

NEON meeting notes. 10/28-29/2006

List of attendees: Cort Anderson (U. Idaho), Barb Bond (OSU), Dave Brashears, Todd Crowl (COREO; IRON), Jim Ehleringer (U. Utah), Dave Evans (WSU), Katy Kavanagh (U. Idaho), Tim Link (U. Idaho), Michael Loik (UC Santa Cruz), John Marshall (U. Idaho), Art McKee (Flathead Lake), Chuck Peterson (Idaho State), Jim Richards (UC Davis), Dave Roberts (Montana State), Alistair Smith (U. Idaho), Dave Williams (U. Wyoming) [and students from U. Idaho: Aki Koyama, Rob Pangle, Elizabeth Powers and Jessica Schedlbauer] FOR CONTACT INFO SEE APPENDIX A.

These minutes represent two days. Day 1 was a west-wide domain meeting with participants from CALEON, PNWREO, SWEON, NORMEO and IRON and the focus was on multi-domain RFI questions. Day 2 was primarily NORMEO participants and the focus was on the Core site RFI. Both meetings were held at the Priest River Experimental Forest in Priest River, Idaho.

I. West-wide domain meeting 10/28/06

Meeting starts at 10:15am-.

Individual presentation 10-15minutes in length.

Michael Loik: Precipnet

- Address issues of precip change
- Warming and CO2 projects
- Integrate existing studies on altered timing and magnitude of ran and snowfall
- Participant experimental sites centered in southwest US
- Past activities: national center for ecological analysis and synthesis(conceptual framework), meetings (PULSE, etc)
- What would warming of 13 degree F mean for your water supply?- snow to rain shifts
- Methods- use of 50 yr old snow fences along a 50 km transect to cause snow depth forcing-equilibrium snow drift
- 5 by 100m study plots, experimentally changing snow depth
- significant differences in soil moisture and temp, melt timing, plant phenology, etc
- <http://www.konza.ksu.edu/ramps>
- clouding and manipulation issues- both snow and rain?, same forcing everywhere? Use site-specific GCM scenarios? Include rain on snow events?
- Measure: microclimate (BioMesoNet towers), soils (soil moisture, respiration, N availability), plant and ecosystem responses (leaf level photosynthesis and midday leaf water potential, leaf level chlorophyll fluorescence, spectral reflectance) productivity and plant species composition (ANPP, litter decomposition, plant and soil C and N)
- Questions: Can you reduce snow pack levels? Select sites based on how much you want to reduce snow pack
- Questions: What about using living snow fences? That is a possibility, need to wait for them to grow up

Todd Crowl:

- Trying to figure out role in COREO
- R5 mid January
- NSF appointed decision team will take info from RFI responses and turn into full blown NEON proposal
- Multiple teams to look at different sites
- Need cover document with statements of consensus
- Facilitate conductivity- find meetings with groups of people working across different scale, listening and taking notes
- Las Cruces meeting is 3rd and final meeting,
- IRON meeting in Reno- site selection

Dave Breshears: Connectivity

- Connectivity framework for community RFI response
- Elevator question
- What are the expected consequences of an increasing...
- Basic premise: the climate system involves process at multiple finer scales (ecosystem dynamics across scales)
- Climate dynamic
- Think about other gradients, ex land use gradients
- Continental scale patterns and dynamics, drivers of change
- Hypothesis: interactions between climate and land use acting through connectivity in water, wind, disturbances, people, animals,
- Hypothesis: some resources are becoming more concentrated with time (Nitrogen) and others are becoming more distributed
- Goal: maximize participation in NEON , partner with existing and emerging observations
- Encourage development of domain and multi-domain question that build on this connectivity framework: drought, snowmelt, fire X warming, etc
- For each multi domain question need: dominant broad and fine scale transport vector
- Meeting will focus: part 1 RFI, develop responses to RFI
- How processes in a domain are connected to other domains
- Question: How to measure connectivity with towers?
- NEON problem: lack of making hard decisions
- What about key biological figures at meetings? Fracturing?
- Need to reach out to AGU

Jim Richards: Caleon update

- Biodiversity hotspots and population (Myers 2000, Cincotta 2000)
- How changes in climate are going to affect biodiversity
- Endemic plant species in CA
- Hotspots of change, San Lucia Mtns, species turnover due to migrations, Sierra Nevada migrations as well
- Looking at shifts in species, major differences in biogeochemical effects of humans (anthropogenic effects on N deposition on species)

