



Science

An update on science, science education, research, and natural resource management affecting the national parks of the San Francisco Bay Area

Parks for

Global Climate Change and Western National Parks

Global warming is one of the most pressing environmental issues of the 21st century. For many years, scientists have been studying this phenomenon and the evidence is becoming increasingly clear. Earth's climate is warming and some ecosystems like those found in the areas preserved by the National Park Service will experience dramatic changes. While the Earth's climate has changed in the past due to natural causes, the warming trend over the last few decades seems to be primarily the result of human activities. Of major concern is the buildup of carbon dioxide and other "greenhouse gases" in the atmosphere. Many scientists think the American West will experience the effects of climate change sooner and more intensely than some other regions. The West is already warming faster than the East, and that warming is already profoundly affecting the scarce snow and water of the West.

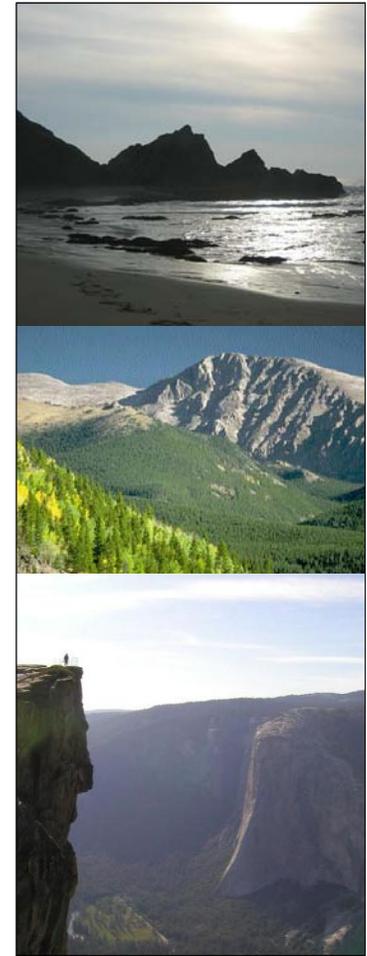
What scientists know...

- In the last 100 years, ambient temperature of the earth's atmosphere has risen 1.4° F. More than 20 % of this change has occurred within the last 10 years, with the 5 hottest years on record, in rank order, being 2005, 1998, 2002, 2003, and 2004.

What scientists think they know...

- The globally averaged surface temperature of the earth is projected to rise 2.5 to 10.4 degrees Fahrenheit from 1990 to 2100 if man-made greenhouse gas emissions are not reduced.
- The Pacific Northwest is

- Regional precipitation patterns are changing with some areas becoming wetter and other areas getting drier; overall, we are experiencing about a 2% increase in global precipitation annually.
- Precipitation in the Pacific Northwest is higher than historical, but snowpack has decreased by more than 30% in the last 50 years.
- With less snow and warmer winters, the timing of spring runoff in the Pacific Northwest is up to 20 days earlier than normal.
- Higher temperatures in spring and summer and earlier melting of the snowpack in recent years have contributed to an increase in the frequency and duration of wildland fires. Recent studies have concluded that a changing climate, not previous fire-suppression policies or land-use changes, is the major cause. The 2006 wildfire season has set a 45-year-high in the number of acres burned.



Western national parks such as Point Reyes National Seashore, Rocky Mountain National Park, and Yosemite National Park are all expected to be impacted by global climate change.

Feature Articles

- 2 Weed Watchers
- 3 Raptor Monitoring
- 4 Giant Underwater Sand Waves

expected to continue to receive less snow in winter with more rain, rain on snow conditions, and mid-winter melting of snowpack.

- Summers in the Pacific Northwest are expected to be drier, especially later in the season and stream flows probably will be lower than normal in late summer. Some mountain streams will become ephemeral (briefer than normal).

What scientists think is likely...

- Globally we are likely to experience more storms and they could be more intense.
- The overall ability of mountain systems to provide fresh water to downstream communities will likely decrease.

Some possible consequences of climate changes to national parks...

