

The Estuarine Research Federation Initiative in Biocomplexity: Facilitation of Research on Estuarine Responses to Climate Change and Variability

Abstract

The NSF Special Competition in Biocomplexity provides a rare opportunity to focus efforts on interdisciplinary problems related to the biocomplexity of coastal and estuarine environment, highly variable and changing environments. This initiative can allow the scientific community to address how estuaries respond to climate change and variability and make significant contributions unlikely to be fostered by traditional research funding mechanisms. This proposal seeks to facilitate the involvement of estuarine and coastal scientists in identifying and proposing productive and innovative avenues of research related to the effects of climate change and variability on biocomplexity and the mechanisms by which their biocomplexity allows ecosystems to adapt to those forces. Under the leadership of the Estuarine Research Federation (ERF), we plan to hold a town meeting in association with ERF's upcoming biennial conference, ERF 2001, in November 2001. We are seeking support to host a focused workshop in 2002 to identify gaps in our current knowledge and critical research needs. The product of this workshop will be a report identifying research priorities and several peer reviewed papers synthesizing the state of our current knowledge. We will communicate this information to estuarine scientists capable of addressing estuarine-climate change issues through ERF's web site, newsletter, its peer-reviewed journal *Estuaries*, and affiliate society regional meetings. Special efforts will be made throughout this process to bring climate change scientists and social scientists together with scientists working in traditional estuarine disciplines to facilitate idea sharing and team building. We believe these activities will greatly accelerate the involvement of the estuarine community in addressing these complex and critically important questions.

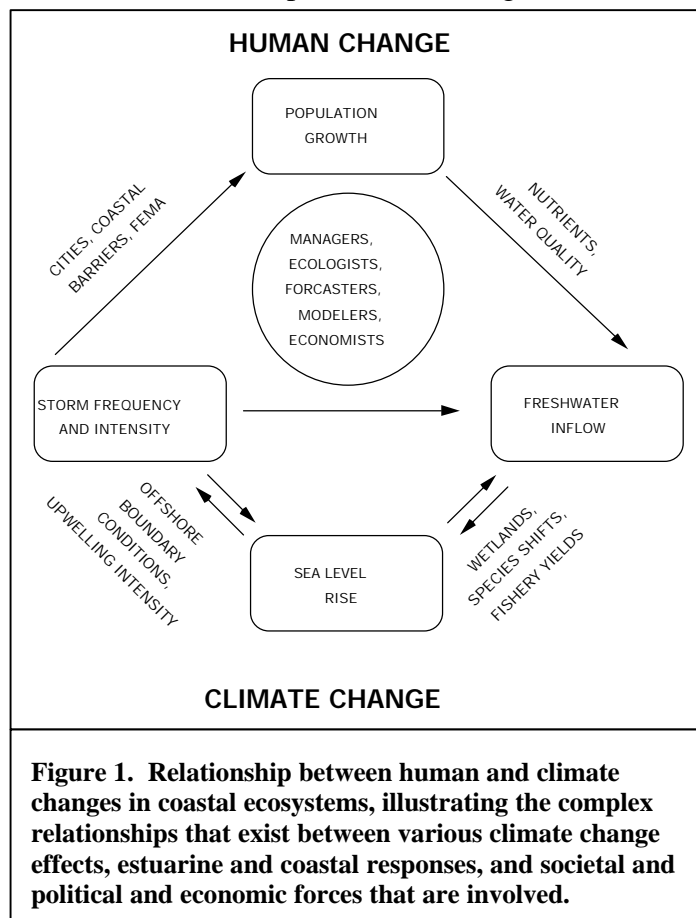
Introduction

Two grand provinces of our planet, the continents and their surrounding oceans, meet at an extraordinarily fragile and important boundary, the coastal zone. This boundary is a dynamic interface between terrestrial, oceanic, and atmospheric systems across which passes a disproportionately large fraction of material fluxes and within which important living resources abound. Home to diverse and productive communities of plant and animal species, coastal ecosystems are highly prized by humans as locations for development and as sources of food. Coastal areas are the sites of the nation's and the world's most intense activity and population growth (Emeis et al. 2001). Worldwide, approximately 75% of the human population now lives in coastal watersheds (Emeis et al. 2001), and these areas experience some of the most intense use by humans of any ecosystem. Understanding the natural and human ecology of coastal environments is of critical concern to society.

