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Research poster: Building infrastructure: Climate monitoring transects in Nevada

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Building Infrastructure: Climate Monitoring Transects in Nevada

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INTRODUCTION

Part of the EPSCoR effort to establish cutting-edge scientific infrastructure in Nevada is the placement of permanent environmental monitoring systems in remote locations representative of crucial eco-hydro-climatological zones.

Accordingly, an interdisciplinary team from the Ecological Change and Water Resources project components has been pursuing the goals of identifying suitable locations, partnering with landowners, designing monitoring systems, and acquiring system hardware.

The permanent nature and ultimate mission of supporting decades of future research experiments make these instrumental transects a centerpiece of Nevada's EPSCoR enterprise. Each of the steps towards final installation has taken tremendous effort on the part of over a dozen team members, as logistical and legal realities are constantly weighed against scientific objectives. Here we present the results of these pursuits, and all of the fantastic research possibilities that they offer.

Dr. Franco Biondi contemplates treeline climate in the shadow of *Pinus longeava* (Great Basin Bristlecone Pine) near the Long Now subalpine site.

National Park Service Ecologist Gretchen Baker talks with Dr. Dale Devitt and David Simeral near the Nevada Land Conservancy sagebrush site.

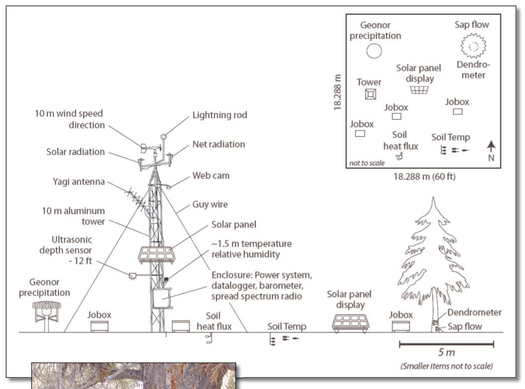
SITE INSTRUMENTATION

Initial instrumentation packages are broad in scope, and will allow scientists from a wide range of disciplines to apply themselves with success to critical research questions regarding changes in climate and impacts to various environmental systems.

Monitoring hardware includes a standard meteorological complement - wind speed/direction, air temperature, precipitation, net radiation, solar radiation, and snow depth. Various other ecological and hydrological properties will also be observed: soil water content, soil infiltration rate, soil temperature, and soil heat flux, with applicable locations logging runoff, shallow subsurface flow, water level, tree sap flow, and tree radial growth.

In addition to the sensor packages, webcams at several sites will also be utilized to visually record site conditions such as plant cover, plant phenology, snow depth distribution, etc..

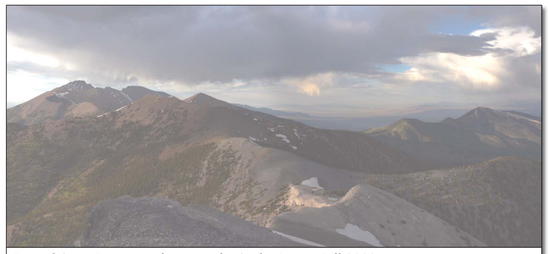
System design has incorporated flexibility in power supply, data storage, and communications capabilities to support a range of future research additions to the initial installations.



