


Cyberinfrastructure Enabled Environmental Sensors

High Performance Wireless
Research and Education
Network (HPWREN)

Santa Margarita Ecological
Reserve (SMER)
Sky Oaks Field Station (SOFS)

Cabrillo National Monument (CNM)



The **High Performance Wireless Research and Education Network** (HPWREN) is a **National Science Foundation** funded research project, which also functions as a collaborative large-scale cyberinfrastructure, supporting research, education, and first responder activities in remote locations. These activities extensively utilize HPWREN-connected environmental sensors for real-time data, across a vast geographic area in Southern California. An example of the sensor use includes California firefighters regularly accessing high-resolution network cameras, and receiving automated real-time pager alerts when telemetry data shows critical environmental conditions.

The geographic scope of the HPWREN infrastructure extends from San Clemente Island in the Pacific Ocean to east of Salton Sea, and from the border to Mexico to the Joshua Tree National Monument and parts of the San Bernardino National Forest.

An important component since 2001 is the **San Diego State University's** (SDSU) **Field Stations Program** (FSP), with its approximately 4,600 acre **Santa Margarita Ecological Reserve** (SMER) and 1,600 acre **Sky Oaks Field Station** (SOFS). At about 30 miles distance between these two very different environments, they are supported via

separate high-speed links to the HPWREN backbone.

The SMER network is comprised of eleven telecommunication sites (TCS), seven of which are powered solely by solar energy systems. The TCS nodes provide approximately 80% wireless network coverage throughout the reserve, which connects 24 weather stations, three hydrological stations, and 13 remote cameras to the Internet via HPWREN. Also supported are two seismic sensors. The main SMER network backbone operates at around 20Mbps, with secondary links operating at 1-2Mbps. It is connected to HPWREN via a 45Mbps link.

The Sky Oaks Field Station is being utilized for geological, ecological, and global climate change research. Three Eddy Covariance systems measure ecosystem carbon and energy balance, and are also equipped with high-resolution network cameras. **Earthscope's Plate Boundary Observatory** utilizes sensors in a bore hole to measure earth crust movements. In addition, systems measuring nitrogen deposition, weather stations, and vegetation spectral analysis sensors continuously collect data, transmitted in real-time to remote locations via HPWREN.

Another area of current and future sensor collaboration is with the **National**

Park Service (NPS) and its **California Mediterranean Research Learning Center** (CMRLC). To date, this has resulted in four solar-powered real-time high resolution cameras at the **Cabrillo National Monument** (CNM), supporting both public and non-public locations near the Point Loma tidepools. The cameras are used for research and education purposes, as well as to expand access for visitors with disabilities. Connectivity at several megabits per second is available for the **Live Interactive Virtual Exploration** science lectures series and other distance education programs along approximately one mile of shoreline managed by the NPS. It also extends to other areas of the park. Planning is under way to implement more sensors at CNM and other NPS sites.

In addition, a camera and two acoustics sensors support education and behavioral research at the **California Wolf Center**, and collaboration plans on environmental sensors and cameras are well under way with multiple **Native American reservations**.

<http://hpwren.ucsd.edu/>

<http://www.nsf.gov/>

<http://fs.sdsu.edu/>

<http://www.researchlearningcenter.org/>