

ECOLOGY AND OCEANOGRAPHY OF HARMFUL ALGAL BLOOMS

An Inter-Agency Research Program

Announcement of Opportunity

Deadline: 14 March 1997

NATIONAL SCIENCE FOUNDATION
Directorate for Geosciences, Division of Ocean Sciences

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Coastal Ocean Program

ENVIRONMENTAL PROTECTION AGENCY
Office of Research and Development, National Center for
Environmental Research and Quality Assurance

OFFICE OF NAVAL RESEARCH

INTRODUCTION:

The National Oceanic And Atmospheric Administration's (NOAA) Coastal Ocean Program, the National Science Foundation's (NSF) Division of Ocean Sciences, the Environmental Protection Agency's (EPA) Office of Research and Development, National Center for Environmental Research and Quality Assurance, and the Office of Naval Research (ONR) announce an opportunity to conduct process-related field research, modeling, and laboratory studies on Harmful Algal Blooms (HABs). The Ecology and Oceanography of Harmful Algal Blooms (ECOHAB) Program will support coordinated, well-integrated, interdisciplinary process-oriented field studies by research teams. Individual studies will also be supported to develop predictive models and address gaps in knowledge related to mechanisms that regulate harmful algal species. A total of about \$3 million is anticipated for FY 1997 and each of the following four years, contingent on appropriations. Additional funds may be made available to support this program through the National Ocean Partnership Program, administered by the Office of Naval Research. The majority of funding will support interdisciplinary process-oriented field studies by research teams. Up to three integrated, interdisciplinary field studies and up to 10 individual projects are anticipated. The deadline for proposals is March 14, 1997. Final selections will be made by May 15, 1997, for projects to begin in summer 1997. NOAA will act as the lead agency for the ECOHAB program via the Coastal Ocean Program.

RATIONALE:

Among coastal issues facing the nation today, HABs are scientifically complex and socially relevant. For the purpose of this ECOHAB Announcement, Harmful Algal Blooms include toxic and noxious phytoplankton and benthic algae. Periodic blooms in some coastal areas have caused virtual collapse of ecosystems with accompanying serious economic impacts. HAB phenomena have caused human illness and death, have altered marine habitats through shading and overgrowth, have adversely impacted fish and other marine organisms, and have completely closed down aquaculture operations.

Evidence suggests that over the last few decades, the frequency and duration of HABs have been increasing both nationally and worldwide. Formerly, only a few regions of the U.S. were affected by HABs, but now virtually every coastal state has reported major blooms. In

many cases, the blooms extend over larger geographic areas and are composed of more than one harmful or toxic species. Furthermore, HABs are not unique to the United States and have attracted international interest from many countries that have commercial and recreational interests in the coastal ocean.

There is a trend toward more frequent and larger HAB outbreaks, and greater variety of toxins. In spite of a growing list of affected resources, our understanding of the biological, physical, and chemical processes that regulate HABs is limited. Economic losses in the U.S. from HABs over the last 20 years have totaled tens of millions of dollars. The costs of HABs are realized in the need for toxin monitoring programs, closures of shellfish beds, mortality of fish and shellfish, and disruptions in tourism.

HABs are not only economically costly, but are also potentially deadly. Human illnesses due to natural algal toxins include: ciguatera fish poisoning (CFP), paralytic shellfish poisoning (PSP), amnesic shellfish poisoning (ASP), neurotoxic shellfish poisoning (NSP), and diarrhetic shellfish poisoning (DSP). Severe cases of PSP can result in death from respiratory arrest within 24 hours of consuming the toxic shellfish, and ASP can have the devastating side effect of permanent memory loss.

Toxic blooms of algae can potentially impact virtually all compartments of the marine food-web due to adverse effects on viability, growth, fecundity, and recruitment of marine organisms. Toxins can move through ecosystems in a manner analogous to the flow of carbon or energy, and the impacts can thus be far-reaching. Likewise, dramatic ecosystem state shifts can derive from the macroalgal overgrowth in benthic systems. In the context of ecological effects, our present knowledge base is inadequate even to define the scale and complexity of many HAB phenomena.

