A PROPOSAL FOR

COORDINATION FOR LAND-MARGIN ECOSYSTEMS RESEARCH (LMER)

Project Summary

LMER research seeks to investigate and understand the changes that are occurring in coastal environments due to human population growth, land use changes and global climate change. To comprehend the many factors involved, it is necessary to conduct research on a multidisciplinary, comprehensive and coordinated level. Accordingly, the five present LMER sites have met regularly, with funding from NSF, to facilitate the cooperation needed to solve common problems, compare results, focus on shared goals and coordinate research with similar coastal ecosystem programs.

In addition, the Coordinating Committee and its co-chairs, Drs. John Hobbie and Christopher D'Elia, have worked to develop awareness of LMER within the scientific community as well as opportunities for cooperative research, to coordinate LMER activities with other agencies, and to create ties to international coastal research efforts, while the coordination office has increased communication among the projects and facilitated organization of meetings.

This proposal requests funds to continue the operation of the LMER coordination office at the Marine Biological Laboratory in Woods Hole, support the activities of the LMER Coordinating Committee and regular meetings of LMER scientists. Dr. John Hobbie will continue to act as chair of the Coordinating Committee.
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Introduction to the LMER Program

Nowhere are the effects of global and local environmental change more pervasive than at the land-water margins. In the United States, the rate of human population growth in the last few decades has been more rapid than at any time since 1900. Three factors help explain this increase: the greater availability of natural resources, the increased ability and need to improve the quality of life, and the increased human morale and income. The rate of increase in human population growth in the last few decades has been more rapid than at any time since 1900.

Recent economic development has been accompanied by increased pressures on coastal land and water use. Increased population growth, coastal development, and industrial and agricultural changes have led to increased demands on coastal resources. Coastal development has increased through land-use changes that reduce coastal wetlands and other areas of wetlands; increased pollution of coastal environments by sewage and storm runoff; increased pollution of coastal environments by sewage and storm runoff; and increased pollution of coastal environments by sewage and storm runoff. The rate of change of land cover is expected to continue to increase as coastal development continues in response to economic growth.

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A report covering workshops in 1987, "At the Land-Sea Interface: a call for research on the causes of the changes caused by humans and by other elements of the environment" has been studied in coastal regions but studies have been conducted in isolation from each other, without the necessary multidisciplinary, comprehensive, and coordinated research. Research projects of the future must focus on interactions and feedbacks among all land, water, and atmosphere. Given the large amount of observational data on coastal regions, the future should add the multidisciplinary, comparative, and large-scale approaches. Accordingly, four important elements of research were identified:

1. Interdisciplinary teams
2. Comparative approaches to test the commonality of processes
3. Experimental studies across space and time scales
4. Development of large-scale conceptual, analytical, or numerical models

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Project Description

Introduction to the LMER Program

Nowhere are the effects of global and local environmental change more pervasive than at the land-ocean margins. In the United States, the rate of human population growth in coastal counties since 1960 is roughly twice the increase for the country as a whole. More people means mounting pressure on natural resources and more disturbance to coastal regions. When these land use and population changes interact with expected global climate changes, the ecosystems at the margin of the land will face still increasing stresses. Among the many changes will be loss of habitat, including coastal wetlands; interception of water and sediment that reduces wetland areas on many coasts; invasions by exotic species; increasing rate of sea-level rise; increased pollution of near shore environments by industrial and agricultural chemicals, and increased nutrients in near-shore environments.

Research on the effects of disturbance in the coastal regions has usually focused on one or a few factors, an example being the effect of organic loading on oxygen conditions. Here, a modest amount of research on the causes of oxygen depletion has led to improved wastewater treatment and to curtailed losses of fisheries and recreational resources in many cases. Coastal environments, however, are affected by multiple factors for change including the changing inputs from land, sea level rise, and nutrients. To understand the effects of these factors on the land-margin ecosystems and to determine effective management and restoration strategies requires increasingly sophisticated scientific understanding of complex interrelationships. Both understanding and management require research not only on estuaries and other aquatic habitats but also on the coastal watersheds that are inextricably linked to the water.