- Predicted changes in snow melt- loss of spring snow pack in sierra Nevada, predicted losses of half h2O- effects on agriculture
- Onion Creek Exp Forest- N Fork American River headwaters research and conservation agreement, east and west side of Sierra Crest
- One of few areas that has flow year round
- Onion Creek – mixed conifer forest, 7000ft elevation, on boundary of precip, 85-90% precip is snow in winter months

Jim Ehleringer: urban centers/Iron update

- IRON-NEON- a launch pad for regional to national ecological studies
- Climate change, snow pack and water, invasives, infectious disease, urbanization and water, closed basin (GSL as spatial integrator)
- Great Basin- basin and range, where is the site?
- IRON site- desert/ sagebrush ecosystem, can't assess climate change, snow pack, can assess invasives (cheat grass)
- Marry biodiversity with structure function interests
- Site Unuqui- sage steppe, 70 miles from Salt Lake
- Lake and reservoir cores provide historical archive
- Urbanization, water transport issues
- Ecosystem change in IRON range- urbanization
- Urban ecology- how ecosystems function when dominated by humans
- 6 towers in Salt Lake City- (rate of CO2 increase 2 times keeling curve?)
- other considerations important to managing sites: proximity to major universities, federal and state agencies, airports, talented technical help, field site and labs for technicians/repairs
- education- outreach possibilities: the Leonardo, Natural history museum, etc
- IRON transect- within and across domain, water, land use change, urbanization
- Most CO2 comes from home heating- urbanization intensifies resource use
- Infrastructure and partnership is essential to success

Barb Bond: PNW update

- Core Sites- a combination of Wind River and Andrews
- Most climatically diverse region
- Observational research- how will changes in climate land use and human water use affect water cycles and water resources in the PNW? How will these altered water cycles affect other ecological functions and states? How will altered ecological functions and states affect ecosystem services? How will these altered ecosystem services affect human attitudes behaviors? How will altered human attitudes and behaviors affect changes in climate land use...
- Complex resource management choices, urban and suburban expansion, unidirectional effect of land use change and climate change
- Impacts on snow pack, stream flow, etc
- Questions posed by PNW critical zone observatory: what are the variations in snow pack with elevation
- How do variation in snow pack and changes in snowmelt Influence Mountain and lowland ecosystems? What are water availability, water quality, and ecosystem health implications of

changes in the spatial and temporal distribution of snowmelt runoff? How do climate, weathering processes, vegetation, geology, and hydrology interact to produce the observed landscape? What are the implications for geologic hazards?

- Deployment: we're not there yet, discussions have focused on 3 or more E-W transects arrayed on a latitudinal gradient, focus on valley and upriver drainage
- Got mountains? Don't ignore mountainous terrain, tell us about snow, use mountains as integrator
- Bond's axiom: any forested site in the mountainous western US that is flexible with current technology is not representative of the region, flat flux measurements not representative of region
- NEON is a time and place to figure out how to measure fluxes in mountainous terrain, develop new technology
- Flux tower is 1 dimensional flux upwards, mountains are 3D, 4D with time dimension
- Current models of land surface response to climatic drivers assume that landforms act as linear sums of the component pieces
- In complex steeply sloping topography there are many reasons to believe that ecological function is dominated by nonlinear feedbacks...
- Topographic heterogeneity affect ecosystem processes
- Study site: soil and vegetation plots, transects small basins heavily instrumented, large basins with less instruments
- Question: should the location of future efforts be incorporated into our thinking?
- Issue: eddy flux in complex terrain (need to account for advection), PEP report will take wrong technologies into account, but the more changes that need to be made the more difficult

Dave Evans: INEWS

- Isotope Network for early warning signals
- INEWS- isotopes as sentinels of change
- NEON offers potential for 3D images, seasonal, latitude variation
- Changes in isotope ratios over time act as canary in coal mine- indicator for environmental change
- Ecosystem inputs: BioMesoNet tower- wet and dry N deposition
- Hydrology- tracking 2H and 18O at NEON sites- a sentinel indicator of hydro geologic response to global change-
- Sources of atmospheric deposition- European network sites similar to NEON- ratio of oxidized NO_x , use isotopic signature to track sources of industrial pollution
- Tracking isotopes at NEON fixed sites: a sentinel of hydro ecologic and biogeochemical response to global change: change in source inputs, changes in buffering capacity, shifts in biogeochemical processes, changes in structure and function, integration of disturbance effects
- There is no monitoring of isotopic composition of precipitation, nothing going on with atmospheric deposition
- Potential to link with GIS- act as very fast ROI, deliver to congressman