Processes that occur at ecological interfaces and over steep environmental gradients are often the most scientifically interesting and productive for study, but present some of the greatest challenges as well. Understanding the processes occurring in the coastal zone requires the collaboration of terrestrial ecologists, planners and hydrologists, estuarine chemists and ecologists, and physical oceanographers, climatologists and atmospheric scientists. The NSF Special Competition in Biocomplexity provides a unique opportunity for estuarine and coastal scientists to focus their efforts on interdisciplinary problems of this magnitude, and to make significant contributions unlikely to be fostered by traditional research funding mechanisms. This proposal seeks to facilitate the involvement of estuarine and coastal scientists in identifying and proposing productive avenues of research in coastal and estuarine science, and especially those focused on how these important and biocomplex systems are influenced by climate change and variability.

Coastal environments continually change because of the natural variability of climate and runoff and because of their sensitivity to small changes in sea level and to variation in the intensity and frequency of storms. Recently, these changes have been accelerated as these environments and the physical drivers of climate, sea level and runoff have been subjected to human-caused changes at a pace that is outside the bounds of natural variability. Coastal ecosystems are now facing changes in nutrient loading, species composition and abundance, and sea level and temperature that are greater than measured over the last century (NRC 1994, IPCC 2001).

Figure 1 illustrates a simplified view of the complex relationships between climate change and variability and the major forcing functions known to be important to estuarine and coastal environments. Climate change has considerable influence on atmospheric processes, which in turn directly and indirectly influence precipitation, land-use patterns, and runoff from terrestrial environments, the physical structure of the estuarine and coastal environment, as well as its biota (including humans). Because coastal zone management is driven by social, economic and political forces, even the complex relationships usually studied by estuarine scientists are lacking in important



elements of the complete response. The need for identification of the key linkages and important and approachable research topics could not be more critical than at this time.

We are optimistic that the interdisciplinary nature of estuarine and coastal research will continue to provide the foundation for fruitful collaborations and research that will successfully address complex research questions. On numerous occasions, the estuarine community has been instrumental and effective at identification of important research needs for the coastal zone (NRC 1994, Hobbie 2000, NRC 2000, AGU 2000, Boesch et al. 2000). Collaborative efforts of estuarine scientists have also produced the required research foundation for effective management of the coastal zone. In the Chesapeake Bay, for example, there has been sufficient progress made in our understanding of the effects of nutrient overenrichment that significant restoration efforts are now underway (Boesch et al. 2001). In a wide range of estuarine ecosystems, including Florida Bay, the Mississippi delta, and San Francisco Bay, research on estuarine responses is now proceeding hand-in-hand with management and restoration processes. Still, many other research and management challenges related to climate change and variability are ahead (Boesch et al. 2000; IPCC 2001; Livingston 2000).

Why focus on effects of climate change and variability in estuaries?

Two major categories of research for the coastal region – the effects of increased human population and climate change – emerged from the 1994 U.S. National Research Council (NRC) report ‘Priorities for Coastal Ecosystem Science’. The report further suggested that these two issues require interlocking strategies that demand a large-scale ecosystem perspective. The effects of rapid human population growth, nutrient loading, landscape changes, and overexploitation of resources were the focus of recent NSF initiatives in Land-Margin Ecosystem Research (LMER) and are important topics for continued research through the LTER network and other programs. The 1994 NRC report also points out the susceptibility of coastal ecosystems to changes in climate and weather patterns. While the effects of sea level change have been the most well publicized, changes in precipitation, riverine transport of materials and storm frequency and intensity are expected as well (Boesch et al. 2000). Expected change in the variance of these parameters may have even larger effects than those associated with changes in the average conditions. Finally, estuaries and wetlands are a focal point for concern about how global change may alter the distribution of vector-borne diseases.

Our appreciation of the potential effects of climate change and variability on coastal systems has increased greatly in the last 5 years (IPCC 1996, IPCC 2001). As part of the U.S. National Assessment of the potential consequences of climate variability and change, a report has been issued which examines the potential effects on coastal areas and marine resources (Boesch et al. 2000). This report identifies many issues of concern but only makes general recommendations for research priorities.

