

Biocomplexity in the Environment (BE): Integrated Research and Education in Environmental Systems

- **Dynamics of Coupled Natural and Human Systems (CNH)**
 - **Coupled Biogeochemical Cycles (CBC)**
 - **Genome-Enabled Environmental Science and Engineering (GEN-EN)**
 - **Instrumentation Development for Environmental Activities (IDEA)**
-

Program Solicitation

NSF 01-34

DIRECTORATE FOR BIOLOGICAL SCIENCES
DIRECTORATE FOR COMPUTER AND INFORMATION SCIENCE AND ENGINEERING
DIRECTORATE FOR EDUCATION AND HUMAN RESOURCES
DIRECTORATE FOR ENGINEERING
DIRECTORATE FOR GEOSCIENCES
DIRECTORATE FOR MATHEMATICAL AND PHYSICAL SCIENCES
DIRECTORATE FOR SOCIAL, BEHAVIORAL, AND ECONOMIC SCIENCES
OFFICE OF POLAR PROGRAMS

DEADLINE(S) :

March 16, 2001 Deadline for CNH and IDEA

March 29, 2001 Deadline for CBC and GEN-EN



NATIONAL SCIENCE FOUNDATION



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SUMMARY OF PROGRAM REQUIREMENTS

GENERAL INFORMATION

Program Title: Biocomplexity in the Environment (BE): Integrated Research and Education in Environmental Systems

Synopsis of Program: This special competition promotes comprehensive, integrated investigations of environmental systems using advanced scientific and engineering methods. The concept of biocomplexity stresses the richness of biological systems and their capacity for adaptation and self-organizing behavior. By placing biocomplexity studies in an environmental context, this competition emphasizes research with the following characteristics: (a) a high degree of interdisciplinarity; (b) a focus on complex environmental systems that include interactions of non-human biota or humans; and (c) a focus on systems with high potential for exhibiting nonlinear behavior. In this third year of a multi-year effort, proposals are sought in four topical areas: 1. [Dynamics of Coupled Natural and Human Systems \(CNH\)](#); 2. [Coupled Biogeochemical Cycles \(CBC\)](#); 3. [Genome-Enabled Environmental Science and Engineering \(GEN-EN\)](#); 4. [Instrumentation Development for Environmental Activities \(IDEA\)](#).

In all topical areas, [quantitative approaches](#), [education](#), and [global perspective](#) should be addressed. Consistent with the guidance provided in each of the four topical areas, individuals or small groups may submit proposals to conduct research projects or exploratory and planning activities. This comprehensive approach to research on biocomplexity in the environment is expected to improve science-based predictive capabilities for decision-making.

Cognizant Program Officer(s):

- For contacts in *Dynamics of Coupled Natural and Human Systems*, see www.geo.nsf.gov/be-01.htm#cnh.
- For contacts in *Coupled Biogeochemical Cycles*, see www.geo.nsf.gov/be-01.htm#cbc.
- For contacts in *Genome-Enabled Environmental Science & Engineering*, see www.geo.nsf.gov/be-01.htm#genen.
- For contacts in *Instrumentation Development for Environmental Activities*, see www.geo.nsf.gov/be-01.htm#idea.
- For contacts about the integrative element on *Education*, see www.geo.nsf.gov/be-01.htm#edu.
- For contacts about the integrative element on *Global Perspective*, see www.geo.nsf.gov/be-01.htm#gp.

- For contacts about the integrative element on *Quantitative Approaches*, see www.geo.nsf.gov/be-01.htm#qa.

Applicable Catalog of Federal Domestic Assistance (CFDA) Number(s):

- 47.074 --- Biological Sciences
- 47.070 --- Computer and Information Science and Engineering
- 47.076 --- Education and Human Resources
- 47.041 --- Engineering
- 47.050 --- Geosciences
- 47.049 --- Mathematical and Physical Sciences
- 47.078 --- Office of Polar Programs
- 47.075 --- Social, Behavioral and Economic Sciences

ELIGIBILITY INFORMATION

- **Organization Limit:** None
- **PI Eligibility Limit:** None
- **Limit on Number of Proposals:** None

AWARD INFORMATION

- **Anticipated Type of Award:** Standard Grant
- **Estimated Number of Awards:** 110, of which approximately 70 will be for projects and 40 will be for exploratory, conference, or planning activities (total of four topical areas)
- **Anticipated Funding Amount:** \$55 million (total of four topical areas)

PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

- **Full Proposal Preparation Instructions:** Supplemental Preparation Guidelines
 - The program announcement/solicitation contains supplements to the standard Grant Proposal Guide (GPG) proposal preparation guidelines. Please see the full program announcement/solicitation for further information.

B. Budgetary Information

- **Cost Sharing Requirements:** Cost Sharing is not required

- **Indirect Cost (F&A) Limitations:** Not Applicable.
- **Other Budgetary Limitations:** Specific topical areas may have award size limitations. Details are in Section II, Program Description.

