

Maine EPSCoR: National Science Foundation (NSF) Experimental Program to Stimulate Competitive Research (EPSCoR) Research Infrastructure Improvement Track I Award Program



NSF EPSCoR Award I
FY1980-1987 - RII-8011448
NSF Funds: \$2.9M * Total Project \$4.3M



“An Experimental Program to Stimulate Competitive Research: Phase B Implementation Plan in Maine”

This program focused on Earth Sciences and Marine Sciences. The research in Earth Sciences was conducted at the University of Maine (UMaine) within the Department of Geological Science and was comprised of two components—Appalachian Geology and Coastal Sedimentology. The Marine Sciences research was conducted jointly by scientists from UMaine and from the Bigelow Laboratory for Ocean Sciences (BLOS). The marine research focused on the Gulf of Maine—UMaine provided the leadership for studies of the dynamics of material in bottom sediments; BLOS provided the leadership for studies of the water column.

Maine’s experience as a first-round EPSCoR state was clearly successful in strengthening the targeted areas of Appalachian Geology and Maine Sciences, allowing Maine EPSCoR researchers to consequently compete with greater success for additional federal research funds.

Intellectual Merit:

- Research results by Maine scientists not only extended the boundaries of their disciplines, but also contributed to our practical knowledge of the geology and marine environment of Maine. These findings have been of major significance to Maine as policymakers continuously seek to efficiently and successfully manage the State’s natural resources for current and future generations.
- The EPSCoR targeted researchers, on average, were highly successful in achieving funding for their continuing research projects. *From July 1984 through July 1987, the 8 EPSCoR researchers at the University of Maine were awarded a total of 30 competitive grants totaling over \$800,000.*

Faculty:

- UMaine was able to attract nationally competitive scientists to fill critical positions in both Geological and Marine Sciences; *5 Faculty members were hired during this award.* UMaine supported the retention of these scientists by appointing them to new tenure-track positions in their academic departments.

Physical Infrastructure:

- \$1,000,000 in award funds were used for physical infrastructure at UMaine including an Ar-dating Laboratory and a Heat-flow Laboratory.

Capital Equipment:

- The laboratories used by the EPSCoR researchers were equipped and modernized to enhance continuing research competitiveness.
 - *During the award period, \$160,000 in grant funds purchased the following major equipment: Mass Spectrometer (\$125k in 1980) Ratheon Ocean Systems RTT-1000A-1 (\$30k in 1983); Spectrophotometer (\$10k in 1983)*

Broader Impacts:

- Cooperation and lines of professional communication among researchers at UMaine, the BLOS, regulatory staff, policy makers at the Maine Geological Survey, and the State Department of Marine Resources were established and continue today.

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**NSF EPSCoR Award II
FY1990-1993 - RII-8922105
NSF Funds: \$1.2M * Total Project \$5.5M**



“EPSCoR Human Resource Development Supplement - Global Climate Change: Maine EPSCoR Marine Science Component; Abrupt Global Climate Changes and their Consequences to Maine”

The overall goals of this EPSCoR program were to develop an interdisciplinary and well-equipped scientific team to resolve the record of recent abrupt global climate change and consider the impact of future climate change on Maine's environment. There were two project areas: (1) Global Climate Change: Maine EPSCoR Marine Science Component, and (2) Abrupt Global Climate Change and their Consequences to Maine. The research included determining and comparing the paleo-environmental records from 45-degrees North latitude (Maine and the Atlantic Ocean) and 45-degrees South latitude (southern Chile). The goal of this comparison was to test leading hypotheses regarding the mechanisms of global climate-change. Based on those findings, the research team evaluated the potential response of global sea level and the ecosystems of Maine to potentially abrupt climate change associated with greenhouse warming.

