SCOR Working Group Proposal

(max. 6000 words, excluding Appendix)

Title: **Harnessing global pELagic FISH biochemical data to address Sustainability challenges under climate change scenarios**

Acronym: **ELFISH**

Summary/Abstract (max. 250 words)

Globally, there is concern that climate change and human activities are impacting the availability and distribution of essential nutrients needed to sustain marine ecosystems but also human health through fish consumption. This highlights a growing need for biochemical data, including measurements of macro- and micro-nutrients, and contaminants in fish, that are currently incomplete to address the cross-sector UN Sustainable Development Goals. Specifically, many current databases often lack related spatio-temporal and biological information fundamental to assess and predict the impacts of global change on ocean biogeochemical cycling and nutrient delivery. This WG will bring together an international and interdisciplinary team to (i) develop an open-access global database of compiled and curated biochemical data obtained from research and monitoring programs that include fine-scaled biological, ecological and spatio-temporal information matched to available environmental data; (ii) develop and implement novel predictive models of pelagic-derived biochemical data under climate change scenarios; and (iii) propose a collaborative interdisciplinary framework to further accelerate progress in sharing and using biochemical data. The WG will focus on pelagic fish from nearshore to open-ocean systems, as they are important to global fisheries resources supply, highly sensitive to global change and a critical source of essential nutrients and contaminants. The WG will leverage previously successful climate-ecosystem work and the advances of data analytics to improve our ability to understand, map and predict the availability of nutrients essential to ecosystem and human health. Achieving such ambitious objectives requires a coordinated international effort which the SCOR platform facilitates.

Scientific Background and Rationale (max 1250 words)

Marine ecosystems are changing rapidly due to increasing human pressures such as overfishing, climate change, and pollution. This includes worldwide observations of alterations in the species composition of primary producers (Gregg et al 2017) or declines in fatty acid availability as a result of global warming (Colombo et al. 2020). How these changes impact the oceans' capacity to deliver sufficient, safe and nutritious food to a growing human population is not well understood. Importantly, fisheries resources provide more than 3 billion people with 20 percent of their average per-capita intake of animal protein and represent a critical source of energy, and macro- and micronutrients (FAO, 2020). There is a need for governments and private companies to address consumer nutrition and health issues and to change

consumer and industry demands for sustainability. Together, these issues highlight a growing need for spatio-temporal biochemical data (including nutrient and contaminant composition) in fisheries resources, and increased predictive capacity that can support ecosystem-based management objectives and nutrition-sensitive policies, as well as inform public health actors and seafood consumers (Gustafson et al. 2016; Thilsted et al. 2016).

Data detailing the biochemical composition of fisheries resources includes measurements of energetic value, proteins, fats, carbohydrates, vitamins, and minerals as well as contaminants. Such data are used for many different purposes across health, fisheries, environmental and trade sectors and are sourced from various research disciplines which traditionally operate in silo. Although regional biochemical data on a number of fisheries resources are available, they often lack related spatio-temporal and biological information (Rittenschober et al. 2013). Without this crucial information, there is limited ability to assess and predict the impacts of global change on ocean ecosystems and nutrient delivery.

This WG will bring together an international and interdisciplinary team to identify, compile and model biochemical data on fisheries resources acquired from environmental and fisheries-related studies (Figure 1) that have high resolution spatio-temporal and biological information. The model species chosen are abundant, widely-distributed and socio-economically important pelagic fish, representative of different trophic levels (e.g., forage fishes and tunas). Pelagic species are nutrient-dense food sources with high quality proteins, long-chain polyunsaturated fatty acids, and micronutrients such as iron, zinc, and selenium essential to ensure optimal child development and human health, and thus the importance of collecting global data on these species is widely recognized (Hicks et al. 2019). The WG will build on successful work undertaken under the IMBeR-CLIOTOP umbrella that brought together dietary, stable carbon and nitrogen isotope, and environmental datasets for tuna species and modelling expertise to undertake global meta-analyses (Young et al. 2015). As part of these collaborations, Lorrain et al. (2020) revealed global changes in phytoplankton species communities over the last 15 years. The group also described global patterns of tuna movements and trophodynamics and demonstrated that pelagic trophic structure differs between low and high oxygen areas (Pethybridge et al. 2018; Logan et al. 2020). These works reveal a major knowledge gap that climate-driven changes in marine ecosystems are likely to impact nutrition production for human consumption, but this link has not been established empirically.