C. Deadline/Target Dates

- **Letter of Intent Due Date(s):** None
- **Preproposal Due Date(s):** None
- **Full Proposal Due Date(s):**

March 16, 2001 Deadline for CNH and IDEA

March 29, 2001 Deadline for CBC and GEN-EN

D. FastLane Requirements

- **FastLane Submission:** Full Proposal Required
- **FastLane Contact(s):**
 - Brian Dawson, Computer Specialist, Directorate for Geosciences, Division of Earth Sciences, telephone: 703.292.4727, e-mail: bdawson@nsf.gov.
 - Florence Rabanal, Fastlane Project Coordinator, Directorate for Mathematical and Physical Sciences, telephone: 703.292.8808, e-mail: mpsoadfl@nsf.gov.
 - Maya S. Anderson, Program & Technology Analyst, Directorate for Biological Sciences, Division of Integrative Biology & Neuroscience, telephone: 703.292.8421, e-mail: biofl@nsf.gov.
 - Philip Johnson, Computer Specialist, Directorate for Social, Behavioral, and Economic Science, Division of Behavioral and Cognitive Sciences, telephone: 703.292.8740, e-mail: pxjohnso@nsf.gov.

PROPOSAL REVIEW INFORMATION

- **Merit Review Criteria:** National Science Board approved criteria. Additional merit review considerations apply. Please see the full program announcement/solicitation for further information.

AWARD ADMINISTRATION INFORMATION

- **Award Conditions:** Additional award conditions apply. Please see the program announcement/solicitation for further information.
- **Reporting Requirements:** Standard NSF reporting requirements apply.

TABLE OF CONTENTS

SUMMARY OF PROGRAM REQUIREMENTS

I. INTRODUCTION

II. PROGRAM DESCRIPTION

III. ELIGIBILITY INFORMATION

IV. AWARD INFORMATION

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

B. Budgetary Information

C. Deadline/Target Dates

D. FastLane Requirements

VI. PROPOSAL REVIEW INFORMATION

A. NSF Proposal Review Process

B. Review Protocol and Associated Customer Service Standard

VII. AWARD ADMINISTRATION INFORMATION

A. Notification of the Award

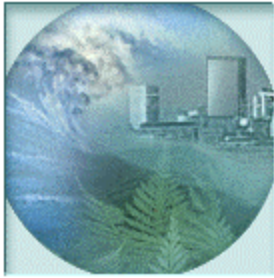
B. Award Conditions

C. Reporting Requirements

VIII. CONTACTS FOR ADDITIONAL INFORMATION

IX. OTHER PROGRAMS OF INTEREST

I. INTRODUCTION



Biocomplexity refers to the dynamic web of often surprising interrelationships that arise when components of the global ecosystem--biological, physical, chemical, and the human dimension--interact. Investigations of [Biocomplexity in the Environment](#) are intended to provide a more complete understanding of natural processes, of human behaviors and decisions in the natural world, and of ways to use new technology effectively to observe the environment and sustain the diversity of life on Earth (*click on the image to visit the BE web site*). By placing biocomplexity studies in an environmental context, this

competition emphasizes research with the following characteristics: (a) a high degree of interdisciplinarity; (b) a focus on complex environmental systems that includes interactions of non-human biota or humans; and (c) a focus on systems with high potential for exhibiting nonlinear or highly coupled behavior with other systems.

Emphasis is also placed on developing the people and tools needed to advance biocomplexity studies. To establish and strengthen interdisciplinary areas of investigation, new communities of investigators need to be formed. This can be accomplished by bringing members of disparate disciplines into teams, by developing new methodologies and expertise, and by reaching beyond the borders of the United States for partners in inquiry. In the process, the next generation of researchers learns to work in diverse teams, cross disciplinary boundaries, and use advanced communication and information technologies to work across many scales of time and space. Plans for enhancing instrumentation and access to information are also included.

Four interdisciplinary areas will be emphasized and supported in this competition during the next five years depending on available funding. These areas are:

- [Dynamics of Coupled Natural and Human Systems \(CNH\)](#), emphasizing quantitative understanding of the short- and long-term dynamics of natural capital and how humans value and influence ecosystem services and natural resources, including consideration of landscapes and land use and the influences of uncertainty, resilience and vulnerability in complex environmental systems on societal institutions.
- [Coupled Biogeochemical Cycles \(CBC\)](#), focusing on the interrelation of biological, geochemical, geological, and physical processes at all temporal and spatial scales, with particular emphasis on understanding linkages between cycles and the influence of human and other biotic factors on those cycles.
- [Genome-Enabled Environmental Science and Engineering \(GEN-EN\)](#), encouraging the use of genetic information to understand ecosystem functioning and the adaptation of organisms to ecological roles.
- [Instrumentation Development for Environmental Activities \(IDEA\)](#), supporting the development of instrumentation and software that takes advantage of microelectronics, photonics, telemetry, robotics, sensing systems, modeling, data mining, and analysis

techniques to bring recent laboratory instrumentation advances to bear on the full spectrum of environmental biocomplexity questions.