Intellectual Merit:

- This research was the first comparison of its kind and significantly advanced scientific knowledge regarding the global climate system by substantiating that the direction and timing of climate change is synchronous in both hemispheres. Consequently, atmospheric forces are the primary cause of abrupt global climate change.
- **The following findings were presented in four papers in *Science*:** (1) the Younger Dryas cold event was expressed in New Zealand, and was thus global in extent; (2) pronounced climate changes during the past 50,000 years in Florida were contemporaneous with major surges of icebergs into the North Atlantic (Heinrich events), and were thus part of a global phenomenon; (3) advances of Andean glaciers in Chile were also contemporaneous with Heinrich events; and (4) the El Nino/Southern Oscillation phenomenon may have originated at about 5000 years ago.
- **From 1989-1992 the two research clusters received the following in additional external funding**
 - \$2.3M - Global Climate Change
 - \$4M - Marine Molecular Biology

Faculty and Students:

- From 1992-1996, Faculty supported on this project published over 200 scientific articles and abstracts in Global Climate Change and Marine Molecular Biology.
- This project supported 12 Graduate Student Internships and funded 7 undergraduate trips abroad.

Physical Infrastructure:

- EPSCoR funds were used to create a Stable-Isotope Laboratory at UMaine that has broad capabilities for research in climate change and other sciences and the Paleoecology Computer Modeling Center and Process Sampling Laboratory were upgraded.
- **Funds were also used to support new laboratories, including:**
 - 2 Archaeology Labs (\$58,000)
 - Chemical Oceanography Lab (\$93,000)
 - Vegetation Modeling Lab (\$28,000)

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NSF EPSCoR Award III
FY1992-1996 - RII-9108766
NSF Funds: \$3M * Total Project \$8.8M



***“Maine EPSCoR Advanced Development Program
Wood Science Engineering, Marine Molecular Biology and Global Environmental Change”***

There were 3 Clusters or Project Areas in this award: Marine Molecular Biology (MMB), Wood Science Engineering (WSE), Global Environmental Change Center (GECC).

MMB

- **Faculty, Students, Staff:** Key accomplishments included (1) creation of two new tenure-track faculty positions at UMaine; (2) initiation of a continuing annual hands-on intensive short-course in Marine Molecular Biology, which is taught at MDIBL by UM faculty; (3) establishment of a fully-instrumented and professionally staffed Automated DNA-Sequencer facility at UM, (4) support of nine research projects; and (5) a graduate student in the MMB research cluster was awarded the Outstanding Student Award in the U.S., including Canada, due to her research in molecular biology.
- **Physical Infrastructure:** The NSF-EPSCoR-funded DNA-sequencing facility and overall research capacity in MMB played a key role in the school’s research and education programs. In addition, new applications of marine-related genetic research were used to address specific needs of the state’s emerging aquaculture industry. These efforts were developed in cooperation with Maine’s Center for Biomedical Technology.
- **Other Grant Funding:** *MMB PIs received \$2,577,466 in additional external funding* and the high-resolution Gas Chromatograph-Mass Spectrometer purchased with EPSCoR funds leveraged a 2-year, \$600,000 contract from the Maine Dept. of Environmental Protection.

WSE

- **Intellectual Merit:** Timber Bridge/FRP Hybrids Project: In FY 1994, WSE PIs in this project developed a viable technique for bonding FRPs to wood, and constructed and tested twelve full-scale FRP-reinforced laminated beams. The results demonstrated that with as little as 2% reinforcement with FRPs by volume, the strength of glulam beams made with low-quality eastern hemlock is increased by up to 50%. These results had great significance for the current and future economic value of Maine’s abundant, low quality timbers. *Consequently, several Maine industries expressed interest in commercializing the reinforcement process and in producing FRP-reinforced beams in Maine.*
 - The PIs completed a study of mechanical properties of under-utilized Maine wood species, with a focus on red maple. The study involved NDE testing of the stiffness of 25,000 bf of red maple. The results showed that Maine red maple has excellent stiffness properties, even in the lower grades. As a result of this study, the Maine DOT plans to build four bridges using red maple of the next two years. Three demonstration bridges were designed and constructed in 1995.

