NATIONAL ECOLOGICAL OBSERVATORY NETWORK

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NEON, Inc. Announces the Selection of the National Core Sites and Research Question Designs

NEON, Inc. is excited to announce the selection of a set of Core Sites and initial science question gradients for submission to the National Science Foundation as part of NEON's Project Execution Plan. In the past year, planning for the National Ecological Observatory Network (NEON; www.neoninc.org/) has made major advances. The Integrated Science and Education Plan (ISEP) was completed and reviewed, the Conceptual Design Review was held, a Request For Information (RFI) on prospective sites and integrative science questions was released, and responses were received. The RFI responses were scientifically evaluated in a workshop in Sioux Falls, South Dakota, organized by NSF and hosted by the US Geological Survey. The USGS subsequently provided geographic information support to the attendees and to the NEON team. A small group met in Boulder, Colorado after the Sioux Falls meeting to create a national network that includes specific site recommendations. This site-specific plan will be submitted to the National Science Foundation for review as a Major Research Equipment and Facilities Construction project in the spring of 2007. Evaluating the RFI responses and selecting sites consistent with the ISEP was a complex and humbling challenge, the basis for which is detailed below.

The NEON, Inc. observing strategy and site selection process is based on systematic sampling across the largest scales of ecological variability to provide a basis for "scaling up" analyses across the nation. NEON has divided the continent into eco-climatic regimes called "domains." The conterminous US plus Puerto Rico has 17 domains, and Alaska and Hawaii add three more. The NEON Core Sites will be in wildlands (i.e, largely natural vegetation, not intensively managed) and will form the stable, fixed elements of the design, which also includes relocatable gradient sites and mobile (truck mounted) laboratories. The Core Sites will be in place for 30 or more years, have extensive sampling and instrumentation, and serve as a base for staff operating the site and associated gradient and mobile laboratories. The Boulder team's procedure was to first identify preliminary Core Sites, then consider science question gradient studies, and finally to revisit the Core Site candidates. The overriding criterion for the Core Site backbone of the network was to observe national-scale impacts of highly "connected" phenomena across the entire country. Examples include impacts of invasion or disease, climate change, large-scale modes of variability such as El Niño, and large-scale transport phenomena, such as inputs of Asiatic dust and pollution.

In selecting Core Sites, we considered all of the scientific criteria identified in the ISEP and RFI documents (see www.neoninc.org), as well as specific recommendations from

the Sioux Falls workshop. We took the science themes chosen in Sioux Falls, and grouped them into three categories that *generally* suggested similar site selection strategies. These themes were:

- Land use
- Climate change-ecohydrology-biogeochemistry
- Biodiversity-invasives-disease

Note that these categories are synergistic. For example, while a great deal of biogeochemical variability is due to climate (chemical and physical), the land-use aspects are captured in the land-use contrasts. Similarly, invasion is also dependent on land use, and so on. We used eco-climatic representativeness (see http://research.esd.ornl.gov/~hnw/neon/withindomainrep2) of the domain as a first filter, and then considered each candidate site in relation to land use, invasion biology, and adjacent domains. Many of these decisions were difficult, and alternate sites within domains brought different strengths. A surprise to our team was that it was often easier to work through domains where alternate, competing sites had been suggested, because the candidate most appropriate for developing strategy could be selected to complement adjacent domains or anchor question-oriented gradient sites. However, in some cases the decisions are still conditional, pending review by a site visit team.

After the preliminary Core Site decisions, we assigned resources to question-oriented gradient studies. We began this process with four critical decisions.

- First, many of the RFI responses and the Sioux Falls workshop suggested an integrative national strategy for assigning these systems, rather than the toolkit approach we had originally suggested. This decision was based on the scientific input from a huge number of colleagues and is consistent with the National Science Foundation's vision for a national facility. NEON cannot be everything to everybody, but this plan is exciting, innovative, and one our community can be proud of.