- Many of the glaciers in Glacier National Park will be completely gone by 2030. Other national parks are also losing glaciers including North Cascades National Park, which has 60 percent of the land covered by glaciers in the United States south of Alaska. In addition, the dramatic snow-covered mountain peaks of Glacier, Grand Teton, Mount Rainier, North Cascades, Rocky Mountain, Yosemite, and other national parks could be barren of snow in the summers, when most people visit national parks.
- A warming climate will shift vegetative zones northward and the animals that depend on specific vegetation types will shift northward and upwards in elevation, if they are able. Specific zones that are now protected within federal lands, such as national parks, could shift out of a protected status or worse, not be able to shift if the northward area is highly developed. For example, in Yosemite National Park, the pika population is in danger of extinction as warming temperatures occur higher and higher on the mountainsides. Since pikas (small mammals related to rabbits) are native to cold habitats, with each season, the cool habitat in which they make their homes shifts further upslope. Eventually, if this continues, they may have nowhere higher to go.
- The last two remaining grizzly bear populations in the lower 48 states reside in northwestern Montana and in and around Yellowstone National Park. In all, approximately 600 grizzly bears are left where 100,000 once roamed over the western portion of the US and Mexico. Nutrient-rich whitebark pine seeds are a critical food source for the grizzly bears. Warmer winters have enabled bark beetles to significantly increase mortality of whitebark pines

over their entire American range with little sign of relief. Not only does this lower the grizzlies' survival rates, they are now more likely to experience human conflicts in their search for alternate foods.

- Joshua trees, like those found at Joshua Tree National Park, require cool winters and freezing temperatures in order to flower and set their seeds. Researchers have documented substantial mortality of Joshua trees and predict that because of climate warming, the trees will be unable to persist much longer within the park.
- Beaches and other coastal areas of Golden Gate National Recreation Area, Channel Islands National Park, Point Reyes National Seashore, and Olympic National Park have been judged by the U.S. Geological Survey to be highly vulnerable to sea-level rise resulting from global warming. Species associated with the intertidal and subtidal zone will lose habitat.

In perspective, there is little doubt that human activities are having a major impact on the atmosphere and ecosystems of our planet. Fortunately, scientists tell us we already possess the technologies needed to reduce the abundance of carbon dioxide. We also possess the ability to make individual choices to conserve and reduce energy use.

Source: National Park Service, Natural Resources Defense Council, the Rocky Mountain Climate Organization, and United States Geological Survey.

Weed Watcher Invasive Plant Early Detection Volunteer Program

The National Park Service San Francisco Bay Area Network (SFAN) Inventory & Monitoring program (I&M), in partnership with the Golden Gate National Parks Conservancy, has created an invasive plant early detection monitoring system for the Golden Gate National Recreation Area. This program solicits sightings of high-risk plants from trained volunteers, as well as park and partner staff. The "weed watchers" is a pilot program designed to teach participants to identify 50 invasive plants, and then to capture reports of sightings through survey hikes along trails and roads in vulnerable areas where these plants might be invading.

Volunteers learn to identify these invasive plants during guided hikes with I&M staff. Invasive plant sightings are entered into the Weed Information Management System (WIMS), created by The Nature

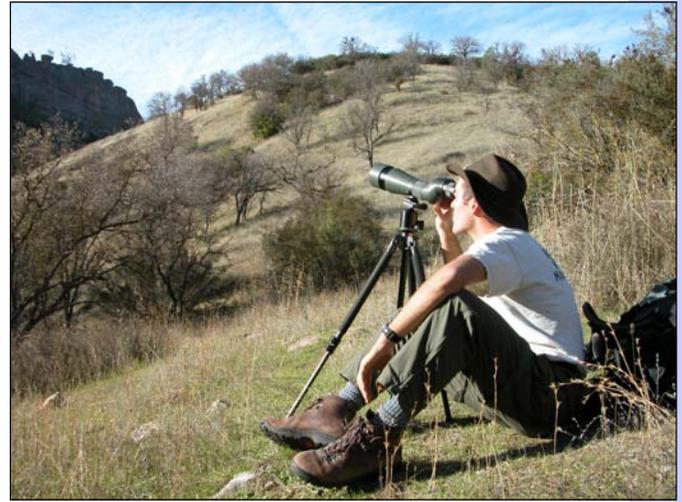
Conservancy, the Sonoma Ecology Center, and University of California-Davis Information Center for the Environment. The WIMS system uses handheld GPS units to capture the location of invasive plant sightings, which are then transferred to a database so that sightings can be tracked and shared with park and partner staff for removal. Once trained to identify the plants and record the necessary sighting information, volunteers can roam trails in the park in search of invasive plants, expanding the search area covered by park staff.