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{WSE, cont.}

- **Physical Infrastructure:** PIs also completed New England's largest bridge testing facility (65' x 30' bridge with maximum load of 400,000 pounds) and 19 demonstration bridges were built or planned.
- **Other Grant Funding:** During the award period, PIs received \$1.6 million in additional external funding. In addition, they received these specific awards:
 - *\$4.5M from USDA over 5 years to improve wood research at UMaine*
 - *FHA funding of wood bridges: \$552,000 Maine DOT award*
 - *The University of Maine received a \$3M award from the Economic Development Administration for a new Composite-Reinforced Wood Hybrid Research Pilot Plant, and Testing Facility.*

GECC:

- **Intellectual Merit:** The following findings made during the award period by GECC researchers were presented in four papers in *Science*: (1) the Younger Dryas cold event was expressed in New Zealand, and was thus global in extent; (2) pronounced climate changes during the past 50,000 years in Florida were contemporaneous with major surges of icebergs into the North Atlantic (Heinrich events), and were thus part of a global phenomenon; (3) advances of Andean glaciers in Chile were also contemporaneous with Heinrich events; and (4) the El Nino/Southern Oscillation phenomenon may have originated at about 5000 years ago.
 - Collaborative research by a GECC archaeologist and a paleoclimatologist showed that the famous "El Nino" climate oscillations, which significantly affect ocean-atmosphere conditions from South America to California today, began abruptly only about 5,000 years ago. *These results, which suggest that El Nino may disappear if global temperatures continue to increase, were also published in Science.*
- **Faculty and Students:** The GECC Cluster hired two new Quaternary geologists specializing in stable isotopes and, as a result, built an internationally competitive research program at the University of Maine. These faculty members brought great scientific expertise to the University and were instrumental in bringing the quality of the analytical work performed in the Stable-Isotope Laboratory to the highest level achievable in any laboratory in the country. A critical factor in the success of this program was the commitment by the University of Maine at the time of hiring to support these positions permanently, as additions to university faculty already engaged in the UMaine's Global Climate Change initiative.
- **Physical Infrastructure:** The Stable Isotope Lab, including 2 Mass Spectrometers, established under EPSCoR II—is considered one of the U.S. leading labs.
- **Other Grant Funding:** GECC PIs received \$4 million in additional grants during this award period.

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**NSF EPSCoR Award IV
FY1996-1999 - RII-9629575
NSF Funds: \$5.3M * Total Project \$9.4M**



“Structural Composites Semi-Works and Testing Facility at the University of Maine & Improving Research Capacity in Cold-water; Marine Aquaculture at the University of Maine”

This award supported two projects at UMaine: Structural Composites Semi-Works and Testing Facility at the University of Maine (AEWC—Advanced Engineered Wood Composites) & Improving Research Capacity in Cold-water, Marine Aquaculture at the University of Maine (AQUA).

AEWC: Physical Infrastructure: This EPSCoR award supported the creation of the Advanced Engineered Wood Composites (AEWC) Center at UMaine. Officially opened in 1999, the AEWC’s original 30,000 square-foot laboratory was founded with the vision of being unique in the world for its capability to integrate wood- and bio-based composites materials development, processing research, advanced materials research, and large-scale structural testing under one roof. Since 1999, the Center has achieved remarkable growth and expansion of its capabilities. While the Center remains a leader in bio-based composite engineering and wood science, it is now known world-wide for research in composite materials for civil infrastructure, consumer markets, military applications, and the boatbuilding industry; materials and structures for deepwater offshore wind power; nano-composites; and novel engineering solutions for the transportation and power industries.

- **Faculty:** AEWC hired 3 new faculty members during the award period, in the areas of Wood Science and Technology Civil and Environmental Engineering—all 3 researchers continue today at UMaine’s AEWC.
 - **Development and support of New and Junior Faculty and Students.** Two new faculty—prominent in their fields of composite materials and polymer science, a research project engineer, and an administrative assistant were hired through the project in 1998. One of the two new faculty members brought over \$600,000 in research funding and three graduate students. The applicant pool for the faculty positions exceeded 200 and AEWC was able to attract their top choices, particularly because of the AEWC program and the new research facility.
- **Other Grant Funding:** By 1998, this NSF EPSCoR grant allowed AEWC cluster researchers to leverage significant resources and to conduct dozens of projects, including:
 - \$380,000 from the USDA WUR program (4 projects at \$95,000 each)
 - \$400,000 from industry/private sources for CRW laboratory
 - \$140,000 NSF REU
 - \$630,000 NSF MRI
 - \$200,000 NSF-Career award
 - Numerous projects ranging from \$5,000 to \$35,000 from the Maine DOT, USDA Forest Products Lab, USDA Timber Bridge Initiative, and the FWHA Timber Bridge Demonstration program

