

National Ecological Observatory Network (NEON)

Project Description: NEON will be a continental scale research platform consisting of geographically distributed infrastructure for ecological research that is networked via state-of-the-art communications technology. Cutting-edge sensor networks, instrumentation, experimental infrastructure, natural history archive facilities, and remote sensing will be linked via the internet to computational, analytical, and modeling capabilities to comprise NEON.

Principal Scientific Goals: NEON will advance ecological research by enabling studies of the biosphere at regional to continental scales, quantifying the forces regulating these systems, and predicting the consequences of climate and land use change on the biosphere. Through remote sensing, in-situ observation, experimentation, synthesis, and modeling, the National Ecological Observatory Network will enable transformative scientific approaches needed to quantify and understand the complex biosphere processes and interactions that operate across local to continental scales.

As a “shared-use” research platform to advance fundamental understanding of the biosphere NEON will facilitate interdisciplinary research on the complex interactions between the biological, physical and human drivers of ecological change. NEON will be used to make comprehensive, regional to continental-scale observations on ecological systems and thus will represent a virtual laboratory for research to obtain a predictive understanding of the biosphere.

Principal Education Goals: The knowledge base NEON will create, its real time and continuous integrated data, simulation and observation capabilities, and its networked communication will be an asset for formal and informal education and training. NEON will foster the NSF goal of integrating research and education by creating a research-intensive and collaborative learning environment. A NEON gateway will provide resources to support informal public education and provide opportunities for citizens to actively participate in scientific investigations. Data from standard measurements made using NEON will be publicly available.

Partnerships and Connections to Industry: Federal agencies such as the U.S. Geological Survey (USGS), the Environmental Protection Agency (EPA), and the Department of Energy (DOE) participated in the NEON Advisory Board and planning committees. A NEON Federal Agency Coordinating Committee meets on a regular basis¹. Discussions are underway with the U.S. Department of Agriculture (USDA), National Park Service (NPS), USGS, and DOE on formal agreements. NEON will be the only observation network that will be able to provide the *in situ* biospheric component called for in the U.S. Group on Earth Observations Ten-year Strategic Plan. International perspectives are provided through the Global Lakes Ecological Observatory Network (GLEON) with Australia, New Zealand, Taiwan, China, South Korea, U.K., Finland, Sweden, Israel, and Canada. GLEON is a cyberinfrastructure and sensor prototype for NEON that focuses on lake metabolism. Private foundations, e.g., the Heinz Center, Nature Serve, and U.S. Landtrust, are participating in the NEON design and research and development. NEON-generated information will be useful to natural resource industries, such as forestry and fisheries. Resource managers and decision makers will participate in NEON through partnerships; use of its facilities, data, and forecasts; and education, training, and outreach opportunities. NEON’s scientific and networking demands require technological innovations that involve partnerships with industry for infrastructure development, deployment, and operation.

Management and Oversight: The Division of Biological Infrastructure (DBI) within the Directorate for Biological Sciences (BIO) provides oversight for the development, construction, and implementation of NEON. The NEON program officer, in consultation with a BIO-NEON committee, which includes the

¹ A full list of the members of these committees can be provided on request.

BFA DDLFP, formulates the program planning of NEON, i.e., drafting, release, and review of program solicitations, etc. The BIO Advisory Committee provides external advice to BIO about specific program planning aspects of NEON.

The NEON program officer is a member of the NSF Environmental Observing Networks Task Force and serves on the PATs for other large facility projects, such as the Network for Earthquake Engineering Simulation (NEES), OOI, and Global Environment for Network Investigations (GENI). Coordination with other federal agencies occurs through the NEON Federal Agency Coordinating Committee. In addition, NEON is represented on the Architecture and Data Management task force of the U.S. Group on Earth Observations, the U.S. component of Global Earth Observation System of Systems (GEOSS), an activity of the National Science and Technology Council, Committee on Environment and Natural Resources.

Current Project Status: In FY 2006, a research community Consortium (NEON Inc.), which provides a link between NEON planning and construction, was established. The NEON Integrated Science and Education Plan and Networking and Informatics plans were merit reviewed. The preliminary Project Execution Plan (PEP), and Project Development Plan (PDP) were submitted for review. Research and development on environmental sensors, networks, and cyber tools that advanced the development of NEON as a network of nationally deployed infrastructure was supported through the R&RA account. R&RA funds were also provided to the Consortium of Regional Ecological Observatories to evaluate deployment criteria and locations across the continental U.S., Alaska, Hawaii, and Puerto Rico and to form the collaborations, partnerships, and organizations needed for NEON infrastructure deployment.