II. PROGRAM DESCRIPTION

Program Description Contents

- [Integrative Elements](#)
 1. [Quantitative Approaches](#)
 2. [Education](#)
 3. [Global Perspective](#)
- [Topical Areas](#)
 1. [Dynamics of Coupled Natural and Human Systems \(CNH\)](#)
 2. [Coupled Biogeochemical Cycles \(CBC\)](#)
 3. [Genome-Enabled Environmental Science and Engineering \(GEN-EN\)](#)
 4. [Instrumentation Development for Environmental Activities \(IDEA\)](#)

A. INTEGRATIVE ELEMENTS

Three integrative elements--quantitative approaches, education, and global perspective--should be incorporated in all activities. An integrated, quantitative, systems-level method of inquiry is essential in biocomplexity studies. Education is expected to be integrated with all research, and inclusion of specific plans for formal or informal education activities is encouraged. A global perspective should be adopted, but specific international collaborations and networks for research and education, though strongly encouraged, may not be appropriate or practical in all cases.



1. Quantitative Approaches. In all topical areas described in Section II.B., competitive projects will be those that take a systems approach to questions central to biocomplexity in the environment. Such projects involve the study of nonlinearities, feedback processes, or explicit and *a priori* integration across multiple components or scales of time and space, and use a conceptual, mathematical or computational model, computer simulation, or artificial intelligence technique to direct the research. Mathematical models must include estimates of uncertainty and experiments should be designed to attain a high level of precision.

2. Education. Encouraging the development of a new generation of scientists and engineers trained in comprehensive approaches to investigation of environmental systems is an important goal of this initiative. Competitive projects will be those that provide integrated research and education experiences for participants that may include undergraduates, graduate students, teachers, and postdoctoral associates. Investigators are encouraged to include students in

research teams, in various interdisciplinary settings, or in various work sectors or research platforms.

NSF encourages inclusion of specific formal educational activities from pre-college to faculty levels, as well as informal education for the lay public, resource managers, and policymakers. Proposals in the topical areas may address, for example, the development of materials for use in integrative, comprehensive curricula that will educate students in the diverse character of biocomplexity in the environment. Informal education channels such as science centers, aquariums, and similar facilities that are easily accessible and attractive to the public may also be utilized to help enhance the public's ability to deal with complex environmental information and make informed decisions about the environment. Educational efforts at the K-12 level should promote the acquisition of scientific inquiry skills, take advantage of technology and use it appropriately, and be consistent with the National Science Education Standards (For more information about these standards, see www.nap.edu/catalog/4962.html and www.nap.edu/catalog/5704.html).

3. *Global Perspective.* Investigators are encouraged to identify international research partners, as appropriate. Planning visits for groups of researchers to consider larger scale collaborative efforts may be requested, as well as support for collaboration between individuals. For some developing countries, funds for equipment as well as support for human resources development in those countries may be requested. Funding requests may include support for US students. Proposals that enable groups of 5-10 US undergraduates to perform research activities of limited duration abroad will also be considered. NSF may also be interested in other means of developing support for collaborative research, education, and outreach in the topical areas of this competition, but investigators should consult with the cognizant program officers for *Global Perspective* listed in the General Information Section before submitting proposals. For information on international collaborative programs, see [NSF 00-138](#).

[Return to Program Description Contents](#)

B. TOPICAL AREAS

Proposals must be focused on biocomplexity questions in one of the following four topical areas:

1. Dynamics of Coupled Natural and Human Systems (CNH)

This topical area focuses on the complex interactions among human and natural systems at diverse spatial, temporal, and organizational scales. Emphasis is placed on support of interdisciplinary teams from the natural, social, and mathematical sciences, engineering, and education whose coordinated work will enhance theoretical understanding of the dynamics of integrated human and natural systems. Proposals may be submitted on any topic associated with the Dynamics of Coupled Natural and Human Systems, but projects focusing on natural capital; landscapes and land use; or uncertainty, resilience and vulnerability are of particular interest.

"Natural capital" refers to both tangible goods, such as food and fuel, and less tangible services, such as water purification and erosion control, that are provided by functioning ecosystems. Land-use changes often have consequences for biodiversity, regional climate, or hydrological patterns, so highly interdisciplinary studies focused on the interplay of the built environment, natural resource use and conservation, and social, ecological and geophysical factors are

appropriate. Projects aimed at understanding the nature and dynamics of uncertainty as well as the resilience and vulnerability of social institutions to environmental change are of interest, as are investigations of how institutions and policies for managing the natural resource base respond to change or to the potential for change.

Example research areas that might be pursued include:

- Thresholds and nonlinearities in ecological and social systems, emphasizing theoretical and empirical research linking human and biogeophysical processes to ecosystem services and other forms of natural capital
- The influence of future patterns and events on the demand for and provision of natural resources, ecological and geophysical services, including interdisciplinary work to improve forecasts across spatial and temporal scales
- Patterns and legacies of human settlement, migrations, urban development, ecological succession, and climate on land use and land cover
- Comparative studies of social or political institutions between regions with similar biogeophysical characteristics but different political or social institutions, or between areas with similar governing bodies but different environmental endowments
- Model development and testing for a variety of disturbance scenarios, including alternative treatments of uncertainty
- The role that access to scientific information, or the lack thereof, plays in environmental justice, and the most effective methods for disseminating scientific information to traditionally disenfranchised groups.