Dave Williams: BASIN II & NEON

- Biogeosphere atmosphere stable isotope network phase 2 (BASIN II)

- Foster common approaches for isotope measurements meta analyses on how biogeochemical cycles have changed
- Provide opportunities for training
- Coordinate linkage to NEON
- Merge isotope data with modeling and remote sensing
- Further develop web based databases
- BASIN can assist with NEON related isotope measurements by: ensuring reliability of measurements, training and education, develop better interlab standards, develop standardized reference materials, organize inter lab comparisons
- First national scale observations

John Marshall:

- George Mount FTIR technique- leave room for new technology as it comes
- Snow packs are declining- places are most vulnerable if near 0C all year, once hit 1C melts, maritime snow pack declining more heavily than continental
- Cross over between biophysical and biological processes (bufo boreas example)
- Larix occidentalis species distribution with temp and moisture- predicted to disappear (international journal of plant science, Rehfeldt et al.)- what about increased fire hazard and new disease vectors
- Look for canaries, more animal representation

Katy Kavanagh: key points in RFI

- ISEP and RFI summary
- NEON is designed to address scientific questions focused on the interactions of ecosys...
- Instrumentation 5 packages: fundamental instrument unit, fundamental sentinel unit, mobile relocatable system, airborne observation platform, land use package
- RFI requirements: found in NEON handout
- Experimental long-term research: water use and N deposition by humans interact and affect aquatic and terrestrial ecosystems, how do alter...
- Integrative research projects: understanding and forecasting wildfires, understanding and forecasting species invasions, understanding and forecasting fluxes of C and water,
- Conclusion: questions that link external drivers and internal responses of ecosystems...

Questions:

- Stick with more general questions, elastic, key pithy question
- Time series of water balance and vapor pressure
- How does increasing monsoon strength and early snowmelt influence ecosystem service/functions
- Seasonality and nature in which precip arrives as driver as ecosystem processes: monsoons in SE, decreased snow pack PNW
- How will changes in climate, land use, and human...
- How will changes in timing and delivery in water in the US affect ecosystem processes?
- Timing of use? Snow pack as storage vs. reservoir
- How are the delivery, timing, and state of water inputs and use changing in the US effect ecosystem processes?

- How do changes in the seasonality and phase of precipitation and water use impact the provision of ecosystems in the western US?
- Climate change is reducing snow pack and increasing monsoonal strength in the western US. What are the impacts on biogeochemistry and community composition?
- Who are we writing questions for? How do we dummy it down to stress the importance of declining snow pack and effects on water resources not ski access

Modes of connectivity:

- Wind/atmosphere, stream flow, land surface-atmosphere feedbacks, invasive species spreading with roads and trains (linear connectivity) and planes/ships
- Land use- urban expansion, urban linkages, ex-urbanize
- Gradient components- urban, core, water (montane gradient/complex topography)
- Climate change- temp, precipitation (IPCC projections) increasingly hot temps in west coupled with decreased precip
- Gradient from urban to wild land core facility

Invasive Species:

- Shifts in species, gradients in invasiveness and invisibility
- Dichotomy between flux tower and biotic elements- develop ability to determine consequences in large scale changes, learn what changes are in environment, land use, transportation, disturbance, changes in resource availability, etc
- Theme: changes in species composition and their feedback
- Change nutrient cycling, nutrient store, probability of wildfire, disappearance of economically significant species, etc
- Pose invasives as hypothesis, certain sites more vulnerable to invasion
- Hypothesis: more heterogeneous the environment, the less likely for whole sale large species invasions, plains areas are more vulnerable to invasion
- What about invasive diseases, don't just focus on cheat grass, unique western flavor
- How observable is the reduction in native species? How do you monitor invasives coupled with loss of natives? Possibility of site scientist, team