A Conceptual Design Review was held in November 2006. The review panel concluded that “NEON has made impressive progress in engaging the ecological community, in defining representative NEON domains across the continent, and in creating a vision for a continental-scale environmental biology capability. NEON has defined site-independent domain systems of fixed and movable sensors, with associated remote and mobile sensing, biotic data gathering and cyberinfrastructure. An integrated science plan illustrates how this system may be used to address NEON science questions. NEON has defined a governance process for the construction and operations phases. First cost estimates and preliminary schedules have been developed.” The review panel also recommended that, led by the new Chief Executive Officer, NEON should prepare for a Preliminary Design Review (PDR) (planned for May 2007) and outlined the steps needed to achieve this goal.



Persistent sensing, sentinel measurements, remote sensing campaigns, satellite images, and legacy data will be connected and enabled via cyberinfrastructure into a national research platform. *Credit: Nicolle Rager-Fuller, NSF*

In FY 2006, R&RA funding was provided to NEON for the Cyberinfrastructure for Environmental

Observatories: Prototype Systems to Address Cross-Cutting Needs competition to stimulate interdisciplinary collaborations that result in the development and deployment of viable prototype cyberinfrastructure for environmental observatories. The resulting awards expanded NEON research and development to include a cyberinfrastructure research program to address interoperability with other networks and observing systems.

During FY 2007, R&RA funds will be used to complete the final PEP for NEON, address specific site deployment, support NEON office activities, and begin work on Environmental Impact Assessments and/or Environmental Impact Statements (EIA/EIS). R&RA funds will also continue to support ongoing R&D projects such as environmental sensors and networks, cyberinfrastructure for environmental observatories, and enabling technologies for ecological forecasting. Following successful reviews as specified in NSF's Guidelines for Planning and Managing the MREFC Account, FY 2007 MREFC funds will be used for the construction and evaluation of the integrated NEON fundamental sensor infrastructure and cyberinfrastructure backbone, focusing on the NEON Fundamental Instrument Unit (FIU) Sensor Array Integration, the Cyberinfrastructure Network Integration, and Software Development to create an end to end observation system.

In FY 2008, NEON R&RA funds will be used to complete site deployment assessments and selection, EA/EIS studies (as appropriate); NEON project office costs prior to initiation of construction (if construction is delayed in FY 2007 or until late in FY 2008), and ongoing R&D projects on environmental sensors and networks, cyberinfrastructure for environmental observatories, and enabling technologies for ecological forecasting. MREFC funds are requested for the NEON Construction Office, Project Management Control System, and to begin mass construction of the NEON Fundamental Instrumentation Unit and embedded cyberinfrastructure and network level cyberinfrastructure.

Major milestones for NEON are listed below.

FY 2006 Milestones:

- NEON Inc. established
- NEON Science Plan and Requirements merit review completed
- Baseline Networking and Informatics Plan and an external design review completed
- NEON Conceptual Design, Preliminary PEP, and PDP completed
- Management review of the NEON Design Consortium and Project Office completed
- R&D of cyberinfrastructure to address interoperability with other environmental networks and observing systems funded

FY 2007 Milestones:

- NEON Conceptual Design Review (CDR) conducted in November 2006
- NEON infrastructure deployment plan to be finalized
- Final PEP to be completed
- NEON Preliminary Design Review (PDR) to be conducted in May 2007
- EIA/EIS will begin
- NEON fundamental technology unit (BioMesoNet, sensor micronets, and enabling cyberinfrastructure) will be assembled and integrated
- NEON Construction Project Office will start-up
- R&D projects on environmental sensors and sensor networks, cyberinfrastructure, and enabling technologies for ecological forecasting and social science collaboration continue

FY 2008 Milestones:

- Finalize national infrastructure deployment locations
- Complete EIA/EIS, if appropriate,

Major Research Equipment and Facilities Construction

Fully integrate and validate NEON fundamental technology unit (BioMesoNet, sensor micronets, and enabling cyberinfrastructure) and cyberinfrastructure
 Initiate deployment of BioMesoNet and basic towers
 Bring Project Management Control Software System to a fully operational status
 Complete R&D projects on environmental sensors and sensor networks, cyberinfrastructure, and enabling technologies for ecological forecasting and social science collaboration