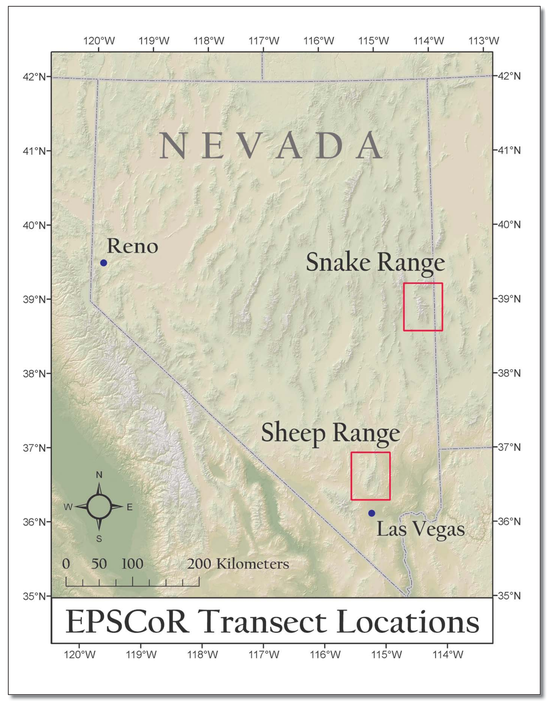
A test tower is set up at UNLV's UWCC hydroecological experimiment center, featuring the primary instrument package, plus sap flow meters and a Geonor precipitation gauge.

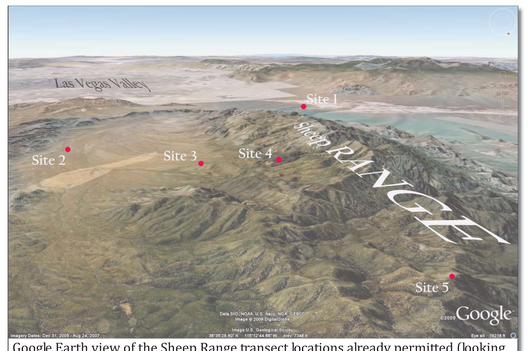
Technician Brian Bird configuring the UNLV test tower. Instrument towers at most of the sites will be 10m in height, and support the meteorological sensors in addition to solar arrays and communications antennas.

This point dendrometer is recording incremental radial tree growth at 30min intervals as part of a site located in Pinyon-Juniper woodland in Great Basin National Park.



Typical Great Basin weather over the Snake Range, Fall 2009.





Google Earth view of the Sheep Range transect locations already permitted (looking south from above Hayford Peak).

SITE LOCATIONS

Location, location, location. With the power of geographic coverage in mind, EPSCoR Climate Monitoring Stations have been organized into two separate "transects", each one traversing a significant Great Basin mountain range. In eastern Nevada, the lofty Snake Range will be fitted with seven individual stations. To the south, the rugged Sheep Range is set to receive five stations.

Each station will be located in a distinct eco-hydro-climatological zone, using both elevation and the vegetative species mix as indicators of likely differences in meteorological and hydroclimatological attributes. This comprehensive approach to monitoring typical Great Basin environment types lends tremendous value to assessing time-series data in relation to climate variability.

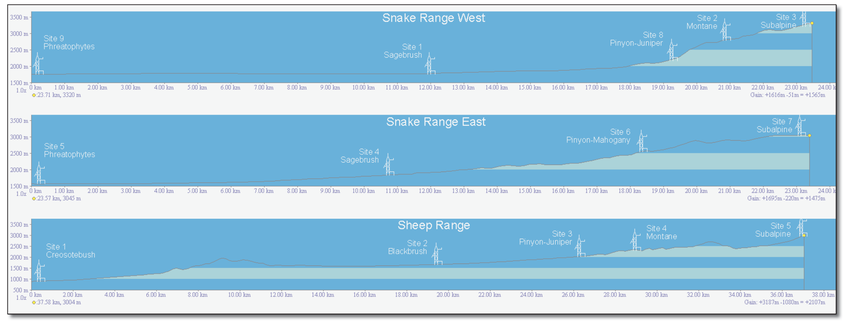
By providing instrumentally-uniform study sites in both north and south regions, the EPSCoR infrastructure allows ecological, hydrological, meteorological, and climatological research to be conducted comparing equivalent elevational zones at differing latitudes, along with observations of long-term implications of variable mesoscale climatology.

Initially, team members evaluated several mountain ranges and dozens of potential site locations. Gradually, as partnerships were formed with amicable landowners and managers, the potential site list was reduced to the nearly final version below.