Projects may be totally independent activities, or they may be conducted in association with existing projects or activities, including Long-Term Ecological Research sites, NSF-supported Human Dimensions of Global Change centers and teams, NSF Science and Technology Centers or NSF Engineering Research Centers in relevant topics, or similar venues. If the proposed activity is associated with other activities currently supported by NSF or other funders, the project description should make clear how the proposed work is different from lines of inquiry and activities for which support has already been acquired. A letter from the ongoing activity agreeing to the proposed project should be included as Supplementary Documentation.

Most of the approximately \$11.5 million expected to be available in this topical area will be used to support multi-investigator research and education projects and programs of 3-5 years duration. Support for any award will not exceed \$500,000 per year. A limited number of small awards (not to exceed \$100,000) may be funded in response to proposals for workshops or symposia, including meetings to build and strengthen international and/or interdisciplinary teams; proof-of-concept studies and small-scale pilot studies; and high-risk exploratory research. Approximately 40 awards are anticipated.

[Return to Program Description Contents](#)

2. Coupled Biogeochemical Cycles (CBC)

One of the central challenges of environmental research is understanding how the physical, chemical, geological, hydrological, and biological processes that comprise the Earth's natural systems are functionally interrelated and modified by human behavior. Studies of coupled biogeochemical cycles across wide spatial and temporal scales will lead to the development of quantitative knowledge and integrative models for the cycling of water, carbon and other bioactive elements. This will illuminate the complex web of material and energetic pathways connecting the biogeochemistry and dynamics of life on Earth and will provide the basis for understanding the co-evolution of Earth and its biosphere and the limits of environmental predictability.

This topical area stresses interrelationships among earth system cycles. Proposals should address linkages between two or more biogeochemical cycles and at least one of the following: (1) human influences or (2) non-human biotic influences on a biogeochemical cycle.

Specific areas of interest may include, but are not limited to:

- Relationships of cycling of carbon to the cycling of other biolimiting elements in terrestrial, atmospheric, polar, freshwater and marine environments, and the feedback relationships between carbon cycling and ecological dynamics, population genetics, ecosystem productivity, and the evolution of species; studies of biological, geochemical and physical mechanisms regulating carbon biogeochemistry may focus on the present or the geologic past
- Patterns and mechanisms of cycling of life-supporting elements in terrestrial, freshwater, polar and marine ecosystems within regional gradients of chemical, hydrologic and climatic conditions, and feedbacks between elemental cycling and ecosystem structure and function
- Intersections of the hydrologic and ecologic sciences, for example, climate alteration by terrestrial vegetation, ecosystem and hydrological functions of riparian zones, hydrological controls on aquatic ecosystems, and ecosystem vulnerability and resilience to extreme hydrological events
- Extent and significance of deep biospheres and life in extreme environments, for example, investigation of biologically controlled or induced mineralization, the production of gas hydrates in polar and marine environments, molecular-scale geomicrobiology, and transport of microorganisms in the subsurface environment
- Rhizosphere processes, such as greenhouse gas production and carbon sequestration, the effect of soil physical and chemical properties on rhizosphere functioning, alteration of the rhizosphere by changes in land use, and the responses of soil processes to elevated atmospheric carbon dioxide.

Proposals may be submitted by single investigators or by groups, but must be highly interdisciplinary. Proposals may be submitted for projects up to 5-year duration and may include

the full range of research proposals, workshops, planning and development activities, and high-risk exploratory research. No project will be supported for more than \$3 million over a five year duration. Approximately \$22 million is expected to be available in this topical area and a total of about 30 awards are anticipated.

[Return to Program Description Contents](#)

3. Genome-Enabled Environmental Sciences and Engineering (GEN-EN)

This topical area focuses on the use, adaptation, and development of genomic methods that will further understanding of the ecological roles of organisms. Genomics utilizes the totality of genetic information within a cell, from sequences to analyses of gene and genome function, to understand how organisms operate. Genomics is revolutionizing the biological and geological sciences and providing a powerful tool to understand the co-evolution of life on earth. Using genomics to investigate phylogenetic relationships among organisms is expected to increase understanding of biocomplexity and evolution in depth on global and deep-time scales.

In this topical area, there are two main goals: (1) collect and analyze genomic data to establish phylogenetic relationships of life on earth, particularly those at poorly resolved deep branches; and (2) use genomic information contained in single celled microbes, multi-cellular organisms, and more complex organizational units such as communities to understand the interplay of suites of genes with the environment.

Research proposals may focus on, but are not limited to, these specific areas:

- Genomic analysis aimed at assembly of deep branches of the tree of life (Any proposal in this area should include plans for analytical and informatics tools to maintain and utilize the data.)
- Using genomic data to reveal the identities and activities of uncultured microorganisms, including those in extreme environments, with results placed in a phylogenetic context
- Development of quantitative or conceptual models leading to the use of genomic data to predict phenotype or to understand organismal design principles
- Development of genomic and functional genomic approaches to investigate key parameters that influence an organism's role in an environmental niche
- Investigation of how similar sets of genes in different species create distinct phenotypes or physiologies adapted to specific environments.