FY 2009 – FY 2013 Milestones:

Continue construction of NEON research, networking, informatics, and education, training, and outreach infrastructure
 Support operations and research activities as NEON components are commissioned and come on-line

Funding Profile: The NEON baseline is under revision based on the continental design recommended in the NRC report. The revised baseline will be reviewed as part of the PDR scheduled for May 2007. The figures shown here reflect the FY 2007 Request. The revised baseline is expected to include higher funding levels in FY 2009 and in the out years. After this thorough cost review, a revised budget for NEON infrastructure and maintenance and operations will be provided.

Requested MREFC Funds for NEON
 (Dollars in Millions)

FY 2007						
Request	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	Total
\$4.00	\$8.00	\$20.00	\$30.00	\$26.00	\$12.00	\$100.00

NEON Funding Profile
 (Obligated Dollars and Estimates in Millions)

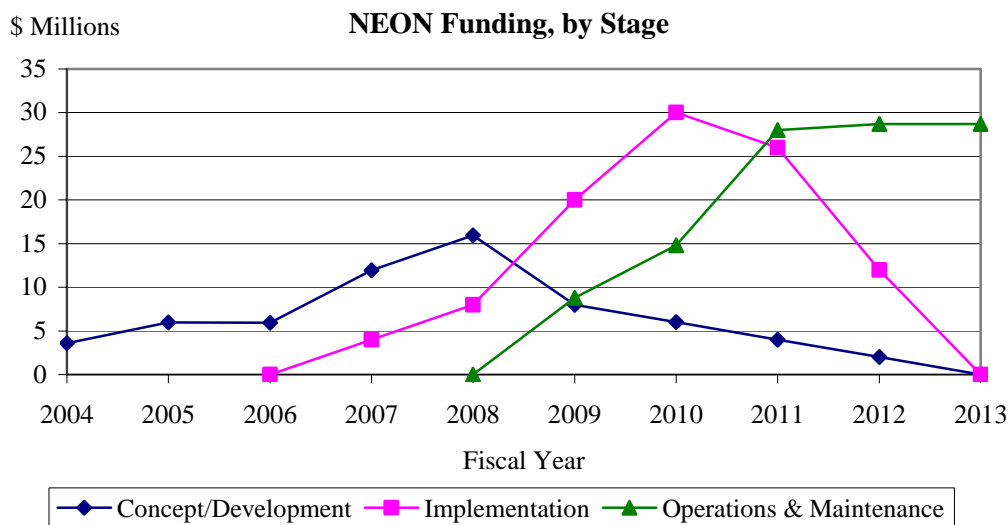
	Concept/ Development		Implementation ¹		Operations & Maintenance		Totals		Grand Total
	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	R&RA	MREFC	
FY 2004 & Earlier	5.83						\$5.83	-	\$5.83
FY 2005	5.98						\$5.98	-	\$5.98
FY 2006 Actual	6.04						\$6.04	-	\$6.04
FY 2007 Request	11.94			4.00			\$11.94	\$4.00	\$15.94
FY 2008 Estimate	15.94			8.00			\$15.94	\$8.00	\$23.94
FY 2009 Estimate	8.00			20.00	8.80		\$16.80	\$20.00	\$36.80
FY 2010 Estimate	6.00			30.00	14.80		\$20.80	\$30.00	\$50.80
FY 2011 Estimate	4.00			26.00	28.00		\$32.00	\$26.00	\$58.00
FY 2012 Estimate	2.00			12.00	28.70		\$30.70	\$12.00	\$42.70
FY 2013 Estimate	-				28.70		\$28.70	-	\$28.70
Subtotal, R&RA	\$65.73		-		\$109.00		\$174.73		
Subtotal, MREFC		-		\$100.00		-		\$100.00	
Total, Each Stage		\$65.73		\$100.00		\$109.00			\$274.73

NOTE: The expected operational lifespan of this project is 30 years after construction is complete. Implementation funding levels will be updated when the Preliminary Design Review is complete (see information below). Annual operations and maintenance estimates for FY 2009 and beyond are presented strictly for planning purposes. They will be updated as new information becomes available.

Information pertaining to the data in the table is provided below.