EPSCoR scientists have reached agreements with a diverse group of landholders, both private and public. In the Sheep Range, all sites are located on U.S. Fish & Wildlife land. In the Snake Range, three sites are located on land owned by the Long Now Foundation (www.longnow.org), one site hosted by the Nevada Land Conservancy (www.nvlc.org), with the final three awaiting permitting by the Bureau of Land Management and National Park Service.

Site	Name/Ecological Zone	Elevation	Vehicle Access	Winter Access	2-Way Communications (Anticipated)	Permit Acquired (Jan 2010)
SNAKE RANGE TRANSECT						
Site 1	Long Now Sagebrush	1790m (5,870 ft)	Yes	Yes	Yes	Yes
Site 2	Long Now Montane	2810m (9,220 ft)	Yes	No	Yes	Yes
Site 3	Long Now Subalpine	3355m (11,010 ft)	Yes	No	No	Yes
Site 4	NV Land Conservancy Sagebrush	1835m (6,020 ft)	Yes	Yes	Yes	Yes
Site 5	Snake Valley Phreatophytic	1560m (5,120 ft)	Yes	Yes	Yes	No
Site 6*	GBNP Pinyon-Mahogany	2590m (8,500 ft)	Yes	No	Yes	No
Site 7*	GBNP Subalpine	3070m (10,070 ft)	Yes	No	No	No
Site 8*	BLM Pinyon-Juniper	2200m (7,220 ft)	Yes	Limited	Yes	No
Site 9*	BLM SV6 Phreatophytic	1750m (5,740 ft)	Yes	Yes	Yes	No
* 2 of these 4 sites will be fully instrumented, pending permit conditions						
SHEEP RANGE TRANSECT						
Site 1	Creosotebush	900m (2,950 ft)	Yes	Yes	Yes	Yes
Site 2	Blackbrush	1670m (5,480 ft)	Yes	Yes	Yes	Yes
Site 3	Pinyon-Juniper	2065m (6,775 ft)	Yes	Yes	Yes	Yes
Site 4	Montane	2320m (7,610 ft)	No	Limited	Yes	Yes
Site 5*	Hayford Peak Subalpine	3015m (9,890 ft)	No	Limited	Yes	Yes
* Hayford Peak location pending logistical review						

Dr. Michael Young confers with Brian Bird and Dr. Franco Biondi at Sheep Range Site 2, a Joshua Tree and Blackbrush community.



TECHNOLOGY

In order to provide years of reliable service, the transect equipment design is being kept as robust and as simple as possible, while still targeting the interdisciplinary science and future research goals contained in the original Project Proposal. Core equipment for data logging and on-site storage is sourced from Campbell Scientific, as are many of the basic sensors. Noteable additions include Geonor vibrating-wire type precipitation gauges, Judd ultrasonic snow depth sensors, Agricultural Electronics point dendrometers, Dynamax sap flow sensors, and Canon webcams.

In addition to the data-gathering packages, the infrastructure will also feature two very necessary but often overlooked systems: Power and Communications. Because each site will be isolated from line power, all energy used to keep instruments running will have to be generated locally using renewable sources. The equipment will rely primarily on solar power to charge a bank of heavy-duty batteries, with the possible addition of wind generators in some locations. The goal of the infrastructure is to provide enough all-season power generation and storage capacity for the present as well as retain the abilty to add future equipment with minimal additional expense.

A communications system is truly the backbone of any remote installation - the amount and type of data delivery drastically alters the applicability of any monitoring system. In order to facilitate usefulness of the EPSCoR installations to a wide range of scientific investigations, communications systems are being considered that utilize as much modern technology as possible, while still providing reliable delivery of data.

While the ultimate goal would be to have high-speed wireless internet connections at each tower, it is clear that some sites will allow this easier than others. Factors that influence comms planning are winter access, annual weather extremes, site power capacity, proximity to internet access points, and costs. Initially, some sites will get minimal communications capacity, and multiple telecommunications technologies will likely be evaluated at the more remote locations over the life of the project for effectiveness and durability.