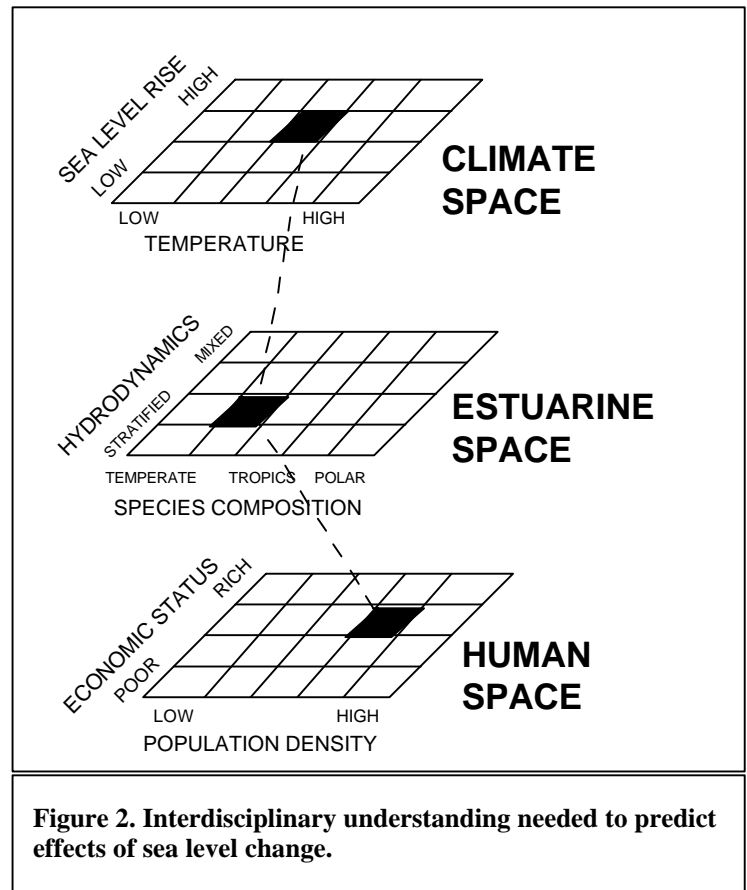
Understanding and predicting the effects of climate change on estuarine systems requires integration of expected changes in climate, the effects on oceanic boundary conditions, upland ecosystem responses in watersheds (which produce changes in runoff), and the response of humans to these changes (Fig. 2). The responses in different estuaries to climate change are likely to vary, but depend on interactions of three main properties: the nature of climate change or variability, physical and biological (including biocomplexity) properties of the estuary, and the surrounding land use patterns (or watershed properties) driven by the intensity of use by humans. Interdisciplinary teams and studies will be needed to provide this understanding.

In the past, estuarine ecologists have focused much attention on estuarine signatures, i.e., the middle layer depicted in Fig. 2 (e.g., recent articles on estuarine signatures in *Estuaries* 23(6), 2000 and 24(2), 2001). Understanding the unique properties of one particular estuary (which are a function of place, time, and human use) can consume entire professional careers. Future research may need to focus more on creating an interdisciplinary understanding of general processes, which can be applied across estuarine systems. This research is much more valuable to coastal zone managers, who have to make difficult and expensive decisions on competing uses of nearshore areas on a daily basis. For example, managers are making decisions on restoring coastal wetlands at great expense but those same wetlands may not survive through the predicted rise in sea level. Although there has been much recent success in estuarine interdisciplinary research, future research must tackle ever more complex problems, specifically in the area of biocomplexity. Estuarine scientists, by having experience with biological systems that are driven by physical processes and whose products have management implications defined by socio-economic forces, are moving toward research that the Biocomplexity Program is trying to foster.

Project Objectives

The project has three main objectives:

1. Identify the major research priorities for the study of the impact of climate change and variability on estuarine ecosystems;



2. Facilitate the building of teams of estuarine scientists, social and economic scientists, and climate scientists that can address these research priorities;
3. Provide scientists, managers, and policy makers with better tools and information so that they can begin to factor issues on the effects of climate change and variability on estuarine ecosystems into their work.

The pivotal role of the Estuarine Research Federation

The Estuarine Research Federation (ERF) is uniquely suited to carry out this project, being the premier scientific organization for estuarine scientists and many coastal managers. Through its operations, ERF can raise the visibility of climate change issues within the estuarine research and management communities and can easily communicate the new information to people who will find it useful. We propose several activities that will be organized by ERF that we believe will allow us to have a much greater impact than could be achieved by a workshop alone.

First, ERF's biennial conference in November 2001 will provide focus and a kick-off for the proposed Initiative on Estuarine Biocomplexity. As described below, this conference has already been structured to facilitate the exchange of information between traditional estuarine scientists, physical oceanographers and climate modelers. Second, ERF can very effectively transmit the findings of a small working group to the broader community. ERF publishes the internationally distributed journal *Estuaries*, which is an outlet for review articles and dedicated issues devoted to special topics within estuarine science (e.g., Florida Bay – 1999; Coastal Eutrophication – 2002, in preparation). ERF's journal and conferences have strong participation by international scientists from Europe, Asia and Australia (Fig 3).

