NEON "RFI" WORKSHOP

Version 1.0

USGS Center for Earth Resources Observation and Science
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"Notes and Comments" are those captured by Scarlett Lundquist (USGS)
"Other Comments" are those captured by Scribe for that response.
Scribes are identified on the assignment spreadsheet.

RESEARCH RESPONSES 4

Research Responses

Allen_MicrobialDiversityEcosysFunc

Questions for research and experiment responses

1) What is the central hypothesis or question and how does it address the NEON grand challenges? If so, briefly describe how.

How similar is microbial richness and composition among the 20 domains, and do they change similarly with short-term fluctuations in the environment and across space and time gradients with the changing global environment?

How do these changes affect the ecosystem functions provided by microbial diversity?

The questions addresses the biodiversity, climate change, and biogeochemistry grand challenges

2) Does response pose questions at a regional or national scale?

National

3) How will the design permit scaling from the sensor or measurement to continent?

Using modeling (Daycent)

4) How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or processes at regional or continental scales?

No manipulations

5) How will the proposed science or experiments lead to transformational results, either specified by the RFI response or apparent during the workshop discussion?

Improving understanding of large scale patterns in microbial identity/function was viewed as an important contribution. There were questions in the discussion about the feasibility of the scale of the metagenomic components. There was also concern that simply describing patterns and using simple correlations with environmental or process rate information would not be transformational.

6) Which NEON in situ and remote sensors and sentinel measurements are needed to address the research? What cyberinfrastructure needs are implied?

Advanced Tower System, Basic Tower System, Relocatable Tower System, and Rapid Deployment System. Cyber infrastructure needs would be large to process the metagenomics and rhizotron data.

Several types of software will be needed to undertake these analyses. These include:

- gene sequence alignment and phylogenic analysis
- automated data acquisition and storage
- modeling of sensor output
- modeling of microbial life-history dynamics

7) How do the sites proposed in the science and experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site deployment design (e.g. core site, gradient sites, comprehensive national network, experimental gradients, experimental network).

Sites are logical

8) Are there new resources (people, data, instruments, money) suggested and are they required beyond that described in the RFI?

AMR
Metagenomics labs and sample processing

9) Are there other projects, programs, networks, or organizations that would be required to logically, effectively, and efficiently address the question?

GenomicsCollaborations with entities such as the UCR Institute for Integrative Genome Biology (http://genomics.ucr.edu/) or the J. Craig Venter Institute (http://www.venterinstitute.org/) with facilities for rapid throughput sequencing are essential (e.g., Venter et al. 2004, Tringe et al. 2005, Whitaker and Banfield 2006). There are a number of facilities scattered throughout the country and associated with federal facilities (e.g., DOE) that could serve a cooperating role in this type of activity. Cost estimates vary widely and if this topic area is pursued, additional cost estimates can be prepared, and additional funding sources pursued. This activity will provide access to a large number of new genetic resources, and ones whose activity can be tightly coupled to environmental processes.

10) What are the education, training, and outreach goals of the proposed science and how will NEON resources contribute to their success?

Comments & Notes

Microbial Diversity and Ecosystems Functions:
Observational RFI, will use all 20 domains and will link with other networks. Link with other models. Linking microbes is essential, big contribution to NEON. Don't propose any sensors. They propose to collect field samples and send to labs. How would be apply this to a small scale and then expand later? New capabilities would need to process the number of samples that would be collected. Facilities would need to be able to do the sample processing, as well as training. Data mining…should be a yes. Cutting edge techniques. How do you make identity of microbials useful at this state? Technology is coming for these processes and NEON is still about

6 years away. This infrastructure will need to be in place for this to take place. They could not do this without NEON. The bacteria side should be added into this RFI.

Asner-CAO

Gregory P. Asner and Christopher B. Field, "Integrating Airborne Hyperspectral and LiDAR Remote Sensing for Ecosystem Research and Monitoring in NEON"

Questions for research and experiment responses
1) What is the central hypothesis or question and how does it address the NEON grand challenges? If so, briefly describe how.

This is an instrumentation proposal, addressing the technical issues of airborne remote sensing instruments and requirements for NEON science grade data. This RFI identifies a key role for airborne remote sensing data between spatial scales of field data and continental scale satellite data. There is a need to measure at high spatial resolution (to capture grain size) over relatively large areas/regions. Overarching requirement to measure biogeochemical properties, physiological processes, and ecosystem structure to understand ecosystem functional impacts of land use, climate change/variability and biological invasions [NEON grand challenges]. Objective is to quantify ecosystem properties in 3-D space and time.

2) Does response pose questions at a regional or national scale?

Yes, goal is to scale from site measurements to regional observations. Intermediate scale to satellite measurements.

3) How will the design permit scaling from the sensor or measurement to continent?

This proposal did not deal with sampling design but establishes criteria and mission concept for measurement requirements to meet NEON-science objectives. Provides a valuable contribution on the requirements to co-fly hyperspectral imagers and full waveform LiDARS.

4) How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or processes at regional or continental scales?

This suite of measurements will allow researchers to extend and extrapolate site-based measurements to larger regions. The deployment sampling issues were not addressed but the RFI sets out the issues about how to co-operate these two sensor types together to get NEON-quality data. The constraints on mission design as described in this RFI will impact frequency of observations, areal extent of observations, and opportunities to respond to unusual events and plan experiments. Types of information retrieved are: quantified concentrations of chlorophyll a, b, carotenoids, anthocyanins, canopy water and biophysical measurements like leaf area, fractional vegetation cover, % woodiness, or litter/debris, etc. These data will be acquired simultaneous with $0.25m^2$ 3-D imaging of the canopy, giving ground topography, canopy height and depth, tree crown shape, understorey, fuel ladders, etc.

5) How will the proposed science or experiments lead to transformational results, either specified by the RFI response or apparent during the workshop discussion?

The RFI plan will allow a new generation of remote sensing data using state-of-the-science instruments that simultaneously characterizes and quantifies both ecosystem structure and physiological/biogeochemical properties simultaneously. This information, repeated at regular intervals and acquired over the 20 domains will transform scaling of site measurements to larger regions and permit improved testing of ecosystem models by measuring large areas. These instrument suite were identified in earlier NEON documents.

6) Which NEON in situ and remote sensors and sentinel measurements are needed to address the research? What cyberinfrastructure needs are implied?

High fidelity (=quality) hyperspectral imager, capable of measuring at 1m spatial resolution, co-bore sited with a full waveform LiDAR are described. The requirements for flying them together are described and limitations on each technology.

The RFI describes a need for 3 FTE staff to support this technology. Most of the "standard" data outputs can be automated. There is a requirement to obtain specialized software to automate the calibration and analysis steps but such software has been developed by various researchers in the community.

The RFI did not describe the IT infrastructure required but datasets are large. Assumption is that computational requirements for storage and processing will decrease. The CAO today can produce automated products in near-real time. I think there is significant potential to reduce cost and provide data by automating production of data products.

7) How do the sites proposed in the science and experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site deployment design (e.g. core site, gradient sites, comprehensive national network, experimental gradients, experimental network).

This RFI described the instrument and flight requirements but not the deployment requirements. The authors have an existing instrument package that serves as a model for NEON and provide good description of the operational issues.

8) Are there new resources (people, data, instruments, money) suggested and are they required beyond that described in the RFI?

They describe a cost of operating the instrument facility to perform the operations to transform the data to standard products as $500k/yr for 3 FTEs (director and two techs). I do not think this aspect of the RFI addresses (1) instrument maintenance and calibration; (2) scheduling and planning missions, (3) data processing, and (4) data delivery. I think all of these operations are likely to cost around $500k/yr and require larger staffing (which might be done at lower cost/person).

The authors identify the need to develop an advanced hyperspectral imager that would measure from the near-infrared (~1000nm) to the shortwave infrared (~2500 nm).

9) Are there other projects, programs, networks, or organizations that would be required to logically, effectively, and efficiently address the question?

The PIs suggest developing the HSI sensor with the Jet Propulsion Laboratory (the recognized experts on this technology).

10) What are the education, training, and outreach goals of the proposed science and how will NEON resources contribute to their success?

Does not describe, but training and education are key to utilization of these data.

Advice: Concurrent hyperspectral and lidar data will transform ecology and should be part of NEON. This CAO system represents a good prototype for the airborne observatory for NEON. Assume that cost will be less than identified here as these instruments were NEW industrial designs and copies will be less expensive. NEON will need a full-spectrum (380nm-2500nm or to 4000nm, if possible) imager and cost of $2.5M is for JPL to develop a new design (today) to do this. In 8 yrs. it is likely that these instruments will have been designed and NEON can buy copies at significantly lower cost.

Primary data processing can be automated today (and are in the CAO) so this should significantly reduce operating cost and provide data in near-real time.

Comments & Notes:
Integrating Airborne Hyperspectrial LIDAR proposal:
Essential to plot date to satellites. Can measure at high special resolution at sub meter, full wave of LIDAR. Three dimension of land. Relatively low flying because of intensity of return. Technical requirements, what are their requirements for instrumentation. There is a lot that can be done with the date. How are you going to fly the missions? They don't go into that. At 1 meter scale, they would not go around to all 20 domains. Deployed for manipulative experiments. The lidar provides detailed information for maps and biochemical aspects. Vegetation cover and things of that would come with it. It would be transformational. It means a high quality and well calibrated instrument. The data sets are very large. By the time NEON is established, the computer requirements will be well established. The prototype has already been designed. Lots of gradients are proposed and Lidar will need to be done. Another groups will use. Critical…Lidar can link into GIS and land use change and they meet most of the grand challenges of NEON. All grand challenges and community will need to have Lidar. Can measure carbon dioxide in atmosphere and water particles. Innovative instrument design, incredible step forward. Concern...not much analysis of what process to meet needs of all sites. Coordination through CLICK. Data collection and analysis, NEON could use this instead of duplicating. NASA is look at new innovation of this for satellites. Flight platform .5 meter2 resolution a day. Invasive plant species to pick out plants, live from dead and start counting. Spectutal signatures of deer, cow, and larger special, can start counting.

Williams_Stable Isotopes

Dave Williams and colleagues describe an Isotopic Network of Ecological Warning Signals (INEWS) to use stable isotopic measurements as tracers, recorders, and integrators of environmental chance. The network will be based on three types of warning systems—ecosystem inputs and outputs, the difference between them, and the isotopic composition of sentinel organisms.

What is the central hypothesis or question and how does it address the NEON grand challenges? If so, briefly describe how.

- What are the long-term changes in the continental-scale sources of water and nitrogen into ecosystems?
- How do climate and land use affect the processing of carbon, nitrogen, and water within ecosystems and their export from ecosystems, and how do organisms integrate and record these responses?

There is a clear and compelling relationship between these questions and the grand challenges.

2) Does response pose questions at a regional or national scale?

Yes, clearly.

3) How will the design permit scaling from the sensor or measurement to continent?

Scaling algorithms are not described. The network will estimate ecosystem responses to continental variation in site productivity, land-use, and urbanization using a input-output assessment of stable isotopes.

4) How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or processes at regional or continental scales?

No manipulations are proposed.

5) How will the proposed science or experiments lead to transformational results, either specified by the RFI response or apparent during the workshop discussion?

I think the sheer scale of this work could be transformative. However, I do have concerns about the "black box" nature of the work. I would be more likely to see this RFI as transformative if I were convinced that the network could describe mechanisms that give rise to changes.

Although the investigators propose to "….incorporate mechanistic models and interpolation methods for interpretation and visualization of isotopic variation across the continent", I have doubts about how they can do terribly much that is mechanistic that based on the measurements proposed.

I think the RFI would be substantially improved by using a series of examples, like those in http://neoninc.org/documents/Isotope_network_12.pdf to make specific predications on how climate and land use drivers are expected to alter isotopic signals. The current document contains lots of general statements about what can be achieved—these could be made much more engaging and believable with a few, well chosen specific illustrations.

6) Which NEON in situ and remote sensors and sentinel measurements are needed to address the research? What cyberinfrastructure needs are implied?
: The network will obtain atmospheric, aquatic, and terrestrial samples from tower sites associated with (a) core wildland sites, (b) urban sites, and (c) intermediate tower sites, each of which are ultimately selected by NEON (60 in total). Since these measurement efforts are national in scale, they will need to be acquired from a geographically dispersed national network.

BioMesoNet Towers. INEWS will rely on sample collections currently proposed in the ISEP for isotopic measurements. It will measure the isotope ratios of elements in water and atmospheric deposition. Modeling and forecasting efforts will also rely on the proposed measurements for microclimate, NO_x and NO_y, dry deposition, and wet deposition. Root and mycorrhizae phenology and turnover, and soil nitrate concentration, pH, moisture, and temperature will also support modeling efforts for isotope composition of soil microbes

Aquatic Sensor Arrays. Water collected with the automatic stream samplers will be analyzed for the isotope ratios of elements in water, inorganic nitrogen, and organic fractions. Supporting information for modeling and forecasting efforts include flow rates, dissolved organic carbon and nitrogen concentrations, pH, and temperature (details in Table 1).

Fundamental Sentinel Unit. INEWS will measure the isotopic composition of soil microbes, mice, and resident and migratory birds to integrate across multiple temporal and spatial scales. This complements biodiversity, biogeochemistry, organism tracking systems, phenology, and functional genomics measurements in the ISEP. All will be incorporated into modeling and forecasting efforts.

The LUP and Cyberinfrastrucuture will be necessary for modeling and forecasting efforts using isotope measurements at a continental scale.

7) How do the sites proposed in the science and experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site deployment design (e.g. core site, gradient sites, comprehensive national network, experimental gradients, experimental network).

The investigations propose that all tower sites be used to capture as much variation as possible in geogprahic position and land-use. This is logical.

8) Are there new resources (people, data, instruments, money) suggested and are they required beyond that described in the RFI?

No

9) Are there other projects, programs, networks, or organizations that would be required to logically, effectively, and efficiently address the question?

10) What are the education, training, and outreach goals of the proposed science and how will NEON resources contribute to their success?

The goal is to "developing transformational interdisciplinary courses for graduate students, postdoctoral researchers, faculty and K-12 educators." My impression is that Ehleringer's isotope course at the Univeristy of Utah has transformed the science of many students. To the extent that this will be a template for the courses proposed, I think the RFI goal is feasible.

Comments & Notes:
Williams – Stable Isotopes

- One of the "jewels" that connects science from many areas.
- Promising integrator
- Isotopes can reveal things that bulk flux measurements cannot
- Whendee – Very good; had lots of things to pull out for NEON. Especially the technology. Throughput required would be awesome. People involved are world leaders in this area. So if anyone can they can. Aquatic part not well developed. Could be encouraged to make it stronger.
- Tom – Comment regarding input-output diagram – this proposal offers a lot of interesting possibilities. This design relating inputs to outputs via a mechanistic model leaves a little to faith. With that caution, it is a good response.
- Are there 3 sites per domain? Antonio – read a lot in the proposal about urban.
- There is no preconceived notion of how the observation network should be, but they have tried to fit with NEON
- When land use changes, isotopes change, and it is a real issue.
- They are suggesting that isotopes can integrate the signal from a wide range of things.
- Very inexpensive add-on.

INEWS: Isotope Network
Hypothesis:
Climate, Land Use and Climate interaction, infectious disease and invasive species.
Doubts: Considerable portion of the science in isotope fractionation is still uncertain. What do they actually represent?

Monitoring isotopes inputs and outputs. They go across scales sentinels of ecological change from soil moisture, mice to birds.

It is integrated. This science has never been done on a continental scale. Potential for big stuff. It will already use the structure that already exists. They anticipate proximity of these sites, that would fall along a gradient that pairs being for use for INEWS. 60 sites total. Isotopes ecology has brought together biological, physical and social sciences.

Comments: Crosses many scales. The aquatic part was not well developed but needs to be stronger.
This proposal offered a tremendous amount of possibilities. Measurements that achieve a large amount of integration but sometimes they are not the best measurements.

A jewel in NEON…that was the comment.

Comment: Did they say, there would be three sites per domain? Wildland to Urban and it skipped everything in the middle. The third site was to cover what was going on in between. This is new stuff and has never been done before. Trying to match and fit with NEON. Managed areas can stay the same or change. They are trying to suggest that isotopes can be a signal of what is going on in the area.
This would be an add on to the network.

BretHarte_TundraTaigaPNWClimateGradient

Background
The existing N-S climate and biotic gradient in Alaska can be used to address the NEON Science Challenges.

Temperatures have already risen more than two degrees (C) over the past three decades. The annual temperatures ranges from –10o to +5oC and the annual precipitation from 10 to 470 cm.

Vegetation follows the climate from a temperate rain forest in the south through boreal spruce and aspen forests in the interior to tundra in the north.

Effects of climate change so far depend greatly on the state of the permafrost that underlies most of Alaska.

The existing knowledge of climate change effects on ecosystems comes from the long-term studies at two LTER sites (Arctic/Toolik, Bonanza Creek/Caribou Poker Creek) **yet** there is no standardization of what is being measured and how. A NEON network offers **coordination and standardization of measurement protocols** across the network that will provide the opportunity to compare ecosystem response across the gradient. Equally important, NEON will provide **long-term data sets** at sites where the only data so far came from three-year projects that may or may not continue into the future. Finally, the NEON network will provide intensively-collected data from **new locations** along the climate and biotic gradient and in this way **fill in many of the gaps** in our knowledge.

In general, the Alaska Gradient study is concentrating on obtaining complete data sets over a long period from sites located in quite different ecological settings (N-S climate and land cover/land use gradient).

Questions for research and experiment responses

1) What is the central hypothesis or question and how does it address the NEON grand challenges? If so, briefly describe how.

Carbon exchange (NEP) will be driven by gradients in permafrost, vegetation, and initial conditions. Climate changes are altering ecosystems in the southern part of the gradient now and will affect northern areas during the next 30 years.

Specific hypotheses:

i. H_o The response of the carbon cycle to warming will be different along the N-S climatic gradient due to differences in underlying permafrost, vegetation, and initial conditions: 1) in tundra, decomposition will exceed plant growth resulting in reductions in NEP until forest and shrub encroachment becomes significant; 2) in taiga, forest growth will exceed any increase in decomposition leading to greater NEP unless fire frequency increases to the point that there is conversion to grassland.

ii. H_o Climate changes are currently altering ecosystems and biota in the southern half of the Alaska climate gradient; similar changes will begin to occur in the northern half of the gradient in the next 30 years. Climate caused changes include: permafrost is thawing, the abundance of invasive plants and insects is increasing, and changes in abundance of woody species is altering factors affecting the radiation balance of the terrestrial system.

Addresses both the climate change response and the feedbacks (e.g., albedo, fire) grand challenges:

1) How will ecosystems and their components respond to changes in natural- and human-induced forcings such as climate, land use, and invasive species across a range of spatial and temporal scales? And, what is the pace and pattern of the responses? (NEON ISEP p. 14)

2) How do the internal responses and feedbacks of biogeochemistry, biodiversity, hydroecology and biotic structure and function interact with changes in climate, land use, and invasive species? And, how do these feedbacks vary with ecological context and spatial and temporal scales? (NEON ISEP p. 14)

2) Does response pose questions at a regional or national scale?

Regional. It encompasses 3 NEON domains. But a large, important, and under-sampled region.

3) How will the design permit scaling from the sensor or measurement to continent?

1 - Through process-based studies that will advance our mechanistic understanding modeling of ecosystem response.

2 – Through development and application of process-level models: GEM, TEM, SPA. A notable aspect here is their proposed use of time series modeling. Specifically, it is stated that "Each new time series added to a monitoring platform doubles the value of time series already being monitored because it can then be paired up in a new input-output analysis and used for model identification and to assess the performance of existing models."

This study would fill in an important gap of forest-tundra transition, which is not well sampled. Proposal notes that there are several extant intensive study sites, but that that there has been little standardization of protocols nor synthesis among studies focusing on different climate zones/factors. The NEON infrastructure would advance intercomparison/modeling ability and modeling.

It would be ideal if ways could be developed to connect the AK gradient to Lower 48 northern and alpine ecosystems. Modeling of course goes in this direction, but it would really strengthen NEON as an observational platform if there were a connection to key/related sites in the lower 48 such as northern wetlands, boreal forest, and alpine tundra. This would also make AK a stronger sentinel site with respect to the national network.

4) How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or processes at regional or continental scales?

In general, through process-based measurements and modeling. Specifically:

Site Characterization: initial biomass, tissue chemistry leaf area, canopy structure, soil structure, soil chemistry, etc., which will be used to initialize the models and set boundary conditions for the simulations.

Driver variables: These data are required to drive the model through time and include air and soil temperature, light levels, rainfall, humidity, N and P deposition in various forms, CO_2 & O_3 concentrations, etc. These data will not only be used to run the model for current conditions but will also be used to quantify seasonal patterns, year-to-year variability, and short-term trends from with long-term driver time series can be built.

Flux Characterization: These data will be used to quantify internal cycling and throughput rates of C, N, and P and will be used to calibrate and test the models. The data include eddy flux estimates of NEE and ecosystem respiration, litter fall estimates of C and nutrient cycling rates, soil respiration, lysimeter based nutrient losses, etc.

Projection: Projections will be made in both space and time (often called scaling). Data will be needed both to drive the models and to test them. Spatial projections will require remotely sensed (satellite and aircraft based) ecosystem characteristics like NDVI and atmospheric transmisivity. Models that are developed and calibrated using plot-scale data should be tested by projecting these models spatially, using the resulting flux estimates as boundary conditions for transport models, and comparing the results to airborne flux data. Temporal projections will require scenarios of climate, CO_2, and nutrient deposition, which will need to be constructed based on GCM climate projections and an assessment of local intra- and inter year variability from NEON-based measurements.

5) How will the proposed science or experiments lead to transformational results, either specified by the RFI response or apparent during the workshop discussion?

There is a significant opportunity to improve the connections between research in boreal and arctic regions (partly due to boundaries and programmatic issues, e.g., geographic definitions in US Arctic Research and Policy Act of 1984). A similar situation exists between Alaska research and northern regions research in the Lower 48.

With respect to the climate change grand challenge, this gradient covers an area that is currently undergoing rapid, large changes and which serves to some extent as a bellwether of what might be expected in the future in the continental US.

6) Which NEON in situ and remote sensors and sentinel measurements are needed to address the research? What cyberinfrastructure needs are implied?

LANDSAT, Quickbird, photographs:

Our basic needs for remote sensing include **high resolution imagery** at each of the NEON gradient sites, and **lower resolution, less frequent imagery covering the entire gradient** (most of the state of Alaska). Our remote sensing needs can be met through a combination of existing satellite and airborne systems, and the NEON integrated remote sensing and spatial measurement airborne system proposed by Ustin et al. (2006)

- 2 core sites with 1 advanced biomesonet and 4 basic biomesonet towers (1 of the 4 will go to an experimental area).
- 10 domain gradient sites with 1 relocatable tower system each.
- 1 rapid deployment system use of the airborne observation platform

7) How do the sites proposed in the science and experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site deployment design (e.g. core site, gradient sites, comprehensive national network, experimental gradients, experimental network).

Design is strongly tied to existing infrastructure with the 2 LTERs and the Barrow Observatory.

In general, the Alaska Gradient study is concentrating on obtaining complete data sets over a **long period** from sites located in quite **different ecological settings**.

Gradient sites were selected to represent the broad gradient of **temperature and precipitation** amounts, the main **vegetation types** that are representative of the domains, and **vegetation boundaries** where changes are underway.

At all proposed gradient and core sites there is a lake or a **stream nearby** where aquatic measurements (aquatic sensor arrays) can be carried out in small lakes or low order streams.

They will require the **full suite of NEON systems** for our studies that will use the NEON tool boxes as described in the ISEP.

Fundamental Sentinel Unit (**FSU**) that supports diverse measurements on organisms, soils, hydrology, aquatic processes two core sites, c**) Ten Mobile Relocatable Systems** (**MRS**) that provides investigators with flexibility in thse deployment of instrumented systems to collect data, d) An **Airborne Observation Platform (AOP)** with remote sensing instruments to provide regional information for scaling and extrapolation from sites.

8) Are there new resources (people, data, instruments, money) suggested and are they required beyond that described in the RFI?

Organismal sampling: vegetation growth, insects, fungal parasites, soil fauna, mosquitoes, and zooplankton, bethic invertebrates, fish, tissues of herbivores.

Important point is that additional resources will required to harden the field sites/instruments for over winter operation (estimated at ~$10K/site--could be at least that much based on this reviewer's experience).

9) Are there other projects, programs, networks, or organizations that would be required to logically, effectively, and efficiently address the question?

LTER
BLM
NOAA Observatory
US Arctic Observatory Network (NSF) site at Toolik Field Station
International Tundra Experiment ITEX
International Permafrost Network

Ideally, the AK gradient plan would address how existing databases and measurement networks would be exploited.

10) What are the education, training, and outreach goals of the proposed science and how will NEON resources contribute to their success?

Plans are to use public awareness and interest of change in e.g., phenology and snow melt, to engage students and citizen scientists.

Data collected will present rich opportunities for **curriculum development** for science education, and for **outreach to the general public**

Many of the ecological consequences of climate change are **of concern because they alter highly visible and easily understood ecosystem services**, such as water availability, agricultural productivity, subsistence resources, the frequency of fires, and the stability of roads and infrastructure in permafrost-dominated systems that experience thawing.

Many of the climatic and biotic **variables** that will be monitored (such as temperatures, vegetation cover and timing of snowmelt) are **easy to comprehend** and to **measure**, and so can be used to **link local conditions to larger** continental and global issues

Phenology of key organisms and **spring melt**, and shifts in the composition of plant communities.

Link to similar data in other regions.

Comments & Notes:
BretHarte_TundraTaigaPNWClimate Gradient:

Use the natural gradient in Alaska can be used to address the NEON Science challenges. Coordination and standardization of measurement protocols. 2 degrees climate change over the last 30 years. Permafrost is declining. Look at warm and the stress on the ecosystems. They are proposing a domain study by way of process modeling. Specific boundaries between eco-zones and where there are shifts and why. Proposing to do stream measurements. Outreached science to k-12 students. Make students involved in measurements.

Comments: How is this relevant to one domain? They amplify the climate change that is very relevant to the area and discuss the extreme changes in the area. This RFI really discusses what NEON is trying to show with climate change. Trying to understand climate change effects in a local context. Strength, simulation modeling. They say how they are going to use the model to answer questions. Three of four of these proposals that deal with subsets of US that are locally crafted, when you look at them all, shouldn't we be putting them together on continental level but it could be a weakness. Permafrost is not an issue in the southeast. This RFI was good on how we tackle climate change on a larger scale.

Comments: There are other networks looking at permafrost. Building of these networks are critical.

Joe MacFadden: Worked in area for many years. 1) three domains, a gradient study covers in many of some of the other domains would. 2) look for hypothesis across gradients. NEON would be able to offer this 3) encourage to look at this area, what you would find in Alaska, you would find in alpine areas and tundra in the lower 48. Link the observation area up with the cold lands, would make sense to predict of things to come.

Mishler_Biodiversity

Mishler et al., Biodiversity changes through time and space on a continental scale

Brent Mishler and colleagues describe how to use the full continental NEON network to answer the overarching question: "How will native biodiversity respond to climate change?" The central idea of the RFI is that future ranges of native taxa can be predicted from modeling their recent past ranges in climate space and projecting shifts in those ranges using contemporary models of climate change. Although such models currently exist, they are oversimplified. The RFI proposes to improve current models by incorporating factors beyond climate—for example soil types, land use, and interspecific interactions. NEON would provide the data needed to parameterize and validate models predicting species ranges.

Biodiveristy would be inventoried over time by characterizing phylogenic structure of all native organisms at each wildland core site. Sites would be inventoried by taking DNA samples from as many organisms at possible at frequent intervals. Sequencing these samples would provide the basis for developing site-specific phylogenies, which, in turn, would be linked to functional traits of interest, particularly traits regulating ecosystem function.

Detailed studies of three groups of species (ecosystem dominants and keystones, indicators, and endangered species) would be undertaken to reveal particular impacts of climate change, including disturbance and regeneration, responses of juveniles, and phenology.

Technology would be developed for the "automatic monitoring of biological diversity" using remote sensing.

Questions for research and experiment responses

1) What is the central hypothesis or question and how does it address the NEON grand challenges? If so, briefly describe how.

The RFI is directly aligned with both of NEON's grand challenges.

2) Does response pose questions at a regional or national scale?

The RFI proposes work at a continental scale

3) How will the design permit scaling from the sensor or measurement to continent?

Specific algorithms for such scaling are not provided. The link between NEON data and the models proposed is poorly described, as are the models themselves. It is not at all clear how the data obtained will support the development of predictive models. The link between biological diversity and climate is opaque.

4) How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or processes at regional or continental scales?
NA

5) How will the proposed science or experiments lead to transformational results, either specified by the RFI response or apparent during the workshop discussion?
It is difficult to answer this question from the RFI. The phylogenetic approach as an alternative to traditional assessments of biological diversity could be transformative, particularly if the phylogenies can be directly related to functional traits. What these key functional traits might be, however, is never explained other than some vague references to ecosystem function. There was not enough information to determine if the climate / range modeling is truly innovative or offers incremental improvements over what is being done now. In particular, I did not understand how soil types, land use, and interspecific interactions would be included in these new models. The researchers do a poor job of explaining how phylogenies will improve predictions of range shifts with climate change. Other than some references to infrequently cited papers, they provide no information on the models they will build or use, on how these models will be validated, on how uncertainty will be incorporated into models, or on the climate change scenarios / models they will use. Even constructing phylogenies can be controversial, and details are not provided on how alternate phylogenies will be reconciled. It is not clear why knowing similarities between species enhances the ability to model climate effects on biological diversity.

6) Which NEON in situ and remote sensors and sentinel measurements are needed to address the research? What cyberinfrastructure needs are implied?

The full suite of climate measurements may be needed. Few details are provided on the abiotic variables that will be used in modeling efforts. DNA samples from as many organisms as possible would be required—this appears to be a truly large addition to the sentinel measurements. For "animals" (vertebrates?), the RFI proposes use of software developed by one of the PI's. This software has not been widely accepted by the ecological community. The first paper describing it has been cited only 19 times by researchers other than the author since 2002. Analysis of microbial diversity will require special software and cyber-infrastructure, most of

which is under development. No definition is given of 'native biodiversity.' For large numbers of small and highly mobile organisms, the technology and software described will be inadequate and it is not at all clear how the researchers will measure key ecological traits that relate to ecosystem function (Do we even know what these traits are?). One advancement is the inclusion of ecological interactions as key 'traits,' yet measuring these for tens or hundreds of species that are interdependent in unknown ways escapes the described technology or effort.

The PI's propose to develop technology for "automatic monitoring of biodiversity." The assertions in the paragraph describing automatic monitoring are naïve at best, misleading at worst. For the foreseeable future, monitoring biological diversity will require boots on the ground.

7) How do the sites proposed in the science and experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site deployment design (e.g. core site, gradient sites, comprehensive national network, experimental gradients, experimental network).

All of the sites would be used.

8) Are there new resources (people, data, instruments, money) suggested and are they required beyond that described in the RFI?

Substantial funding will be required for DNA sequencing and compiling phylogenies, even if sequencers are present at each core site. The researchers also acknowledge that much of the data their analyses require must be collected by people (volunteers?), so that substantial effort will be required outside the infrastructure provided by each NEON site.

9) Are there other projects, programs, networks, or organizations that would be required to logically, effectively, and efficiently address the question?

Museum collections across the continent. Although collections at the Berkeley Museum of Natural History appear appropriate for the historical data needed, it is not clear that museum specimens exist for all other NEON sites that would allow the proposed reconstruction of species 'climate envelopes.'