The limited scope of past HAB studies has precluded a fundamental examination of the many factors that regulate the distribution and abundance of species involved in HABs. This interagency ECOHAB program represents a major response to address the need for long-term, large-scale, interdisciplinary research. The primary objective of this Announcement of Opportunity is to solicit proposals for research on the environmental processes that facilitate and regulate HABs in the coastal ocean. The general goal is to develop a predictive understanding of how physical and biological processes interact to promote bloom

development, affect bloom dominance, and contribute to bloom maintenance or decline.

PROGRAM DESCRIPTION:

The significant public health, economic, and ecosystem impacts of HAB outbreaks are severe, and the practical motivations for a coordinated national research program are made all the more pressing by the escalating trend in their incidence. In recognition of this need, academic and government scientists as well as program managers from several agencies worked together to formulate a research strategy entitled *ECOHAB: The Ecology and Oceanography of Harmful Algal Blooms, a National Research Agenda*. The entire document is available at: <http://www.redtide.whoi.edu/hab/>. The research plan put forth in the ECOHAB report was designed to increase our understanding of the fundamental processes underlying the population dynamics of HABs and the impacts they precipitate. This involves a recognition of the many factors at the organismal level that determine how HAB species respond to and potentially alter their environment. Also of interest are the manners in which HAB species affect or are affected by food-web and community interactions, and how the distribution, abundance, and impact of HAB species are regulated by the environment.

Research questions related to HABs encompass a variety of disciplines at a variety of scales. The complex processes involved in the growth and accumulation of individual harmful algal species result from an array of chemical, physical, and biological interactions. Algal blooms can occur over wide geographic areas, and while many blooms are localized in the coastal waters where they form, some blooms are transported long distances from their point of origin to the affected resources.

Our knowledge about each of the many harmful algal species varies significantly, and even the best-studied remain poorly characterized with respect to the population and community aspects of bloom dynamics. These inherent challenges involved in studying HABs have inhibited the development of useful predictive models on population development, transport, toxin accumulation and ecosystem impact. Research needs fundamental to the long-term management of fisheries resources and marine habitats include resolution and integration of various rate processes important to the population dynamics (e.g., input and losses due

to growth, grazing, encystment, excystment, and physical advection).

MULTIPLE AGENCY INTERESTS

To address the increased need for research on Harmful Algal Blooms, the National Oceanic and Atmospheric Administration (NOAA), National Science Foundation (NSF), Environmental Protection Agency (EPA), and Office of Naval Research (ONR) combine each agency's unique interests and missions into this coordinated research program. The following outlines specific agency interests in harmful algal bloom research.

NOAA---HABs and related biotoxin risk must be managed if we are to build viable and valuable sustainable fisheries, protect threatened and endangered species, and effectively manage coastal activities and resources. NOAA's interest is in developing predictive and early warning capabilities to assist in mitigating the impacts of HABs on public health, living marine resources and coastal habitats.

NSF --- Many aspects of species-specific dynamics of algal populations and species succession that contribute to bloom formation are poorly understood. NSF's interest is in increasing our understanding of the direct and indirect causes of HABs in our coastal regions and their ecological consequences through research on the physiological and ecological basis of bloom formation, the physical and chemical attributes of coastal oceans that facilitate them, the population attributes of bloom species, and the long term consequences of ecosystem changes.

EPA --- The ecosystem protection research program supports an integrated approach to protect the integrity of ecosystems that are affected by algal blooms through bioindicator development and to restore degraded ecosystems using a watershed approach. Two specific areas of emphasis for ecosystem protection related to HABs are contaminated sediments and nonpoint sources of pollution with investigations conducted at the regional or watershed scales.

ONR --- Algal blooms resulting from complex coupled physical/biological processes strongly affect the physical, optical, and acoustic properties of the coastal ocean. ONR's interest is in characterizing and forecasting the physical, bioacoustical and optical properties of blooms to improve the capability of the fleet to operate

effectively within coastal environments worldwide.

