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U.S. Department of the Interior
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Top photo: Scenery at McClures Beach on Point Reyes' Tomales Point
Jessica Weinberg, NPS

Climate Change: Where Will Our Beaches and Coastal Wetlands Go?

By Will Elder
Interpretive Ranger

There are many uncertainties about how our local conditions might be affected as the globe warms and climates change. Scientists aren't sure if rainfall will increase or decrease, or if fog will become more persistent or less common. One thing is certain though: sea levels will rise.

Also, as the atmosphere becomes warmer it will hold more moisture, making winter storms more intense. Along the California coast, the frequency and size of winter storm waves are already increasing. Currently, these fiercer storms and bigger waves are having an even greater impact on beach erosion than sea level rise.

The average wave direction also appears to be shifting to the south during strong storms and El Niño events (which may also become more common in a warmer world). This shift in wave direction erodes the south end of beaches while building up the north—a dynamic that is already visible at Ocean Beach in the Golden Gate National Recreation Area.

One of the nation's oldest tide gauges at Crissy Field shows 0.2 meters (8 inches) of sea level rise over the last 100 years. The rate of sea level rise is now accelerating because of melting glaciers and the expansion of sea water as it warms. Scientific projections vary—mainly due to differing greenhouse gas emission scenarios—but all indicate from about 0.5 to 1.4 meters (1.6 to 4.6 feet) of sea level rise by the year 2100. Unfortunately, carbon dioxide is being released at a rate higher than even the worst case projected scenarios.

As our coastlines continue to change, will we also have to change where we spend a day at the beach or watch wildlife along our shores? There is no one answer to this question, as it depends on differences in the geology, topography, and vegetation at each site. Along low-lying stretches of beach, with soft or deeply buried bedrock, scientists estimate that shoreline erosion may happen at a rate of up to 100 to 1. This means up to 100 meters of shoreline retreat for every 1 meter of sea level rise. Harder Franciscan rocks in some parts of Golden Gate and sedimentary and

Continued on page 2

granitic rocks at Point Reyes National Seashore will erode more slowly, but beaches at the base of the bluffs will likely go under water.

In areas with soft bluffs, like around Fort Funston, the cliffs may erode at the 100 to 1 rate, but the beaches at their bases might be maintained by sediment from that erosion. Typically coastal beach sand is supplied by rivers, not bluff erosion. How climate change might affect the way rivers carry and distribute sediment is a big unknown. If it rains more and floods are larger, more sediment could flow downstream, actually making the beaches near river mouths larger.

Tidal marshes and wetlands—vital habitat for a myriad of waterfowl and aquatic life—also are threatened by sea level rise both inside San Francisco Bay and along the coast. In a bit of encouraging news, these habitats may be able to compensate for rising water levels if vegetation can grow quickly enough and there is enough sediment coming in to the area.

That's exactly what happened when groundwater pumping from under wetlands in the South Bay caused them to sink by about 1 meter over just a few decades. Although the wetlands dropped faster than the predicted rate of sea level rise for the next century, they accumulated sediment and organic matter quickly enough to stay above water.

Will Elder, NPS

Already erosion-prone cliffs at Fort Funston will disappear even faster as a result of rising sea levels and fiercer storms

Will Elder, NPS

Big storms that periodically send surf crashing over the road to Fort Point offer a glimpse of what this area might look like in the future

In areas where wetlands cannot build up fast enough, they may shift inland provided there are undeveloped lowland areas for them to move in to. In an urbanized region like the Bay Area though, roads, houses, pipelines, airports, and other key infrastructure crowd the shoreline in many places. The need to maintain this expensive infrastructure will lead us to build seawalls, levees, and hardened shorelines. Unfortunately, these structures cause beach loss and shoreline erosion in nearby areas. Besides, with these structures in the way how will our beaches and wetlands migrate inland?

National and local park lands and other protected areas should provide critical buffer zones between the coast and urban infrastructure. Park managers are considering climate change scenarios in their planning and management decisions, but parks only occupy a relatively small part of the area's shorelines. Local government planners and other organizations also need to set aside inland areas for future wetlands and beaches. Planning for the future now is our best tool, but will it be enough to stand up to the ravages of climate change?

Only time will tell.

