between these levels. The second is the development of the models evoked by Beverton and Holt, Schaefer and others to take into account the biotic and abiotic factors in the environment. Ultimately the two approaches will combine.

At the same time is needed a combination of field and experimental work to test and retest such models in order that they may be perfected and adjusted to different sorts of populations and conditions. What is wanted, in fact, is the development and application of concepts in dynamic ecology to these vital problems of recruitment, growth and mortality as they affect the populations under study.

12. It was repeatedly noted that the complexity of the problems involved in fishery oceanography increasingly call for a team approach to their solution in which specialists from different disciplines would be required working in close collaboration. Attention was directed to the growing role of behavioral, or even fish psychology, research as an element of such teams.

Aside from this brief summary of aspects of fishery oceanography requiring intensification, the reader's attention is directed to the voluminous correspondence in the volumes of Comments on Fishery Oceanography and particularly to the letters from Uda, Rass, Cushing, Davies, Sette and Blackburn included therein.

The Working Group, lastly, turned its attention to problems involved in liaison among workers in fishery oceanography and the rest of the scientific community investigating the sea and the atmosphere.

The necessary breadth of the field of fishery oceanography as noted in the definition given above requires the closest possible liason between workers in it and among them and all other investigators of the ocean.

The Working Group on Fishery Oceanography extended particularly warm thanks to the Institute of Marine Research, Bergen, to its Director, Dr. Gunnar Rollefson, and to other staff-members, for the cordial welcome, the fine facilities provided, and the excellent atmosphere in which its deliberations could be conducted, all of which lent pleasure as well as effectiveness to the meeting in Bergen.

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APPENDIX III  
INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION  
RESOLUTIONS OF THE SECOND SESSION  
Administrative Matters  
RESOLUTION I

PARTICIPATION BY INTERGOVERNMENTAL AND  
NON-GOVERNMENTAL ORGANIZATIONS IN THE  
WORK OF THE COMMISSION

The Intergovernmental Oceanographic Commission

Recalling and reaffirming Paragraphs 1 and 2 of Resolution 1 of the

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First Session of the Commission;

Recalling that the Statutes of the Commission prescribe the relationships between the Commission and the United Nations and the agencies of the United Nations system, and already provide specifically for the invitation of the United Nations and such agencies of the Commission, without the right to vote;

Recalling further that the Statutes of the Commission prescribe that "the Commission shall determine the conditions under which other intergovernmental organizations and non-governmental organizations shall be invited to participate in meetings of the Commission without the right to vote";

1. Decides that the Secretary shall, under the authority of the Bureau and the Director-General of UNESCO, invite organizations falling in the following categories to participate in sessions of the Commission as well as appropriate meetings of the subsidiary organs of the Commission, without the right to vote;

- (a) Intergovernmental organizations active and interested in oceanic endeavors, whose collaboration can help advance the work and objectives of the Commission and whose members are States which are members of the United Nations or of the agencies of the United Nations system.
- (b) Non-governmental organizations active or interested in oceanic endeavors, whose collaboration can help advance the work and objectives of the Commission.

2. Requests the Secretary to notify the United Nations, the agencies of the United Nations system, and the organizations meeting the conditions in (1) above of the regular sessions of the Commission and of such other meetings of the Commission or its subsidiary bodies which they may attend, that is, meetings not limited specifically by the Commission to certain participants and meetings which are within the competence of the organizations;

3. Requests the Secretary, under the authority of the Bureau and the Director-General of UNESCO, to establish effective working relationships with organizations meeting the conditions in (1) above, as appropriate.

I n t e r n a t i o n a l O c e a n o g r a p h i c P r o g r a m sRESOLUTION II  
COMPREHENSIVE PROGRAMME FOR WORLD OCEAN STUDYTHE INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION

Being convinced that the development of a comprehensive program for world ocean study is of paramount importance as a framework within which various national, regional, and worldwide international programs for oceanic investigations should be planned,

Realizing that such a comprehensive program for world ocean study should include the physical, chemical, geological, geophysical, meteorological, biological and fishery oceanography aspects of the world ocean and that those features that vary with time and space must be considered as well as those that vary only geographically,

Realizing further that the scientific aspects of the program should be developed by scientists in the various disciplines involved,

Noting that preliminary proposals have already been introduced both for studies of the dynamics of the northern Atlantic and Pacific Oceans and for surveys of the time-independent variables and that specific programs for the Indian Ocean, Tropical Atlantic, Southern Atlantic, and Kuroshio Current area are in various stages of development;

Requests SCOR in consultation with WHO, IAEA, other appropriate UN agencies, and the IOC advisory body on fishery oceanography and other pertinent groups, to prepare a general scientific framework (GSF) for the Comprehensive Study of the World Ocean for consideration at the Third Session of the Commission to serve as a basis for developing various national, regional, and worldwide international programs for ocean investigations.

Requests the Secretary to transmit to SCOR, WHO, IAEA, other appropriate UN agencies and the IOC Advisory Body on fishery oceanography, for guidance in formulating this general scientific framework, copies of the plan for the dynamic study of the northern Atlantic and Pacific Oceans (IOC/INF/20), the plan for ocean-wide surveys of the time independent variables (IOC/INF/32), the guidelines prepared by the IOC Secretariat (NS/IOC/2-3a), and thereports of the IOC Working Groups on Fixed Stations, Communications, and Data Exchange, and further

to provide these organizations with the following guidelines for developing a general scientific framework for the Comprehensive Study of the World Ocean:

- (1) The general scientific framework should be directed towards the thorough and expeditious field, laboratory, and theoretical investigation of the nature and resources of the world ocean with due respect to the practical application of the collected data to commerce, navigation, fisheries, weather forecasting, and other human activities.
- (2) The GSF should take into account the available knowledge of phenomena and processes taking place in the oceans together with the data already collected on the space and time variations of the oceanographic characteristics of the various oceanic areas.
- (3) The GSF should include synoptic studies of relatively large portions of the world ocean as well as regional and specialized studies on a smaller scale in the better-known areas in order to obtain more complete knowledge of the development of oceanic processes or of the geographical distribution of oceanic properties.
- (4) The GSF should ensure that the investigations of meteorological phenomena accompany the investigations of the physical oceanographic phenomena with a view toward improving the knowledge of the air-sea interaction.
- (5) In developing the GSF, consideration should be given to relating the geological and geophysical observations to the Upper Mantle Program, the World Magnetic Survey, and other comparable international projects.
- (6) The GSF should take into account that the operational implementation of the program will utilize the best available methods for precise navigation and position control and the most modern oceanographic instrumentation and techniques available as well as oceanographic buoys, weather ships, fishery research ships, aircraft and satellites, coastal and oceanic fixed stations, and the best available methods for rapid data transmission, exchange and processing.

- (7) Due consideration should be given to the fact that the operational implementation of the program developed from the GSF will be dependent upon complete exchange of information and data and on standardization and intercalibration of observational techniques.

### RESOLUTION 3

#### COORDINATION OF THE INTERNATIONAL INDIAN OCEAN EXPEDITION

##### The Intergovernmental Oceanographic Commission

Recognizing the urgent need for maintaining the coordination of the various national operational programs for cruises to the Indian Ocean,

Recognizing further that coordination must also be established within several of the separate scientific disciplines represented in the International Indian Ocean Expedition

Noting that the Expedition is already well underway and that the time for accomplishing this further coordination is short;

Requests that each IOC Member State participating in the International Indian Ocean Expedition and each participating non-member state who has not already done so appoint as soon as possible a national coordinator for its national IIOE program. These National Coordinators, collectively, will constitute an International Coordination Group, meetings of which, together with the Secretary of IOC and the relevant experts, will be called by the IOC Bureau whenever it deems such a meeting to be necessary.

Requests that SCOR, at its Executive Meeting 1-3 October, appoint a small group of experts concerned with the Expedition, each of whom will represent one of the pertinent scientific disciplines represented in the IIOE. Each will review the work accomplished to date in his discipline, evaluate the present plans for future work, and advise IOC through SCOR of his specific recommendations prior to 31 March 1963. Those recommendations will be reviewed by the IOC Bureau and the National Coordinators in order that Member States can consider modifying the national plans as necessary to accomplish the overall scientific objectives of the IIOE.

### RESOLUTION 4

#### METEOROLOGICAL ASPECTS OF THE INTERNATIONAL INDIAN OCEAN EXPEDITION

##### The Intergovernmental Oceanographic Commission

Noting the report of SCOR to the second Session of the Commission,

Urges its member governments to make adequate financial provision for the planned programmes

Decides that because responsibility for coordination of the Expedition has passed from SCOR to IOC, the International Scientific Coordinator for Meteorology previously appointed by SCOR will work under the responsibility of the Secretary of the Commission.

Noting that research and service to Expedition vessels by the International Meteorological Center (IMC), Bombay would be greatly helped by promptly radioed weather messages, and since all ships traversing the Indian Ocean are being asked to cooperate,

Recommends that operators of all participating oceanographic vessels should ask the meteorological services of their respective countries to designate these vessels "selected ships" and, in accordance with standard WMO practice, to provide them with instructions for the making and rapid transmission by radio, of surface weather observations, and that observations should be made at or near 00, 06, 12 and 18 hours GMT encoded, and sent as soon as possible to the most convenient ship-shore radio station for inclusion in meteorological broadcasts, and that the same routine should be followed for ship-board upper air observations.

Noting that daily synoptic surface and upper air charts will be plotted and analysed at the IMC for two years, starting 1 January 1963,

Recommends that operators of oceanographic vessels should specify their day to day requirements for forecasts, coded or facsimile charts, etc., to the Director of IMC, and that the Director of IMC should make every effort to satisfy these requirements.

Noting that Indian Ocean Research, particularly in fisheries, would be aided by charts of sea surface temperatures,

Recommends that the Director of IMC should arrange for the construction of semi-monthly sea surface isothermal charts for the two year period starting 1 January 1963 and that he should make reproductions of the charts available at cost to interested scientists and arrange for publication of the charts at the conclusion of IIOE, in addition to furnishing copies of the charts and data at no cost to world data centres A and B,

Invites WMO to take all possible action to assist in the establishment and operation of the IMC.

RESOLUTION 5  
FISHERY OCEANOGRAPHY IN THE INDIAN OCEAN

The Intergovernmental Oceanographic Commission

Having been informed of three resolutions which were adopted by the World Meeting on the Biology of Tuna and related species, convened by FAO at La Jolla, California, U.S.S. on 2-14 July 1962, and which are concerned with the international Indian Ocean Expedition;

Being informed that the surface temperature charts called for in one of these resolutions could be provided readily by the proposed International Meteorological Center;

Recalling that the Report of SCOR on the Indian Ocean Expedition states "that because the information from the Expedition will be of fundamental and far-reaching value to the long-term development of the ocean fisheries of the region, fisheries scientists should be encouraged to utilize the information to assist in such development",

Recalling that the SCOR Working Group on Fishery Oceanography's broad and inclusive definition of fishery oceanography requires a close cooperation between the fishery and non-fishery oceanographer and points out the mutual advantage if close cooperation is achieved,

Realizing that in the International Indian Ocean Expedition the opportunity exists for such close cooperation,

Appreciating that much of the information arising from the International Indian Ocean Expedition can be of much greater value if by appropriate means it can be made immediately available to fishermen and scientists in the interested countries;

Commends to its Member States the substance of these resolutions and reports for incorporation in the framework of the IIOE programs, requests their assistance in making available to fishery scientists for these purposes the most detailed statistics possible of catch and effort of all commercial fisheries in the Indian Ocean, and further requests that both these matters be brought to the attention of the fisheries scientists of such Member States and interested organizations for appropriate actions;

Recommends to fisheries organization of participating States the systematic collection of oceanographic data on all fisheries research vessels, insofar as the primary mission of the vessels will allow, and the prompt transmission of these data to world data centers,

Invites, in particular, the collaboration of FAO and SCOR in securing the achievement of these ends, and

Requests the Secretary, in consultation with the appropriate advisory bodies to appoint a Subject Leader for the fisheries aspects of the International Indian Ocean Expedition, who shall be responsible under the Secretary for coordinating the programs concerned, and for securing the utmost benefit from the International Indian Ocean Expedition in respect to all fisheries of the area, existing and potential. The Secretary, in consultation with appropriate bodies, will develop adequate means of supporting financially the work of this Subject Leader.

#### RESOLUTION 6

#### INTERNATIONAL SYNOPTIC INVESTIGATIONS OF THE ATLANTIC AND PACIFIC OCEANS (NORTH OF 20°S)-

#### The Intergovernmental Oceanographic Commission

Recognizing the SCOR project for the programme of international synoptic oceanographic study of the North Atlantic and North Pacific (North of 20°S) is of a scientific and practical interest and undertaking of a project of this kind will lead to better knowledge of the nature and character of the variations in the oceanic circulation and that the implementation of such a project will require well organized concerted international actions and coordination by the IOC;

Noting that the enormous scale and volume of the proposed investigations, the methodological difficulties involved and also the unpreparedness of many countries for the immediate execution of such a scale programme in the full volume, make it necessary to implement the proposed investigations stage after stage;

#### Decides:

- (1) That the proposed program of Synoptic Investigations of the Atlantic and Pacific Oceans mentioned above be adopted as the basis for the development of a general scheme for international synoptic oceanographic investigations of the Atlantic and Pacific Oceans (north of 20°S).
- (2) that the first stage of such investigations consist of the following:
  - (a) International Cooperative Investigations of the Tropical Atlantic (ICITA) according to the programme worked out by the IOC Working Group in Washington, 20 to 23 June 1962.