For more information about this program or to volunteer, contact Andrea Williams, Natural Resource Specialist, SFAN I&M program at (415) 331-0639 or Andrea_Williams@nps.gov. Updated information will also be posted to the program's website: http://www1.nature.nps.gov/im/units/sfan/vital_signs/invasive_plants.cfm

Raptor Monitoring at Pinnacles National Monument

The 2006 season marks the 20th year of raptor monitoring at Pinnacles National Monument. This national park unit provides a diverse habitat for numerous cliff-nesting raptors, including sensitive species such as Prairie Falcons (*Falco mexicanus*), as well as a spectacular array of summits and cliff-wall routes for rock-climbers. The objectives of the raptor monitoring program are to determine long-term trends in territorial occupancy and productivity of breeding raptors in the park, and to establish advisory areas to protect nesting raptors from the impacts of climbers and off-trail hikers during the breeding season.

As high trophic-level predators, raptor species serve as important indicators of ecological health at Pinnacles National Monument. As a result, long-term productivity data from raptor monitoring provides resource managers with a measure of park-wide ecological conditions, and provides a basis for continuing to implement advisories in high visitor use areas. Pinnacles National Monument has built a strong and supportive relationship with local climbing organizations, including Friends of Pinnacles and the Access Fund since the climbing advisories are based on specific occupancy and breeding data collected each season. Breeding records are also shared with the Santa Cruz Predatory Bird Research Group and the California Department of Fish and Game to put raptor monitoring at Pinnacles into the broader context of state and nationwide long-term vital signs monitoring efforts.



The objectives of the raptor monitoring program are to determine long-term trends of breeding raptors at Pinnacles National Monument and to establish advisory areas to protect nesting raptors.

Data collected in 2006 confirmed 60 active nests from 13 raptor species, the highest documented breeding numbers for a season on record at Pinnacles National Monument. Ten Prairie Falcon nests produced 30 fledglings, slightly higher than the 20-year averages of 7.9 Prairie Falcon nests and 26.6 fledglings. A nesting Peregrine Falcon (*Falco peregrinus*) pair also produced 3 fledglings for the 2nd consecutive year, after an absence of breeding records for the species in the park for 48 years. Other significant nest records included the first ever for White-tailed Kites and Long-eared Owls, and the first two Turkey Vulture nests confirmed in the park in 22 years. Additional nesting raptor species of concern included Golden Eagles (*Aquila chrysaetos*), Sharp-shinned Hawks (*Accipiter striatus*), and Cooper's Hawks (*Accipiter cooperii*). The long-term raptor monitoring efforts at Pinnacles National Monument help managers to more clearly balance the needs of wildlife and human visitors in the park, and ensure the continuing productivity of the diverse raptor species at Pinnacles.

For more information, contact, Marcus Koenen, Inventory and Monitoring Coordinator: Marcus_Koenen@nps.gov.

Pacific Coast Science and Learning Center's Grant Recipients for 2006

The Pacific Coast Science and Learning Center at Point Reyes National Seashore is pleased to announce our annual minigrant award recipients for 2006. Projects were funded at Pinnacles National

Monument, Golden Gate National Recreation Area, Point Reyes National Seashore, and for the Tomales Bay Biodiversity Partnership. Each project utilizes high school interns as field assistants working one-on-one with researchers to help foster the next generation of scientists who are interested in park management and conservation. Grants range from \$1,000 to \$2,000 and were prioritized according to significance to park management, sound methods, utilization of a high school intern, and matching funds. The following grants received funding:



Paul da Silva

The flowers of spring are better known than the insects they depend on, but this is rapidly changing due to inventory work currently underway.

"Quantitative Dune Habitat Insect Survey at Point Reyes National Seashore" - Dr. Paul da Silva and Dr. William Lenarz, College of Marin

Significance: Because of rare species at Abbotts Lagoon and the extensive restoration efforts there, this has applicability to ongoing management and conservation efforts.