Jessica Weinberg, NPS

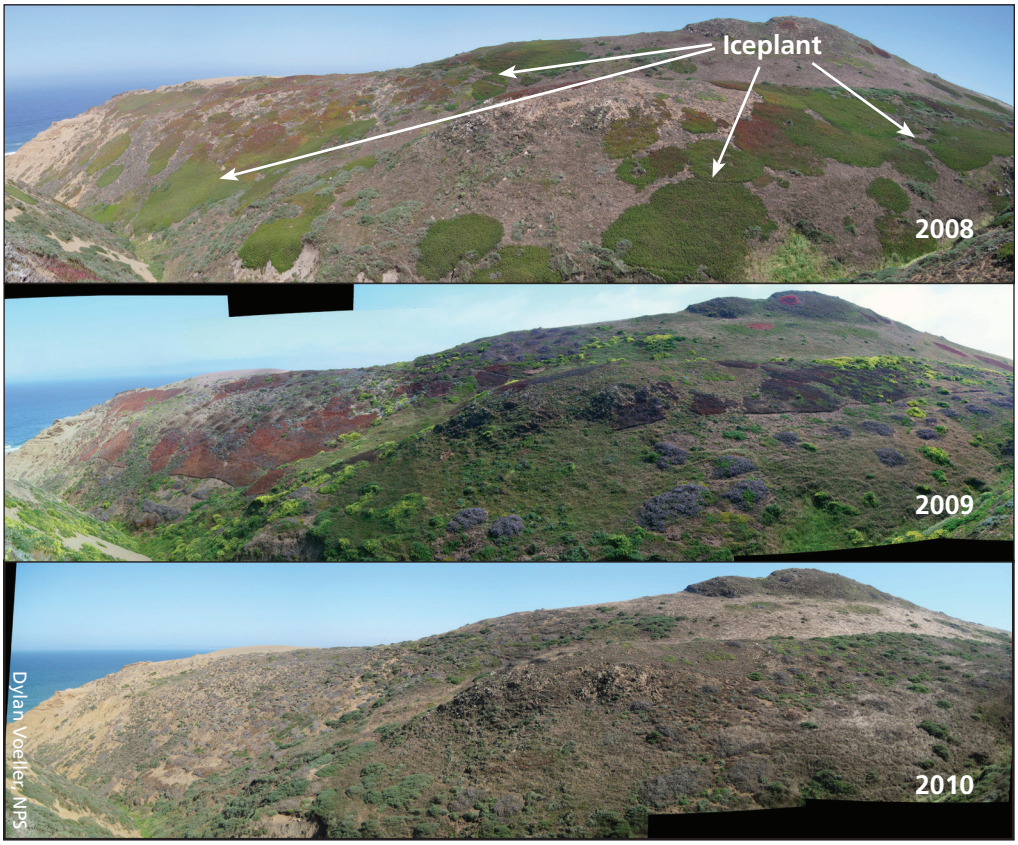
Brightly colored balls show how high the water will get at Crissy Field under different sea level rise scenarios

This article is based on interviews with Drs. Noah Knowles and Patrick Barnard of the U.S. Geological Survey. Interview podcasts and transcripts are available at: http://www.nps.gov/goga/photosmultimedia/climate-update.htm.

For more information visit http://www.pacinst.org/reports/sea_level_rise/.

Dune Restoration at the Point Reyes Headlands

By Jessica Weinberg
Science Communication Intern



The photo series above shows iceplant covering many parts of the dunes (bright patches in the top photo) and then the gradual return of a mosaic of more natural dune habitat over time (middle and bottom photos)

Less than 10 years ago, Point Reyes National Seashore was on the brink of losing the highly visible dunes surrounding the historic Point Reyes Lighthouse—one of the park's most iconic features. This beautiful and complex ecosystem is composed of one of California's only active "climbing" dunes, which has built up on top of more ancient dunes known as paleodunes. Not only are the dunes themselves unique, but they also support 14 rare plants and many extraordinary animals that are all native to Point Reyes, including the endangered Myrtle's silverspot butterfly.

The major threat to these dunes was an aggressive invasive species called iceplant. Originally brought to Point Reyes from South Africa in the early 1900s to stabilize sand along roads to the lighthouse, iceplant has since spread throughout the area, forming dense mats that smother native habitat. This invader was halting the climbing dunes' natural movement, overpowering native plants, driving out wildlife, and potentially triggering a cascade of additional unpredictable ecological consequences.