In this new area, training should emphasize interdisciplinary experience in computational biology, genome science, and the biogeosciences. Particularly important are plans for archiving of data, of trees, and of voucher specimens, and for timely release of results to the scientific and general community. Approximately \$11 million is available in this topical area. NSF anticipates making 15 team awards of 3-5 years duration and total support not to exceed \$1.5 million.

[Return to Program Description Contents](#)

4. Instrumentation Development for Environmental Activities (IDEA)

This activity will support the development of robust instrumentation and associated software for observing, modeling and analyzing a wide range of complex environmental materials, life forms, and processes. The instrumentation should take advantage of recent advances in microelectronics, photonics, telemetry, robotics, and physical and chemical sensing systems to bring recent advances out of the controlled environment of the laboratory into the full spectrum of the Earth's environments. A unifying theme will be the development of *in situ* instrumentation or remote sensing techniques that minimize environmental impact while increasing real-time data-gathering opportunities. An important goal of research in this area is the development of useful instrumentation that can be widely disseminated and aid production of environmental data of high quality and comparability. Critical to the effective use of advanced instrumentation will be its integration into intelligent, adaptive systems with associated software for complex modeling, simulation, data collection, pattern recognition, management, and analysis.

Activities in this area might include but are not limited to:

- Development, use, and dissemination of robust diagnostic systems that can be used for observing and remote sensing of complex environmental systems and processes, including living components
- Development, use, and dissemination of micro-mechanical and/or microelectronic systems (laboratories on a chip) that can be used *in situ* and can withstand the rigors of harsh natural environments
- Development of sensors for microbial activity using recent advances in micro-fabrication that enable high-density arrays of biologically based detection elements, e.g., nucleic acid, enzymatic, or immunochemical
- Coupling together of space-based observations of environmental phenomena with ground based *in situ* measurements of living systems and environments
- Development of technology to enhance the acquisition, display and analysis of real-time *in situ* environmental measurements.

In order to encourage the interplay of skills from disciplines such as engineering, physics, and computational science with areas such as biology, polar studies, and oceanography, proposals that support interdisciplinary teams or formation of such teams are solicited. Small interdisciplinary teams of typically 3-5 faculty researchers may request up to about \$500,000/yr for up to five years. Workshop, planning, or exploratory awards are one-time, one-year awards for up to \$100,000 that are expected to encourage development of interdisciplinary teams. Exploratory or planning grants should be aimed at providing preliminary results that can lead to group proposals in the near future. Approximately \$10.5 million is expected to be available in this topical area to support 8-10 team awards and 15-20 one-year activities of various types.

[Return to Program Description Contents](#)

III. ELIGIBILITY INFORMATION

The categories of proposers identified in the [Grant Proposal Guide](#) are eligible to submit proposals under this program announcement/solicitation.

IV. AWARD INFORMATION

Estimated program budget, number of awards and average award size/duration are subject to the availability of funds. The estimated number of awards and anticipated funding amount for each topical area are provided in Section II, Program Description.

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

Full Proposal Instructions:

Proposals submitted in response to this program announcement/solicitation should be prepared and submitted in accordance with the general guidelines contained in the NSF *Grant Proposal Guide* (GPG). The complete text of the GPG is available electronically on the NSF Web Site at: <http://www.nsf.gov/cgi-bin/getpub?nsf012>. Paper copies of the GPG may be obtained from the NSF Publications Clearinghouse, telephone (301) 947-2722 or by e-mail from pubs@nsf.gov.

Proposals involving Multiple Institutions:

In the case of proposals involving multiple institutions, a single institution should be identified as the lead institution and a single proposal describing the entire project should be submitted by that institution. Funds may be distributed among partner institutions via subcontracts from the lead institution. A budget on the standard NSF budget form should be submitted for each subcontractor. Letters confirming collaborations can be scanned and submitted via FastLane as Supplementary Documentation. If single projects are submitted in the form of multiple proposals (often called "collaboratives"), all proposals in the set shall be returned without review.

Proposals involving Foreign Investigators:

Proposers are reminded to provide as supplementary documentation the curriculum vitae of all proposed foreign counterpart investigators as well as letters of endorsement from the foreign counterparts' institutions.

Directing the Proposal to a BE Topical Area:

Once you have identified the Program Solicitation Number on the proposal Cover Sheet, the four relevant topical areas (i.e., CNH, CBC, GEN-EN, IDEA) will be listed in the Program Box. Highlight the topical area that your proposal addresses and click on the "Select Program" button. Your proposal will automatically be assigned to the correct directorate and division on the Cover Sheet.

Proposers are reminded to identify the program solicitation number (NSF 01-34) in the program announcement/solicitation block on the proposal Cover Sheet (NSF Form 1207). Compliance with this requirement is critical to determining the relevant proposal processing guidelines. Failure to submit this information may delay processing.

B. Budgetary Information

Cost sharing is not required in proposals submitted under this Program Solicitation.