THE ECOHAB PROGRAM STRUCTURE

The goals of this research effort are to:

- Understand the causes of blooms;
- Determine the sources, fates and consequences of HABs in food webs and fisheries;
- Develop an enhanced predictive and early warning capability for the occurrence and impact of HABs; and
- Explore means for mitigation and control of HABs.

To address these needs, this Program will support research on the

- Mechanisms underlying the initiation, distribution, and accumulation of individual bloom-forming species;
- Physiological and biochemical bases of the ecological role of toxins in bloom forming species;
- Physical and biological processes that influence the transport, fate, and effects of marine biotoxins and other HAB impacts;
- Influence of human and natural drivers on the biophysical mechanisms that facilitate and regulate HABs, including detection and tracking of conditions suspected of being conducive to bloom formation and potential methods of control;
- The longer-term consequences of ecosystem changes brought about by the increasing frequency of planktonic blooms and the ecosystem state shifts that can come with macroalgal overgrowth in benthic systems and persistent blooms in the plankton, and,
- The development of models of the physical, biogeochemical, and ecological processes that can ultimately lead to HAB prediction systems.

A significant challenge to the implementation of this program is that HAB phenomena are diverse with respect to the causative organisms involved, the hydrographic or environmental regimes in which they occur, the factors regulating bloom dynamics, and the nature and extent of their impacts. While laboratory

research helps define factors that could be significant in causing blooms, field research and model development are essential to determine and predict the conditions under which blooms form. Comprehensive interdisciplinary studies are needed to fully understand the complex mechanisms underlying the growth and accumulation of harmful algal species in blooms, the formation, transfer, fate of toxins, the impacts on ecosystems, and the influence of human activities on these processes.

PROPOSAL SUBMISSION

This Announcement provides an opportunity for investigators to propose research programs to address the national problem of HABs. To accomplish the Program's objectives, proposals may address integrated, interdisciplinary field studies on biogeochemical, ecological, and physical processes, or targeted individual studies on specific biological or physical processes that regulate the occurrence of HAB species. Proposals are requested to investigate fundamental physical, biological, and chemical oceanographic questions critical to scientifically-based management of fisheries resources, public health, and ecosystem health in regions threatened by HABs. Proposals may address either regional field studies or targeted individual studies as described below. The program is to be funded at a level of up to \$3 million per year in fiscal years 1997-2001 contingent upon availability of funds.

Regional Field Studies

Proposals from teams of investigators are encouraged, with clear identification of the individual having responsibility for program integration and synthesis. These regional field studies should be well-integrated, model-based, suitably-scaled, and interdisciplinary process studies concentrating on the interaction of the various environmental factors underlying specific HAB problems. We anticipate funding at least 2 teams of investigators of the regional studies in addition to the individual studies. Proposed regional studies must be interdisciplinary and present a balanced and well-justified scientific plan for addressing the issues identified in this announcement and in the ECOHAB National Research Agenda. We envision the regional studies to span 3-5 years, encompassing appropriate field studies and data synthesis and analysis, with decreasing funding levels in the non-field years to cover activities described in this Announcement. Proposed efforts should take advantage of existing

research efforts and facilities sponsored by other agencies.

Regional field studies should focus on processes influential in the onset, distribution, maintenance, and destruction of HABs, such as the physical structure of coastal waters, competition among phytoplankton or benthic algal species, and adaptive behaviors that result in species dominance.

Timely response to harmful algal blooms and potential toxicity is hindered by the complexity of mechanisms that contribute to bloom formation and dominance. Therefore, the ability to forecast the onset of blooms and/or predict the subsequent growth, distribution, and dissipation of bloom conditions is of great importance for prevention, mitigation, and management. We particularly encourage proposals that include the development of models to help nowcast and forecast these conditions, ultimately leading to HAB prediction systems.

