

Response to the NEON RFI
by
The Consortium for Connectivity at Continental Scales (3CS)

TITLE: Coram Experimental Forest

1. Submitting Domain: **Northern Rockies (12)**

2. RFI Response: **CORE WILDLAND SITE**

3. Lead Scientist(s):

Name: Ward McCaughey

Address: Rocky Mountain Research Station, Forestry Sciences Laboratory, 800 East Beckwith Avenue, Missoula, MT 59801

Phone: 406-329-2125 Email: wmccaughey@fs.fed.us

Name: Arthur McKee

Address: Flathead Lake Biological Station, 32125 Bio Station Lane, Polson, MT 59860

Phone: 406-982-3301 x 226 Email: Art.McKee@umontana.edu

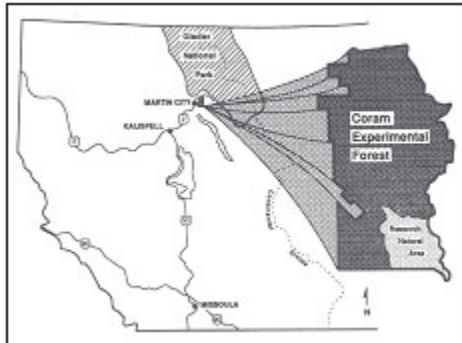
4. Key Contributing Scientists:

Samuel Cushman Rocky Mountain Research Station scushman@fs.fed.us	Dave Evans Biological Sciences Washington State University rdevans@wsu.edu	Andrew Hansen Montana State University hansen@montana.edu
Ric Hauer Flathead Lake Biological Station University of Montana Ric.Hauer@umontana.edu	Kathleen Kavanagh University of Idaho katyk@uidaho.edu	Brian Lamb Laboratory for Atmospheric Research Washington State University blamb@wsu.edu
John Marshall University of Idaho jdm@uidaho.edu	George H. Mount Laboratory for Atmos. Research Washington State University gmount@wsu.edu	Chuck Peterson Biological Sciences Idaho State University petechar@isu.edu
Dave Roberts Montana State University DRoberts@montana.edu	Steve W. Running University of Montana swr@ntsg.umt.edu	Jack Stanford Flathead Lake Biological Station University of Montana Jack.Stanford@umontana.edu
Elaine Sutherland Rocky Mountain Research Station esutherland@fs.fed.us	Cathy Whitlock Dept. of Earth Sciences Montana State University Whitlock@montana.edu	Dave Williams Renewable Resources University of Wyoming dgw@uwyo.edu

1.0 Abstract

1.1 Name of the NEON domain. Coram Experimental Forest (CEF) is located within the Northern Rockies Domain (12), referred to as the Northern Rocky Mountain Ecological Observatory (NoRMEO) by the region's scientists, and sometimes abbreviated as NRM on NEON-related maps and tables assembled by COREO and 3CS.

1.2 Geographic coordinates (latitude/longitude) and size (acres). The approximate center of CEF is Latitude 48.38, Longitude -113.98 and it is 7,244 acres (2932 ha) in size. A map of the CEF is attached (ESRI shapefile).



Locator Map:

For a larger image and additional maps go to <http://flbs.umt.edu/sitemaps/coram.aspx>

1.3 Site's characteristics that make it an ideal NEON site. CEF is located on the Flathead National Forest and administered by the Rocky Mountain Research Station (RMRS). CEF's status as an Experimental Forest ensures long-term site integrity and administrative collaboration. It is broadly representative of western larch/Douglas-fir forests and mixed-conifer cover types found along and west of the Continental Divide. CEF includes the Coram Research Natural Area, 340 ha (839 ac) in size, with old-growth larch stands over 300 years old. Access to CEF is good with a well maintained road network. Near the entrance, is a flat to gently sloping area of young forest suitable for a flux tower with easy access to line power. Excellent opportunities exist for NEON facilities development adjacent to the Experimental Forest's headquarters located in Hungry Horse, Montana. The University of Montana's Flathead Lake Biological Station is nearby and provides another possible site for NEON facilities.

CEF is central to the Crown-of-the-Continent ecosystem and adjacent to Glacier Park in an area that remains largely intact and still has all native terrestrial vertebrates present, and it is also centrally located along the maritime-to-continental climatic gradient within the Domain. Surrounded by areas protected by wilderness and National Park designation, this large (2900 ha) Experimental Forest is specifically dedicated to research and education. A rich history of research in CEF, Glacier Park, and the surrounding area has produced many long-term studies and legacy data sets that are germane to NEON themes and questions.