Other Budgetary Limitations: Specific topical areas may have award size limitations. Details are in Section II, Program Description.

C. Deadline/Target Dates

Proposals submitted in response to this announcement/solicitation must be submitted by 5:00 PM, local time on the following date(s):

March 16, 2001	Deadline for CNH and IDEA
March 29, 2001	Deadline for CBC and GEN-EN

D. FastLane Requirements

Proposers are required to prepare and submit all proposals for this Program Solicitation through the FastLane system. Detailed instructions for proposal preparation and submission via FastLane are available at: <http://www.fastlane.nsf.gov/a1/newstan.htm>. For FastLane user support, call 1-800-673-6188.

Submission of Signed Cover Sheets. The signed copy of the proposal Cover Sheet (NSF Form 1207) must be postmarked (or contain a legible proof of mailing date assigned by the carrier) within five working days following proposal submission and be forwarded to the following address:

National Science Foundation
DIS – FastLane Cover Sheet
4201 Wilson Blvd.
Arlington, VA 22230

VI. PROPOSAL REVIEW INFORMATION

A. NSF Proposal Review Process

Reviews of proposals submitted to NSF are solicited from peers with expertise in the substantive area of the proposed research or education project. These reviewers are selected by Program Officers charged with the oversight of the review process. NSF invites the proposer to suggest at

the time of submission, the names of appropriate or inappropriate reviewers. Care is taken to ensure that reviewers have no conflicts with the proposer. Special efforts are made to recruit reviewers from non-academic institutions, minority-serving institutions, or adjacent disciplines to that principally addressed in the proposal.

Proposals will be reviewed against the following general review criteria established by the National Science Board. Following each criterion are potential considerations that the reviewer may employ in the evaluation. These are suggestions and not all will apply to any given proposal. Each reviewer will be asked to address only those that are relevant to the proposal and for which he/she is qualified to make judgements.

What is the intellectual merit of the proposed activity?

How important is the proposed activity to advancing knowledge and understanding within its own field or across different fields? How well qualified is the proposer (individual or team) to conduct the project? (If appropriate, the reviewer will comment on the quality of the prior work.) To what extent does the proposed activity suggest and explore creative and original concepts? How well conceived and organized is the proposed activity? Is there sufficient access to resources?

What are the broader impacts of the proposed activity?

How well does the activity advance discovery and understanding while promoting teaching, training, and learning? How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.)? To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks, and partnerships? Will the results be disseminated broadly to enhance scientific and technological understanding? What may be the benefits of the proposed activity to society?

Principal Investigators should address the following elements in their proposal to provide reviewers with the information necessary to respond fully to both of the above-described NSF merit review criteria. NSF staff will give these elements careful consideration in making funding decisions.

Integration of Research and Education

One of the principal strategies in support of NSF's goals is to foster integration of research and education through the programs, projects, and activities it supports at academic and research institutions. These institutions provide abundant opportunities where individuals may concurrently assume responsibilities as researchers, educators, and students and where all can engage in joint efforts that infuse education with the excitement of discovery and enrich research through the diversity of learning perspectives.

Integrating Diversity into NSF Programs, Projects, and Activities

Broadening opportunities and enabling the participation of all citizens -- women and men, underrepresented minorities, and persons with disabilities -- is essential to the health and vitality of science and engineering. NSF is committed to this principle of diversity and deems it central to the programs, projects, and activities it considers and supports.

Additional Review Criteria

Successful proposals in all topical areas of the competition must be highly interdisciplinary, address the inherent complexity and highly coupled nature of environmental systems, and involve systems that include interactions of biota or humans. The three integrative elements--quantitative approaches, education, and global perspectives--are also important. Research projects must include quantitative approaches or advanced conceptual models to study the systems chosen for investigation and specific plans for education. Plans that promote the development of long-term international partnerships will be given special consideration.

In addition to NSF's standard review criteria, planning or exploratory activities will be evaluated on their interdisciplinarity and their potential to advance the study of biocomplexity in the environment.

In the evaluation of proposals submitted by teams of investigators, including those on behalf of an international collaborative group, considerations in addition to standard NSF review criteria are:

- Strength of the collaborations planned and degree of interdisciplinarity
- Effectiveness of the group organization and management plan
- Value to education in these topical areas
- Strength of the dissemination plans
- Extent, effectiveness, and long-term potential of collaborations with industries, national laboratories, and comparable research centers abroad, when appropriate.

A summary rating and accompanying narrative will be completed and signed by each reviewer. In all cases, reviews are treated as confidential documents. Verbatim copies of reviews, excluding the names of the reviewers, are sent to the Principal Investigator/Project Director by the Program Director. In addition, the proposer will receive an explanation of the decision to award or decline funding.

B. Review Protocol and Associated Customer Service Standard

All proposals are carefully reviewed by at least three other persons outside NSF who are experts in the particular field represented by the proposal. This will be the case for proposals for all research projects over \$100,000 submitted in response to this announcement. More specifically, proposals in this category will be reviewed externally by mail review and/or panel review. Development or planning activities, exploratory, conference, or incubation proposals for under \$100,000 may be reviewed by a scientist, engineer, or educator serving as a NSF Program Officer and/or outside experts.