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AQUA:

- **Intellectual Merit:** The CCAR's research focus is very wide ranging and includes studies on development of rearing protocols, systems engineering, nutrition, physiological studies, environmental impact, integrated aquaculture, economics, health, control of reproduction and genetics. The participants in this project identified the bacterium species responsible for Juvenile Oyster Disease
- **Faculty:** Approximately \$2 million in NSF EPSCoR funds were used to hire five faculty members in critical research areas
- **Physical Infrastructure:** EPSCoR program participants were instrumental in the conversion of a fish hatchery--purchased by the University--in Franklin, Maine into a substantial aquaculture research facility and business incubator. This facility is the now the Center for Cooperative Aquaculture Research (CCAR). The CCAR's research is aimed at developing technologies for farming a diverse range of aquatic organisms.
 - The facilities at the CCAR are extensive and numerous. Large scale facilities hold permanent populations (such as broodstock) or temporary populations (such as nursery stage fish). Large numbers of fish or invertebrates for production in multiple tanks can allow replicated trials in some cases and so research can complement production.
 - This project also extensively improved shellfish culture and research facilities at the University of Maine's Darling Marine Center in Walpole, and enhanced multiuse aquaculture research facilities at the UMaine.
- **Broader Impacts:** These infrastructure improvements and research outcomes stimulated the establishment of a new state-funded business incubator program for the aquaculture industry, co-located at the three UM sites, as well as a \$20+ million investment by the USDA to establish the National Cold Water Marine Aquaculture Center at the University of Maine.

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**NSF EPSCoR Award V
FY2000-2003 - EPS-0093432
NSF Funds: \$3M * Total Project \$6M**



“University of Maine Research Infrastructure to Enhance Maine’s High-Technology Industries (Biosensors) & Intelligent Spatial Technology Institute (ISTI)”

This NSF EPSCoR Award supported two research projects: the Biosensors program, and the creation of an Intelligent Spatial Technology Institute (ISTI).

Biosensors

Intellectual Merit: UMaine’s Biosensor Technology program is centered within the Laboratory for Surface Science & Technology (LASST), an organized interdisciplinary research unit that was established in 1980 to combine expertise from several academic departments and industrial partners. Building on this solid foundation, the NSF EPSCoR award allowed for the development of a comprehensive biosensor research program addressing the theory, design, and fabrication of sensor elements, and the characterization and testing of prototype sensor arrays.

Faculty: *This EPSCoR program supported the hiring of three new faculty members in the field of Biosensor research:* a bioengineer, a biochemist and a microbiologist. These researchers were attracted to the University of Maine by the lure of doing multidisciplinary research in a brand new facility, and by the collaborative environment in the State of Maine which would allow them to work with several small, high-tech businesses, and to address the needs of world-class scientists at the non-profit Jackson Laboratory in Bar Harbor. With the addition of the clean room, which they helped design, one new faculty member commented that “It’s unusual to find this broad scope of technology in one place - that means we have a large toolbox for any instrument we want to build, and it positions the University to be very competitive.”

A major emphasis for the Biosensor Technology group was to concentrate on overcoming significant scientific and engineering barriers that have prevented the successful commercialization of biosensors to date. Results of their research have application to many areas such as genetics, proteomics (the study of proteins produced by cells), oceanography, aerospace technology, optics, dermatology, materials science, paper coatings, food science, and homeland security.

Major Equipment: \$105,192 Pattern Generator; \$128,742 E-Beam System; \$250,000 Wafer to Mask Aligner; \$113,465 UV Laser System.

Other Grant Funding: Biosensor researchers in this award period *leveraged an additional \$4.6M* in external funding for their research. These grants are funding research that develops analytical devices for fields as diverse as genome sequencing, bioterrorism, water quality, human health, and pathogen detection in fish.

