A Proposal for forming SCOR WG:
Global Patterns of Phytoplankton Dynamics in Coastal Ecosystems: Comparative Analysis of Time-Series Observations

1. Introduction

A. Background & Rationale

Marine ecosystems are changing rapidly in response to natural processes, human activities, and climate change. These drivers of change have become subject of increasingly intense focus from both research and management perspectives. There are some important scientific questions that need to be addressed with regard natural vs human-induced change including 1) the qualitative character of the ecosystem responses ("what changes?"), 2) their amplitudes ("by how much?"), and 3) their timing and spatial and temporal scales ("when and where are rates of change most profound?"). Phytoplankton are excellent indicators of marine ecosystem change. They are ecologically and biogeochemically important and relevant indicators, since they conduct a large share of system-scale primary production and hence C cycling, and they are highly sensitive to a suite of environmental stressors. There is much accumulated evidence that diverse ocean regions undergo strong and sometimes abrupt changes in phytoplankton composition, and productivity at roughly decadal intervals (i.e. regime shifts). This variability is associated with corresponding changes in atmospheric, hydrologic, chemical, and higher trophic-level biological processes and state variables. However, our understanding of global change is incomplete because we have not adequately explored, inventoried or compared available observational data. Nor do we know how to anticipate the timing and direction of the next major shifts.

In October 2007, nearly 100 phytoplankton ecologists gathered in Rovinj, Croatia and attended the AGU Chapman Conference: "Long Time-Series Observations in Coastal Ecosystems: Comparative Analyses of Phytoplankton Dynamics on Regional to Global Scales" (http://www.agu.org/meetings/chapman). They analyzed and compared phytoplankton changes in many coastal marine ecosystems around the world.

A recent example of a climate change-induced shift in biological communities was reported by Cloern et al. (2007) for San Francisco Bay. The abrupt change in the biological communities was first detected as increasing phytoplankton biomass and the occurrences of new seasonal blooms that began in 1999, overriding the influence of changes in the input of nutrients. There were coincidental higher level biotic changes, including sharp declines in the abundance of bivalve mollusks, the key phytoplankton consumers in this estuary, and record high abundances of several bivalve predators: Bay shrimp, English sole, and Dungeness crab. The phytoplankton increase is consistent with a trophic cascade resulting from heightened predation on bivalves and suppression of their filtration control on phytoplankton growth. These community changes in San Francisco Bay across three trophic levels followed a state change in the California Current System in the form of sudden increased upwelling intensity, amplified primary production, and strengthened southerly water flows. These diagnostic features of the East Pacific ''cold phase'' led to strong recruitment and immigration of juvenile flatfish and crustaceans into estuaries where they feed and develop. This study utilized three decades of observations to reveal a previously unrecognized mechanism of ocean–estuary connectivity. This shows that interdecadal oceanic regime shifts can propagate into estuaries and coastal waters, altering their community structure and efficiency of transforming land-derived nutrients into algal biomass.

B. Proposed SCOR Working Group

We are proposing to form a SCOR Working Group to focus on coastal ecosystems (estuaries, fjords, bays, sounds, open waters of the continental shelf, etc.) where perturbations from terrestrial, atmospheric, oceanic sources and human activities converge to cause changes that ramify across local and global scales. Human pressure on coastal regions and continental margins is increasing with expanding urbanization and the conflicting demands of tourism, agriculture and aquaculture, water diversions, wind parks and other developments. This idea to develop a SCOR Working Group grew out of the recent AGU Chapman Conference: "Long Time-Series Observations in Coastal Ecosystems: Comparative Analyses of Phytoplankton Dynamics on Regional to Global Scales" (convened by James Cloern and Nenad Smodlaka, October 8-12, Rovinj, Croatia). There was a strong consensus at this conference that a more detailed and more global comparison of phytoplankton time series would be timely, technically feasible, and an extremely valuable next step to more fully understand commonalities and contrasts with regard to ecological responses to natural and man-made changes captured in our global network of coastal phytoplankton time series.

Such an analysis must be an international cooperative effort – the relevant data sets are in many places and have been collected by many independent researchers, agencies and nations. Many of the necessary data are available now, and the Working Group can begin immediately. Endorsement and sponsorship by SCOR will help us attract and retain approvals and financial support from national agencies.

We will try to establish a strong interaction and working relationship with the SCOR WG on zooplankton time series and SCOR WG 132 on HABs. This interaction will be very beneficial as they are dealing with the similar challenge of analyzing global time series data sets.

We also expect to attract co-sponsorship and additional financial support in the form of travel funding for associate WG members from various organizations such as IMBER, GEOHAB, PICES, IOC and Census of Marine Life. We have invited the organizations to nominate associate members. We will maintain our interactions with these organizations during the WG active period, for example, we will send them our annual meeting notices before meetings and our annual reports for their feedbacks.