Targeted Individual Studies

We are also requesting proposals for individual studies that address gaps in knowledge related to the nature of HAB phenomena. These studies should, as with the regional studies, address fundamental ecological and oceanographic questions related to HABs. For example, individual studies by one or more investigators could address research issues such as physical transport; techniques for identifying, detecting, and monitoring biotoxins and HAB species; nutrient kinetics; physiological bases of growth and toxin production for harmful species; toxin transfer through the food web; and mechanisms for controlling blooms. The purpose of the individual studies is to encourage research into key questions on the underlying mechanisms involved with HABs, without necessarily being limited to the selected study region(s). These studies should however, be limited to the goals and objectives of the ECOHAB National Research Agenda.

PREPARATION AND SUBMISSION OF PROPOSALS:

This opportunity is open to all interested, qualified, non-Federal and Federal researchers in the U.S. Proposals submitted in response to this announcement should be prepared and submitted in accordance with the guidelines stated below. Proposals will be subjected to initial screening for relevance to the ECOHAB Program and will be returned without review or

advance notification if deficiencies are found. Successful investigators may be asked to make minor revisions in their proposals to fit into an overall program structure.

Prospective investigators are strongly encouraged to include a discussion of how their proposed programs directly address the program goals and how proposed efforts take advantage of existing research efforts and facilities sponsored by other agencies and academic institutions. Prospective investigators should provide a full scientific justification for the research. Proposals should be written to allow adequate review of the details of such things as goals and objectives, conceptual framework, methodological approaches, and integration with other relevant HAB efforts.

Questions that should be addressed in research proposals include:

- **Demonstrated and Potential Harmful Impacts:** What are the present and potential impacts of the HAB problem on human health, the regional economy, fisheries, and ecosystems?

- **Geographic Extent of the Problem:** Is the problem regionally widespread or confined to a relatively small area?

- **Persistence/Predictability:** Is the bloom persistent in time and/or space or recurring to the point that the specified research strategy is appropriate?

- **Existing Data:** Is there an existing body of knowledge about the problem and the area (e.g., oceanographic, biological, meteorological, toxicological) that will allow a field study to be designed effectively?

- **Ongoing, Related Studies:** To what extent could other field programs currently in the region provide additional resources and opportunities to successfully meet the program objectives?

- **Applicability of Results to Other Areas:** Will the information derived from the study have implications for multiple regions or multiple management strategies?

- **Management Implications:** To what extent will the information to be derived from the study have importance (value) to resource management decisions?

Proposals should include plans for the documentation, archiving, and dissemination of ECOHAB Program research data. All funded participants must adhere to data management policies applying to recipients of federal funding in ocean sciences. For examples of data policies, refer to the Coastal Ocean Processes (CoOP) Data Policy available through the CoOP Office or (<http://www.coop.hpel.umd.edu>) or U.S. GLOBEC Data Policy Report No. 10 available at www.usglobec.berkeley.edu/usglobec/reports/datapol/datapol.contents.html. Additionally, data should be submitted to the National Oceanographic Data Center in a timely manner.

The awardee is wholly responsible for the conduct of research and preparation of the results for publication. The ECOHAB Program welcomes proposals on behalf of all qualified scientists and strongly encourage women, minorities, and persons with disabilities to compete fully in any of the research and research-related programs described in this document. In accordance with Federal statutes and regulations, no person on grounds of race, color, age, sex, national origin, or disability shall be excluded from participation in, denied the benefits of, or be subjected to discrimination under any receiving financial assistance from NOAA, NSF, EPA, or ONR.

All proposals involving Federal and/or academic scientists must be submitted to the address below. Use the following instructions when preparing your proposal. Full proposals must include the original and 14 unbound copies in the appropriate format and be received by 14 March 1997. Proposals received after the deadline or proposals that deviate from the prescribed format will be returned to the sender without review. All proposals should be sent directly to:

**ECOHAB Coordinator
NOAA Coastal Ocean Program
1315 East-West Highway
Silver Spring, MD 20910**

If you have any questions or require further information, contact the Dr. Kevin Sellner, ECOHAB Coordinator, NOAA Coastal Ocean Program, 301-713-3338.