CEF was designated a UNESCO Biosphere Reserve in the 1970s for experimental research, paired with nearby Glacier National Park that serves as control—the research link/partnership between the two areas is well established. Other partnerships include the University of Montana, Flathead National Forest, USGS/BRD scientists, Flathead Valley Community College, local high schools, and the entire research arm of the USDA Forest Service. Partnerships with regional tribal colleges are in development.

2.0 Characteristics Relative to Domain

General information about the key characteristics of the Domain is provided in **Appendix I. Deployment Strategy: Northern Rocky Mountains Domain** (p 10), which also describes the proposed deployment strategy for NEON infrastructure that was developed by the region's scientists.

CEF was designated in 1932 and has nearly 75 years of research history. The Experimental Forest is broadly representative of the western larch/Douglas-fir forest cover type, a widely distributed type found west of the Divide, and has a rich diversity of sites, aspects, age classes and composition including old-growth larch stands with 300 year old trees. The main forest cover types are: western larch and interior Douglas-fir that cover much of the Forest; Engelmann spruce/subalpine fir on cooler, moist sites; western redcedar/western hemlock on lower to mid-elevation moist sites; and whitebark pine/subalpine fir/mountain hemlock along the high ridges. The Coram Research Natural Area in the south end of the Forest, 340 ha (839 ac) in size, contains excellent examples of old-growth larch stands.

CEF is located in the northern part of the domain, slightly west of the Continental Divide (~ 20 mi), making it central to the maritime-to-continental climatic gradient within the Domain. The climate is classified as a modified Pacific maritime-type with occasional intrusions by continental air masses flowing westward over the Divide. In summer, this can raise temperatures and drop the relative humidity, and in winter can drop temperatures substantially for several days. Annual precipitation averages about 35 inches (88.9 cm) at lower elevations of 3300 feet and about 50 inches (127 cm) at higher elevations over 6000 feet. The May through August mean temperature is about 61° F with highs on occasion exceeding 100° F. Winter temperature average about 19° F, with occasional periods of minimums plunging below -20° F. Length of frost-free growing season ranges from 81-160 days.

A rock layer primarily comprising argillite and quartzite underlies most of the upper slopes. Glacial outwash and till were deposited on the lower areas. Rich loamy soils predominate. Soil depths range from a few cm on steep, upper slopes to over 3 m on gentle, lower terrain. Six soil types are present: loamy-skeletal soils on materials weathered from impure limestone and argillite; loamy-skeletal soils on argillite, siltite, and quartzite; loamy-skeletal soils on glacial till; loamy-skeletal soils on both alluvium and glacial outwash; loamy-skeletal soils on glacial outwash; and fine and fine-loamy soils on lacustrine deposits. These soil types are common in the Northern Rockies as is the geology of the Forest, which is limestone, dolomite, and argillite of the Helena Formations and Tertiary Kishenehn sediments.

The geomorphology, mountainous topography, vegetation, animal communities and streams within CEF are representative of much of the Northern Rockies Domain. It is surrounded by broad river valleys, another Domain characteristic.

CEF is adjacent to Glacier Park in an area that remains largely intact -- about 70% of the surrounding Flathead River Basin is in Glacier National Park or U.S. Forest Service wilderness areas -- and still has all native terrestrial vertebrates present. CEF was designated a UNESCO Biosphere Reserve in the 1970s for experimental research, paired with nearby Glacier National

Park that serves as control -- the research link/partnership between the two areas is well established. A rich history of research in CEF, Glacier Park and the surrounding area has produced many long-term studies and legacy data sets that are germane to NEON themes and questions. When considering the research conducted by the Flathead Lake Biological Station throughout the Flathead Basin and scientists associated with nearby Glacier National Park, this is a well studied landscape.

3.0 Ownership, Accessibility, and Use Constraints

3.1 Ownership status. CEF is located entirely on National Forest lands and is administered by the United States Forest Service's Rocky Mountain Research Station (RMRS) whose headquarters are located in Fort Collins, Colorado.

3.2 Entity currently owning property. RMRS is the legal owner. Local administration is RMRS's Forestry Sciences Laboratory in Missoula, Montana, and Ward McCaughey, a research scientist with RMRS is the manager of the Experimental Forest.