10) What are the education, training, and outreach goals of the proposed science and how will NEON resources contribute to their success?

This section is particularly weak. Other than a broad-brush assertion that the work will be useful to managers of conservation areas and interesting to citizens, these opportunities are not described beyond acknowledging that a large number of citizen volunteers could be used to collect required data. No mention is provided for quality control of volunteer data collection.

Other comments or questions:

- No component of this research is cast in terms of testable hypotheses.
- The proposal provides very superficial explanation of the research required to construct species' range maps, allow for uncertainty, relate phylogeny to ecosystem function, or predict responses to (various) future climate change scenarios.
- No explanation is provided for how current measured range maps will be compared with future predicted ranges. How will models be validated? How will changes in key ecological traits with climate be incorporated into models?
- No framework for analysis or interpretation is included
- The relationship between biodiversity, phylogeny and ecosystem function is poorly addressed. What role does phylogeny play here?
- The researchers propose a novel approach to biodiversity that is necessary because listing the species present at each NEON site is not possible. How can phylogenies be build if the species present are not identified or known?
- The proposal calls for the construction of site-based phylogeneies for all organisms based on DNA sequences, together with voucher specimens, GPS co-ordinates, photographs, sound tracks, important physiological, demographic, ecological and ecosystem-level traits, all of which are repeated at frequent intervals for hundreds of species. How this work will be integrated and carried out is poorly considered.
- Finally, what happens if a species range is not completely represented by the 20 NEON sites?

- Worry about "regular" type of taxonomy being short changed by this approach (e.g., monitoring for native bees). The problem is that if does not work, there will be little information.
- Seems to have tried to expand from microbial study to these other taxons, and it does not seem to add much to traditional approaches. There are other frontier species (e.g., Haunta virus work) that one could build from. It is clearly important to know and have info about phylogeny and have great kinds of implications.
- This is not a 30 year project. Instead much of the work could be done once. There is value in the project, but it may not be a long term effort. The value of this kind of study is often taxon specific (e.g., knowing origins of strains of plague has import for infectious disease spread).
- Good idea to inventory each site (and that is a first step of this work). Would provide a means to network with other types of studies (who also do inventory work – e.g., Smithsonian's Encyclopedia of Life and Great Smoky Mountains National Park All Taxa Inventory). It was noted that this study does include microbes, which are the focus of the Allen proposal that was received quite well.
- Climate extremes may not relate to edge of organism's ranges. Influences on range and population may not be clear.
- The reviewers did not see that it is realistic within NEON to catalogue everything. The project does not seem to move NEON forward? [Comment – NEON (within ICEP) is interested in a few indicator species that may be indicative of changes within ecosystems.]
- At the same time we need to have and maintain a strong toolbox to deal with evolutionary biology.
- Mining data in itself is useful for the core sites.

- It is not clear why frequent monitoring of phylogeny is needed for this study. It may be useful for some taxa.

Mischler-BioDiversity – Scribe comments:
Modeling range shift in species, assessing a few range of species respond to climate change. Incorporates a greater richest by including land use soil types. Inventoried by charteristing by each wildland core site. DNA samples taken from species and sequences them in each site. Linked to functional traits of interest. Brief discussion of developing technology of automatic modeling of biodiversity. Related to NEON grand challenges. Scaling...no specific algrarythem provided. Transformational? Yes if it is linked but it was not clear in the proposal that it was clear that this would happen. Full sweep of climate measurements needed**.** All sites would be used. Substantial funding needed beyond NEON funding would be needed to get DNA samples. Scant attention on training and outreach. There is a good idea here, ecological forecasting but no one has ever stepped up to say this is the way we should do it. Logical idea but was not well implemented in the RFI. Comment: worry about taxonomy short changed because of this approach. Survey would be needed and a lot of resources would be needed. It was not clear in RFI how this would work. Don't want traditional approach to be ignored. Was not clear how the new approach would provide more information than the traditional approach. Didn't do a good job to show how their approach would do this.
Was the range of this RFI to have a complete survey all organisms in each domain? All genetic composition, for everything? I don't think it gets up one step forward. NEON is not going to accomplish anything with this.
(Kris): If you read the ISEP, no intent to collect and identify every species in each site however that there will be key organisms that will be identified within each site that will be collected and observed, certainly not all of them. More specific meaning in terms of grand challenges.

They are looking at doing an inventory at each site and then doing a genetic background, three phases models and testing predictions of future climate change. Then they will focus on key species on how

Richardson_PhenologyMonitoring

Questions for research and experiment responses

1) What is the central hypothesis or question and how does it address the NEON grand challenges? If so, briefly describe how.

Central Questions:

a) **What are the inter-relationships among of climatic drivers, changes in canopy structure related to and corresponding changes in surface-atmosphere exchange.**
b) **What are the inter-relationships among climatic drivers, changes in canopy structure and changes in surface-atmosphere exchange?**" In other words, "**What are the relationships between structure and function, and how is this climatically mediated?**"

Hypotheses

H1. The timing of canopy green-up and senescence exerts a strong control on interannual variation in ecosystem carbon uptake.

H2. Interannual variation in the timing of canopy green-up and senescence is controlled by variation in climatic factors.

H3. Climate change is affecting the timing of canopy green-up and senescence, and therefore also ecosystem carbon uptake.

H4. Phenological responses, and consequent carbon uptake effects, to climate variability and change vary among ecosystems.

2) Does response pose questions at a regional or national scale?

QUESTIONS themselves are not, but…design permits scaling…see below.

3) How will the design permit scaling from the sensor or measurement to continent?

By allowing us to understand relationship between structure and function sufficiently well to parameterize models that can be run over large areas.

4) How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or processes at regional or continental scales?

Not manipulative. Observational

.

From Proposal:

NEON would provide a consistent and distributed platform for a task that is inherently continental in scope. The tower infrastructure, ancillary measurements, and cyberinfrastructure required for the proposed measurements could only come from a national facility such as NEON. The webcam data could also be linked with the Airborne Observation Platform (AOP), providing greater spatial and temporal resolution than is generally available with conventional remote sensing. By connecting The CO_2 flux and meteorological data collected at each BioMesoNet tower would provide the foundation for developing or testing models of relationships among climate, phenology, and surface-atmosphere exchange, which will improved our knowledge and understanding of the way ecosystems work and respond to changes, especially at large scales.

How will the measurements collected be used in predictive models?

Improving predictive models of surface-amosphere exchange requires improved models of phenology, and better understanding of the relationships between canopy structure and seasonal dynamics of CO_2 uptake and release. The information provided by continuous time series of canopy phenology will result in improved paramterization of models that require information about canopy state (presence/absence or LAI) as an input (e.g., BGC++, CANOAK, LINKAGES, MAESTRA, SPA). Conversely, the same data will be extremely useful for testing of ecosystem models in which phenology is predicted (e.g., BIOME-BGC, ecosys, PnET-II; see also Wythers et al., 2003), as model performance tends to be poor in this regard (Hanson et al., 2004). Related to this, Siqueira et al. (2006) note the importance of leaf area dynamics in controlling interannual variation in modeled CO_2 fluxes.

MY SHORT ANSWER: SIMPLE measurements to connect structure to process to a) test/parameterize models, and b) extend to many OTHER sites

5) How will the proposed science or experiments lead to transformational results, either specified by the RFI response or apparent during the workshop discussion?

VERY simple measurements, but taken over huge expanse.

6) Which NEON in situ and remote sensors and sentinel measurements are needed to address the research? What cyberinfrastructure needs are implied?

The Biomesonet network.
The required cyberinfrastructure should not task what is already envisioned for NEON; utilizing the built-in web server functionality of current webcams, no on-site computer support would be required other than an Internet connection. With images collected only during daylight hours, each tower would accumulate roughly 5 GB of data per year, so the storage and bandwidth requirements are similarly low. Remote-control and surveillance-type uses (for animal activity or site security purposes) of site webcams would consume greater quantities of bandwidth. Additional cyberinfrastructure would be necessary to distribute images to scientific and educational users and for image analysis. For example, as part of the NEON website, simple, server-side scripts could be used to process webcam images and update, for example, a network-wide series of "phenology state" graphics.

7) How do the sites proposed in the science and experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site deployment design (e.g. core site, gradient sites, comprehensive national network, experimental gradients, experimental network).

All Biomesonet towers.

8) Are there new resources (people, data, instruments, money) suggested and are they required beyond that described in the RFI?

One camera should be mounted on each Advanced BioMesoNet tower system. We recommend that in order to provide information about smaller-scale spatial variability in canopy phenology, additional cameras also be mounted on each of the three additional Basic BioMesoNet tower systems. Wireless webcams are available for such purposes. Observations from the cameras could be linked to the observer-based measures of phenology made as part of the Fundamental Sentinel Units (FSUs).

Images should be recorded as minimally compressed RGB images at a 30 minute time step (to correspond with the time step of the flux and meteorological measurements). Live images can be uploaded to a specific web page, and can be analyzed on the fly for relative color channel brightnesses for pre-determined regions of interest. All images should be archived to an external server.

We recommend that instrumentation be added to each Advanced BioMesoNet tower system so that radiometric measurements of phenology (e.g., f_{APAR}, broadband NDVI) can also be calculated. The required instrumentation would be as follows:

- Incident and reflected PPFD (1 sensor each, e.g. Li-COR 190).
- Incident and reflected global radiation (1 sensor each, e.g. Kipp & Zonen CMP3 or equivalent).
- Canopy-transmitted PPFD (minimum of six sensors arrayed around the BioMesoNet tower).
- Instruments should be sampled every 5 s and half-hourly means, standard deviations, and maxima archived.

9) Are there other projects, programs, networks, or organizations that would be required to logically, effectively, and efficiently address the question?

I think that at least in some places, it will be important to measure component processes….species composition, npp, soil respiration, to fill out the rest of the processes that are being inferred by the phenological dynamics.

10) What are the education, training, and outreach goals of the proposed science and how will NEON resources contribute to their success?

Fantastic opportunities for education and outreach…with streaming Webcams et.

Richardson…Phenology Monitoring

Comments…

Data will permit scaling

Will not provide transformational results, but are absolutely critical as this RFI response adds visual data and very good educational potential

The results will be inexpensive and visual and are thus worthwhile.

Good validation data for scaling up…

Question for data management…how are data going to be made available? Cyberinfrastructure should account for this, but may not currently be doing so.
The visual data need to be accommodated. What is the size of the job? If there are frequent observations, this should be accounted for.

Should be coordinated with the National Phenology Network (NPN) and work with NPN on species and protocols for consistency.

General agreement on this requirement as part of a scaling package
Richard_Phenology Monitoring:

Simple…monitor canopy structure, carbon balances. Couple of simple intruments on the biomeses towers. Global radiation and a webcam. Questions…does not pose questions on a national scale. Carbon dynamics. Many questions could be asked. Lead to transformational results. It is cheap. Not high risk and not new tools, Greenness is nothing new but it will be streamed through network, working through model and lots of educational pluses. Can see animals walking by web cams. Part of biomeso network. Critical to data in the network. Inexpensive, direct instrument that is on the network. Lend itself to something that NEON needs to the network. Validation to data. Putting them on key sites to put them at key sites.

Comments: Webcam data, there was nothing to archive and retrieval. Remote sensing data and some way to archive the data. That will need to be addressed.

This proposal estimated 5 gbs a year per site.
Capture the phenology in some way to show climate change. Create a way through visualization to capture this change. NEON should be involved.

Natural and something we have suggested at every site. Many NEON sites should take observations of species and protocol and be apart of NEON.

Dodds_StreamExperimentalNetwork

STREON Summary

This large group of stream ecologists have proposed a continental wide approach to determine how nutrient enrichment alters ecosystem dynamics.

1: What is the central hypothesis or question and how does it address the NEON grand challenges?

Broad question: How will the chronic nutrient inputs (nitrogen or phosphorus) and higher probabilities of extreme events (droughts and floods), and simplification of food webs (loss of consumers) all impact the resistance and resilience of stream ecosystem function (stream-wide respiration, production, and nutrient retention)?

Mechanisms will be defined by which aquatic ecosystems resist and recover from three of the most pervasive forms of human-induced disturbance.

Relation to grand challenges includes:
- Nutrient loadings connected with land use change
- Extreme hydrologic events connected to climate change
- Food webs response to climate & land use change

2. Does response pose questions at a regional or national scale?

Continental wide scale includes sites that cover most NEON domains (except Pacific Southwest?) with a mix of streams, rivers and wetlands, as appropriate to each region.

A. The proposal includes several questions that consider multiple scales such as interactions among drivers: Resistance and resilience of ecosystem functioning (productivity, respiration, nutrient cycling/retention) are jointly determined by frequency of extreme hydrologic events (droughts/floods), rate of nutrient loading, and food web structure.

B. Process-level understanding is used to provide basis for scaling.
Time scales of ecosystem feedbacks and regime shifts: Long term nutrient loading & increased frequency of hydrological disturbance interact to promote irreversible 'regime' shifts that alter resistance & resilience of ecosystem functioning to droughts/floods.

C. Interacting and multiple stresses on natural streams. Spatial scales of response: resilience and recovery of ecosystem functioning over continental scales will vary with regional context including local species composition & diversity, climate and hydrologic disturbance.

3. How will the design permit scaling from the sensor or measurement to continent?

Choice of "representative" streams, rivers and wetlands. The selection of measurements and sites are intended to provide the needed stratified sampling at the continental scale.

Both measurements and sites are scalable becasue they will presumably be independently instrumented and operated.
The overall concept is good; the rationale for specific site selection needs to be clear.

4. How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or processes at regional or continental scales?

Observational RFI depends on natural variability, rather than a controlled experiment. This comparative study provides an analysis of pattern among a large number of streams that will be well defined in terms of their basin characteristics.

The experimental RFI doe included manipulative experiments that include

- Upstream and downstream on manipulated reach
- Parallel control and treatment sections of stream

5. How will the proposed science or experiments lead to transformational results, either specified by the RFI response or apparent during the workshop discussion?

Key advantage: Common protocols for the sites essential for broader assessments and development of general insights; Common data and information system (data retrieval) facilitates research and discovery.

This type of experimentation is not done by different investigators when each is working independently to design and operate field studies. The LTER network, USGS sites, Forest Service Experiment Stations generally develop independent experimental designs and their data can be difficult or impossible to compare or integrate into a comprehensive, continental-scale series of observations. The power of NEON will be to coordinate data collection and analysis as well as have comparable designed experiments on a set of streams.

6. Which NEON in situ and remote sensors and sentinel measurements are needed to address the research? What cyberinfrastructure needs are implied?

The research and observational studies will use:
2 NEON aquatic sensor packages per each of the 30 sites (10 are already core wildland sites); satellite data for watershed characteristics, baseline and change.

Cyberinfrastructure needs are not yet completely defined and will be of critical importance.

7. How do the sites proposed in the science and experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site deployment design (e.g. core site, gradient sites, comprehensive national network, experimental gradients, experimental network).

The design is based on regional questions (e.g. multiple Phoenix area sites) plus national gradients across the continent and in Puerto Rico, Hawaii.
Rationale for how many sites and where they are located to be further developed.

8. Are there new resources (people, data, instruments, money) suggested and are they required beyond that described in the RFI?

Watershed-scale understanding would be useful. Remote sensing will provide some essential information.
Several measurements beyond standard NEON packages are needed.
Response does include some groundwater observation wells.
Is hyporheic sampling also included where appropriate? Are weather stations, energy balance measurements available? Need basic precipitation, snowpack data where available.

9. Are there other projects, programs, networks, or organizations that would be required to logically, effectively, and efficiently address the question?

Synergy with other existing and planned networks should be further explored and developed to enhance optimal connectivity among sites within different watersheds. Are the important upstream and downstream connections that need to included in the site selection and design? There is a need to weigh various tradeoffs between opportunistic sites and representative sites with different degrees of hydrologic connectivity and ecological connectivity..

10. What are the education, training, and outreach goals of the proposed science and how will NEON resources contribute to their success?

Some sites use LTER schoolyard activities and other well organized activities for environmental education and outreach. Response includes the usual types of interactions at this point. Much more could be done with the output to provide opportunities for developing modules that use data sets in undergraduate and graduate education, which could be shared with many universities.

Notes & Comments:

Dodds
Stream Experimental Network

Primary input:

Secondary Input and Additional Comments:

Good selection of sites – at least 10 of which are LTER, and strong colleagues

Most of these are LINKS sites

Outreach could be good

This is a logical extension of the LINKS experimental program; to get to NEON network level but now needs different site selection criteria and more intellectual linkage with NEON

Could build off existing data to take next steps forward that make it more of a network

Dodds_StreamObservational Network:
STREON: two proposals of the same group. 30 observational sites, building on existing research sites in 19 of 20 domains, multi-decadal observations. Grand challenges relation: nutrient loadings connected with land use change. Extreme hydrological events connected to climate change. Food webs response to climate and land use change.
Covers most NEON domains, except Pacific Southwest. Mix of streams, rivers, and wetlands. Interactions among drivers, time scales of ecosystem feedbacks and regime shifts and spacials scales of response. Multiple stressors: climate change or diversions.
Which comes first, the sites or the gradients. Both the measurements and sites are scalable since they will presumably be independently instrumented and operated. Concept is good; rationale for specific sites. Key advantage: common protocols for the sites essential for broader assessments and development of general insights. Common data & information system facilities research & discovery. Most important thing is cyber infrastructure. Rationale for how many sites and where sites are located still need to have further information. Is hypothetic sampling included? Snow pack level? Precipitation, what is coming in? Some LTER schoolyard activities but seemed very

standard stuff. Need to explore opportunities for developing modules that use data sets in undergraduate and graduate education which could be shared with many universities.

Comments: Other aspects of RFI need to be combined. Expand on senergy aspects of RFI.
Comments: A lot of overlap with other RFI's with water sheds, and need to have a stream and water shed network. It would be affected. If you have an idea how this can be accomplished, please let NEON how they can get them together. Need to get all proposals together and prioritize the different information that has to do with watersheds.

Comments: would like to have seen, how many location will let you see hydrological connections across the domain?

Would it be possible to write what we want the sites to have? If we talk about criteria we can meet what NEON is really is all about, especially with watersheds. As a continental study, we should have this but as a region, the criteria would different.

Boundaries are not established when it comes to watersheds. Really hard to integrate.

Do I want to be in a area that is going to be changing in 20 years or some place that will not change?

Capture and be sensitive to drought and floods.

Su_SurfaceRadiativeFlux

Wenying Su, Bev Law, and Warren Wiscombe,
"Standardize radiation measurement at NEON sites"

This RFI brings up the critical point that accurate solar radiation measurements are absolutely required in the final spec details of the NEON BioMesoNet towers. The high accuracy of these measurements will require not only investment in top quality pyranometers and radiometers, but also investment in a centralized calibration and maintenance facility.

Questions for research and experiment responses
1) What is the central hypothesis or question and how does it address the NEON grand challenges? If so, briefly describe how.

This is a measurement proposal for obtaining consistent, high quality, accurate measurements of radiation. Accurate surface radiation flux measurements are critical to answer NEON science questions. Only by following the recommended measurement and calibration protocols (based on BSRN/ARM methods), will NEON obtain climate quality radiation data. Without a careful instrument and measurement protocols, errors will be significant and make the data less valuable to answer continental scale questions related to climate change and ecosystem function.

Ecosystem processes, such as CO2 and H2O exchange, are highly sensitive to the amount of absorbed solar radiation. Past experiences with AmeriFlux has revealed that normal protocols

for measuring solar radiation using off-the-shelf instruments and calibrations can result in errors in the range of 10-20% when compared to the accurate standards obtained through the Baseline Surface Radiation Network (BSRN) and the Atmospheric Radiation Measurement (ARM) network. This level of error will potentially induce large errors in higher-order derived parameters such as ecosystem quantum yield, surface energy budget, and evapotranspiration.

The central hypothesis of this RFI is that (1) pollution and clouds, which are both components of global change, affect the partitioning of solar radiation into direct and diffuse components, (2) that the fraction of diffuse radiation will increase in the future, and (3) ecosystems will respond to these changes in radiation partitioning in their surface-atmosphere fluxes.

2) Does response pose questions at a regional or national scale?

The science question that this instrumentation proposal addresses is: How do aerosols and clouds, through impact on radiation budget, affect functioning of different ecosystems and the feedback of these systems to the atmosphere due to exchanges of CO2, H2O and energy?

This question is posed for the national scale of NEON.

3) How will the design permit scaling from the sensor or measurement to continent?

Recommend to co-locate these with AERONET and flux towers. Measurements of solar radiation across the entire NEON, and carefully calibrated to provide highly accurate and matched observations, will permit accurate articulation of the network as it's used to feed data to models.

4) How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or processes at regional or continental scales?

There are no manipulative experiments. There are, however, predictions about how ecosystem CO2 and H2O exchange will respond to "global dimming" due to increased aerosol loading or cloudiness.

The role of aerosols on ecosystem CO2 budgets is uncertain. Decreasing PAR (with increased aerosols) decreases photosynthesis but increasing diffuse PAR (with increased aerosols) has opposite forcing and increases light use efficiency and increases CO2 fixation. By obtaining highly accurate measurements of solar radiation, we will be able to address mechanistic questions such as this.

5) How will the proposed science or experiments lead to transformational results, either specified by the RFI response or apparent during the workshop discussion?

Not directly transformational but requirement for accurate radiative flux measurements. The respondents make the point that the NEON BioMesoNet towers must be designed with top-shelf, highly accurate radiation measurement systems, which are maintained through dedicated and regular calibration and maintenance.

6) Which NEON in situ and remote sensors and sentinel measurements are needed to address the research? What cyberinfrastructure needs are implied?

Part of the flux/radiation budget measurements design.

7) How do the sites proposed in the science and experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site deployment design (e.g. core site, gradient sites, comprehensive national network, experimental gradients, experimental network).

Recommend to co-locate these with AERONET and flux towers, presumably at NEON core sites.

8) Are there new resources (people, data, instruments, money) suggested and are they required beyond that described in the RFI?

No.

9) Are there other projects, programs, networks, or organizations that would be required to logically, effectively, and efficiently address the question?

No.

10) What are the education, training, and outreach goals of the proposed science and how will NEON resources contribute to their success?

None.

Notes & Comments:

Wenying Su, Bev Law, and Warren Wiscombe, "Standardize radiation measurement at NEON sites"

Su_SurfaceRadiativeFlux:
Improve the radiation measurements on the biomeso net. Air pollution, participle loading, reductions of radiation. Compared the instruments over a year by very accurate measurements by DOE. They were off 27 watt per meter^2. NEON would have to standardize the radiation measures and calibration the sensors. Set up facility to do this calibration and testing. Need for instrumentation. Was always an assumption that this was always done. Is this done as a precaution or suggest some sort of outsourcing from the network. That bias was got by a certain slope over a year.
Comments: Do they have a facility for this? It needs to happen.
Have some test beds that will have all the instruments in a small area and get bias associated with the data and some way to improve the system. Some sort of calibration?

Are we building around the established structure or are we building new?
The tower structure is good, we just need to correct the calibration problem.

Comment: Upgrade the baseline radiation network standards.

Major issues of NEON are being discussed and being developed by Tiger Team.

Davis_Ameriflux

AMERIFLUX Consortium for Continental Trends

Lead Scientists:

Kenneth Davis
David Hollinger
Bev Law
J. William Munger

1) **What is the central hypothesis or question and how does it address the NEON grand challenges?**

How will the carbon and water cycle of the terrestrial ecosystems of the USA, in particular exchanges between ecosystems and the atmosphere, respond to future changes in climate, land use/vegetation cover, soil/hydrology status, and environmental chemistry, and thus feed back to future climate change?

Diagnosis (current data)
Attribution (analysis of current data in face of gradients in climate, land use, hydrology, and environmental chemistry)
Theory/Modeling (?)

Biosphere atmosphere exchanges are at the core of climate forcing on both directions (biosphere on climate and vice versa). Gauging these exchanges with sufficient spatial and temporal resolution, for long spans of time, is fundamental for any further understanding. As the Mauna Loa notorious CO2 time series illustrate, long term datasets of the nature produced by Ameriflux towers are required to detect any climate induced deviation from those natural fluctuations.

2) **Does response pose questions at a regional or national scale?**

both

3) **How will the design permit scaling from the sensor or measurement to continent?**

Nested BioMesoNet towers, Movable Towers, Remote Sensing, Modeling of ecosystem processes
High precision CO2 measurements can aid inverse modeling
Problems: terrain representation, gradients, scaling up

4) **How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or processes at regional or continental scales?**

No experiments proposed (observational, analytical, modeling only)
[although the network has experiments like FACE or induced drought (Amazon) that could certainly help understand sensitivities and responses in complex systems]

5) **How will the proposed science or experiments lead to transformational results, either specified by the RFI response or apparent during the workshop discussion?**

Follow synthesis efforts in Ameriflux?
Great advances in understanding from gradient (climate, soils, landuse, etc) comparisons

- difficult comparison due to variation in methods
- comparison of "daytime" NEE (ecophysiological responses mostly)
- problems with nighttime

6) **Which NEON in situ and remote sensors and sentinel measurements are needed to address the research? What cyberinfrastructure needs are implied?**

BioMesoNet towers (actually, Ameriflux towers are proposed as backbones for biomesonet), 10-40 with advanced package plus 110-80 relocatable tower systems with terrestrial sensor arrays.

-Besides the common flux measurements high precision CO2 measurments (for inverse modeling) are suggested.
-Biometric measurements of carbon accumulation are essential and not explicitly included in the biomesonet system

Big overlap between NEON and Ameriflux. Existing Ameriflux time series, data base development, site distributions and network management experience, if duly integrated, are precious resources for NEON, saving time and money (and bringing back to AmeriFlux community long term funding for monitoring)

Ameriflux scientists have a strong history of international research, that can serve NEON (global forcings)

Neon has broader scientific mandate than Ameriflux

Cooperative vs centralized (or standardized) model (relate to Euroflux)

KEY : NEON provides a vision of a consistent network that would enable long-term observations across sites to detect trends over years to decades (funding, standards, methods, management, et.)

7) **How do the sites proposed in the science experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site deployment design (e. g. core site, gradient sites, comprehensive national network, experimental gradients, experimental network)**

Clusters of observations within domains, high-resolution RS and extensive ground sampling (biometric inventories, stream gauge networks) at these clusters will be used methods for interpolating this understanding across small-scale (tens of km to few hundred km) regions. Continental scale extrapolation will then be evaluated against large-scale inventories (atmospheric, biomass and hydrologic budgets)

Development of models in a similar fashion as what is done for climate models will result from simulations validated to reproduce known scenarios, hoping his will mean the acquisition of predictive capacity

How to deal with non-analogs respecting climate-change scenarios (the parrot dilemma)

Deployment configuration

The complete network of tower sites required to encompass all of the driving factors is not known

The RFI then proposes a four tiered approach to develop the ideal configuration:

- present a network of existing sites
- suggest observational strategies for the science question (and not specific locations)
- suggest how existing sites can be integrated in the observational strategy
- propose a structure for evolution of the network design (reiteration)

Continental scale

- 40 BioMesoNet long term tower systems, 20 years time span (2 per NEON domain, core or gradient sites)
- 15 relocatable tower systems with terrestrial sensor arrays, 5 year rotations covering 60 additional locations (aprox 3 per NEON domain)

Local scale

- 15 relocatable tower systems with (advanced?) terrestrial sensor arrays deployed in 5 clusters of 3 towers, co-located with one of the 40 long-term towers in the continental scale design, making a 20 year deployment for 5, 4-tower clusters (?)
- 50 additional relocatable tower systems deployed in clusters of 5, for 5-year deployments, at each of the 40 long-term advanced BioMesoNet tower systems that are part of the continental-scale observational design (biomesonet would host 5 relocatable tower systems. (?)

Final Remarks

From the analyses of existing AmeriFlux sites the RFI thinks the number of sites proposed to NEON would create a meaningful measure of continental gradients in fluxes

Further criteria

- micrometeorological suitability (the most serious limitations of eddyflux technique)

- Biogeostatistics (still lots to do)
- Domain expertise (reaching out)

Integrating Ameriflux into NEON
-Multitiered selection of sites
-Interagency negotiations (DoE & NSF)
-Ameriflux visibility, calibration expertise, database management, network coordination resources

Complementary measurements
-carbon inventory data, hydrologic budgets, RS and ecosystem experiments are considered the essential complements to address the question

8) Are there new resources (people, data, instruments, money) suggested and are they required beyond that described in the RFI?

- a toolbox of instruments to assist with flux measurements in complex terrain: the advection toolbox (draino type?)
- flux aircraft
- airborne trace gas measurement
- Sap flux on biomesonet (cheap and valuable)
- Tall tower (Wisconsin)
- ABL

9) Are there other projects, programs, networks, or organizations that would be required to logically, effectively, and efficiently address the question?

Ameriflux itself, which is part of a global network (fluxnet, external forcing)

10) What are the education, training, and outreach goals of the proposed science and how will NEON resources contribute to their success?

- technician crowd (master level students to run towers)
- summer schools (under and graduate) on micrometeorology
- outreach to local groups (state level climate change bodies)
- K-12 through interactive web access

The RFI stress that there is a shortage of people with technical skills in environmental biology / micrometeorology, suggesting that NSF/IGERT could help over the long term, becoming NEON a hands-on laboratory for this type of education

Proximity to major universities can make NEON create great sinergies.

(recommendation: environmental services exhibits)

Comments & Notes:

- Ameriflux desire for NSF to invest and continue the substantial existing dataset and measurements, and to extend them. We think it's appropriate and important. These long-term measurements are scalable and key to NEON.
- The expertise present in this group is critical to NEON.
- To what degree do flat sites across the country offer the opportunity to answer all the grand challenge questions, in addition to the Ameriflux questions?
- The idea of an advection toolbox to move beyond flat terrains is absolutely critical. Virtually all core sites will have complex terrain, so direct attention needs to be done to make the flux measurements accommodate this.
- The add-on of high precision CO2 measurements and the additional sap flux measurements generated discussion. These measurements are necessary (aircraft, high precision measurements, etc) for scaling up the regional level. Would allow more critical constraints, extension to a boundary level budget, and so extension to region.
- The hypotheses follow the NACP program, which is a good synergy and should be followed up on.
- NEON could provide a huge amount to secure funding of the current Ameriflux towers (only 21 are in the Tier 1 category, funded long-term by DOE), but also the member tower sites that are voluntarily members. In 10 of the NEON domains, there are no current Ameriflux towers.
-

Ameriflux:
Consortium for Continental Trends
Diagnosis, current data,
Attribution and theory/modeling

To measure the continent:
Nested BioMesoNet towers, Movable towers, remote sensing, modeling of ecosystems processes
Problems: terrain representation, gradients, scaling up. Flux towers, one dimension data: there is a problem to transform a one dimension into two dimension.
No experiments:
How will this lead to transformational results?
-Follows synthesis efforts in Ameriflux
-Great advances in understanding from gradient
-Difficult comparison due to variation in methods.
-Comparison of "daytime" NEE, ecophysiological responses mostly,
-Problems with nighttime.

What is needed to do research?
BioMesoNet towers, 10 -40 towers

Big overlap between NEON and Ameriflux: this will save time and money.

High precision CO2 measurements.
Further criteria:

1. micrometerological suitability, the most severe limitations of eddyflux technique
2. biogeostatistics, still lots to do,

Ameriflux itself is part of a global network.

Become core gradient sites with NEON. They give reason why they should. What degree do flat sites across the country answer the grand challenge questions. This idea to move beyond flat terrain is essential. Not everything is represented in flat spots.
Good idea but has some limitations. Technical advances need to happen.