- (b) Specialized investigations of the process of development of oceanic currents and of existing scales of their variations. Those investigations should be organized on the national level and should include the wide use of direct methods for the measurement of currents.
- (c) International synchronous oceanographic observations to great depths at several (10 to 15) standard sections in the Atlantic and Pacific Oceans starting in 1963.
- (d) Those national and regional investigations in these oceans which would be complimentary to the work mentioned in paragraphs (a), (b), and (c) including those conducted by ICES, ICNAF, IANPFC, IPFC and other regional organizations.
- (e) Exchange and intercomparison of current-measuring and buoy equipment and methods.
- (f) Continuation of working out and analysis of the IGY and other previous data by ICES and other organizations.

Request the Secretary of the IOC:

- (a) to ensure necessary coordination of the steps included in the first stage of synoptic oceanographic study of the Atlantic and Pacific Oceans outlined above;
- (b) to call special attention of Member States to the need for the quickest possible development of the technical means for the study of the oceanic circulation simultaneously with the implementation of the first stage of synoptic oceanographic investigations mentioned before;
- (c) to organize continuous analysis of the first stage together with the proper development of technical means for the study of oceanic circulation and to ensure, in consultation with pertinent advisory bodies, the future development of programs of synoptic international investigations of the large scale dynamics by the oceans as affected by the ocean-atmosphere interactions, and the formulation of plans for the further stages of such investigations.

RESOLUTION 7  
INTERNATIONAL COOPERATIVE INVESTIGATIONS OF THE TROPICAL  
ATLANTIC

The Intergovernmental Oceanographic Commission

Approved Report NS/IOC/INF.21 of the Working Group on the International Cooperative Investigations of the Tropical Atlantic and Report NS/IOC/INF 21(1) of the Coordination Group.

Adopts the International Cooperative Investigations of the Tropical Atlantic as an official program,

Commends to its Member States active participation therein,

Requests FAO, UNESCO, WMO, IAEA, CCTA/CSA and other interested organizations to support this program and to commend to their Members active participation therein, and further

Establishes a Coordination Group which will have members nominated by participating Member States and to the meetings of which representatives of interested organizations shall be invited to attend in the role of observers. The Chairman of the Group, the International Coordinator, will be responsible to the Secretary of the Intergovernmental Oceanographic Commission and will have the functions described in Report NS/IOC/INF.21(1).

RESOLUTION 8  
GENERAL BATHYMETRIC CHART OF THE OCEANS

Whereas the Commission believes strongly that accurate GEBCO charts based on all available sounding data, obtained both by the various hydrographic offices and oceanographic establishments of the world, will be a valuable aid to the study of the oceans;

The Intergovernmental Oceanographic Commission

Noting the prime responsibility of the International Hydrographic Bureau as the Data Centre for bathymetric data and welcoming the work of that Organization on the GEBCO and the supporting scheme, whereby national hydrographic offices become regional centres for the collection of data in particular regions on plotting sheets;

Further noting with pleasure that certain non-member states of IHB have provisionally agreed to prepare master plotting sheets for the scheme under the aegis of the IOC and by working through the World Data Centres;

Also noting that the next edition of the GEBCO series, on scale of 1/10 million, will be prepared from those sheets by the IHB, taking advice as necessary from the ICSU - SCOR - IHB - IAPO Committee;

Considers that the existing arrangements are satisfactory but that progress should be reviewed at the next session of the Commission including the question of larger scales;

Taking into account further the fact that the IHB have allocated a sum of money for the GEBCO but that it is not yet known what expenses will be incurred, that the speed of production is therefore uncertain and that until the scheme is in operation, national hydrographic offices are unable to assess the amount of additional work involved in the preparation of the plotting sheets.

Considers that it is undesirable to take any steps to increase the rate of production of GEBCO at the present time but recommends that the IHB be asked to prepare a progress report for the next session of the Commission and that this proposal be reconsidered at that meeting.

Authorizes the Secretariat to approach the Economic and Social Council of the United Nations with regard to their work on the International Map of the World (IMW) and other interested bodies to discuss any financial assistance they may be willing to offer if required.

#### RESOLUTION 9

#### INSTALLATION AND MAINTENANCE OF TIDE GAUGES

The Intergovernmental Oceanographic Commission,

Recognizing the importance to oceanographical and other geophysical research of an evenly distributed and properly maintained network of tidal stations throughout the world oceans, as proposed by the Permanent Service for Mean Sea Level through the Secretary-General of FAGS (NS.IOC.INF-23), and

Recognizing further that such a network should be of a permanent nature, and so designed as to provide data for other types of oceanographical research in addition to mean sea level requirements,

Invites the Permanent Service for Mean Sea Level, through FAGS, and in consultation with IAPO, WMO, SCOR, SCAR and other interested organization to submit to the third session of the Commission:

- (a) a report on the existing distribution of properly maintained tidal stations.
- (b) A proposal for an improved network of such stations, and
- (c) any further information which would enable the Commission to take further action in promoting such a network;

Requests member countries to provide the Permanent Service, at the earliest opportunity, through the Secretariat of the Commission, an up-to-date list of existing, properly maintained, permanent tidal stations under their control;

Bearing in mind the application of recent developments in electronics to sea level recording, and also the absolute necessity of accurate geodetic levelling of tide gauge datums,

Commends to member countries, especially those unable to participate in the larger and more expensive projects of the Commission, the considerable value to world oceanography resulting from an increase in the number of permanent tide gauges.

#### RESOLUTION 10

#### TSUNAMI WARNING SYSTEM

#### THE INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION

Desiring to encourage the improvement of an international system for providing advance warning of the arrival of destructive seismic sea waves (Tsunami),

Recognizing that the establishment of adequate observation posts for obtaining seismic and sea level data is essential to the operation of such a system,

Recognizing further that both international communications and communications within the various countries involved must be adequate for dependable 24 hour operation,

Observing that research on the causes, nature, and effects of tsunami needs to be intensified and that development of improved tsunami measuring equipment is needed,

Noting that the United States through the Coast and Geodetic Survey currently operates an international Tsunami Warning System in the

Pacific and that they are eager to have other Pacific nations join with the eleven now cooperating in this system,

Noting further that WMO has established a Panel which is considering how that body can assist in the establishment of such a world wide system, that UNESCO has taken effective steps toward the international promotion of knowledge in seismology, and that the IUGG has established a Tsunami Committee to promote tsunami research.

Recommends that Member States of the Commission in the Pacific area who are not part of the present Tsunami Warning System establish adequate internal communications and responsible administration for their part in the system, establish and operate seismic and tidal stations, and integrate their system with that operated by the United States.

Requests the Secretary, in collaboration with the USC&GS, WMO, UNESCO, IUGG and other interested bodies to determine what further action should be taken by the Commission to insure the fullest participation in and most effective operation of this system.

RESOLUTION 11  
SOUTH ATLANTIC COOPERATIVE INVESTIGATION  
BY ARGENTINA, BRAZIL, and URUGUAY

The Intergovernmental Oceanographic Commission, after careful consideration of the description given in document NS/IOC/2-3(h), paragraph I, of the investigation already in course by Argentina, Uruguay, and Brazil in the zone of common interest where the Brazil and Falkland Currents converge.

Recognizes the utility of this programme, not only for the countries concerned, but for the understanding of a general oceanographic problem common to many areas and having an important bearing on the fertility of the sea;

Applauds the efforts of the three countries in conquering the great difficulties inevitably encountered in a first programme of such magnitude, especially by the commendable method of pooling resources, human and material, and a complete interchange of technical knowledge, and

Recommends that members of the IOC, having the possibility of increasing the profit of this programme by the application of more modern methods of measuring currents, primary production, and so on, join efforts with the countries concerned, either by lending them the

necessary equipment or by sending people and equipment to work aboard their ships.

#### RESOLUTION 12

##### COOPERATIVE STUDY OF THE KUROSHIO AND ADJACENT REGIONS

###### The Intergovernmental Oceanographic Commission

Recognizing the importance of the thorough scientific investigation of the Kuroshio, the major ocean current influencing the oceanic and meteorological conditions in whole East Asia,

Considering that the necessity for the cooperative systematic investigation of the Kuroshio was approved at the meeting of representatives of marine scientific institutions in East and South-East Asia held at Manila in 1962 under the auspices of the South-East Asia Science Cooperation Office of UNESCO (SEASCO).

Noting that such an investigation would also be of value to local fisheries, commerce, and navigation interests as well as providing knowledge of the air-sea interaction in an area of frequent and destructive typhoons,

Recommends that the interested Member States of the Commission develop the programme for the cooperative systematic seasonal investigation of the Kuroshio in the East China Sea, Southern Sea of Japan, and the Eastern Philippines Sea including studies of the physical, chemical and biological oceanography, and collaborate actively in those investigations,

Recommends further that meteorological and physical oceanographic observations be carried out simultaneously whenever possible and that echo sounding records be obtained when the vessels are underway.

Requests the IOC Secretariat, through SEASCO, and in cooperation with WMO and IPFC to assist the Member States involved in developing this programme.

#### RESOLUTION 13

##### ICNAF ENVIRONMENTAL PROGRAMME

###### The Intergovernmental Oceanographic Commission

Welcomes the interest and good wishes expressed by ICNAF in their letter of 7th September (Dec, NS/IOC/INF-27) and particularly welcomes their desire to cooperate with the Commission, as already shown by

the information provided concerning their environmental programme in general and their projected surveys of the waters around Greenland, during 1963, in particular.

Recognizing the fishery objectives of these programmes, the Commission notes also how they may be expected to contribute directly to the objectives of basic oceanographic studies on the north-west Atlantic Ocean,

Recommends that members of IOC concerned with these regions give all possible assistance to the ICNAF programme, and

Requests the Secretariat to keep ICNAF informed of any proposals for oceanic research covering or overlapping the ICNAF area.

RESOLUTION 14  
STUDY OF THE MEANS OF SPEEDY UTILIZATION OF  
SYNOPTIC OCEANOGRAPHIC DATA

The Intergovernmental Oceanographic Commission :

Noting the recent development of 'synoptic oceanography' and the benefit expected from such development as was presented by the USSR (Ref: ICOR/8 - 12 July 1960) and USA (UNESCO/NS/Ocean/92/(2) 18 February 1960) and reports from the ICES Sub-Committee for Telegraphic Exchange of Oceanographic Observations (1960-1961) and the growing demands of fishery oceanography (NS/IOC/INF-33);

Considering that data of sea surface temperature and other synoptic oceanographic factors are utilized by some countries for the prediction of fisheries conditions as well as for meteorological forecasts (Ref: Report of the Chairman of the Working Group on the Relations with the International Fisheries Organizations submitted by the Chairman of the CMM Working Group on RIFO, - CMM-III/Doc.4, V.1960);

Considering further that, although speedy collection of these synoptic data and distribution by means of facsimile broadcasting and other new techniques are developed on national or regional bases, there is no well organized system for communication regarding these data;

Requests the Bureau of IOC

to ensure that these problems be considered by the IOC Advisory Group on Fishery Oceanography as well as the Working Groups on Communications, Fixed Oceanographic

Stations and Data Exchange, where appropriate.

Recommends that member countries of IOC conducting synoptic oceanographic observations submit reports to the Secretary of IOC on the present status in this field of their respective countries.

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Implementation of Recommendations of  
First Session and Recommendations of  
Working Groups

RESOLUTION 15  
ADVISORY CHANNELS TO THE COMMISSION

The Intergovernmental Oceanographic Commission:

Recalling Resolution I adopted by its First Session and the consideration of the advisability of establishing advisory channels to the Commission in all fields of oceanography at its First Session and, through correspondence with members and intergovernmental and non-governmental organizations, since that Session,

Recognizing its need for scientific advice on the broad aspects of oceanography,

Designates the Scientific Committee on Oceanic Research of the International Council of Scientific Unions as the advisory body to the Commission on the broad scientific aspects of oceanography, and

Recognizing further its need for scientific advice on fishery oceanography and the desirability of achieving effective use of research resources provided for fisheries in coordination with those provided for other aspects of oceanography,

Noting that the Food and Agriculture Organization of the United Nations has established an Advisory Committee on Marine Resources Research,

Aware, however, that some members of the Commission are not at present members of the Food and Agriculture Organization,

Designates the Advisory Committee on Marine Resources Research of the Food and Agriculture Organization as the advisory body to the Commission on fisheries aspects of oceanography, the Committee being augmented for this purpose by two additional members from countries

not members of FAO to be recommended by the Bureau of the Commission as invited by the Director-General of FAO in his letter of August 17, 1962. Taking into account the important activity of the USSR in fishery oceanography, it is recommended that the two additional members of this Committee be selected from scientists in this field of research in the USSR, Further, it

Requests the Bureau and the Secretary of the Commission to consult WMO, IAEA and other appropriate intergovernmental and non-governmental organizations of a world-wide and regional nature on international programmes in oceanography.

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#### RESOLUTION 16

#### COMMUNICATIONS FACILITIES

#### The Intergovernmental Oceanographic Commission

Having seen the report of the meeting of the Working Group on Communications

Considering that steps should be taken in order to implement the recommendations of this report

#### Resolves:

1. To adopt the report of the working group on communications annexed to this resolution.
2. To request the Member States of the IOC to communicate this resolution and the report to their national Telecommunications Authorities for the purpose of considering the possibility of allocating radio channels for the purpose mentioned in the report.
3. With the objective of coordinating the allocation and use of specific radio channels among the countries concerned, the Bureau of IOC should be instructed to convene by mid-1963 a meeting of experts representing national telecommunications, oceanographic and meteorological authorities.
4. Previous to the meeting proposed in Section (3) the Bureau of IOC should convene an IOC working group to work out section VIII of the annexed report.