3.3 Restrictions on the use of, or access to, the site. CEF is a typical USFS Experimental Forest in that it is open to research and educational use that does not interfere with on-going studies and fits within the management plan for the Forest. Prospective users work with the Experimental Forest manager, Ward McCaughey to develop an acceptable research or education project/program. The variety of on-going research led by PIs who are university faculty is evidence of the open collaboration that exists.

3.4 Existing easements. None.

3.5 Long-term (30+ years) accessibility and availability. CEF was established in 1932 for research and RMRS plans to maintain CEF for research, monitoring and education for at least the next 30 years. All experiments and or monitoring efforts would need to be developed with and coordinated through the manager, Ward McCaughey and the Flathead National Forest. CEF has been receptive to collaborative studies, and that cooperative attitude will continue. An excellent road network already exists (see map), and line power runs along the west boundary.

3.6 Restrictions on the feasibility of conducting experiments on the site. As their name implies, Experimental Forests such as CEF allow manipulative experiments and installation of equipment for research and monitoring purposes. All experiments and or monitoring efforts would need to be developed with and coordinated through the manager, Ward McCaughey and the Flathead National Forest. CEF has been open to collaborative manipulations and experiments, and that will continue.

3.7 Environmental assessment: Date and Outcome. There is no current environmental assessment for the Coram Experimental Forests.

3.8 Environmentally sensitive site characteristics. There are no known endangered species or suspected archaeological issues within the CEF Forest boundary. It does sit within grizzly bear and lynx habitat, and any experimental manipulation would need to be evaluated in relation to

effects on those species. But, it is not anticipated that this would present any obstacle to installation of experiments or sampling instruments and arrays described in the NEON ISEP.

3.9 Airspace restrictions. There are no known airspace restrictions.

4.0 Existing Infrastructure

4.1 Existing and/or potential housing facilities. There are two permanent houses (Administrative headquarters) located in Hungry Horse, Montana which are owned and administered by the Rocky Mountain Research Station. These houses are located on a USDA Forest Service owned site that is administered by the Hungry Horse Ranger District of the Flathead National Forest. The RMRS site manager and assistant site representative coordinate lodging requests for the two houses. There is a minimal daily fee for staying in the houses which have bedrooms, bathrooms, some laboratory space, and kitchens.

4.2 Existing and/or potential laboratory facilities. There is limited laboratory and meeting space currently availability in the two RMRS houses. However, RMRS is willing to cooperate and collaborate in building of laboratory or meeting facilities on the Government compound in Hungry Horse. There is plenty of room for development of facilities and all utilities are present.

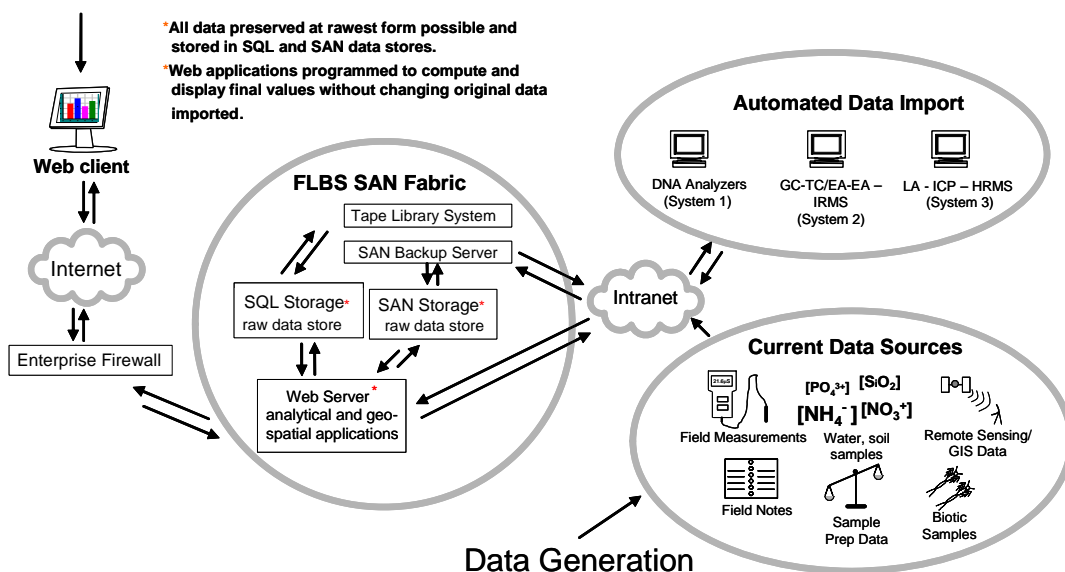
In addition, the Flathead Lake Biological Station with extensive laboratory, office and housing facilities <<http://www.umt.edu/flbs/>> is located a short drive from CEF (~ 45 min) and provides another short- or long-term site for NEON support facilities. The Bio Station is also very willing to discuss development of NEON facilities, and explore the possibility of collaborative management of NEON infrastructure with RMRS.