"Examining the incidence, effects and population genetics of Batrachochytrium dendrobatidis in and around Pinnacles National Monument" - Paul Johnson, Pinnacles National Monument, National Park Service

Significance: This is a fungus thought to be responsible for amphibian die-offs around the world and this project is critical to the planning of valley yellow-legged frog reintroductions at Pinnacles National Monument.



Ectomycorrhizal fungi form a symbiotic relationship with specific trees in which fungi gain carbon and other essential organic substances and in return, helps the tree take up water, mineral salts and metabolites. This relationship also helps trees fight off parasites, predators, and pathogens.

"Are microbes dispersal limited? Investigating aerial spore dispersal of ectomycorrhizal fungi at Point Reyes National Seashore" - Kabir Peay, University of California, Berkeley

Significance: Point Reyes National Seashore vegetation and fire programs are still working to understand the

"invasibility" of scrub and grasslands by conifers. This research may be a piece of that understanding.

"Sediment Metal Concentrations in the Rodeo Lagoon watershed (Golden Gate National Recreation Area) and their effects on the surrounding ecosystem" - Dr. David Edwards, Wesleyan College

Significance: Future projects of lagoon restoration, parking lot modification, and native species reintroductions are dependent upon the understanding of the physical and chemical makeup of the area.

"Postlarval Settlement of Green Crabs in Tomales Bay: Implications for invasive and native species management" - Seth Miller, Bodega Marine lab, University of California, Davis

Significance: Invasive European green crabs are a significant non-native predator in Tomales Bay that likely have far-reaching ecosystem impacts on dungeness crabs, shorebirds, and infaunal invertebrates. Understanding how crab larvae disperse and settle may lead to better understanding of potential for control and management strategies. This dataset will also help populate the Tomales Bay Biodiversity Inventory Database with detailed information on green and dungeness crab distribution (www.tomalesbaylife.org).

"Inducible defenses of the introduced oyster drill (Urosalpinx cinerea) in Tomales Bay" - Julia Blum, Bodega Marine lab, University of California, Davis

Significance: This project lays the groundwork for understanding how oyster drills may impact native oysters in Tomales Bay. This dataset will also help populate the Tomales Bay Biodiversity Inventory Database with information on oyster drill distribution and characteristics.

Giant Underwater Sand Waves Revealed for the First Time Ever, Submerged between Ocean Beach and Marin Headlands, Golden Gate National Recreational Area

A field of giant underwater sand waves was mapped in high resolution for the first time ever just west of the Golden Gate Bridge in a cooperative effort by the United States Geological Survey (USGS) and California State University, Monterey Bay. These features are among the largest of anywhere in the world, rivaling such well known sites as the Bay of Fundy in Nova Scotia and Cook Inlet in Alaska. Over 40 large sand waves were mapped, with crest to crest lengths of up to 722 ft and heights up to 33 ft, with the entire sand wave field being submerged in

100 to 350 feet of sea water. The scale of these massive features is unusual because of the modest tide range in the region, as opposed to other sites where large sand waves are present. But these features persist because an enormous flow is forced through the relatively narrow Golden Gate strait resulting in tidal currents that typically exceed 5.6 mi/hr. These strong flows effectively sweep all mobile sediment through the narrowest portion of the channel. However, the large sediment transport capacity of this channel diminishes as the channel emerges from its narrowest region, resulting in the formation of one of the largest sand wave fields in the world.

The survey was completed over 44 days in the fall of 2004 and 2005 using a multibeam sonar system. Patrick Barnard, Dan Hanes and Dave Rubin of the United States Geological Survey (USGS) commissioned and analyzed the survey data that was collected by the Sea Floor Mapping Lab at California State University-Monterey Bay, headed by Rikk Kvitek. In addition to the USGS, funding for this survey was also provided by the United States Army Corps of Engineers and the National Oceanic and Atmospheric Association.