Connectivity

- Bluing of the west- populations get so large that they start radiating and take with them political values, change landscape because of the values they bring with them- land use ethics- western connectivity
- What is more important- land use policies or are individual research interests?
- How can one land region change that it significant enough to have an influence on neighboring domains? Come up with design, address national scale changes
- Paper: US tapwater water isotope ratios relative to precipitation indicating origi-n

- Central valley CA pop is predicted to grow, water issues, efflux of people that will effect the rest of the west, move from Midwest to CA and then radiate throughout the west
- What do people transport with them? Water issues, trace gas pollutants, we are not exporting much nitrogen, no connectivity,
- the issue isn't material, how different land use plans effect ecological systems across the US
- integrated multidisciplinary ecological studies coupled with socioecological studies
- NEON has to be conceptual and question oriented
- Massive abandonment of urban studies, congress will run if we propose to study humans
- If you want to study change, how can you not include humans?
- Is there a group of social scientists putting a proposal together? Utah
- Climate change is a major integrator of humans, causes humans to move, cannot separate, we are drivers of the current system
- Land use change that goes back to connectivity and water- management of forests, changing the nature of vegetation cover, change albedo and evapotranspiration which would change water vapor leading to stream level changes- water scale surface changes- broaden to energy exchange include latent heat, may be because of land use mgt or urbanization
- Human extraction with water and moving water tables- using water that is irreplaceable in our lifespan
- Details of question are not as important as picking a framework for everyone in the west to work under- identify framework, can't be fancy

Following the presentations we spent a couple of hours talking about potential common themes for western domains. The following is a hit and miss summary of some of the key topics

1. How do changes in seasonality, delivery and state of water inputs change ecosystem services in the western US? Climate change and land use are reducing snowpack and increasing monsoonal strength in the western US.
2. Key gradients to consider: moisture; urban->wild, topographic **Potential common approach for western domains: each domain has a wildland to urban gradient with a core site either at the "supply" end of the gradient or somewhere along that gradient. Two other sites w/in domains would be "serviced" by mobile capacity and perhaps part of national tool box.
3. Another theme: Invasive species. They are key to functional relationships in IRON. Question: discriminate between environmental shifts causing shifts in species vs. introductions of invasives. For every site – identify an invasive species. Comments – FIU's include about 12 people: a site scientist plus three or four technicians plus a crew of people who go out to make measurements. John Marshall: suggestion to worry only about invasions that are perceivable through remote sensing or at a weir, and other than that leave the story of invasives to other programs. Coming back to the connectivity theme:

III. In the last phase of the meeting we congregated into groups representing the main themes brought out through the earlier discussions. These groups were:

Key Points:

- Species shifts/ invasives- Cort, Chuck P
- Snowmelt/monsoon- John Marshall, Jim Richards

- Urbanization- Jim Ehleringer, Mike Loik
- Connectivity- Allistar, Dave Breshears
- Isotopes as sentinels- continental scale- Dave Evans, Dave Williams
- Influence of topography on ecosystem processes- Katy, Barb Bond, Dave Roberts

On Jim Ehleringer’s suggestion, each group was given the task of filling out four quadrats of what Jim called a “Quad Chart”:

General Question (this is the “elevator” question)	Specific requirements for sites
Specific questions for cross-domain emphasis and linkage	Toolbox needs

See Appendix B for the quad charts produced by each group.

4 Quadrant layout:

- General question
- Site requirements
- Specific cross domain question

- Toolbox needs

Climate Example:

- General question:
- Site requirement: watershed catchment
- Specific questions:
- Toolbox needs: airborne

Meeting adjourned 5PM

II. NoRMEO meeting 10/29/06

Meeting starts 8AM

Fundamental NEON Science Questions:

Questions:

- 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?
- How do the internal responses of biochemistry, biodiversity, hydro ecology 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 scale?

NoRMEO: NEON and Regional Questions:

- 1) How do land use and climate change interact to influence ecosystem processes and biodiversity in the Northern Rockies
- 2) How do rates of land use and climate change vary spatially in the Northern Rockies?
- 3) How is climate change influencing snow pack depth and duration and hydrologic runoff?
- 4) What are the reciprocal interactions between changes in climate, hydrology, fire, invasive species and exurban development?
- 5) What are the social, economic, and health feedbacks to humans from ecological response to land use and climate change?