- 5. That the Bureau of IOC takes steps to implement section VII of the annexed report.
- 6. To invite WMO to consider and support the recommendations of the annexed report, and in particular to participate actively in the meetings referred to in 3 and 4 above.

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RESOLUTION 17

FIXED OCEANOGRAPHIC STATIONS

The Intergovernmental Oceanographic Commission :

Having studied the Report of the Working Group on Fixed Oceanographic Stations, which is attached to the present resolution and

Considering that the various recommendations of the Working Group should be implemented.

- 1. Resolves to accept the report of the Working Group;
- 2. Authorizes and instructs the Bureau and Secretary to take appropriate action in accordance with the various recommendations in the report.

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RESOLUTION 18

LEGAL STATUS OF FIXED OCEANOGRAPHIC STATIONS

The Intergovernmental Oceanographic Commission

Recalling that Resolution No. 7 of its First Session recommended to UNESCO that steps be taken in consultation with IMCO to clarify the legal status of unmanned and manned observing buoys.

Having considered documents NS/IOC/INF.34 entitled "Preliminary Report of the United Nations Educational Scientific and Cultural Organization and the Intergovernmental Maritime Consultative Organization on the Legal Status of Unmanned and Manned Buoys", and document NS/IOC/2-5(b), the Report of the Working Group on Oceanographic Stations,

Noting the need for further clarification of the legal status of fixed oceanographic stations and the establishment of safety rules

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for their proper use,

Decides

1. To request the Director-General of UNESCO in consultation with the Secretary-General of IMCO, to study further the relevant existing international maritime conventions with the view of defining in a new international convention the legal status of fixed oceanographic stations.
2. To request members of the Intergovernmental Oceanographic Commission to report to UNESCO during the first half of 1963;
  - a) on their domestic laws, regulations, orders, court and administrative decisions, diplomatic correspondence and any other legal authority concerning such fixed oceanographic stations;
  - b) on their regulations and practices concerning the marking and identification of fixed oceanographic stations;
  - c) on what legal problems, if any, they would wish considered in a new international convention concerning fixed oceanographic stations, together with the possible solutions that might be adopted in an international convention.
3. To request the Secretary of the Commission to inform the Maritime Safety Committee of IMCO of all suggestions emanating from the Commission and from the implementation of this resolution concerning the marking, the identification and any other safety aspects of fixed oceanographic stations.
4. To express the wish that the Maritime Safety Committee of IMCO study such suggestions and other safety aspects of the use of fixed oceanographic stations and indicate the results of its study and deliberations to the Commission.
5. To request the Director-General of UNESCO to continue his close cooperation with the Secretary-General of IMCO on all legal aspects of fixed oceanographic stations.
6. To request the Director-General of UNESCO to present a report to the next session of the Commission on the different questions dealt with in this resolution together with any suggestions he may deem appropriate.

## RESOLUTION 19

STANDARDIZATION AND INTERCALIBRATION OF  
OCEANOGRAPHIC TECHNIQUES AND METHODSThe Intergovernmental Oceanographic Commission

Noting the report of SCOR to the Second Session of the Commission on standardization and intercalibration of oceanographic equipment and methods given in UNESCO/NS/IOC/INF-36 and the results of the SCOR-UNESCO intercalibration tests in Hawaii and Australia (NS/IOC/INF-25(2), and 25 (3) pp. 7-14, and of the Soviet Union at Gelendjik (NS/IOC/INF-25).

Appreciating the great importance of this subject to the future of international cooperation in oceanography

Realising that many of the difficulties in some fields lie in an insufficient knowledge of the basic techniques in use

Requests member governments to promote the examination of all the oceanographical techniques in use in their respective countries with regard to precision and intercomparability.

Resolves that after consulting the Commission's advisory channels the Secretariat should arrange that those national laboratories best qualified to undertake the task should make a critical examination of particular methods and techniques

Requests member governments of the Commission to give such financial support as will allow these laboratories to carry out the tasks assigned to them

Further requests the Secretariat, in consultation with the Commission's advisory channels, to consider the recommendations made by the participants in the SCOR-UNESCO tests in Hawaii and Australia and to arrange that the necessary action arising from these recommendations be taken.

Requests the Secretary with the assistance of the Advisory bodies to arrange for national and international intercalibration tests to be undertaken and adequate finance to accomplish these objectives.

## RESOLUTION 20

DATA EXCHANGEThe Intergovernmental Oceanographic Commission

Noting "The Report of the Working Group on the organization of Oceanographic Data Exchanges" NS/IOC/2-5(c) and NS/IOC/2-5(c) Addendum,

Recognizing the complexity of the subject matter considered by this Working Group,

Approves the Report of the Working Group as a Provisional Guide for the development of effective Data Exchange methods and procedures.

Recommends to Member Nations and participating activities thorough study of the Report and implementation of specific recommendations as rapidly as possible,

Authorizes the continuation of the Date Exchange Working Group to further develop effective methods and procedures and to report at the next meeting of the IOC. Special attention should be paid to the problems of speedy dissemination and utilization of synoptic oceanographic data.

RESOLUTION 21ADOPTION OF THE METRIC SYSTEM AND CELSIUS SCALEThe Intergovernmental Oceanographic Commission,

Noting that international adoption of the Metric System and Celsius Scale should be one of the major keys to promoting marine sciences,

Considering that the use of the Metric System was recommended by the Working Group on Data Exchange held in Washington from 7 to 10 August, 1962.

(Ref: NS/IOC/2-5(c));

Noting further that data are to be submitted to the World Data Centres in the Metric System and Celsius Scale.

Bearing in mind that for purposes of international exchanges of meteorological data, the World Meteorological Organization (WMO) has already adopted the said system at its 3rd Congress.

Recommends that member countries of IOC take the necessary steps to encourage, as far as possible, the use of the Metric System and Celsius Scale in their oceanographic publications.

RESOLUTION 22  
SCOR AND THE SECRETARIAT

The Intergovernmental Oceanographic Commission

Recognizing that during the course of this Second Session it has requested SCOR to undertake a heavy burden of responsibility for scientific advice and planning;

Recognizing further that it has greatly extended the tasks of the Secretariat of the Commission;

Recommends that Member States support the formation and operation of national scientific committees for oceanic research, and through these committees provide support which will assist SCOR to carry out the work it has been requested to undertake by the Commission;

Recommends further that Member States consider ways, possibly including the temporary assignment of their own personnel to the Office of Oceanography of UNESCO, in which they may assist the Secretariat to fulfill its responsibilities.

Requests the Secretariat and SCOR from time to time to make known their needs for assistance and support from the Member States and National Committees.

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## APPENDIX IV

Report Presented to the Bergen Meeting of the SCOR  
Working Party on Fisheries Oceanography  
(10-14 Sept., 1962)

The Accomplishment of Fisheries Oceanography  
in Japan and its Future Oceanography  
Michitaka Uda  
(Tokyo University of Fisheries)

INTRODUCTION

The development of Fisheries Oceanography is roughly shown in Table I.

The fisheries oceanographical organization was founded by Tasaku Kitawara in 1909. Anixwis 1913 those prefectural Fisheries Experimental Stations with ships have been making regular lines of oceanographic observations. The results are published in the Semi-annual Oceanographic Investigations (Kaiyōtyōsa Yōhō"), Vol.1-75. Most of the data are from the prefectures of Tyosen (afterward Korea) using "Misago maru" (154 tons), Taiwan, using the "Syōnan maru" (417tons) Hokkaido, using "Tankai maru" (85 tons) and others. The Imperial Fisheries Experimental Station (Tokyo) have had the Sōyō maru" (202 tons). During the period 1931-1942 simultaneous surveys were made by many ships successfully using Nansen Bottles with the reversing thermometers in the Japan Sea and Pacific approaches.

The potential characteristics of Japanese Fisheries Oceanography having so many numbers of surveying boats was necessitated to elucidate the complicated and variable hydrographic conditions.

Before 1948 the effort of fisheries oceanographical investigations has been concentrated into the biological surveys of important food fishes and its environmental conditions (oceanographic structure and its variation). The ultimate aim of this investigation was to obtain the means of fisheries prediction.

Since 1949 the eight regional fisheries research laboratories with the research vessels "Sōyō maru", "Tenyō maru," etc., have been carrying out surveys for the conservation and exploitation of fisheries

resources. Fisheries Agency with research boats "Tōkō Maru" (1000 tons) and "Syōyō maru" (700 tons) etc., has conducted surveys for new fishing grounds in the Atlantic, Indian Ocean and South Pacific Ocean with its adjacent waters.

The Imperial Fisheries Institute, which later became the Tokyo University of Fisheries, built a training and research ship, the "Kaiyō maru" (140 tons) in 1900. This was followed by the Unyō maru (442 tons) in 1909, the "Hakuyō maru" (1327 tons) in 1929, and finally the "Umitaka maru" (1397 tons), with the "Shinyō maru" (236 tons) and "Hayabusa maru" (100 tons). The ships associated with the fisheries department of several universities are:

Hokkaido Univ . . . . .	"Oshoro maru", "Hakusei maru"
Kagoshima Univ. . . . .	"Kagoshima maru", "Keiten maru"
Shimonoseki Fisheries Inst.	"Koyō maru"

All these are carrying out training and researches in fishing navigation, and fisheries oceanography.

The educational institutions for fisheries in Japan show the advanced popular feature of Japan.

### I. Oceanography on Availability

Many exploratory cruises by experimental fishing boats, using modern scientific methods and equipments on the basis of long maritime experiences, aided materially to discover new fishing grounds, and consequently contributed to the expansion of Japanese fisheries with tremendous increase of yields (Uda, 1959, 1960).

The localization of fish concentration is associated with the pattern of a narrow zone of the optimum water (a complex of optimum water temperature, salinity, turbidity, currents, bottom configuration, depth and character (including sediments) of bottom, food plankton, benthos, etc.) or optimum oceanographic structure for each fishery.

As a compiled result of studies for the existing fishing grounds during the first half of this century, Uda (1940, 1957) prepared a diagram of optimum temperature spectra for some of the important commercial fishes of Japan which indicates the basic pattern of fish shoaling curve in response to normal environmental conditions.

Temperature trend observation foretell the occurrence of sardine (Uda and Okamoto, 1936 ) etc.

In 1918 T. Kitawara proposed "Kitawara's Law", fish assemblage near a line of convergence-"Siome", which was further developed by M.Uda(1936, 1958), stating that the oceanic front reveals the area where marine life is concentrated and where fishing is favorable, usually presenting a "Siome" (streak of a line of convergence) on the ocean surface as an indicator.

Fringing zone to the area of upwelling (divergence), ridging or doming of deeper cold water, and eddies or in other word peculiar, threedimensional oceanographic structure corresponds to good fishing grounds.

Enrichment pattern due to topographically developed back-eddy systems (near a strait, channel, peninsula, cape, island, reef, estuary mouth, etc.,) corresponds rich feeding areas, and consequently good fishing grounds for mackerel, squids, anchovy, sardine and yellowtail, etc., (Uda, Ishino, 1958).

Dynamically produced eddies along oceanic fronts are rich feeding areas supplied with an abundance of planctonic food and small fishes.

In the northern hemisphere, cyclonic (counterclockwise) eddies constitute good fishing area in the marginal zone (e.g. saury, whales, etc., in the Polar Frontal Zone; albacore in the Kuroshio Front) in association with the favorable water temperature. In the southern hemisphere, clockwise eddies develop along the Antarctic Convergence as favorable whaling grounds, just north to the pack-ice zone. (M.Uda, 1954, 1960; K. Nasu, 1959).

The meteorologically abnormal onshore-current "Kyuto" (rapid current or storm current) produces a heavy catches of yellowtail, sardine, tuna, etc., into the coastal set-net fishery by the approach of the intruding unfavorable water masses (abnormally warm, saline). (T. Miura, 1926; M. Uda, 1927; K. Kimura, 1940; M. Uda 1953).

An useful estimation of fish abundance and concentration is introduced by echo-trace or by DSL considering the amount of food plankton(Uda, Hashimoto, 1956).

Many fishing grounds had been newly exploited by means of echosounders, dredges, core samplers, e.g., Yamato-Bank in the Japan Sea, that in the Okhotsk Sea, and many volcanic guyot as fish-bank for tunas, because topographical or geological irregularities on the sea

bottom such as reef, bank, sea-mount, canyon, sea valley, ridge, etc., bring about the localization or concentration of fishes, affecting their migration route.

## II. Marine Meteorological Aids

Japanese fisheries oceanographers made some success in studying problems associated with the safe and efficient conduct of fishing operations in cooperation to Japanese fishermen, e.g. methods of locating fish schools or aggregations of commercially valuable fish, or of discovering unutilized fish-populations by using fish-finder, aerial scouting, fish lamp, electric shock, and the observation of oceanographic structure, etc., in addition to the classical methods.

Concerning the operation of fishing gear and boats in order to prevent or at least effectively reduce the damage due to storms, high winds, abnormal currents, advanced knowledge of sea conditions were obtained. For example, studies of set-net fishery using the method of model experiment (H. Miyamoto, 1952), studies of the whaling in the North Pacific subarctic waters (Uda and Nasu, 1956) taking account of sea fog and state of sea, set-net damage investigation due to storm wave (Uda, Tsujita, 1948, 1956, ), etc., could be quoted. Yellow-tail catch at the set-net fishing grounds has shown a close relation with the occurrence of cyclones and atmospheric fronts in winter and spring, showing peak of catch on a few days before and after the passage of a cyclone. This fact enables fishermen to predict the catch by the weather map (M. Uda, 1927, 1937 derived statistically).

