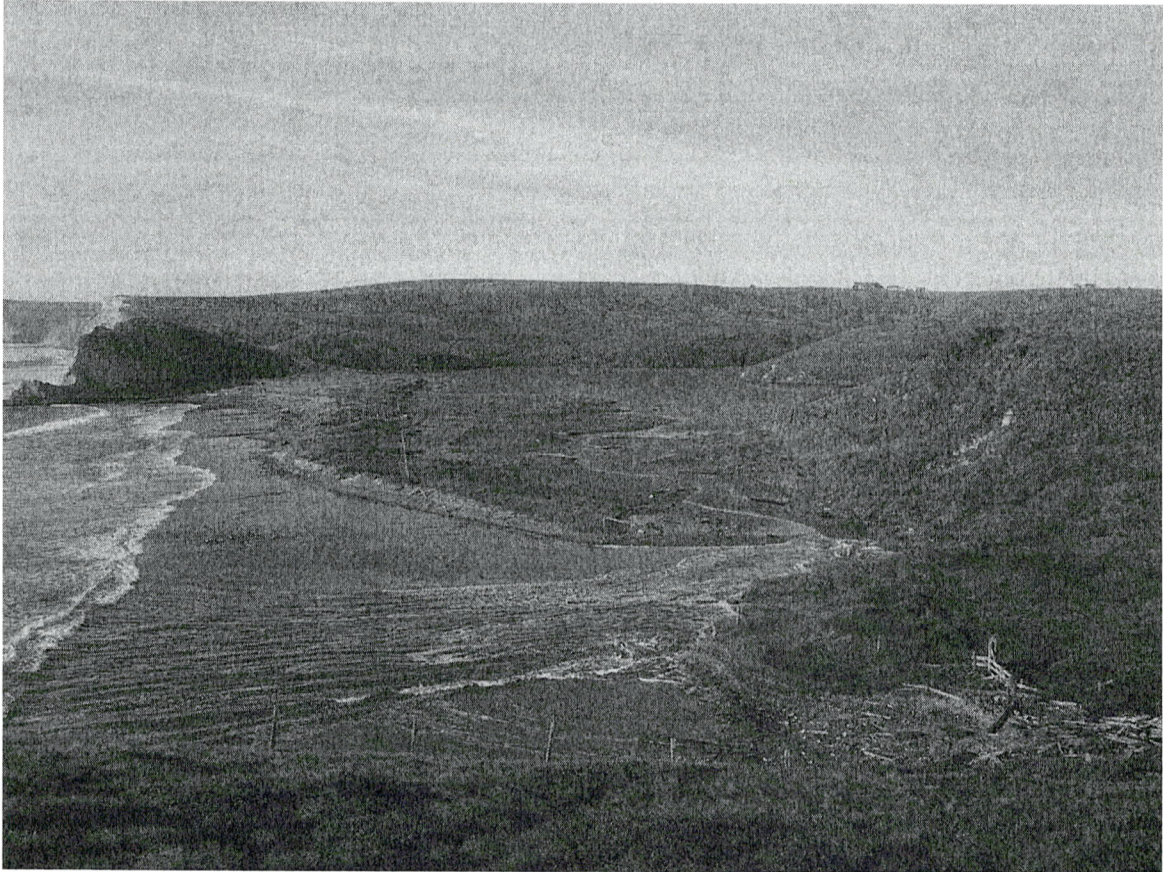


Restoration of Horseshoe Pond to a Coastal Lagoon/Tidal Estuary



Implementation Plan

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Abstract

Though Point Reyes contains a great deal of estuarine habitat, there are a number of areas where artificial ponds have replaced the dynamic tidal system. Horseshoe Pond was constructed between 1943 and 1952 for livestock watering at the now decommissioned D Ranch. Located just west of the mouth to Drakes Estero along Drakes Beach, this site is clearly marked as an estuary in the 1862 US Coast Survey topographic maps, but a 350-m dam at the pond/beach interface currently excludes tidal flow. Historically the 35-acre pond functioned as a summer coastal lagoon and a winter tidal estuary.