Follow closely with NA Carbon program. There is a disconnect between funding and operations, the synthesis of the two is important.

There is no set DOE tier 1 funding. Even with those funds, there is not enough to fund those sites. That is why there is an interest in NEON to help keep it going.

Scalability, primary issue…the biomesonet towers are super ameriflux towers but they are represent a single measurement. Complex terrain is an issue. The sites are working on the issue with complex terrain and need to recognize that the sites are going to be in a non-ideal terrain. It should be a goal of NEON.

How to bring NEON and Ameriflux together?

Ehleringer-GradientSites

Review Summary
Overall, well written and well thought out. Particular strong detail and emphasis on specific location of sites within the Great Basin (domain 15). Could have more detail on how specific measurements

A domain specific response is appropriate to NEON goals if and only if
- -The coverage of the sites is such that the study is truly regional
- -The gradient is evident (and well defined).
- - The study considers relevant gradients (and relevancy needs to be defined)

It is not clear how this effort differs from an urban NSF proposal.

Details of this response relate to the details that will be in the core site selection.

They could extent the study all the way to the Sierra Nevada. There are interesting climate gradients, but this study seems to focus on the urban aspects of the study.

Details of the Response
BAR SALT- Gradient Sites for the Great Basin Domain (Domain 15)

Background
The Intermountain Region is characterized by combinations of lower elevation shrub steppe (basin), where rainfall is the primary precipitation input, and higher elevation forested

mountainous regions (range), where snowfall is the primary precipitation input. They propose a combination of 'basin and range' (**BAR**) observations to capture the variation across this mosaic that makes it challenging to characterize the entire domain with a single location.

This response contains additional details related to the proposed gradient sites within the Great Basin Domain (Domain 15), but it is otherwise consistent with the hypotheses, objectives, and measurement schemes of the national 3CS and COREO documents.

It contains additional details related to the gradient sites selected within the Great Basin Domain

Questions for research and experiment responses

1) What is the central hypothesis or question and how does it address the NEON grand challenges? If so, briefly describe how.

Climate hypothesis. Changes in the **timing, form, and seasonality** of precipitation as well as changes in **drought frequency** and **intensity** will alter ecosystem structure and function, ultimately leading to changes in species distributions.

Land-use change and urbanization hypothesis. As a result of the impact of humans on the landscape through land-use change and urbanization, sensible heat, latent heat, and CO2 fluxes will increase across a chronosequence of urban/suburban sites; and land-use changes result in shifts in the distributions and concentrations of resources that will feedback on the **capacities of native ecosystems to provide goods and services**.

Infectious disease and invasive species hypotheses: (a) Climate and land-use interact to alter the **mode, rate of spread, and impact of invasive species** on natural and managed ecosystems; (b) the emergence and expansion of diseases or their vectors/hosts can be predicted by an **understanding of the interactions between disturbance, climate, and human dynamics**; (c) the **impact of disease will affect ecosystem function** and services and human health.

2) Does response pose questions at a regional or national scale?

Regional

3) How will the design permit scaling from the sensor or measurement to continent?

Each of the sites described and proposed for the Great Basin Domain is a component of the national efforts lead by the Consortium for Connectivity at Continental Scales (3CS) and Consortium of Regional Ecological Observatories (COREO).

This RFI was developed in coordination with integrated efforts at the national level led by the Consortium for Connectivity at Continental Scales (3CS) and Consortium of Regional Ecological Observatories (COREO).

It contains additional details related to the proposed gradient sites within the Great Basin Domain (Domain 15), but it is otherwise consistent with the hypotheses, objectives, and measurement schemes of the national 3CS and COREO documents.

4) How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or processes at regional or continental scales?
Gradient of sites: 1 - Onaqui-Benmore 'basin' wildland site, 2 - 'range' Red Butte Canyon site.

Within Red Butte Canyon, we will have towers located in both the lower and upper portions of the watershed to partition these ecosystem processes by elevation, creating a 3-zone gradient with the wildland 'basin' site, 5 sites in addition to Red Butte Canyon and the core Onaqui-Benmore sites: that differ in both total annual precipitation and temperature (Figure 2) and in the amount of summer rainfall (Figure 3).

5) How will the proposed science or experiments lead to transformational results, either specified by the RFI response or apparent during the workshop discussion?

These sites form an integral part of the national network designed by 3CS and COREO that links domains to form a national network and also constitutes a cohesive domain-level gradient that allows us to address regional questions that have national importance.

6) Which NEON in situ and remote sensors and sentinel measurements are needed to address the research? What cyberinfrastructure needs are implied?
The remote sensing needs are exactly as described in the 3CS and COREO RFI documents.

7) How do the sites proposed in the science and experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site deployment design (e.g. core site, gradient sites, comprehensive national network, experimental gradients, experimental network).

The overall importance of water in the Great Basin makes existing climate variation and changes in climate over time compelling foci for NEON research.

We have selected 6 sites that, in combination with the core wildland site, represent the significant domain-wide variation in climate, which is primarily dictated by amount and seasonal pattern of precipitation, modified by temperature and elevation. study sites to form a gradient that captures the climate, biodiversity, and invasive species science question critical to the Great Basin and surrounding domains.

8) Are there new resources (people, data, instruments, money) suggested and are they required beyond that described in the RFI?

9) Are there other projects, programs, networks, or organizations that would be required to logically, effectively, and efficiently address the question?

10) What are the education, training, and outreach goals of the proposed science and how will NEON resources contribute to their success?
Multiple education and outreach facilities serving K-12 and public outreach have expressed a serious interest in participating in NEON, including

- Bean Museum, Brigham Young University, Provo (UT)

- Children's Museum, Salt Lake City (UT)
- Great Basin National Park (NV)
- Idaho State Museum of Natural History (ISU, Pocatello, ID)
- National Park Service, Upper Columbia Basin Network Sagebrush Steppe Parks (Craters of the Moon National Monument and Preserve (ID)
- City of Rocks National Reserve (ID)
- Hagerman Fossil Beds National Monument (ID), John Day Fossil Beds National Monument (OR)
- Lake Roosevelt National Recreation Area (WA)
- Natural History Museum, University of Utah, Salt Lake City (UT)
- Sawtooth Science Institute, Sun Valley (ID)
- Snake River Birds of Prey National Conservation Area, BLM Boise (ID)
- The Leonardo, Salt Lake City (UT)
- The Peregrine Fund, World Center for Birds of Prey, Boise (ID)
- Western Governors Association, Salt Lake City (UT)

In addition, there are several active programs that link University researchers with primary and secondary schools (e.g., the NSF-funded GK-12 Program at ISU, USU, and UU).

Comments & Notes:

Ehleringer: Gradient Sites: Great Basin:
Climate hypothesis, timing, form and seasonally.
Land-Use Change and urbanization
Infectious disease

Specific to Great Basin:
Each of the sites is a component for the national effort lead by the consortium for connectivity at continental scale. Extensive outreach K-12. A domain specific response in key to NEON goals. Since it is not a continental scale, is this proposed study is similar to other RFI or can be included into a larger study?

Comments: There is not a single LTER there or data sets for the area. We need more data and understanding of that area.

Same question as for Alaska as for Great Basin: is this is only site available for the area or being proposed for that area.

Domain verses region? Have they located their sites to be truly regional? As for there gradients, was there three or more? Urban sites important to NEON but this RFI did not do justification to what they were looking for. How can this be scales up? Have they covered the region, are they looking at relevant gradient?

Fetcher_WatershedGradientStudy

Susquehanna Watershed Gradient Study
Ned Fethcher[1],
Dale Burns[1], Joseph Graney[2], Keneth Klemow[1], Steven Rier[3], Karen Salvage[2],
John Titus[2], William Tothill[1],Weixing Zhu[2]

[1]Wilkes University
[2]Binghamton University
[3]Bloomsburg University

1) What is the central hypothesis or question and how does it address the NEON grand challenges? If so, briefly describe how.
Hypotheses
Throughout the watershed land use will remain the primary determinant of water quality. Location in the waterhsed will show an interaction with land use, but the effects will be small compared to land use alone.

Global climate change will produce increased winter precipitation (Chang 2003) and decreased transpiration in summer (Gedney et al. 2006) within the SRB, resulting in more runoff and increrased probability of catastrophic flooding events. Declines in forested areas coupled with increases in impermeable surfaces will increase the likelihood of floods.

2) Does response pose questions at a regional or national scale?

3) How will the design permit scaling from the sensor or measurement to continent?

4) How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or processes at regional or continental scales?

5) How will the proposed science or experiments lead to transformational results, either specified by the RFI response or apparent during the workshop discussion?

6) Which NEON in situ and remote sensors and sentinel measurements are needed to address the research? What cyberinfrastructure needs are implied?

How do the sites proposed in the science and experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site deployment design (e.g. core site, gradient sites, comprehensive national network, experimental gradients, experimental network).

7) How do the sites proposed in the science experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site deployment design (e. g. core site, gradient sites, comprehensive national network, experimental gradients, experimental network)

8) Are there new resources (people, data, instruments, money) suggested and are they required beyond that described in the RFI?

9) Are there other projects, programs, networks, or organizations that would be required to logically, effectively, and efficiently address the question?

10) What are the education, training, and outreach goals of the proposed science and how will NEON resources contribute to their success?

Notes and Comments:

Notes: Fetcher – Susquehanna Watershed Gradient Study
Scribed by Kevin Griffin 2/5/07
(Sorry most of these are very general not related to this proposal – but this is the discussion we had!)

Need to be clear on partnerships with CUASHI

Scale and scaling going to be critical with regard to specific drivers and the observations required. How can we move beyond this specific watershed? How do we integrate the measurements and science across the scale of watersheds and the appropriate atmospheric scales?

Not enough information about how to use data to actually answer the questions, particularly in regards to scale – yet this is crux of the issue for the design of NEON. (nuts and bolts)

Multi disciplinary teams needed in advance to link measurements with models and analysis.

Points to domains – difficult (across NEON, not specific to this proposal).
Use of aircraft important and needs more discussion.

Lots of back ground in this watershed and particularly the Chesapeake Bay. Links to basin scale studies and efforts through other programs – Waters test bed & CUASHI

Bringing data and models together is the key, both techniques and models exists its how to make sure they will be connected appropriately.

NEON to be predictive – How do we get beyond observations to actually predict response to climate change. If we don't we have missed the bus.

Prediction is what we want; it needs to be our framework. It has to be goal of NEON

We need to have NEON built on theory if we are going to get to forecasting. Most of the responses we have discussed so far are observation heavy but theory, analysis and forecasting light yet this seems backward. Needs focus on prediction.

Process level understanding should be the basis, by gaining a mechanistic understanding we will ultimately be able to pass on the correct information to the models for prediction, but with out knowing the mechanisms and processes we can't forecast.

May be a result of NEON being an equipment based concept at this point

Perhaps the long term goal of forecasting and continental scale ultimately comes from quality processes level studies that ultimately, in time will lead to answering questions as theories develop.

We have no theories to build on so we are left with empiricism (the parrot that mimics the human voice)

This is because we do not have the "Math of Ecology"

Comment & Notes:
Fetcher_WatershedGradient Study

How does land use interact with position in the watershed and future changes in t climate to affect water quality and quantity as well the associated aquatic Susquehanna River Basin. Location in the watershed will show an interaction with land use but the effects will be small compared to the climate change. Basic tower system, one per watershed, aquatic sensor array, relocateable towers.

CUAHSI- not national while NEON is doing national scale.

This proposal would cut across two domains. More regional.
Comments: How does biomesonet in one domain capture the variation between domain?

There is a scaling problem. Connectivity across the scales. Somehow is needs to come together.

General question: Is this what NEON is about? Small watershed study?
Smaller regional scales problems are important and smaller scale but are we missing the continental scale?

In our responses to these responses, a process level component, we are never going to cover 100% of the area not mater what network we have. We need to develop a process level to meet the models.

To facilitate future projects, use for models, it can used on a larger scale and take these issues into account. Predictions can be taken into account.

Ward_N_Deposition

Mulholland-Ward N Deposition Small Watershed: Burke

Questions for research and experiment responses

1) What is the central hypothesis or question and how does it address the NEON grand challenges? If so, briefly describe how.

One of the key environmental impacts occurring currently and projected to occur is the persistent addition of anthropogenic nitrogen to ecosystems. Much of the addition is atmospheric (though not all). It is clear that there are aquatic responses, and the terrestrial responses are a bit less clear because of interactions with precipitation, weathering status, other pollutants, and a myriad of other factors. Terrestrial responses are a key factor influencing stream loading. Studying N deposition effects is important!

This NEON Research Design (Observational) is intended to address the issue of how ecosystems will respond to future changes in nitrogen deposition and the interactive effects of N deposition and changes in ozone exposure and climate. Specific questions to be addressed are as follows:

- What are the interactive effects of changes in N deposition (and related air pollutants such as ozone concentration) on productivity, biogeochemical cycles, and N retention of forested ecosystems and the streams that drain them?
- How does N deposition interact with changes in ozone and climate variability and change to affect biodiversity and susceptibility to invasive species in forest and stream ecosystems?
- Are there feedbacks involving N deposition and its direct effects that alter the ability of forests and streams to retain N?
- How do the long-term trends in N retention in forested watersheds relate to long-term trends in N retention in mixed land use watersheds in the same region?

Hypotheses:

Hypotheses addressed by this Research Design are as follows:

● Future rates of N deposition will result in loss of retention and increasing hydrologic outputs of NO_3 from forests as they mature and approach saturation; these effects will be spatially variable due to spatial variations in deposition rate and forest species composition.

● N deposition will interact with changes in air pollution (e.g., ozone) and climate to produce significant changes in the productivity, biogeochemical cycling, and biological communities in forests and the streams that drain them

● Feedbacks involving the direct effects of N deposition and interactive effects with climate will alter the ability of forests and streams to retain N?

Addresses grand challenges of climate change, hydroecology, and biogeochemical cycling.

2) Does response pose questions at a regional or national scale?

It utilizes both space (a continental gradient in N deposition and climate) and time (long term measurements) to address the questions. The design is flawed in the sense that correlations will be used to address the questions. Lots of things will be changing both in time and in space, so the interpretation will be limited to some extent. This is not fatal…long term monitoring is important! I think the key thing is that these measurements will be, and are, important beyond the focus of N deposition and climate interactions.

3) How will the design permit scaling from the sensor or measurement to continent?

By a) using the gradient to capture a wide variation in N deposition, and b) pairing sites with varying conditions to get at the site level controls.

("The primary gradient over which these responses will be studied is N deposition. However, differences in air temperature, ozone exposure, forest vegetation type, and soils/geology are incorporated into the research design by selecting two sites at each N deposition node (see deployment configuration below").
"Sites will include small forested watersheds drained by a low-order stream (wildland sites). By comparing stream N outputs from intensively instrumented, small paired forested watersheds that differ in vegetation type and/or soil/geological features, this research design further addresses the issue of variability of forest responses to land use change and the role of forests in heterogeneous landscapes".

"Forest and stream ecosystem responses to be studied range from ecosystem-scale processes to molecular/genetic measures of microbial processes and diversity. Response variables will include:

Carbon exchange and ecosystem productivity (forest and stream)
Soil N cycling and retention
N gas emissions from soil and stream
Watershed N retention
Forest tree species distributions (canopy and understory)
Microbial functional diversity and N cycling enzymes"

4. How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or processes at regional or continental scales?

Not manipulative. Observational

As I said above, there are some limitations to the mechanistic understanding because it is observational not experimental. I think though that this is the face of NEON!
.

5) How will the proposed science or experiments lead to transformational results, either specified by the RFI response or apparent during the workshop discussion?

What they say: . A long-term, broad scale monitoring program such as NEON is needed to better understand the long-term trajectory of forest ecosystem responses to N deposition as well as underlying mechanisms producing those responses in different regions of the U.S. A large-scale, gradient approach also provides insights into potential connectivity and interrelationships of responses among regions that would not emerge with single site research.

What I think:
It would be more "transformational" if it extended beyond the east coast gradients proposed. Right now, the results will really only apply to highly weathered, warm, wet places.

6) Which NEON in situ and remote sensors and sentinel measurements are needed to address the research? What cyberinfrastructure needs are implied?

From proposal:

The instrumentation to be deployed at each site includes the Fundamental Instrument Unit with most of the instrumentation from the Advanced BioMesoNet package (including the canopy, soil, and stream sensor arrays). This instrument package will permit collection of the data necessary to determine basic meteorological properties, wet and dry N and S deposition and wet deposition of base cations, ozone concentrations, forest productivity and transpiration (CO_2 and water vapor exchange with the atmosphere), soil CO_2 flux and nutrient dynamics, nutrient export in stream outflow, and stream metabolism. Additional measurements that would be useful include ^{15}N analysis of NH_4 and NO_3 in precipitation, soil water, and stream water (perhaps at weekly intervals on water collected manually) to identify sources of N export from the watershed (i.e., recent deposition, remineralized soil N). This sensor package will be used to address the first 3 questions of this Research Design.

Portions of the Fundamental Sentinel Unit involving biogeochemistry, biodiversity, and functional genomics related to soil and stream microbial diversity and biogeochemical fluxes will also be deployed at each site. This instrumentation is needed to address questions 2 and 3 above.

The stream sensor array will be deployed at the 3^{rd}-4^{th} order stream site draining the mixed land use catchment at each node.

7) How do the sites proposed in the science and experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site deployment design (e.g. core site, gradient sites, comprehensive national network, experimental gradients, experimental network).

The main element of the design is that keeps the major biome the same, but crosses the major N deposition gradient of the continent. That's what's logical. And that at each location along the gradient, there is a paired small watershed that has different vegetation/soils etc.

What might be missing is the high pH, less weathered soils of the rest of the country.

8) Are there new resources (people, data, instruments, money) suggested and are they required beyond that described in the RFI?

One camera should be mounted on each Advanced BioMesoNet tower system. We

9) Are there other projects, programs, networks, or organizations that would be required to logically, effectively, and efficiently address the question?

Nicely linked with existing LTER and other research sites.

10) What are the education, training, and outreach goals of the proposed science and how will NEON resources contribute to their success?

Nicely linked with existing schoolyards, but needs more elaboration.

Comments from discussion:

- No manipulation---very few studies of long term effects of nitrogen addition in controlled studies. How can the main effects and interactions be identified when everything changes in space and time?
- Absence of a conceptual model hinders this proposal.
- Exact same variables will be measure in the Alaska gradient study but to answer different questions.
- This offers a beautiful scaling opportunity that does not seem to be realized properly.
- Message to next level-the process that NEON had to go through it went from a major national planning effort to the RFI's, there were very few ecologists in the country who could coordinate national level approaches, resulting in some of these regional projects.
- Many confounding influences in this proposal—latitude, elevation, etc.
- To develop predictions of N deposition over space, we need a network. Long term data in this region are valuable even though they are not available across the network.

- No manipulation---very few studies of long term effects of nitrogen addition in controlled studies. How can the main effects and interactions be identified when everything changes in space and time?
- Absence of a conceptual model hinders this proposal.
- Exact same variables will be measure in the Alaska gradient study but to answer different questions.
- This offers a beautiful scaling opportunity that does not seem to be realized properly.
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- Many confounding influences in this proposal—latitude, elevation, etc.
- To develop predictions of N deposition over space, we need a network. Long term data in this region are valuable even though they are not available across the network.

Comments & Notes
Ward_N_Deposition:
Gradient analysis of nitrogen deposition. Variation of each gradients that this covers. Mostly established sites. There are no experiments here. There are very few long term study here. The only control would be in Maine. How well in 30 years did this affect us?
The exact same gradient levels will be measured in Alaska as RFI we discussed.

Should do this on a continental scale and do a lot of modeling if we are not going to be doing experiments.

Using creative techniques to measure the nitrogen, such a satellites. They have links to other measurements. Use towers as platforms.

National scale thinking, climate changes in one and measurements of nitrogen in another RFI. NEON Inc. should be thinking nationally for next round of revisions.

On the other side: There are some questions that make since for us to focus in a region or a domain. Some cases we need to look continentally and others will need to be regionally.

(went on tangent on how NEON should be collecting data and modeling scenarios)

Goeckede_GradientSitesWestCoast

Terrestrial Ecosystem Responses to Climate and Land Use at the regional scale, and Feedbacks to Future Climate

1. **Question:** How does variation in climate, land use and disturbance influence budgets and fluxes of carbon dioxide, water vapor and energy for ecosystems at different disturbance stages along a climate gradient, and what are the feedbacks between land use change and climate change over multiple spatial and temporal scales?

2. Questions are at regional scale and involve Four domains: PNW, PSW, Great Basin, Desert SW
3. **Design permits scaling** via "A regional network of sites stratified by disturbance state and climate zone will provide data to understand the relationship between vegetation, climate change and the impacts on resources relevant to human welfare."
4. **Manipulative experiment provides a mechanistic understanding of imp. processes and patterns** –

*Land-use/disturbance gradients will be nested within the climatic gradients in four NEON domains (PNW, PSW, Great Basin, Desert SW)…

*The option of examining both disturbance gradients for a given climate zone as well as different successional stages along climate gradients will provide an ideal situation for distinguishing relationships among disturbance history, vegetation type, climate, and the budgets of carbon, water, and energy.

*The proposed network of sites will establish a foundation for model calibration and validation, and reduce uncertainties in understanding ecosystem feedbacks on climate forcings, and providing guidelines for sustainable management practices in the Western U.S..

* All the towers required to deploy the envisioned multi-regional transects of sites will be NEON Relocatable Tower Systems with some additional instrumentation from NEON Terrestrial Sensor Packages.

ALSO need

* Landsat data are required initially to determine vegetation cover and disturbance classification via subsequent analysis using methods developed by this research group

5. **Transformational results:** Looking together at land use, disturbance, and change in biochemical cycles and biodiversity over large region.
6. **NEON sensors and measures:** high-precision CO_2 concentration sensors, sonic anemometers and fast-response infrared gas analyzers, **Cyberinfrastructure needs:** a regional center for instrument calibration, data download via remote wireless, preliminary data processing, and data quality assessment.
    - rapid remote communication access has to be provided for each of the locations which allows online instrument status checks and automated data collection.
    - For each of the disturbance clusters, a powerful workstation needs to be provided for data handling and processing.
    - For modeling purposes, e.g. the operation of spatially-distributed ecosystem models, a multi-processor cluster computer will be required.

7. **How do sites provide way to answer question**: large area involved, models coupled to data collection --

"The science questions will address pace, pattern, and variation of ecosystem responses and feedback to climate change from local to multi-regional spatial scales, addressing timescales from interannual variability to long-term trends over decades."

Such a factorial deployment of eddy flux towers along successional, topographic and latitudinal transects is the only way to understand how and why ecosystems differ spatially, and it may also serve as an early warning system to detect changes in ecosystem function. It could therefore also serve as a unifying deployment strategy for NEON on the continental scale, which would certainly require systems provided by the Continental Research Toolbox.

8. **New resources:** Crane
9. **Other projects required:**

10. Ed, training and Outreach goals:

* Sensitivity of systems: The education programs and data products from NEON can help spark connectedness to these systems of people who inhabit them.

* Disturbances: The education programs and data products from NEON may help communities understand the nature of disturbances on their welfare.

* Proximity to major universities: Relate to university students via the proximity of the studies

Discussion notes:

These are good questions that should also be asked in other places.

Education plan not so well developed.

Well thought out experimental design, excellent modeling framework, very good questions, not sure how disturbance will be separated from land use.

Scaling approach very well developed (ground to satellite).

How land use and disturbance are defined, sampled, and separate and interactive effects could be better developed.

Comments & Notes:

Large area involved, modeling,
Didn't talk much about opportunities for biodiversity and outreach.

Mention that techniques should be extended to the rest of the US. Scaling approach was well developed. Add a "crane" to the portfolio.

Was an interest use of land use, disturbances, Talk about the gradients are deforested, and is second growth forest. Verses, urban land. Talk about the changing rotation cycle.

Good elements in this proposal. Talked about in detail and related them to their hypothesis. Could go continental in concept, is a good building block. Strength, Bev Law was on this from Ameriflux, good translation in modeling, how do you use towers to translate information. Good tips on data management.

How long do they want to do these measurements? Nothing different from ISPE. But other sites would have different lever of disturbances.

Tu_C_and_O_Stable Isotope

Questions for research and experiment responses

Tu et al. "Isotopes in Biosphere-Atmosphere Exchange

This RFI provides the argument that on-line, continuous measurements of the stable isotope concentrations of C and H in atmospheric CO2 and H2O at the NEON BioMesoNet towers is crucial to our ability to interpret dynamics in net ecosystem CO2 and H2O exchange. By studying fractionation of the heavy and light isotopes of C and H we will be able to gain detailed insight into the component processes of net CO2 and H2O exchange, which is not possible using the traditional eddy flux measurements (which provide a net flux, not component gross fluxes). The panel converged on the opinion that high density (in time) measurements of isotopes in atmospheric trace gases and periodic measurements of isotopes in soil, plant and water samples are critical as core measurements at the BioMesoNet towers. This will require investment in laser-type instruments or spectrometers ($60-150 K per site) at each of the core sites and investment in isotope surveys at each site on at least a five-year recurrent schedule. Expertise in the installation and use of the laser instrument is crucial to obtaining high-quality data, and NEON Inc. should seek this expertise through members of the Biosphere-Atmosphere Stable Isotope Network (BASIN).

1) What is the central hypothesis or question and how does it address the NEON grand challenges? If so, briefly describe how.

How do the interactive effects of climate, land use, hydrology and environmental chemistry affect the carbon and water cycles of terrestrial ecosystems of the United States, in particular exchanges between ecosystems and the atmosphere, their response to long-term changes, and feedbacks to the climate system.

Understanding and forecasting fluxes of carbon and water requires robust techniques to partition the net fluxes made by eddy covariance into their process-level components, estimate the environmental sensitivities of the separate fluxes, and incorporate those sensitivities into forecasts using models. Stable isotopes of C and O in CO2 (13C, 18O) and H2O (D, 18O) provide powerful constraint on different biological and physical processes as each imparts a process-specific isotopic signature on atmospheric CO2 or H2O. As a result, the combination of meteorological and stable isotope techniques has significantly advanced our understanding of land-atmosphere fluxes of carbon and water.

2) Does response pose questions at a regional or national scale?

- *What are the current carbon and water fluxes of terrestrial ecosystems of the U.S. at hourly to multi-decadal time scales? (Diagnosis)*

- *How are the current carbon and water fluxes influenced by variability and gradients in climate, land use, hydrology and environmental chemistry? (Attribution)*

- *How can the interactive effects of climate, land use, hydrology and environmental chemistry on carbon and water fluxes be described by theory and expressed in a numerical fashion (Theory/Modeling) for forecasting impacts of future changes at the continental scale? (Prediction)*

3) How will the design permit scaling from the sensor or measurement to continent?

Will allow *partitioning ecosystem-atmosphere fluxes into process-level components related to plantand microbial carbon fluxes and plant and soil water fluxes at hourly to decadal time scales and from ecosystem (~ 1 km2) to continental spatial scales.*

Will allow *spatial and temporal variability in these fluxes to be attributed to gradients (in space) and trends (in time) in land-use and disturbance history, climate, abiotic properties of the surface (e.g. soil type, slope, hydrology), and chemical environment (e.g. nitrogen deposition, atmospheric ozone.*

Will allow *numerical models to be developed which capture the mechanisms responsible for this spatial and temporal flux variability, and which are able to reproduce the observed fluxes across the full range of observed temporal and spatial scales.*

4) How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or processes at regional or continental scales?

Stable isotopes of C and O in CO2 (13C, 18O) and H2O (D, 18O) provide powerful constraint on different biological and physical processes as each imparts a process-specific isotopic signature on atmospheric CO2 or H2O. As a result, the combination of meteorological and stable isotope techniques has significantly advanced our understanding of land-atmosphere fluxes of carbon and water. Isotopes have improved out ability to trace the exchange of CO2 between the land-ocean surface with the atmosphere – allowing quantification of terrestrial and oceanic carbon sinks and sources. Recently, stable C and O isotopes in CO2 have been used to partition net ecosystem CO2 exchange (NEE) into the gross fluxes of photosynthesis (GPP) and respiration (R), respiration (R) into autotrophic (Ra) and heterotrophic (Rh) sources, and to improve the understanding of isotopic discrimination processes at the ecosystem scale. Stable O isotopes in water have similarly been used to partition evapotranspiraiton (ET) into soil evaporation (E) and transpiration (T).

5) How will the proposed science or experiments lead to transformational results, either specified by the RFI response or apparent during the workshop discussion?

Will provide unprecedented insight into climatic controls over the individual processes that control ecosystem carbon and water fluxes.

6) Which NEON in situ and remote sensors and sentinel measurements are needed to address the research? What cyberinfrastructure needs are implied?

Tunable diode lasers at BioMesoNet towers.

7) How do the sites proposed in the science and experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site deployment design (e.g. core site, gradient sites, comprehensive national network, experimental gradients, experimental network).

Site locations are not as important as is the need for broad coverage of ecosystem types.

8) Are there new resources (people, data, instruments, money) suggested and are they required beyond that described in the RFI?

A need for people to conduct surveys of isotopic composition of soil, water and plants at within the footprints of the core site BioMesoNet towers.

9) Are there other projects, programs, networks, or organizations that would be required to logically, effectively, and efficiently address the question?

Coordination with the BASIN network. Would be useful to coordinate with those groups developing models such as LES (large eddy simulation), but this would require high-precision CO2 measurements, which would have to be added through inclusion of the new portable AIRCOA sensors at the BioMesoNet.

10) What are the education, training, and outreach goals of the proposed science and how will NEON resources contribute to their success?

Comments and Notes:

Bruce Baker - May have to live with biases

Standardization & Calibration is the main take home message. Could be a cautionary message.

SU - Based on Ameriflux model, we will need to cross calibrate.

Examine instrumentation of Aeronet

BB - NEON is a large program. All the instruments will not be identical. Thus, it is critical to have a test bed to determine biases.

Glyn – Is this a statement that may have broader implications for other NEON instruments.

How much will existing/ongoing radiation measures be used?

Antonio Nobre – Should correct problems instead of making a new network.

Joe McFaden – did not find that NEON instruments would be better than Ameriflux instruments. Perhaps NEON should be upgraded. This needs a cost-benefit analysis.

David Breshears – In terms of money, much of it will be in towers. We should seriously take suggestions from Ameriflux.

Virginia Dale – If the data are not collected, organized, or analyzed correctly, we will not get to where we want to be.

Glyn – We need to move beyond the concept, but focus on details.

Liz – there is a whole other component of NEON that is focused on data management, archive, QA/QC etc. issues. TIGER teams are focusing on algorithms for the data questions.

Geoff Henebry – The ISEP did not focus on careful radiation measurements. This proposal addresses this perceived weakness.

Susan Ustin - Shadow-band radiometers should be included on each tower.

Bruce Baker – Common instrumentation may be critical to make continental comparisons.

Cost differences is not known.

Joe McFadden - CNR radiometers - $5000, a cheaper one will be coming out in a few months.

About $20K buys you a complete set. However, "care and feeding" costs are also needed.

Bruce Baker - To make high quality climate measures - $75-80K for a tower, not including maintenance.

Kevin Tu – was there a suggestion for a "gold standard" to move around?