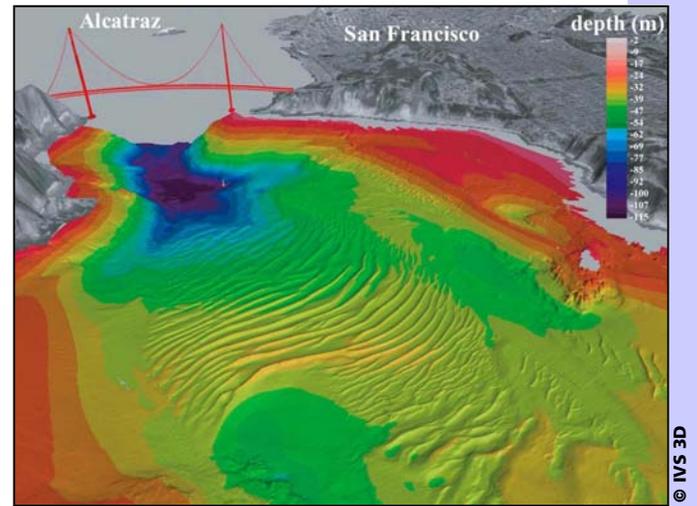
For more information and to see images go to: http://walrus.wr.usgs.gov/coastal_processes/EOS_Transactions

My College Internship at Point Reyes National Seashore, by Adrienne Barrett

As I progressed towards graduation from College of Santa Fe, I was steered toward the National Parks Internship Program. I was told this program consisted of a seven week tenure in any national park in the country. I also learned the internship consisted of substantial reading and writing assignments. It would be a lot of work, but it would also give me invaluable career insight and educational independence.

I knew I was interested in education and outreach about conservation issues, but I wasn't sure which park to choose. My advisor suggested Point Reyes, I had never heard of Point Reyes. As it turns out, I spent seven weeks in the majestic maritime ecosystems of Point Reyes National Seashore between the visitor center, the Pacific Coast Science and Learning Center (PCSLC), and special projects. I was incredibly busy, and incredibly stimulated.

Learning the ropes in the visitor center, such as where maps are located and how to answer the top



Oblique view of the giant sand waves and other bed forms at the mouth of San Francisco Bay. The view is from the northwest toward the Golden Gate Bridge. The city of San Francisco is in the upper right corner. The Golden Gate Bridge is approximately two kilometers long. The land was imaged using digital orthophotos draped over a U.S. Geological Survey digital elevation model.

questions, was all I had energy for in the first three weeks. As I settled into the routine, I found that working in the visitor center was comfortable to me, but working on interpretive and communications projects was exciting.

On my interdivisional days, I worked in the education department of the PCSLC. Their work with the "Coastal Science Review" (a science publication) was very interesting because I enjoy writing and graphic design as mediums to communicate about science to the public. My internship sponsor explained that the publication was going through a remodel, and she offered me the opportunity to collaborate on the new layout. It was challenging to work within the style guidelines of the National Park Service, but working with limitations always strengthens the creative muscles.

The layout work I did with the PCSLC helped me with later work I did for interpretation. I was responsible for creating an interpretive program about Kule Loklo, a reconstructed Coast Miwok village. In the process of creating a program about the site, I had gathered a great deal of information and I wanted to create a self-guided brochure for visitors. At a recent Coast Miwok event, I had taken several photographs of trainers and trainees practicing traditional skills such as weaving, flint knapping, and dancing. I made drawings from these images, and incorporated them into my brochure as graphics. I was thrilled to be able to bring myself to my work for the public and for Point Reyes.



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Parks for Science is published bi-annually to showcase creative and collaborative science, science education, research, and natural resource management supporting science-informed decision making within the national park system and associated academic institutions and partners. The Pacific Coast Science and Learning Center is a part of the San Francisco Bay Area Network of national parks and is located at Point Reyes National Seashore.

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After my summer internship, I definitely knew I wanted to move forward communicating about sustainability and conservation. The people I met through this experience, the people doing the work I want to do, were nothing short of inspiring. All of my supervisors were the intelligent, capable and passionate role models I hoped I would be able to learn from. I preferred the independence of my project days over the structured shifts in the visitor center, so I am not sure that I see myself in the interpretive division in the future. This internship did, however, help me find some direction and focus my learning

objectives. There is definitely a need for creativity in the way that science is expressed to the public. Documentary film, photography, illustration, web design, public speaking and publications (among others) are all fantastic means to this end. The remainder of my college education will be spent refining my skills in these areas, so that in the future, I can be of service to this cause.



Adrienne Barrett

Sunset on Inverness Ridge, one of many images photographed during Adrienne's internship.