Restoration objectives include removal of the dam and concrete spillway, restoration of native dune habitat, closeout of the quarry and old ranch roads, and rehabilitation of associated wetland and stream habitats. Evaluation of the site has been on going since October 2000. A draft Environmental Assessment will be ready for review January 2003. Accomplishments to date include completion of a U.S. Army Corps wetland delineation and report, Cowardin wetland delineation, rare plant surveys, shorebird, waterfowl, and terrestrial bird surveys, wildlife observations, water quality monitoring, fish sampling, topographic surveys, California red-legged frog surveys, and cultural resource surveys have been conducted on site. The Seashore is awaiting response on a Biological Assessment submitted to the US Fish and Wildlife Service in July, 2002.

Implementation will likely be contracted out to a private construction company with site oversight provided by NPS staff. The project and budget is broken into six major tasks, including monitoring. Post-project monitoring will be conducted by graduate level students. The recruiting would be conducted through the Pacific Coast Learning Center and the oversight provided by the PORE Water Resources Branch.

Planning costs for the project have been funded through the Servicewide Dam Safety program funding call and the Point Reyes National Seashore Association (PRNSA). Funding through the Water Resources Division will cover the implementation and monitoring aspects of the restoration project.

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1.0 Introduction

The National Park Service, Point Reyes National Seashore (PRNS), proposes to remove an earthen dam and concrete spillway at Horseshoe Pond in order to restore historic hydrology and alleviate eutrophic water conditions. Located entirely within the PRNS, Horseshoe Pond is a 35-acre coastal lagoon situated on the north side of Drakes Beach near the mouth of Drakes Estero (Figure 1). The site lies within the historic D-Ranch boundaries. This dairy operated between at least 1870 and 1998 when the dairy lease was abandoned and full management returned to the PRNS.

PRNS obtained funding through the Dam Safety Program of the National Park Service (NPS) to deconstruct the dam and restore natural hydrologic process. Aerial photos from 1941 (Figure 2) reveal that the historic outflow of Horseshoe Pond existed in the southwest corner of the pond, opposite the current channel out onto Drakes Beach. The Horseshoe dam was constructed between 1943 and 1952, by the Hall/Horick Family as a road to their east pastures and a hunting cabin on the shore of Drakes Estero. This effectively cut off regular tidal exchange between the lagoon and Drakes Bay.

Within the pond, changes in the hydrologic function since the 1950s have set up conditions leading to degraded water quality and variable salinity. The dam impeded tidal flow into and out of the pond, resulting in development of a much less dynamic aquatic ecosystem. The storage of accumulated nutrients from the former D-Ranch dairy operation exacerbates this problem.

The project area, Figure 3, includes all access roads, the dam removal area, and two potential California red-legged frog (*Rana aurora draytonii*) mitigation sites within the Horseshoe Pond watershed.

1.1 Project Description and Objectives

Located just inland of Drakes Beach, between the mouth of Drakes Estero and the Ken Patrick Visitor Center (Figure 1), the project area was one of a few naturally functioning coastal lagoons within the PRNS. PRNS intends to remove the earthen dam and concrete spillway at Horseshoe Pond that currently restricts salt water intrusion. These actions alone will return the site from an oligohaline pond to a coastal lagoon. Restoration of Horseshoe Pond will likely require complete removal of the current spillway structure and re-establishment of the historic outflow channel. Historic aerial photographs of the site and our knowledge of similarly functioning, unimpaired coastal ecosystems along the central California coast suggest that these objectives will restore Horseshoe Pond to its original ecological and physical function.

PRNS proposes to extend restoration tasks to sites and habitats adjacent to Horseshoe Pond in order to address site rehabilitation at the landscape level. These actions include rehabilitation of the quarry where original fill for the dam was obtained, closeout of old ranch roads, removal of invasive dune species and restoration of native dune habitat.