Comments:

- How does NoRMEO fit into the grand plan, how do you take advantage of the continental network? Might not all be NEON data, can come from forest service or EPSCoR, etc
- Put high priority on question 2 and 3:
- Focus on how species are developing and the interactions with humans
- Water influences/links with urbanization, biodiversity (structure of species community), physical processes (fire etc)- (question 4)
- Question 5: good for lip service, U of Utah may be able to help, integrate research, socioeconomic feedbacks with disease- link between UI and WSU, lose economically important species and water resource issues, economics and infectious disease research (appoint Dave Evans)- How will we fill the box?

Tool Packages for 5 questions:

Question 1:

Q1A:

- Question A (QA) not answerable under NEON infrastructure
- Strike QA- not going to be successful by spending energy on this question
- Dave Tillman will propose to do this at every site- look at gradients across country and do manipulations of biodiversity, but will not answer question because he will only address plant species
- QA: not much traction within NEON, but the component is in NEON

Q1B:

Q1C:

- Relates to connectivity
- Not a NEON trackable question

Sidetrack:

- We decided to prioritize west wide research, answering these questions limit us to discuss what the priority questions are
- Need to determine and prioritize
- Couple precip and urbanization- series of snow pack/water manipulations, becomes continental when tie into other western domains
- Isotopes as sentinels is a tool
- Complex mtn terrain is a challenge
- Connectivity is the part of the driver between urbanization and snowmelt and makes the research continental- fits with continental effort
- Think about core site that fits with consortium
- 3 possible RFI: observational, core site,...
- Does NoRMOE only address the core site in RFI?
- Every domain will get core site, but not enough funding for every domain to have additional observational sites
- Could propose inexpensive measurements at observational sites
- Uncertainty with finances of NEON
- With NorMEO move from maritime to continental- propose gradient studies across domain
- Main driver in west is water, quantify variation within sites
- Worst thing NEON did was establish domains- but want to establish continental research with artificially established domains
- John's precip vulnerability figure and tamarack disappearance slide is compelling- continental perspective
- Jerry Rehfeldt's paper in review- predicted changes in species composition and community- driven by correlations with temp and precip- link species shifts to snowmelt/climate shifts
- Combo of fuels and climate- Frank Church is going to burn
- NEON is bad tool to study these issues
- Where are the hotspots where we expect changes, make and test models, use models to scale up and forecast
- Core site should cover main driver where we expect they would occur
- Where do we set up NEON to maximize the likelihood that we observe the driver

Transect Set up:

- Suggest start with maps and lay transects along gradient to have low budget measurements- water as driver
- Put 3 sites with transects from continental to maritime
- Mote et al 2005 snow water equivalent graph: Selway not vulnerable, just about everything else is
- How do we set up a transect?
- Propose tenderfoot, PREF, and one other as transect (see John's slide, green triangles)

- Water question use mobile in basin region in spring move up into the Rockies
- Should the core site be connected to the additional sites? Contribution to overall network (see Katy's handout on RFI)
- Strategy: contrast across domain, maritime to continental, propose to submit several sites, somewhere we need across domain transect
- Tenderfoot (near Bozeman), lodgepole,
- Propose to submit 3 RFIs with the 3 sites as different priority sites

Discussion on sites:

- Propose to select 1 site and go with it, limited time to write 3 quality RFIs
- Make 1 primary with the other 2 experimental forests as secondary sites
- Will the group support the RFI if one site is proposed instead of 3?
- Should NoRMEO propose 1 or 3 sites?

Site Appointees:

- Tenderfoot- Art, Dave R. and Ward
- Coram- Art and Ward
- PREF- John Marshall, Allistar Smith, Dave Evans
- Yellowstone?—Dave R.

Additional NoRMEO business:

- General letter-Katy, will draft a NoRMEO letter that can be included in each of the RFI stating a willingness of NoRMEO members to work at these sites
- National efforts and meeting attendees-
- Alan Knapp rainout shelters and N fertilization (meeting Dec 8, John and Dave Williams will attend),
- artificial snow pack manipulationsConnectivity (COREO meeting 11/28, Dave Roberts will attend. Katy K perhaps, John M perhaps),
- isotopes as sentinels (Dave E and Dave W. electronic meeting),
- Tillman- biodiversity? (Cort/Chuck will check into),
- Future NoRMEO meetings: maybe
- If others want to be a part of NoRMEO send contact info to debbier@uidaho.edu