## III. Oceanography on the Estimation of Population Size

In recent years the traditional Japanese fishermen displayed a remarkable activity to exploit unexplored fishing areas in the world oceans in advantage of oceanographic knowledge above mentioned. However, our most important task to estimate relative population size is still not fulfilled.

Longterm cyclic fluctuation in commercial fisheries as the result of changes in the reproduction, development, distribution or availability of fish-stocks caused by the cyclic environmental changes depend on the degree to which the conditions depart from those laid down by Uda (1958) as the optimum conditions. Thus, concerning fluctuations of tunas, sardine, herring, salmon fisheries etc., studies based on the oceanographic and climatological changes were undertaken by M. Uda (1958, 1961, 1962a, 1962b, )

Fluctuations of Hokkaidō herring fishery was keenly studied in long past years by Hokkaidō Fisheries Experimental Station and Hokkaidō

Regional Fisheries Research Laboratory (Kurakami et al, 1925, Kawana, 1948, 1949; Hirano, 1953, 1957; Konda 1953). Herring decline in recent years is mostly attributed to the oceanic warming from south. However, the mechanism in detail is still unknown.

Fluctuation of sardine fishery alike to California sardine occurred in Japan was studied intensively by Nakai and others (Tokai Regional Fisheries Research Laboratory (Z.Nakai et al, 1962). The cause of recent decline was sought in the anomalous condition of meandering Kuroshio and the cooling down of northern Japan Sea. (Uda, 1958) Nakai, 1956).

Now in Japan the regional fisheries laboratories are studying the critical environmental conditions controlling the rate of mortality or survival in the early stage of fishes (herring, sardine, horse mackerel, etc.,) such as the characteristic water masses, transport and dispersal by wind and currents:

Fluctuations of skipjack, bluefin-tuna, and albacore fisheries are also remarkable in Japan, presumably due to the change of environmental conditions in response to the growth and decay of Kuroshio and Oyashio Currents. (Uda, 1961, H. Yamanaka, 1962).

The effects of overfishing and water pollution upon the fish-stocks for coastal fisheries are another important problems being attacked by fisheries scientists including the fields of population dynamics and coastal oceanography. After the World War II new field called micro-oceanography (including nearshore oceanography or estuarine oceanography) for the use of many fishermen engaging pearl oyster culture, oyster culture, laver culture, fishes (yellowtail, puffer, sea bream, etc.,) and shrimp, octopus culture, etc., are rapidly developing in Japan. Artificial production of fishing grounds by dam construction, wave protecting fence, channel digging, pumping circulation, etc., with the combination of oceanographic and marine engineering methods.

#### IV. Development of Fisheries - Oceanographic Observation and Information

Started from coastal daily regular observation, offshore monthly regular observation (sectional and synoptic) in combination with the field survey of fishing grounds during half a century, we have published normal or average oceanographic charts (temperature, salinity, transparency, currents, etc.,) in the waters around Japan. Also, general

distribution of plankton, benthic animals and commercial fishes with its time variation pattern.

Concerning interrelationship of the aggregation, movement of fishes and environmental conditions, as well as the relation between the meteorological disturbance and fisheries, studies are made with the result of some useful prediction indices. Thus, by the requests of fishermen, fisheries forecast (by means of radio broadcast, telephone, newspaper, etc.,) started 25 years ago in national and regional or local scale for some important fisheries (skipjack, saury, sardine, mackerel, yellowtail, herring, squids etc.).

We, fisheries oceanographer found anomalous Kuroshio associated with the occurrence of cold water mass and great influence on fisheries conditions. Moreover, we were able to forecast the cool summer associated with the abnormally cold Oyashio current in conjunction to the profound change of fisheries conditions and rice crop harvest in the northern Japan.

After the World War II, the estimation of fisheries yield or the absolute population size on vital statistics, using the powerful tool of population dynamics have made some progress. However, they are convinced soon that the reproduction potentials or recruitments are too much changing in response to the change of natural environments. On the contrary to the decline of western spawning population the sudden growth of the eastern spawning population was found in the case of herring fishery and sardine fishery within recent ten years. Tremendous yields of pacific saury and squids show quite strange fluctuation to the eyes ignorant for oceanography. The uprising of bluefin-tuna and skipjack fishery, the occurrence and disappearance of Yellow Sea shrimp fishery, the outburst and still continuing fishery of horse mackerel in recent years are all credible through fisheries oceanographic interpretation.

Since 1952, Japanese High Sea Salmon Fisheries and Longline Tuna Fisheries started to extend their operation. Tuna fishermen conducted observation of water temperature to the depth of 200m. by BT and currents by drift of gears. Salmon gill-netter observed color of the sea, transparency, water temperature of 50m depths, and currents by the drift of nets.

Since 1947 the Antarctic whaling has began again, Whalers conducted observations of water temperature down to 50m depths, currents, transparency, salinity, eye-observation of the patch of food plankton, pack-

ice or iceberg, etc. Set-net fishermen are carrying out observation twice a day of water temperature (0.50, 100m depths), transparency, currents, weather, etc.

This, nowadays practices of Japanese fishermen of oceanographic aids to their daily fishing operation are very popular.

On the otherhand, since 1955 NORPAC Project almost continued ocean-wide surveys were undertaken internationally. Tuna fishermen, whalers, and trawlers are now all accustomed to the world-wide fishing cruise in Japan. Accordingly, Japanese fisheries oceanography are turning to world-wide scale.

In recent years groups of Japanese tuna fishermen have started their own research and published their journals "Katuwo to Maguro" (Tokyo), "Maguro Gyogyo" (Misaki), and "Wakasio" (Shizuoka).

Tokai University is publishing regular oceanographic charts for fishermen's use and arranging Facsimile broadcast for far-ranging tuna boats. Meteorological Agency are publishing every decade temperature map with the weekly radio broadcast. Marine Observatory at Nagasaki publishes another oceanographic map every ten days in East China Sea for trawlers and purse seiners, anglers. Japanese Hydrographic Office serves seasonal current maps (GEK measured and geostrophic current) with wireless current communication. Tohoku Regional Fisheries Research Laboratory publishes fisheries oceanographic chart every 5 days for the skipjack and saury, tuna fishermen's use. Tokai and Nihonkai Regional Fish Lab. do the similar service.

The international and national cooperated communication and oceanographic maps for fishermen's use should be considered in future.

#### V. Future Prospect

Future lines of fisheries oceanographic research should be concentrated to elucidate the actual state of environmental effects and to clear up the mechanisms and factors, and ultimately to be able to predict the fisheries fluctuation.

Fisheries oceanography should aim to challenge the changing seas and oceans and biological changes at the various trophic levels, especially environmental requirement critical for survival of fish larvae, etc. We should bring together fisheries biology, especially population dynamics which tell us how a fish population reacts to fishing in a steady environment and fisheries oceanography which can afford the relative population strength or the prospect of their trend.

in a changing environment. How the environmental factors affect on the marine life to be studied physiologically and ecologically might be an important aspect.

Longterm fluctuation of oceanic climate and fish population with the interrelated mechanisms could be solved by the well-coordinated surveys cooperated of all interested countries and organizations.

Oceanographic instrumentation and related engineering techniques, and experimental studies on the sea and in the laboratories should be promoted. The joining of the related sciences is the key to solve the problem. As a mere human scientist in the ocean having the same object we should take off all the obstructive wall between us.

Fisheries Oceanographic Center, national and international, might be needed to promote the said activity in cooperation. The reconstructed SCOR organization should involve the leading fisheries oceanographical division which deals all important fishery oceanographical problems in liaison to the Advisory Committee on Marine Science of FAO, etc. from high scientific point of view, people not confined in any shell but openly discuss hand in hand and recommend the agreed proposal enlightened by our ultimate purpose of fisheries oceanography. We should carefully avoid the unnecessary friction among the withstanding competition and turn them into the amalgamated cooperation.

Permanent organization, conference, and symposia for fishery oceanographic research should be considered and encouraged. Fellowship, exchange, training, education for fishery oceanographers should be raised. Particularly cooperated research of fishery biological and oceanographical studies, to estimate, evaluate and conserve populations, in order to secure maximum sustainable catch is noted. Within the safe limit of conservation oceanographic aids to increase the marine production most effectively might be promoted to study.

All utilizable development in other fields of oceanography should be positively adopted. For those reasons the existing organization should be reflected. For example, numbers of international expeditions in the world oceans and piled up data should be utilized most efficiently for fisheries purpose. (e.g. IIOE, Northern Waters Proj.)

How the fishery oceanography has considered in such great international expeditions? Hitherto, UNESCO and SCOR refrained and FAO outlooked unsatisfactorily. At first fishery oceanography should aim the remedy of them.

References

Table 1. Chronology of Fisheries Oceanography in Japan

- 1889 . . . "Reports of Preliminary Survey of Fisheries in Japan (5 Sea-regions)" was published by Fisheries Agency (Shimmoske Matsubara et al).
- " . . . A private Fisheries College "Suisan Densyuzyo" was established by Dai Nihon Suisan Kai (Japanese Fishermen Society). Imp. Fish. Inst. - Tokyo University Fish.
- 1893 . . . Current Investigation by Drift-Bottle Experiment was started by Yuzi Wada. He published the monthly normal surface water temperature charts in the NW Pacific in 1910.
- 1900 . . . Fisheries Agency started the systematic coastal observations. Also offshore subsurface observation was undertaken in Sagami Bay.
- 1901 . . . K. Kishinoue attended ICES Meeting at Christiania. Tokuro Akanuma (Fish.Ag.) developed Akanuma's Hydrometer in general use.

The first Pref. Fisheries Experimental Station (Aichi) was established in 1894 and the first Fisheries High Schools (Obama, Miyako) in 1895.

- 1904 . . . Kinataro Okamura and Tokichi Nishikawa studied Red Tide plankton in Mie pear-oyster fram.
- 1909 . . . Tasaku Kitawara and others (Fish.Ag.) started the systematic oceanographic observation which was organized for fisheries use around Japanese waters.
- 1913 . . . Hisatosi Marukawa introduced Knudsen's chlorine titration method in the exploratory surveys of the Yellow Sea and Okhotsk Sea fishing grounds.
- 1915 . . . The reversing thermometer was introduced
- 1916 . . . The electric hydrographic winch was introduced.
- 1918 . . . The first oceanographic vessel "Ten-Oo maru" (163 ton) belonging to the Dept. Of Oceanography in the Imperial Fisheries Institute (chief T.Kitawara)

Since 1918 the Japanese Hydrographic Office (founded in 1871) has conducted an active program of offshore hydrographic observations, esp. in the Kuroshio area and North Equatorial Current area. Since 1925 the echo-sounding technique was adopted which expedited bottom depth charts and the discovery of many fishing banks.

1920. . . . . Kōbe Marine Observatory (founded by Takematu Okada in 1920) started marine meteorological and oceanographic observation from mainly geophysical point of view with the research vessel "Shunpu maru" (125 tons)
- 1905 . . . . . First oil-burning skipjack fishing boat was built for experimental fishing (Fuji maru)
- 1918 . . . . . T. Kitawara first remarked the accumulation of fish-shoals near the "Siome" (lines of convergence) which has been further developed by Uda (1938--).
- 1925-'35 . . . . . Research vessel "Sōyō maru" (Imp. Fish. Inst., Imp. Fish. Expt. St.), (212 tons) expedition of benthic communities on the continental shelf of Japan (leader, H. Marukawa, studied by H. Aikawa, and H. Niino).
- 1927 . . . . . "Set net fishery" (Journal) started. Teinosuke Miura first remarked yellowtail catches closely related to the passages of cyclones which has been developed by M. Uda (1927-1937) statistically.
- 1930 . . . . . Mokuichi Shimoda (Fish. Ag.) exploited longline tuna fishing grounds in the Eastern Indian Ocean by "Hayukō maru" (training boat of Imp. Fish. Inst. 1327 tons).
- 1931 . . . . . The Japanese Society of Scientific Fisheries started.
- 1931-'41 . . . . . Synoptic Survey of Wakasa Bay (1931), Japan Sea and Yellow Sea (1932, '33, '41), North Pacific Ocean (1933-'41) by fisheries research boats.
- 1939 . . . . . Anomalous Kuroshio survey by "Sōyō maru". (M. Uda).
- 1941 . . . . . The Oceanographical Society of Japan started.
- 1948 . . . . . Fisheries Broadcast Information by wireless telegraphy and radio from the Imperial Fisheries Inst.

October 14, 1962

- 1949 . . . Sardine Resource Research Program started by Fisheries Agency. And 8 Regional Fish, Res, Lab.
- 1952-'62 . . Fisheries Oceanography Symposium held. In 1962 The Japanese Society of Fisheries Oceanography started.
- 1952-'57 . . Bikini Expedition by "Shunkotsu maru".
- 1955 . . . NORPAC Project
- 1956 . . . EQUAPAC Project
- 1957-'58 . . IGY Survey
- 1956-'62 . . Antarctic Expedition by "SOYA" and "UMITAKA MARU".
- 1959-'61 . . Japan Trench Deep Sea Expedition by "RYOFU MARU".
- 1956-'62 . . International North Pacific Fisheries Investigation (Salmon fishing ground, etc.)

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INSTITUTO DE INVESTIGACION  
DE  
LOS RECURSOS MARINOS

CABLE: IREMAR - CALLAO  
Telefono: 90522

AV. BOLOGNESS 122  
La Punta, Callao  
PERU  
September 5, 1962

Dear Dr. Chapman:

Quoting your letter of August 8, I really enjoyed the large amount of correspondence I received from the Working Party and especially from you during the past months.