Sack_HawaiiObsGradient

RESEARCH DESIGN – OBSERVATIONAL. INFRASTRUCTURE, SITES AND MEASUREMENTS FOR ASSESSING THE IMPACTS OF CHANGING CLIMATE AND LAND USE ON ECOSYSTEMS ARRAYED ALONG PRECIPITATION, SOIL SUBSTRATE AGE, AND ELEVATION GRADIENTS IN THE PACIFIC TROPICAL NEON DOMAIN – Dr. Lawen Sack

1. **What is the central hypothesis or question and how does it address the NEON grand challenges?** Proposed RFI attempts to meet the NEON grand challenges (at least on domain level) as it attempt to answer:

Claims to meet most of NEON's Grand Environmental Challenges, including how abiotic factors fundamentally control the functioning of native dominated ecosystems across multiple levels of organization (pollinator webs, food webs, atmospheric science, infectious diseases, biogeochemistry, and numerous other natural processes and their interactions); how human factors such as land-use, invasive species, and global environmental change impact ecosystem composition, structure and function; and how climate, soils and land-use change alter the ecohydrology of tropical watersheds. A critical outcome will be new knowledge to protect the threatened Hawaiian ecosystems, and numerous opportunities for broader impacts, including increased environmental awareness and understanding among K-12,

undergraduate and graduate students, and citizen scientists in Hawaii, U.S.-affiliated Pacific islands and elsewhere.

2. **Does response pose questions at a regional or national scale?**

Regional for the most part -- but could become national in scale if stated experiments are adopted to other domains.

Stated questions to be answered:

How does the "baseline" composition, structure and functioning of Hawaii's unmanaged, native-dominated ecosystems vary with soil development, and with regimes of temperature, precipitation and cloud water inputs?

How will altered precipitation, cloud water inputs, temperatures and stream flow interact with changes in land-cover (invasive species, land-use) to impact ecosystem composition, structure and function, including disease transmission?

How do changes in climate interact with soil properties to impact the physiological and biogeochemical processes that control biosphere-atmosphere exchanges of C and H_2O, including gross primary productivity and stand water use?

How can variation in ecosystem properties across Hawaii's natural climate gradients be used to predict long-term responses *at given sites* to changing climate?

How do critical ecological thresholds determined across climate, flow regimes and soil gradients indicate when a given site may be pushed over a threshold in response to climate change?

If they got everything they asked for could they answer these questions? – I am not sure.

3. **How will the design permit scaling from the sensor or measurement to continent?**

The RFI does attempt to join levels of scaling from on the ground data to aircraft/satellite remote sensing. Connection to continent?

4. **How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or process at regional or continental scales?**

Yes for regional scale – probably less so for continental scale. However, care was taken to ensure comprehensive research projects did cover important patterns and processes which are also present at the continental scale.

5. **How will the proposed science or experiments lead to transformational results?**

If all the intergraded experiments and measurements work as presented one can expect transformational results in Ecology.

A transformational result in Policy decision could also occur with the Ecosystem Services mapping efforts on page 32 to 35 -- but am skeptical that it can be done to the level of influencing policy makers.

6. **Which NEON in situ and remote sensors and sentinel measurements are needed to address the research? What cyberinfrastructure needs are implied?**

The RFI claims that NEON level cyberinfrastructure is feasible. RFI goes into extensive detail as to what is currently present and provides details of what is needed (See RFI under Cyberinfrastructure Support Required).

7. **How do the sites proposed in the science and experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site deployment design?**

The RFI proposes focusing on the use of three gradients soil substrate age, moisture and elevation. These gradients will cover nine life zones from tropical forest to alpine arctic environments. The gradients will include: ***The soil substrate age gradient, The moisture gradient, The pristine elevation gradient, The altered elevation gradient***

The schematic description of PACNEON sites arrayed across gradients of soil substrate age, moisture and elevation are below.

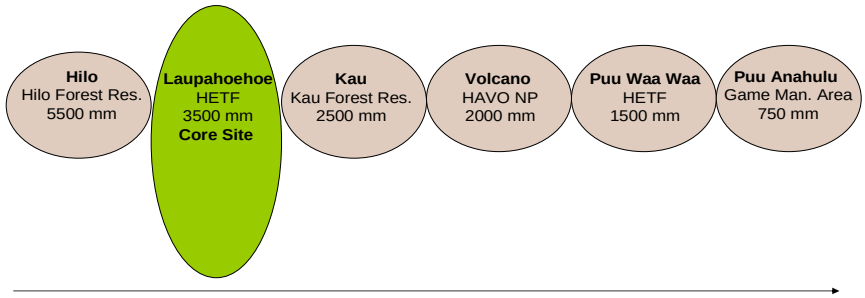


Figure 1. Sites making up PACNEON's Precipitation Gradient, where mean annual precipitation varies from 750 mm to 5,500 mm while mean annual temperature (15.5 deg C) and substrate age (5,000 y) are constant.

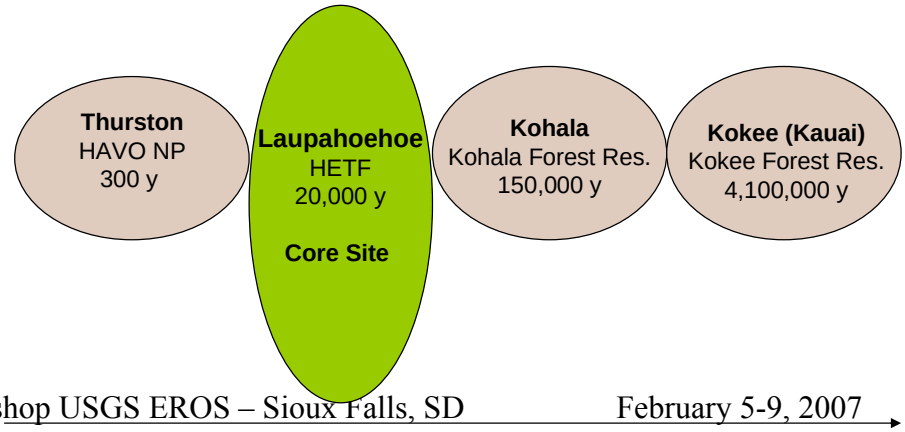


Figure 2. Sites making up PACNEON's Soil Substrate Age Gradient, where age varies from 300 to 4,100,000 y while vegetation, mean annual precipitation (3500 mm) and mean annual temperature (15.5 deg C) are constant.

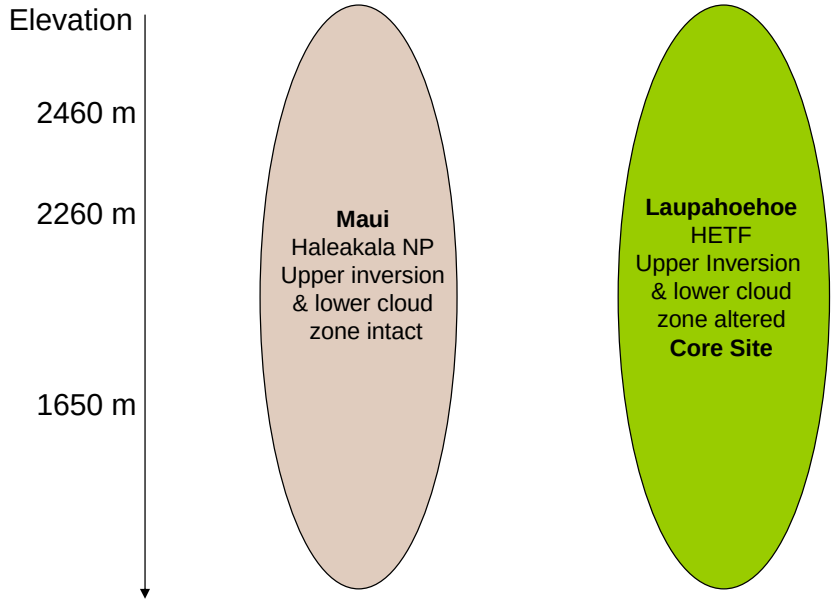


Figure 3. The two elevation transects making up PACNEON's Temperature Gradient. The Maui transect is considerable wetter and soils are much older than in the Hawaii Experimental Tropical Forest on the Island of Hawaii. Further, human alteration of vegetation communities above tree line has been much more pronounced at the Hawaii Experimental Tropical Forest site – the Haleakala transect is pristine.

8. **Are new resources suggested and are they required beyond what is described in the RFI?** Yes, new resources are suggested (see RFI under Additional Resources) but RFI states that estimates for conducting functional genomic studies are not included and that additional expenses are likely. No additional resources beyond what is currently stated in the RFI could be identified but field personnel numbers and cost seem optimistic. Other sites in U.S. Territory's not included in RFI but potential exists to do so.

9**. Are there other projects, programs, networks or organizations that would be required beyond what is described in the RFI?** None identified.

10. **Education, Training and Outreach Goals** Educational component present but appears mostly as an add-on -- standard stuff.

Comments to Sack Research Responses:

- Put together by a group of 80 scientists
- Big domain being covered. Focuses on big islands – restricted to Hawaiian Islands.

- Can't meet challenges on their own.
- They say they address broad set of things, but due to lack of time in writing response, it is not clear that they could answer the questions if they get all the resources they ask for.
- Focus is more on aircraft measurements than satellites
- Regional/not continental
- For NEON Hawaii will be the dominant territory because of costs involved in the transfer of equipment and other resources to other island territories
- They seem to be very optimistic about their cost estimates.
- Bruce – well-written – how can you scale this to continental U.S. Gradients are needed not only in continental US but in Hawaii as well. Richard – It will be a challenge to tie it in
- Kevin – remote sensing needs – they included some aircraft data; they pooh-poohed satellite data.
- Antonio – whether this work is "representative" is questionable. On the other hand, Hawaii is tropical. So fantastic laboratory for observing effects of global warming.
- Richard – invasive species in insular environments go crazy. It is easier to measure effects quickly compared to over the continental U.S.
- Antonio – NEON infrastructure is a leader for some upcoming infrastructure that needs to be global eventually. So, it would be a good start towards becoming global.
- Chris – clarification – discussion mentioned diversify, insular flora fauna, etc. but in the list there was no mention of biodiversity as a significant part of their approach – Richard – they did in both observational and experimental; they will be looking at earthworms (not native to Hawaii and can change a whole amount of change in the soils).
- Whendee – DO you include Hawaii and Puerto Rico – they are end members from a geologic and other perspectives. Not sure I agree that Hawaii is a good model to extend it to continental for studying invasion.
- Alan – Notion that this was put together quickly is not correct. There have been COREO workshops etc. Several years of discussion over a lot of ideas. There are enough similar mechanisms that move things around that doing this in Hawaii is worth it. They have done a pretty comprehensive job in providing the response.
- Richard - There needs to be an outcome from this that can be communicated in a manner that can influence decisions (w.r.t. invasive species)

Sack Comments:

How do you scale Hawaii to continental scale? You cannot. However, there are some meaningful gradients. But extending the gradients, via modeling, is questionable – truly a scaling issue.

However, Hawaii is a special case with many (and steep) gradients and is thus a wonderful laboratory. An example is the approach to dealing with invasive species. But – Hawaii may not be representative of how these invasions happen. On the other hand, examples of invasives in Hawaii have broken new ground in our understanding of invasives, for example with transport of exotic species that other domains may experience at some time.

Hawaii and Puerto Rico represent climatological end-members, as both new and old environments, which is important.

It is a strong proposal, with good, wide participation.

For remote sensing needs, they include the CAO…

Sack_HawaiiObsGradient comments:
Over 20 experiments in this response. It focuses on one domain. The focused on the comprehensive domain only. It can carry over to value to the continental, if it is carried over to core sites on the continent. The area covered is covered of that is of the US. The researched focused mainly on the domain of Hawaii Islands.
They clearly state how they will meet all NEON's grand challenges. On their own, they won't meet the challenges, but will need to be incorporate in all the domains.

It is regional on the most part but could become national in scale experiments are adopted to other domains.

They give information on covered cloud water inputs, and disease transmission by pigs.

There is a missing connection between the experiments to what they are claiming to meet. Talk about scaling from on the ground to the towers to the air craft and satellite.
The scaling was just for the pacific.

A transformational result in Policy decision could also occur with the Ecosystem Services mapping efforts on page 32-35. They discuss how policy will be made or influenced.

They talk about what CyberInfrastructure and what is needed.

Other sites in U.S. Territory's not included in RFI but potential exists to do so.

Very optimistic about field personnel, unless towers are very self sufficient.

Outreach- very standard.

How does NEON justify Hawaii on a continental scale? Gradients are needed.

Did this RFI present in Biodiversity in the research or experiments? Yes..both..will go over in their research. Will cover invasive species like earth worms, and remove the pigs that cause a lot of damage. From a biodiversity point of view, they are tackling that issue.

Do you count Puerto Rico and Hawaii into the continental?

Comments:

Hawaii is included in many proposals.

Hayes_GradientSites

Hayes. RFI Part 1: Observational Research Design for the Southeast Region Domain (Domain 3)

Reviewers: primary – Hansen; seconds – Loveland, Baker; scribe - Hobbs.

1) What is the central hypothesis or question and how does it address the NEON grand challenges? If so, briefly describe how.

Central question: How do Southeast ecosystems respond to interactions among changes in climate, disturbance, and land use?

Response variables: Water quality and hydrological parameters, distributions of exotic and native species, air quality, biomass composition, litter accumulation (fuel), carbon flux, and biogeochemistry.

Rationale: The domain is particularly sensitive to changes in climate, has a coastal component responsive to sea-level change, is exhibiting one of the most dramatic and rapid changes in patterns of land use nationally, and has one of the most significant influx of invasive and exotic species in North America.

Hypotheses: The region will experience greater climatic variance that will shift frost-prone areas, weather patterns, and frequency and intensity of droughts and tropical storms.

We predict changes in composition and types of biotic communities, northerly distributional shifts in species, and increases in incidence and impacts of exotic invasive species from tropical areas.

Changes will result in increased intensity of fires.

Changes in climate due to alteration in longer term cycles, such as ENSO but particularly AMO, are likely to influence ecosystems differentially along the gradient due to greater sensitivity to these cycles in the southern portion of the gradient and decreasing sensitivity for ecosystems in the northern portion of the gradient.

(a) clear water → highly colored water; (b) net autotrophy → net heterotrophy; (c) autotrophic → detrital-based food webs; (d) benthic plant → plankton dominance of primary productivity; (e) increased connectivity with surrounding wetlands and terrestrial landscapes in terms of nutrient cycling, bioenergetics, and dispersal of biota; and (f) major changes in the structure and function of metazoan food webs, including plankton, macro-invertebrates, amphibians and fish.

Reviewers Evaluation: The questions are consistent with overarching NEON questions. The approach is attractive in listing as response variables terrestrial both aquatic factors and aiming to quantify interactions among these. The hypotheses are mostly rather general (e.g., climate will become more variable and organisms will move north). However, there are interesting region-specific hypotheses. These include change in frost zones and differential response to ENSO and change in it in the future.

The means by which these hypotheses will be answered are not clearly presented. A description of how the measurements will be analyzed to answer the questions is not presented. For example, modeling approaches are not discussed.

2) Does response pose questions at a regional or national scale?

Evaluation: The focus is entirely within this domain. Linkages with other domains are mentioned, but not specific coordination is presented.

3) How will the design permit scaling from the sensor or measurement to continent?
Project would link closely with domain toolboxes employed in other domains, the Global Lake Ecological Observatory Network (GLEON), and the continental toolbox.

Evaluation: Little information is presented on how measurements would be integrated and scaled across landscapes or the domain.

4) How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or processes at regional or continental scales?
Our companion submission, RFI Part 2, "Experimental Study of Fire Return Cycles and Ecosystem Effects of Suppression" strongly compliments this RFI Part 1 submission.

Evaluation: The proposal does not summarize the experiments, so there is not a basis for answering the question.

5) How will the proposed science or experiments lead to transformational results, either specified by the RFI response or apparent during the workshop discussion?

Evaluation: The proposal claims that this coordinated set of measurements across this north south gradient will be unique. However, the proposal does not demonstrate that the results will be transformational because it does not present a rigorous study design nor set of methods by which hypotheses would be tested.

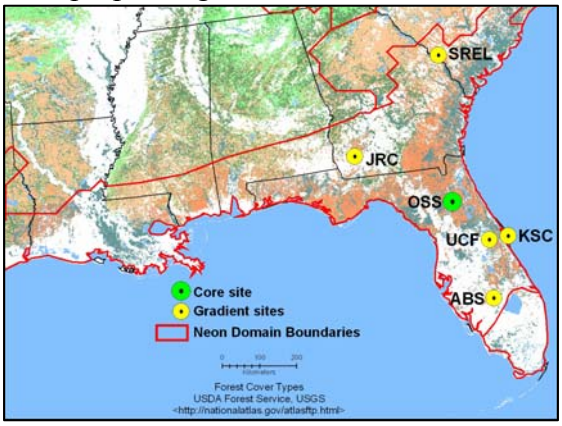
6) Which NEON in situ and remote sensors and sentinel measurements are needed to address the research? What cyberinfrastructure needs are implied?

a. *Wildland Core Site.* At OSBS we request full wildland core site deployment.
b. *Gradient sites.* We require five complementary relocatable basic BioMesoNet towers with some additional features and the associated relevant sensor arrays (canopy, soil, aquatic) primarily at the five proposed gradient sites (SRS, JRC, UCF, KSC, ABS). These 5 towers will be based primarily on concrete pads at each gradient site to support an extended campaign to measure environmental variability and support observations along the gradient over 2-3 decades, a timeframe that is meaningful biologically and within likely trajectories of land use, climate teleconnections and climate change..
c. *Rapid deployment systems.* Given a predictable high frequency of major disturbance events in the Southeast domain (especially hurricanes and fires) we anticipate the regular need for Rapid Deployment Systems, to provide the self-sufficient mobile capacity to respond to such events.

7) How do the sites proposed in the science and experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site

deployment design (e.g. core site, gradient sites, comprehensive national network, experimental gradients, experimental network).

Our proposed gradient is oriented to address a strong north-south climatic gradient extending from the South Carolina coastal plain through central Florida. This gradient includes the southernmost boundary of the freeze zone in the continent. Moreover, this gradient reflects a major gradient in mean, maximum and minimum temperatures, large differences in seasonality of precipitation, and represents the strongest climatic gradient in the southeastern domain. The proposed sites were selected such that a significant landuse gradient is overlaid on the climatic-geographic gradient, with sites proposed from highly urban to wildland sites.



From north to south the proposed sites include:

Savannah River Site,
Jones Ecological Research Center
Ordway Swisher Biological Station
University of Central Florida
Kennedy Space Center
Archbold Biological Station

Evaluation: The rationale for the set of sites is that they lie along a climate gradient, but no specific evaluation of representation of the climate gradient is presented. The treatment of land use is unclear. The extent of the discussion of this is that one site is in an urban setting. How the individual and interactive effects of climate, land use, and disturbance will be evaluated is unclear.

8) Are there new resources (people, data, instruments, money) suggested and are they required beyond that described in the RFI?

Additional sensors and additional deployments to enable more accurate measurements of carbon flux

Echolocation monitoring sensors to track changes in activity and distribution of bat populations.

9) Are there other projects, programs, networks, or organizations that would be required to logically, effectively, and efficiently address the question?

No.

10) What are the education, training, and outreach goals of the proposed science and how will NEON resources contribute to their success?

Outreach activities will target K-12 schools, particularly those with large populations of students in underrepresented groups in science, technology, engineering, and mathematics.

The domain educational director will work with graduate students, principal investigators, and personnel at the core and gradient sites to adapt existing environmental education activities and develop new modules that relate to land use change, climate change, and invasive species.

Modules will include engaging and inquiry-based activities.

We will build on existing relationships to local K-12 schools and to state-wide educational societies (e.g., Florida Science Teachers' Association.

We will develop a summer program for teachers to train them in use of modules and connection of modules to other lessons.

Evaluation: The education program seems well thought out and could be very effective.

Summary Evaluation:

The response deals with one domain. The authors focus on climate, land use, and disturbance as drivers, but they do not make clear how the complex interactions among these would be teased out. The study design is not specified (e.g., how will the measurements at the urban site inform questions about land use change?). The analyses by which measurements would be used to answer questions are not discussed. There is not a modeling component and it is unclear how measurement data would be scaled to landscapes and the region. The education plan is well developed.

Group comments:

There is an opportunity in the SE to build on previous studies of ecosystem fragmentation and connectivity and linkages with neighboring regions of the US.

Forest land use in the SE is shifting from wood products to real estate development a land use change that could be incorporated into the NEON scheme.

Comments & Notes

Comments on Hayes Gradient Sites

Concern about appropriateness of gradient sites, particularly urban sites.

Opportunity to generalize from highly patchy system—to develop methods for scaling up.

This is only site for south east.

Impacts of industrial forestry in southern pine forests. Traditional uses of forested land shifting toward suburbanization.

Hayes_GradientSites:
Focused in Southeast Domain. Central question: How do the southeast ecosystems respond to interactions among in climate, disturbances and land use?

This domain is particularly sensitive to climate change in climate, responsive to sea level change and rapid invasion on non-native species.

They predict changes in species, and shifts in frost-prone areas, weather patterns, and intense droughts and tropical storms.

The domain scale proposals because there are local predictions of climate change.

A description of how the measurements will be used to answer the questions is not present. For example, modeling approaches are not presented.

Little information is presented on how measurements would be integrated and scales across landscapes or the domain.

The proposal does not summarize the experiments.
Followed the NEON approach to what would be used and needed.
The treatment of the land is unclear. The extent of the discussion of this is that one sire is in an urban setting. How the individual and interactive effects of climate, land use and disturbance will be evaluated. Really only talked about urban sites. What is the next step thinking, across land use and gradients. There was no specific evaluation of representation of the climate gradient is presented.
Outreach: best use of graduate students and outreach with K-12 students. Florida Science Teachers Association. Lot of thinking about outreach.

The impact on frost has really impacted the agriculture ecosystems.

Did they address pine use gradients: Tuned into disturbances, such a forestry machines. They have another experiment that addresses the pines and forest industry. Land is being changed by land management, urban development that is taking over on traditional rotations.

Jones-WatershedConsortium

Questions for research and experiment responses
1) What is the central hypothesis or question and how does it address the NEON grand challenges? If so, briefly describe how.
The central question is to examine how different forcings of environmental change affect water quantity and quality, carbon sequestration, species composition, and ecosystem productivity at the small watershed scale (ca. 10-100 ha). Inherent in this question is how these forcings and responses develop over time in different environmental settings and ecosystem types. This addresses the NEON grand challenge of response to natural- and human-induced forcings by observing the variation in conditions and functions of small watersheds over the multi-decade time scale that encompasses natural- and human-induced forcings. It also addresses the grand challenge of how internal responses and feedbacks interact with changes in climate, land use and invasive species via testing 4 major hypotheses related to (i) ecological responses to changes in environmental conditions, (ii) differences in responses in different geographic areas, (iii) responses involving species composition of biota versus ecological functioning, and (iv) similarities in hydrologic responses and dissimilarities in biotic responses among regions.

2) Does response pose questions at a regional or national scale?
Yes, by focusing on a coordinated network of small watersheds, investigators will be able to answer questions for individual watersheds or subgroups of watersheds (regional scale), as well as the entire network (national scale). Proposed sites occur within 18 of the 20 NEON domains.

3) How will the design permit scaling from the sensor or measurement to continent?
Of more than 50 small watersheds identified as potential sites, the investigators propose to instrument a subset using a flexible strategy of site selection and instrumentation focused on core and gradient sites that would facilitate spatial extrapolation. Beyond this, scaling up to larger spatial scales is not explicitly addressed. One thing also not explicitly addressed, but critical to the success of this and similar efforts to collect data in numerous drainage basins, is to standardize types of data collected, and methods of collecting, archiving, and retrieving data. Numerous individual scientist and government agencies will use these data for integrative, synthetical studies and trend analysis, and any NEON-based watershed program will be much more effective if data are consistently collected and readily available, as is currently the case for many LTER sites.

4) How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or processes at regional or continental scales?
The proposal does not include formal manipulative experiments, but uncontrolled experiments will occur in response to invasive species, climate variability, etc. Inclusion of (semi)quantitative conceptual models of specific watershed processes would certainly provide a framework to test mechanistic understanding even in the absence of controlled or directed manipulative experiments.

5) How will the proposed science or experiments lead to transformational results, either specified by the RFI response or apparent during the workshop discussion?
Despite the history of data collection in small watersheds, a substantial challenge remains in developing an integrated understanding of how major forcing phenomena will drive ecosystem change over the coming decades. An integrated network of small watersheds across the continental scale, as facilitated by NEON, would permit integrated ecological, hydrological, and environmental observations and simulation modeling at scales larger than that of a single watershed. Essentially, the proposed science will encourage scientists to build on existing, local-scale data and examine larger spatial scales. One might argue that existing data collection networks such as LTER, also allow this, but the proposed NEON system would certainly enhance efforts at integrative, larger-scale studies.

6) Which NEON in situ and remote sensors and sentinel measurements are needed to address the research? What cyberinfrastructure needs are implied?
The advanced and basic BioMesoNet tower systems, the terrestrial and aquatic sensor arrays, Fundamental Sensor Units, and some mobile/relocatable platforms are required. Current satellite systems plus the instrument package for the proposed NEON Airborne Observation Platforms are needed.
Cyberinfrastructure needs are partially addressed by existing systems developed by the Consortium for Small Watershed Science and cooperators such as the ARS, USGS, CUAHSI, and LTER. The investigators would like to expand the data harvester capacity to incorporate

additional sites, data streams, and functions, as well as finer temporal resolution, and data and model version control.

7) How do the sites proposed in the science and experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site deployment design (e.g. core site, gradient sites, comprehensive national network, experimental gradients, experimental network).
The investigators mention core and gradient sites, but do not provide details as to how these might be chosen. The proposal focuses primarily on a comprehensive national network. Experimental gradients and an experimental network are not mentioned per se, but are implied.

Sites should be chosen in accordance with a clearly developed rationale with regard to not only watershed size, but also issues such as hydrologic connectivity across NEON domains, and watersheds that represent gradients of specific features of interest (e.g. climate, land use). Hydrologic connectivity, in particular, provides a potentially very powerful organizing concept for choosing sites in that small watersheds, for example, integrate atmospheric deposition and precipitation across domains, whereas larger watersheds influence surface-water supply, water quality, and migratory organisms across domains. This RFI focuses on small watersheds and is not coordinated with other RFIs that focus on streams, but eventually all stream-related projects should be integrated in design and implementation to provide the most useful coverage of freshwater systems. Although headwater streams are disproportionately important, relative to their size, in terms of influencing water, sediment, and nutrient supply to stream networks, the NEON sites should include watersheds of different sizes so as to examine the many processes that do not scale linearly with drainage basin size. Focusing on at least a few very large drainage basins will also allow investigators to characterize regional-scale effects such as hypoxia in receiving water bodies (e.g. Mississippi River and Gulf of Mexico), which reflects processes acting across the entire watershed.

8) Are there new resources (people, data, instruments, money) suggested and are they required beyond that described in the RFI?
No?

9) Are there other projects, programs, networks, or organizations that would be required to logically, effectively, and efficiently address the question?
This would be a broadly collaborative effort between existing groups, primarily the Consortium for Small Watershed Science and the LTER network, and NEON. The proposal essentially builds on existing efforts by the two former groups. The work should also be closely coordinated with proposed CUAHSI hydrologic observatories and NSF critical-zone observatories, and utilize or mimic existing programs such as EPA's "Surf your Watershed." It will be particularly important when coordinating with these programs, to standardize methods of data collection, archiving, and access from the public domain.

10) What are the education, training, and outreach goals of the proposed science and how will NEON resources contribute to their success?
The proposal cites past successes in K-12 and university education by LTER and other existing groups related to the proposed research. Small watersheds are effective learning sites because they are clearly bounded and visible, yet reflect much broader influences. The new scale of

analyses inherent in NEON would help to emphasize these broader (e.g. transcontinental) influences. The investigators also propose to communicate results to leaders and policy makers from local to national scales.
Many different governmental agencies mine the data from these watersheds – we need better data organization and make data more accessible to all.

Kaneshiro_3CS_Supplemental

Kasneshiro and colleagues propose to develop "across-island transect corridors" within which integrated environmental monitoring will occur in swaths that extend from windward-to-leeward coasts of the islands of Kauai, Oahu, Molokai, Maui, Kahoolawe, and Hawaii. This gradient includes unusually rich variation in elevation, soil types, evolutionary history, extotic invasion, and human land-use. Standard NEON measurements would be taken in these corrirodors and reported in "near real time" using *InteleSense*-based cyberinfrastructure.

Questions for research and experiment responses
1) What is the central hypothesis or question and how does it address the NEON grand challenges? If so, briefly describe how.

The investigators offer the NEON grand challenges as the central question. As an adjunct, they will address questions on infectious disease:

What drives the emergence of novel diseases? What drives the resurgence of familiar and not-so familiar diseases of humans and wildlife? Are these two processes ecologically linked? What is the relationship between native and non-native wildlife and novel disease emergence? What is the effect of land-use and biodiversity on disease emergence / resurgence?

2) Does response pose questions at a regional or national scale?

Questions are posed at a region scale.
3) How will the design permit scaling from the sensor or measurement to continent?
There no discussion of how sensor measurements will be scaled to the region under study. Measurements are proposed in "near real time" which sounds as if they will be taken very frequently (minutes? seconds?). There is no discussion about why this time scale is needed, warranted, or feasible.

4) How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or processes at regional or continental scales?
The work proposed does not involve manipulations.

5) How will the proposed science or experiments lead to transformational results, either specified by the RFI response or apparent during the workshop discussion?
There is an unusual opportunity here to study lots of variation in a relatively small area of land, variation in elevation, soils, evolutionary history, and human disturbance. However, there is no

serious thought given to how the effects of many sources of variation and their interactions will be disentangled. There in no cogent analytical framework, no serious consideration of how the truly massive set of data collected will support insight. Although we are told that these data will allow ecological forecasting, must imagine how that might be done. I have no idea whether the science proposed will be transformative or whether it will simply be high tech monitoring.

6) Which NEON in situ and remote sensors and sentinel measurements are needed to address the research? What cyberinfrastructure needs are implied?

The RFI proposes to use the full suite of NEON measurements. However, there is no description in the RFI about how these measurements would be used to answer the overarching questions.

7) How do the sites proposed in the science and experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site deployment design (e.g. core site, gradient sites, comprehensive national network, experimental gradients, experimental network).

It is hard to answer this question because there is very little detail on how the measurements will be used to answer questions. Instead, there is a long description of the sites and the opportunities they offer by viture of their physical characteristics and their history. How these opportunities will be exploited is never really described.

The work proposed on infectious diseases is engaging, but the description of how these questions will be answered is cadaverously thin:

"Combining distribution and abundance studies of mammal and birds along transects through the core and gradient NEON sites with information on disease vectors (water, fleas, or mosquitoes and non-Native birds) for Leptospirosis, murine typhus and avian malaria respectively will enable us to address…"

8) Are there new resources (people, data, instruments, money) suggested and are they required beyond that described in the RFI?

Presumably, there will need to be a lot of boots on the ground to do the "…distribution and abundance studies of mammals and birds along transects through the core and gradient NEON sites." Many of the transects will be in rough, inaccessible country containing *lots* of species birds and mammals. Reliable understanding of how distribution and abundance changes along soil and elevation and land use gradients will require statistically rigorous estimates that are expensive and time consuming to apply to a single species, let alone an entire community. Many more muddy boots will be needed to gather information on "on disease vectors (water, fleas, or mosquitoes and non-Native birds) for Leptospirosis, murine typhus and avian malaria respectively." Do not underestimate the magnitude of the expense required to pull this off. Doing this kind of work properly will require a huge budget, I would guess, *at least* $1 million per year. I honestly don't think the responders have thought carefully about actually doing what they propose to do. This kind of stuff simply can't be done on the cheap no matter how many sensors you have in place.