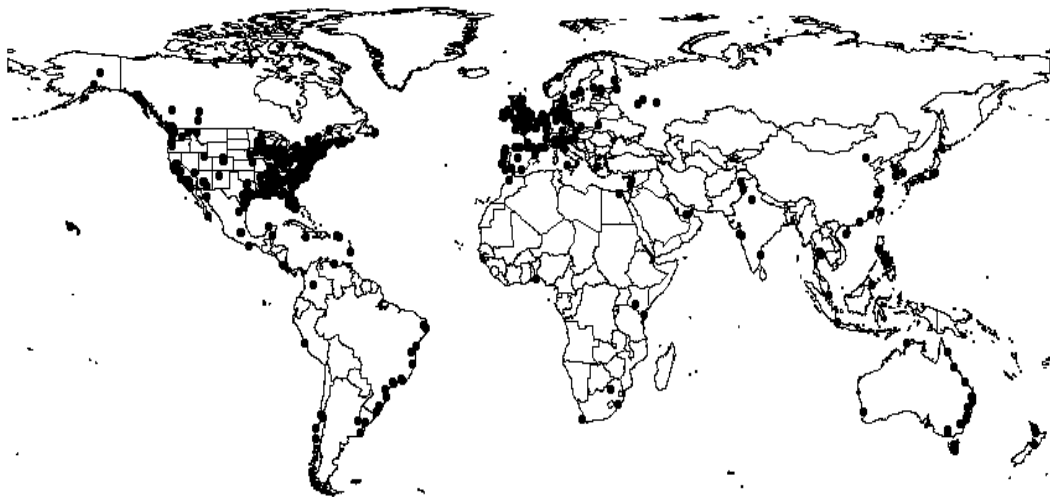


Fig. 3. International distribution of Estuaries Online and membership in the Estuarine Research Federation, as of March 2001 (filled circles).

ERF has five regional affiliate societies that can provide an effective mechanism for transferring the results of any focused activity to scientists and managers around the US. Student involvement in the affiliate societies is also very high providing us with an opportunity to reach the next generation of professionals early in their career.

As one measure of the ERF's leadership in this area, this proposal for the Estuarine Biocomplexity Initiative grew from discussions among Estuarine Research Federation governing board members at their April 2001 board meeting. ERF's governing board represents diverse interests in estuarine science and encompasses broad geographic and research constituencies (Table 1). Nearly all of the board members have participated actively in the development of this proposal. The ERF governing board members are committed to an open process that will identify critical research needs regarding estuarine responses to climate change and variability.

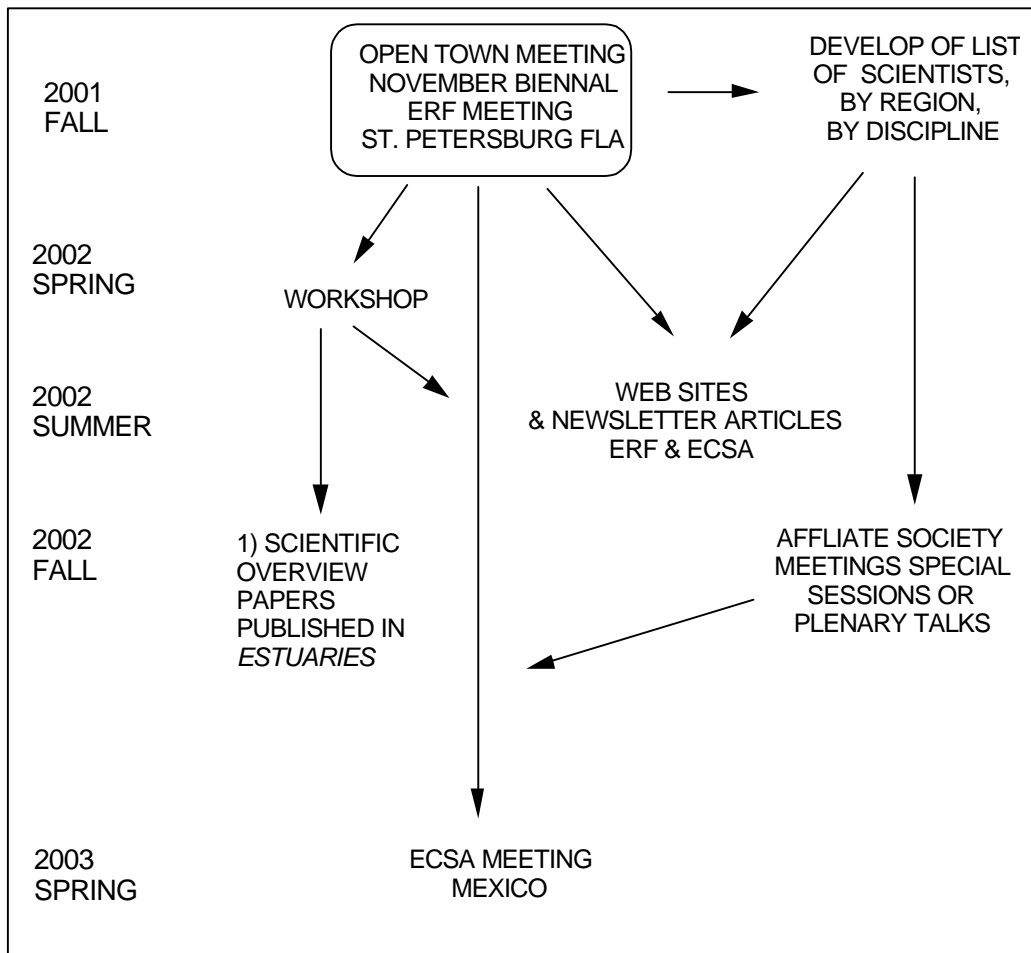
Table 1. Participants in ERF's Board discussion of how to facilitate estuarine research on biocomplexity related to climate change, research team building, and communication of results to the entire estuarine community.