- In a second, related decision, we did not assign gradient resources to within-domain heterogeneity studies per se, but will assume that the NEON Mobile Laboratories and Airborne Observing Platform will be the primary means of scaling within domains. We recognize that many domains had planned to sample geographic, climatic, or edaphic gradients using relocatable systems and that this decision will generate a lot of disappointment.

- Third, because most of the RFI responses and the Sioux Falls groups did not suggest distinct strategies for the gradient toolkits, we pooled the resources of the domain and national toolkits, as described in the RFI, and assigned the budgets for the systems to a single type of system, the relocatable class system. Relocatable systems will be installed for three to five years, include canopy, soil, and atmospheric observations, and the Fundamental Sentinel Unit's sample collection protocols. We assumed that some of the relocatable systems will have aquatic arrays, some eddy covariance capability, and some atmospheric chemistry, depending on local hydrology, topography, and mission. Financial and logistical considerations limited this pool of systems to approximately 60, which is as little as half of some previous estimates of the number of NEON systems.

The change in numbers reflects the upgrading of Basic BioMesoNet systems to the relocatable class of system, and the evolving quality of our cost and staff estimates.

- Fourth, we considered the logistics of maintaining relocatable systems. We adopted a core-plus-constellation strategy because staff based at each Core Site will have to maintain the gradient sites and conduct the Fundamental Sentinel Unit sampling protocols there. While earlier documents had suggested a distance constraint of 100 km, we adopted a less-limiting three-hour travel time between core and gradient sites. This creates restrictions, particularly in larger domains.

We implemented the RFI and Sioux Falls science question priorities via a network that included planned *contrasts* within domains (e.g., mature versus young forest, urban versus wildland) *compared* across domains (urban-rural in the Northeast and Southwest), using the core-and-constellation strategy. The design is rigorously based on scientific priorities and equally rigorously scaled to maintain budget discipline. These questions are for the first cycle of deployment; additional questions will be implemented as the network matures. Resources are such that not all domains receive the same initial number of systems: some domains may have no first-cycle deployment, and systems must move between domains as needed.

While most studies are based on within-domain contrasts, a few larger-scale gradients are implemented as cross-domain studies, including nitrogen deposition and ecohydrological gradients. Measurement systems are also allocated in response to science. For example, most urban and rural sites have atmospheric chemistry, but not all intermediate suburban sites do. Similarly, eddy covariance systems are allocated where the flux measurements are relevant and feasible. The table below shows the themes of the selected within- and between-domain studies. Exact geographic data for gradient sites is still being developed, and so we list below the themes addressed in the initial deployment and the domains associated with these themes. The table also indicates whether the theme is addressed by within-domain contrasts, compared across domains (e.g., land use), or via an intrinsically cross-domain approach (e.g., nitrogen deposition). As soon as exact locations, numbers, and instrumentation are identified for the gradient sites, NEON will make an announcement.

Invasive species will be studied using a design suggested in Sioux Falls. Many invasives move as “fronts” and some of these fronts are closely tracked. NEON will identify locations at these fronts and place systems at or slightly outside the fronts to allow the early stages of invasion and its ecological consequences to be observed. Locating these sites will require the use of operational data and forecasting, a dynamic that will create significant interaction between NEON site selection, data, and ecological forecasting. Four to six relocatable systems will be held in a reserve for invasive studies; exact site locations will be defined closer to deployment.

The Sioux Falls workshop also evaluated a number of suggestions for manipulative experiments. Working groups are now taking ideas articulated at Sioux Falls and developing feasibility studies for several experiments, assessing their scientific,

engineering, and cost implications. As soon as these groups complete their work, NEON, Inc. will report to the community.