Proposal objectives

Objective 1 of the WG is to develop a global database consisting of biochemical data for pelagic fish obtained by ocean-related studies and monitoring programs around the world (**Figure 1**). These data include measurements of macro- (fats, proteins, and energy value) and micro-molecules, such as fatty acids, minerals, contaminants (e.g., mercury), and the related biological (species, size, and trophic level derived from bulk and compound-specific stable isotope ratios) and spatio-temporal metadata. The spatio-temporal metadata in particular is “mandatory” because they will enable a global oceanographic and environmental framework of comparison over time. The resulting global biochemical database will then be complemented with outputs from biogeochemical models and/or satellite-derived (remote-sensing) products, so that environmental (oceanographic and climate) data can be matched to the date and location of fish capture.

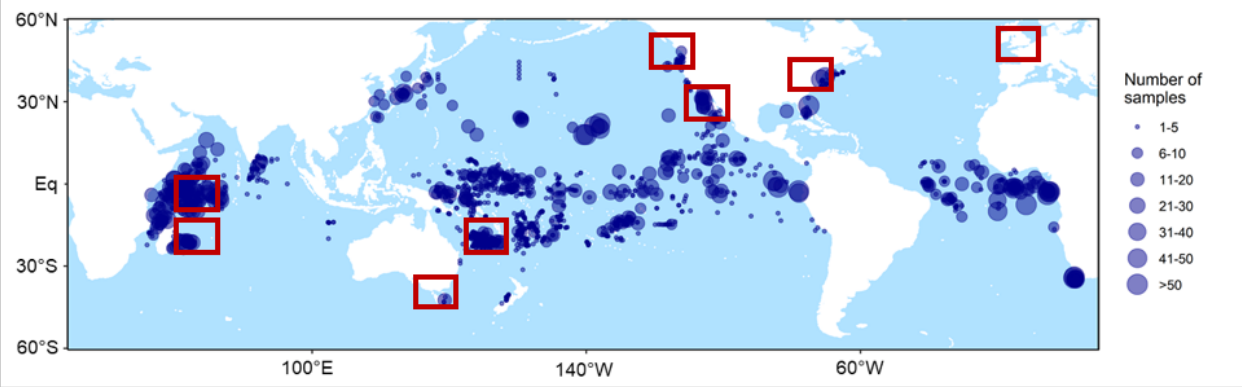

Fig. 1. Example of the location of available biochemical datasets, here for mercury concentrations, stable carbon and nitrogen isotopes and protein/fat datasets already compiled from several projets (N = 9000, blue dots, Médieu et al. In prep). In red, the location of people involved in the project that are leading several national projects covering the three ocean basins (e.g., ANR MERTOX: Unreavelling the origin of mercury in the global ocean, TIPTOP: Tuna from the South Pacific : Persistent Organic Pollutants and microplastics, CONSWO: Balancing risks with benefits associated with consumption of swordfish and tuna CANAL: Influence of environmental and biological factors on tuna meat quality, COSTAS: COntaminants in the Trophic system: phytoplankton, zooplankton, Anchovy and Sardine).

Objective 2 seeks to address the pressing need to develop a reliable predictive capability in relation to understanding large-scale distribution patterns and the effects of climate change on the availability of essential nutrients and interconnected ecosystem and human health outcomes (Landrigan et al. 2020). The WG will develop novel statistical models to map and predict the availability of nutrients in fish, and to project changes in nutrients and contaminants under climate change scenarios (e.g. projected increases in ocean warming, deoxygenation, and shifts in phytoplankton dynamics as determined by global Earth System Models used by CMIP for IPCC reporting, Kwiatkowski et al. (2020)). This will build on existing predictive modelling efforts including those by Hicks et al. (2019) who found that species-level environmental and ecological traits can identify general, macro-scale patterns of the distribution of nutrients from marine fisheries catches. The group will also use predictive modelling approaches successfully applied to CLIOTOP tuna stable isotope datasets to better understand carbon and nitrogen-based processes driving pelagic food web dynamics (Logan et al 2020; Pethybridge et al. 2018).