Reviewers will be asked to formulate a recommendation to either support or decline each proposal. The Program Officer assigned to manage the proposal's review will consider the advice of reviewers and will formulate a recommendation.

NSF will be able to tell applicants whether their proposals have been declined or recommended for funding within six months for 95 percent of proposals. The time interval begins on the proposal deadline or target date or from the date of receipt, if deadlines or target dates are not used by the program. The interval ends when the Division Director accepts the Program Officer's recommendation.

In all cases, after programmatic approval has been obtained, the proposals recommended for funding will be forwarded to the Division of Grants and Agreements for review of business, financial, and policy implications and the processing and issuance of a grant or other agreement. Proposers are cautioned that only a Grants and Agreements Officer may make commitments, obligations or awards on behalf of NSF or authorize the expenditure of funds. No commitment on the part of NSF should be inferred from technical or budgetary discussions with a NSF Program Officer. A Principal Investigator or organization that makes financial or personnel commitments in the absence of a grant or cooperative agreement signed by the NSF Grants and Agreements Officer does so at its own risk.

VII. AWARD ADMINISTRATION INFORMATION

A. Notification of the Award

Notification of the award is made to *the submitting organization* by a Grants Officer in the Division of Grants and Agreements. Organizations whose proposals are declined will be advised as promptly as possible by the cognizant NSF Program Division administering the program. Verbatim copies of reviews, not including the identity of the reviewer, will be provided automatically to the Principal Investigator. (See section VI.A. for additional information on the review process.)

B. Award Conditions

An NSF award consists of: (1) the award letter, which includes any special provisions applicable to the award and any numbered amendments thereto; (2) the budget, which indicates the amounts, by categories of expense, on which NSF has based its support (or otherwise communicates any specific approvals or disapprovals of proposed expenditures); (3) the proposal referenced in the award letter; (4) the applicable award conditions, such as Grant General Conditions (NSF-GC-1)* or Federal Demonstration Partnership (FDP) Terms and Conditions * and (5) any announcement or other NSF issuance that may be incorporated by reference in the award letter. Cooperative agreement awards also are administered in accordance with NSF Cooperative Agreement Terms and Conditions (CA-1). Electronic mail notification is the preferred way to transmit NSF awards to organizations that have electronic mail capabilities and have requested such notification from the Division of Grants and Agreements.

*These documents may be accessed electronically on NSF's Web site at http://www.nsf.gov/home/grants/grants_gac.htm. Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (301) 947-2722 or by e-mail from pubs@nsf.gov.

More comprehensive information on NSF Award Conditions is contained in the NSF *Grant Policy Manual* (GPM) Chapter II, available electronically on the NSF Web site at

<http://www.nsf.gov/cgi-bin/getpub?gpm>. The GPM is also for sale through the Superintendent of Documents, Government Printing Office (GPO), Washington, DC 20402. The telephone number at GPO for subscription information is (202) 512-1800. The GPM may be ordered through the GPO Web site at <http://www.gpo.gov>.

Special Award Conditions

Additional award conditions may be included addressing the pilot testing and evaluation of materials on pre-college students and the distribution or commercial publication of materials developed, a license for government use, and program income. Meetings or workshops for principal investigators may be called by NSF, but not more frequently than once a year. Investigators will be expected to make every reasonable effort to attend and to use grant funds to support their travel expenses.

C. Reporting Requirements

For all multi-year grants (including both standard and continuing grants), the PI must submit an annual project report to the cognizant Program Officer at least 90 days before the end of the current budget period.

Within 90 days after the expiration of an award, the PI also is required to submit a final project report. Approximately 30 days before expiration, NSF will send a notice to remind the PI of the requirement to file the final project report. Failure to provide final technical reports delays NSF review and processing of pending proposals for that PI. PIs should examine the formats of the required reports in advance to assure availability of required data.

NSF has implemented an electronic project reporting system, available through FastLane. This system permits electronic submission and updating of project reports, including information on project participants (individual and organizational), activities and findings, publications, and other specific products and contributions. PIs will not be required to re-enter information previously provided, either with a proposal or in earlier updates using the electronic system.

VIII. CONTACTS FOR ADDITIONAL INFORMATION

General inquiries regarding Biocomplexity in the Environment (BE): Integrated Research and Education in Environmental Systems should be made to:

- For contacts in *Dynamics of Coupled Natural and Human Systems*, see www.geo.nsf.gov/be-01.htm#cnh.
- For contacts in *Coupled Biogeochemical Cycles*, see www.geo.nsf.gov/be-01.htm#cbc.
- For contacts in *Genome-Enabled Environmental Science & Engineering*, see www.geo.nsf.gov/be-01.htm#genen.
- For contacts in *Instrumentation Development for Environmental Activities*, see www.geo.nsf.gov/be-01.htm#idea.
- For contacts about the integrative element on *Education*, see www.geo.nsf.gov/be-

[01.htm#edu](#).