I also enjoyed your visit to Perú during which you saved enough time to stay with us in our Marine Resources Research Institute and see our team of FAO Fishery Oceanographers at work. I am sure that you went away with the conviction that it is a harmonious team, which works hard and fast. So you may say to the Bergen group:

- 1) that fishery oceanography is developing in Perú well, being until now the unique scientific endeavor in this country which pushes forward the research of the Marine environment and its living resources in the area of the Perú current;

- 2) that our research is but a part of the Tropical East Pacific study, which should be integrated soon, on a coordinated basis-in scope and pursuits-with the other research centers of this great geographical unit;
- 3) that the Peruvian one-species fishery is, at present, unique in the world, which deserves to be studied as it creates numerous interesting problems.

I am enclosing a "short" note answering the questions related to the Fishery Oceanography. You may use it at the Bergen meeting.

You may have seen that under the present circumstances with Dr. Sparre still on sick-leave, and the work to do, it is impossible for me to travel to Bergen and stay away for some time from my duty station. I, therefore, present my apologies to you and to the other members of the Bergen Working Party on Fishery Oceanography.

It is our hope that your work will be useful and do not forget that the FAO Fishery Oceanographers are hard-working people and that with or without criticism we shall continue our exciting research with the aim to understand a little better how living resources of the sea are distributed and how they react under the ever-changing factors of the marine environment.

With best wishes to all and kindest personal regards to you.

Sincerely yours,  
/s/ Zacarias Popovici  
Acting Director

ZP.mab/834

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#### APPENDIX V

#### CONSIDERATIONS ON FISHERY OCEANOGRAPHY

by Zacarias Popovici

#### Introduction

The Scientific Committee on Oceanic Research decided during its meeting held in Monaco in November 1961, to appoint a SCOR WORKING GROUP on Fisheries Oceanography with the following terms of reference:

1. To discuss and define the subject of fisheries oceanography
2. To state what fisheries oceanography has accomplished,
3. To state what fisheries oceanography should be trying to accomplish.
4. To state what progress is needed in other sciences so that the aims set out in 3 can be attained.

5. To communicate the statements through SCOR to interested laboratories and organizations.

The author has been invited to contribute to this work. The following lines contain a number of considerations on fishery oceanography and its further development.

1. What is fisheries oceanography?

The original name of fisheries oceanography was "Fisheries Hydrography" and its use was started with the work of the International Council for the Exploration of the Sea in Copenhagen. Within the frame of work of the Council, fisheries hydrography included the physical and chemical aspects of the fishery science and practice. The study of the sea and of fish was undertaken with the purpose to understand the causes of fluctuations in abundance and to obtain the necessary knowledge to predict the availability of local and migratory fishes in time and space.

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Later on, the advancement of ecology brought with it the concept that the fish populations, as well as the other organisms, are intimately associated with the type of water and conditions of the region in which they live, so that changes in their distribution and fluctuations in their abundance could be understood and explained only after having obtained sufficient information on the relationship between these resources and the physical, chemical and biological processes in their environment. Thus the problems of relationship of the environment to the availability and changing abundance of fishes became a prime purpose of fishery science, and this brought with it the need to intensify the study of the marine environment. This research was growing rapidly and the general knowledge of oceanographic conditions was getting better. Some of the principles governing the processes in the whole ocean are known by now and they help to understand how longer period changes in the oceanic climate affect the occurrence of fish and other living organisms in the different parts of the world ocean. But this research is being done often in areas of interest for fishery. - Without participation of fishery scientists.

These scientists admit that fisheries problems are easier solved when physical and chemical data on environment are taken concurrently

with biological data, because this procedure respects the factor "time" and helps to explain better the intimate association between fish and certain type of water as well as the effects of even small changes in the environment on the behaviour of the fish. Fishery scientists also admit that some aspects of the general oceanography are of more importance to their scientific problems and to fisheries than other. Therefore they prefer to work in a well coordinated team together with oceanographers.

Historically, Hydrography is older than Oceanography and therefore, the term fishery hydrography is considered by many specialists as more adequate. But, the present definition of oceanography is such that hydrography remains included in it and therefore the change of the name of fisheries hydrography into fishery oceanography may be well justified.

If we accept the definition of oceanography given by the U.S. National Academy of Science Committee on Oceanography as being "the science which studies the oceans, their boundaries, and content", and if we also agree that this science can be subdivided in: meteorological, physical, chemical, and biological oceanography, then, we can assume that the fishery science requires contributions of knowledges from all these subdivisions and uses them with the specific purpose to solve clearly defined problems of fisheries.

The dependency of this science upon other sciences is not unique. General Oceanography also depends upon other sciences and same applies to Ecology and a number of other disciplines. In the same way, fishery oceanography depends upon general oceanography and fishery science, being a link between them.

Yet there exists by now a great divergence of opinions, which could be grouped as follows:

- (1) the term fishery oceanography includes the whole field of fishery science;
- (2) the term should have a restricted use, and be applied to a small part of physical oceanography;
- (3) the term fishery oceanography doesn't have the right to exist at all, being only applied general oceanography.

I defend the concept that the term "fishery science" should be maintained as distinct from the term "fishery oceanography", because each has a reasonably well defined objective and unity or purposes. Indeed:

Fishery Science is the study of the living aquatic resources, of the fluctuations in their abundance in time and space and of the forms of their harvesting with their implications. It has to contribute to the solution of the acute problem of protein deficiency in the world by:

- (1) description of populations living in each region where commercial fishery exists;
- (2) studies of population dynamics of living aquatic resources; and of the complete biological cycle;
- (3) estimations of the size and distribution of living aquatic resources;
- (4) search for new fishery resources;
- (5) prediction of availability of fish and other living resources in time and space and
- (6) research on the effects of man's activities on the exploited living resources, and on organisms used by them as food and on the rest of marine communities.

Fishery Oceanography utilizes the basic data from oceanography and fishery science to establish and explain the relationship between the ever changing meteorological and oceanographic processes, and aquatic populations. It studies the links between physical, chemical and biological factors as well as the effects of the changes on the potential fertility of the sea and on the abundance, distribution and behaviour of all the organisms making up what we call "living resources of the sea."

Considering the actual work of an oceanographer in a team of fishery scientists as a point of departure, I propose to define fishery oceanography in the following terms:

"Fishery Oceanography is the study of physical and chemical factors and processes in and near the ocean which have or may have a bearing on the basic capacity of the sea to produce organism matter, as well as on the living resources and on activities to their harvesting."

Purposes: The main purposes of fishery oceanography are:

- To obtain knowledge on the physical and chemical factors and

processes of the marine environment which have or may have a bearing on the production of organic matter and on the behaviour, distribution, abundance and availability of living resources. By this way it should establish the links between physical and chemical factors and marine organisms.

- To study the factors responsible for the high potential fertility of certain areas of the sea (like upwelling and abundant nutrient supply to the photic layer, mixing, presence of boundaries, eddies, etc.,).
- To locate by means of echosounding the places and depths of massive concentrations of fishes, and to establish the periods in which they occur and the oceanographic conditions of the environment which are favorable to these phenomena.
- To study the relationship between variations in the oceanic circulation and the major changes in the distribution of fish populations.
- To achieve a broader knowledge on the principles governing the natural phenomena in or near the sea which cause major fluctuations in the populations of living resources.
- To predict major changes which take place in the physical conditions of the environment and in the abundance of living resources and which could have a bearing upon the harvesting activities of man.

The sum of the broadly outlined purposes show that fishery oceanography is nothing else but oceanographic research carried out with the purpose of satisfying the need of fishery science. It covers in reality all oceanographic phenomena which influences the production potential, the populations of living resources and the results of their harvesting and it leads to a better understanding of the inter-relationship between processes in the marine environment and marine organisms in general.

Farming of marine organisms, was not mentioned, because I consider it a special and more advanced form of harvesting living aquatic resources, thus, an activity which also belongs to fishery.

## 2. What has the fishery oceanography accomplished?

### 2.1. Cooperation and integration of marine sciences

Because of the urgent need to explain the behaviour of the

living resources of the sea in an ever changing environment, fishery scientists and oceanographers contributed to a better cooperation among marine scientists and to the integration of the marine sciences as well as to the building of the oceanographic research endeavour which takes the ocean as a unit.

## 2.2. Role as pioneer of the general oceanography

In many parts of the world, fishery oceanography is the unique branch of oceanography which is active, because local authorities have an interest and understanding for its development.

The impact of fishery oceanography on universities has been extraordinary during past years, especially in Ecuador and Peru, where the unique places for adequate training of students are the Marine Resources Research Institutes, created with the assistance of the Special Fund of the United Nations and having FAO as Executive Agency.

## 2.3. Progress of knowledge

Fishery oceanography increased the oceanographic knowledge in many parts of the world by discovering unknown currents and undercurrents characteristics stimulate major concentrations of marine organisms.

The contribution has been outstanding in nearshore areas.

## 2.4. Aid to fishermen

In the practical field, fishery oceanographers told fishermen under which environmental conditions could they make better catch, how to use the echosounding equipment and in which areas exist major concentrations of fish accessible for exploitation. In some cases predictions on fish abundance have also been made, in relation to oceanographic findings.

## 3. What should fishery oceanography try to accomplish?

It should try to obtain new information on environmental conditions which may have a bearing on the living resources of the sea, their seasonal distribution and availability, as well as on their most economical harvesting. Such information concerns the following aspects:

### 3.1. Food producing capacity of the sea:

Fishery Oceanography should try to bring together good and usable data on the structure of the sea and on the processes which main-

tain and determine its food producing capacity in nearshore areas as well as in oceanic areas.

### 3.2. Fishery resources:

It should increase knowledge on existing fishery resources, especially in tropical waters, in relation to the main oceanographic characteristics of each region.

It should try to locate the areas of concentration of fishery resources and to establish the oceanographic causes of the shifting of the limits of such areas, when and where this may occur.

### 3.3. Synopsis, Catalogues and Atlas:

In relation to the great endeavour of assessment of living fishery resources, fishery oceanography should contribute to develop:

- (1) Oceanographic Synopsis of the regions which present interest to fishing activities.
- (2) Seasonal fishing charts for pelagic and demersal resources; and
- (3) Atlas representing the oceanographic characteristics of the fishing areas.

The work on these lines started by F.A.O. in cooperation with fisheries commissions and individual scientists should be intensified.

### 3.4. Fish eggs and - larvae:

Fishery scientists should intensify the research of fish eggs and larvae, especially in the sea areas where new fishing activities are being started, and fishery oceanographers should investigate the influences of currents and eddies on transport, dispersion and survival of the larvae. Such influences may present interesting aspects in the region of trade winds and monsoons.

### 3.5. Pollution problems:

Fishery oceanography should intensify research on oceanographic factors which may contribute to the dilution or concentration of pollutants (organic wastes and atomic wastes) in oceanic regions, where major interest of fisheries exists.

### 3.6. Plankton Blooms:

Fishery oceanography should intensify research on the oceanographic conditions of the areas with frequent plankton blooms and, in connection with it, try to establish the causes of poisonous plankton blooms and their effects on environment, living marine resources and man.

### 3.7. Anomalous conditions and mass mortalities:

Anomalous changes in some of the environmental conditions which produce mass mortalities of marine organisms should be established.

### 3.8. Boundary processes and limiting factors:

Fishery oceanography should increase the research effort on boundary processes between the atmosphere and the sea and on processes in the sea that may influence the behaviour and abundance of the living resources; it should try to establish the principal limiting factors of their dispersion or distribution during the successive seasons and, in general, the causes of major changes in their abundance, and the time of their appearance and residence in certain areas of the sea.

### 3.9. Prediction:

Fishery Oceanography should try to find practical methods to predict (1) the effect of the changing environmental conditions on the marine organisms and (2) the occurrence of fish concentrations and probable directions of their migration.

### 3.10 Management:

It will be necessary to develop methods for the management of the exploitation of the areas rich in marine resources, in accordance with the findings of fishery science and oceanography. Proper understanding of such findings is prerequisite to the wise management of marine fishery resources.

In the developing countries, governmental fishery agencies should be advised that their prime duty is related to:

- (1) conservation problems and
- (2) normal development of harvesting activities of aquatic living resources.

They should also be advised to base their decisions, when ever possible, on findings of fishery scientists actively engaged in research of fishery problems, when taking measures to reduce the fishing of a species with the purpose of avoiding or eliminating overfishing, and ensuring reasonably normal yields from year to year.

## 4. What work is needed from other scientific disciplines in order to advance?

### 4.1. Ecology and Physiology of marine organisms

The interaction between the aquatic organisms and their environment as well as the effects of the major changes on the living resources of the sea can be understood only after proper knowledge of

the physiology and ecology of these organisms. When trying to explain correlation between certain oceanographic findings and behaviour of fish, fishery oceanographers find a great obstacle; the lack of adequate data on limits of tolerance of fishes (as well as of other aquatic organisms) toward the factors of the physical environment and the insufficient knowledge of the behaviour of the organisms in different environmental conditions. Therefore, the whole study of the effects of environment on fish is progressing too slowly. It means that research on ecology and physiology of marine organisms should be strongly stimulated in the near future.

#### 4.2. Oceanography

The research of ocean processes should be extended more and more to the Southern Hemisphere.

#### 4.3. Marine Meteorology

The establishment of a network of observational points on islands along the coasts of the continents and on the high seas is required to obtain a better coverage of data on weather and surface temperature of the sea. This applies especially to the Southern Hemisphere. W.M.O. should be invited to participate in the planning and execution of this network.