Anne Giblin, Marine Biological Lab, Woods Hole, Massachusetts	President, Estuarine Research Federation
Nancy Rabalais, LUMCON, Chauvin, Louisiana	Past-President, Estuarine Research Federation
Dennis Allen, Baruch Marine Lab, South Carolina	President-Elect, Estuarine Research Federation
Linda Schaffner, Virginia Institute of Marine Science	Secretary, Estuarine Research Federation
Paul Montagna, Marine Science Institute, University of Texas	Member-at-large, Estuarine Research Federation
Peter Doering, South Florida Water Management District, West Palm Beach, Florida	Member-at-large, Estuarine Research Federation
Linda Deegan, Marine Biological Lab, Woods Hole, Massachusetts	President, New England Estuarine Research Society (NEERS)
Stan Hales, Richard Stockton College Pomona, New Jersey	President, Atlantic Estuarine Research Society (AERS)
Evan Chipouras, University of Tampa, Florida	President, Southeastern Estuarine Research Society (SEERS)
Cynthia Moncreiff, University of Southern Mississippi, GCRL, Ocean Springs	President, Gulf Estuarine Research Society (GERS)
Jan Newton, Department of Ecology-EAP, Olympia, Washington	President, Pacific Estuarine Research Society (PERS)
Mark Luther, University of South Florida	Chair, ERF2001 conference
Joy Bartholomew, Port Republic, Maryland	Executive Director, ERF
Stephen Threlkeld, University of Mississippi, Oxford	Managing Editor, Estuaries

The ERF governing board has resolved to share in the support of three activities that will facilitate research on estuarine responses to climate change and variability:

1. In association with the ERF 2001 conference in November, ERF will hold a well-publicized open forum, i.e. “town meeting”, to introduce and solicit feedback on the Initiative on Estuarine Biocomplexity from members of the estuarine science and management communities. Participation of attendees at the jointly-held meetings on meteorology and modeling (see below) will be solicited;
2. In spring of 2002, we will hold a workshop to bring together key scientists from a wide variety of estuarine-related disciplines to develop several synthesis papers in which key research goals will be identified;
3. In fall of 2002 and spring of 2003, we will communicate findings from the town meeting, workshop and synthesis papers in our journal, *Estuaries*, in the Federation’s newsletter and web site, at ERF affiliate society meetings, and at an international symposium of the European-based Estuarine and Coastal Sciences Association, (ECSA) that will be held in Sonora, Mexico.

Fig. 4. Overview and time frame for proposed activities.



The desired outcome of these activities is development of broad interest in Biocomplexity issues by members of the estuarine community and, in that context, greater thinking and

understanding of the consequences of climate change and variation. We should point out that this latter outcome is important because, although estuaries arguably will be among the ecosystems most affected by climate change, these consequences have not received the same attention that terrestrial or even open ocean ecosystems have. The outcomes will be evidenced by development of consensus on research topics in the area of estuarine responses to climate change and variability, publication of synthesis papers, and development of proposals by extant and new research teams appropriately configured for these very complex research efforts.