A report based on three NSF-sponsored workshops in 1987, "At the Land-Sea Interface: a call for basic research," noted that many of the changes caused by humans and by other aspects of global change have long been studied in coastal regions but studies have been conducted in isolation from each other, without the necessary multidisciplinary, comprehensive and coordinated research. Research projects of the future must focus on interactions of external forces and responses with special emphasis on the connections between land and water. Given the large amount of observational data on coastal regions, research in the future should add the multidisciplinary, comparative and large-scale approaches. Accordingly, four important elements of research were identified:

- Interdisciplinary teams
- comparative approaches to test the commonality of processes
- experimental studies across space and time scales
- development of large-scale conceptual, analytical, or numerical models

The implementation of the recommendations of the meeting report began when the Ecosystems Studies section of NSF’s Division of Biotic Systems and Resources (now
Division of Environmental Biology) and the Biological Oceanography section of the Division of Ocean Sciences issued a call for proposals in 1988. As a result of that competition, as well as competitions in 1989, 1991, and 1992, there are presently five LMER sites. After the Spring 1994 competition we expect there will be a total of six or seven sites.

LMER Goals

The 1994 Announcement of Opportunities for Land-Margin Ecosystems Research (LMER): Studies at the Land-Sea Interface, National Science Foundation, includes the following: "The goal of LMER is to increase the understanding of 1) the organization and function of land-margin ecosystems; 2) the linkages between these systems and adjacent terrestrial and marine systems; and 3) the impacts of major natural environmental perturbations in these regions.

The research proposed should emphasize major ecological questions that stress the study of linkages between terrestrial and coastal ecosystems. The work should seek to understand the causes of major ecological and environmental changes that influence land-margin environments, and how the populations, communities and ecosystems of the land-margin environments responds to these changes."

The Current LMER Program

The five present sites are Waquoit Bay, Tomales Bay, Chesapeake Bay, Columbia River and Plum Island Sound. The sites are widely distributed geographically, and represent different types of land-margin environments. Chesapeake Bay is a mid-Atlantic estuary, with a very large, complex watershed in a temperate, relatively moist climate. The Columbia River estuary has a large freshwater inflow, short residence times, and a relatively arid and expansive watershed that includes parts of five Pacific Northwest states and two Canadian provinces. Tomales Bay is a drowned rift valley in coastal northern California, fed by a small watershed mostly covered by grazed grasslands and forests. Plum Island Sound is a bar-built estuary with a glaciated watershed covered by thin soils and the greatest expanse of intertidal wetlands in New England. Waquoit Bay is a shallow coastal bay in southern New England, surrounded by forested and urbanized watersheds.

The five projects include many excellent scientists from a broad base of universities and research institutions. In Spring 1994, there were 80 scientists involved with LMER, from a total of 26 universities and institutions.

LMER Research Results

The Columbia River site focused on the particles trapped near the river bed, the estuarine turbidity maximum, as the site of intense geochemical and biological activity. Intensive cruises throughout the seasons revealed that the dominant zooplankton of the lower
estuary were dependent upon the microbes concentrated on particles; this food chain transfers carbon efficiently to higher trophic levels similar to the way a benthic system operates.

The Waquoit Bay site investigated the sources and losses of N in watersheds; denitrification in ground water was a major loss. Increased N loading in a series of coastal bays caused a replacement of eelgrass by macroalgal seaweeds as the dominant producer; when macroalgae are abundant anoxia occurs a number of times a summer and greatly reduces numbers and diversity of benthic animals.

In Chesapeake Bay, the LMER project collected information from various agencies on inputs from land of water and nutrients and also made intensive measurements of phytoplankton biomass, physical structure, nutrients, and oxygen. Comparative and whole system budgets of C, N, P, and Si were developed at three locations to examine responses to nutrient loading rates and relations between material loading rates and exchanges with the ocean. A striking change of nutrients from the inorganic to organic forms was found from the freshwater to the oceanic end of the bay.

The LMER study of Tomales Bay developed detailed C, N, and P budgets for a number of years as well as a history of the 3 orders of magnitude variation in the annual input of organic matter from land to the sediments. Processes in the bay release P from particles so the bay is a net source of dissolved P to the coastal ocean; Tomales Bay processes consume dissolved inorganic N, a net loss of N to the coastal system.