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#### APPENDIX VI

Prof. Dr. Adolf Buckmann  
Institut für Hydrobiologie  
und Fischereiwissenschaft  
der Universität Hamburg  
Hostenwell 24

p.t. Northeim/Hann, 9.8.62  
Bürgerm. Petersstr. 21

Dear Dr. Chapman:

I beg your pardon for not giving my comments on the questions raised in your letter of December 25, 1961, nor up to now answering your letter of May 31st. As a matter of fact, my health failed, and I experienced a nice little breakdown, which required quite a long convalescence. Even now I am still on leave, but intend to return to Hamburg by August 15th.

Not a few of the many people who got a copy of your letter of December 25th, thought that there had been an error in mailing palmed it on me. With my much reduced power of reading it took me some time to find out what was the matter.

In Germany fishery research and oceanography actually worked together from the beginning. At first fishery research was the strong one of the twins and took oceanography out in the sea. Later on, oceanography caught up and, after World War II, was by far the stronger. They had made considerable progress during the war, both in knowledge and instrumentation, while fishery research was shattered by it. But then Böhnecke, Dietrich and Joseph took us out at sea by RV "Gauss" till we had once more a seagoing vessel, the "Anton Dohrn". And cooperation was carried on as before. I hope to be able to come to Bergen. It is up to the doctor on my return, to tell if I may. And perhaps you would have to put up with the fact that I cannot yet do a full day's work.

At any rate, I shall comply with your request and let you have, at Bergen, copies of a statement on our views concerning fishery oceanography - no questionnaire necessary, the matter being constantly discussed among us.

You will also get a survey of the results of German fishery oceanography. I feel that this matter is in my brains ready to be taken out at request. I have seen a good deal of it in my lifetime. Surely it is of limited extent, and as you will expect, no German fisherman or trawler owner has become the richer for it.

I do not intend to go into details at present. But I should like to add a few comments.

The question of regulations of the fishery for the protection of certain exploitable stocks being given, the fishery research worker has got to understand factors and conditions determining the yield of the stock. This is not only selectivity and extent of the fishery, but also the influence of biotic and abiotic factors of the "Lebensraum". Exact and correct knowledge of the Lebensraum and its influence on the stock is required. This is what oceanography must give us. This of course means oceanography in the broadest sense, including physical, chemical, biological, geographical (if you prefer, geological) oceanography.

For this reason I have asked the Hamburg University to change the name of my petty little institute to: Institut für Hydrobiologie und Fischereiwissenschaft. We want the knowledge of the Lebensraum of the stock. Perhaps some successor or mine may enlarge the institution to verify its proud name.

There are difficulties for University institutions to do fishery research work on survey lines. But on the other hand there must be some marine research which is not under the fishery administration. I know, what I am talking about.

Moreover, I for one am quite prepared to let oceanographers do their work as they like, if only they tell me about their results in a manner that can be swallowed by the brains of a biologist.

October 14, 1962

I and my friends will then consider whether the new more detailed and more correct knowledge of the Lebensraum can help us to understand more clearly the life and dynamics of the exploited stock.

Yours sincerely,  
/s/ Bückmann  
(Prof. Dr. Bückmann)

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SCOR WORKING GROUP ON FISHERY OCEANOGRAPHY  
ON THE TERMS OF REFERENCE OF - - - - -  
by A. Bückmann, Hamburg

In Germany it has been constant use that fishery research work at sea was combined with oceanographic investigations of various description. Questions relating to fishery oceanography have been repeatedly and thoroughly discussed. Therefore, the present author did not think it necessary to start a questionnaire, but thought himself entitled to give a summary of what may be regarded as the common views of German fishery research workers and oceanographers.

### 1. The Subject of Fishery Oceanography

The subject of fishery oceanography is to provide the knowledge of the "milieu" of exploitable marine resources. The term "milieu" is meant to include all factors, abiotic and biotic of the "Lebensraum" affecting these stocks. "Oceanography" is used in a broad sense, including physical, chemical, biological and geological oceanography and of meteorology of marine regions. Fishery oceanography should investigate such factors as will effect distribution, migrations, shoaling and concentrations of exploitable stocks, which have an immediate bearing on the economy of fishing. It should also investigate factors affecting reproduction, recruitment, survival and growth, which are of outstanding importance for the understanding of population dynamics.

### II. Accomplishment of Fishery Oceanography

A separate paper has been circulated giving a review of the more outstanding results of German fishery oceanography. It may serve to show the character of these results. Up to now they have been of little importance for the economy of the fishing industry. On the other hand they have considerably improved our understanding of the conditions of life of the exploited stocks.

If fishery research work were largely restricted to observations of fishing, effort, catch, and landings, much will be known concerning the fishery and very little about natural conditions affecting the stock. Then there would be a danger of attributing any changes in the landings that might be observed to changes in the intensity and selectivity of the fishery. It is by combined investigations on the stocks in the sea and the conditions of the Lebensraum that short term fluctuations in recruitment, growth, egg production and stock size as well as long term changes have been found to be connected with fluctuations and changes in natural conditions.

### III. Aims of Fishery Oceanography

The answer to this question is implicitly contained in the definition given under (I).

Fishery oceanography may provide valuable information as to where and when a marine resource may be most economically exploited. Several nations have experienced the necessity to do a considerable amount of exploratory fishing. The knowledge of the momentary local abundance of food fish may be helpful to the fishing industry, but it may be of very limited value if the concentrations change fast, as may be the case. It is suggested that exploratory fishing should be combined with hydrographic investigations and rather aim at finding out the conditions under which concentrations of marine commodities may be generally found.

Variations in the stock from natural causes are a severe difficulty when the danger of overfishing seems imminent and regulations of a fishery are contemplated.

To avoid this difficulty the use of the mathematical models of population dynamics seem to offer themselves. In these models the constancy of natural conditions is assumed. The effect of fishing on stock and yield is varied in what we may call an intellectual experiment. Now data on stock density (catch per unit of effort) yield, rates of recruitment, growth, and natural mortality are derived from observations on the actual stock, mostly in the form of average values.

are not a priori correct. The results derived from them have to be verified by the comparison of predictions and observations, just as the laws of classic physics have been verified. This verification once more calls for the knowledge of natural factors affecting the yield.

Fishery oceanography is thus thought indispensable for the solution of the most important tasks for fishery research.

In spite of the fact that many marine resources are restricted to the shelf areas, fishery oceanography should not be. Shelf areas are known to be strongly influenced by the condition of the open ocean. *Sebastes marinus*, one of the marine resources most important for Germany, is a form of the continental slope and is by some scientists regarded as belonging to the oceanic realm of the bathy-pelagial. The influence of the open ocean on the shelf areas and their inhabitants and also the increasing need of using the oceanic resources themselves ask for better knowledge of the hydrographical and biological features of the open ocean.

#### IV. Necessary Progress in other Sciences

The progress in physical and chemical oceanography and marine geology has been fast in recent years. The use of electronic sets has given more and more exact data, and the use of continuously recording implements has given us a more correct and much more detailed picture of the "Lebensraum" of marine resources. It would seem that the fishery biologist has not up to now made full use of the information which can be given to him. In many cases connections between factors of the milieu and stock parameters are only indicated by covariation, while the causal nexus is not yet known. It is thought necessary to fill in this gap, and it is supposed that in most cases it is to be found in the field of marine biology.

It is furthermore felt that the study of behaviour of marine commodities has not yet received the attention it deserves. Our mental images of the interaction between the food fish and the fishery and the food fish and the "Lebensraum" are generally fairly mechanical. As a matter of fact it has been shown that the behaviour of food fishes is much more complicated than previously assumed. There are indications that food fish stocks in certain respects react as self-regulating systems. Conceivably behaviour plays a role in self-regulation. We should know about it.

Thus it appears that it is marine biological research which lags behind and should be intensified in order that fishery oceanography can fulfill its objects.

P.S. This review has been circulated during the last weeks amongst most of the German scientists regarded as competent for the problems of fishery oceanography. Besides short notes of agreement given by some addressees two larger comments have been provided by Prof. G. Dietrich, director of the Institute for Marine Research of Kiel University and Scientific President of the German Commission for Marine Research, and by Prof. J. Lundbeck, director of the Federal Institute for Sea Fisheries in Hamburg. Prof. Dietrich feels that the term "fishery oceanography" is not an independent unit within science. Its establishment is not badly needed from the scientific point of view. He understands - as I did - fishery oceanography as a part of the physical and biological oceanography and has to be taken apart from Fisheries Research.

In agreement with his collaborators Krefft and Sahrhage Prof. Lundbeck asks for a definition of fishery oceanography which should not be too general. It should never be equalized with the oceanography as a whole but should embrace only the registration and investigation of those phenomena of the environment, which may cause the horizontal and vertical distribution of food fishes, and their local concentrations, migrations and the catchability. Finally the results reached by this work have to be applied to those areas underexploited up to now in order to prospect practical fisheries. It should also be kept in mind that fishery oceanography has a special task in developing countries where a better use of the resources of the sea is badly needed. "In spite of the desirability of the intensification of the general marine biology we should not forget that only a small part of all lines of research in marine biology are of direct bearing for the practical fishery." Therefore Lundbeck feels that at the present time fishery research is not developed enough to utilize the general aspects of the oceanography as a whole properly and to formulate questions to be solved by other branches of oceanography. Therefore, from the fisheries point of view it seems more necessary to intensify the fisheries research in its closer sense instead of asking for more intense work in general oceanography.

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RESULTS OF FISHERY HYDROGRAPHY IN GERMAN  
-- -- -- -- MARINE RESEARCH -- -- -- --

A. North Sea

During the years preceeding world war I, the "croisières périodiques trimestriels" were used for investigations on the quantity and distribution of fish fry along with hydrographical investigations, and the latter were carried out on all cruises intended for fish fry investigation, with the aim of characterizing the spawning places of the more important food fishes as to temperature and salinity. The results were published by HEINCKE, EHRENBAUM and STRODTMANN.

During the later part of the time between World War I and II, combined investigations were carried out in the Southern North Sea on the distribution and mixing of water bodies and the distribution and transport of fish fry of different species. In addition to temperature and salinity the distribution of nutrients and other chemical characters was taken into consideration, and the distribution of "Leitformen" of the zoo- and phytoplankton were used to define the components of mixed waters. The results have been published by KALLE (nutrients), ZORELL (physics), KUNNE (Zooplankton) BUCKMANN (herring fry) AURICH (other fish fry). As an instance of the results it was shown that herring larvae derived from the Sandettiè and Channel entrance spawning were carried in numbers towards the middle North Sea (German Bight) by the residual currents.

After World War II, similar investigations showed a change in the distribution of water of channel origin in the North Sea compared with 1935-1937. It was found that e.g. plaice spawning off Borkum now took place in middle North Sea water of northwestern origin and was much increased (Dietrick, Bückmann, Bohl).

At the same time the mixing process of the water masses of the open North Sea and the continental coastal water was elucidated by Dietrich, Evidence was found that the herring and plaice larvae of the open North Sea were brought into the coastal water where they spend their first year of life, by this mechanism.

Incidentally, a covariation was found during the investigations under (2) and (3) between meristic characters of herring larvae and water temperature during their development. Recently the effect of temperature and salinity on meristic characters has been investigated experimentally (BUCKMANN, BUCKMANN u. HEMPEL, HEMPEL u. BLAXTER).

GOEDECKE has shown that the increase of temperature in northern

boreal waters was also felt in the Southeastern North Sea, chiefly in summer surface temperature. AURICH observed a striking increase in the amount of pelagic fry of fish of southerly range of distribution in the shallower part of the North Sea, e.g., Sole, Sardine, and Anchovy.

According to the investigations of DIETRICK, SAHRAGE and SCHUBERT the distribution of prespawning communities of herring in the middle North Sea to the North and East of the Dogger bank is connected with temperature distribution in the area, being chiefly related to the water mass of low temperature (about 6-7° centigrade) below the summer thermocline in this area.

On the other hand spawning in the Dogger area is connected with fairly high temperatures at the bottom of the western and southwestern slopes of the Dogger bank. The catch of spawning herring may be adversely affected by low temperatures in these quarters.

The influence of water temperature on the distribution of haddock in the North Sea has been shown by the same authors who stressed the use of thermometric methods in location of fish of certain species.

#### B. Baltic

In the Baltic fishery investigations were also regularly carried out together with hydrographic research. In this area the hydrographical conditions in the spawning places of plaice, flounder, dab, and cod were much more complicated than in the North Sea. Turbot and (partly) flounder spawn on the coastal banks of the middle Baltic in surface water of low salinity, where the eggs do not float, but develop normally while lying on the bottom(MIELCK).

Most food fish, however, spawn in the deep basins (Bornholm Danzig, Scotland basins), where water of higher salinity is found in deeper layers. Generally there is lack of oxygen near the bottom. KANDLER found out that cod eggs rise from the bottom to the level of equilibrium density of the sea water, which he found at 6-80 m depth in the Bornholm Basin and just above the area of oxygen deficiency.

KALLE showed that in the 1940's conditions favoring the renewal of bottom water in the middle Baltic and causing an inflow of Kattegat water over the several sills beneath the Baltic surface water were

much more abundant than in former decades, and MEYER-WAARDEN pointed out that the change and abundance of food fish stocks may well be connected with this change. A combined survey by hydrographers and biologists in 1962 showed that in the most recent years no oxygen is in the deeper layers off Bornholm and Scotland, Consequently, no fish has been there now.