2. The Nature of the Scientific Opportunity

Phytoplankton

Phytoplankton are dominant marine primary producers; they mediate nutrient flux and cycling as well as transfer of organic matter to higher trophic levels, including invertebrate grazers, planktivorous fish, and carnivores. Hence they are a key link between nutrients and secondary production. As key primary producers, phytoplankton reflect immediate effects of changes in the input of nutrients in coastal ecosystems. Because different phytoplankton groups require different nutrient ratios, their composition responds to changes in the ratios of ambient nutrients. For example, diatoms require silicate and their relative abundance may be regulated by Si concentrations relative to other nutrients. Phytoplankton productivity and floristic composition are subject to physical forcings such as horizontal exchange between estuaries and the open sea (Cloern et al. 2007) and vertical mixing regimes, and they are also regulated by light fluctuations, and temperature. Changes in phytoplankton productivity and composition can be driven by climatic forcing and variability such as monsoons (Yin 2002), typhoons or hurricanes (Paerl et al. 2001, 2006) and rainfall (Paerl 1995). In addition, phytoplankton are broadly distributed and abundant, and can be quantified by relatively simple and intercomparable sampling methods. Finally, demographic traits of phytoplankton make them particularly suitable for comparative analysis of ecosystem changes across regional to global scales.

Availability and diversity of phytoplankton time series

Many researchers and governmental agencies around the world have relied on phytoplankton as a key indicator of water quality monitoring programs and many data sets have been presented in the Croatia AGU Chapman conference. Those data sets included:

Working Group 1: dominant scales of variability in phytoplankton biomass, abundance, floristic composition, species composition, and/or species diversity			
Name	**Country**	**Ecosystem**	**Series**
Paulo C. Abreu	Brazil	Patos Lagoon Estuary	1986-1990, 1993-2007
Susan I. Blackburn	Australia	Huon Estuary, Tasmania	1996-2005
H. O. Briceño	U.S.	Biscayne Bay, Florida Bay, Florida Shelf	1989-2007
Francisco.P. Chavez	U.S.	Monterey Bay	1988-2007
James E. Cloern	U.S.	North & South San Francisco Bay	1969-2007
Valerie David	France	Gironde Estuary	1978-2003
S. Fonda Umani	Italy	Gulf of Trieste	1986-2005
Miles Furnas	Australia	Great Barrier Reef Lagoon	1992-2007
S.A. Gaeta	Brazil	Brazil Coastal Waters	2004-2007
Charles L. Gallegos	U.S.	Rhode River Estuary	1969-2007
Amatzia Genin	Israel	N Gulf of Aqaba	1988-2007
Rita A. Horner	U.S.	Washington Coast	1997-2007
Arantza Iriarte	Spain	Bilbao & Urdaibai . Estuary	1997-2007
Jacco C. Kromkamp	The Netherlands	Oosterschelde/Westerschelde	1987-2006
Robert Le Borgne	France	Ivory Coast, New Caledonia	1969-1979, 1979-1989
WKW Li	Canada	Bedford Basin	1967-2007
Michael W. Lomas	U.S.	Bermuda Atlantic Series	1989-2007
Emma Orive	Spain	Nervion River Estuary	2000-2006
Elgin S. Perry	U.S	Chesapeake Bay	1985-2004
N. Ramaiah	India	Bay of Bengal	1962-1965, 2001-2006
Diana Sarno	Italy	Gulf of Naples	1984-1991, 1995-2008
Dietmar Straile	Germany	Lake Constance	1980-2006

Sanna Suikkanen	Finland	Northern Baltic Sea	1979-2003
Alexander Vershinin	Russia	NE Black Sea	2001-2006
Hidekatsu Yamazaki	Japan	Tokyo Bay	1996-2006
Working Group 2: evidence for external forcings of variability and change			
Name	Country	Ecosystem	Series
Ana B. Barbosa	Portugal	Ria Formasa Lagoon	1991-1993
Vanda Brotas	Portugal	Tagus Estuary	1999-2007
Rita B Domingues	Portugal	Guadiana River Estuary	1999-2005
Naomi Greenwood	U.K.	Liverpool Bay	1989-2006
Malcolm S. Robb	Australia	Swan Canning Estuary	
Bradley Eyre	Australia	Moreton Bay & Brunswick Estuary	1984-1991; 1995-2007
David G. Borkman	U.S.	Narragansett Bay	1959-1997; 1999-2006
Jonathan H. Sharp	U.S.	Delaware Bay	1980-2003; 1950s – present
Larry W. Harding, Jr.	U.S.	Chesapeake Bay	1989-2007
Hans W. Paerl	U.S.	Neuse River-Pamlico Sound	1993-2006
Clarisse Odebrecht	Brazil	Patos Lagoon Estuary, Cassino Beach	1987, 1989-1990, 1992-2006
M Ribera d'Alcalà	Italy	Gulf of Naples	1979-2006
Alina Tunin-Ley	France	Ligurian & Tyrrhenian Seas	1908-1914, 1929-1931, 1969-1970, 1984, 1988, 2002-2005
Nenad Smodlaka	Croatia		1987-2007
Jacob Carstensen	Denmark	Kattegat	1993-2007
Daniel Conley	Sweden		
Hans Christian Eilertsen	Norway	Norwegian Coast/Barents Sea	1974-2007
Karen Helen Wiltshire	Germany	North Sea Helogland	10 years
Xavier Desmit	The Netherlands	North Sea	1975-2003 ; 1990-2006 (Phyto)
Martina Loebl	Germany	Belgian, Dutch, German Coastal	1990-2005
C J M Philippart	The Netherlands	Wadden Sea	1995-2004