The Plum Island Sound site, the newest of the LMER projects, has assembled fundamental information to compare present fish community structure with historic data as well as to construct budgets for sediment metabolism and nutrient remineralization. Research in watersheds revealed that streams draining urban areas have 4-7 times higher concentrations of nitrogen than do streams draining forests; uptake by wetlands, riparian forests, and sediment processes removes 2/3 of the watershed nutrient load before the rivers reach the estuary.

The Need for Coordination

Each LMER project is independently designed with its own scientific theme and geographic orientation. There exists, however, a great deal of commonality among the projects. Working together only improves the quality of research by solving common problems, comparing results, focusing on shared goals, gaining exposure and cooperation in the greater research community and coordinating with other similar coastal projects.

To meet these goals, in 1992 NSF funded the LMER coordination office. To date, the coordination office has organized two All Scientists’ meetings, held in Woods Hole, Massachusetts, and in Seaside, Oregon, two to three meetings per year of the LMER Coordinating Committee, produced several publications, and facilitated communications among the LMER sites. The activities of the Committee co-chairs and members have
strengthened LMER ties to both national and international land-marine projects, coordinated inter-LMER activities and acted as liaison with other governmental agencies.

Coordinating Committee Structure and Functions

A formal coordinating committee has been set up with one representative from each of the LMER projects and co-chairs John Hobbie and Chris D’Elia. (Due to increased responsibilities, Dr. D’Elia will probably be unable continue to serve as co-chair.) The tasks of this committee are to help coordinate inter-LMER project activities such as technique agreements, communication, workshops, meetings of scientists and data sharing; to foster activities at a program level to give definition and visibility to LMER at a national level such as presentations and discussions at agencies and national meetings; and to provide a focal point and collective representation of the LMER sites in their external relationships with other agencies and international programs.

There are two main functions of the LMER Coordinating committee, its co-chairs, and the coordination office: to coordinate LMER project activities and LMER program matters. In the original proposal a number of activities were proposed. Achievements to date, and plans for the future, in each field include:

1) Organize LMER meetings:

In year one of the grant, three meetings of the LMER Coordinating Committee were held: in Fairbanks, Alaska, Woods Hole, Massachusetts and in Washington, DC. The All Scientists’ meeting was held in Woods Hole in November 1992. In the second year of the grant, three meetings of the coordinating committee were held: Seaside, Oregon, Hilton Head, South Carolina and Arlington, Virginia. The All Scientists’ meeting was held in Seaside in October 1993. Arrangements for the coordinating committee meetings were made by the coordination office, while arrangements for the scientists’ meeting were jointly made by the host site and the coordination office. Reports of the All Scientists meetings, edited and produced by the coordination office, have been distributed widely.

Future plans include a Fall 1994 All Scientists’ Meeting near the Plum Island Sound site; a Fall 1995 All Scientists’ meeting at a site to be determined and two coordinating committee meetings a year. The budget also includes travel to LOICZ meetings and/or funding for LOICZ representatives to attend LMER meetings, as well as travel to the Chesapeake Bay-Northern Adriatic meeting in Slovenia in October 1994.

2) Improve communications among LMER projects:

In Spring 1993 a directory of all LMER personnel was published which includes names, addresses, telephone and FAX numbers, e-mail addresses, sites and specialties. This will be updated when the new sites are chosen in 1994. Information about LMER has been included on a regular basis in the LTER newsletter. Inter-site information is also shared via e-mail.
In Spring/Summer 1994, the coordination office plans to issue the first LMER newsletter.

3) Develop the comparative approach among LMER projects including appropriate procedures for data sharing archiving, ideas for synthesis and common measurements, and models of various coastal processes:

The All Scientists’ meetings have focused on cooperative and comparative research. For example, a workshop at the November 1992 meeting concentrated on the problem of how to incorporate biological processes into physical models of water movements. At the same meeting, a workshop focusing on GIS methodology identified a general model of watershed discharge of nutrients as a top priority.

At the 1993 All Scientists’ meeting, the workshop on food web structure and function developed two questions for LMER groups to collectively pursue over the next several years. The group studying estimation of fluxes through estuarine cross-sections identified the need to improve the conceptual framework for thinking about fluxes in estuaries and to develop smart sampling of biologically relevant parameters.