Objective 3 will develop a framework to facilitate future collaborative, inter-disciplinary and cost-effective data sharing and monitoring programs in critical pelagic fisheries locations focusing on developing countries (e.g., Indian and Pacific Small Island Developing States) and therefore to build capacity in those locations and improve the access and utility of spatio-temporal biochemical data to meet multi-sector data needs (e.g., fisheries industry, governments). By unpacking the most important cross-sector data linkages, the WG will gain crucial insights into the types of data available, key stakeholders, and where the largest challenges or data gaps lie. A key component here will be connecting with members of the FAO International Network of Food Data Systems (INFOODS, http://www.fao.org/infoods/infoods/en/) that aim to improve the quality, availability and use of food composition data used.

Why a SCOR WG now?

The 2019 Lancet Commission Report on the global syndemic of obesity, malnutrition, and climate change is one of an increasing number of high-profile outputs identifying the close links between human and

ecosystem health. However, these research disciplines are currently poorly integrated and the research infrastructure necessary to understand these links is inadequate. To help redress this imbalance and provide a pathway forward, strategic cross-disciplinary and cross-institutional collaborations and knowledge are crucial. However, such collaborations are inherently difficult to form, manage and fund. Indeed, the work that we propose, based on strong international collaborations, is rarely funded by standard research grants from national research agencies. A SCOR WG would provide critical leverage for capacity building grant opportunities and securing additional funding support from regional institutes and agencies, particularly for increased involvement of early career scientists, including from developing countries which rely to a large extent on the nutritional quality of their pelagic fisheries resources for their economy (Batty & Fernandes 2018; Andriamahefazafy et al. 2020).

Activities and outputs from this WG will build awareness of data gaps, complementarities and overlaps as well as stimulate discussion to develop more holistic approaches that use biochemical data to support next generation decision-making systems and promote environmental, economic and societal sustainability. WG members will bring existing biochemical data together with environmental variables and develop spatio-temporal and predictive models that can directly address multi-sector objectives while better informing policy-makers and seafood consumers. We believe that this WG is timely, if not urgent, given the challenges associated with progressing towards both the UN Decade of Ocean Science and Sustainable Development Goals, and the immense need to understand synergies and trade-offs between the societal and environmental goals and targets.

Terms of Reference (ToR) (max. 250 words)

1. Develop a global database of biochemical measurements and related spatio-temporal and biological metadata for pelagic fish species (**objective 1**) gathered from existing ocean-related studies and monitoring programs (example in **Figure 1**). The focus will be to compile all available records of macro-, micronutrients and contaminants in addition to information on the origin (e.g., date and location), size and trophic level of the fish.

2. Obtain environmental data known to influence ecosystem and nutrient dynamics (e.g., sea surface temperature, chlorophyll-a, mixed layer depth and oxygen concentrations) to match with the origin of the gathered pelagic biochemical data (**objective 1**).

3. Develop novel models that will map and predict the availability and distribution of pelagic-derived biochemical compounds (nutrients and contaminants) under climate change scenarios (**objective 2**). These models will be first applied at regional scales on particular biochemical compounds and species for which there is sufficient data available, then expanded to larger (ocean basin and global) scales to undertake regional comparative assessments.

4. Identify important next steps by describing the current overlapping and growing requirements for collaborative spatio-temporal biochemical composition data, such as those compiled by WG for pelagic fish, to address ecological and nutrition challenges in a changing environment (**objective 3**).

5. Share knowledge and transfer skills in modelling and in the sharing, merging and stewardship of environmental and biochemical data with international (with a focus on early career) scientists in both

developed and developing nations (**objectives 1-3**).

Working plan (logical sequence of steps to fulfil terms of reference, with timeline. Max. 1000 words)

The WG will progress the ToR largely through regular email exchanges, online meetings, and information exchange platforms (including a Slack Team, google drive and gitHub). Two WG meetings will be convened over the next three years and planned to coincide with international conferences or regional meetings to optimize SCOR funding support for a greater number of members with priority given to early career scientists and/or those from developing nations. This will also assist in knowledge transfer and capacity building.

There are several parallel strands of activities for this WG (see timetable below).