NOTE: The NEON baseline is under revision based on the continental design recommended in the NRC report. The revised baseline will be reviewed as part of the PDR review scheduled for May 2007. The figures shown here reflect the FY 2007 Request. The revised baseline is expected to include higher funding levels in FY 2009 and in the outyears.

- **Concept/Development:** In FY 2003, the National Research Council’s study on NEON recommended that the infrastructural elements needed to address the six greatest ecological research challenges be simultaneously deployed across the U.S. and that a central NEON governance structure be established. A redefinition of an earlier scope, schedule, and cost for NEON was required in light of these recommendations. In FY 2004 and FY 2005, an award was made for a NEON Design Consortium and Project Office to redefine NEON (science and education plan and reference design) and to develop the preliminary PEP for simultaneous national deployment. In FY 2006, the NEON Science Plan and Requirements, the Networking and Informatics Plan, preliminary PEP, PDP, and Construction Costs were completed. Support will be continued for ongoing R&D projects on enabling technologies.
- **Implementation:** Construction costs for NEON research, networking, and education infrastructure will be vetted at the PDR in May 2007. After a thorough cost review, a revised budget for NEON infrastructure and operations and maintenance will be provided. NEON will include the standardized technology deployed across the U.S. and connected via cyberinfrastructure into a national research platform. In FY 2007, MREFC funds will be used to begin to establish the NEON Construction Office and assemble and evaluate the NEON fundamental technology unit (BioMesoNet, sensor micronets, and enabling cyberinfrastructure) that will be deployed. In FY 2008, MREFC funds will be used to complete staffing and infrastructure for the NEON construction office and begin materials acquisition for large scale deployment of the NEON FIU and cyberinfrastructure.
- **Operations and Maintenance:** Initial operations support will begin in FY 2009 as the CI backbone components of NEON (networking and informatics infrastructure) are commissioned and brought on-line.



Future Science Support: Since NSF supports 63 percent of the fundamental environmental biology research performed at U.S. academic institutions, advances in the field of ecology, and the infrastructure

to enable those advances, depend largely on support from NSF. Current research infrastructure is inadequate to enable studies to address the complex phenomena driving ecological change in real time and at the appropriate scales. As a continent-wide research instrument, NEON will be. Along with direct operations and maintenance support for NEON, NSF will support research performed using the NEON platform through a special competition and through ongoing research and education programs. Based on prior experience with other new activities, BIO expects that within 3-5 years proposal submission to regular programs to use NEON will have grown sufficiently to negate the need for a special competition and resources dedicated to the competition will be transferred to core programs.

NEON will support a large and diverse group of organizations and individuals; foremost are the scientists, educators, and engineers who will utilize NEON infrastructure in their research and educational programs. NEON will provide enhanced research opportunities for existing field-based research networks, using natural history collections, and the cyberinfrastructure communities that are facilitating network-level ecological science. As a cyberinfrastructure enabled network, NEON will be accessible to academic and research institutions, state and federal research and management organizations, minority serving institutions, community colleges, K-12 school systems, the general public, natural resource and conservation organizations, and other public and private organizations. Thousands of researchers will be able to use NEON, tens of thousands of children may participate in NEON activities through its educational programs, and the NEON data, information and research products will be fully accessible via the Internet.

Associated Research and Education Activities: During the design and planning stage, NEON strategic R&D has focused on reducing project risk by funding scientists and engineers to pursue research in the areas of cyberinfrastructure (e.g. prototyping for environmental observatories, embedded, scalability), sensor prototyping (aquatic genosensor, animal tracking, harsh environments), dynamically drive data analysis, end-to-end cyberinfrastructure design of the NEON fundamental instrument unit, and software development for field and data hand held devices. In addition to training graduate students, these research projects included undergraduate participation through funding from the Research Experiences for Undergraduates Program. Outreach conducted by these individual projects includes K-12 students, teachers, and the public. As an example, during engineering week over 600 K-12 students, from elementary school to senior high school students around Missouri, along with their teachers, visited an engineering lab focused on developing animal video sensing. Workshops were conducted in the areas of social science, modeling, and animal sensing. These workshops focused on evolving technologies, technical and development issues, fostering collaborations, enhancing interoperability among observing systems, and communication. Active outreach to and involvement by minority serving institutions was initiated through the establishment of a NEON mentorship program by the Science and Engineering Alliance. The program involves Historically Black Colleges (HBCUs), Hispanic Serving Institutions (HSIs) and Tribal Colleges and Universities (TCUs).