Jennifer L. Martin	Canada	Bay of Fundy	1980-2007
Michael L. Parsons	US	N Gulf of Mexico	
Trevor Platt	Canada	NW Atlantic, remote sensing	1990-2005
Working Group 3: consistent patterns among ecosystems in terms of relationships between environmental parameters, phytoplankton biomass and changes in species/floristic composition			
Name	Country	Ecosystem	Series
Malcolm C. Baptie	U.K.	North Sea, UK NE coast	1969-2007
Mauro Bastianini	U.K.	Gulf of Venice	1986-2007
Suncica Bosak	Croatia	N Adriatic Sea	1998-2006
Eileen Bresnan	Scotland	NE Scotland Coastal	1997-2007
Maria Degerlund	Norway	Norwegian coast/Barents Sea	3 decades
R. H. Freije	Argentina	Bahía Blanca Estuary	1978-2006
Inga Hense	Germany	Baltic Sea	1975-2006
Carlton D. Hunt	U.S.	Boston Harbor, Cape Cod Bay, Massachusetts Bay	1992-2008
Tapan Kumar Jana	India	Sundarban Mangrove Forest	1988-2001
R. Kraus	Croatia	Northern Adriatic	1972-2006
Dongyan Liu	China	Jiaozhou Bay	
A. Lincoln MacKenzie	New Zealand	Marlborough Sound, Tasman & Golden Bays	1993-2007
Ivona Marasović	Croatia	Northern Adriatic	1962-1982
Snejana P. Moncheva	Bulgaria	Black Sea	1954-2003
Patricija Mozetic	Slovenia	Gulf of Trieste	1984-2006
Tatyana Osadchaya	Ukraine	Black Sea	1998
Edward J. Phlips	U.S.	Indian River Lagoon	1997-2007
Igor G Polikarpov	Ukraine	Sevastopol Bay	1937-1938, 1960-1968, 2001-2007
Kevin G. Sellner	U.S.	Chesapeake Bay	1984-2007
Ted Smayda	U.S.	Narragansett Bay	1974-2007
Kuninao Tada	Japan	Seto Inland Sea	1991-2006, 1973-2005

Norbert Wasmund	Germany	Baltic Sea, Mecklenburg Bight	1979-2006
Kedong YIN	Hong Kong	Hong Kong Coastal	1991-2004
A. Zingone	Italy	Gulf of Naples	1984-1991, 1995-2009

Currently, intensive comparative phytoplankton data analyses are underway as a result of the AGU Chapman Conference. The central questions being addressed in these analyses include:

(1) What are seasonal patterns of phytoplankton biomass variability?
(2) Do these patterns change over time?
(3) What is the magnitude of seasonal vs interannual variability?
(4) Is there evidence for interdecadal changes as trends or regime shifts?

Our goal is a global-scale analysis, and synthesis of chlorophyll and phytoplankton biomass/composition time series sustained for at least a decade in nearshore coastal marine waters. Here is a table of data sets we have acquired already. (salinity and temperature are the routine parameters monitored in all monitoring programs)

Country	Place	Start	End	Gaps	Chla </TD>	Nuts	Turb	DO
Argentina	Bahia Blanca < /P>	1974	2007	Y	Y	Y	Y	Y
Denmark	Baltic-Kattegat	1967	2006	Y	Y	Y	Y	N
US	Barnes Sound							
Canada	Bedford Basin	1967	2006	Y	Y	Y	Y	N
Spain	Bilbao Estuary	1997	2006	N	Y			
US	Biscayne Bay	1993	2006	N	Y	Y	Y	N
Denmark	Bornholm Bay	1987	1997	N	Y	Y	Y	
US	Chesapeake Bay	1984	2004	N	Y	Y	Y	N
US	Delaware Bay	1978	2003	Y	Y	Y	Y	Y
France	English Channel Roscoff	1997	2007	Y	Y	Y	Y	N
France	English Channel Wimereux	1997	2007	Y	Y	Y	Y	N
US	Florida Bay	1989	2007	N	Y	Y	Y	Y
US	Georgia Strait	1990	2005	Y	Y	Y	Y	Y
France	Gironde Estuary	1997	2007	Y	Y	Y	Y	N
France	Golfe de Lion	1997	2007	Y	Y	Y	Y	N
France	Golfe de Marseille < /TD>	1997	2007	Y	Y	Y	Y	N
Palmer Stn								
US		1990	2005	Y	Y	Y	Y	Y
Israel	Gulf of Aqaba	1988	2006	N	Y			N
Italy	Gulf of Naples	1984	2006	Y	Y			~~N~~
US	Hood Canal	1990	2005		Y	Y	Y	Y
Australia	Huon Estuary	1996	2005	Y	Y	Y	Y	N
US	Indian River Lagoon							
US	Long Island Sound	1988	2005	Y	Y	Y		Y
US	Manatee Bay							
US	Massachusetts Bay,	1992	2007	N	Y	Y	Y	Y