The global biochemical database component (**objective 1**) represents the most crucial and time-consuming activity for the WG. Firstly, we will decide on the metadata fields required, such as the species, tissue, origin (date and location), size and trophic level of the fish, and their desired format and resolution. Particular effort will be extended to accommodating all information provided by the WG, and to align the metadata with multi-sector needs. Special attention will be paid to tracking methodologies used to acquire biochemical measurements to ensure that standardised data units are applied (e.g., absolute quantification of fatty acid values and length-standardized mercury concentrations) for inter-compatibility. Existing pelagic fish biochemical data with the required metadata, will then be gathered from ocean-related studies and monitoring programs. The datasets will finally be compiled into a relational database using an existing model (Chassot et al., 2017). To assist with this component, the WG will draw on learnings from past international data compilation efforts (e.g., >9000 records under the CLIOTOP and MERTOX projects; >1500 records under CONSWO) to ensure that data quality and traceability are maintained. In several cases, student-led regional-level data sharing and compilation projects have already started or are planned to coincide with efforts of the SCOR WG.

The assembled global pelagic-derived biochemical database will then be integrated with the most up-to-date environmental data by matching origin (date and location) of pelagic fish samples and their related biochemical data to their corresponding environmental data. This will include the extraction of spatial-temporal data from climatologies based on remote sensing and observational data as in Pethybridge et al. (2018). More specifically, environmental data considered will be NPP, O_2, NO_3, $\delta^{15}N$, $\delta^{13}C$ extracted from the Model of Ocean Biogeochemistry and Isotopes (MOBI, Somes et al. 2017), the isotope enabled Pelagic Interactions Scheme for Carbon and Ecosystem Studies version 2 (PISCESv2, Aumont et al., 2015), and satellite-derived net primary productivity models (e.g., VGPM, http://www.science.oregonstate.edu/ocean.productivity) to determine the most significant environmental drivers on fish nutrition, which will provide a more robust view of baseline "bottom-up" biogeochemical controls on upper trophic levels including fish.

Then, for the modelling component (**objective 2),** identified relationships will be used to predict nutrients or contaminants in fish following simplified IPCC-based climate scenarios (e.g., a 3°C increase of temperature consistent with the SST warming projected in 2100 under RCP 8.5 IPCC scenario, Bindoff et

al. (2019)). The WG will draw upon expertise and experience of a broad range of statistical models (i.e., hierarchical Bayesian approaches) and broadly applied climate change projections (CMIP6 outputs), to investigate the impact of contrasting future ocean conditions on nutrient and contaminant concentrations in fish.

In parallel to activities directly related to objectives 1 and 2, the WG will work towards unpacking cross-sector data linkages and developing a data sharing framework (**objective 3**) to accelerate progress using biochemical data to better predict climate change scenarios of ocean ecosystems and human health outcomes. This includes describing the type, accessibility, and quality of such data (e.g., the spatial, temporal, and species resolution), as well as the analytical means to obtain these data. The WG then will describe key steps, processes, challenges and opportunities to effectively co-design and co-implement the integration of fisheries resources compositional datasets from multiple sectors into a shared digital repository.

Timeline

Year 1: start compiling existing biochemical data and related metadata on pelagic fish obtained as part of environmental and fisheries-related studies and monitoring programs (**objective 1**). Key here will be for the WG to describe and agree on the mandatory metadata fields to be included. The WG will also outline a structured implementation plan for the modelling component (**objective 2**). Ideally, WG members would have their first meeting to discuss the compilation of datasets at the 2022 Ocean Sciences Meeting in Hawaii. If this is not possible online resources and platforms will be used instead.

Year 2: finalize data compilation efforts for at least three key taxa groups or species so that spatio-temporal predictive models can be implemented (**objectives 1 and 2**). The second in-person SCOR WG meeting will serve to discuss, interpret and write-up model results for peer-reviewed publications. It will be hosted in one of the partner countries (Seychelles or New Caledonia) to coincide with an annual meeting of the tuna Regional Fisheries Management Organisations. Prior to the meeting a questionnaire will be sent out out to focal points to inform a workshop, held on location, with the aims to: 1) communicate results effectively; 2) provide hands-on training and targeted skill development to local scientists and national fisheries, environmental and health officers; 3) co-develop avenues for integration of skills into data collection protocols and monitoring plans.