Meeting Adjourned at 11:30 am

Appendix A: List of attendees

Last Name	First Name	Company	Address	Address2	City	State	Zip	Email	Phone	Fax
Anderson	Cort	Univ. of Idaho/CRISSP	PO Box 441136 Fish & Wildlife	CNR Rm 105	Moscow	ID	83844-1136	cla@uidaho.edu	208-885-8914	208-885-9080
Bond	Barb	Oregon State University	Dept of Forest Science		Corvallis	OR	97331	barbara.bond@oregonstate.edu	541-737-6110	541-737-1393
Breshears	Dave	University of Arizona	College of Agriculture and Life Sciences School of Natural Resources	BIO SCI EAST Rm 226e 1311 E 4 St.	Tucson	AZ	85721	daveb@ag.arizona.edu	520-621-7259	520-621-8801
Crowl	Todd	COREO, IRON	Utah State University	Ecology Center	Logan	UT	84322	facrowl@cc.usu.edu	435-797-2498	
Denner	Bob	USFS	RMRS		Moscow	ID		bdenner@fs.fed.us		
Ehleringer	Jim	Univ. of Utah	Biology		Salt Lake City	UT	84112	ehleringer@biology.utah.edu		
Evans	Dave	Washington State Univ.	School of Biological Sciences		Pullman	WA	99164	rdevans@wsu.edu		
Kavanagh	Katy	Univ of Idaho	Dept of Forest Resources	PO Box 441133	Moscow	ID	83844-1133	katyk@uidaho.edu	208-885-2552	208-885-6226
Koyama	Aki	Univ of Idaho	Dept of Forest Resources	PO Box 441133	Moscow	ID	83844-1133	koya0981@uidaho.edu		
Link	Tim	Univ of Idaho	Dept of Forest Resources	PO Box 441133	Moscow	ID	83844-1133	tlink@uidaho.edu	208-885-9465	
Loik	Michael	UC Santa Cruz	Dept Env Studies	1156 High St	Santa Cruz	CA	95064	mloik@ucsc.edu	831-459-5785	831-459-4015
Marshall	John	Univ. of Idaho	Forest	PO Box	Moscow	ID	83844-	jdm@uidaho.edu	208-885-	

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McKee	Art	Flathead Lake Biological Station	311 Bio Station Lane		Polson	MT	59860	Art.McKee@umontana.edu	406-982-3301x226	
Pangle	Rob	Univ of Idaho	Dept of Forest Resources	PO Box 441133	Moscow	ID	83844-1133	pang1809@uidaho.edu		
Peterson	Chuck	Idaho State University	Dept of Biological Sciences	Box 8007	Pocatello	ID	83209	petechar@isu.edu	208-282-3922	208-282-4570
Powers	Elizabeth	Univ of Idaho	Dept of Forest Resources	PO Box 441133	Moscow	ID	83844-1133	powe2478@uidaho.edu		
Richards	Jim	Univ. of California, Davis	Land, Air and Water Resources	One Shields Ave	Davis	CA	95616-8627	jhrichards@ucdavis.edu	530-752-0170	530-752-1552
Roberts	Dave	Montana State University	Ecology	PO Box 173460	Bozeman	MT	59717-3460	droberts@montana.edu	406-994-4548	406-994-3190
Schedlbauer	Jessica	Univ of Idaho	Dept of Forest Resources	PO Box 441133	Moscow	ID	83844-1133	sche4619@uidaho.edu		
Smith	Alistair	Univ of Idaho	Dept of Forest Resources	PO Box 441133	Moscow	ID	83844-1133	alistair@uidaho.edu	208-885-1009	208-885-6226
Williams	David	University of Wyoming	Dept of Renewable Resources	Dept 3354, 1000 E. University Ave.	Laramie	WY	82071	dgw@uwyo.edu	307-766-2494	307-766-6403

Appendix B: Quad charts from western domain meeting at Priest River Expmt Forest
Saturday Oct. 27

- Connectivity- Allistar Smith, Dave Breshears
- Isotopes as sentinels- continental scale- Dave Evans, Dave Williams
- Urbanization- Jim Erhleringer, Mike Loik
- Influence of topography on ecosystem processes- Barb Bond, Katy Kavanagh, Dave Roberts
- Snowmelt/monsoon- John Marshall, Jim Richards
- Species shifts/ invasives- Cort Anderson, Chuck P