In many areas of the Point Reyes Lighthouse Headlands ice plant had to be painstakingly removed by hand

Efforts to rescue the Point Reyes Headlands' dunes from a complete iceplant infestation began in 2002. Between 2002-2004 the National Park Service, with the help of volunteers, hand-cleared iceplant from a 100-acre area south of the lighthouse, which resulted in a 20% rise in native plant diversity after three years. Between 2008-2009 they cleared another 80-acre site, both manually and with the careful application of herbicide, and some rare native plants can already be seen where iceplant once grew. Spurred on by these successes, yet another project is underway to remove any iceplant re-growth, eliminate remaining patches of iceplant bordering previous removal areas, and to control other invasive plants likely to hinder native species as they re-colonize. Since anyone visiting the lighthouse will see these restoration efforts from the road, there will also be informative displays to explain what is being done and why.

For now, native plants and animals are reclaiming the dunes in the Point Reyes Headlands. The continued dedication of park staff and volunteers will be necessary to keep it that way, and to eventually reclaim Point Reyes' many other coastal dune systems that are still suffering from invasions of iceplant and other non-native species.

More information can be found at: http://www.nps.gov/pore/parkmgmt/planning_dunerestoration.htm.

Featured Resource: Endangered Black Abalone

A black abalone nestled in a rocky crevice

By Charles Briscoe
Science Communication Intern

Status and Threats

The smooth, dark-shelled black abalone (*Haliotis cracherodii*) can live a remarkable 20-30 years and reach about 4 to 8 inches on its diet of algae and kelp. Once plentiful in rocky intertidal areas between Point Arena and Cabo San Lucas, overharvesting, poaching, and withering syndrome have decimated this once important food source for humans, sea otters, and other marine mammals. The International Union for Conservation of Nature has designated the black abalone as "critically endangered" and they were added to the federal endangered species list in 2009.

The Project

Scientists believe that black abalones are most abundant south of Monterey Bay, but no long-term population survey has been done in the San Francisco Bay Area. With funding from the National Marine Fisheries Service, the Golden Gate National Recreation Area (GOGA) and Point Reyes National Seashore (PORE) recently launched a survey of black abalones within the parks' marine boundaries. The effort is being lead by GOGA aquatic ecologist, Darren Fong, and PORE marine ecologist, Dr. Ben Becker.

Accessing potential abalone habitat was challenging for Fong and his interns, Amy Henry and Kari Eckdahl. Some surveys required extremely early departures, lengthy hikes, and overnight stays in remote areas.

The team conferred with park rangers and Google Earth to figure out which trails offered the safest way to navigate steep coastal slopes. They also consulted with Dr. Peter Raimondi's team at U.C. Santa Cruz who shared their wealth of survey experience, teaching the interns how to identify good black abalone habitat and access it safely.

Because black abalone habitat is below the average low water line, Amy and Kari surveyed on consecutive days during spring tides, which occur around a full or new moon and result in more extreme high and low tides.

Once a promising site was located, Amy and Kari set up a survey plot, took GPS coordinates, drew a map, took photos, and then thoroughly scoured the area for abalone. They noted the presence of other key species like ochre stars, bat stars, owl limpets, red coralline algae, and sea-birds and also took weather data.

If black abalones were found, they documented the site in more detail and conducted a more intense search. Between field days Amy and Kari busily logged all this data, improved their site maps, and planned the next round of surveys.

Looking Ahead

The first round of thirty surveys yielded very few black abalones, but did confirm that they are living within park boundaries. Future investigations will revisit larger sites and those which were inaccessible during the first series. These surveys also identified potential black abalone habitat for future surveys, research, and restoration projects.

Intern Amy Henry was part of the team that gathered data about endangered black abalones and their habitat within the park

Rocky Intertidal Monitoring on Alcatraz

National Park Service biologists monitor intertidal areas at Alcatraz to learn more about these incredibly diverse ecosystems and how the organisms that live there are affected by what happens in San Francisco Bay

By Lily Kelsey
Interpretive Intern

Alcatraz's rocky intertidal fringe has been a natural feature of the island for centuries. It was further expanded by rock removed from other parts of the island between 1869 and 1872 to help keep enemy ships away.

Today, this richly diverse ecosystem is home to numerous species of plants and animals. It is also the focus of both long- and short-term monitoring programs studying the effects of oil spills, natural disasters, and climate change on intertidal habitat.