Year 3: continue efforts to implement spatio-temporal predictive models and communicate findings in scientific papers, at regional and international meetings and workshops, and in media. There will also be concerted effort to inform policy makers and consumers of the development and implementation of the predictive models (**objective 2**) and of future integrated research needs. The group will seek to use a multi-perspective approach to highlight the growing need for standardized and integrated biochemical data and metadata, and to outline a pathway towards building a more integrated research infrastructure for addressing multi-sector objectives across ecosystem health and human health (**objective 3**). The WG will also plan to seek additional funding to expand international participation and ensure broad uptake and use of data and models developed under the SCOR WG.

Deliverables (state clearly what products the WG will generate. Should relate to the terms of reference. Max 250 words).

1. A global-scale dataset, consisting of biochemical composition measurements in key pelagic fish species and the related metadata and environmental data, will be submitted as peer-reviewed data paper in open access journals. This includes additional contributions to existing international open-access databases (e.g., the global tuna stable isotope data set developed under CLIOTOP; Bodin et al. 2021) (**objective 1, ToR 1-2**)
2. Model predictions and maps for nutrition aspects of key species or taxa (**objective 2**)
3. R-code and packages of new model developments and implementations will be made freely and widely available on GitHub for use by the broader community (**objective 2, ToR 3**)
4. Several scientific research papers in peer-reviewed and open access journals will be produced by members of the WG including several young scientists. These papers will present the data and model results for particular pelagic species (or groups of species) and compositional measurements (**all objectives and ToRs**)
5. A perspective paper, to be published in a high-impact journal, that will describe a data sharing framework and actions needed to enable multiple sectors to bring together and use different sources of biochemical data to support sustainable development goals in a changing environment (**objective 3 and ToR 4**)
6. Presentation of results and conclusions of the predictive research and perspectives papers at regional and international meetings (**ToR 5, years 1-3**)
7. Status or synthesis reports, workshop reports and media pieces (**years 1-3, whenever required**)

Capacity Building (How will this WG build long-lasting capacity for practicing and understanding this area of marine science globally. Max 1500 words)

All of the WG objectives are closely tied to a capacity building plan to obtain, improve and transfer skills, knowledge, tools and other resources to different countries and territories and for different stakeholders, including policy makers and the public. Firstly, the development, compilation and publication of the global biochemical datasets, which will include spatio-temporal and environmental metadata, will ensure that critical information is broadly shared with, and made available to multiple end users and stakeholders around the world. All data, documentation and processing algorithms associated with the datasets will be published along with the data paper to maximise the utility of the WG's activities for the wider research community. Similarly, all new model developments by the WG will be made available on GitHub with adequate documentation of instructions for use to ensure broader uptake by others. Where requested, members will work with interested stakeholders to help increase the capacity of the various countries to understand and use the biochemical data acquired.

The WG meetings, in particular, will coincide with a high-level international conference (e.g., Ocean Sciences Meeting) and an annual Regional Fisheries Management Organisation meeting (e.g., Western and Central Pacific Fisheries Commission working group, Indian Ocean Tuna Commission working party); providing a unique opportunity to organise a workshop focused on sharing and using environmental and biochemical data to address ecological and nutrition security challenges under climate change scenarios. To optimise the delivery of the workshop, we propose to coordinate with key local stakeholders and design

a questionnaire to identify (i) targeted participants (e.g., local scientists, national fisheries officers) and (ii) key areas representing opportunities for engagement and capacity building. This questionnaire would then be sent out to identified individuals and answers provided to craft relevant skills training material (e.g., data collection, data manipulation and standardisation, simple analyses etc…). Participants would also be encouraged to bring along their own datasets to increase relevance, facilitate uptake, and maximise effective implementation. The workshop would also be used to communicate results of efforts to date and discuss with cross-sectoral stakeholders on: 1) how these may best be contextualised for integration into data collection protocols and monitoring plans as well as local policy-making, and 2) what additional analyses or needs emerge given existing challenges and commitments.