4.3 Availability of electrical, gas, or other power, and water sources for facilities and field use. Line power runs along the access road at the entrance of CEF therefore minimal cost would be involved in supplying power to newly installed field facilities such as a flux tower or sampling infrastructure. Propane tanks can be placed anywhere within the secure road network of CEF and serviced by local companies during the summer months. Electricity, water and propane are available for potential NEON facilities at the local Ranger District location (shared with CEF housing), as well as at the Flathead Lake Biological Station. The potential for telemetry from the Forest to either the local headquarters site or the Bio Station is excellent.

4.4 Existing computer resources and cyberinfrastructure. The RMRS houses at the local Ranger Station have PCs with limited internet access. As mentioned below, the adjacent Ranger Station has T-1 access, and could be easily connected.

The nearby Flathead Lake Biological Station (FLBS) has excellent computer resources and cyberinfrastructure. The diagram below shows the operational structure and services of the Bio Station cyberinfrastructure for laboratory analytical systems, field measurements and user interface. This is constantly under development, for example a new module for taxonomic inquiry (aquatic insects) will soon be operational. A portal to the existing system can be viewed

User Data Query



at <www.umt.edu/flbs> via the SaRON page. The Bio Station employs three people full-time for informatics management.

4.4.1 Internet access. There currently are phone connections in each of the two RMRS houses. There are T1 lines located in the main office of the Hungry Horse Ranger District which is located near the RMRS houses on the same administrative site. T1 line can be quickly installed in the RMRS houses.

The Flathead Lake Biological Station has full T-1 linkage.

4.4.2 Data and information management policies. No specific policy is in place at this time other than we expect collaborators to willingly share data.

4.5 Road access to and within the site. The RMRS houses are located on paved roads within the Hungry Horse Ranger District Administrative Site less than 1/4-mile off US highway 93. The entrance to the Forest proper is located on a paved road approximately 2 miles off highway 93. Road within the EF are gravel and well maintained by the Flathead National Forest. Gating of roads within the Forest provide security for research installations.

4.6 Security measures. As described above, most roads within CEF are closed to motorized vehicles except for administrative use only. This same travel restriction would apply to any new roads or access trails established in the future. RMRS views research site security and integrity as paramount for maintaining long-term studies, and we anticipate no change in that position. Any additional security measures would be coordinated through the RMRS and the Flathead National Forest.

5.0 Supplementary Information

5.1 Description of existing gradients at the site. The EF has an elevational gradient from 3300 to 6400 feet. Overstory vegetation ranges from ponderosa pine, Douglas-fir, lodgepole pine, and western larch at the lower elevations to mountain hemlock, whitebark pine, subalpine fir, and

Engelmann spruce at the higher elevations. Mid-elevation sites contain western larch, Douglas-fir, lodgepole pine, grand fir, subalpine fir, western hemlock and Engelmann spruce.

As with most areas within the Rockies, elevation and aspect combine with precipitation and temperature gradients to produce distinct gradients of soil moisture availability, transpiration stress and energy loading. These profoundly influence the plant community composition and structure and, in turn, habitats for vertebrates and invertebrates. These gradients are quite steep within CEF, and offer a rich mix of habitats and conditions.

5.2 Site history and legacy data. After designation as an Experimental Forest in 1932, formal research began on the Coram Experimental Forest in 1948. Through the 1950s, the primary objectives were to learn how to regenerate western larch and associated conifers using even-aged regeneration methods coupled with a wide range of site preparation treatments. Research in the 1960s determined how to regenerate larch by seeding and planting and how young larch forests, growing under a wide range of stand densities, respond. Studies in the 1970s featured multidisciplinary studies in a forest residues utilization research and development program along with some watershed-level research. Research in the 1980s investigated old-growth dynamics within the Coram Research Natural Area, cone production in young larch stands, and differences in bird populations within logged and unlogged areas. The 1990s saw the continuation of long-term research in stand dynamics, growth and yield, and expanded the dissemination of results through conservation education to local, regional, and international audiences.