### C. North Atlantic

Combined hydrographic and fishery investigations were carried out in the Barents Sea in 1913, 1927, and 1937/38. Between 1927 and 1937 the fishing places for cod had shifted from the shallows of the Cape Kanin and Kolgujuk Island towards the outer margin of the coastal banks of the southern Barents Sea (LUNDBECK). During the same time water temperatures near the bottom had risen; while up to 1927 cold Barents-sea water prevailed beneath the ramifications of the Murman Stream of Atlantic water, these ramifications had increased in volume by 1937 so that water of +2° centigrade touched the bottom on the new fishing grounds (GOEDNECKE).

Haddock was still caught in the autumn in shallow water and in evident association with the highest bottom temperatures found (U.SCHMIDT).

In a similar way LUNDBECK found that the extension of fishing grounds on either side of the Spitzbergen-Bear Island banks was connected with boreal Atlantic water at the bottom in these quarters. There are sufficient indications that arctic water masses have had a much more extended distribution here at least at the beginning of this century, when several trials to institute a fishery in these northern waters had failed.

Off the Norwegian coast the experience of German trawlers tended to show that Saithe, (=pollock)-fishing was connected with certain wind directions. No very definite differences in temperature and salinity distribution were found, when U. SCHMIDT investigated the matter. On the other hand the regime of deep water currents on the Norwegian shelf appeared to be strongly influenced by meteorological conditions. During the I.G.Y.-cruises of the polar-front-programme KRAUSS observed by continuous observations during a storm that in addition to internal waves of tidal rhythm a new wave grew into existence. Investigations are planned to show whether internal waves arising by storm and/or pressure differences would influence the currents when surging on the shelf. In addition the Saithe catches will have to be surveyed.

The cooperation of at least 3 research vessels will be required.

There is some evidence that the distribution of the larvae of *Sebastes marinus* in the vicinity of the Reykjanes Ridge is connected with the hydrographic structure of the ocean water. Further investigations are required.

When the new fishing area of the Anton-Dohrn-Bank was found on the Greenlandian shelf in 1955 it appeared that the bottom water in this place was much colder than could be expected in a redfish fishing area. Under certain conditions at any rate *Sebastes* is found in water masses influenced by arctic deep water.

Recently MEYER and RODEWALD observed that changes in the abundance of certain food fishes off Labrador and in the Barents Sea coincided with changes in the pressure anomalies over certain areas of the North Atlantic.

Hamburg, August 16<sup>th</sup>, 1962

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A U T O N E T I C S

A Division of North American Aviation, Inc.  
9150 East Imperial Highway, Downey, California

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RESEARCH AND DEVELOPMENT Post Office Box R-3  
Anaheim, California

2 October 1962

In reply refer to:  
62AN/R&D-721

Dr. Wilbert M. Chapman  
Van Camp Foundation  
739 Golden Park Avenue  
San Diego 6, California

Dear Dr. Chapman:

Please accept my apologies for the extreme tardiness in answering your letters of 25 December 1961, and 1 June 1962, wherein you solicited comments on fisheries oceanography. As you will note from

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the letterhead, I have accepted a new position, and it was concurrent with your December letter. At the same time, I sustained a serious illness that has markedly restricted my activities. However, I have repeatedly reviewed your December letter and should like to make the following comments:

Fisheries oceanography - its meaning, scope or definition. Fisheries oceanography, to me, involved the integration of life history changes brought about by changes in the physical environment. Fisheries investigators have, and justifiably carried on "cookbook" research and analysis that involves only a limited amount of new exploration and acquisition of special data. With the advent of "think" groups, newly discovered principles and concepts about the oceans, we see developments that will undoubtedly stir active field work, and biological and oceanographic data acquisitions that will lead to techniques for forecasting and providing improved means of exploiting naturally variable marine fisheries resources on an educated basis.

What needs to be done to sustain the fisherman's means of livelihood, meet the needs of an expanding human population, and provide for tomorrow? We need to understand and regulate our viable ocean resources with some degree of efficiency. Improved instrumentation and means for excerpting oceanographic data on a massive area basis and throughout a large water column are vitally needed. Therefore, the contributions that can be offered in situ observations, sampling and measurements by deep submergence research is yet to be realized. The developments of small manned deep submersible vehicles and the development of instrumentation for acquiring information about the marine environment throughout a large water column and over wide horizontal areas on a continuous in situ basis is possible, but yet to be done. In addition, oceanographic information systems that will provide synoptic information over a wide sector of ocean area will be required to yield the necessary information to better understand the significant dynamic characteristics of the environment that are directly relatable to the fisheries.

Questions emanating from fisheries biologists continue to strain the state-of-the-art techniques, equipment and theories used by physical and chemical oceanographers to resolve or answer such inquiry. As a consequence, theories and questions have been advanced by the biologist regarding water mass differences both horizontally and vertically. Biological indicators, geographically restricted populations, productivity fluctuations and other biological phenomena reflect, or are suspected to accompany, changed in the physical and chemical characteristics of water masses. However, historical data

and present techniques for rapid acquisition and analysis of biological as well as the physical-chemical data are totally inadequate to provide answers to theories or to problems involving short time span. Resolution of problems involving a fluctuating fishery due to natural environmental causes other than man predation need to be answered. Personnel trained specifically as bio-chemists, taxonomists, physical oceanographers, chemical oceanographers, or any of the other disciplines currently involved in fisheries research will continue to find it difficult to reach decisions about the big picture unless they are provided with the tools and academic scope of training necessary to comprehend the interplay of the environment and fish population fluctuations that are not exemplified by the majority of present-day "fisheries oceanographers".

To avoid redundancy in your combined set of inputs, I'll close this off with

Yours very truly.  
 AUTONETICS  
 /s/ A. B. Rechnitzer  
 Chief, Oceanology.

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APPENDIX VIII

SECOND JAPAN - U. S. CONFERENCE  
TOKYO  
 COMMITTEE REPORT

Committee I Agenda Items I, IIIA, and V October 10 and 11, 1962

OBJECTIVES OF DISCUSSION

The items of the Conference agenda assigned to Committee I for discussion were (1) current trend in tuna production and forecast for the tuna resources (Item IA to IC), (2) expanded utilization of tuna fisheries (Item IIIA) and (3) bilateral exchange of current information (Items VA and VC).

The Committee met on October 10 and 11 on the understanding that (1) the morning sessions be conducted by the Japanese moderator and the afternoon sessions by the United States moderator, (2) no summary minutes be made each day, but instead a summary report be prepared by a Drafting Committee consisting of members of both countries at the end of the Committee's work, (3) duplicate tape recordings of the entire proceedings of the Committee be made for both countries' use, and (4) no daily press release from the Committee members and observers be made.

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The participants of the committee are as follows:

Japanese delegation

Government representatives

Dr. Tasuku Hanaoka (Moderator)  
Mr. Masamichi Nakamura  
Dr. Takashi Ino  
Dr. Hiroshi Nakamura  
Dr. Hideo Higashi  
Mr. Noriaki Oka  
and other specialists

United States delegation

Government representatives

Mr. Donald R. Johnson (Moderator)  
Mr. Fred E. Taylor  
Mr. John A. Holston  
Mr. Lorry Nakatsu

Industry representatives

Mr. John B. Calise  
Mr. Charles R. Carry  
Dr. Wilbert M. Chapman  
Mr. Clifton D. Day  
Mr. August J. Felando

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IA Biological and oceanographic information  
in respect of the current trend in tuna  
production and forecast for the tuna  
resources

Dr. H. Nakamura presented an extended summary of the present status of Tuna Research in Japan, the full discussion of which is given in Report No. 2 which had been prepared for the conference by the Japanese Government. He noted that statistical records of catch by location, catch per unit of effort, and size composition of catches were obtained on a regular basis from about 30 to 40 percent of the Japanese tuna fleet. This system resulted in obtaining a detailed record of individual vessel operations for about 3,000 to 3,500 fishing trips per year. This sort of information was augmented by extensive ecological investigations made at sea from vessels. Available for the latter work were the

principal research vessels, Shoyo Maru and Shunyo Maru; sixteen vessels from prefectural stations; and about forty training vessels attached to the various fishery high schools, colleges and universities. The objectives of such research in the tuna was, generally speaking, the planned production of tuna from the whole world ocean. By this was meant not only inquiry into those matters which would increase the opportunity of Japanese fishermen to harvest the sea, but also into those matters necessary to the framing of conservation measures when those should be found to be required. These objectives and general activities would continue into the future much as they had gone in the past except that they would gradually be expanded as budget and other requirements became available. A principal new departure would be the large scale tagging of tunas, which was likely to give further definition to the natural population units in the different tuna populations, hopefully on a worldwide basis. A summary description was given, species by species, of the principal findings to date. This is covered in greater detail in the above noted Report No. 2.

Mr. Johnson from the American side proposed a series of questions arising from this excellent presentation. These questions and a brief summary of their answers are noted:

1. Is it intended that the system of biological statistics recommended by the appropriate resolution of the "FAO World Meeting on the Biology of the Tunas and Related Species," held in La Jolla, California, July, 1962, will be put into effect by Japan, and what was planned in this respect?

Mr. Oka gave an extended answer to this question, detailing the methods by which fishery statistics of seven main sorts were gathered in Japan, the difficulties which were encountered because of the high variety, great geographic spread, and complex nature of the far-flung Japanese fishing efforts. He noted the great improvements of fishery statistics in Japan, illustrating this by example in the 1960 Annual Volume of Fishery Statistics and noting that this same sort of compilation of a provisional nature was also now being published by monthly intervals as well.

Upon recommendation from the Nankai Laboratory made in 1959, they had begun the gathering of tuna statistics of similar nature as were recommended by the FAO Tuna Meeting and he illustrated this by example of the bulletin which had been published for the first six months of the April 1961 - March 1962 period. The objective was to obtain full records of effort and catch by species and time, by geographic areas of five degrees of latitude and longitude, for

Japanese tuna operations in the entire world ocean. He noted that this was still in an experimental stage and did not purport to yet cover the whole tuna catch. The system was new to Japanese fishermen. It would take time to perfect it. They were going about doing this as rapidly as they could. They were giving particular priority to perfecting this system in the Eastern Pacific in order to comply with the requests for information from the Inter-American Tropical Tuna Commission.

Mr. Johnson noted the responsibility which our two countries had of protecting the tuna resources of the world ocean from overfishing, growing out of the fact that our fishermen together made upwards of 80% of the world tuna catch, and that such a system of biological statistics on a world-wide basis was a fundamental and absolute necessity in order to fulfill this responsibility in the family of nations. It was agreed that the fulfillment of the above noted resolution from the FAO Tuna Meeting as rapidly as possible was a highly necessary desideratum and would be pushed forward as rapidly as possible.

2. What were the relations of changes in ocean climate to variations in the yield of skipjack?

Voluminous information and reports were available on this subject arising chiefly from research at the Tohoku Regional Fisheries Research Laboratory. Copies of these would be provided to the American Group.

3. How is the new experimental purse seine for skipjack working?

Mr. Nakamura gave an account of the operations since August, a description of the net and vessel, and results to date. It was noted that the experimental results to date had not been revolutionary, but still they did show some promise and Taiyo Gyogyo intended to carry them on further.

4. Would Japan be able to participate through research vessels, scientists, reports from fishing vessels, etc., in the upcoming International Cooperative Investigations of the Tropical Atlantic?

A considerable description and discussion of this project was given and it was noted that Professor Uda of the Tokyo University of Fisheries would soon be returning from meetings in Norway, France and the United States, bringing further information on this subject and others. The Japanese side said that it was difficult to give

a concrete answer at this time because budgetary problems were involved and their limited research resources had already been pretty well allocated to a rather full program in the Eastern Pacific. Nevertheless, the desirability of participating in the Atlantic work, because of the large Japanese fishing effort there, was realized, and study would be given as to how this might be done. During this discussion an extended description of the forthcoming campaign of the "Shoyo Maru" in the Eastern Pacific, in informal coordination with the Inter-American Tropical Tuna Commission and the National Institute of Marine Resources of Peru, was given.

5. What was the relationship of thermocline on the availability of different kinds of tuna to different kinds of gear?

An exchange of information on this point was had, the principal result of which was that, while there is much hypothesis as to the reaction of the tropical tunas to variation in thermocline depth, not much of a concrete nature was yet known on this subject.

6. What is the wage structure, share system, etc., in the Japanese Fishery and how is this arrived at?

Mr. Oka described the great complexity of this subject in the Japanese Fisheries and referred the group to a paper he had prepared on the subject for the Fisheries Division of FAO which was due to be published shortly by that organization. Mr. Oka also agreed to provide the American side with a list of all of the separate publications in Japanese of fishery statistics of all sorts as soon as he could compile it.

Questions and comments raised by Japan were as follows:

1. What is the program of U. S. tagging experiments?

A discussion was held concerning this sort of research which has been carried on rather extensively to date by United States scientists in the Pacific and Atlantic Oceans, and of the results to date. Dr. Nakamura expressed particular interest in being kept fully informed on the tagging of bluefin this year off California. It was agreed that this information would be provided as soon as the American group returned home.

2. What was the main cause for the recent conversion of U. S. tuna fisheries from the live bait system to the purse seine

system? Were there any changes in fishing ground and in size of catches during this conversion?

U. S. answered that the introduction of nylon net and power block cut down the cost of tuna fishing over what it had been by the live bait system, increasing the catch per unit of effort. Also some explanation about the temporary increase of fish size directly after the conversion, and of the supposed cause for this phenomenon was presented.