We will also consider developing a freely accessible e-learning course on platforms such as OpenLearn. Topics of interest and to be covered will be gleaned from responses to the questionnaire as well as from key partners. Courses will be built upon existing courses offered by WP members (e.g., use of biochemical tracers in ecology). Through these exercises, the WG will also extend and strengthen each institution's capacities in all the WG's areas of expertise.

The perspective paper will incorporate insights from members and a wider network of researchers that will provide the broader community with the relevance and guidance on key considerations and best practices for integrating biochemical data from multiple datasets. Particular consideration will be given to regions of interest and concern to provide tangible recommendations towards an agenda for the integrated study of ocean and human health that can be scaled. This will entail consultation with various stakeholders across fisheries, environmental and human nutritional health research disciplines and government departments to discuss specific user needs and concerns. Such dialogue will help develop and strengthen partnerships and will also ensure that the compiled datasets and model results obtained by the WG match user needs. Any insights will be shared broadly to extended member networks with the intention that approaches, models and frameworks are picked up and adapted for regional and international programs. Several WG members are already well connected and implemented in regional government initiatives given their interest aligned with this proposal which will ensure effective dissemination of the deliverables (e.g., outreach, website, social media, workshops) with regional organisations.

All scientific papers and datasets published by the WG will be open-source and submitted for peer-review. We will also disseminate our learnings and findings through media of established institutional, regional or international networks (e.g., SPC Fisheries Newsletter distributed to 20 Pacific countries and territories: https://coastfish.spc.int/en/publications/bulletins/fisheries-newsletter; WIOMSA Newsbrief distributed to 10 East Africa countries: https://www.wiomsa.org/news/). The knowledge obtained from the WG deliverables will be presented at institutional and public seminars, and national and international conferences wherever there is opportunity. Members will also undertake information days intended for the general public to raise awareness on conservation and health issues, demonstrate value in ecosystem data collection, and describe how the information generated can be used in decision-making for sustainable environmental management and health issues.

Post-graduate students enrolled in PhD or master diplomas will be engaged in key components of the WG, including stakeholder engagement, data collection, data processing and modelling. They will acquire new cutting-edge skills and access to an international network of interdisciplinary scientists.

Working Group composition (as table). Divide by Full Members (10 people) and Associate Members, taking note of scientific discipline spread, geographical spread, gender balance, and participation by early-career scientists (max. 500 words)

The WG consists of 18 members from a broad set of research disciplines (from marine ecology and fisheries to physical oceanography, and seafood nutrients and contaminants), career stages (early to senior), gender, and geographical spread of institutions (Europe, Australia, North and Central America and East Africa) that are participating in research across all major ocean basins (**Figure 1**). Seven of the WG members, including the three co-chairs, worked together in the highly successful CLIOTOP Marine Predator Isotope task team which produced five high-impact research papers and an accompanying open-access stable isotope dataset. Three members are from Small Island Developing Countries where fisheries resources constitute an essential part of human consumption and are the primary provider of proteins. Each WG member has an extended network of collaborators with many of the mid-level and senior researchers having access to higher degree research students to participate in the WG activities. These aspects will ensure that the WG successfully communicates, produces deliverables, and develops capacity building globally.

Full Members (no more than 10, please identify chair(s))

	Name	Gender	Place of work	Expertise relevant to proposal
1	Anne Lorrain (co-chair)	F	IRD, France	Stable C, N, Hg isotopes; marine ecology; biogeochemistry
2	Heidi Pethybridge (co-chair)	F	CSIRO, Australia	Fatty acids, ecosystem models; climate-fisheries interactions
3	Nathalie Bodin (co-chair)	F	SOS, Seychelles	Pelagic fisheries; food web ecology; seafood nutrients; contaminants
4	Anela Choy	F	SIO and University of California, USA	Biological oceanography; stable isotopes, mercury; plastics; dietary studies
5	Christopher Somes (ECR)	M	GEOMAR, Germany	Isotope and biogeochemical modelling
6	Colette Wabnitz	F	UBC, Canada; and Stanford, USA	Marine fisheries; food web ecology; environmental change and seafood micronutrients; equity.
7	Felipe Galván-Magaña	M	Interdisciplinary Center of Marine Science (ICIMAR), Mexico	Tunas & billfishes trophic ecology; stable C and N isotopes; heavy metals; marine ecology
8	James Robinson (ECR)	M	Lancaster University, UK	Pelagic fisheries; seafood nutrients; tropical ecology
9	Valérie Allain	F	The Pacific Community (SPC), New Caledonia	Fisheries scientist;capacity building; stakeholder engagement; knowledge transfer
10	Zahirah Dhurmeea (ECR)	F	Albion Fisheries Research Centre (AFRC), Mauritius	Fisheries assessments; population dynamics; biochemical tracer applications