	Boston Harbor							
Ireland	Mulroy Bay	198 8	2005	Y	Y	Y	N	N
US	Narragansett Bay	1968	2006	Y	Y			N
Spain	Nervion River Estuary	2000	2006	Y	Y			N
US	Neuse River Estuary	1994	2006	N	Y		Y	Y
US	New York Harbor & Bight	1972	1993	N	Y	Y	Y	Y
US	North Inlet Estuary	1981	2001	N	Y	Y	Y	N
Netherlands	Oosterschelde	1991	2004	Y	Y	Y	Y	Y
W Antarctic	Palmer Station	1991	2006	Y	Y	Y		
US	Parker River Estuary	1994	2007	Y	Y	Y	Y	
Brazil	Patos Lagoon	1986	2006	Y	Y	Y		N
US	Puget Sound	1989	2006	Y	Y	Y	Y	Y < /TD>
France	Rade de Brest	1998	2007	Y	Y	Y	Y	N
France	Rade de Villefranche	2007	Y	Y	Y	Y	N	
US	Rhode River Estuary	1969	2006	Y	Y			N
Denmark	Ringkoebing Fjord	1980	2007	N	Y	Y	Y	Y
US	San Francisco Bay	1975	2007	N	Y	Y	Y	Y
US	St. Lucie Estuary							
US	Tampa Bay	1974	1998	Y				
Hong Kong		1985	2007	Y	Y	Y		Y
US	Tomales Bay	1987	1995	N	Y	Y		N
Spain	Urdaibai Estuary	1997	2006	N	Y			N
Germany	Wadden Sea	1984	1996	N	Y	Y		N
Netherlands	Westerschelde	1978	2006	Y	Y	Y	Y	Y
US	Willapa Bay	1990	2005	Y	Y	Y	Y	Y

Guiding Questions

We believe that large-scale (between-region and between-ocean) comparisons of phytoplankton time series are the essential next step. Local- and regional-scale observational programs are maintained in coastal marine waters of all continents, but their data remain largely isolated. Our goal is to locate, assemble, and synthesize multi-decadal observations to obtain quantitative and descriptive depictions of phytoplankton variability as an indicator of environmental change. We envision a global phenology of phytoplankton at the land-sea margin and a conceptual model from which coastal ocean observing systems can be built. As a logical outgrowth of (and next step following) the Chapman Conference, the working group will focus on a comparative analysis of ecosystems to address three guiding questions:

1. *What are the dominant scales of variability in phytoplankton biomass, abundance, floristic composition, species composition, and/or species diversity? Is there evidence for secular trends or regime shifts? With which criteria can we best differentiate long-term from episodic, seasonal and interannual signals?*

2. *Is there evidence for external forcings of variability and change (e.g., effects of climate change, basin scale oscillations, land-based inputs, atmospheric deposition, alien species)? Are changes coherent in space and/or time?*

3. *Are there consistent patterns among ecosystems in terms of relationships between environmental drivers, responses in phytoplankton biomass and changes in species/floristiccomposition?*

To date, relatively few between-region comparisons of phytoplankton time series have been completed. All previous comparisons have been at smaller scales (within an individual current system, or at most one ocean basin), compared to the global scale that include inter-regional comparisons that we are proposing. We now have access to both the data and the tools needed to carry out a global synthesis.

Methodological opportunities and issues

Several methodological issues affect the analysis of phytoplankton time series and only a brief summary is given here. However, even though these issues will complicate our work, we can still obtain a meaningful global comparison.

The first issue is diversity of the sampling methodology. No phytoplankton sampling method is perfect, and there have been differences in sampling methodology both within and between data sets, particularly for earlier data. However, we do not expect these differences to be a serious technical barrier to between-region comparisons. A key reason for this is that our analysis focuses on comparisons of anomaly time series rather than of regional climatologies. Hence, we are primarily interested in the temporal variability of relative abundance, not the spatial variability of absolute abundance. Several of the proposed WG members have expertise in evaluating effects of changes in sampling methodology within individual time series.

A second issue is consistency of taxonomic identification within and among data sets. Again, we are primarily comparing anomalies relative to local norms, and looking for when, where, and how long the community changes. We also expect that all or most of our analyses will be weighted on the better-known taxa that dominate the community in each region.

A third issue is the volume, accessibility, and diversity of data. The situation here is much improved over even a few years ago. Good computer tools for dealing with the diverse origin and moderately large data sets are now more available, cheaper, more flexible and user-friendly. We anticipate that this trend will continue. Although data management work will be necessary, we do not expect that electronic assembly and consolidation of the phytoplankton data sets will be a major technical problem. In fact, we have already assembled several key data sets as part of the Chapman Conference.