Proposed Activities

1. TOWN MEETING (Fall 2001)

A town meeting will be held at ERF 2001 (4 – 8 November 2001) in St. Pete Beach, Florida. The purpose of the town meeting is to articulate how climate change effects in the coastal zone is a Biocomplexity issue, and to describe and solicit contributions for the planned workshop. It will also provide a place for an open dialog, and provide introductions to scientists from multiple institutions who would not normally attend the same scientific society meeting. A programmatic focus of ERF 2001 is to bring physical oceanographers, climate modelers and ecologists together. The conference is co-sponsored by the Estuarine and Coastal Sciences Association (ECSA), ERF's European counterpart, and two closely related meetings will be held simultaneously with ERF 2001, the American Meteorological Society (AMS) Fourth Conference on Coastal Atmospheric and Oceanic Prediction and Processes and the Seventh Estuarine and Coastal Modeling Conference (ECMC). This is the first time these four societies will jointly hold their meetings providing a unique opportunity to reach a wide, international audience and form dialog between estuarine ecologists and physical scientists.

Also joining the ERF 2001 conference will be a meeting of the directors of the National Sea Grant College Program, which is responsible for outreach to the coastal management community and the directors and research coordinators from the National Estuarine Research Reserve System. The Board of Directors of the Restore America's Estuaries, an organization for education and outreach to citizens, will also meet at the ERF conference in St. Pete and will be invited to participate in the dialogue on climate change and variability. These three groups all are closely tied to scientists and managers working on estuarine protection and estuarine restoration.

The town meeting will be held on Wednesday evening during the ERF 2001 Conference to take advantage of the overlap between the above-mentioned meetings. The town meeting will be well-advertised, free and open to all, and used to solicit and build a network of people who are interested in pursuing follow-up activities in their own regions and organizations. This process will also help to identify individuals to participate in the smaller follow up workshop, who might not have been known to the steering committee. The meeting will be advertised on the ERF web site, affiliate web sites, and through existing list-serves for ERF and its affiliates. Participants will be able to sign up for the town meeting over the web site or at the conference.

Agenda for Town Meeting

The town meeting will begin with a brief introductory presentation by a senior ERF representative to set the stage and describe the general goals of the project. A NSF representative will then describe the Biocomplexity Initiative. We will ask that one member from the AMS and ECMC to present very brief overviews on their interests in climate change and variability in the coastal zone. An ERF representative will finish by describing how estuarine research is uniquely positioned to answer questions posed by the Biocomplexity Initiative, with a particular focus on climate change and variability. Finally, the Workshop convener will describe next steps, and provide an open forum to solicit applications from people to participate in the workshop. We anticipate that interested individuals will be able to continue to have involvement and communication with each other through a list-serve.

2. WORKSHOP (Spring 2002)

A workshop will be held in spring 2002 to bring together key senior and younger scientists in a 3.5-day, Dahlem-style forum. This workshop will facilitate the development of consensus by scientists from different disciplines by focusing their efforts on the production of at least three synthetic papers. The workshop will result in two products:

1. Three synthesis papers that will be published in *Estuaries*; and
2. A statement of research needs for the future

These consensus statements will be posted on the ERF web site (<http://erf.org>) and published in *Estuaries* as a commentary. The statement will focus on the key research priorities in examining the potential consequences of climate change and variability on estuaries and on how estuarine research can serve as a model system for biocomplexity research.

Steering Committee

To organize and run the town meeting, workshop, and follow-up outreach activities, the ERF Governing Board will appoint a Steering Committee. To insure continuity of purpose and direction, two members from the working group that wrote this proposal will be on the steering committee. All members of the working group (Table 1) have indicated their willingness to serve on the steering committee, but all are willing to let others serve to meet the goals of this ERF Initiative. We will also include as members, two scientists who have successfully worked in multidisciplinary research teams in other ecosystems. Members of the steering committee will attend the full workshop and participate in follow-up activities. The steering committee will have multidisciplinary and broad regional representation, including a social scientist, estuarine ecologist, watershed scientist, physical oceanographer, and climatologist. The Board will ensure that at least some of these scientists have a solid understanding of the current directions in biocomplexity research.

The guide to working in multidisciplinary teams that has emerged from the joint NSF/EPA Water and Watersheds Program will be required reading for the workshop.