Associate Members (no more than 10)

	Name	Gender	Place of work	Expertise relevant to proposal
11	Catherine Munschy	F	IFREMER, France	Persistent and bioaccumulative organic contaminants in marine biota
12	Christopher Parrish	M	Memorial University, Canada	Lipid chemistry and applications of fatty acids as ecological tracers
13	Eva Maire (ECR)	F	Lancaster University, UK	Ecological and environmental determinants of micronutrient availability from fish
14	Fany Sardenne (ECR)	F	CNRS, France	Marine trophic ecology; stable isotopes; fatty acids; trace metals analysis
15	Joan Navaro	M	Institute of Marine Sciences (ICM), Spain	Marine pelagic ecosystem dynamics
16	John Logan	M	Massachusett Division of Marine Fisheries, USA	Stable isotope ecology; fisheries science

17	Kirsty Nash (ECR)	F	University of Tasmania, Australia	Functional ecology and human nutrition; climate change scientist
18	Pearse Buchanan (ECR)	M	Liverpool University, UK	Ocean biogeochemical modelling, climate change, isotopes

Working Group contributions (max. 500 words)

1- A. Lorrain (co chair), Principal Research Scientist at IRD, France, has extensive experience on the use of marine organisms as sentinels of global changes through stable isotope techniques. Her experience with global biogeochemical datasets and interdisciplinary studies through her international network will greatly assist all aspects of this WP.

2- Heidi Pethybridge (co chair), is a senior quantitative ecologist and ecosystem modeller at CSIRO, Australia. Her extensive experience in the development and application of statistical and mechanistic models to assess the potential effects of climate and fisheries on marine biogeochemical cycling and ecosystem dynamics, will assist this WG, particularly objective 2.

3- Nathalie Bodin (co chair), marine ecologist and ecotoxicologist, from Sustainable Ocean Seychelles (SOS), has strong expertise in marine fisheries, food webs and seafood security issues. Her skills in the management of large fisheries, ecological and biochemical datasets and related metadata will benefit this WG, particularly objective 1.

4- Anela Choy is an Assistant Professor of Biological Oceanography at Scripps Institution of Oceanography (SIO), University of California, San Diego. Her expertise in food web ecology and biochemical tracer data across distinct marine food webs undergoing environmental change(s) will be key in supporting the objectives of the WG.

5- Christopher Somes is a biogeochemical and isotope modeler at GEOMAR, Kiel, Germany. His experience in the development and application of biogeochemical and isotope models incorporated with Earth System Climate Models will assist the WG by quantitatively assessing climate and other human-induced impacts on marine ecosystems.

6- Colette Wabnitz is the lead scientist at the Center for Ocean Solutions, Stanford University, USA and Research Associate at UBC, Canada. Her research explores the role of fisheries in meeting food and nutrition security goals, and modelling food web responses to large scale exploitation and climate change. Her interdisciplinary experience and multi-sectoral networks will benefit objectives across this WG.

7- Felipe Galván-Magaña is the lead scientist of the shark and rays project at CICIMAR, Mexico. His experience in large marine predator's trophic ecology using stable isotopes, heavy metals and marine food web ecology completely align with the objectives of this WG.

8- James Robinson, quantitative marine ecologist at the Lancaster University, UK, examines the role of wild fisheries in supplying nutritious seafood, and holds a Leverhulme Early Career Fellowship to examine climate change impacts on tropical fisheries. His statistical modelling skills and experience with ecological, fisheries, and nutrient composition datasets will benefit this WG, particularly objective 2.

9- Valérie Allain, Senior Fisheries Scientist at SPC, New Caledonia, has expertise in tuna ecosystem structure, and climate impacts on ecosystems. Her interdisciplinary experience and large network of fisheries observers in the western and central Pacific will benefit various objectives of the WG.