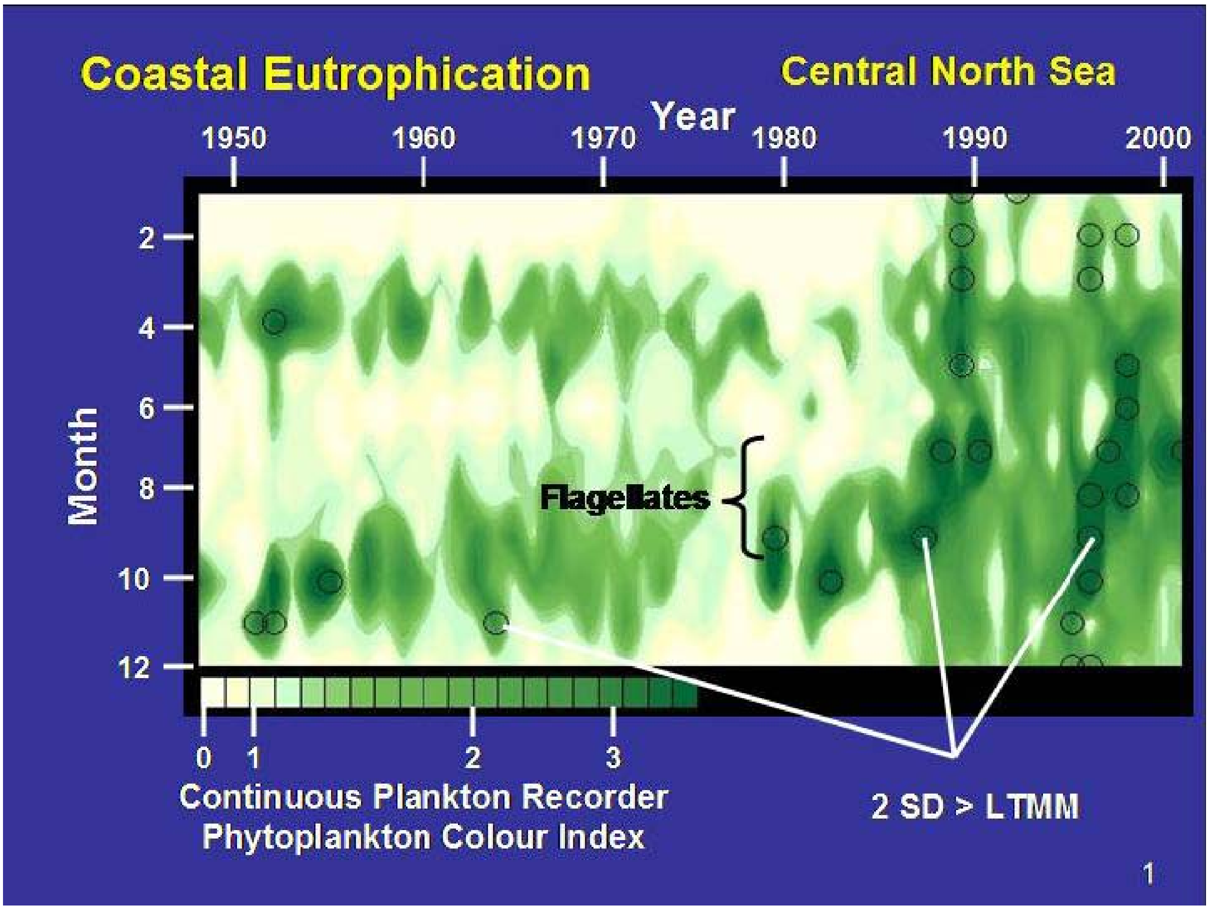
The final issue is the use of statistical tools. During the Chapman Conference, a few statistical experts were invited to help participants to perform statistical analyses on their own data set. They demonstrated how to deal with temporal and spatial autocorrelation, and with data gaps. This knowledge will be utilized by our SCOR WG in the next phase of global time series analysis. Application, evaluation, and bundling these statistical tools for distribution/publication will be another important WG product.

Regional and Global Comparisons

Phenology, the study of biological life cycles and their connection to weather- and climate-driven environmental variability, is a key ecological discipline that is being applied to the documentation and understanding of global-scale changes in the distribution and abundance of terrestrial species. A prominent example is the European Phenological Network (http://www.dow.wau.nl/msa/epn/); planning for a U.S. National Phenology Network has begun (*Eos* 86(51):539). These observational and research programs are motivated by recognition that biological seasonal cycles are sensitive and powerful integrative indicators of environmental change, and by observations of significant phenological changes over the past century manifested as shifts in the timing of plant flowering, bird migrations, and hibernation patterns of mammals.

This working group will be a step toward forming a coastal phenological network, a potential component of a global ocean observing system, to identify patterns and underlying processes of phytoplankton community change in the world's estuaries, bays, lagoons, and continental margins. We will follow the lead of terrestrial scientists who are advancing the application of phenological studies as a cornerstone of global efforts to measure, predict and ultimately manage changes in the Earth's living resources. As coastal oceanographers, we feel a sense of urgency because implementation of this essential approach in these important aquatic ecosystems lags behind the applications on land.