Alcatraz is one of five sites in the Nationa Park Service (NPS) San Francisco Bay Area Network

A small purple shore crab (*Hemigrapsus nudus*) is one of the many species that call the intertidal areas of Alcatraz home

collecting monitoring data. Other sites in include Bolinas Point and Santa Maria Creek in Point Reyes National Seashore, and Point Bonita and Slide Ranch in the Golden Gate National Recreation Area.

Every year since 1989, NPS staff have counted and measured target intertidal species like mussels, sea stars, and algae. This information is then combined with Multi-Agency Rocky Intertidal Network (www.marine.gov) data collected all along the West Coast. Analysis of this comprehensive dataset gives researchers a broader perspective on the changes taking place along the entire coast, as well as locally.

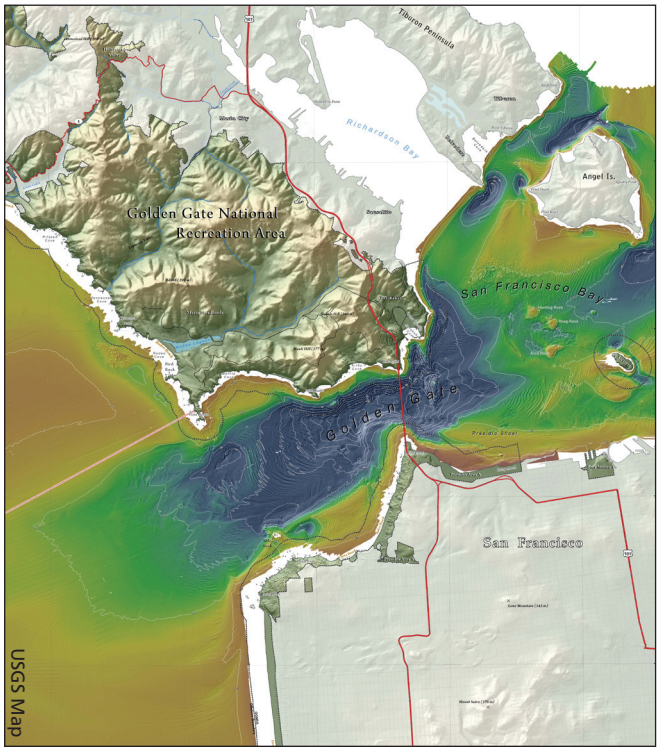
A U.C. Santa Cruz analysis of data collected on Alcatraz showed changes in the populations of the most abundant species as a result of the Cosco Busan oil spill in fall 2007. Species of *Fucus*—a brown algae that is the very base of the rocky intertidal food chain and is also important habitat for many intertidal invertebrates—decreased due to the spill. On the other hand, there was an increase in *Porphyra* and *Ulva*, which are annual "early colonizer" species that recover quickly after disturbances. These findings were used to demonstrate injury to rocky intertidal habitat in the Natural Resource Damage Assessment and restoration planning process, and to identify restoration options for the oil spill.

This year, two visiting organizations lent a hand to the surveys. Moss Landing Marine Laboratories scientists took algae samples from all the different intertidal zones for a study on the presence of introduced species. Researchers from the Smithsonian Environmental Research Center and U.C. Davis surveyed for Asian Kelp (*Undaria pinnatifida*)—a highly invasive species spread by boats and marine equipment that showed up in the Bay Area in 2009.

Fortunately, underwater cameras as well as a visual survey of exposed pilings around the dock and behind the power plant and did not find this invader on Alcatraz.

For more information about these projects and the parks' rocky intertidal areas see http://www.sfnps.org/intertidal.

Habitat Maps Give a New Window into the Deep



Beautiful colors show the contours and elevations of the terrain in and around the San Francisco Bay

By Daniel Strain
Science Communication Intern

An array of animals from Dungeness crabs to schools of rockfish, scuttle and swim between the boulders, shipwrecks and sandy hills that stretch across the bottom of San Francisco Bay and along the coast. In 2009, marine geologists began to pull together a series of sea floor studies to draw an unprecedented map of these nooks and crannies. With these maps, park staff will be able to find and protect the Bay's most important hotbeds of life.

"We tend to look out over the water and just see water," says Tamara Williams, park hydrologist at Golden Gate. "There's a whole other world under the surface that's filled with life."