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ISTI

Intellectual Merit: IST's major research findings were in three domains: (1) ontology-based geospatial models for events, (2) mobile spatial computing, and (3) geosensor networks. Driven by the semantic web and the need to capture explicitly semantics, we have developed new computational methods and tools to incorporate geontologies into information systems. At the EPSCoR-created Intelligent Spatial Technologies Institute a new mapping technology was developed. Called iMaps, this handheld technology supports the delivery of geospatial information in the form of intelligent, interactive, and Internet-connected maps. iMaps integrate location sensors (GPS, gyroscope, laser) with geospatial information to provide users faster and more accurate information. Key features of iMaps include intelligent zooming and panning, adaptive orientation, task-oriented thematic display, interaction with voice and pen, real-time updates, and flexible use in various terrains and vehicles. This form of intelligent spatial technology requires significant advancements in information management, database technologies, and human-computer interaction. By working across these research areas, the investigators can ensure that their information systems products accurately respond to the needs of users and society—and are not too complicated to operate.

Throughout this project, significant research and educational opportunities were provided for students at the undergraduate and graduate levels. The work of the iMaps project is directly investing in the development of new GIS-based computer software products and systems. New technologies and their applications include: advanced field surveying technologies, global positioning systems, digital photography, remote sensing, and easy-to-use spatial data management tools for use by all levels of Maine government, Maine's surveying companies, and the military. UMaine transferred this technology to existing Maine companies, and used it to recruit GIS companies to Maine.

Faculty: *This EPSCoR program supported the hiring of three new faculty members in the field of Intelligent Spatial Technologies.*

Major Equipment: ISTI Purchased high-end workstations for new faculty members: \$150,000 each; total: \$450,000

Other Grant Funding: ISTI researchers in this award period *leveraged an additional \$9.5M* in external funding for their research.

Spin-off Company: The ISTI's spin-off company, Intelligent Spatial Technologies (IST) LLC has been a continuing collaborator on several research projects, providing a new avenue for technology. IST has evolved to *iPointer Inc.*, a privately owned geospatial research and product development company headquartered in California. iPointer has developed a flexible and scalable geospatial platform, The iPointer® ID Engine, for Location-based Mobile Search.

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NSF EPSCoR Award VI
FY2003-2006 - EPS-0132384
NSF Funds: \$6M * Total Project \$12.7M



“Establishing Research Competitiveness in Biophysical Sciences in Maine”

This project established the Institute for Molecular Biophysics (IMB) as an internationally recognized interdisciplinary research center for investigating the molecular processes that determine cell function and fate. The IMB integrated a robust, sustainable research program with education and outreach agendas to significantly enhance Maine’s R&D infrastructure and human capital. A collaboration among the University of Maine (UMaine) and two Maine non-profits—The Jackson Laboratory (TJL) and Maine Medical Center Research Institute (MMCRI)—the IMB leveraged the significant strengths of these partners. This collaborative project bolstered Maine’s capacity and competitiveness in biomedical research with vibrant research programs in biological applications of ultra-high resolution microscopy, the development of novel probes for microscopy and *in vivo* imaging, biocomputing and bioengineering.

Faculty: *This EPSCoR award supported the hiring of 4 new faculty members.*

Students: The research and education of 61 post-doctoral, graduate and undergraduate students was directly supported by NSF EPSCoR funds. In addition, IMB scientists mentored over 23 post-doctoral associates and 20 graduate students in the Functional Genomics Program (supported by an NSF IGERT grant).

Major Equipment:

- Axioplan 2 MOT Microscope and Software: \$85,000
- 4Pi confocal laser scanning microscope and table: 163,000

Physical Infrastructure: The following equipment was custom designed and built by IMB researchers: a 2-photon confocal microscope; a single photon time-correlated fluorescence Raman spectromicroscope; IR micro fluidic cell for synchrotron studies; SFG apparatus.

Other Grant Funding: In the 4 years of NSF funding, IMB members submitted over 50 grant proposals in support of IMB related projects. Of those, 23 were funded for more than \$6 million. Notably, the IMB received an NSF MRI award and a \$ 1.2 million grant from the Keck Foundation that supported the acquisition of a 4Pi microscope and a multiphoton confocal microscope. Researchers at UMaine soon after received another NSF MRI to acquire and develop ultra-high resolution spectroscopic instruments. The IMB’s international partners received nearly 6 million Euros from the European Union and Deutsche Forschungsgemeinschaft (DFG) to support IMB research and collaborations.

Intellectual Merit: In the period of this EPSCoR award, IMB researchers published 160 articles in peer-reviewed journals and completed 5 book chapters.