The Project Execution Plan (PEP) will be developed and then submitted to NSF in April 2007. In the intervening period, four to five site visits will clarify a few unresolved issues, and some aspects of this design will be refined or even altered. The site visit teams will work with the communities in these regions to optimize the outcome and produce the strongest possible PEP. At the same time, the NEON, Inc. team will work with the community to bring greater detail to the question-oriented gradient design and pin down specific sites and costs. There will be several webcasts in which the entire community may engage with NEON, Inc. At the same time, the RFIs contained comparatively little information on the use of the mobile laboratories and uneven attention to remote sensing. We will be soliciting input to refine these aspects of the plan as well.

This final design is different from many previously envisioned. It reflects the evolution of the science, especially during the RFI process, the synergistic interactions in the community, and the greatly improved understanding of the financial and staff resources resulting from the Conceptual Design Review. Considerable flexibility remains in the instruments and measurements to be deployed and the future locations of the mobile laboratories, so that the current NEON design can evolve as our science matures. Many difficult decisions remain, and NEON, Inc. depends on the community's input. Everyone at NEON, from the Project Office staff to the Board of Directors, is open to any and all communications, and we look forward to hearing from you.

The quality, commitment, and professionalism of the ecological science community throughout this process has been incredible, and while there are too many people to thank here individually, NEON, Inc. and the NSF greatly appreciate the organizations, agencies, and individuals who contributed to this process.

Initial NEON Candidate Core sites

These candidate core sites have been selected for inclusion in the NEON Project Execution Plan.

Domains		Core Site Locations
No.	**Name**	
1	Northeast	Harvard Forest
2	Mid-Atlantic	Smithsonian Conservation and Research Center
3	Southeast	Ordway-Swisher Biological Station
4	Atlantic Neotropical	Guánica Forest (Puerto Rico)
5	Great Lakes	Site visit to be held before final determination
6	Prairie Peninsula	Konza Prairie Biological Station
7	Appalachians/ Cumberland Plateau	Walker Branch Watershed (Oak Ridge National Laboratory)
8	Ozarks Complex	Talladega National Forest
9	Northern Plains	Woodworth Field Station
10	Central Plains	Central Plains Experimental Range (1)
11	Southern Plains	Kerr Wildlife Management Area (preliminary: site visit required)
12	Northern Rockies	Yellowstone Northern Range
13	Southern Rockies / Colorado Plateau	Niwot Ridge (1)
14	Desert Southwest	Santa Rita Experimental Range
15	Great Basin	Onaqui-Benmore
16	Pacific Northwest	Wind River Experimental Forest
17	Pacific Southwest	San Joaquin Experimental Range (preliminary: site visit required)
18	Tundra	Toolik Lake (2)
19	Taiga	Caribou-Poker Creeks Research Watershed (2)
20	Pacific Neotropical	Laupahoehoe Forest Unit/ Hawaii Experimental Tropical Forest

(1) – Domains 10 and 13 will be managed in a coordinated manner with partially combined staffs
(2) – Domains 18 and 19 will be managed administratively as a single domain with merged staffs

Theme: Land Use

Within-Domain contrasts

Urban-suburban-exurban-rural (Domains: 1, 4, 10, 14)
Forest management (Domains: 3, 5, 16)
Agriculture to forest (Domains: 8)
Exurban development (Domains:12)
Agriculture and biofuels (Domains: 6, 9)

Theme: Biodiversity-invasives-disease

Within-Domain contrasts

Sentinel sites near ports of entry (Domains: 1, 2, 3, 11, 14)
Invasive plants and their management (Domains: 11, 14, 15, 20)
Tropical invasions (Domains: 20)

Invasive front studies

(specific locations to be determined)

Theme: Climate change-ecohydrology-biogeochemistry

Within-Domain contrasts

Dust sources and sinks (Domains 13, 15)
Ecohydrological climate change (Domains: 17, 18, 19)

Cross-Domain studies

Basin-scale hydrological linkages (Domains 3, 8)
Nitrogen deposition (Domains: 1, 2, 5, 7, 8)
Permafrost dynamics (Domains: 18, 19)