Decades of intensive human use have left their mark on the bottom of San Francisco Bay. Layers of silt and pebbles—the residue of gold and silver mines along the Sacramento and San Joaquin rivers—hide the estuary's original geology. Bridges, jetties and pipes have since added their own architecture to the sea floor.

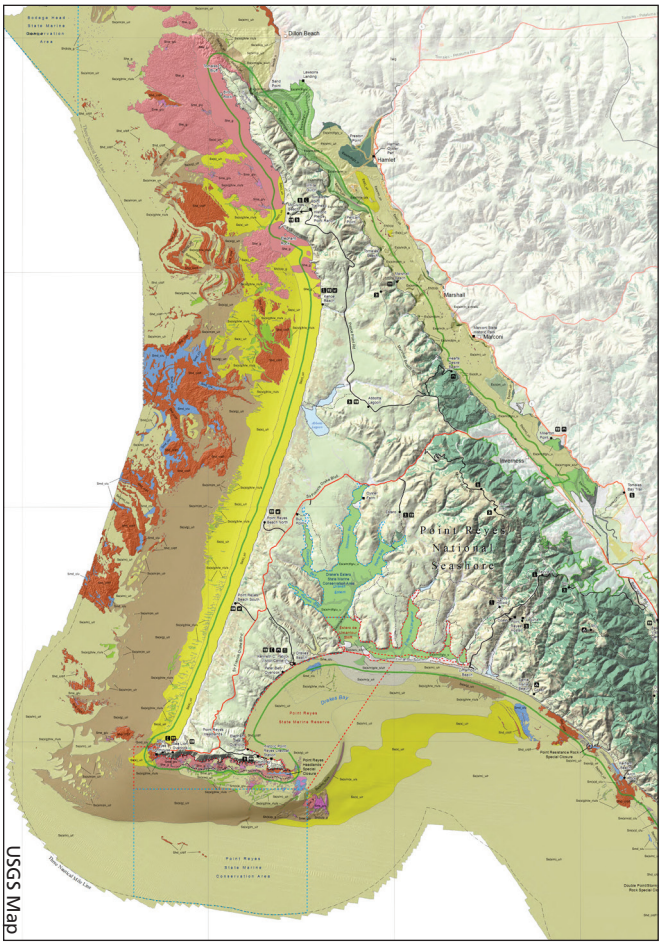
In 2006, the U.S. Geological Survey (USGS) explored this environment bit by bit with sonar and with long scoops that pulled sand and pebbles up for a closer look. Researchers with Moss Landing Marine Laboratories then used the USGS's data to pinpoint natural and man-made seabed habitats.

The team mapped 52 different habitat types from boulder fields to "sediment waves"—underwater ridges that roll with the current—in the Bay and on the continental shelf. Both rock-solid and rolling habitats create important living spaces for marine plants and animals. Rockfish and adult lingcod dart between boulders to catch small fish and escape from bigger ones. Juvenile lingcod hunt among sediment waves, and researchers think that migratory fish, such as salmon, may nestle between the ridges to rest.

Moss Landing researchers just completed a similar exploration of the waters around Point Reyes this year. Scientists have described few other near-shore areas in such detail, Williams says. With new tools to understand bay and ocean bottom conditions, park staff can ensure that future pipelines and cables skirt away from places critical to marine life, as well as avoid high energy areas where construction and maintenance would be difficult.

For ocean-lovers, this deep-water map brings an opportunity to peek at a world that would normally remain hidden. "It's often a challenge for us to get people to think about the bay and the ocean as habitat," but, Williams says, "this makes it a lot easier."

These maps are available at http://www.sfnps.org/marine.



Each color in the map above shows different types of benthic habitats off the coast of Point Reyes National Seashore

New Park Science Website www.sfnps.org

Mason Cummings, NPS

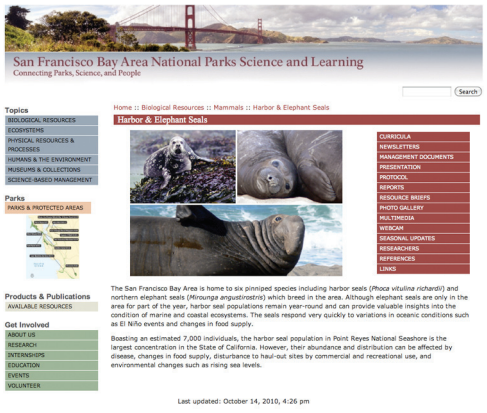
The San Francisco Bay Area Network and its partners launched a new Virtual Learning Center website on November 15, 2010. This new site is a great resource for park and partner organization staff, educators, researchers, and members of the public looking for a broader and more easily accessible source for science and natural resources information.