10- Zahirah Dhurmeea, Scientific Officer at AFRC in Mauritius, is a fish biologist conducting modelling on various kinds of datasets (e.g., fatty acids, tuna population dynamics). Her contribution to this WG extends to data and sample acquisition through her connections and to promote capacity building.

Relationship to other international programs and SCOR Working groups (max. 500 words)

IMBeR research program CLIOTOP (Climate Impacts on Oceanic Top Predators): The proposed WG activities will expand upon collaborative efforts that occurred under the CLIOTOP Marine Predator task team (http://imber.info/science/regional-programmes-working-groups/cliotop/). Over a 12-year timeframe, the task team compiled regional tuna stomach content and stable isotope datasets and undertook worldwide comparative analyses. Their work, resulting in five high impact published articles and one open-access data paper, greatly enhanced our understanding of the key processes involved in ocean ecosystem functioning, particularly in the context of climate variability. Whilst there are continued efforts by WG members to obtain additional stable isotope data on pelagic species, there is a growing desire and need to integrate additional biochemical parameters.

The international program **GEOTRACES** aims to improve the understanding of biogeochemical cycles and distribution of trace elements and their isotopes in the marine environment. It has delivered the first robust view of dissolved iron concentrations throughout the global ocean, which has provided a key constraint for global biogeochemical modelers. This has led to the **SCOR WG 151** iron model inter-comparison to constrain global iron-biogeochemical models, in which WG member C. Somes is an active participant and collaborator on a new model connecting marine biogeochemical cycling to fish biomass that suggests the global marine iron cycle is sensitive to projected climate change and that this could impact phytoplankton and community dynamics. The proposed WG will thus be able to benefit from the networks, knowledge and model developments and associated data outputs generated by SCOR WG 151 and GEOTRACES.

FAIRFISH - Hidden Hunger, Forgotten Food (https://cordis.europa.eu/project/id/759457) is an ERC funded grant that adopts an interdisciplinary approach, incorporating ecological, social, and health sciences, to evaluate the contributions fisheries can make in tackling food and nutrition security in East and West Africa. Through an in-depth analysis, FAIRFISH uncovers the ecological and socio-cultural determinants of the contributions fisheries make to human health by: 1. Using a traits based approach, to establish the ecological and environmental determinants of nutrient availability among fish species. 2. Integrating an analysis of power, to determine what power relations enable or constrain access to nutritious food. 3. Integrating findings from 1 and 2, to quantify the impact of key social drivers on nutritional inequality, and uncover opportunities to meet nutritional needs.

The Blue Food Assessment (BFA) is a collaborative initiative by the Stockholm Resilience Centre and the Stanford Center for Ocean Solutions, with Springer Nature and EAT Foundation as close collaborators for academic outreach and broader impact. Two WG members are part of the leadership team for this initiative. It consists of several key scientific papers across several domains, including nutrition, demand, environment, justice, climate change, and smallholders, to examine the possibilities and challenges associated with a growing reliance on aquatic foods within the global food system. The aim of the assessment is to provide impactful and actionable science that will feed directly into the UN Secretary General's global Food Summit scheduled for September 2021.

Key References (max. 500 words)

Andriamahefazafy et al. 2020. The paradox of sustainable tuna fisheries in the Western Indian Ocean: Between visions of blue economy and realities of accumulation. Sustainability Science, 15(1), 75-89.

Aumont et al. 2015. PISCES-v2: an ocean biogeochemical model for carbon and ecosystem studies. Geosci Model Dev 8, 2465–2513. https://doi.org/10.5194/gmd-8-2465-2015

Batty & Fernandes 2018. Management of Tuna Fisheries for Sustainable Development in the Pacific Islands: Regional Cooperation in a Shared Fishery as a Means of Achieving the Sustainable Development Goals. Asia-Pacific Journal of Ocean Law and Policy, 3(2), 176-209.

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Appendix For each Full Member, indicate 5 key publications related to the proposal.

Anne Lorrain (co-chair)

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Nathalie Bodin (co-chair)

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James Robinson

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Valérie Allain

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Zahirah Dhurmeea

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