NEON: a hierarchically designed national ecological network

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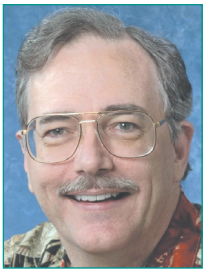

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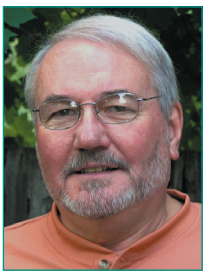

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In the past year, planning for the National Ecological Observatory Network (NEON; www.neoninc.org/) has made major advances. The Integrated Science and Education Plan (ISEP) was completed and reviewed, the Conceptual Design Review was held, a Request For Information (RFI) on prospective sites and integrative science questions was released, and responses were received. This February, NEON Inc released its site-specific design proposal, identifying core wildland sites and environmental gradients for study. This site-specific proposal will form the basis of the NEON Project Execution Plan, which 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, to give a total of 20. The NEON network includes stable, fixed elements (core wildland sites), relocatable gradient sites, and mobile laboratories. The NEON domains have been chosen as elements of a continental-scale observing strategy, based on theory and informed by a wide range of datasets and statistical approaches.

The NEON Inc spatial sampling design is based on climatic, edaphic, and topographic attributes, delineated into domains using climate data and soil properties. The domains are mapped based on physical variables that effectively capture key biological aspects of US ecology. The NEON domains were based on an explicit multivariate statistical procedure that is transparent and repeatable, and provides a national stratification that shows how best to deploy our 20 core sites in order to maximize the coverage, coherence, and representativeness of the network. The domains can also be used to extrapolate measurements made at sites, facilitating upscaling (http://research.esd.ornl.gov/~hnw/neon/withindomainrep2). This sampling plan, based on 20 domains, makes NEON the largest and most comprehensive ecological network to have been statistically designed before deployment.

NEON's design can be viewed as a hierarchy of constraints. While we often think of climate as an independent variable relative to biology, at the continental scale climate variables are constrained by latitude, "continentality", and orography (the physical geography of mountains). The influence of the ocean basins that surround the continent also percolates into each domain, affecting temperature, precipitation, and their variability in time (eg via El Niño). Core wildland sites address these largest scales.

Characteristic patterns of land use, management, disturbances (such as fire or flooding), and recovery develop within the domains, constrained by the biophysical setting, the local biota, and historical effects. Different patterns of natural resource use and settlement tend to evolve in each domain (eg timber production in forested areas and agriculture in regions with ample fertility and precipitation or irrigation). These varying patterns of socio-environmental regimes allow the study of ecosystem interactions with human dynamics. Relocatable gradient sites sample these smaller scales of variation.

Ecologists have primarily exploited naturally occurring variability along gradients where only one factor varies, as in Hans Jenny's famous studies along soil age and climate gradients. The NEON domains do not represent sites chosen along single-factor axes; instead, they sample regimes in which climate, biota, soils, and land-management practices vary together. While this design does not allow for simple statistical inference, it provides diverse conditions across which hypotheses, questions, and models can be addressed. Modern statistical and process models are now sophisticated enough to be used with this complex and interactive regime design.

Considerable flexibility remains in the instruments and measurements to be deployed and the future sites of the relocatable facilities, so that the current NEON design can evolve as our science matures. The current network design balances the broad system of national coverage with the relevance of individual sites and sub-networks to local and regional questions. Many difficult decisions remain, and NEON Inc depends on the community's input. Everyone at NEON Inc, from the Project Office staff to the Board of Directors, is open to any and all communication and looks forward to hearing from you.