Selection of Workshop Attendees

Approximately forty attendees will be selected by the steering committee. Attendees will be required to attend the entire workshop, prepare and synthesize information on their area of expertise prior to the workshop, and participate in writing one of the scientific papers that will result from the workshop. Applications will be solicited and applicants encouraged at the town meeting. Applications will also be available at a web site set up for this ERF initiative, at <http://erf.org/>, and distributed to the other appropriate scientific societies. Participation will not be limited to ERF members. The steering committee will strive to achieve diversity in attendees. We plan a mix of scientific disciplines, scientists at different stages in their careers, geographic, and international participation. We will look for experts in human dimensions of coastal management, atmospheric/climate, watershed (terrestrial processing, freshwater runoff and nutrient export), estuarine ecology (biogeochemistry, animal and plant ecology, biocomplexity, fisheries), and physical oceanographers or hydrological engineers (oceanic boundary conditions, estuary circulation, watershed dynamics). Other criteria will include experience working in multidisciplinary teams or demonstration of a willingness to work in multidisciplinary research.

Workshop Agenda

The workshop will be held in the spring of 2002 at a conference center or hotel with conference facilities. The basic scheme of a Dahlem-style conference is to convene in general sessions to agree on daily goals, break into smaller workgroups to create ideas and text, and reconvene in general sessions so that work groups can report on the daily progress. The workshop will last 3.5 days and will have two goals, to have finished a document outlining the major research priorities to advance our understanding of the effects of climate change and variability on estuarine ecosystems, and to make substantial progress on 3 scientific papers synthesizing our knowledge to date on specific topics.

On the first day there will be a general session featuring presentations on the three major topics. Presentations will be made by non-estuarine scientists describing interdisciplinary topics, such as factors controlling climate change, watershed dynamics, biocomplexity in other ecosystems, and human dimensions, as well as by traditional estuarine scientists. During the afternoon, subgroups will meet, and at the end of the day reconvene in general session and report progress. Subgroups are led by members of the organizing committee who act as facilitators to promote discussions. In addition, each subgroup has a recorder who will be the note taker or transcriber.

The three subgroups, from which the three papers will be derived, will be broadly based on the following three topics identified as critical areas for more research by Boesch et al. (2000) and the IPCC's most recent report (2001):

- 1) **Coastal Hazards and Physical Transformations of Coastlines and Wetlands**
Sea level rise, coupled with a change in storm frequency and/or intensity will alter natural coastal ecosystems and human use of the coast.
- 2) **Changes in Freshwater Loads to Coastal Ecosystems**
Changes in the timing and the amounts of runoff will alter nutrient and contaminate delivery, affect biotic resources and have the potential to significantly change estuarine circulation and flushing.
- 3) **Alterations and Geographic Shifts in Ecosystems Boundaries**
Shifts in geographic boundaries may occur due to changes in temperature, circulation and freshwater runoff.

For the following two days, the group will convene in brief general sessions in the morning to describe daily goals and then break into subgroups to create ideas and text. We expect that the three subgroups may further divide up to address specific issues. The group will reconvene in general sessions at the end of the day. Much of the afternoon on the third day will be spent presenting and discussing the final recommendations for research needs. We expect that these recommendations will include specific identification of tools that may be needed to support further efforts. For example, GCMs produce global scenarios that are not immediately amenable to local or regional applications without modification (IPCC 1996, 2001). Making local scenarios generally available once they are produced could be extremely valuable to both the scientific and the management community.

The final morning will be devoted almost entirely to polishing text on the recommendations and agreeing on homework assignments to complete the synthesis papers. As has happened in other similar workshops, such as the SCOPE workshop on the nitrogen budget of the North Atlantic, additional papers are likely to be produced in addition to the three we have suggested.

Products from the workshop will be published in the peer-reviewed, ERF journal, *Estuaries*, posted on the ERF web site with links to other society web sites, and on a listserv created for interested individuals.

3. OUTREACH ACTIVITIES (Fall 2002, Spring 2003)

Once the workshop is complete, the products will be used to raise the visibility of the importance of climate change and variability in estuaries and coastal areas through a variety of outreach activities. Within ERF's regular operations there are platforms for outreach and further communication, i.e., the regularly scheduled meeting of the five affiliate societies and our European counterpart society, ECSA, described in more detail below. Other opportunities to disseminate the new information will be found on an ad hoc basis through ERF's collaborations with other scientific societies and organizations with a mission of coastal and estuarine work. Examples of such ad hoc collaborations where outreach will be accomplished include nationally –focused organizations such as the Association of State Wetland Managers, Restore America's Estuaries, the National Association of Estuary Programs, the National Estuarine Research Reserve Association,

the Sea Grant Programs and ERF's liaisons with other scholarly societies, especially the American Society for Limnology and Oceanography, the Society of Wetland Scientists, the American Fisheries Society.