The textbook depiction of coastal phytoplankton phenology is a recurrent annual cycle of high diatom biomass in winter or spring, leading to a successional shift toward flagellate/dinoflagellate dominance in summer or autumn. However, site-based studies reveal sharp departures from this idealized pattern in many coastal waters, including winter dinoflagellate blooms, summer diatom blooms, sustained multi-year blooms of single species, or perennial dominance by small flagellates. The few published reports of multi-decadal observations reveal significant variability in annual cycles as trends or discrete regime shifts as shown below for the central North Sea.



This figure shows annual and interannual variations in phytoplankton biomass in the North Sea. Before the mid 1980s, the annual cycle was characterized by spring and fall blooms that were usually less than 2 standard deviations from the long term monthly mean (LTMM) and dominated by diatoms. Beginning in the late 1980s, the annual cycle did not exhibit the summer decline as seen in previous years due to sustained blooms of flagellates. There was also an increase in frequency of monthly means that exceeded 2 SDs above the LTMM. This can be interpreted to indicate the effects of increases in anthropogenic (land-based) inputs of nutrients, perhaps exacerbated by increasing temperature and/or vertical stability. The colour index is well correlated with surface chlorophyll concentrations estimated from SeaWiFS imagery (Cloern, unpublished)

Our conceptualization of coastal phytoplankton phenology is mainly biased by the large number of studies in the Northern Hemisphere, especially in Europe and North America; hence there is uncertainty about its generality at the global scale. This working group will bring together knowledgeable scientists and managers with observational data sets from northern and southern hemispheres to establish a global phenology of phytoplankton in coastal ecosystems. This working group has four main objectives:

1) Quantitative depictions of phytoplankton community variability that consider all ecologically relevant time scales of change and the broad diversity of phenologies expected across the habitat variability that is characteristic of the world’s coastal zone.

2) A conceptual framework for understanding the environmental drivers of phytoplankton community variability, including climate change, but also other modes of global change, including translocation of species, eutrophication, aquaculture, habitat transformations, hydrologic manipulations and landscape changes in watersheds.

3) Compilation and dissemination of observational data from which the conceptual framework was developed and can be rigorously tested.

4) A set of 'rules' that defines coastal phytoplankton dynamics from which coastal observing systems can be designed and implemented.

There is a clear need for long-term time-series observations that are "operational" in the sense that data streams are sustained, routine, of high quality, and used to support management decisions concerning water quality and living resources, as well as advances in science.

3. Proposed Terms of Reference

- Identify and consolidate a globally representative set of "long phytoplankton time series".
- Facilitate the migration of individual data sets to a permanent and secure electronic archive.
- Develop and share protocols for within-region and within-time-period data summarization (e.g. spatial, seasonal and annual averaging, summation within taxonomic and age categories). The goal is to clarify what level of details provides the optimal tradeoff (i.e. information gain vs. processing effort).
- Based on the above, develop priorities and recommendations for future monitoring efforts and for more detailed re-analysis of existing sample archives.
- Once regional data sets are compiled and collated, we will carry out a global comparison of phytoplankton time series using (in parallel) a diverse suite of numerical methods. We will examine:
  - Synchronies in timing of major fluctuations, of whatever form.
  - Correlation structure (scale and spatial pattern) for particular modes of phytoplankton variability (e.g. changes in total biomass, species composition shifts, alongshore or cross-shore displacements of geographic distribution).
  - Amplitude of variability, both for total biomass and for individual taxa, and a comparison to the amplitude of population fluctuations.
  - Likely causal mechanisms and consequences for the phytoplankton variability, based on spatial and temporal coherence with water quality time series.
  - Sensitivity and specificity of data analysis tools.

4. Time Frame and Expected Products

We will begin work in 2009 and will continue for three years. We will convene annual WG meetings (each about 4-5 days), and a larger open attendance workshop or conference in the final or penultimate year. For each year, expected activities and products include:

Year 1: Summarize and evaluate methods, results, and questions arising from the phytoplankton time series analyses that have been completed to date. For the proposed new comparative analyses, select and prioritize the set of regional time series, and the suite of variables from each time series that will be compared (e.g. total phytoplankton biomass, major groups and/or species-level phytoplankton taxonomic composition, phenology, and physical and biological environmental indices). Identify and address obstacles to pooled analyses (e.g. incomplete processing, differences in formatting, differences in resolution). Develop recommendations for data exchange, and feasible enhancements of sample processing.

Year 2: Begin comparative analyses. Evaluate sensitivity and specificity of data analysis (statistical) tools, and improve their availability and "user-friendliness". Identify time scales and time intervals of particular interest. Post selected tools and data on a web or ftp site (initially closed, and eventually public).

Year 3: Complete comparative analyses of phytoplankton and environmental time series, incorporating any new data that have become available during years 1-3. Identify synchronies (if any) in timing of fluctuations, and quantify correlation time and space scales. Prepare interpretive paper(s) for symposium presentation and publication. Prepare recommendations for "best practice" time series sampling and analysis methodologies.