3. What program does the U.S. have for research on albacore?

The main emphasis is on the study of the relationship between oceanic conditions and the location of fishing grounds, Also the U.S. wishes to promote the study of population structure and the productivity of the population in coordination with Japanese scientists.

4. Is there any information available about the tuna fisheries based on Palau?

U.S. answered that this fishing had not yet started but, if it started, scientific information resulting from it would be provided to Japan.

An extended discussion was then engaged in concerning the great expansion being undertaken in ocean research of all sorts by many countries in the world. The primary role in all of this by the two great maritime and fishing nations, Japan and the United States, was noted. Aside from the Tropical Atlantic and Eastern Pacific investigations, the gigantic International Indian Ocean Expedition in which thirty nations were cooperating and intended to spend perhaps as much as one hundred million of dollars was noted. Cognizance was taken of the great effect of the Intergovernmental Oceanographic Commission on these international cooperative investigations and the high desirability of getting a proper component of fishery oceanography worked into these problems was noted. Several of the pertinent resolutions arising from the recently concluded IOC meeting at UNESCO in Paris were discussed, particularly those dealing with a comprehensive program for world ocean study; coordination of the International Indian Ocean Expedition; Meteorological aspect of the International Indian Ocean Expedition; fishery oceanography in the Indian Ocean; International Synoptic Investigations of the Atlantic and Pacific Oceans north of 20° degrees south latitude; International Cooperative Investigations of the Tropical Atlantic; Comparative Study of

Kurashio and adjacent regions; Study of the Means of Speedy Utilization of Synoptic Oceanographic Data; and advisory channels to the commission. The formation of an Advisory Committee on Marine Resources Research by FAO which would act in an advisory capacity to the Intergovernmental Oceanographic Commission in respect of fishery oceanography was discussed.

Dr. Hanaoka noted that there was also a ferment of such planning activity in respect of expanded ocean research in Japan and that discussions on all of these subjects were going forward, particularly among the Fisheries Agency, the Meteorological Agency and the Science and Technics Agency. This group expected to have a full report on these recent activities shortly from Professor Uda, and plans would be developed as to how Japan could most effectively engage in these vast cooperative international undertakings. Japan was fully alive to its responsibility as a great maritime and fishing nation, and the great benefits which could be expected to derive from these investigations to the fisheries.

#### IB. Tuna fishing operations and catch information

A summary of the presentation by Mr. Oka of Japan is as follows:

The Japanese statistical system is highly complicated and is characterized by the fact that a great deal of effort is being devoted to the compilation of statistics on the small-scale coastal fisheries.

Up till now, tuna catch statistics have been compiled by chiefly utilizing data based on transaction invoices and data prepared with the cooperation of the fishery associations. However these statistics represent landing statistics and very frequently are at variance with the actual catch amounts. Accordingly, their breakdown into individual fishing grounds is difficult.

For the first time, an attempt has been made since 1961 to obtain reports direct from the fishing vessels, but the rate of reporting is poor. Data for 6 months have been completed to date.

Therefore, we are moving in the direction of improving this situation by means of drawing up a list of fishery operators and establishing statistical fishery zones for this purpose, so as to enable us to obtain a clearer picture of the distribution of the fish catch.

As from this year we hope to prepare statistics also as regards the catch in terms of large fishery zones (oceans), productivity, state of fishing operations and situation of shipboard treatment of fish, parallel with the compilation of the aforementioned fish catch statistics.

#### IC. Administrative measures in tuna fishing industry

The discussion then went to the administrative measures in respect of the tuna fisheries exercised in both countries.

Mr. Johnson noted that aids to industry in the United States had heretofore been confined largely to the support of research. This has been primarily in biology and oceanography but also to some extent in technology and economics. Recently, programs of loans and mortgage insurance for vessel owners have also been adopted. Health and welfare benefits common to other industries were also provided for the fishing industry. Protection of sorts was available for vessels seized on the high seas under rights and claims not recognized by the United States. Regulations on the Federal level were largely limited to submission of catch statistics, prohibitions against combining in restraint of trade, and the requirements relating to quality of the finished product. On the State level California also has regulations prohibiting the landings of fish smaller than certain sizes.

On the international level regulations arising from the recommendations of the Inter-American Tropical Tuna Commission would soon take effect in respect of yellowfin tuna fishing in the Eastern Pacific.

Mr. M. Nakamura gave a summary of the administrative controls exercised in Japan over the tuna fishery. He noted that Mr. Okuchi had touched upon this in the opening statements in plenary, that it had been treated in detail during the 1959 conference, and that recent developments were summarized in Report No.4, submitted to this conference by the Government of Japan. The only new development of consequence along this line had been the recent decision by the Government of Japan to issue licenses to about 200 additional tuna vessels of 100 gross tons or less in size. The necessity for doing this had arisen from the increase in demand for tuna and the need for assistance to certain sections of the Japanese fishing industry arising from international and domestic fisheries adjustments. It would be some time before these new vessels actually got built and put in operation. But it was stressed that Japan is

still paying much attention lest the tuna populations and market be unfavorably influenced by this action. A description was given of the various schemes of general and special insurance provided by the National Government and prefectural associations in Japan in respect to hull and gear as well as for death or injury to personnel. Mr. Johnson agreed to provide the Japanese group with a copy of the United States Fishermen's Protective Act of 1954. This has been done.

IIIA. Exchange of information on the various studies related to expanding the use of tuna.

Dr. Higashi gave an extended presentation concerning research in Japan aimed at improving the technology of processing, and distribution of tuna for human consumption. Reference was made to Report No. 6, "Food Technology to Extend Utilization of Tuna and Skipjack," and Report No.7, "Fish Sausage as a High Protein Food."

1. In Japan, a considerable portion of the tuna and skipjack harvest is eaten as raw meat. This has made it necessary to carry out studies on keeping quality to insure preservation of high levels of freshness, appearance and palatability.

2. Fundamental research has been carried out to control denaturation of muscle protein of tuna and skipjack. These studies contributed to development of the fish sausage industry. Studies included (a) determination of suitability of meat properties for fish sausage, (b) chemical treatment for making fish material suitable for fish sausage, and (c) extension of the number of species of fish usable as fish sausage material. Studies leading to longer shelf life than that of ordinary sausage are proving advantageous for consumers, in that further distribution of good quality products has become possible. Further improvement of shelf life and palatability will make fish sausage available for marketing in other regions of the world.

3. Efforts have been devoted to research on the nutritive aspects of tuna and skipjack. Accurate determination of tryptophane content in fish protein enabled Japanese technologists to evaluate the protein score of fish as being as high as that of livestock meat in contrast with a statement by FAO.

In respect to lipids of fish, investigations on highly unsaturated fatty acids have been carried out for similar purposes as in the U.S.A. Both studies show that fish oil is effective in lowering

cholesterol in the blood serum. Deterioration of highly unsaturated fatty acids due to oxidation is the cause of the fishy odor that fish products often have as their disadvantage. It is expected that further advances in studies of antioxydants and synergists which have been under way will eliminate the causes of deterioration of fish oils and make fish products more acceptable. Rich levels of vitamin contents in the edible portions of tunas and skipjack have been noted in comparison to lower vitamin contents in other kinds of fish. A recent advance in studies on provitamin D and vitamin D has led to an interesting hypothesis as to the function of a yellow carotenoid pigment and of a fluorescent hydrocarbon contained in the skin of tunas. These substances seem to participate in converting provitamin D into vitamin D. Vitamin D was found to accumulate in the skin and the body of bluefin tuna, skipjack and black marlin at a high level.

4. Incidental catches of sharks on tuna longlines may afford the possibility of expanding the utilization of the shark from this type of fishery. A marked difference in kind and level of the chemical components of shark from those in teleostean fishes makes it difficult to use shark meat for food products other than fish paste. Attempts have been made to prepare fish solubles for human consumption from shark meat and from the by-products of tuna and skipjack, by employing enzymic digestion techniques.

Dr. Higashi noted the high desirability of further and continuous exchange of information and scientists between Japan and the United States as that might stimulate further use of tuna,

Mr. Holston briefly reviews the technological research being carried on at the different regional technological laboratories of the Bureau of Commercial Fisheries.

Emphasis in research investigations related to the present agenda of Committee I is mainly placed upon quality improvement of fishery products. Little or no technological research is now under way directly on tuna. Research programs on tuna, to be initiated in the near future, include effects of harvesting and handling conditions on finished products. Brief accounts of this proposed physiological investigation were presented in Exchange Paper No. 8.

Important research works, currently being conducted at U.S. Bureau of Commercial Fisheries, Technological Laboratories, include:

- 1) Gloucester, Massachusetts, Laboratory:  
Denaturation of muscle protein during freezing and storage of frozen fish.
- 2) College Park, Maryland, Laboratory  
Nutritive effects of fishery products upon animal and human life, growth and well-being.
- 3) Seattle, Washington, Laboratory:  
Efficacy of fish oils in lowering cholesterol level in blood.  
Determination of the mechanisms responsible for the development of objectionable odors in fish oils.

Close cooperation is maintained with research institutions outside the Bureau of Commercial Fisheries such as the Hormel Institute of the University of Minnesota and the laboratories of the University of California. Research subjects undertaken at these organizations are related to: 1) the effects of antioxidants and synergists in preventing deterioration of fish oil, 2) the physiological effects of highly unsaturated fatty acids before and after oxidation, and 3) on the physical constants of electrophoretically separated proteins.

Questions and comments made by the U.S. side were related to:

- 1) Information on studies to prevent loss of color and of "Bloom" or iridescence of tuna meat due to refrigeration:
- 2) relationship between fishing methods and keeping quality of tuna.

Works on tuna proteins, etc., by Dr. Olcott of the University of California; the work on substituting highly unsaturated fatty acids for those existing in the mitochondrial membranes, particularly at Davis, California, etc.,

A discussion was had of the exchange of official and private publications and books on fisheries. The Japanese group agreed to provide a short list of text books on fisheries matters available for purchase in Tokyo stores, and noted that both the Science and Technics Agency and the Fisheries Agency were in the process of constructing complete bibliographies of books and publications in fisheries and ocean research in Japan which would be made available as soon as they were completed. The American group agreed to provide also a list of principal text books, etc., dealing with fishery and ocean research subjects.

## V, Bilateral exchange of current information

In discussion under agenda item five, it was further agreed that:

- (1) The exchange of research data and publications between individual scientists and laboratories which had been proceeding so well, especially since the 1959 conference, should be encouraged to expand by all practical means;
- (2) The direct exchange of scientists between laboratories, both on visits and for longer periods of study, was felt to be one of the most valuable means available for the exchange of information, and that this should be increased by all feasible means.
- (3) The exchange of biological samples, such as specimens for taxonomic work, blood samples for racial determinations, etc., should be encouraged wherever such is practical.
- (4) There should be further joint programs of vessel operation and of scientists at sea along the lines of the Norpac and Equapac expeditions and the recent joint cruise to study the spawning of albacore. Attention was again drawn to the forthcoming cruise of the Shoyo Maru into the Eastern Pacific and the high desirability of collaboration by Japan and American fishery oceanographers in the Pacific, Atlantic and Indian Ocean expeditions and international cooperative oceanographic programs.
- (5) The full and prompt exchange of data and publications should be enhanced.
- (6) Attentions should be given to study of means of speedy dissemination of synoptic oceanographic observations both to scientists and to the fishermen at sea.

Mr. Johnson described the meetings of Tuna Biologists and the Eastern Pacific Oceanic Conference that are held each year on the Pacific coast of the United States. These are informal and non-governmental. Each occupies two and one half days. They follow each other so that one week of five days is used for the two meetings. The personnel attending each overlaps. Next year they will be held at Lake Arrowhead, California in the last week of September. Professor Uda attended EPOC this year. It would be most beneficial if such eminent Japanese scientists could attend these meetings each year. They would be most welcome.

In conclusion it was noted by the American side that the United States lands about 150,000 tons of tuna a year worth about \$43,000,000 to its fishermen and spends about \$2,000,000 per year on research directly applicable to tuna. It was discussed that Japanese budget for researches of tuna resources were very small comparing with that of U.S. and that though considerable volume of tuna research had been accomplished by Japan in spite of that fact, Japan had been still paying much effort to obtain more budget for that purpose.

A good deal of study was being given to these matters in Japan especially in the Japanese Council for Marine Sciences and Technics and in the Fisheries Agency. Tuna research in Japan would be enhanced just as rapidly as funds could be made available for this purpose.

There was general appreciation expressed by both sides on the friendly atmosphere and cooperative attitudes in which the committee had been able to conduct its deliberations. The Committee concluded its work at 5:30 p.m., 11 October.

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#### APPENDIX IX

Conseil International des Unions Scientifiques - International  
Council of Scientific Unions      Special Committee on Oceanic Research

16 October 1962

The President  
Van Camp Foundation  
739 Golden Park Avenue  
San Diego 6, California U.S.A.

Dear Wib:

The SCOR Executive decided it would like your full report(not just the summary rushed to IOC) and the 2 or 3 Volumes of Comments circulated to its members, national committees, etc., (total about 50). I understand the report could be included in the final Volume.

Please tell me which is the best procedure - SCOR to give you a mailing list, you to send me 50 copies, or some other way. In any case I would like you to tell me to whom you have, and will, distribute the Volumes. Don't hesitate to let me know the cost of all the correspondence.

October 14, 1962

Finally, SCOR felt that you and your group deserved our thanks for the job you turned out in record time. When I get through the accumulation of work here I shall send a note of thanks to all the group who assumed active membership.

Yours sincerely,

/s/ George

(G. F. Humphrey)  
President

APPENDIX X

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