PROPOSAL FORMAT

Proposals submitted in response to this Announcement of Opportunity should be prepared and submitted in general accordance with the guidelines provided in the NSF

publication, "*Grant Proposal Guide*" (GPG) NSF95-27. Specific guidelines outlined in this Announcement supersede those specified in the GPG. Single copies of this brochure are available at no cost from the NSF Forms and Publications Unit, phone (703) 306-1130, or via e-mail from pubs@nsf.gov (Internet). Proposals will be subjected to initial screening for the requirements in the GPG and this Announcement and will be returned without review or advance notification if deficiencies are found. Proposals will NOT be forwarded to other Programs if found to be inappropriate for this competition.

A. Sections of the Proposal:

1. **Signed title page.** Proposals should be clearly identified by a project title starting with the acronym "ECOHAB", a short title (<50 characters) if needed, principal investigator(s) name(s) and affiliation(s), complete address, phone, FAX, and E-mail information, and a budget summary broken out by year. The title page should be signed by the Principal Investigator and the institutional representative(s) should be identified by full name, title, organization, telephone number, and address.

2. **Half-page abstract/project summary.** An abstract must be included and should contain an introduction of the problem, rationale, scientific objectives and/or hypotheses to be tested, and a brief summary of work to be completed. The abstract should appear on a separate page, headed with the proposal title, institution(s), investigator(s), total proposed cost, and budget period.

3. **Statement of work/project description.** The proposed project must be completely described, including identification of the problem, scientific objectives, proposed methodology, relevance to the goals of the HAB Program and its scientific priorities. The project description section should not exceed 15 pages for *targeted individual studies* (see above) and 20 pages for the collaborative, multiple investigator, interdisciplinary *regional field studies* proposals. Both page limits are inclusive of figures and other visual materials, but exclusive of references.

Include: i.) the objective for the period of proposed work and its expected significance, ii.) the relation to the present state of knowledge in the field and relation to previous work and work in progress by the proposing principal

investigator(s), and iii.) a discussion of how the proposed project lends value to the program goal. A year-by-year summary of proposed work must be included with intermediate outcomes. Provide a full scientific justification for the research; do not simply reiterate justifications presented in this Announcement of Opportunity document. Project management should be clearly identified with a description of the management function within a team.

Studies may be proposed by submission of several collaborative proposals having some common objectives from different investigators, or by an omnibus proposal that contains various interdisciplinary components. In either case, a common overview statement of research approach and objectives should be prepared. The proposal must provide a data policy statement as listed on the examples on the web sites listed in this Announcement.

4. Milestone chart. Timelines of major tasks covering the duration of the proposed project.

5. Budget. Present the budget in fiscal year increments (October to September for Fiscal Years 1997, 1998, 1999...). Include the following categories: salary and wages, fringe benefits, equipment, travel, materials and supplies (expendables), publication costs, computer services, sub-awards, total cost of this proposal, and cost sharing with other programs.

6. Biographical sketch. For all applicants. Focus on information directly relevant to undertaking the proposed research. Use no more than two pages.

B. Proposal format and assembly:

Staple the proposal in the upper left-hand corner, but otherwise leave it unbound. Use 8.5x11" size paper with 1 inch (2.5 cm) margins at the top, bottom, left and right of each page. Use a clear and easily legible type face in standard size of 12 points. All copies must be printed on one side of the page only.

PROPOSAL REVIEW AND SELECTION

Review of proposals and support of the ECOHAB Program will be handled cooperatively by NOAA, NSF, EPA, and ONR. Proposals will be evaluated based on the criteria described in the NSF *Grant Proposal Guide* and in accordance with established NSF and NOAA procedures for external merit review. Proposals' responsiveness to the stated goals of this ECOHAB Program Announcement and the ECOHAB Initiative, and complementarity with

other research projects will also be considered in the evaluation by panel(s) of expert scientists.

Review and Selection

All grant applications are initially reviewed to determine their legal and administrative acceptability. Acceptable applications are then reviewed by an appropriate technical peer review group. This review is designed to evaluate each proposal according to its scientific merit. In general, each review group is composed of scientists, engineers, social scientists, and/or economists who are experts in their respective disciplines and are proficient in the technical areas they are reviewing. In addition to the four criteria included in the *Grant Proposal Guide*, the reviewers will also use the following criteria to help them in their reviews:

1. The originality and creativity of the proposed research, the potential contribution the proposed research could make to advance scientific knowledge in the environmental area and the appropriateness and adequacy of the research methods proposed.