Six Submitted Quad Charts

FROM THE CONNECTIVITY GROUP

Connectivity - NoRMEO Quad Chart for Western US- <i>Draft</i>	
<p>General Question</p> <p><i>What are the ecological consequences of an increasingly connected western US?</i></p>	<p>Site Requirements</p> <p><i>Potential process connections among sites via vectors such as water and wind/atmosphere, with some replication across domains</i></p>
<p>Specific Cross-Domain Questions</p> <p><i>Are there spatially and temporally synchronous responses and/or responses influencing neighboring domains for: species shifts, invasives, fire, biogeochemistry, water sources and sinks with respect to urbanization and climate gradients?</i></p>	<p>Toolbox Needs</p> <p><i>All at cross-domain scales and across gradients:</i> <i>Core, supplemental towers, and existing towers, with cold-flow drainage met</i> <i>MRP</i> <i>AOP</i> <i>LUP</i> <i>Weirs / runoff / sediment</i> <i>INEWS / BASIN</i> <i>Population Genomics</i></p>

FROM THE ISOTOPE GROUP

General Question	Site Requirements
How do alterations of precipitation regimes and nitrogen deposition alter ecosystem water and nitrogen dynamics, at regional to continental scales?	First- or head water watershed in each of the 20 domains where the primary inputs of water and nitrogen are from the atmosphere
Specific Cross Domain Question	Toolbox Needs
<p>Stable isotopes can act as a sentinel of hydroecologic and biogeochemical response to global change, and how biogeochemical transformations of water and nitrogen in one domain impacts inputs, cycling, and outputs of water and nitrogen in neighboring domains at a continental scale.</p> <p>Isotope monitoring of atmospheric inputs at continental scale detects changing patterns of water and nitrogen ecological drivers and ecosystem service.</p>	<p>BioMesoNet Samples for water and atmospheric N deposition</p> <p>Water samples from aquatic sensor array</p> <p>GIS</p>

FROM THE URBAN GROUP

General question	Site needs
Increasing urbanization and population growth in the Western USA increases the ecological footprints by placing greater demands on limited water resources, altering the capacity of ecosystems to provide goods and services, and creating point sources with downstream feedbacks on wildland ecosystems.	Urban sites across all domains
Specific cross-domain questions	Tool box needs
<ol style="list-style-type: none"> 1. The sustainable supply of water in coastal regions of the west will be more vulnerable to climate-change impacts on montane snowpacks, in contrast to colder continental regions. In contrast, interior regions may be more vulnerable to interannual variability, such as associated with drought. 2. Altered climates in urbanized areas with differentially affect water and energy demands, with consequential effects on the urban landscape. 3. Intensive urbanization and sprawl of the kind developing in the west now will result in enhanced point source effects on wildland sites. 4. Periurban conflicts will exacerbate land-use changes, with consequences for energy balance, water exchange, and nutrient cycling. 	<ul style="list-style-type: none"> • Airborne observation platform • Land use package • Advanced biomesonet tower – EC, trace gases, isotopes • aquatic sensor array • terrestrial sensor array • fundamental sentinel measurements • census data

FROM THE MOUNTAIN TOPOGRAPHY GROUP

<p>General Question</p> <p>How does topography influence accurate forecasting of ecosystem responses to climate change and land use? Will forecasts have significant errors if we apply methods and models from flat land to mountain ecosystems?</p>	<p>Site Requirements</p> <p>20-domain topographic gradient (measured by LiDar) of core sites plus a topographic gradient of 3 wild sites per domain w/in mountainous domains.</p>
<p>Specific cross-domain questions/hypotheses</p> <ol style="list-style-type: none"> 1. hyp 1. water distribution and microclimate in steeply sloping geography alter ecosystem sensitivity to climate change compared with flat geographies 2. hyp 2. input/output responses and ecological make-up of topographically complex systems are less sensitive to climatic change until a threshold is reached, and then change is more rapid and profound. 	<p>Toolbox needs</p> <p>Biomesonet tower (PLUS: new ways PLUS new R&D to develop capacity to measure fluxes in complex topography)</p> <p>Inputs and outputs of isotopes (C, N, O)</p> <p>Inputs and outputs (in streamflow) of N</p> <p>(These hypotheses would also benefit from EXPERIMENTS)</p>