It also addresses one of the Network's biggest communication hurdles by bringing together science and natural resources information for all San Francisco Bay Area national parks in one place. Available resources include maps, photos, videos, podcasts, fact sheets, briefings, brochures, references, links, research projects, reports, management documents, educational programs, volunteer opportunities, and much more.

This information is provided in a number of ways, including by:

Topic - A view of the home page shows how subject-specific information is organized in increasing levels of detail.

Once a topic is selected (in this case harbor and elephant seals), all available products, researchers, references, and links can be found in the red menus on the right.



Park - in addition to general information, users can search for natural resources information specific to each park.

In the example shown below, a search of vegetation-related topics in Golden Gate reveals available products, shows how many of each kind there are, and includes any featured research projects.

Resource - multimedia, fact sheets, resource briefs, species lists, reports etc... are available all together regardless of topic (in the red menus on the right-hand side of the page.

Http://www.sfnps.org is based on the virtual learning center model developed by the Greater Yellowstone and Southwest Networks. Support for this website comes from the National Park Service's Inventory & Monitoring Program and Pacific Coast Science and Learning Center as well as the Golden Gate National Parks Conservancy and the Point Reyes National Seashore Association. It is part of a larger, nation-wide effort to create a network of similar Virtual Learning Centers.

Engaging Park Visitors in Coastal Resources

By Michelle O'Herron
Science Communication Specialist

Ranger Doug Hee has a variety of techniques he uses to reach different audiences at Point Reyes

National Park Service interpretive rangers play a key role in the visitor experience—from answering basic logistical questions, to the mission-critical task of sharing the stories that bring the parks' cultural and natural treasures to life. I sat down with Point Reyes National Seashore Interpretive Ranger Doug Hee to learn how he meets the challenge of communicating about the park's breathtaking array of coastal resources.

"I think a lot of people really do appreciate what Point Reyes has to offer and are astounded by how beautiful it is." But, Doug says, for the most part visitors ask about what is most visible. Migrating whales, elephant seals, wildflowers, and, of course, the thick and inconveniently view-obscuring coastal fog top that list. "What we try to do as interpreters is to look for opportunities to move that understanding to a higher level."

The fog often provides just such an opportunity. A common question like "Do you guys ever get any sunny days out here?" can offer the chance to connect a visitor to the resource in a deeper way. "If I feel that they're willing to engage with me, I'll say that the fog is the product of upwelling, which is what makes this place *so* diverse. And then I'll talk a little about what that means."

The stunning biodiversity of Point Reyes' coastal and marine environments is one of Ranger Doug's favorite topics. "Even the locals maybe haven't thought about how much there really is here. We can reach people in all stages of their understanding by talking about these ecosystems."

When visitors ask about elephant seals or grey whales Doug mentions cool facts about their deep dives and long migrations, but he may also talk about how these animals were almost hunted to extinction and what people did to protect them. "That's part of what we're trying to do," Doug says "connect people with these stories. Maybe it's extinction, preservation, or survival. These are universal concepts and ideally they are going to be compelling."

The challenge, according to Doug, is knowing which of these ideas will resonate with each visitor. "For every resource or tangible thing there is an intangible meaning that can be associated with it. "But," he says, "that meaning varies from person to person depending on their backgrounds and experiences."

And these connections, if they happen, are not always immediate. "I kind of equate it to teaching, you never know when you've made your impact with someone. It may happen in the moment, it may happen hours or days from now, or it may happen much further down the line." But one thing is pretty certain, it wouldn't happen at all without the hard work and talents of people like Ranger Doug.

National Park Service
U.S. Department of the Interior

Point Reyes National Seashore
Point Reyes, CA 94956
www.nps.gov

Point Reyes National Seashore Association
Point Reyes Station, CA 94956
www.ptreyes.org

Golden Gate National Parks Conservancy
San Francisco, CA 94123
www.parksconservancy.org

Marin County Wildlife & Fisheries Committee
Novato, CA 94947

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