9) Are there other projects, programs, networks, or organizations that would be required to logically, effectively, and efficiently address the question?

10) What are the education, training, and outreach goals of the proposed science and how will NEON resources contribute to their success?

There is a charming, if idiosyncratic, description of the success of a single K-12 fellow. The site will do more K-12 education and outreach.

Kenneth Y. Kaneshiro, with M. Kido, K. Montgomery, C. Mundt, B. Wilcox, J. Wilson, P. Hogan, A. Asquith, D. Burney, D. Kapan, B. Gibson, E. Baumgartner, N. Okamura. "Gradient Sites for the Pacific Tropical Domain (Domain 20)"

Questions for research and experiment responses

1) What is the central hypothesis or question and how does it address the NEON grand challenges? If so, briefly describe how.

This RFI was submitted as a supplement to the 3CS and COREO RFIs and proposes "mountain to the sea" serial transects of ecosystems on multiple islands in the Hawaiian islands to address NEON's Grand Challenges, including human impacts on biodiversity, increasing vulnerability to natural disasters (storms, earthquakes, tsunamis), and emerging zoonotic diseases. The primary focus of this RFI was infectious disease.

2) Does response pose questions at a regional or national scale?

Observes HI sites but addresses a NEON Grand Challenge question.

3) How will the design permit scaling from the sensor or measurement to continent?

Linked with 3CS and COREO; specifically with the Florida-Puerto Rico domain program, although nothing specific is given on how that scaling will take place.

4) How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or processes at regional or continental scales?

Proposes that the use of "research corridors" transecting the Hawaiian islands are a natural experiment, following the age gradient in geological/biological history. In particular, the RFI proposes to use this as an experiment on how diseases emerge, spread, and contract.

5) How will the proposed science or experiments lead to transformational results, either specified by the RFI response or apparent during the workshop discussion?

There is some potential for this to be transformation, particularly if it could be extended or scaled to include other COREO objectives, particularly with the other Island Domain, Puerto Rico program.

6) Which NEON in situ and remote sensors and sentinel measurements are needed to address the research? What cyberinfrastructure needs are implied?

Propose to integrate measurements with their existing InteleSense-IT program. A tiered wireless sensor network architecture. This was viewed as potentially extendable to other domains, research and experiments.

7) How do the sites proposed in the science and experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site deployment design (e.g. core site, gradient sites, comprehensive national network, experimental gradients, experimental network).

Proposes gradients in elevation from mountains to sea on multiple islands of different ages. This seems appropriate for HI, but the RFI did not provide information on how this could be scaled to other domains or systems.

8) Are there new resources (people, data, instruments, money) suggested and are they required beyond that described in the RFI?

The RFI would include a coalition of university, industry, federal and state partners in their "Institute for Earth Observing Systems" and new cyber infrastructure (InteleSense) developed with EPSCoR funding. This RFI could be more explicitly liked with the other HI research and experiment RFIs.

9) Are there other projects, programs, networks, or organizations that would be required to logically, effectively, and efficiently address the question?

no

10) What are the education, training, and outreach goals of the proposed science and how will NEON resources contribute to their success?

Propose to employ a GK-12 like program to provide educational outreach to K-12. Encourages graduate students as science mentors to K-12. Their EPSCoR program facilitated formation of "learning communities" to foster new participatory research/education where non-scientists experience the scientific process and are integrated into data collection. This engages the broader public community and enhances public understanding of ecological and environmental issues. They propose this as a model for NEON outreach.

Kenneth Y. Kaneshiro, with M. Kido, K. Montgomery, C. Mundt, B. Wilcox, J. Wilson, P. Hogan, A. Asquith, D. Burney, D. Kapan, B. Gibson, E. Baumgartner, N. Okamura. "Gradient Sites for the Pacific Tropical Domain (Domain 20)"

Questions for research and experiment responses

1) What is the central hypothesis or question and how does it address the NEON grand challenges? If so, briefly describe how.

This RFI proposes a "mountain to the sea" of serial transects of ecosystems on multiple islands in the Hawaiian islands to address NEON's Grand Challenges, including human impacts on biodiversity, increasing vulnerability to natural disasters (storms, earthquakes, tsunamis), and emerging zoonotic diseases.

Describe features in addition to the RFI submitted by COREO and 3CS groups.

2) Does response pose questions at a regional or national scale?

Observes HI sites but addresses NEON Grand Challenge questions.

3) How will the design permit scaling from the sensor or measurement to continent?

Linked with 3CS and COREO; specifically with the Florida-Puerto Rico domain program.

4) How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or processes at regional or continental scales?

Propose "research corridors" transecting the Hawaiian islands provides a natural experiment, following the age gradient in island/biological history. In particular to use this as an experiment on how diseases emerge and spread.

5) How will the proposed science or experiments lead to transformational results, either specified by the RFI response or apparent during the workshop discussion?

Participate in COREO objectives, particularly with the other Island Domain, Puerto Rico program.

6) Which NEON in situ and remote sensors and sentinel measurements are needed to address the research? What cyberinfrastructure needs are implied?

Propose to integrate measurements with their existing InteleSense-IT program. A tiered wireless sensor network architecture.

7) How do the sites proposed in the science and experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site deployment design (e.g. core site, gradient sites, comprehensive national network, experimental gradients, experimental network).

Propose gradients in elevation from Mountains to Sea on multiple islands of different ages.

8) Are there new resources (people, data, instruments, money) suggested and are they required beyond that described in the RFI?

Coalition of university, industry, federal and state partners in their "Institute for Earth Observing Systems" and new cyber infrastructure (InteleSense) developed with EPSCoR funding.

9) Are there other projects, programs, networks, or organizations that would be required to logically, effectively, and efficiently address the question?

no

10) What are the education, training, and outreach goals of the proposed science and how will NEON resources contribute to their success?

Propose to employ a GK-12 like program to provide educational outreach to K-12. Encourages graduate students as science mentors to K-12. Their EPSCoR program facilitated formation of "learning communities" to foster new participatory research/education where non-scientists experience the scientific process and are integrated into data collection. This engages the broader public community and enhances public understanding of ecological and environmental issues. They propose this as a model for NEON outreach.

Comments & Notes:

This is an exclusively Hawaiian. Not really sensor based.

They say they will support the COREO and the three C's and was read as a companion to other proposals. Left out the other grand challenges and really focused on the invasive species. Both Hawaiian proposals touch on this. They are no inconsistent with what is proposed for US. There transects do from wet side to dry side. They will look at other climate change issues. Lots of educational aspects of this proposal. They were just emphasizing the parts that is unique.

Comments: Infectious disease, there is not a lot discussed about what is going to be done. With what is said how they are going to accomplish this, this isn't going to done with sensors but with workers, and what are the hidden and large cost with NEON. Lot of man hours and people to get the information that is needed to conduct these experiments.

Comments: Very difficult RFI to read, they did have stream measurements. Measurements are very vague.
Comment:
What issues are important for domain that span across regions?
Risk, this will be viewed by community that there was input into the NEON design. We should think about the level of specificity.

Maybe the domain gets a mobile unit.

Jacobs-CUAHSI

Panel Discussion Summary

CUAHSI Hydrologic Measurement Facility Partnership to Enhance NEON's Hydrologic Observations and Experimentation

Jennifer Jacobs (Department of Civil Engineering, University of New Hampshire) and others

RFI Response Summary

This response is to demonstrate a willingness to establish formal linkages between the Consortium of Universities for the Advancement of Hydrologic Sciences Inc. (CUAHSI) Hydrologic Measurement Facility (HMF) and NEON activities to best achieve our mutual objectives. Like NEON, the HMF is an infrastructure governed by overarching science questions.

Established in 2002, the goal CUAHSI-HMF is to facilitate access to advanced instrumentation and expertise to support hydrological sciences (broadly defined) and to transform watershed-scale hydrologic research by developing, prioritizing, and disseminating a broad-based research and education agenda for the hydrologic sciences. The underlying approach is derived from a continuous process that engages both research and applications professionals (mission statement #1) and facilitates access to advanced instrumentation and expertise in support of these endeavors (mission statement #2). This coordinated effort is organized around three general study areas: water cycle science, biogeochemistry, and geophysics, and has focused on enhancing hydrologic research to scale in time and space that has previously been unavailable to most investigators. This focus is integral in achieving both CUAHSI's and NEON's prime challenge questions.

CUAHSI's mission, governance, vetted challenges to hydrologic science, and proposed suite of activities and instrumentation are the product of active and ongoing community involvement. They can be found at http://www.cuahsi.org/, and where relevant, outlined below.

1) What is the central hypothesis or question and how does it address the NEON grand challenges? If so, briefly describe how.

Coordination around three general CUAHSI / NEON areas - water cycle science, biogeochemistry and geophysics
CUAHSI-HMF initiatives can directly assess the hydrological aspects of both NEON's Grand Challenge Questions

2) Does response pose questions at a regional or national scale?

Yes: but regional - CUAHSI is starting out on a couple of river basins

3) How will the design permit scaling from the sensor or measurement to continent?

Not specifically discussed

4) How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or processes at regional or continental scales?

NA - Research Observatory

5) How will the proposed science or experiments lead to transformational results, either specified by the RFI response or apparent during the workshop discussion?

Central ecological - hydrological couplings:
- water cycle, biogeochemistry, geophysics

6) Which NEON in situ and remote sensors and sentinel measurements are needed to address the research?

Water Cycle

- - 5 prioritized technologies: evapotranspiration Flux Suites, Electromagnetic Surveys, Passive Microwave Sensors, Network Sensor Arrays, and Mobile Precipitation Radar new and emerging technologies: Eddy Covariance, Integrated Cavity Output Spectroscopy, Large Aperture Scintillometer, soil water sensor network --- can be incoproated into basic- and advanced BioMesoNet, the mobile and rapid deployment towers

Biogeochemistry

- - CUAHSI proposes to provide the infrastructure to directly assess biogeochemical cycling to hydrologic processes among spatial-temporal scales initial plans to link data sonde and Wet Chemistry Field Analyzers [dissolved O2, pH, turbidity, specific conductivity, NO3, NH4, and PO4]

Geophysics

- EM data over large areas of interest
- CUAHSI HMF-GP facilities may be a core facility and 10-20 nodes

CUAHSI cyberinfrastructure team working to interface with NEON's cyberinfrastructure

7) How do the sites proposed in the science and experiment responses provide a logical, effective, and efficient way of addressing the question?

Details not specified

8) Are there new resources (people, data, instruments, money) suggested and are they required beyond that described in the RFI?□

Related to CUAHSI

9) Are there other projects, programs, networks, or organizations that would be required to logically, effectively, and efficiently address the question?

Related to CUAHSI

Potential mechanisms for partnership
- independent external board with members from the user community
- joint board that contains both NEON and CUAHSI members
- person-to-person contacts

10) What are the education, training, and outreach goals of the proposed science and how will NEON resources contribute to their success?

Not explicitly discussed but NEON and CUAHSI education goals related

Summary of Group Discussion

A NEON-CUAHSI partnership should have merit to both groups. Existing networks potentially have a lot to offer to NEON and offer an opportunity to avoid duplication. CUAHSI offers elements that fit the operational network goals of NEON. The NEON leadership should pursue an appropriate level of cooperation.

The sites listed in the CUASHI RFI response are incomplete from a NEON perspective. Any discussion on cooperation must address the establishment of additional sites.

McFarland-Elevational Gradients

Workshop Summary

McFarland – Assessing Global Change over Elevational Gradients in the Northeast Domain.

Questions for research and experiment responses
1) What is the central hypothesis or question and how does it address the NEON grand challenges? If so, briefly describe how.

<u>Central Hypothesis:</u> How do the effects of climate, weather, and atmospheric pollution on ecosystem functioning vary over an elevational gradient?

<u>NEON Challenge:</u> The influence of climate change and biogeochemical cycles on ecosystem functions and biodiversity.

2) Does response pose questions at a regional or national scale?

Regional (Northeast) -- Note: This response does not propose any specific sites; rather, it suggests that studies on elevational gradients should be used to study target species that would be sensitive to climate change.

3) How will the design permit scaling from the sensor or measurement to continent?

This aspect was not included in the response.

4) How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or processes at regional or continental scales?

No experiments were proposed.

5) How will the proposed science or experiments lead to transformational results, either specified by the RFI response or apparent during the workshop discussion?

Elevational gradient analyses could be used to assess distributional changes of species resulting from climate change; ecotoxicology studies and biodiversity changes along these gradients and among different land use types (ski areas) would provide data associated (correlated) with climate change.

Does this qualify as "transformational science"? Probably not, but specifics of studies and sites are not provided, so this cannot be fully evaluated.

6) Which NEON in situ and remote sensors and sentinel measurements are needed to address the research? What cyberinfrastructure needs are implied?

Not specified in response.

7) How do the sites proposed in the science and experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site deployment design (e.g. core site, gradient sites, comprehensive national network, experimental gradients, experimental network).

No sites are proposed.

8) Are there new resources (people, data, instruments, money) suggested and are they required beyond that described in the RFI?

Not discussed in response.

9) Are there other projects, programs, networks, or organizations that would be required to logically, effectively, and efficiently address the question?
Not discussed in response.

10) What are the education, training, and outreach goals of the proposed science and how will NEON resources contribute to their success?

The Vermont Institute of Natural Science has an education department, and information derived from this organization through NEON will be disseminated through the department to the public.

Kratz_GLEON

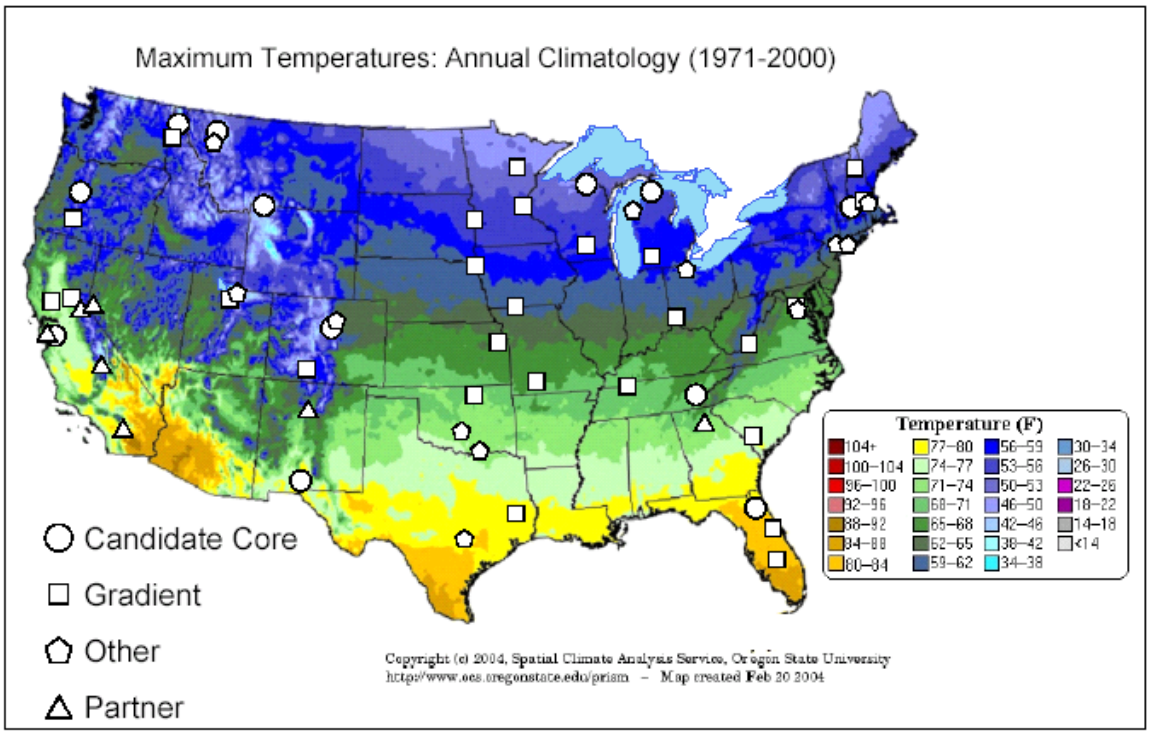
Questions for research responses:

GLEON – Kratz and Williamson

1. What is the central hypothesis or question and how does it address the NEON grand challenges? If so, briefly describe how.

How do changes in climate, landuse and invasive species alter lake metabolism and, consequently, ecosystem services through biogeochemical, biodiversity and hydro--ecological responses?

Lakes are "sentinels" and "integrators" of change in biogeochemistry, hydroecology and biodiversity.



2. Does response pose questions at a regional or national scale?

National distribution locations is proposed for lakes, reservoirs and wetlands to integrate landuse changes and climate changes into basin-wide responses. NEON is needed to make hierarchical connections within nested watersheds. Comparisons of changing trends or abrupt shifts in whole-lake metabolism can be used in forecasting within a network of sites designed as an "early warning system" for changes in water quality and associated ecosystem services.

On-site and regional analysis of Fundamental Sentinel Units (FSU) of key species for ecosystem function (e.g., primary production measured by chlorophyll and communities changes among diatoms, green algae and toxic cyanobacteria; grazing by native and non-native Daphnia, crayfish; and biofiltration by zebra mussels or corbicula). These biotic responses to changes in climate and nutrient inputs provide information on effects of landuse change, eutrophication and invasive species.

Anoxia (dead zones) kill fish and other biota, release nutrients from sediments, increase methylation of mercury, alter taste and odor of drinking water.

3. How will the design permit scaling from the sensor or measurement to continent?

Domain differences will alter runoff of water and nutrients over a hierarchy of scales that alter whole-lake metabolism and ecosystem net productivity. Distributions of lakes across the continent (including Alaska) and in Hawaii and Puerto Rico are integrated into the design to determine which ecosystems are heterotrophic and net sources of carbon dioxide to the atmosphere and which are net sinks and storage components of carbon and nitrogen.

Related core and gradient sites (67) will be linked to nearby data collection for temperature, wind speed and direction, precipitation, N-deposition, UV and total radiation.

4. How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or processes at regional or continental scales?

Different landuses will be viewed as "treatments" and "reference" sites in wilderness core sites will be used for comparative studies. No controlled or replicated experiments are proposed at this stage. Changes in different domains will be compared with regard to the impacts of floods and droughts as well as landuse.

5. How will the proposed science or experiments lead to transformational results, either specified by the RFI response or apparent during the workshop discussion?

The extensive and intensive sampling will provide the first integrated analysis of domain differences in hydroecology that relate ecosystem processes and whole lake metabolism to sustaining essential ecosystem services (pure drinking water, recreational uses of lakes, etc.). Changes in the intensities and frequencies of floods and droughts are anticipated to result shifts in nutrient cycling and multi-trophic level interactions that influence food webs and water clarity (trophic cascades). There is a close connection to water transparency, dissolved organic matter

(DOM) and ultraviolet (UV) light penetration related to changes in ozone layers and atmospheric changes. These differences in UV and photosynthetically available radiation (PAR) combined with differences in nutrients (especially changing absolute and relative amounts of nitrogen and phosphorus). The integrated network will link N-deposition, surface and groundwater sources of carbon and nutrients while also providing analysis of dispersal and impacts of invasive aquatic species.

The proposal emphasizes N-deposition but some inclusion will likely be needed on other sources of N and the importance of N:P ratios for shifting phytoplankton production.

6. Which NEON in situ and remote sensors and sentinel measurements are needed to address the research? What are cyberinfrastructure needs?

GLEON is intended to develop cyberinfrastructure needed for transmission and analysis of multi-sensor data streams through satellite transmissions. Infrared sensors will measure net CO2 balance and inflow and outflow gauges will measure water budgets and lake levels. Buoys of profiling sensors will measure physical parameters with depth. Some sensors will be positioned immediately above the water surface (or on nearby shore locations). Aspects of the physical, chemical and biotic data need to be modeled and used in forecasting annual and inter-annual dynamics. Data storage and modeling scenarios will be needed as the network sites generate near real-time data.

New sensors will needed for improved measurements of UV penetration, micro-nutrients and plant pigments (chlorophyll and phycocyanin).

7. How do the sites proposed in the science and experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site deployment design (e.g. core site, gradient sites, comprehensive national network, experimental gradients, experimental network).

The combination of lakes (41) and reservoirs (30) provide a wide distribution of sites for effective testing of specific relationships. Their positions within the drainage network in each watershed is important (but not yet specified) to determine if "lake chains" along river systems alter rates of sedimentation, nutrient transport and water clarity. Many of the lakes and reservoirs are well studied by different agencies, universities and a wide range of partners capable of cost sharing in maintenance and operation budgets.

8) Are there new resources (people, data, instruments, money) suggested and are they required beyond that described in the RFI?

The continued development of wireless sensors will be needed for remotely deployed buoys.

9) Are there other projects, programs, networks, or organizations that would be required to logically, effectively, and efficiently address the question?

Data from Landsat, MODIS, and SeWiFS satellite and airborne remote sensing sources will be used for defining optical properties of lakes. Imaging spectrometers and airborne hyperspectral sensors will be used for analysis of transparency, DOC and suspended sediments. Synthetic aperture radar (SAR) will help track water level depths in lakes, reservoirs and adjacent wetlands. Coordination with USGS, EPA and other federal agencies will be needed to effectively coordinate site selection and sharing in data acquisition needs for maintenance and operating budgets.

10) What are the education, training, and outreach goals of the proposed science and how will NEON resources contribute to their success?

A distributed network of scientists, teachers, citizen scientists and members of various lake associations was formed in March, 2005. Their web site focuses on the Satellite Lake Observatory Initiative (www.lakesat.org) and their educational outreach efforts are ongoing (gleon.org). They propose connections with several professional societies and minority groups specializing in environmental sciences.

NOTES & COMMENTS:
Kratz_GLEON

Tuesday / 6/Feb/2007,

- **Secondary** strong effort, national scope, concern how you do from measurements to integrated
- **Secondary** great instrumentation possibilities, that is the strength

- it is important not to oversell retrieval of signals from water bodies (problems with blue?)

-RS proposed is to extrapolate and compare, there are great models, to interpret changes in water quality. RS allows going from headwaters down the basin, getting indications, it is useful, but right now we do not have everything together.

-Hyperspectral …emerging technologies

- Connect inland water with coastal waters

- Site selection, NEON should pick representative lakes, not one unique non-representative lake (site selection is lousy)

Lake and reservoirs. Lakes are “sentinels” and “integrators” of change in biogeochemistry, hydroecology and biodiversity.
Set up early warning system when a lakes metabolism changes. How are connect on a continental scale. NEON is needed to make hierarchical connections within nested watersheds.

Lot of good core sites and gradient sites.

How do you go from answering the questions to the measurements? But it held up very well. Strength of proposal was the instrumentation.

Comments: way to relate it to events or slow processes. Remote sensing, how does it move across the water, with sensors, we will be able to measure, over flow and how it changes the composition of the lake. Hopefully it will be there with the advancement of remote sensing.

Comments:
Site selection, pick foot hill reservoir, these places that they picked are not places that are representative of area. Need to go back to school on site selection.

-

Peters_3CS

3CS Consortium for Connectivity at the Continental Scale
Lead Scientists: Debra Peters USDA ARS – Las Cruces, NM
Peter Groffman, Inst. Ecosystem Studies
Knute Nadelhoffer, University of Michigan
And a cast of ~80, including an endorsement from COREO (Consortium for Regional Ecological Observatories)

Questions for research and experiment responses

1) What is the central hypothesis or question and how does it address the NEON grand challenges? If so, briefly describe how.

What are the ecological consequences of an increasingly connected world?

Interactions between climate and land use acting through connectivity in water, wind, disturbances, animals, and people can explain ecological dynamics at multiple scales, from local to continental. Some resources (e.g. N) are becoming more concentrated as a result…others are becoming more distributed (e.g., infectious diseases, invasive species).

Addresses NEON grand challenges via four themes that are used to develop specific research questions, measurements, experiments, and models. There are separate documents for each of the themes, which are very well developed and thought-through. While these are separate themes, they are interrelated and have consistent hypotheses of connectivity. The themes address both Science Challenges and include:

1) **Climate change for Inland Sites** – a quantitative assessment of ecological responses to spatial and temporal climate variation at multiple scales and across ecosystem and land-use types. Including:
a) changes in biogeochemistry, biodiversity, hydroecology, and biotic structure and function; and
b) changes in connectivity in resources and biota

Focused on four interrelated aspects of climate variability that are likely to change in the future:

- increased intensity and frequency of droughts,
- increased mean annual temperature,
- altered spatiotemporal patterns of snow accumulation and snowmelt, and
- altered fire regimes.

2) Climate in Coastal regions – understanding and forecasting the effects of sea level rise and intense windstorms on coastal and upland ecosystems – how they will influence the structure, functioning, and capacity to deliver services (e.g. C sequestration, storm protection, pollution control, habitat support and food for human consumption).

Will consist of 14 coastal wetland and 47 inland forest sites in 14 NEON Domains. Addresses science challenges by using a framework based on connectivity as the effects of sea level rise will be different around continental margins in areas with different accretion rates, controlled by ecological and geomorphic factors including climate and land use change, biogeochemistry, tidal range, species composition and biodiversity.

This integrative approach is necessary for addressing inland effects from large storm events and will require information on feedbacks and interactions among climate, land use, and human actions

3) Invasive Species and Infectious Disease – the spread of invasive species and infectious disease as drivers of ecosystem change across regional and continental gradients of climate and land use. Increased connectivity of global human population has increased the frequency of biological invasions and disease outbreaks

Two fundamental kinds of measurements are needed to understand and forecast the effects of invasive species and infectious disease: a) population, community, and ecosystem impacts, and b) rates and modes of spatial spread.

4) Land Change – ecosystem responses to urbanization and pollution across climatic and societal gradients.

Emphasizes urbanization…urban areas are important point sources of atmospheric and aquatic pollution, as well as recipients of pressure from these pollutants and introduced species.

2) Does response pose questions at a regional or national scale?
Mostly national, although the coastal change and urban land use change themes are focused within sectors…each emphasizes inter-scalar connectivity

3) How will the design permit scaling from the sensor or measurement to continent?
The entire proposal is oriented toward scaling, using the theme of connectivity to track movement of materials…it emphasizes a number of gradients, including climatic, land use, N, over a variety of ecosystems.

4) How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or processes at regional or continental scales?
NA

5) How will the proposed science or experiments lead to transformational results, either specified by the RFI response or apparent during the workshop discussion?

Expect a large suite of critically important ecological questions will be addressed through this coordinated network of sites, which cannot be answered using current infrastructure, for example

- how will changes in connectivity driven by changes in climate (and other drivers) at multiple scales interact to influence landscape to continental scale distribution and abundance of key species
- how will transcontinental transportation of materials (e.g. pollutants, dust, air borne pathogens) affect ecosystems?
- What are the consequences of shifts in key species for biogeochemical cycles, hydrological regimes, and ecosystem services across a range of scales?
- Under what conditions will changes in broad-scale climate change interact with connectivity to cascade down scale and drive ecosystem responses at finer scales?
- Under what conditions will variation in land use, disturbance, and connectivity in resources amplify changes in climate to result in shifts in species distributions with consequences for ecosystem dynamics and services

6) Which NEON in situ and remote sensors and sentinel measurements are needed to address the research? What cyberinfrastructure needs are implied?

Quickbird
IKONOS
Leica ADS40 airborne sensor
Worldview II satellite
GeoEye-1 satellite
Leica ALS50
Hyperspectral imager
Full waveform LIDAR
Thermal imager
Gas fluxes
Atmospheric chemistry

Current ISEP specified measurements that will be needed
Relocatable Biomesonet tower with full sensor package
Canopy microclimate and soil sensor arrays
Aquatic sensor arrays

Airborne particles
Dry deposition
Wet deposition
Rapid deployment unit
A large number of measures for Climate Coastal required from Advanced Tower, canopy array, soil array, aquatic array
Additional Needs:
Saltation activity (LU)
Aerosol optical depth (LU)
Visibility (LU)
Horizontal dust flux (LU)
CO2 probe (CC)
Ultrasonic level sensor (CC)
IRGA sediment elevation table (CC)

Invasive species requires many special measures in addition to those provided in the FSU – additional vectors (not just mosquitoes and rodents) will need to be monitored

7) How do the sites proposed in the science and experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site deployment design (e.g. core site, gradient sites, comprehensive national network, experimental gradients, experimental network).

Climate coastal – logical deployment of sites at coastal areas distributed around the country 5 on West Coast (incl. Alaska & Hawaii), 3 on Gulf Coast, 4 on East Coast, 1 on Puerto Rico and Great Lakes. 47 inland sites, mostly focused in high storm potential areas in Southeast US.

Climate Inland sites represent N-S and E-W gradients, representing temperature and precipitation gradients…elevation gradients are also represented. Located in all domains in conterminous US. Will use entire network of Domain Toolbox, Core Wildland, and Gradient sites. Will upgrade 6 additional gradient sites. Will also instrument intensively headwaters of 3 major river basins (Columbia, Rio Grande, CA Central Valley) to examine ecological impacts of snowmelt.

Land use presents a rationale for urban/suburban/urban fringe gradient in 6 domains…include agriculture in 2 domains and a method for comparing to core wildland sites within domains. They will also use relocatable towers in 5 metropolitan areas (Baltimore-Washington), Cincinnati, Austin-San Antonio, Phoenix-Tucson, and Portland-Seattle in urban or soon to be developed areas…using Biomesonet sensor package and canopy, aquatic, and terrestrial sensor arrays

Invasives – will leverage off of location of wildland core sites and relocatable sites. Domain toolbox was created with invasive species and infectious disease as important drivers. Have listed 6 candidate sites for each domain – one wildland and 5 relocatable sites…consider gradients of species diversity and human population density, as well as climatic. Redeployable sites will address “hotspots”

8) Are there new resources (people, data, instruments, money) suggested and are they required beyond that described in the RFI?
This proposal largely leverages the resources already suggested by the various toolboxes…limited additional instrumentation is required for the land change element, largely emphasizing air pollution monitoring.

9) Are there other projects, programs, networks, or organizations that would be required to logically, effectively, and efficiently address the question?
WATERS, NPN, Ameriflux, National Atmospheric Deposition Program, LTER…

10) What are the education, training, and outreach goals of the proposed science and how will NEON resources contribute to their success?
Connections with Citizen Science programs, provision of data to educators, etc…leverage off of NEON District Education Centers, workforce development at Community Colleges

Comments & Notes
COMMENTS - 3CS

Secondary Reviewer Commentaries

Roger Bales – NEON could benefit the community with a look at the changing snowpack-wildfire interaction. The site selection may have been done quickly for this study. Perhaps more optimization could be done. Not much overlap with STREON.

Bob Parmenter – This was basically a COREO production. Took individual domain sanctioned sites. This was designed to provide theoretical overview to prevent overlap.

A number of experiments (e.g., GLEON, Herbivory) were built under this.

The inland sites for the coastal climate response were ones that would be influenced by a hurricane.

Others' Comments and Discussion

Covich – coastal climate response was designed to provide for high wind/storm events in addition to hurricanes.

Burke – This seems like the entire NEON proposal. How will this get forwarded to the NEON Inc. since this was the basis for NEON.

Blood – the purpose of the meeting is to data mine to create more refined science questions to address subsets of the overarching concepts.

This is not a proposal that is going to be funded to do anything.

Silver – We should make a list of nuggets, key attributes that we would like to see.
We should make a list as we go along.
We like this measurement, this unit, this research concept.

Baker – where do the different agencies come in to NEON. NOAA has been given money to instrument the Gulf Coast.

Does NSF want to rebuild or partner?