2. The qualifications of the principal investigator(s) and other staff, including knowledge of pertinent literature, experience, and publication records as well as the probability that the proposed research will be successfully completed.

3. The availability and/or adequacy of the facilities and equipment proposed for the project.

4. The responsiveness of the proposal to the research needs set forth in the solicitation.

5. Although budget information is not used by the reviewers as the basis for their evaluation of scientific merit, the reviewers are asked to provide their view on the appropriateness and/or adequacy of the proposed budget and its implications for the potential success of the proposed research. Input on requested equipment is of particular interest.

Grant Administration

While NOAA, NSF, EPA, and ONR will maintain separate funding mechanisms, a common review process will be used to evaluate and select proposals. Upon conclusion of panel merit review, meritorious proposals may be

recommended for funding by either NOAA, NSF, EPA, or ONR, at the agencies' option. Subsequent grant administration procedures will be in accordance with the individual policies of the awarding agency. In addition to the extramural funding, NOAA will fund investigators from NOAA laboratories and state agencies that successfully compete through the ECOHAB Program announcement.

The National Oceanic and Atmospheric Administration (NOAA), the National Science Foundation (NSF), the Environmental Protection Agency (EPA), and the Office of Naval Research (ONR) provide awards for research in the sciences and engineering. The awardee is wholly responsible for the conduct of such research and preparation of the results for publication. The NOAA, NSF, EPA and ONR therefore, do not assume responsibility for such findings or their interpretation. The NOAA, NSF, EPA and ONR welcome proposals on behalf of all qualified scientists and engineers, and strongly encourage women, minorities, and persons with disabilities to compete fully in any of the research and research-related programs described in this document.

In accordance with Federal statutes and regulations, and NOAA, NSF, EPA and ONR policies, no person on grounds of race, color, age, sex, national origin, or disability shall be excluded from participation in, denied the benefits of, or be subjected to discrimination under any program or activity receiving financial assistance from NOAA, NSF, EPA and ONR. **Facilitation Awards for Scientists and Engineers with Disabilities** provides funding for special assistance or equipment to enable persons with disabilities (investigators and other staff, including student research assistants) to work on an NSF project. Contact the program coordinator in the Directorate for Education and Human Resources. The telephone number is (703) 306-1636. The Foundation has TDD (Telephonic Device for the Deaf) capability, which enables individuals with hearing impairment to communicate with the NSF

Information Center about NSF programs, employment, or general information. To access NSF TDD, dial (703) 306-0090; for FIRS, 1-800-877-8339.

PRIVACY ACT AND PUBLIC BURDEN

The information requested on proposal forms is solicited under the authority of the National Science Foundation Act of 1950, as amended. It will be used in connection with the selection of qualified proposals and may be disclosed to qualified reviewers and staff assistants as part of the review process; to applicant institutions/grantees to provide or obtain data regarding the application review process, award decisions, or the administration of awards; to government contractors, experts, volunteers and researchers as necessary to complete assigned work; and to other government agencies in order to coordinate programs. See Systems of Records, NSF-50, "Principal Investigator/Proposal File and Associated Records," 60 Federal Register 4449 (January 23, 1995), and NSF-51, "Reviewer/Proposal File and Associated Records," 59 Federal Register 8031 (February 17, 1994). Submission of the information is voluntary. Failure to provide full and complete information, however, may reduce the possibility of your receiving an award.

The public reporting burden for this collection of information is estimated to average 120 hours per response, including the time for reviewing instructions. Send comments regarding this burden estimate or any other aspect of this collection of information including suggestions for reducing this burden, to:

Herman G. Fleming
Reports Clearance Office
Contracts, Policy and Oversight
National Science Foundation
Arlington, VA 22230

This program is described in the Catalog of Federal Domestic Assistance category 47.050 OMB 3145-0058, PT: 34, KW 1008004, 0103001, Announcement No. NSF97-49