An LMER data management and gopher retrieval system, maintained at the Coordination Office, can be accessed by any scientist with an e-mail address, and provides a bibliography of all LMER publications as well as documentation of data files that are available from each site. Information on this system has been distributed to all LMER sites and potential sites.

4) Identify and try to solve problems common to all LMER projects:

Ivan Valiela and his colleagues have written a proposal to evaluate, over a three-year period, eight different methods of measuring denitrification rates in aquatic sediments. John Hobbie has written a proposal for a SCOPE workshop on estuarine synthesis, the goal of which is to set a course for achieving an understanding of estuarine processes and estuarine ecology sufficient to predict the responses of coastal systems to a variety of climate and human impacts.

The Coordination Office will provide the Columbia River LMER with the administrative assistance necessary to provide an Acoustic Doppler Current Meter Profiler to the LMER sites. Funding has been received for the ADCP that can be used by a number of sites. The Coordination Office will schedule its use and administer the funds for its routine maintenance.

5) Work with NSF to develop ideas and sources for supplemental funding.

Each LMER site has developed links to local, state, and federal agencies and private funding institutions and obtained funding from them. The list of agencies involved includes 42 items in a four-page list. Some of the participating organizations are USGS,
NOAA/Sea Grant, USDA as well as agencies such as Maryland’s Department of the Environment and Department of Natural Resources. The individual sites have successfully forged links with these other sources of funding; in the future, the Coordination Office will work with NSF to identify and encourage prospects for additional LMER funding. The EMAP-LMER agreement is a good example of the types of opportunity the Coordination Office will pursue.

6) **Develop scientific community knowledge about LMER and opportunities for cooperative research:**

In November 1992, an article entitled “Understanding Changes in Coastal Environments: the LMER program” appeared in *Eos*, the journal of the American Geophysical Union. An expanded article has been submitted to *BioScience*. Another general article on synthetic results will be written and submitted for publication in the future.

The LMER brochure, published in Spring 1993, will be updated as soon as the sites are finalized for the next funding period.

Meeting reports have been publicized in other professional societies’ newsletters and sent to many within the scientific community as have the LMER directories, brochures, and journal reprints.

John Hobbie has given talks on LMER to the American Society of Limnology and Oceanography (1993 annual meeting in Edmonton) and to groups on the West Coast interested in the development of LMER prospects.

7) **Coordinate LMER activities with existing federal programs:**

Representatives of federal programs have participated in the All Scientists’ meetings. Ken Brink, Coastal Ocean Processes (CoOP), was plenary speaker at the Fall 1992 meeting; Mike Crosby, NOAA, discussed coordination and collaboration between LMER sites and NOAA-OOCRM research sites at the Fall 1993 meeting.

Collaborative efforts have been formally proposed between the EPA’s Environmental Monitoring and Assessment Program (EMAP) program and several LMER sites. The LMER Coordinating Committee worked with LTER and EMAP to exchange ideas for an RFP that would allow research to be done at LMER (and LTER) sites to develop methods and ideas, particularly those on useful indicators of estuarine change, suitable for the EMAP program.

Dr. Hobbie has held discussions with representatives of GLOBEC, EMAP and NOAA’s Status and Trends; he also serves on the LTER Executive Committee.
8) Develop ties to international efforts:

John Hobbie attended a LOICZ steering committee meeting in Woods Hole in Fall 1992 and briefed P.M. Holligan, chair of the LOICZ Core Project planning Committee, on LMER activities and capabilities. Christopher D’Elia, LMER co-chair, and Michael Kemp of the Chesapeake Bay LMER site attended the first LOICZ Project Meeting in May 1993, Raleigh, NC.

Dr. Hobbie has been in touch with John Perretta, the new LOICZ Project Manager in the Netherlands, about future LMER-LOICZ meeting participation. Funds for attending LOICZ meetings or to have LOICZ representatives attend LMER meetings are included in this budget.

