

Climate Smart Actions for Natural Resource Managers Workshop

Case Study: Redwood Creek Restoration at Muir Beach

By Carolyn Shoulders, National Park Service
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Lead Agency/Organization and Partners: National Park Service (NPS), Golden Gate National Recreation Area - Lead agency for planning and implementation. Other partners: Marin County – planning and implementation; Golden Gate National Parks Conservancy – implementation. Funders: California Dept. of Fish and Game, State Coastal Conservancy, U.S. Fish and Wildlife Service, Wildlife Conservation Board, National Park Service.

Project Description: The project is a 46-acre landscape-level restoration at Muir Beach, in southern Marin County, where 20th Century land management actions disrupted the function of fluvial and coastal processes at the mouth of the watershed. The site provides habitat for federally listed coho salmon, steelhead, and California red-legged frog (CRLF), and attracts about 260,000 visitors per year.

This project was not planned as a climate change adaption project. However, its actions are appropriate for climate change planning since they will allow better ecosystem adaptation to changing groundwater elevations, storm surge, tidal influence and more intense flood events.

The purpose of the project is to restore a functional, self-sustaining ecosystem, including wetland, riparian and aquatic components and to conduct the restoration in a manner that will recreate habitat for sustainable populations of special status species, reduce flooding on an adjacent public road, and accommodate visitors in a manner that is compatible with natural resource function.

The historic pre-European landscape featured an open water lagoon that persisted for 5,000 years when sedimentation rates exceeded sea level rise. The lagoon was lost in the 19th Century when sedimentation exceeded sea level rise. In an early phase of project planning, a detailed Watershed Sediment Budget was prepared by Stillwater Sciences and its findings of high sedimentation rates influenced NPS to select a preferred alternative that focused on fluvial restoration, instead of creating the big lagoon. However, extreme sea level rise could lead to conditions more similar to the historic “Big Lagoon” at the site.

Primary objectives for the project are as follows:

1. Remove constraints to natural geomorphic processes such as sediment transport, channel migration, channel-floodplain interaction, and seasonal and long-term beach change.
2. Rely on geomorphic processes to maintain and support the restoration.
3. Accommodate future watershed sediment delivery.
4. Restore natural beach processes.
5. Accommodate physical disturbance (*i.e.*, extreme hydrologic event, storm surge, sediment pulse, etc.).
6. Restore physical complexity of creek channel.
7. Improve coho salmon and steelhead winter rearing habitat.
8. Maintain or improve breeding and rearing habitat for CRLF (*Rana aurora draytonii*).

9. Re-establish natural lateral and longitudinal connectivity among channel, floodplain, riparian, and upland habitats.
10. Enhance native dune processes and increase diversity of native dune communities.
11. Enhance native wetland and riparian plant assemblages.
12. Accommodate visitors in a manner that is compatible with natural resource function.
13. Provide opportunities for public engagement and education.

The estimated project cost is \$10 million.

Approach to Vulnerability Assessment: Vulnerability to climate change effects was evaluated as part of a feasibility analysis and again during preparation of a Final EIS/EIR by consulting hydrologists and engineers, Phil Williams and Associates (PWA). Intergovernmental Panel on Climate Change (IPCC) projections for sea level rise changed during the 5-year period of project planning, and analyses were repeated. Hydraulic models used extreme high tides to estimate the effect of potential sea level rise on upstream flood elevations. Project actions alleviate flood elevations due to the removal of hydraulic constraints and the reconnection of the broad floodplain, and the flood control improvements are generally achieved even with sea level rise. A qualitative approach was used to identify a landward shift of tidal influence, expected increase in groundwater elevations, and beach retreat of 80 to 100 feet, each of which could convert vegetation cover.

Adaptation Actions: Primary actions include relocating a visitor parking lot that functions as a hydraulic obstruction, removing a 1,300 LF levee road bisecting the floodplain, relocating about 2,000 LF of channel to its natural topographic location, expanding an intermittent tidal lagoon, creating off-channel habitat for coho and other salmonids, reconnecting the floodplain by removing artificial fill, constructing a pedestrian boardwalk bridge over a new floodplain for visitor access to the beach, and rerouting a beach access trail to allow foredune restoration.

Implementation: Plans for the project are described in the Final EIS/EIR for the Wetland and Creek Restoration at Big Lagoon, Muir Beach (Dec. 2007). Planning began in late 2002. The first phase of construction began in summer 2009, and as of 2011, the first three of about five phases of implementation have been completed.

Phase 3 actions achieved a primary goal of the project by completing and activating flow in a new 1,437-LF channel alignment. Most of the channel is now fully connected to its floodplain, and the system has an extensive new set of habitat features for coho, steelhead and CRLF. Most of the levee road is removed and a portion of the lower parking lot is removed, with a new 225-LF pedestrian bridge over the floodplain. A new 0.4-acre tidal lagoon expansion and an associated 2-acre floodplain have been restored by removing artificial fill. Some 70,000 native plants have been installed, and about 3,000 hours per year are contributed by volunteers.

The new channel has functioned for only one winter since it was completed, but overbank flows and sediment transport processes thus far appear to function as expected.

Phase 4 actions, expected in 2013, will relocate the visitor parking lot out of the floodplain, construct a boardwalk/bridge over the floodplain for beach access, and restore native foredunes.

Monitoring and Management: Extensive post-project monitoring addresses geomorphology, hydrology and ecology objectives for the project. Adaptive management will be conducted as needed.

Lessons Learned: The project had extensive technical input from hydrologists, ecologists, fish biologists and others at every stage of planning, including the preparation of construction designs. At each stage, refinements were made to the overall conceptual model. This was an expensive and time-consuming process, but the project function was improved as a result.

One of the few things I would do differently is to understand subsurface conditions better as part of early planning processes. This would allow improved planning for soil types, material reuse, likely construction issues, especially for pedestrian crossing over a new floodplain.

For Further Information: Carolyn Shoulders, project manager: Carolyn.Shoulders@nps.gov and two websites: www.nps.gov/goga/naturescience/muir-beach.htm and www.parksconservancy.org/park-improvements/current-projects/marin/redwood-creek.html.

Pre Project
Redwood Creek Restoration at Muir Beach
Golden Gate National Recreation Area

2011/03/25



Post Project
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2011/03/16