An important outreach activity will be to facilitate team building for those scientists interested in research collaborations on the themes of biocomplexity and climate variability and change. There are five ERF affiliate societies: New England Estuarine Research Society, Atlantic Estuarine Research Society, Southeastern Estuarine Research Society, Gulf Estuarine Research Society, and Pacific Estuarine Research Society. The focus of ERF's affiliate societies' meetings is regional estuarine and coastal issues. Each affiliate society has a fall meeting, which reaches a new audience since many participants do not attend the biennial international ERF conference. The outreach activity will provide a broader audience and facilitate groups wanting to collaborate on interdisciplinary or inter-regional proposals. At each meeting we will provide a speaker who can address the scientific issues raised by the working groups. If they wish, we will also assist the affiliate societies in organizing a full or ½ day session on climate variability and change as part of their regional meeting. ERF will supply a keynote speaker for the event and assist the affiliates in identifying other participants, especially climate modelers, physical oceanographers and social scientists.

For the past four years ERF has been considering the plight of estuarine and coastal ecosystems around the world and expanding our abilities to reach out to scientists and managers who work in these ecosystems. For over a decade we have committed ERF's funds to providing copies of our journal to the libraries of over 60 institutions in currency-limited countries. In recent years, we have made efforts to increase ERF's visibility internationally. The impacts of climate change and variability have great potential impacts worldwide and the products of this project will give ERF additional information to share with our international colleagues. To begin our international outreach activities, a presentation will be made at the ECSA conference in Mexico (Spring 2003).

Co-Investigators

Although this project will engage the active participation of the Board of Directors and staff of the Estuarine Research Federation as well as a Steering Committee, the responsible principal investigators of record are Donald Boesch of the University of Maryland Center for Environmental Science (UMCES) and Anne Giblin of the Ecosystems Center at the Marine Biological Laboratory:

Donald Boesch is a past President of ERF, experienced in leading similar community activities, and chief executive of UMCES, which will administer the grant. A biological oceanographer, he led the community-based assessments and planning efforts dealing with Priorities for Coastal Ecosystem Science (NRC, 1994) and the consequences of climate change on coastal environments (Boesch, et al., 2000) that have been referred to in this proposal. He also recently led an assessment of the status of marine pollution in the United States for the Pew Oceans Commission (www.pewoceans.org). Under

Boesch's leadership, UMCES has established the Integration and Application Network (www.umces.edu) to foster and facilitate interdisciplinary integration and the application of science. The IAN has developed the experience and resources needed to organize workshops and produce publications such as those proposed. Furthermore, the ERF business offices are located in Maryland, nearby UMCES, and this will ensure effective grant and logistics management.

Anne Giblin is the current President of ERF. She is a biogeochemist with extensive experience with estuarine systems. For the past 5 years she has been working with both hydrologists and modelers examine the effects of climate change and variability on ecosystems (see C.V. e.g. Stieglitz et al. in press a,b, McKane et al. 1997, Rastetter et al. 1997). She has recently been funded by NOAA Sea Grant to examine the role that changing freshwater discharge has on nitrogen cycling in estuaries. Giblin has participated in a number of synthesis activities similar to the one proposed here including the SCOPE nitrogen project (Seitzinger and Giblin 1996), the SCOPE sulfur project (Giblin and Wieder 1992), and she was lead PI for an NSF funded LTER inter-comparison project. Giblin has previously organized several conferences of similar size.

Budget Justification

The project is planned for a two-year period (Fig. 4). The direct costs of the budget are mainly composed of participant travel expenses to the workshop, and travel expenses to support outreach activities. A total of 40 participants in addition to the steering committee are anticipated to attend the workshop. Estimated costs are \$1100/participant, which assume 4 days per diem at \$125/day, and \$600 travel costs for a total of \$55,000. The conference rental and meal service fees are estimated to total to \$4,000. Travel expenses for one member of the steering committee to attend 5 affiliate society meetings (\$1000/trip) and to travel to the ECSA meeting in Mexico (\$2,000). Support of the web site for this activity and Journal costs total \$8,000. A small salary request, 2 months, is added for an administrative assistant to support efforts to organize the workshop and assist with travel arrangements.

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