Blood – There has been discussions with other agencies. On February 21st there will be a meeting to coordinate agencies to get more bang for our buck.

Rama – Is NASA involved? If so, who?

Blood – All agencies were invited.

Covich – how do we put boundaries on what is NEON-wide? What are the aspects of connectivity? The outcome from Las Cruces is a consortium of observatory networks (COREO) trying to add new things to the existing networks. Coastal storms were not being well-served. The towers were thought to be unstable. Larger scale impacts of intense precipitation and wind were poorly quantified. To make towers more robust physically and in terms of capability.

Parmenter – NEON will focus on the ecosystem response to the storm.

Baker – NOAA does have systems that survived Katrina and could work to partner with NSF to make a more robust, complete network. From the Climate Reference Network, the lat, lons could be given to provide a more complete view of the NOAA capabilities. These will be there for the next 50 years. The data are free.

Covich – we need to keep an eye on the questions that we are addressing. We should data mine to develop intellectual

Silver – like to see Nitrogen up in terms of its connectivity and concentration patterns.

Bales - Mountain snowpack rain/snow transition zone is an area that is undergoing change from a human intervention standpoint.

Geoff Henebry – To what extent did the proposal deal with drought effects?

Bales – it may not be well-addressed, but it is mentioned.

Dale – The climate models in the southeast are producing different results. The impacts are dramatic in particular for infectious diseases.

Covich – We know that drought influences the SE related to ENSO. Drought definitions are highly variable that need to be scaled to the biota and the historic record. This is critical in terms of ecosystem services and how the public views this effort.

This may relate to agriculture as well. USDA has applied economic analysis.

We need fine scale data to integrate across these domains.

Baker – Climate Project through NOAA has been funded to produce products that actually provide information where droughts are. We are going to be the drought portal. On a different scale, the drought may be inferred since there are so few measures of soil moisture. U.S. and Canada is coming up for a standard for soil temperature and moisture.

Dale – Oak Ridge is doing the throughfall displacement. The timing of the drought is critical. Spring drought may be critical. NEON's charge is to look at non-ag systems.
NEONs charge is to look across Grand Challenges to put them together. Collecting the data to put them together is NEON's domain.

Bale – Soil moisture measures are not being included. They are not spatially representative. Hydrologic drought is what is being considered buy NEON. We have index sites, but not spatially representative. I would increase the number of soil moisture probes from 4 to 100 to cover the heterogeneity.

Baker – I would like to see where you plan to put these so NOAA could enhance the system.

Covich – NEON could accelerate the sensor development We need to consider fire impacts in the SE and across the US.

Parmenter – Closure comments. A NEON site is a small place on the landscape. When we talk about climate, we need to get representative sites. The location of the towers on these sites need to placed very methodically.

Tu – We are missing the fact that this response relates to connectivity. Connectivity is a process that needs to be studied unto itself.

Scribe Notes

Primary reviewer comments – this is a comprehensive set of responses that have a unifying theme of connectivity that works well for NEON's purposes. The scaling approaches are well done in most cases, although some details are lacking.

Secondary Reviewer Commentaries

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Other Comments & Notes:

Peters_3CS:

3CS: Consortium for Connectivity at the Continental Scale: COREO
Interactions between climate and land use acting through connectivity in water, wind, disturbances, animals and people explain ecological dynamics at multiple scales from local to continental. 4 Theme, specific research questions, measurements, experiments and models.

1. Climate change for Inland Sites: ecological responses to spatial and temporal climate variation at multiple scales and across ecosystems and land use-types.
2. Climate in Coastal regions- how they will influence the structure, functioning and capacity to deliver services…14 coastal wetland and 47 inland forest sites in 14 NEON Domains. Focus on storm areas in southwest.
3. Invasives: will leverage off of location of wildland core sites and relocatable sites.

Expect a large suite of critically important ecological questions that will addresses:
All resources will be used for this RFI. Will use the entire network of core wildland, Domain Toolbox and Gradient sites.

Workforce development at community colleges for Outreach.

Experimental responses are under this RFI, like on streams, like nutrient loading. 5 proposals under this proposal.

Comments: Western wildland, snow pack; this is what NEON can benefit the community, looking at the forest and wild fire interactions. Site selection was done a little quickly, spend more time on that to help the network. A little more optimization would help.

Bruce Baker: Capturing the gradient, 47 inland? Region scale…How to get a continental scale with only 47 sites…but they were just talking about inland areas that are in storm surge areas. 47 inland site that are strictly related to hurricane.

What this response made available to all the domains? It was…but a very short time.

Capture high wind event and high rainfall, really means storm impacts.

Indy: This proposal is NEON…clarification, all gradient sites and all core sites…why do we have all these other proposal and we have this one too? How do we evaluate this against everything else?

Baker: Where do other agencies come into play with NEON, a couple other observing systems are being set up, like NOAA or does NSF want to partner up or rebuild something?

NSF is coordinating with other agencies. There will be a meeting on the 21st to discuss coordinating with other agencies.

The design of the network was suppose to withstand the winds and weather of the area.
The integration is looking at the ecosystems response is while NASA and NOAA is looking at the storm itself and not at how the ecosystems are affected. It would be a good partnership. It is important in this design.

US Climate reference station, in the planning process, all calibrated, and the data is free. It is a resource that could be useful to NEON and NSF.

Could Bruce Baker provide lat and long of stations?

We also need to keep and eye on the themes we are trying to integrate? Intellectual connectivity, capture the ideas. We need to data mine this proposal.

A NEON site is a small place on a scale, and as for drought, we need to get representative places.

Running_SatelliteDerivedMeasurements

1) What is the central hypothesis or question and how does it address the NEON grand challenges? If so, briefly describe how.
Three products currently being produced over the entire global land surface using MODIS instruments on Terra and Aqua (NASA's EOS satellites) need to have continuity beyond the life of these instruments. The three products are:

- *Carbon variable -- Daily Gross Primary Production, summed to annual Net Primary Production (GPP and NPP)*
- *Water variable – Daily Terrestrial Evapotranspiration (ET)*
- *Annual Vegetation Disturbance Index (DI)*

These products need to be adapted to NEON, particularly at optimum spatial and temporal resolution for NEON science.

These measurements are important and useful for at least the following NEON Grand Challenges:

- *Biogeochemical Cycles (DI product helps us to "evaluate how they are being perturbed by human activities, and determine how they might better be stabilized")*
- *Climate change —"The challenge is to increase our ability to predict climate variations, from extreme events to decadal time scales; to understand how this variability may change in the future; and to assess realistically the resulting impacts."- Carbon flux estimates are an important indictor of impact of climate change. GPP and NPP provide this information. [Page 5 of response - last para of section III.1 includes use of NPP in evaluating greenhouse gas mitigation, and a few other applications to NOEN challenge areas]*
- *Hydroecology – Evapotranspiration product provides extensive coverage at the national/global level. Useful input for an improved understanding of and ability to predict changes in freshwater resources and the environment caused by floods, droughts, sedimentation, and contamination.*
- *Land Use – The DI product provides a frequent and national/global scale assessment of human induced and natural (e.g. due to wild fires) changes to vegetation.*

This RFI suggests satellite products that would be of benefit to NEON. **Satellite products are clearly an important component of NEON; tower data can be used to validate satellite**

imagery, and then satellites can be used as a key scaling tool. It is not clear that these specific products are the ones (all or a subset) that are needed for NEON. There are several products being produced routinely from satellite data, and they should be examined as well.

Land use change at 30 m would be better covered with Landsat data.

The disturbance product is produced only once a year. That is not frequent enough. (However, it could be produced more frequently). It is a recently proposed product and has not been produced.

The ET product has never been produced. It would be good to know why this product is not available.

This RFI response could be viewed as a place holder for the satellite products that NEON needs.

2) Does response pose questions at a regional or national scale?
The questions are addressed at a national scale. National scale is covered since the products are global.

3) How will the design permit scaling from the sensor or measurement to continent?
The measurements are from satellite-borne instruments that provide global coverage every two days. Hence the continent is already fully covered by the products indicated. The RFI response assumes that some U.S. (or other nations') agencies will continue to launch and operate satellites to continue the types of measurements being currently used for these products. The key is validation of products generated by these measurements through other, independent correlative data. The design includes the use of data from a number of in situ data for such validation on an on-going basis.

Good coverage; uses existing satellite capabilities; would link to ground based measurements

4) How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or processes at regional or continental scales?
This is not a manipulative experiment. This response deals with adaptation of existing set of satellite-data-derived products to NEON's goals.

5) How will the proposed science or experiments lead to transformational results, either specified by the RFI response or apparent during the workshop discussion?
Not clearly identified in the proposed work, but provides large scale datasets for use in models on a national scale

Not transformational in and of itself. This response is viewed as an appeal for careful thought about what type of satellite data are needed.

6) Which NEON in situ and remote sensors and sentinel measurements are needed to address the research? What cyberinfrastructure needs are implied?

The proposal does not call out specific NEON measurements.. However, considerable in situ measurements are being used in the production of the products indicated in this response for purposes of validation and "anchoring" of satellite-derived products. The expectation is that the results of this effort would be archived and managed for the long term using NEON infrastructure resources. Also, the response assumes continued observations from space-borne instruments and their processing into standard products on a routine basis as is currently being done in the EOS program. The proposed work is a small increment over that infrastructure.

We can not assume that existing infrastructure will continue; this is key and the NEON team needs to consider how to assure that appropriate satellite products will continue to be available. An incremental amount of work is needed to make the existing products applicable to NEON. There was also concern that NEON would have to rely on another agency for key resources for the project.

7) How do the sites proposed in the science and experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site deployment design (e.g. core site, gradient sites, comprehensive national network, experimental gradients, experimental network).

None provided in the RFI response.

8) Are there new resources (people, data, instruments, money) suggested and are they required beyond that described in the RFI?
The RFI response provides a suggested complement of personnel based on the responder's experience with the EOS program. The team includes the following, not all full time:

- *Director*
- *Computer systems manager*
- *Software engineer*
- *Data manager*
- *Algorithm scientist*
- *Validation scientist*

A budget estimate is provided in the response to cover this. I assume this would be a "steady state" requirement. The data and instruments and an infrastructure to provide them in a manner comparable to what is being done today is assumed to exist.

Could data processing be automated to reduce staffing requirements?

9) Are there other projects, programs, networks, or organizations that would be required to logically, effectively, and efficiently address the question?
Covered in comments above

10) What are the education, training, and outreach goals of the proposed science and how will NEON resources contribute to their success?

None given in the RFI response, even though there is good potential in the work itself for education, training ad outreach.

Steven W. Running, "Satellite derived measures of terrestrial primary production, evapotranspiration and the annual landcover disturbance covering the entire NEON domain"

Questions for research and experiment responses

1) What is the central hypothesis or question and how does it address the NEON grand challenges? If so, briefly describe how.

Airborne remote sensing has limited coverage in time and space. Only satellite remote sensing can make continental measurements with regular repeat intervals. This is not an instrumentation RFI but a data analysis proposal. This RFI describes three datasets that the PI and colleagues have produced under NASA funding from NASA's MODIS satellite. The goal is to extend MODIS type products into the future. These can provide an important national monitor for climate change and can provide a landscape template for extrapolating intensive site measurements.

This is also not a requirements study as it does not examine NEON science issues closely and describe how these data products will be needed. The variables proposed "relate to measurements needed for NEON grand challenges in climate change, biogeochemical cycles, hydroecology and landuse, and … for study of biodiversity and invasive species." The coarseness of the spatial resolution of the data (now at 0.5deg. and 1km) can be used in biodiversity and invasive species studies.

The author states that it is not clear which agency will have responsibility for continuing the datasets he now produces.

NEON must work with NASA, NOAA and USGS to get the satellite data required for NEON science and the specific products it needs (and at the right spatial/temporal scales). NOAA's CLAS is responsible for producing the "climate data records" for NPOESS and they should participate in discussions.

2) Does response pose questions at a regional or national scale?

The objective is to have coherent measurements of the three products for entire nation, produced routinely from the Running lab.

There is no discussion of other possible datasets that NEON investigators might want from satellite data, e.g., land cover types and plant density, nor whether the scales they propose are best suited to NEON objectives. The author is not the only MODIS scientist who may have products of interest to NEON research.

3) How will the design permit scaling from the sensor or measurement to continent?

The RFI includes examples of scaling from Ameriflux data to MODIS products, thus there is an assumption that NEON tower sites can also be scaled. The RFI does not include any plan to integrate between site, airborne, and satellite data. The plan here is to extend their existing data

products over the period with new NEON funding. The extension to NPOESS with very different optics/resolution/bands/overcrossing times make this challenging.

4) How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or processes at regional or continental scales?

The products proposed, GPP/NPP, ET and disturbance will contribute to mechanistic understanding of fluxes at the regional and continental scales. It does not address other products that NEON may want, like net radiation, LAI measurements or land cover types, etc.

5) How will the proposed science or experiments lead to transformational results, either specified by the RFI response or apparent during the workshop discussion?

This is not directly a transformational study but a continuation of existing datasets into the NPOESS satellite era. The value in the data increases with the length of the observations. There is no attempt to relate these measurements to AVHRR time series or show how NPOESS, with different overpass time (afternoon), bands, and spatial resolution will be related to current data (which is dependent on other NASA MODIS products).

6) Which NEON in situ and remote sensors and sentinel measurements are needed to address the research? What cyberinfrastructure needs are implied?

They propose that it will cost $360K/yr for 3 FTE to continue to produce these variables, including $50k for computers.
Given six years of global data product production, the methods should have potential for automation, possibly reducing production cost in future.

7) How do the sites proposed in the science and experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site deployment design (e.g. core site, gradient sites, comprehensive national network, experimental gradients, experimental network).

8) Are there new resources (people, data, instruments, money) suggested and are they required beyond that described in the RFI?

Request is for analysis of standard satellite data products for NEON investigators.

9) Are there other projects, programs, networks, or organizations that would be required to logically, effectively, and efficiently address the question?

NASA is responsible for the analysis of the data from the VIIRS (MODIS replacement) on the NPOESS Preparatory Mission (preceding NPOESS) and NOAA is responsible for climate data analysis on VIIRS on NPOESS. Discussions with other agencies are key to addressing these issues. USGS and/or NASA are responsible for Landsat data analysis (high spatial resolution data used for mapping land cover types and land use change).

NASA is in the "concept study" phase of several new earth observing satellites (to meet recommendations of the NRC Decadal Survey), including possible hyperspectral global mission and a LiDAR (among others). These have important potential for NEON science.

10) What are the education, training, and outreach goals of the proposed science and how will NEON resources contribute to their success?

Not part of this RFI.
Advice: Satellite data is needed for NEON of several types like those in this RFI (this list is not exhaustive). NSF should work with the community to develop a list of products needed before any are selected. NSF should work with other agencies to see if they will provide this data as part of their mandates rather than NSF paying for the primary data processing.

Processing should be able to be automated.

Comments & Notes:

Running_SatelliteDerivecMeasurements:
Three products currently being produces over the entire global land surface using MODIS instruments on Terra and Aqua need to have continuity beyond life of these instruments.
Carbon, water and vegetation (products)
Biogeochemical cycles, climate change, hydroecology and land use: (NEON Grand challenges)
Provides large scale datasets for use in models on a national scale.

Comments:
Thought of this as a grant proposal and not an RFI. The MODIS era is coming to an end. We don't know what is going to happen. They will not launch another one. The INPOS launch won't be launched till 2012. Maybe they will carry MODIS products. They are asked that the funding be continued when MODIS ends. There will be a need for satellite date product. The products that NEON will want. NOAA is responsible for climate change data.

NEON's relationship with NASA and that NASA or NOAA should be providing this data.

Extensive high resolution satellite products needed.
What satellites are products needed for NEON? LANDSAT or other imagery for Land use.
These are placeholders for the products that NEON is needed.

The disturbances index has not been tested.

The budget is not going to go very far when it comes to Land Remote Sensing. It needs the fund to moves forward. However, other agencies need to discuss what products they want.

Shepard_PhosphorusDynamics

VanBloem_AtlanticNeotropical_LULU_Change

S.J. Van Bloem, A.E. Lugo, "Synergy between Changing Natural and Anthropogenic Disturbance Regimes and their Effects on the Biota and Functioning of Neotropical Landscapes"

S.J. VanBloem_AtlanticNeotropical LULC_change
slundquist@usgs.gov
Sara: send notes
Reviewed by Tom Loveland, primary, Tom Hansen, Virginia Dale, secondaries.

Questions for research and experiment responses
1) What is the central hypothesis or question and how does it address the NEON grand challenges? If so, briefly describe how.
Influence of disturbance and climate change on biodiversity. Synergy between these effects of neotropical islands. Design addresses all 7, but strongest in land use/change and invasive species.

Seven hypotheses to be addressed in domain. Summary of expected results from these hypotheses.
Uniqueness of domain ecology. Area of frequent past disturbance. Clarity of proposal hypothesis. Conceptual strategy and not detailed plan.

2) Does response pose questions at a regional or national scale?

Response domain specific issues but does describe connectivity to other NEON activities (3CS, GLEON, Pacific Neotropical network).

3) How will the design permit scaling from the sensor or measurement to continent?
Impacts of human/natural disturbance (landuse/climate, hurricanes, etc.) on complex gradients. Areas of high biodiversity.

4) How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or processes at regional or continental scales?

5) How will the proposed science or experiments lead to transformational results, either specified by the RFI response or apparent during the workshop discussion?

Observational issues

6) Which NEON in situ and remote sensors and sentinel measurements are needed to address the research? What cyberinfrastructure needs are implied?

Towers, airborne platforms, ect. Standard ICEP, aguement towers with soil sensors.
High data requirement and cost to NEON. Have long photo dataset for land use history.

7) How do the sites proposed in the science and experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site deployment design (e.g. core site, gradient sites, comprehensive national network, experimental gradients, experimental network).

Sites in PR well described.
Urban site may not be representative. In city but at a University campus.

8) Are there new resources (people, data, instruments, money) suggested and are they required beyond that described in the RFI?

Specified needs for remote sensing data. Field campaigns to map species.
NASA funded center and perhaps NSF can work with NASA to get this data to their center.

9) Are there other projects, programs, networks, or organizations that would be required to logically, effectively, and efficiently address the question?

Connection to 3CS RFI and to Hawaii and GLEON. NASA funded Center for remote sensing at University.

10) What are the education, training, and outreach goals of the proposed science and how will NEON resources contribute to their success?

Expanded educational opportunities compared to other RFIs. Collaboration with GLOBE. Improve outreach to public, decision-making tools,

Comments & Notes:

Response is a domain specific regional issues, but there are plans for connectivity for other NEON issues. Like the 3CS and the NeoNEON plan also links Global Lakes Ecological Network. Had a proposal for historical aerial photography.
The core site (Guanica Forest) is anchored for gradient sites.

Comments: Puerto Rico has rapid land use change. The lab will need to be linked. The NEON domain should be one end of the gradient.
This is a NASA funded center and maybe the can negotiate with NSF to provide the satellite imagery. The university site is in the middle of the city.

Experiment Responses

Huston-Herbivory

Summary: Michael Huston proposes a manipulative experiment to better understand how herbivory by large and small mammals interacts with soils, climate, and aboveground net primary productivity to control biological diversity and ecosystem processes. At all 120 core sites, fenced plots (2 ha each) will be constructed to exclude large mammalian herbivores. These will be paired with control plots experiencing ambient herbivory. In addition, small mammals will be excluded from 2, 30 x 30 meter exclosures nested with the large mammal plot. The experiment will observe dependent variables including 1) plant species diversity and vegetation structure; 2) carbon sequestration and tissue chemistry (total C and N); 3) albedo and bare soil; 4) higher trophic level responses (diversity and population density of birds, small mammals, selected invertebrates). In addition to the extensive measurements at all sites, there would be a smaller number of sites chosen where animal density is manipulated to achieve multiple levels of herbivory.

1) What is the central hypothesis or question and how does it address the NEON grand challenges? If so, briefly describe how.

The central questions are:

* How does variation in herbivory intensity by mammals interact with variation in soils and climate to affect plant community structure and chemistry, ecosystem processes, the biodiversity of plants and higher trophic levels, and feedbacks to climate through altered CO2 and water vapor exchanges?

* Under what conditions of climate, soils, and herbivory rate is herbivory likely to have the strongest effects on ecosystem processes and properties with feedbacks to local, regional, and global environmental conditions (e.g., albedo, carbon sequestration, evapotranspiration, erosion, biodiversity)?

“This experiment is designed to test a wide range of hypotheses, including the hypothesis that increased grazing intensity in low NPP terrestrical ecosystems decreases plant diversity, while increased grazing intensity in high NPP terrestrial ecosystems increases plant diversity. At intermediate levels of productivity, the classic unimodal “intermediate disturbance” responses (sic) is expected.”

Both of the grand challenges are addressed, although somewhat obliquely. The proposed experiment will identify internal responses and feedbacks of biogeochemistry, biodiversity, and biotic structure and will show how these feedbacks vary with ecological context.

2) Does response pose questions at a regional or national scale?

The experiment exploits variation at continental scales to achieve variation in soils, climate, and net primary production.

3) How will the design permit scaling from the sensor or measurement to continent?
There is no attention given to scaling. One of the real problems of the experiment is the need to achieve a representative sample at each site. I am not convinced that a single scale for all of the exclosures (2 ha) can achieve this. Other exclosure studies have shown that placement of the fenced and ambient plot can have marked influences on exclosure vs. ambient comparisons (Stohlgren et al. 1999). However, this problem may be overcome in the proposed experiment by the large number of sites and their broad range of site characteristics. The scale of the responses are also problematic—for example, I doubt that observing a 2 ha plot could tell you very much about bird species diversity and I am quite sure you can learn *nothing* about bird population density at this scale..

4) How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or processes at regional or continental scales?

This will be a truly comprehensive study of herbivory, but I am concerned about the inferences offered by the extensive portion of the study, that is, the exclosure vs ambient comparisons. The exclosure treatment (no mammalian herbivory) really doesn't have any analog in nature—as Huston points out, mammalian herbivores are truly ubiquitous. There will be variation in levels of herbivory among sites, but this variation will be confounded with variation in soils and productivity, and even more importantly, with the legacies of past herbivory, some of which may be very durable (Manier and Hobbs 2006). I much prefer the design of the intensive studies, where herbivory is manipulated at several levels. More about this in the next section.

5) **How will the proposed science or experiments lead to transformational results, either specified by the RFI response or apparent during the workshop discussion?**

In my view, the science proposed here is incremental, rather than transformative. I will grant that a *big* increment would be gained in our understanding of effects of herbivory, but I honestly don't see these results transforming thinking about mammalian herbivores and their roles in ecosystems. Huston understates the strong insight that has been gained from the many exclosure studies that have been accomplished to date (e.g, McInnes et al. 1992, Pastor et al. 1993, Stohlgren et al. 1999, Hester et al. 2000, Sirotnak and Huntly 2000, Howe and Brown 2001, Verchot et al. 2002, Manier and Hobbs 2006). His statement that "… the effects of herbivores on the landscapes of Yellowstone National Park were not apparent until the reintroduction of wolves altered the grazing patterns of elk and riparian grasslands began to revert to riparian woodlands" can only be described as naïve--the dramatic impact of herbivores on Yellowstone has be well appreciated for most of the 20th century and has formed a well-publicized center of controversy in resource management motivating two inquiries by the National Academy of Sciences.

I agree that understanding of the role of herbivores in ecosystems could be improved with a comprehensive, continental study, but I suggest that such a study should depart from the tired comparison of ambient vs 0 herbivory. The next step, I think, is not to simply write exclosure studies large, but rather to establish sets of treatments that allow more than one level of grazing / browsing at multiple, as proposed in the "intensive" part of Huston's experiment. This could be accomplished with simple technology—fences can be dropped down for, say, 25%, 50%, and 75% of the year, thereby creating multiple levels of grazing intensity. I would scrap the extensive part, which is fraught with confounding effects, and expand the intensive part to, say, 20-40 well chosen sites.

My other criticism is that this experiment is not well motivated by theory. It is claimed that the experiment is designed "…to test a wide range of hypotheses", we are not told in a systematic way what those hypotheses are. Yes, we will look for an effect of herbivores, and the experiment outlined will be able to estimate such effects. However, there is very little thought given to how the experiment would enable us to distinguish between important competing ideas in ecology. I think this experiment could be much improved by strengthening its theoretical foundation, by offering competing predictions that are linked to a body of contemporary theory.

6) Which NEON in situ and remote sensors and sentinel measurements are needed to address the research? What cyberinfrastructure needs are implied?

The experiment proposes to use standard remote sensing, but it is not clear why. With the exception of albedo, all of the responses of interest will be measured on the ground. Lidar measurements are proposed, but these are not capable of detecting structural differences that are likely to be cause by mammalian herbivores. The idea that mammalian herbivores are routinely censused using thermal imaging is simply inaccurate.

There is mention of comparing on-the-ground estimates of NPP with those from eddy flux towers, but the scaling problems associated with such comparisons would appear to be formidable.

7) How do the sites proposed in the science and experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site deployment design (e.g. core site, gradient sites, comprehensive national network, experimental gradients, experimental network).

For the reasons mentioned above, I don't find this design to be terribly compelling. The biggest problem is that the "no herbivory" state that is proposed is highly artificial.

8) Are there new resources (people, data, instruments, money) suggested and are they required beyond that described in the RFI?

Exclosures would need to be constructed. Additional labor would be required to do the measurements, at about $10,000 per year, per site.

9) Are there other projects, programs, networks, or organizations that would be required to logically, effectively, and efficiently address the question?

No.

10) What are the education, training, and outreach goals of the proposed science and how will NEON resources contribute to their success?

Training and outreach are not mentioned in the RFI.

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Anders-FragmentationBiodiversityEcosystemFunction

Effects of Fragmentation on Biodiversity and Ecosystem Function at Local to Continental Scales

L.J. Anderson, C. D'Avanso, and A. Whitmer

Questions for research and experiment responses

1) What is the central hypothesis or question and how does it address the NEON grand challenges? If so, briefly describe how.

How does fragmentation affect biodiversity and ecosystem functioning within and across biomes in the U.S.?

This addresses a component of how ecosystems respond to changes in land-use forcings (i.e., fragmentation) in relation to species dynamics (i.e., biodiversity and invasive species), habitat structure (i.e., edge effects) and biogeochemical cycling.

2) Does response pose questions at a regional or national scale?

Regional and National - The RFI links small colleges who have access to remnants of natural lands (parks, nature preserves, etc.) near their campuses. The colleges are distributed across the U.S. Campuses within a region would compare the responses of their system to the domain core sites.

3) How will the design permit scaling from the sensor or measurement to continent?

The Mobile Relocatable Platforms(MRPs) and consistent measures within fragments will permit regional and continental scaling.

4) How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or processes at regional or continental scales?

N/A

5) How will the proposed science or experiments lead to transformational results, either specified by the RFI response or apparent during the workshop discussion?

Such a broad scale approach to studying fragmentation has not been performed. This could relate to carbon sequestration questions.

Models could be developed to predict how fragmentation affects biodiversity and ecosystem functioning in particular biomes and across broad scales. What are the minimum sizes of ecosystems necessary for proper functioning?
Great theoretical exercise which may be difficult to implement – patch sizes may be too small for fully instrumented towers to operate. The variability in patch characteristics may be difficult to characterize with proposed sampling methodology. However, the biophysical measurements may provide the ecological context of the wildland sites.

6) Which NEON in situ and remote sensors and sentinel measurements are needed to address the research? What cyberinfrastructure needs are implied?

Sensors that can be used to measure carbon fluxes and related environmental parameters, e.g., soil temperature and moisture, solar radiation, air temperature and humidity, etc. are needed.

Satellite remote sensing may enhance landscape measurements.

The consortium of colleges would use existing NEON cyberstructure to distribute and organize data.

7) How do the sites proposed in the science and experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site deployment design (e.g. core site, gradient sites, comprehensive national network, experimental gradients, experimental network).

The specific sites were not addressed; however, there are a wealth of small colleges distributed across the U.S. Different ones could conceivably be marshaled for particular gradients and questions.

8) Are there new resources (people, data, instruments, money) suggested and are they required beyond that described in the RFI?

No.

9) Are there other projects, programs, networks, or organizations that would be required to logically, effectively, and efficiently address the question?

No.

10) What are the education, training, and outreach goals of the proposed science and how will NEON resources contribute to their success?

This RFI response would provide research experiences to a large group of undergraduate students. Minority institutions, in addition to Hampton University, could be identified to contribute.

Comments & Notes

Comments to Anders_FragmentatioBiodiversityEcosystemFunction

1 – T. Loveland: Cross between socialization strategy and measurements…

2 – R. Parmenter: Great theoretical exercise, difficult to implement – patch sizes too small – variability difficult to characterize with proposed sampling.

3 - Idea of using students great idea. How to relate to flux towers.

4 - Minority serving institutions should be specified.

5 – T. Hobbs: Good from standpoint that strived to inform the ecological setting of the core wildland sites.

Questions for research and experiment responses

1) What is the central hypothesis or question and how does it address the NEON grand challenges? If so, briefly describe how.

2) Does response pose questions at a regional or national scale?

3) How will the design permit scaling from the sensor or measurement to continent?

4) How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or processes at regional or continental scales?

5) How will the proposed science or experiments lead to transformational results, either specified by the RFI response or apparent during the workshop discussion?

6) Which NEON in situ and remote sensors and sentinel measurements are needed to address the research? What cyberinfrastructure needs are implied?

7) How do the sites proposed in the science and experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site deployment design (e.g. core site, gradient sites, comprehensive national network, experimental gradients, experimental network).

8) Are there new resources (people, data, instruments, money) suggested and are they required beyond that described in the RFI?

9) Are there other projects, programs, networks, or organizations that would be required to logically, effectively, and efficiently address the question?

10) What are the education, training, and outreach goals of the proposed science and how will NEON resources contribute to their success?

Dodds_StreamExperimentalNetwork

Comments and summary provided in the Research Response above.

Smith_Global_ChangeExperiment

Questions for research and experiment responses (Smith and Knapp)

1) What is the central hypothesis or question and how does it address the NEON grand challenges? If so, briefly describe how.

How will the major terrestrial ecosystems of the US differ in their response to key global environmental changes? (warming, nitrogen and precipitation)

Which ecosystems, or components of ecosystems, are particularly vulnerable and what system attributes can be used to forecast this sensitivity? (survey of 10-12 ecosystem types)

What are the mechanisms (system attributes and feedbacks) that can explain differences in the nature and pace of change among different ecosystems? (assumed to emerge from the **regression analysis**)

Grand Challenge - "Forecasting the nature and pace of ecosystem change in response to human-induced forcing"

2) Does response pose questions at a regional or national scale?

Local observations, national analysis - by using 12 sites in 12 different biomes, but mainly driven by observation, not theory (at this point). The exception to this statement however are the three interesting hypotheses developed to base their observations on:

1. Ecosystems limited by a particular resource are more likely to respond to variation in that resource.
2. The responsiveness of the ecosystem is determined by the nature of the dominant species (long lived dominate species will mean slow ecosystem change while short lived dominate species will mean fast ecosystem change) – *Dominance Hyp*.
3. Ecosystems characterized by small pools and fast turnover of C & N respond quickly, whiles those with large pools and slow turnover times respond slowly. – *Biogeochemical Hyp*.

3) How will the design permit scaling from the sensor or measurement to continent?

No specific information given. Scaling is likely to be theoretical – via modeling and integration (again, not described). The observations are local, but assumed to be regional (representing 10-12 biomes) and the comparison of all 12 regions is suggested to give a continental scale analysis. It's unclear how a regression approach can be used to assess the individual treatments at the individual sites in order to answer the question regarding which ecosystems are most sensitive to a particular environmental driver.