5. Proposed Working Group membership

Our primary selection will be based on broad experience in phytoplankton time series, combined with local knowledge of the content and quality issues for each regional data set. Our suggested list of full members (total 10) includes the following candidates:

Co-Chair, Kedong Yin, Australian Rivers Institute, Griffith University, Brisbane, Queensland, Australia, k.yin@griffith.edu.au

Yin's research interest includes: coastal dynamics of nutrients; eutrophication processes; ecology and oceanographic processes of harmful algal blooms, in coupling processes with environmental variability, and climate changes; and a plenary speaker on "the dynamics of phytoplankton species composition in subtropical waters of south China during the last 15 years",

Co-Chair, Hans W. Paerl, Institute of Marine Sciences, University of North Carolina at Chapel Hill, Morehead City, North Carolina, USA, hpaerl@email.unc.edu

Kenan Professor of Marine and Environmental Sciences, Paerl's research includes; microbially-mediated nutrient cycling and primary production dynamics of aquatic ecosystems, environmental controls of harmful algal blooms, and assessing the causes and consequences of man-made and climatic (storms, floods) nutrient enrichment and hydrologic alterations of inland, estuarine and coastal waters. His studies have identified the importance and ecological impacts of atmospheric nitrogen deposition as a new nitrogen source supporting estuarine and coastal eutrophication. In 2003 he was awarded the G. Evelyn Hutchinson Award by the American Society of Limnology and Oceanography for his work in these fields and their application to interdisciplinary research, teaching and management of aquatic ecosystems.

Susan I. Blackburn, CSIRO Marine and Atmospheric Research and the Aquafin CRC, Hobart, 7001, Australia; susan.blackburn@csiro.au

Dr Susan Blackburn is a Principal Research Scientist with CSIRO Marine and Atmospheric Research and Head of the CSIRO Collection of Living Microalgae. Her research spans phytoplankton environmental issues and bioapplications of microalgae. Working with harmful algal bloom (HAB) species for over 20 years, Dr Blackburn has combined ecophysiological studies in culture with field studies to elucidate regulation of HABs and interrogate life history details, toxin production, molecular characterization and processes, and trophic interactions, particularly of HAB species in south eastern Australian waters. Within CSIRO, nationally and internationally Dr

Blackburn research informs system-wide environmental management and prediction of phytoplankton dynamics and algal blooms through biogeochemical modelling.

Jacob Carstensen, National Environmental Research Institute, Denmark, jac@dmu.dk

Carstensen is a statistician working within marine ecology, in particular long-term trends of ecosystem quality indicators in response to anthropogenic pressures. Particular scientific fields of interests are: biogeochemical processes, phytoplankton community structure and bloom mechanisms, hypoxia, and nutrient management for marine ecosystems.

James E. Cloern, U.S. Geological Survey, Menlo Park, California, USA, jecloern@usgs.gov

Cloern has strong expertise in phytoplankton ecology, particularly phytoplankton response to eutrophication and climate changes. He is very experienced in the synthesis of long term data set, and wrote "Phytoplankton bloom dynamics in coastal ecosystems: a review with some general lessons from sustained investigation of San Francisco Bay, California" in 1996. In 2001, He comprehensively reviewed global data in coastal waters and wrote "Our evolving conceptual model of the coastal eutrophication problem", which has greatly promoted coastal eutrophication research. The paper has been cited 373 times.

Paul J. Harrison, Atmospheric, Marine and Coastal Environment Program, Hong Kong University of Science and Technology, Hong Kong SAR, China Harrison@ust.hk

Harrison is a biological oceanographer with expertise in nutrient dynamics and phytoplankton ecology and recent interest in eutrophication, harmful algal blooms and hypoxia. He is a member of SCOR WG 132 "Land-based Nutrient Pollution and the Relationship to Harmful Algal Blooms in Coastal Marine Systems" and will coordinate activities between the two WGs if this one is funded.

Pia Moisander, Ocean Sciences Department, University of California Santa Cruz, Santa Cruz, CA 95064, USA

Moisander is a microbial ecologist, and her work focuses on planktonic cyanobacteria. She uses molecular approaches in detection of diversity, abundances, and gene expression. Her laboratory has been collecting monthly samples along a transect from the Monterey Bay to the coastal ocean for 3 years and the other time series cruises. Her efforts have focused on picocyanobacteria and other taxonomic groups using the approach based on archived and extracted DNA samples. These data are used in the development of probes to the Environmental Sample Processor, an instrument detecting microbes autonomously in situ while moored.

Clarisse Odebrecht, Department of Oceanography, Federal University of Rio Grande-FURG, Cx.P. 474, 96201-900 Rio Grande, RS, Brazil, doclar@furg.br

Clarisse Odebrecht, professor and leader of research group: Ecology of Marine Phytoplankton and Microorganisms at the Federal University of Rio Grande-FURG, Brazil. Her main research topics include: taxonomy and ecology of marine phytoplankton and microalgae, phytoplankton ecology and coastal eutrophication, studies on harmful microalgae in marine aquaculture.