- For contacts about the integrative element on *Global Perspective*, see www.geo.nsf.gov/be-01.htm#gp.
- For contacts about the integrative element on *Quantitative Approaches*, see www.geo.nsf.gov/be-01.htm#qa.

For questions related to the use of FastLane, contact:

- Brian Dawson, Computer Specialist, Directorate for Geosciences, Division of Earth Sciences, telephone: 703.292.4727, e-mail: bdawson@nsf.gov.
- Florence Rabanal, Fastlane Project Coordinator, Directorate for Mathematical and Physical Sciences, telephone: 703.292.8808, e-mail: mpsoadfl@nsf.gov.
- Maya S. Anderson, Program & Technology Analyst, Directorate for Biological Sciences, Division of Integrative Biology & Neuroscience, telephone: 703.292.8421, e-mail: biofl@nsf.gov.
- Philip Johnson, Computer Specialist, Directorate for Social, Behavioral, and Economic Science, Division of Behavioral and Cognitive Sciences, telephone: 703.292.8740, e-mail: pxjohnso@nsf.gov.

IX. OTHER PROGRAMS OF INTEREST

The NSF *Guide to Programs* is a compilation of funding for research and education in science, mathematics, and engineering. The NSF *Guide to Programs* is available electronically at <http://www.nsf.gov/cgi-bin/getpub?gp>. General descriptions of NSF programs, research areas, and eligibility information for proposal submission are provided in each chapter.

Many NSF programs offer announcements or solicitations concerning specific proposal requirements. To obtain additional information about these requirements, contact the appropriate NSF program offices. Any changes in NSF's fiscal year programs occurring after press time for the *Guide to Programs* will be announced in the NSF [E-Bulletin](#), which is updated daily on the NSF web site at <http://www.nsf.gov/home/ebulletin>, and in individual program announcements/solicitations. Subscribers can also sign up for NSF's [Custom News Service](#) (<http://www.nsf.gov/home/cns/start.htm>) to be notified of new funding opportunities that become available.

ABOUT THE NATIONAL SCIENCE FOUNDATION

The National Science Foundation (NSF) funds research and education in most fields of science and engineering. Awardees are wholly responsible for conducting their project activities and preparing the results for publication. Thus, the Foundation does not assume responsibility for such findings or their interpretation.

NSF welcomes proposals from all qualified scientists, engineers and educators. The Foundation strongly encourages women, minorities and persons with disabilities to compete fully in its programs. In accordance with Federal statutes, regulations and NSF policies, no person on grounds of race, color, age, sex, national origin or disability shall be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving financial assistance from NSF (unless otherwise specified in the eligibility requirements for a particular program).

Facilitation Awards for Scientists and Engineers with Disabilities (FASSED) provide funding for special assistance or equipment to enable persons with disabilities (investigators and other staff, including student research assistants) to work on NSF-supported projects. See the program announcement/solicitation for further information.

The National Science Foundation has Telephonic Device for the Deaf (TDD) and Federal Information Relay Service (FIRS) capabilities that enable individuals with hearing impairments to communicate with the Foundation about NSF programs, employment or general information. TDD may be accessed at (703) 292-5090, FIRS at 1-800-877-8339.

The National Science Foundation is committed to making all of the information we publish easy to understand. If you have a suggestion about how to improve the clarity of this document or other NSF-published materials, please contact us at plainlanguage@nsf.gov.

PRIVACY ACT AND PUBLIC BURDEN STATEMENTS

The information requested on proposal forms and project reports is solicited under the authority of the National Science Foundation Act of 1950, as amended. The information on proposal forms will be used in connection with the selection of qualified proposals; project reports submitted by awardees will be used for program evaluation and reporting within the Executive Branch and to Congress. The information requested may be disclosed to qualified reviewers and staff assistants as part of the proposal review process; to applicant institutions/grantees to provide or obtain data regarding the proposal review process, award decisions, or the administration of awards; to government contractors, experts, volunteers and researchers and educators as necessary to complete assigned work; to other government agencies needing information as part of the review process or in order to coordinate programs; and to another Federal agency, court or party in a court or Federal administrative proceeding if the government is a party. Information about Principal Investigators may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See Systems of Records, NSF-50, "Principal Investigator/Proposal File and Associated Records," 63 Federal Register 267 (January 5, 1998), and NSF-51, "Reviewer/Proposal File and Associated Records," 63 Federal Register 268 (January 5, 1998). Submission of the information is voluntary. Failure to provide full and

complete information, however, may reduce the possibility of receiving an award.

Pursuant to 5 CFR 1320.5(b), an agency may not conduct or sponsor, and a person is not required to respond to an information collection unless it displays a valid OMB control number. The OMB control number for this collection is 3145-0058. 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 and any other aspect of this collection of information, including suggestions for reducing this burden, to: Suzanne Plimpton, Reports Clearance Officer, Information Dissemination Branch, Division of Administrative Services, National Science Foundation, Arlington, VA 22230, or to Office of Information and Regulatory Affairs of OMB, Attention: Desk Officer for National Science Foundation (3145-0058), 725 17th Street, N.W. Room 10235, Washington, D.C. 20503.

OMB control number: 3145-0058.