4) How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or processes at regional or continental scales?

Ultimately this should happen through modeling and integration. It is logical to imagine that mechanistic information from these manipulative experiments will feed models and facilitate scaling. Details at this point are lacking, however a fully developed proposal should be able to deal with this.

5) How will the proposed science or experiments lead to transformational results, either specified by the RFI response or apparent during the workshop discussion?

Difficult to answer, however the hope is that by running a uniform experimental protocols at all sites the most robust mechanistic information should be gained.

6) Which NEON in situ and remote sensors and sentinel measurements are needed to address the research? What cyberinfrastructure needs are implied?

See table 1- nearly all measurements indicated. RS primarily used for pre-treatment evaluation since the experiment is un-replicated and requires that individual plots along the regression analysis be identical prior to the treatments (See table 4 & 5). Cyberinfrastructure discussed on page 17, section III.9 – most standard NEON CI used + additional needs of connectivity, computing power and satellite data.

7) How do the sites proposed in the science and experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site deployment design (e.g. core site, gradient sites, comprehensive national network, experimental gradients, experimental network).

The sites were chosen to represent the greatest possible diversity of vegetation and ecosystem types, without replication, and to span the continent. Each site needs 10 ha of land to devote to the experiments (approximately half to three fourths of which is covered by greenhouses), road access and power. They propose to use of core wildland sites, or potentially gradient sites ("if necessary").

8) Are there new resources (people, data, instruments, money) suggested and are they required beyond that described in the RFI?

Yes they have suggested the need for all of these (people, data, instruments & money) and they would be required to successfully undertake this project. I suspect they may have drastically under estimated the actual costs. Passive heating is unlikely to provide the 2-4 C warming, the use of different types of structures for different plots is unacceptable requiring the most expensive set up at all sites, Its unclear if the environmental monitoring and sensors are included in the estimated costs (36 plots per site to instrumented), maintenance fees seem underestimated for a 30 year duration and no fringe or overhead has been estimated. This is likely to be a very expensive experiment, significantly more than $91 million proposed.

The European Climoor experiment has been able to achieve only 1C passive nighttime warming in low stature ecosystems. Additional warming may be gained by enclosing the sides of the warmed greenhouse, but this has undesirable additional effects (RH, turbulence, trace gases, herbivore access…) that would be differentially applied amongst the treatments. Daytime warming, which is appropriately proposed to be of a lower magnitude than the nighttime warming, will be quite difficult to achieve (uniformly) in many of the sites, potentially requiring repetitive rapid opening and closing of the greenhouse, leading to secondary effects on RH, PAR, turbulence, etc. The proposed arctic site may be the most appropriate place for this experiment; due to lack of true day/night cycle during the growing season, low sun angels, and permafrost (however passive winter warming is obviously limited, yet critical). Similarly a desert site may have a nighttime energy balance which facilitates the experimental design,

however daytime temperatures may be much more difficult to modulate. The large volume of forest greenhouse seems to present multiple problems to this design.

9) Are there other projects, programs, networks, or organizations that would be required to logically, effectively, and efficiently address the question?

Most likely –interfacing with modeling programs is identified as a requirement.

10) What are the education, training, and outreach goals of the proposed science and how will NEON resources contribute to their success?

Stated to be unmatched?
"The high profile nature of such an experiment cannot be underestimated"
Linked to Core NEON sites and the Citizen Science framework

Comments of Primary Reader:
I completely agree that NEON requires a mechanistic understanding of the key ecosystem processes responded to climate change, and the authors do an outstanding job of making this point. Manipulative experiments are an obvious way to add knowledge, and the three human caused global changes identified are clearly of urgent importance (CO_2 is a noted omission). As an RFI, this response if full of good information, solid suggestions and important concepts, however what is lacking is a clear means of scaling, a solid theoretical foundation, and a clear description of the means of analysis. Clearly many of these would be addressable in an actual proposal. Unfortunately I do not believe proposed system can manipulate temperature as desired (+4C with the DTR decreasing as nighttime temperatures increase at approximately twice the rate as daytime temps), severely limiting this portion of the experiment. This is unfortunate as I think this is perhaps the most important and least well understood driver of the three proposed. There may be other ways to deal with these potential limitations if budgets allow (additional active climate control).

Discussion Notes:
The RFI does a great job of addressing the main goals of NEON, and would address interacting effects.

It was unclear how the scaling would be accomplished beyond the direct comparisons among localized experiments.

The experiments would help us understand the potential effects of changes in precipitation, temperature, and nitrogen additions on a variety of biotic and abiotic processes.

There were concerns that the warming scenario was unrealistic.

The nitrogen addition experiments would be feasible; alternatively the design could be limited to rainout and N additions.

If the manipulations are successful, the experiment would yield important information about the direction, shape, and magnitude of response at a range of sites.

There were concerns about the feasibility of the warming (see above).

The project has considerable potential to be a high profile experiment and a platform for education and outreach.

Grulke_DroughtStress

National Experiment on Tree Drought (NETD)
Lead Scientist Nancy Grulke Pacific Southwest Research Station USDS Forest Service, plus a cast of ~12 others

Questions for research and experiment responses

1) What is the central hypothesis or question and how does it address the NEON grand challenges? If so, briefly describe how.

What will be the effect of significant drought stress on the nation's dominant forest trees, associated watershed-scale biosphere/atmosphere carbon and water fluxes, and watershed production of water quantity and quality?

Addresses both NEON Science Challenges by experimentally simulating on the most important predicted forcing factors resulting from climate change (drought as affected by warming, changes precipitation patterns) and will measure ecosystem responses at a range of spatial and temporal scales.

Will determine the pace and scale of response. Will determine feedbacks and interactions in ecosystem biogeochemistry, ecohydrology, and biodiversity….will help identify implications for invisibility and disease susceptibility in forest ecosystems.

2) Does response pose questions at a regional or national scale?

Continental

3) How will the design permit scaling from the sensor or measurement to continent?

Scaling from individual to watershed level to forest-type level…sample sites are distributed throughout the continent.

4) How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or processes at regional or continental scales?
See scaling question

5) How will the proposed science or experiments lead to transformational results, either specified by the RFI response or apparent during the workshop discussion?
Deeper understanding of drought stress on trees/forests and associated watershed-scale biosphere/atmosphere carbon and water fluxes

6) Which NEON in situ and remote sensors and sentinel measurements are needed to address the research? What cyberinfrastructure needs are implied?
Stand composition and structure
Canopy transpiration
Drought stress
Micrometeorological PAR, soil temp, air and leaf temp, soil moisture
Canopy water and CO_2 flux
Water flow from watershed
Water quality from watershed
Sap flow

7) How do the sites proposed in the science and experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site deployment design (e.g. core site, gradient sites, comprehensive national network, experimental gradients, experimental network).

Will impose drought stress on individual trees for 1/3 of trees greater than 15cm at 1.5m height, at 13 sites nationally.

Located adjacent to or near existing experimental watersheds – propose 13 specific sites.

Experiments will be established in 3 watersheds at each site

Forest composition and density will be assessed in 4, ¼ ha plots in each experimental and control site. Tree species and basal area at 1.5m for all trees > 15 cm diam. Will be measured, 1/3 of these trees will have their primary roots pruned over 1/3 of their basal area…2 to 3 primary roots will be cut per tree to induce significant drought for 2 to 4 years…canopy transpiration and foliar temperature will be used to determine when re-pruning is required.

Ten sets of paired trees of the dominant species and representative size will have sapflow monitors installed one year prior to root pruning and used to monitor level of drought stress. Soil moisture within surface layer immediately around treated and control trees will assess effect of hydraulic conductivity and hillslope hydrology.

Canopy exchange of water and C will be measured as response attributes with eddy covariance techniques with relocatable flux towers installed on droughted and control watersheds.

Water quality will be monitored…pH, dissolved inorganic and organic carbon and nitrogen will be used as integrators of watershed response to drought stressed trees

8) Are there new resources (people, data, instruments, money) suggested and are they required beyond that described in the RFI?

Yes…USDA FS Airborne Sciences aircraft

9) Are there other projects, programs, networks, or organizations that would be required to logically, effectively, and efficiently address the question?

USDA FS equipment

10) What are the education, training, and outreach goals of the proposed science and how will NEON resources contribute to their success?
NA

Comments & Notes:

National Experiment on tree drought. This on a continental level. Deeper understanding of drought stree on tree/forests and associated watershed-scale biosphere. Impose drought stress on 1/3 of trees at 13 sites nationally. Hope they will be in range and aspect of the areas within the domain. 3 watersheds at each site. Forest service a critical aspect of this experiment. Pitfalls: run for 15 years. Compensatory root growth and avoidance of drought stress. Siting of flux towers many be limited on some slopes.

Comments: Lacking in details on how they would impose the drought stress. Excited: look for very big changes in a whole, to measure whole scale vegetation scale. If this triggers mortality, it is important on NEON scale. Results are interesting.

How could you separate the stress from pruning the roots to determine drought stress. Hugely problematic. The remote sensing doesn't not relate to measuring drought stress. Probably won't change the CO2 levels and won't be measuring through drought measurement.

Not a good way to doing this. Concept makes sense but methodology is weak.

Field_GlobalChange

Comments & Notes:

Dale comments re Field – Global Change
TITLE: Response concerning: **A NEON Multi-Site Global Change Experiment**

1. Question: ecosystem responses to the interacting effects of warming and elevated atmospheric carbon dioxide
2. Questions are at national scale: The NEON global change experiment should be run as a national facility with a program coordinated across sites.

Eight sites chosen to cover key elements of the parameter space defined by climate, soil, and vegetation should include:

1) Arctic tundra
2) Boreal forest
3) Tropical evergreen forest
4) Temperate deciduous forest
5) Mediterranean woodland
6) Agricultural crop
7) Prairie
8) Desert

3. Design permits scaling via: experimental evidence from greenhouse studies on the long-term responses of managed or natural ecosystems to the factorial combination of warming and atmospheric CO_2 that might occur in 2100.
4. Manipulative experiment provides a mechanistic understanding of imp. processes and patterns – The NEON global change experiment should expose real ecosystems, growing in real soil, to a factorial combination of warming and atmospheric CO2 set at realistic levels for 2100.
5. Transformational results: As a consequence of having no experimental data, all of the ecosystem models used to explore the future are based on concepts that are incompletely tested.
6. NEON sensors and measures: The NEON climate-change research facility should provide the following:

1) Warming of ambient plus 4C.
2) Atmospheric CO_2 at 750 ppm
3) A factorial combination of warming and elevated CO_2
4) Sufficient replication (probably 4 replicates per treatment per site)
5) Sufficient capacity to explore full-scale ecosystems, including ecosystems dominated by trees
6) Replication at a number of sites sufficient to explore responses across the parameter space defined by climate, soils, and vegetation type.
7) The capacity to operate for sufficient time to capture a broad range of relevant mechanisms, including changes in nutrient availability and changes in the relative abundance of plant and microbial species.

7. How do sites provide way to answer question: Will provide data needed to validate and test models. All of the available technologies for providing the necessary combination of warming and elevated CO_2, at the relevant scale, have important limitations. These limitations are minimized in a system based on greenhouses.
8. New resources: greenhouses
9. Other projects required:
10. Ed, training and Outreach goals:

<u>Discussion regarding the Field global change experiment</u>

Takes NEON in a futuristic direction
Great idea – provides mechanistic understanding through manipulative experiment

Compare to FACE experiment, where cost of elevating CO2 can be >$1M/yr – would cost less in greenhouse, once it was built

What experiments would be overlaid onto this facility

Observational work requires long time series to gain insights. A manipulative experiment can cut that time frame.

Need to begin w/ some well thought out modeling framework

This sort of facility, facilitating controlled experiments in short time frames, could resonate w/ Congress.

History w/ FACE experiments suggests that controlled experiments may not provide results within 5 yr.

Early wins: i) spatial variability based on 1 yr of data; ii) what will a facility add to predictability.

Replace time w/ space based on gradients. This sort of facility may contribute in some way.

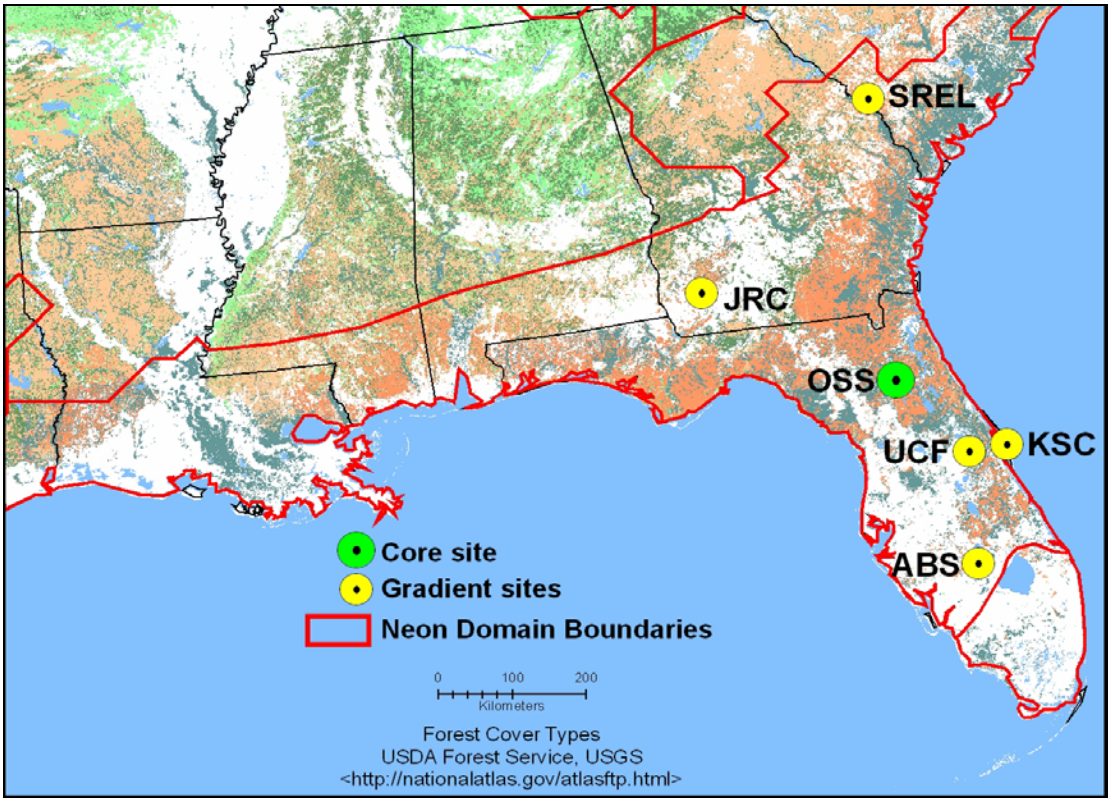
Importance of infectious disease as a hook. May be on cusp of greater public awareness of global change.

In natural ecosystems, catastrophic rather than incremental change may be the rule. So perhaps experiments should focus on manipulating natural systems.

Comments & Notes:
An idea and suggestion paper. Multi site global change experiment. A bunch of greenhouses that set up. National scale. Across 10 sites that would need to cover key areas of 8 different climates. Combination of warming and atmospheric CO2 that might occur. They would each be a climate research facility.
-Will provide data needed to validate and test models. But-they will be very controlled experiment using these greenhouses. Are we just observing the system or are we doing experiments?
Comments: Really something we should think about.
Needing to take into account and provide access to herbivores, getting them in and out. They were aware. It would be completely controlled, closed system…control the environment. The water balance would be monitored and controlled.

Real values that there will be a return in a close time frame.

What does the near term imply?



We are going to need something to show to Congress and there will be return on the investment. For practical sense, we should be advocates of controlled experiments

Importance of modeling.

Short term results that would get the public's attention. Like infectious disease, will be hard to do experiments and with modeling. A series of greenhouses would be good.

The public become very aware and concerned about global change.

Hayes_FireCyclesSuppression:

Hayes et al.: <u>Experimental Study of Fire Return Cycles and Ecosystem Effects of Suppression Using SEEON Gradient Sites</u>

<u>Questions for research and experiment responses</u>

1) What is the central hypothesis or question and how does it address the NEON grand challenges? If so, briefly describe how.

Q: How do ecosystems respond to differing prescribed fire return cycles and fire suppression? This fire ecology proposal addresses the land use, climate, and biodiversity science challenges, but will also likely have an invasive species component.

2) Does response pose questions at a regional or national scale?

Regional (Southeast), but could extend to western forests.

3) How will the design permit scaling from the sensor or measurement to continent?

Regional application only; some atmospheric transport of smoke particulates to other regions of eastern North America; if linked to western forests, potentially larger applications.

Regional scale-ups rely on gradient of sites with identical field experiments; applicable to similar forest types under similar management regimes within the region.

Gradient includes mesic uplands to xeric scrub; 3 of 6 sites are wildland-urban interface having fire/smoke issues.

4) How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or processes at regional or continental scales?

Fire suppression management and policies near urban areas and elsewhere have led to alteration of these naturally fire prone communities resulting in the loss of fire-dependent species, increase in exotic species invasion, increased accumulation of pyric biomass as fuels, and consequently increased risk to human health and safety.
Experimental fire experiment will test management treatments of forests: typical "base" fire frequencies (prescribed), "suppressed" fire treatments (= "base" frequency plus 2-3 years delay), and "restoration" fires of sites that haven't burned for some time.

5) How will the proposed science or experiments lead to transformational results, either specified by the RFI response or apparent during the workshop discussion?

Will enhance land management understanding on this topic.

Is this considered "transformational" science?
6) Which NEON in situ and remote sensors and sentinel measurements are needed to address the research? What cyberinfrastructure needs are implied?

Relocatable tower measurements already on baseline plots at each of the gradient sites in the domain; a combination of Rapid Deployment Systems and Basic BioMesoNet Sensor packages with extra soil sensor arrays, wet and dry deposition collectors, and particulate samplers; and supplemental portable LIDAR, and thermal imaging systems.

7) How do the sites proposed in the science and experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site deployment design (e.g. core site, gradient sites, comprehensive national network, experimental gradients, experimental network).

Experimental Design:

6 sites on gradient;
3 in wildland:urban fringe.
3 Treatments: Base fire frequency, suppressed fire, restoration fire
4 replicate plots, 1-2 ha within a 5-10 ha block, Tower(s) located in plots for fires.

Timeline: 10-yr duration of experiments.

Are plots large enough for Flux Tower fetch? How to capture smoke plume? Distribution and number of towers not specified – rapid movement of tower locations? Will these data be useful?

8) Are there new resources (people, data, instruments, money) suggested and are they required beyond that described in the RFI?

No.

9) Are there other projects, programs, networks, or organizations that would be required to logically, effectively, and efficiently address the question?

Not listed, but probably assistance with implementing prescribed fire (Federal, State, Municipal and private fire units).

10) What are the education, training, and outreach goals of the proposed science and how will NEON resources contribute to their success?

Not addressed; presumably included in SEEON domain response.

Sack_TwoExperiments:

RFI – EXPERIMENT #1 LONG AND SHORT TERM IMPACTS OF INVASIVE SPECIES CONTROL ON NATIVE MOIST FOREST ECOSYSTEMS: REMOVAL OF FERAL UNGULATES AND INVASIVE PLANTS – Dr. Lawren Sack

1. What is the central hypothesis or question and how does it address the NEON grand challenges?

How are population, community, and ecosystem processes affected when invasive primary producers and exotic pigs are removed from affected ecosystems?

What are the relative impacts of control under different levels of primary productivity and soil fertility?

What are the direct and indirect effects of animal and plant removal on biodiversity, biogeochemistry, and net primary productivity?

How will these impacts change over a thirty-year period in which climate change and new species invasion will also be occurring simultaneously?

Invasive plants and feral ungulates are powerful agents of change in ecosystems nationwide. Yet we have little information on the long-term impacts of invasive species on populations, communities and ecosystems, despite these being targets of control at considerable expense by land managers. We have even less information and understanding regarding the long-term impacts of invasive species control, i.e., on how ecosystems change following invasive species removal.

Meets the NEON stated challenge on invasive species?

2. Does response pose questions at a regional or national scale?
Yes, on the regional level but some carry over value to national scale.

3. How will the design permit scaling from the sensor or measurement to continent?
There is a scaling from ground (Soil Sensor Array) to BioMesoNet tower (climate information) to Remote sensing Carnegie Airborne Observatory (CAO) system.

4. How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or process at regional or continental scales?

The combination of the removal experiments proposed and the spatial and temporal dynamics incorporated into the design will help in understanding the roles of exotic species within ecosystems and their influence on the provision of important ecosystem services such as carbon sequestration, water quality and quantity, and biodiversity.

5. How will the proposed science or experiments lead to transformational results?
Probably not.

6. Which NEON in situ and remote sensors and sentinel measurements are needed to address the research? What cyberinfrastructure needs are implied?

Airborne remote resources will be provided by co-Principal Investigator Greg Asner and his Carnegie Airborne Observatory (CAO) system - part of the overall PACNEON approach and toolbox. Specifically the study will capitalize on CAO's capability to remotely sense whole canopy leaf area index, foliar pigments, nitrogen, energy absorption, and light-use efficiency that will inform plot-scale estimates of productivity, water flux, as well as N pools and

cycling. The key technologies that will be employed include waveform-scanning Light Detection and Ranging (LiDAR) and hyperspectral imaging (HIS) (See Observational RFI for additional detail). Remotely sensed parameters will be measured annually to determine differences among treatments both within and across the study areas that span the soil fertility gradient. Analysis of the dynamics of these parameters through time (i.e., on an annual basis) will provide long-term estimates of canopy water, carbon, and nutrient dynamics in response to weed and pig removal.

The RFI states that no unusual cyberinfrastructure or software needs are anticipated in the study.

7. How do the sites proposed in the science and experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site deployment design?

The experiment will take place at three different sites that vary in soil age and hence fertility – adding a spatial component. The treatments will be replicated 4 times at each of the 3 sites. Feral pigs will be removed from half of the plots by erecting 1-ha pig-proof exclosures. Exotic vascular plants will be removed from half of the plots by mechanical and chemical treatment. Neither pigs or exotic vascular plants will be removed from the control plots. The climate/elevational gradients and land use types (i.e., native forest, exotic forest, pasture) that exist within these sites, coupled with the temporal scale of the NEON design, will allow one to predict and monitor how ecological processes in forests and streams are affected by both the invasions of non-native vegetation and future changes in climate.

The experiment will include measurement of treated impacts on the growth, diversity and composition of seedling and understory plants and on invertebrate communities and select populations (e.g. earthworms and mosquitoes).

Measurement	*In situ* or Grab Sample	Post-Processing	Skill Level	Spatial Distribution	Sampling Frequency	Direct or Aggregate
Tree growth	*in situ* dendrometer bands	data analysis	low	plot based	annual	direct
Vegetation composition	*in situ* plant ID and size; nested plots	data analysis	moderate	plot based	biannual	direct
Seedling populations	*in situ* seedling numbers and ID	data analysis	moderate	plot based/subplots	annual	direct
Earthworm populations	grab soil samples	sorting, dry mass	low	subplots	annual	direct

Mosquito populations	grab samples	sorting, counts	moderate	subplots	annual	direct

Measurement	***In situ* or Grab Sample**	**Post-Processing**	**Skill Level**	**Spatial Distribution**	**Sampling Frequency**	**Direct or Aggregate**
litterfall	grab traps	sorting, dry weights, C:N:P	moderate	subplots	monthly for 10 years	direct
tree (>2 cm) diameter growth	*in situ*	data analysis	low	plots	annual	aggregate
foliar and wood tissue	grab samples	specific leaf area, dry weights, C:N:P	moderate	subplots	annually	direct

The hypotheses that the RFI is intended to answer include:

- Removal of weeds and/or pigs will increase native plant biomass, seedling abundance and, perhaps, species richness.
- If weed removal decreases total litter quantity and quality, productivity of the soil invertebrate community will decrease and the composition may change.
- We expect the removal of pigs to increase earthworm abundance and decrease mosquito abundance.
- In the short term, pig removal will have a smaller effect on native NPP than will weed removal. In the long-term, pig removal will foster a greater relative increase in native NPP than weed removal due to the reduction in damage of native plant recruitment, tree roots, and soil invertebrate communities.
- Combined pig and weed removal will have the strongest positive impact on native NPP.
- Total productivity (native + non-native) will be highest in the absence of pigs and lowest in the absence of weeds.

- Weed removal will lower decomposition rates, increase microbial immobilization of N and P, decrease soil nutrient availability, and increase nutrient use efficiency (NUE).

- Pig removal will lead to decreased leaching and gaseous losses of N.

- Relative to control plots, removal of both pigs and exotic plants should lead to the lowest levels of soil nutrient availability, the lowest losses of N and other nutrients via leaching and denitrification, the highest levels of plant NUE.

- Removal of both pigs and weeds will increase soil moisture and infiltration rates.

8. **Are new resources suggested and are they required beyond what is described in the RFI?** Resources needed and their estimation of cost are included in detail in the RFI but done on an annual bases. Also, costs were not included costs of sensors in the soil Arrry or of BioMeson Net tower at each site.

9**. Are there other projects, programs, networks or organizations that would be required beyond what is described in the RFI?** None that were identified.

10. **Education, Training and Outreach Goals** None listed.

Sack – Comments

Liked it, it was well thought out. Cost is the only issue

Antonio – this is one where field ecology can translate into large scales. Can see a host of applications for this type of coupling.
Not relying on satellites is a plus.
If this can be shown to work NASA may see a benefit of putting the instruments in space.
Susan – NASA is currently undergoing mission studies.
Antonio – value of the experiment is doing field ecology and trying to couple field data with aerial remote sensing.
Susan – This is being done now, but still is cutting edge

Very well designed couple of experiments. High chance of success. Will be of great interest at least on a local level. Hawaii is a special environment and we should not be overly concerned about national extension.

John – Experiment can be extended to other places though.

There is a lot of agreement in the room that this type of manipulation experiment is valuable. What happens when you remove invasive species? Putting all invasive species in one group is not the thing to do? Could this be made more sophisticated by classifying invasive species in a way that work done in one domain would be meaningful in another domain.

Richard – if they take out all the invasive species – e.g., Earthworms – there are no native earthworms in Hawaii. IT would not be characteristic of what we are trying to measure.
Can't take out all invasive species.
Alan – have worked in streams in Hawaii and Puerto Rico. The work can in fact carry to other locations. These are general types of phenomena that could be studied anywhere.
Point is to identify the general traits.
Alan – they have been identified in the literature
Richard – A concern is that if we set up long term measurement experiments, other invasive species may complicate the matter. Especially so in Hawaii. It is very dynamic and destructive.
Alan – There is potential here for very interesting comparisons.
Bob – It seems that if overall network is geared to climate change, the impact on streams is from snow melt, rain flow, etc. Experiments about this would be more valuable.
Alan – such manipulations have been done on a small scale. But there has not been a sharing of what works. There are only a couple of places that are capable of doing this now. Water and fire are of great concern everywhere. We explore these regionally, but not continentally.
Tom – In terms of mining there are some good ideas here. Concerned about an unbalanced program in NEON. It would be a mistake to have a lot of resources go into a regional experiment.
Alan – this has to be considered as an experiment that could be done across the board.

EXPERIMENT #2 IMPACTS AND INTERACTIONS OF INVASIVE RIPARIAN VEGETATION AND CLIMATE CHANGE ON STREAM ECOSYSTEM PROCESSES – Dr. Lawren Sack

1. What is the central hypothesis or question and how does it address the NEON grand challenges?

The overarching question of this RFI is how does invasive riparian vegetation impact stream ecosystem functioning? Underlining this question are a number of sub-questions, including:

1) How do invasive species in riparian zones impact the hydrology, hydroecology, biogeochemistry, biodiversity, and functions of streams?
2) How will invasions alter linkages between forests and streams?
3) How do invasive riparian species impact nutrient, sediment, and organic matter loading to coastal areas?
4) How do these impacts vary across spatial and temporal scales, climate or land use gradients, or between insular island and diverse continental streams?
5) Will climate change facilitate invasions of riparian areas of headwater streams flowing through pristine, native forests?

2. Does response pose questions at a regional or national scale? Regional scale more so than national scale due to the characteristics of Hawaiian stream dynamics (e.g. tend to be smaller, with multiple high-flow events, steep gradients).

3. How will the design permit scaling from the sensor or measurement to continent?
Scaling from aquatic sensors to tower arrays to airborne remote sensing will occur. No doubt that there will be some carry over value to the continental level.

4. How will the manipulative experiment(s) provide a mechanistic understanding of important patterns or process at regional or continental scales?

This study will manipulate leaf litter inputs from native and invasive riparian vegetation in headwater streams in the Hawaiian PACNEON domain to determine: 1) the impacts of invasive leaf litter on various stream ecosystem processes, 2) how invasive riparian species impact nutrient, sediment, and organic matter loading to coastal areas, and 3) how these impacts vary across spatial and temporal scales.

The diversity of climate, soil types, and land use gradients within Hawaii are representative of the extreme gradients one would find on a continental scale. Thus, the work conducted within Hawaii would meet the continental-scale requirement of NEON. The continental-scale requirement will also be met be establishing similar sampling stations and manipulations in other domains such as the Pacific Northwest.

5. How will the proposed science or experiments lead to transformational results?
Unlikely to lead to transformational results.

6. Which NEON in situ and remote sensors and sentinel measurements are needed to address the research? What cyberinfrastructure needs are implied?

Measure-ment	Sensor Information				Sampling Information		
	Sensor	Manufacturer/ Distributor	Unit Cost	Maintenance Schedule	Spatial Distribution	Sampling Frequency	Direct or Aggregate
Discharge	Weir	USGS	$20,000	Monthly	Lower-reach stations	Continuous	Direct
Cond, DO, pH, temp, turbidity, depth	YSI probes, pressure transducer	YSI 6920 Datasonde	$10,000	Monthly	Lower- and upper-reach stations	Continuous	Direct and Aggregate
Automatic water sampler	Pressure transducer	ISCO water sampler	$10,000	Monthly	Lower- and upper-reach stations	Continuous	Direct
Fine particulate matter		Coschocton Wheel Water Sampler	$5,000	Monthly	Lower- and upper-reach stations	Continuous	Aggregate

Coarse particulate matter, stage height, water velocity	Acoustic	Nortek As EasyQ	$5,000	Monthly	Lower-reach stations	Continuous	Direct
Coarse particulate matter/plankton counter	Flourometer	Fluid dynamics FloCam	$30,000	Monthly	Lower-reach stations	Continuous	Direct

Measurement	*In situ* or Grab Sample	Post-Processing	Skill Level	Spatial Distribution	Sampling Frequency	Direct or Aggregate
Nutrient and organic matter concentrations	Grab	Yes	Moderate - high	Lower- and upper-reach stations	monthly	Direct
Primary production	In situ	Yes	Low-Med	Lower- and upper-reach stations	monthly	Direct
Algal, invertebrate, fish biomass and densities	In site and Grab	Yes	Low-Med	Lower- and upper-reach stations	quarterly	Direct
Secondary production	Grab	Yes	Med-High	Lower- and upper-reach stations	monthly	Direct

Some cyberinfrastructure support (i.e., repeaters, solar panels, etc.) will likely be needed to continuously and wirelessly stream data to towers or the on-site lab facility.

7. How do the sites proposed in the science and experiment responses provide a logical, effective, and efficient way of addressing the question? Describe the conceptual site deployment design?