Baseline data sets from the Coram Experimental Forest include: stream flow from two flume sites and climate records dating back to the mid 1970s, forest boundary maps, digital elevation maps, stand structure and vegetation maps, and data that is available from many studies conducted on the EF over the past 60 years.

In addition, a long history of research in Glacier Park and the surrounding area by scientists and graduate students has produced many legacy data sets that are maintained by non-Forest Service scientists and are available to NEON. Some examples are given in section 5.3 below.

5.3 Recent and ongoing research and monitoring activities relevant to NEON. Since the 1970s, there have been no new manipulative research projects initiated on CEF. Several old studies are maintained to evaluate stand successional dynamics, and water and climate monitoring are ongoing. Several small independent studies have been conducted on CEF but none that required manipulation of vegetation.

Scientists working at Glacier National Park are tracking the dynamics of glaciers, bird communities, fish abundance and distribution, aquatic insect communities, large mammal abundance and distribution, and many other variables. These include USGS/BRD scientists, Park Service scientists, and faculty and graduate students from many colleges and universities around the US including the Univ of Montana.

Many studies have been conducted throughout the Flathead River Basin around CEF by scientists at the University of Montana's Flathead Lake Biological Station. Table 1 below lists some of the long-term data sets resulting from those studies. In addition to the studies that

provide the long-term data in the table below, the Bio Station has several studies funded by NSF's BioComplexity and Microbial Observatory programs that are based at the Nyack Floodplain, located about 8 miles (10 km) northeast of CEF on the Middle Fork of the Flathead River. These provide another set of legacy data of 5-plus years duration.

Table 1. Examples of regional long-term data sets archived at Flathead Lake Biological Station and relevant to NEON.

<u>Variable</u>	<u>Length of Record (yrs)</u>
Stream- and Lakewater Chemistry	
Alkalinity	30+
Chloride	30+
Conductivity	30+
Organic Carbon	
Dissolved Organic Carbon	25+
Non-dissolved Organic Carbon	25+
Total Organic Carbon	25+
Dissolved Inorganic Carbon	25+
Dissolved Nutrients	
Ammonia	20+
Nitrite + Nitrate	25+
Soluble Reactive Phosphorous	20+
Soluble Phosphorous	20+
Total Nutrients	
Total Phosphorous	25+
Total Nitrogen	25+
pH	30+
Silica, Dissolved	25+
Sulfate	20+
Total Suspended Solids	25+
Turbidity	25+
Benthic invertebrates	25+
Phyto- and Zooplankton	
Abundance	20+
Density	20+
Biomass	20+
Aquatic NPP	25+
Physical-Chemical Water Column Profiles	25+
Temperature	
Dissolved O ₂	
Conductivity	
pH	
Redox	
Photosynthetically Active Radiation	

5.4 Institutional diversity of partnership for site. Research and monitoring partners include scientists within the RMRS, Glacier National Park, University of Montana, Flathead Valley Community College, USGS/BRD scientists, Flathead County high schools, and the Flathead National Forest. Partnerships with regional tribal colleges, particularly Salish Kootenai College and Blackfeet Community College, are in development. Should NEON become operational we

expect use of CEF by faculty and graduate students from Montana State University, the University of Idaho, Idaho State University and University of Wyoming.

5.5 Partnerships with minority-serving institutions, overall academic community and two-year colleges. To date, partnerships have not specifically included Historically Black Colleges and Universities or Hispanic Serving Institutions. As mentioned above, partnerships are in development with some tribal and community colleges that have underrepresented students.

With NEON cyberinfrastructure support this could rapidly change, however, with the Forest's data being directly accessible to college classrooms anywhere. It is easy to imagine a web-based educational program that would involve the span of academic communities.

Appendix I. Deployment Strategy: Northern Rocky Mountains Domain (NRM)

NRM straddles the Continental Divide and is characterized by north-south trending mountain ranges that influence subcontinental climate patterns such that the western portion of the Domain has a warmer, wetter maritime climate with most precipitation in winter, and the eastern portion has a drier, colder continental climate with summer precipitation. Local orography modifies these patterns with gradients from warmer and drier valley bottoms to colder and wetter mountain tops. As a consequence, vegetation grades from wet temperate coniferous forests in the west to valley bottom grasslands and cold temperate montane forests to the east. Fire regimes vary in severity and frequency with these regional and local climate and vegetation patterns. The deep mountain snowpacks feed the headwaters of the three major river systems of western North America (Columbia, Missouri-Mississippi, and Colorado). The region is unique in the lower 48 states in having all native terrestrial vertebrates present. Human populations and land use are in transition from small communities focused on agriculture, timber and mining to thriving small cities and surrounding exurban sprawl. This growth is especially focused in valley bottoms and lower-elevation treeline, setting up conflicts with wildlife and natural resource management.