Katja Philippart, Royal Netherlands Institute for Sea Research (The Netherlands), Texel, The Netherlands, katja@nioz.nl

Philippart is a marine ecologist and her research combines laboratory experiments, field studies, statistical analysis of long-term field observations and modeling techniques to investigate the underlying mechanisms of long-term dynamics within shallow marine coastal communities. Her emphasis is on understanding the role of human influences (eutrophication, fisheries and global warming) within these ecosystems in regulating primary and secondary producers, within the North Sea, Venice Lagoon and the Banc d'Arguin. At present, she coordinates relevant research projects, viz. JetSET (long-term field observations in the western Wadden Sea), and the recently funded national research project (2008-2013) dedicated to monitoring primary production in the western Wadden Sea as a baseline for management of human activities in coastal waters (IN PLACE). She is the Editor-in-Chief of the Journal of Sea Research since 2000, co-author of Marine Coastal Dimension of Climate Change in Europe (EU-IES, 2006, Ispra), and leading author of Climate Change Impacts on the European Marine and Coastal Environment (ESF-Marine Board, 2007, Strasbourg).

Adriana Zingone, Stazione Zoologica A. Dohrn, Villa Communale, Italy, zingone@szn.it

Zingone is an expert in taxonomic and morphologic studies on marine microalgae, and spatial distribution of phytoplankton diversity in marine waters. Her research finding based on biological time series data contributed to revising paradigms and myths of phytoplankton ecology. She also reviewed seasonal patterns in plankton communities in a pluriannual time series at a coastal Mediterranean site (Gulf of Naples): an attempt to discern recurrences and trends.

Potential Associate Members include:

Lawrence Harding, Univ. of Maryland, Center for Estuarine and Environmental Sciences, Cambridge, Maryland, USA, larry@hpl.umces.edu

My expertise is in phytoplankton ecology of estuarine and coastal waters. Research the past 20+ years has focused on Chesapeake Bay using a combination of shipboard and remote sensing measurements. The main theme of my laboratory has been climatic forcing of phytoplankton floral composition, biomass, and primary productivity, drawing on extensive long-term data sets.

Thomas C. Malone, OceanUS Office for Integrated and Sustained Ocean Observations (US), Washington, DC, **USA**, t.malone@ocean.us

Malone has published over 100 peer-reviewed papers on phytoplankton and coastal ecosystem dynamics, science and policy, and integrated ocean observing systems. Chair, IOC-WMO-UNEP-ICSU Coastal Global Ocean Observing System Panel (1998-2000), and Co-Chair, IOC-WMO-UNEP-ICSU Coastal Ocean Observations Panel (2002-2005)

Elgin Perry, USA, eperry@chesapeake.net

Dr. Perry is a statistics consultant providing experimental design and data analysis expertise to researchers involved with environmental research and regulation. Dr. Perry trained in the applied mathematics at the Univ. of Maryland in a interdisciplinary program that included course work and research in mathematical statistics, numerical analysis, and zoology. The majority of Dr. Perry's consulting experience involves collaboration with clients conducting research and monitoring of the Chesapeake Bay. These clients include: the U.S Geological Surve, USEPA Chesapeake Bay Program, Maryland Sea Grant, Maryland Department of Natural resources, Horn Point Laboratory, Chesapeake Biological Laboratory, Wye Research and Education Center, Virginia Department of Environmental Quality, and U.S. Army Corps of Engineers.

Theodore J. Smayda, Graduate School of Oceanography University of Rhode Island Kingston, RI 02881 USA tsmayda@gso.uri.edu

Smayda is a well known phytoplankton ecologist. His major research themes include seminal works on phytoplankton suspension, species succession in marine environments and population dynamics related to diatom and harmful algal blooms. Armed with the skills of knowing the major marine species, an enviable knowledge of the international literature and a constantly inquisitive mind, Smaydea continues to delve into insights related to the dynamics driving phytoplankton blooms. His recent collaborations with the freshwater phytoplankton ecologist Colin Reynolds in generating his present concepts on species strategies, community assembly and development of blooms offer another cornerstone from which to examine the HAB paradigm. His first comments on the importance of life cycles, nutrients and eutrophication in driving the spreading of the bloom phenomena on a global basis were quickly adopted by others and presented or reiterated in their publications. In this regard, he has been a trend setter of ideas that have stimulated others to explore further. In 2002, he received **XHAB2002/ISSHA Yasumoto Lifetime Achievement Awards.**

Sinjae Yoo, Korea Ocean Res. & Dev. Inst. Sa-Dong 1270, Ansan, South Korea sjyoo@kordi.re.kr

Yoo has been studying interannual variation of chlorophyll *a* in the North Pacific ecosystems using satellite image data. He also has been studying primary productivity of the Yellow Sea and East Sea by using ship-board and satellite observations.

We have invited various organizations (GEOHAB, IMBER, PICES, IOC and CoML) to nominate associate members and we are actively working to identify sources of travel funding for the Associate Members. We will be updating SCOR on our progress.

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