This study will be conducted in six of the seven replicate headwater streams in the Laupahoehoe Experimental Forest. Two study stream reaches where monitoring and leaf litter manipulation will occur will be created in each of these streams for a total of 12 stream reaches. One reach will be located upstream in the headwater regions of streams in native dominated forest (1000-1200 m elevation), while the other reach will be located downstream in reaches that flow through invasive forest or agricultural lands (~600 m elevation). Sampling stations will be created above and below each of these stream reaches for a total of

24 sampling stations. Datasondes will also be deployed above and below each of the 12 stream reaches. In addition, water samples will be taken through grab samples and ISCO automatic samplers. Will be run for 30 years.

The manipulation of leaf litter will only occur in the headwater reaches of the 6 streams. Control streams (n=2) will consist of non-manipulated headwater stream reaches, while treatment streams (n=4) will consist of manipulated headwater reaches where we will exclude leaf litter inputs over a period of time using mesh exclosures. After 2 years, native leaf litter from the adjacent forest will be reintroduced to duplicate treatment streams (n=2) while leaf litter from an invasive forest well established in the area will be introduced into the remaining, duplicate treatment streams (n=2). A large number of physical, biogeochemical, and ecological parameters will be measured before, during, and after this time period.

Comparisons among streams reaches flowing through native and invasive riparian forests coupled with manipulations of native and invasive leaf litter inputs will be used to test the following hypotheses:

Invasive riparian vegetation will decrease groundwater recharge to streams and thus alter interactions between forests and streams.

Particulate organic matter and nutrient inputs to streams and nearshore communities will be higher from streams with invasive riparian vegetation.

Primary production, secondary production, and whole stream metabolism will be greater in streams with invasive riparian vegetation.

Invasive aquatic fauna will attain higher densities and biomass in stream reaches with invasive riparian vegetation.

Climate change will open up corridors in watersheds and streams and increase the invasiveness of exotic species in riparian/stream ecosystems.

Comparison among stream reaches flowing through native forests, invasive forests, and pastures will be used to test the following hypotheses:

Changes in land use will change the forms and bioavailibility of nutrients in the water column, increase primary production, increase densities and biomass of invasive aquatic fauna, and increase net daily metabolism of streams.

Manipulations excluding leaf litter inputs into headwater reaches of streams will be used to test the following hypotheses:

While exclusion of leaf litter will significantly decrease concentrations of particulate organic matter in headwater streams, it will increase concentrations of nutrients.

Exclusion of leaf litter will increase primary production, secondary production, and overall whole stream metabolism.

8. Are the new resources suggested and are they required beyond what is described in the RFI? Budget estimates and additional resources are included in the RFI – but as stated in the RFI they do not include the costs for lab analyses, miscellaneous equipment and supplies and personnel costs for the four technicians required.

9. **Are there other projects, programs, networks or organizations that would be required beyond what is described in the RFI?** None identified.

10. **Education, Training and Outreach Goals** None provided.

Comments:

How do you scale Hawaii to continental scale? You cannot. However, there are some meaningful gradients. But extending the gradients, via modeling, is questionable – truly a scaling issue.

However, Hawaii is a special case with many (and steep) gradients and is thus a wonderful laboratory. An example is the approach to dealing with invasive species. But – Hawaii may not be representative of how these invasions happen. On the other hand, examples of invasives in Hawaii have broken new ground in our understanding of invasives, for example with transport of exotic species that other domains may experience at some time.

Hawaii and Puerto Rico represent climatologically end-members, as both new and old environments, which is important.

It is a strong proposal, with good, wide participation.

For remote sensing needs, they include the CAO.

Sack – Two experiments: NOTES

Liked it, it was well thought out. Cost is the only issue

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Other Responses

Field_Fellowships

Comment & Notes:
Field_Fellowships
Proposal for a need for the next generation of NEON. NSF would have fellowships for NEON. 10-20 a year were selected a year that would give you a standing group of 60 students that would have good visibility for NEON. 3 ½ million a year. Specialized training for NEON students and trained in culture and use of instruments.

Comments: Essential but not sure how it will fit into NEON. A formalized system in place about new ecology is a wonderful idea. Example of the NASA fellowship.
Need money for equipment, might think about specialized equipment as well as money to pay students.

PavaoZuckerman-NEON_HQ

NEON headquarters RFI -- Presentation to workshop group by R. Parmenter

Lead Author: Travis Huxman, Univ. Arizona, Tucson

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Figure 1 – the Biosphere 2 facility 35 km north of Tucson, Arizona.

Biosphere II Site Characteristics

1. **Readily accessible year-round from disparate domains within the Nation.**
2. **A climatological and ecological setting and cost of living attractive to future employees.**
3. **education / outreach program, and develop associations with local organizations that can facilitate the management, promotion, and coordination of 'big-science'.**

The University of Arizona is expected to receive a major donation that includes the Biosphere 2 facility along with funds to enable significant renovation and establish major new initiatives including observational, experimental, and modeling research, and education / outreach programs, all aimed at understanding earth, ecological and environmental processes important for sustainability and resilience.

The new facility and its programs, tentatively named the "*OpenEarth Center*" will focus on questions and experiments highly relevant to NEON. Facilities include:

1. **Extensive office & laboratory space (> 15,000 ft^2), including the training facilities described in the Integrated Science and Education Plan, and access to new, state-**

of-the-art instrument laboratories.

2. **Computing resources and networking capacity to support the data transfer requirements from each domain, and the collaboration sessions, video teleconferencing among, and between domains, along with the central facilities as described by the Networking and Informatics Baseline Design (NIBD) blueprint. Cyberinfrastructure at the University of Arizona can be additionally leveraged.**

3. **Housing resources (small apartments and dormitory facilities – for short- or long-term visitor use)**

4. **Conference and meeting facilities**

5. **An existing education / outreach program that could be expanded to a major demonstration endeavor for NEON (attendance of over 250,000 individuals year^{-1} in the 3 y prior to University of Arizona acquisition; > 1 M year^{-1} when including partner Arizona-Sonora Desert Museum).**

The University of Arizona has a demonstrated history in leading complex science programs.

Comments & Notes:

PavaoZuckerman_NEON_HQ
Biosphere II as headquarters. Provides money for renovation. New facility would be named Open Earth Center. Good opportunity for outreach and education with the amount of visitors they have. Some housing on site. University of Arizona partnership. Great facility to have a research center. A good place to have the headquarters. Tucson, Arizona. It is very expensive to keep it. Cost would be so high to maintain.
Comments: They will not be maintaining a different environment from the outside to the inside. So the cost would go down. It is a great place to have HQ in a place that can be coupled with education. The history of ecology in this part of the country is rich. The cost of the building and the building is aging and will need maintained.

They have done a good job outlining the needs of a facility. This would be a good RFI to use as template.

Technical Specifications.

III.1. Describe the ownership status of the site (e.g., private, institutionally owned, leased, trust).

Private

III.2. State the entity who currently owns the property.

Owner of Biosphere 2: Presently is Decisions Investments Corp. which is in negotiations to sell the property to a third party that is willing to donate the facility to the University of Arizona.

III.3. Describe any restrictions on the use of or access to the site.

No restrictions have been stipulated

III.4. List any existing easements on the site.

The site presently have Legal access easement as well easement for utilities, Power, Natural Gas, Communication and Water these easement have been supplied to the U of A

III.5. Does the proposed site have long term (30+ years) accessibility and availability? State any known restrictions in these regards. Also, describe any anticipated significant land use changes in adjacent areas, e.g., industrial developments, resorts and recreational development.

Currently the Biosphere 2 Resides with in a Planned Area Development (PAD) the Surrounding 1600 +/- acres are planned as Housing, and Commercial zones. Land to the West of the site is a lease (SLUP) presently help by Decisions Investments Corp.

III.6. State any restrictions on the feasibility of running experiments on the site.

The state and university have no restrictions on this site

III.7. Has an environmental assessment been performed for the proposed site? If yes, when was it performed and what was the outcome of the study?

A Phase 1 Environmental Site Assessment was conducted by Brown and Caldwell November 24, 2004. No recognized environmental hazards were identified.

III.8. Are there any site characteristics that are environmentally sensitive (e.g., endangered species, known or suspected archaeological issues, proximity to or locations within a historic area)?

There are no environmentally sensitive lands or archaeological issues on site.

III.9. The airspace over sites may have restrictions due to military areas, homeland security issues, and common airways and terminal control areas. If a NEON site is located directly in the approach corridor for a major airport, then it may be very difficult or even impossible to conduct scientific aerial campaigns over the site in the desired manner. Describe any such known issues. (See “Remote Sensing Considerations”)

There is no flight pattern nor is the any flight restriction over this site

Gradient Site Evaluations

Biogeochemistry

Russ Monson (scribe)
Whendee Silver
Antonio Nobre
Kevin Tu

Criteria for choosing cores sites based on biogeochemistry

The criteria chosen for biogeochemical consideration were defined along three primary axes: (1) the degree to which the proposed site represents the entire domain on the basis of climate, soil type, vegetation type and "environmental performance" index, (2) the ability of the proposed site to connect to existing LTER sites (which we assumed to be important for providing a legacy of biogeochemical research and access to future biogeochemical studies of a large variety, and (3) the ability of the proposed site to connect to existing AmeriFlux sites (which we assumed to be important for providing a legacy of surface-atmosphere exchange and controls over regional biogeochemistry). Thus, our criteria were defined along axes of domain representation and potential for biogeochemical understanding.

On the basis of these criteria, we chose:
Domain 1 – Northeast_Foster
Domain 2 – MidAtlantic_ Dallmeier
Domain 3 - Southeast_ Hayes
Domain 4 – AtlanticNeoTropical_VanBloem
Domain 5 – GreatLakes_Belovsky
Domain 6 – PrariePeninsula_Blair
Domain 7 – ApplacianCumberlandPlateau_Mulholland
Domain 8 – OzarksComplex_Ward
Domain 9 – NorthernPlains_Lin
Domain 10 – CentralPlains_Kelly
Domain 11 - SouthernPlains_Wallace
Domain 12 – NorthernRockies_Marshall
Domain 13 – SouthernRockies_Ackerman
Domain 14 – DesertSouthwest_Peters
Domain 15 – GreatBasin_Ehleringer
Domain 16 – PacificNorthwest_Bible
Domain 17 – PacificSouthwest_Hamilton
Domain 18 – Tundra_BrettHarte
Domain 19 – Taiga_Jones
Domain 20 – PacificTropical_Sack

Notes: We considered Ward as part of Domain 8, even though the map line excludes it. We chose the Domain 20 (Hawaiian site) on the basis of its forest cover and substrate age, both of which make it uniquely comparable to the Puerto Rico sites for comparative purposes. We chose the Domain 18 (Toolik Lake) site because of its unique ability to include the long LTER record in the database. In a couple of cases, where choices among competing Core Site proposals were narrow, we consulted vegetation type and potential to add uniqueness to the network (Hawaii, Ozarks Complex, Southern Plains). We noted the unique closely aligned elevational gradient provided by the Domain 10 (Central Plains) and Domain 13 (Niwot Ridge) sites and ability to represent a unique biogeochemical transition in the network.

Criteria for Choosing Continental Gradient Sites

We focused on two important gradient interactions with continental biogeochemistry: (1) the climate-biogeochemistry interaction given the knowledge that the climate is changing over time, and (2) the trend toward high N deposition and the knowledge that this trend is likely to strengthen in time. Using these criteria, we designed two continental gradient networks, one that progresses north-south through a common biome type (grassland), allowing us to keep biome type nearly constant, while studying climate-biogeochemistry interactions over time, and one that progresses west-east passing through a gradient of increasing N deposition. Where possible, we placed gradient sites on existing Core Sites (chosen according to above) or existing AmeriFlux sites. Thus, we came up with the following suggestions:

N Deposition Gradient: Howland AmeriFlux site, Domain 1 Core Site (see above), Bartlett AmeriFlux site, Morgan Monroe AmeriFlux site, Bondville AmeriFlux site, Domain 7 Core Site (see above), Domain 4 Core Site (see above), Domain 13 Core Site (see above), Domain 10 Core Site (see above), Domain 17 Core Site (see above), Domain 15 Core Site (see above), Blodgett Forest AmeriFlux site, Las Vegas FACE site

North-South Climate-Biogeochemistry Gradient: Freeman Ranch AmeriFlux Site, Domain 10 Core Site (see above), Domain 6 Core Site (see above), Shindler AmeriFlux site (Oklahoma), Domain 11 Core Site (see above), a northern grasslands gradient site (Montana), Luquillo LTER Site (Puerto Rico)

Notes: We tried to locate all gradient sites at existing AmeriFlux sites where possible because we recognized the advantage of using climate and CO2/H2O flux data as supporting data streams. We included the Puerto Rico site to pick up a unique interaction between N deposition and a tropical ecosystem.

Criteria for Choosing Within-Domain Gradient Sites

As biogeochemists, we recognized two fundamental gradients that are important to capture in the within-domain placement of FIU towers: (1) elevational gradients to pick up the climate-biogeochemistry interaction, and (2) urban-to-wildland gradients to pickup impacts of pollution (N and O3 deposition) and land-use change on biogeochemical cycles. The elevational gradient will provide a time-for-space substitution that allows for mechanistic understanding of

fundamental climate-biogeochemistry interactions, and potential extrapolation to, and model development of, long-term climate change impacts. We note that much of the spirit of this type of gradient design is captured in the Ehleringer Gradient Site RFI.

Infectious Diseases core and sentinel sites

We have developed and focused our selection criteria with respect to infectious diseases based on the FSU designations of rodents and mosquitoes as hosts/vectors, and therefore are prime considerations for vector-borne infectious disease measurements. As such, sites were selected primarily to address these taxa:

1. Presence of habitats on sites that would likely include (or were confirmed to support) these vector species and their pathogens.
2. Locations of sites along major coastlines and/or river corridors, having potential high diversity and abundances of mosquitoes.
3. Locations of sites in habitats with known high densities of Peromyscine rodents.
4. Locations of sites along continental gradients, particularly with respect to north-south transects that will reflect range expansions that will likely occur with continental-scale climate warming.
5. Locations of sites along east-west continental gradients, that could assay east-west movements of introduced pathogens (e.g., West Nile Virus expansion 2000-2004)
6. Locations of sites along bird flyways to sample for avian-borne pathogens.

Gradients Identified:

Gradient 1. Atlantic East Coast – Puerto Rico to Florida to New England: addresses mosquito vectors in coastal areas (e.g., dengue, malaria, WNV, encephalitis), and rodent hosts with their vectors (e.g., Lyme, hantavirus).

Gradient 2. Midwest – Gulf of Mexico to Canadian Border: addresses both mosquitoes and rodents, with generally forested habitats at eastern edge and grassland habitats on western edge.

Gradient 3. Rio Grande to Northern Rocky Mountains: addresses mosquitoes and rodents. Follows Rio Grande valley from Mexico northward, then bifurcates northward to follow western Great Plains (grasslands) and Front Range of Rocky Mountains (forests) in parallel.

Gradient 4. Desert Southwest through Great Basin to Northern Rockies – addresses mostly rodents; some possibilities for mosquito-borne diseases, depending on local site conditions.

Gradient 5. Pacific West Coast – LA/San Diego area north to Pacific Northwest. Addresses both mosquitoes and rodents; can also pick up introductions of diseases to west coast ports.

Gradient 6. East-West gradient across the southern tier of sites, from Gulf of Mexico to Pacific.

Gradient 7. East-West gradient across Central USA from Atlantic to Pacific.

Gradient 8. East-West gradient from New England to Pacific Northwest.

Gradient 9. Alaska core sites form a north-south gradient.

Gradient 10. Hawaii gradients are proposed within each of the two islands.

These gradients were allocated to capture the spread of infectious diseases in the continental US from both coastal and interior sites. These followed corridors along which pathogens are expected to spread through host/vector populations.

The relocatable platforms can be deployed at the front of expanding ranges of pathogens for study of rapid dispersal and "infection fronts" and therefore site locations need to be responsive.

The mobile platforms of NEON will be critical to fill in gradients and transects among core, continental and relocatable sites.

Invasive Species

20 core and 10 sentinel sites

The criteria for Invasive Cores sites included the following criteria related to proximity of sites to:

- Major ports-maritime and airports
- Highways and other major transportation hubs
- Railroads
- Rivers
- Major Land Entry Points
- Urban centers

GIS was used to measure distances from each source to each potential core site and the closest ones to the most sources were considered highest priority based on the probabilities of dispersal from these entry points and linear sources. For example, the number of roads, airports and seaports associated with a single site in California or Virginia would need to consider ALL parameters and consider weighting of priorities. Interior sites would have different weighting due to lack of maritime ports.

Thiessen polygons were used to find mid-locations among the Core site to establish possible selections of Sentinel sites (also known as "gradient sites" among some groups).

The criteria for continental sentry sites:

- To add more major ports and centers of transportation, we inserted 8 sites to represent 6 north-south gradients and 1 site to represent east-west gradients where invasive species were expected to disperse.
- The anticipated increases in mean annual temperatures across North America were expected to lead to a northward shift in ecosystem distribution and therefore invasive species will also move northward.
- Some species are also expected to disperse east-west along river corridors and along major highways.
- Given the large number of invasive species and high biodiversity in Hawaii we added I additional site to represent both the Big Island of Hawaii and Oahua as a core sites and sentinel site.
- The choices for these locations will be useful in testing major hypotheses regarding the possible relationships among different locations relative to vulnerability to invasion by new species relative to the number and types of native species. Major controversies can be resolved relative to defining parameters for predicting invasions for different types of species and their rates of dispersal.

These gradients were allocated to capture the spread of invasive species in the continental US from additional coastal and interior sites. These followed corridors along which invasive species are expected to disperse.

The relocatable platforms are likely to be deployed primarily at the front of expanding ranges of invasive species for study of rapid dispersal and detailed study of "invasion fronts." Therefore site locations need to be responsive and rapidly positioned.

Land use

Group Report on Choosing Core Sites and Gradient Sites:

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1. The Question: How do changes in landuse type and intensity in space and time alter ecological responses?

(Long discussion of what land use change is most important. We decided that this varies across the continent).

2. The RFI's that address landuse are listed in spreadsheet from group yesterday.

3. Criteria for evaluation:
    a. Least disturbed core site area within a domain;
    b. AND with a strong opportunity for evaluating land use intensity gradient nearby (the representativeness analysis helped us here…actually if it were LESS representative of nearby lands, this was good);
    c. as well as for understanding past landuse history. (For the east, you can do it anywhere because of "witness trees", from the survey record).

4. Domain suggestions BASED on those three criteria:
    a. Domain 1 Northeast: We recommend the Northeast Foster (Harvard Forest) due to:
        i. Its proximity to the Boston proposed landuse urban gradient (Peters and Grimm)
        ii. Its well-documented legacy of landuse history including prior cultivation and forest recovery dynamics
    b. Domain 2: MidAtlantic
        i. We choose the MidAtlantic Hayden because Bruce said to.
    c. Domain 5: Great Lakes. We chose Nadelhoffer because:
        i. It has been a true wildland for over 100 years,
        ii. There is lots of variation in immediate area with respect to landuse, so there are opportunities for studying landuse gradients.
        iii. We don't know enough…need a more careful consideration. This was not a high confidence decision.
    d. Domain 6: Prairie Peninsula:
        i. Konza is fine but we need to acknowledge that it is not so great for evaluating landuse. It is nonrepresentative of the region (but meets our criterion of being undisturbed) but it is not similar to cultivated areas in the region because of its soils…may not provide a great endpoint for a landuse gradient because more than one thing is changing (in particular, cultivated lands are on different soils).
    e. Domain 8: Ozarks Complex. We like both sites because they appear to be highly representative of the local wildland areas, and are both within close range of cultivated and urban areas for opportunities for landuse gradients.
    f. Domain 9: We can only find one proposal…are there two to choose between?
    g. Domain 11: These two sites are very similar with respect to the representativeness analysis. Both have major cities nearby. No decision.
    h. Domain 12: Northern Rockies:
        i. Both Yellowstone (Hansen) and Teton (Chong) have undisturbed wildlands as well as adjacency to some very intensive landuse management gradients, including energy extraction, suburbanization, exurbanization, agriculture/ranching.
    i. Domain 13: Southern Rockies/Colorado Plateau:
        i. We choose Beaver Creek because although it is a natural site, it is adjacent to multiple landuse types and has less confounding between elevation and

landuse. This is a hard one because this domain is so variable within its extent.

j. Domain 14: This is a difficult choice from the landuse perspective. All are near cities, all have grazing. None focused on urbanization, but could be considered. No decision.
k. Domain 16: Pacific Northwest:
    i. We choose Wind River because (Bible) it has a wider variation in forest landuse practices with undisturbed sites for 400 years and active forestry going on,
    ii. it's closer to the Portland urbanization, and potential impacts to the Columbia River from landuse.
    iii. BUT at Andrews they are also doing a lot of forestry landuse manipulations. We like it too.
l. Domain 18: Tundra. Landuse is not a basis for doing work in the tundra, with respect to these two sites. The land is not much used! No decision.
m. Domain 20: Pacific Tropical:
    i. A multitude of landuse gradient opportunities for either site. We need a field trip to decide….
    ii. A transect across the islands would be great.

PHASE II The Continental Gradient Decision

The current design is not strong with respect to its capability to analyze the Grand Challenge questions associated with landuse. The moveable towers near core wildland sites will not provide the type of information needed. ```

Some of the most important ecological changes through time will be responses to human impacts…and there are no core sites located in intensively managed lands. Intensively managed lands should be featured as core sites.

Further, many of the consequences of landuse are continental in scope and result in major river changes that influence estuaries and oceans. Aquatic sensor systems are potentially very important as continental gradients representing landuse intensity at either regional or continental scales.

We should add sites to the wildland core sites that are NOT wildlands, but are representative of the high intensity landuse domain, such as:

A. Intensively cultivated areas in the Prairie Peninsula
B. Highly urban centers …southern California, chaparral foothills (Pacific Southwest)
C. Pine plantations/agriculture in the Southeastern: Fort Benning GA
D. Irrigated cotton in the southcentral part of the country
E. Energy development everywhere and of every type
    a. Biomass,
    b. Wind
    c. Coalbed methane in the northern Rockies/Northern plains
    d. Coal mining

F. Exurban or diffuse development in major parts of the country
G. Afforestration in previously cultivated or logged areas
H. Conservation Reserve Program lands

We are not sure that the towers are as important for the landuse questions as the aquatic measurements; in any case, the aquatic measurements are REALLY important. They integrate across broad areas.

Phase *III*. Discussion of gradients in landuse

The use of the 5 moveable towers to capture gradients in landuse management is a good idea. We found some examples in the Core RFI's that were great. For instance, the gradient represented in the Yellowstone Hansen proposal (page 8) showed a gradient from Bozeman to Yellowstone National Park, that includes wildland, agricultural, exurban development, and urban lands. The relocatable towers will likely capture transitions in landuse over the period during which they are deployed.

The moveable towers or other measurements present some issues with respect to a) confounding space and time associated with landuse change, and b) not representing a permanent realm of inference. We really need fundamental sentinel units for landuse gradients to capture the effects of landuse change. Our group feels strongly that the fundamental sentinel measurements are considerably more important (albeit less sexy), and likely more cost-effective than the tower measurements.

Another RFI with possibilities for landuse gradients is the Jones Small Watershed RFI. There are multiple opportunities for landuse gradients.

The Peters 3C RFI landuse gradients are good examples with ideas about spatial deployment. The ones that include intermediate landuse between urban and rural are especially good examples (e.g. the northeast gradient associated with Harvard Forest), the Mid-Atlantic gradient (Baltimore). In addition, landuse gradients must be located where pressures are strong because of human population increases (for instance in the Upper Mississipi Basin). Gradients associated with landuse should include more than 3 points, truly encompassing the variability that occurs. The focus in this RFI was on urban-suburban, but there are other very important landuse gradients, including exurban growth not associated with the suburban fringe, logging, mining and energy extraction/production, and cultivation management, that must be included.

Finally, restoration efforts associated with wetlands recovery, mineland recovery, and other similar examples represent good opportunities to study as well as demonstrate the results of restoration efforts to the public.

We discussed the gradients in the Peters proposal, but would like to note that we did not have the time to really do a detailed analysis. Here are some notes:

Domain 1: We like the suggestions but encourage the inclusion of an intermediate site.

Domain 2: look like great sites. Includes an LTER site, which is a strength as well as the Jones small watershed consortium.
Domain 3: missing in the Peters proposal. But there should almost certainly be a landuse gradient, since this is an area experiencing strong population pressure and landuse change. Wow! It includes Louisiana, S.Florida, the Everglades!
Domain 4: The Puerto Rico gradient is excellent, including agricultural and urban as well as native forest.
Domain 5: Good thinking to include agriculture as well as urban development, as well as two LTER sites. However, the spread in the landuse gradient is confounded with climate and soils, which is a concern.
Domain 6: No agriculture represented in this gradient; major problem. The tile drainage and underground issues are a major component of N losses,eutrophication and hypoxia. Integration with the Jones small watershed proposal would be a help here.
Domain 7: including urban and suburban fringe is good, but needs attention to exurban development. What about mining affected areas?
Domains 8 not represented. Attention needed here; much population growth, part of Mississippi drainage system, much recent agriculture and some tree planting associated with the Conservation Reserve Program. Rapid landuse change merits implementation of a gradient. What about the Ivory Billed woodpecker???
Domain 9: Not represented in Peters proposal, but Powder River Basin being rapidly influenced by coal-bed methane and coal mining.
Domain 10: Insufficient attention to the matrix of landuse types in the area. Agricultural sites would be major addition, including dryland and irrigated sites, as well as the urban and suburban sites. Sites are available; need to be included.
Domain 11: Landuse gradient a bit too focused on urban; needs attention to rangelands. Spread over so much space that climate will confound.
Domain 12: (see above about Hansen Yellowstone gradient)
Domain 13: We feel that this one crosses domain boundaries, and the Front Range gradient is important but perhaps can be taken care of in Domain 10. But there should be a landuse gradient set up with the other site we recommended in this Domain.
Domain 14: Desert Southwest. A landuse gradient in the Desert Southwest is critical because the area is so dynamic.
Domain 15: This domain includes the fastest growing city in the nation, and the largest extent of rangelands, much mineral extraction, with a major invasive species.
Domain 16: Interesting area for landuse gradients, including logging and urban-suburban gradients.
Domain 17: No gradient recommended in the Peters proposal. But this area of California has some amazing gradients in landuse and should be represented in NEON.
Domains 18 and 19: Urban gradients are not the main landuse issues in Alaska. Rather, mining, energy use, fires, insect outbreaks and logging are important sources of heterogeneity that need to be considered with a gradient approach.
Domain 20: There are strong gradients in landuse in Hawaii. This RFI focuses only on urban gradient, but we think it's important to consider the agricultural gradients as well.

Land use addendum

Major land use types were not adequately covered in the RFI responses, such as agriculture, energy production areas, rural exurban development, reforestation and areas returning to prairie. The domain tool box should be used to place permanent towers in some of these land use types.

To best answer land use questions, it is desirable to sample the major land use types and intensities that characterize each domain. This could involve 5-10 measurement sites around the core wildland site. In some domains, adequately sampling land use gradients will reduce the ability to sample completely the climate gradient. Hence deliberate decisions on the tradeoffs different deployment strategies need be made for each domain.

Parts of the regional gradients should be across private lands, for some of the key land uses are on private lands (e.g., agriculture, private forestry, exurban development).

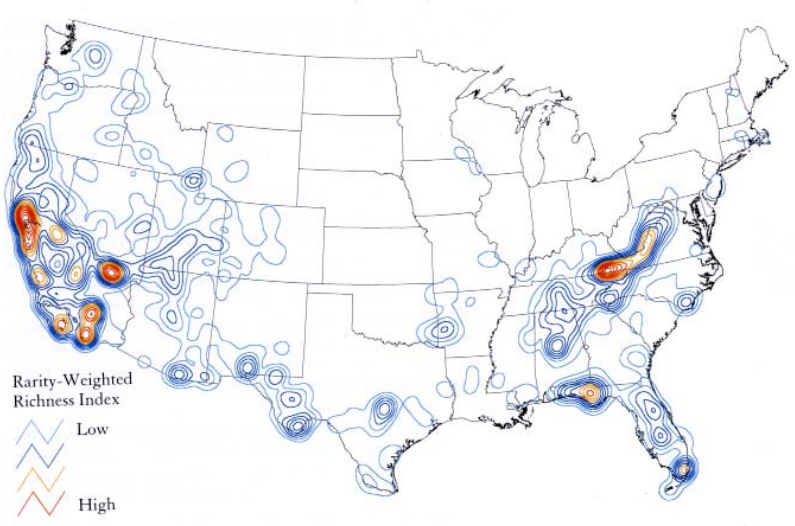
A NEON challenge is to scale from site measurements to "wall to wall" regional and continental forecasting. This can best be achieved by careful integration of observations, experiments, and remote sensing to parameterize simulation models and to allow projection and forecasting across regions and the continent. Hence the location of the core sites and the relocatable sites is critical in ensuring measurement at appropriate points along key gradients.

Spatial statistical expertise should be sought for drawing maximum inference from the relocatable tower approach to adequately deal with some measurements being confounded in space and time.

It would be useful to have "small towers" that complement big ones that would allow new instruments with the ability to address issues of specific concern to land use. Such instruments such as electronic invertebrate traps would allow many places across a landscape to be sampled across many points in time, and reduce the space and time problem mentioned above.

Biodiversity

The lack of locating maps demonstrating information on species richness, endemism, and rarity limited our ability to judge the biodiversity around the proposed core and other NEON tower locations. The map below represents the type of information that would be useful, but the data are not precise enough to currently determine core site evaluation in many of the domains.



Map from the TNC book "Precious Heritage"

The data set used to make this map might allow greater detail that might show the biodiversity concentrations where potential core (or other) NEON sites are proposed. However, this data was not available at the time of the workshop. Also, Alaska is missing (a limited number of native species and endemic organisms in comparison to the lower 48 states) and Hawaii is missing (a limited number of native species, but an extremely high endemic number of organisms in comparison to the continental domains).

For many taxa (including higher plants and vertebrates) there exist current distribution information that would be useful to capture the number of native species and endemism near each of the proposed NEON sites – however, this information was also not available during the workshop. Many of these single taxa maps might be used to represent the whole biodiversity inventory and thus used to simplify the biodiversity estimation near the proposed sites – but one needs to take care that the taxa chosen truly represents as close as possible the whole biodiversity of organisms at the site Single taxa maps also have the advantage of communication because taxa like native fish, woody plants, mammals or birds, will be more easily recognized by the general public and decision makers than many of the invertebrate taxa.

This said, we suggest the following criteria for selecting candidate core sites and continental gradient sites:

1. Site selection should first attempt to maximize species richness within a particular region; this suggestion is based on the premise that climate change, land use change, and invasive species impacts might be more discernable, quantifiable, and potentially of greater magnitude in areas of high biodiversity.

2. Site selection should also emphasize the potential for changes in biodiversity over the next 30 years (NEON lifetime); i.e., sites with heterogeneous habitat types, ecotones, vegetation associations that have demonstrated direction change, and sites subject to land-use disturbances within the measurement area. These sites will likely exhibit climate-induced changes more than sites that are relatively stable.

3. Site selection may also want to include maximum species richness of endemic or threatened/endangered species, in view of the importance of these species to the general public and land managers.

4. Site selection should attempt to integrate the above characteristics in both terrestrial and aquatic ecosystems, where possible.

While a map has not been produced, and sites not selected, by the biodiversity group, we hope that these criteria could be successfully used to rank those sites that would be most useful in tracking climate-induced and land-use-induced changes in biodiversity.