NEON's continental-scale questions involving climate change, land use change and invasive species are also important within this Domain. The effects of climate warming are already apparent with snowmelt and spring runoff peaking about two weeks earlier than in the 1950s, and significant fall rains coming about 10 days later. This translates into earlier growing seasons, longer periods of summer drought, and lower streamflows in a region where water is limiting. The low streamflows constrain human water access, threaten native aquatic species, and favor expansion of aquatic invasives. In terrestrial systems, changes in climate and land use such as irrigation and exurban development have altered the spatial and temporal patterning of NPP. Severe stand-replacement fires are now occurring in lower treeline forests which are adapted to frequent ground fire, threatening the high levels of native biodiversity and putting expanding exurban development at risk. The modification of NPP has also resulted in herbivores shifting their range to irrigated valley bottoms, with attendant increases in population and enhanced spread of disease. Such changes in aquatic and terrestrial ecosystems have strong potential feedbacks that could negatively affect many ecosystem and economic components. In brief, the region provides a great opportunity to understand interactions of these changes and derive ways to mitigate negative effects on ecosystems and human well being.

Given the overlap of issues and questions both within-domain and across all western domains, we propose to establish three transects from urban to wildland sites that span the maritime-to-continental gradient (Fig 1). Along each transect, sites will be selected to characterize four or five land-use types: urban, exurban, agricultural/managed, and wildland (Fig 2). The maritime-to-continental climatic gradient will be sampled continuously via permanent tower installations at the wildland sites of each transect, one of which will be the Core Wildland Site. The relocatable installations will be deployed at sites in different land-use classes, sampling three different land-use classes in the initial installation. Funds will be sought to maintain the initial wildland tower installations, with new towers added at the appropriate land-use positions along each gradient. If funds are not obtained, the relocatable towers will be repositioned at sites along the transects on 2- to 3-year time periods. (Fig 3). The simultaneous deployment of the land-use

towers to different land-use classes will allow early model parameterization. As more land-use classes are sampled in successive time periods, parameterization will improve.

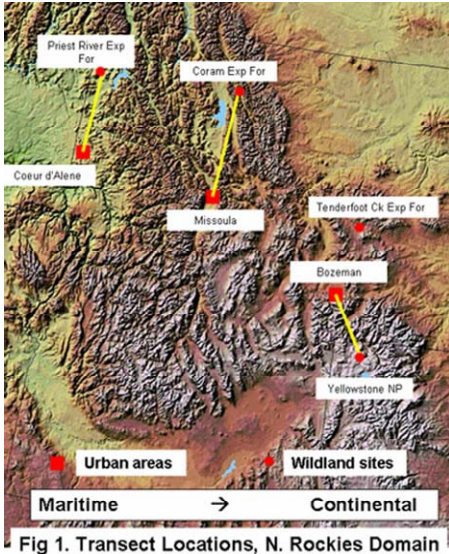


Fig 1. Transect Locations, N. Rockies Domain

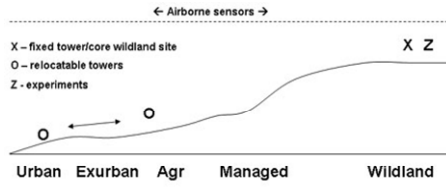


Fig 2. Urban to Wild Transect

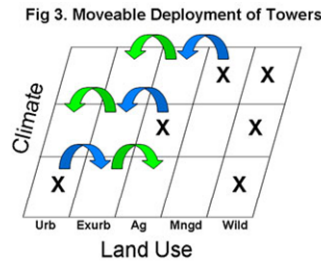


Fig 3. Moveable Deployment of Towers

Four candidate Core Wildland sites have been identified: Priest River Experimental Forest in Idaho (PREF_ID_NRM, maritime), Coram Experimental Forest near Glacier National Park (CEF_MT_NRM, maritime/continental), Tenderfoot Creek Experimental Forest (TCEF_MT_NRM, continental), and the Northern Range within Yellowstone National Park (YNR_MT_NRM, continental).