FROM THE SNOWFALL / SNOWMELT/ MONSOON RAIN SHIFTS DUE TO CLIMATE CHANGE GROUP

General Question	Site needs
<p>Climate change is reducing snowpack and increasing monsoonal rains differently across western ecosystems and this will alter availability of water to sustain ecosystems and for human uses</p> <p>[maritime (warm snow regions) will be more responsive than continental or high elevation (cold snow) areas]</p> <p>[monsoonal areas are likely to see (are having) increased summer precip whereas non-monsoon areas will see increased summer drought; there is a strong gradient across the West]</p>	<p>observational</p> <ol style="list-style-type: none"> 1. elevational transect of gauged watersheds crossing the rain snow boundary 2. ideal should be linked along one drainage including streams, lakes (reservoirs, meadows, wetlands), rivers <p>experimental</p> <ol style="list-style-type: none"> 1. snowfences 2. albedo manipulations 3. canopy manipulations 4. summer rain addition/exclusion
Specific Cross-Domain Questions	Tool Box Needs
<ol style="list-style-type: none"> 1. changes in snow accumulation and storage, time of snowmelt, and seasonality of precipitation will affect terrestrial productivity and community composition 2. shifts in seasonal flow dynamics will alter stream and river communities and aquatic ecosystem processes 3. changes in precipitation seasonality will alter linkages between terrestrial and aquatic ecosystems 4. interaction with atm deposition and timing of N input will result from reduction of large spring pulse and increase in frequency and magnitude of smaller rain driven pulses in areas where the proportion of precipitation shifts from snow to rain 5. in monsoon areas near atm N sources increased summer precip will be accompanied by increased magnitude of N pulses 6. changes in energy balance of land surface are affected by patterns of snowmelt / precipitation and ecosystem response to that 	<ol style="list-style-type: none"> 1. advanced biomesonet tower/ AND new technology to achieve these measurements in complex mountain terrain in catchment areas 2. multiple aquatic sensor arrays along drainage from catchment down 3. soil sensor arrays and canopy microclimate sensor arrays enhanced with new fiber optic temp sensor 4. remote sensing for land surfaces energy balance, snow presence/absence; Lidar assessment of canopy structure and NPP 5. fundamental sentinel unit for catchments but need to focus on widespread dominants (e.g larch, doug fir, ponderosa, sagebrush, pinon, juniper, ??? which insects, amphibians, birds, mammals ??? and some key spring ephemerals, understory spp and deciduous spp to capture phenological responses to changing growing season 6. subcanopy snow albedo needed

<ol style="list-style-type: none">7. Fire interactions due to changes in fuel production and length of dry season.8. complex interactions result from changing patterns of productivity, soil moisture availability and fire regime which may feedback into changes in precipitation regime.9. early snowmelt results in less cold air drainage in spring10. human uses of water for urban and agriculture will be impacted/ interactions with dams, timing of storage and release/ costs of flood protection and damage repair11. These changes are likely to have cross-domain effects through connections by water transport	
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FROM THE INVASIVE SPECIES/SPECIES SHIFT GROUP

<p>General question:How will distribution and abundance of native and invasive species be affected by human or naturally induced change, such as climate change or land use change?</p>	<p>Tool box needs: FSU: monitoring of biodiversity, esp. aquatic invertebrates, amphibians, aquatic plants; terrestrial invertebrates, soil microbial community, invasives in both aquatic and terrestrial habitats. Phenology in multiple systems, aquatic and terrestrial Functional/environmental genomics Aquatic, soil, and canopy sensor arrays</p>
<p>Specific cross-domain questions: 1.What are the knock-on effects of a shift from snow pack to monsoonal precipitation for native and invasive species in aquatic environments? Terrestrial? * 2. What are biogeographic effects of anticipated changes in seasonal water availability, and how is landscape topology likely to determine biotic response, in terms of the distribution and abundance of species? **</p>	<p>Site requirements: 1st and 2nd order streams and associated riparian areas, lake(s), pond(s). Provision for sampling and sample storage to monitor biodiversity (see above), standardized procedures that are coordinated with adjacent domains.</p>

•Changes in the seasonal distribution of water has major effects on the timing of water availability/flow rates in dependent streams and rivers. This apparently predisposes systems to invasion, as evidenced by watersheds that have already experienced this change. Similar pattern is predicted for terrestrial habitats.