Funding has also been requested for the Chesapeake Bay-Northern Adriatic workshop in Slovenia. This proposed workshop, entitled “Trends in Land-Use, Water Quality and Fisheries: A Comparison of the Northern Adriatic Sea and the Chesapeake Bay,” is asking for $30,000 from the U.S.-Slovenia Joint Fund and requests the additional $10,000 from the LMER Coordination office to send four ecologists from the U.S. to the meeting.

Budget

Explanation for Budget Year 1

This budget contains 2 months of salary for Dr. Hobbie and 6 months of salary for an executive assistant. As the LMER program has increased in scope, it has become apparent that one month a year is not sufficient for the duties of the Coordinating Committee chair. Dr. Hobbie’s duties have not only included editing brochures, reports and articles but also the additional tasks of meeting with federal agency personnel to promote agency/LMER interaction, organizing the SCOPE workshop on estuarine synthesis, and giving talks about the LMER program.

The duties of the assistant are to organize the meetings of the LMER Coordinating Committee (transportation, lodging), organize the All Scientists’ meetings, produce reports of the meetings, organize files and phone calls, maintain an LMER directory of scientists, serve as focal point for coordination and information for LMER projects, type and organize letters and agendas, arrange trips to agencies, be the interface between the LTER office and LMER activities (joint meetings, e-mail service), assemble and edit a newsletter, update the LMER brochure and provide assistance as needed on LMER publications.

This budget also contains a small amount ($3,000) for the data management specialist to maintain documentation of archives, and an amount ($3,997) for secretarial/clerical help. In addition, direct Xerox and telephone charges and other direct costs are charged as a proportion of the total cost of running the Ecosystems Center.
The LMER Coordinating Committee is made up of one representative from the present five LMER sites and Dr. Hobbie.

In this budget there are the following meetings scheduled:

1. An October 1994 meeting of All Scientists, hosted by the Plum Island Sound LMER site. Cost will be $53,295, based on inviting five scientists and two students from each site (potential of seven), and approximately eight to 10 additional people representing other coastal research sites and international projects such as LOICZ. Costs of sending additional scientists from each site will be met by the individual projects. Transportation for 59 people would be: $600 per person for 43 people for a total of $25,800; $2,200 for two international flights; $100 per person for 14 people (able to drive to site) for a total of $29,400. Meals and lodging for 59 people for three nights at $135 per day total $23,895 for a meeting total of $53,295.

2. A Fall 1994 Coordinating Committee meeting at the site of the All Scientists’ meeting.

3. Partial funding ($10,000) for the Chesapeake Bay-Northern Adriatic workshop, to be held in October 1994 in Purin, Slovenia, to pay for travel and per diem for four U.S. scientists.

4. A Spring 1995 coordinating committee meeting at NSF in Arlington, VA. Travel for a PI from each of possibly seven sites and Dr. Hobbie at an average of $500 per person is $4,000. Lodging at $100 per person for two nights is $1600. Meals at $35 per day for two days $560. Total of $6,160.

5. The cost of sending three to four LMER scientists to attend the LOICZ meeting in the Philippines in May 1995. Airfare is approximately $1300 per person, lodging and meals are expected to be $150 a day, for 3 days, for a total of $7,000.

6. Funds are also requested for publishing and mailing a semi-annual newsletter, publishing and mailing meetings reports, directory and brochure ($2500).

Explanation for Budget Year II

1. All Scientists’ meeting in Fall 1995 at a site to be decided later; Fall 1995 coordinating committee meeting at the All Scientists’ meeting, and a Spring 1996 coordinating committee meeting at NSF. Increase of approximately 5% is included in budget.

2. Funding in 1995-96 for travel to international meetings and funds for international scientists to travel to the LMER All Scientists’ meeting.
3. Personnel duties and months are the same as in Year I, with an added 5% pay raise.

Explanation for Budget Year III

1. All Scientists’ meeting in Fall 1996 at a site to be decided later; Fall 1996 coordinating committee meeting at All Scientists’ meeting, and a Spring 1996 coordinating committee meeting at NSF. Increase of approximately 5% is included in budget.

2. Funding in 1996-97 for travel to international meetings and funds for international scientists to travel to the LMER All Scientists’ meeting.

3. Personnel duties and months are the same as in Year II, with an added 5% pay raise.