1.2 Background

The historic D-Ranch complex was built sometime between 1862 and 1871 and became part of Charles W. Howard's holdings through the Shafters/Howard Partition of 1867-70 (Livingston 1995). The Shafters/Howard Partition divided parcels on the Point Reyes Peninsula between Oscar L. Shafter, James M. Shafter, and Howard. After changing ownership several times, Bill and Alice Hall bought the ranch in 1940 after living at the complex and leasing the property from owner Quinto Condoni since 1936. The Halls sold the dairy business to son and daughter Vivian and Bill, Jr. in the late 1940's, although it was Vivian and husband Rudolph Horick who operated the dairy from about 1964 on. In 1971, the Point Reyes National Seashore purchased the ranch and established a 20-year lease and occupancy reservation

agreement with the Hall/Horick Family. Upon Mr. Horick's passing in 1980, Mrs. Horick became the sole ranch operator until her death in 1998. At the time of her death, the ranch was operating under a second, renewed five-year special use permit (SUP) that expired in 2001. The National Park Service was unable to reach an agreement on the future of the ranch with the Horick family and subsequently terminated the SUP, effectively closing the dairy facility and evicting the Horick family.

Aerial photos from 1941 and 1943 reveal that the historic outflow of Horseshoe Pond existed in the southwest corner of the pond, opposite the current channel out onto Drakes' Beach (Figure 2). Visible in these photographs is a broad, sandy channel set against the west slope of the drainage. A large plume of sand is seen washed far into the pond from the channel. From these historic photos, the current channel on the west side of the pond appears to be dominated by exterior dune vegetation and interior wetland vegetation. The 1941 photograph, taken in December, shows a small pond set just behind the foredune.

In late 1940s, the Hall/Horick Family built a road leading down from the ranch complex, across the front of Horseshoe Pond, and up a side drainage to the east pastures and a hunting cabin on the shore of Drakes' Estero (Figure 3). This construction project effectively cut off regular tidal exchange with Drakes' Bay. A bridge/culvert complex was developed to allow pond overflow onto the beach through the historic outflow channel, but the remainder of the historic channel was filled with material provided by a quarry set just behind the cliff, along Drakes' Beach. Additional fill was laid along the entire dune barrier extending over to the east side of the pond.

By 1974, the pond had reached its current observed water levels and the historic channel had almost completely filled with vegetation, presumably the same complex of saltgrass (*Distichilis spicata*) and rushes (*Juncus sp.*) present today (Figure 4). At some point prior to 1974, the culvert/bridge system was removed, perhaps due to failure, and the earthen berm sealed up completely with additional material from the quarry. The earthen dam existed in this state until the early 1980s. Storm events and high water levels in the pond began eroding the road and berm around the current outflow of the pond, such that by 1983 a significant portion of the dam had been lost and the remaining road up to the east pastures overlooking Drakes' Estero was only passable at low water. Severe storms in January 1982 may have accelerated this process.

In 1988, the dairy operation received funding from the NRCS Agricultural Conservation Program to construct an alternate route to the east pastures (Figure 5). The existing 60-ft concrete spillway was built across the outflow of the pond in the east corner and reinforced with rip-rap. To allow vehicle passage, fill was taken from the adjacent slope and laid down on either side of the spillway, once again sealing off the pond to tidal exchange.

Water quality conditions in Horseshoe Pond degraded severely during the operation of the dairy. Dairy cows had direct access to Horseshoe Pond for decades, using the site both as a loafing area and for drinking water. Water quality issues were exacerbated by dumping liquid dairy waste from behind the dairy barns downhill to a small holding pond at the head of the west arm of Horseshoe Pond. In a letter to the Park Superintendent dated January 1988, the Sierra Club Marin Chapter expressed concern that "rotting manure carpeted" much of the Horseshoe Pond flood plain below the holding pond and that water flowing down from the ranch complex appeared yellow. A 1990 draft Ranch Unit Plan prepared by the Park Range Conservationist reported that "the manure stream has overflowed this holding pond and streamed directly into Horseshoe Pond like a viscous lava flow. ...[Horseshoe Pond] served as an ultimate sewage lagoon for the dairy for many years."

The special use permit under which the D Ranch operated was terminated in 1998, effectively closing the dairy operation. All dairy cows were subsequently removed from the project site and surrounding watershed. The earthen dam and concrete spillway remain in place, although a 15-ft section of material adjacent to the concrete spillway washed out in January 2002 (Figure 6). Ocean water now flows into Horseshoe Pond through a constricted opening during extreme high tide and storm events. In the summer 2002, the dam effectively cut off tidal action, and the lowered water level due to the dam breach in January 2002 resulted in the drying of Horseshoe Pond.

Restoration will return both rare aquatic and dune ecosystems to the PRNS by alleviating several existing conditions:

- The earthen dam has significantly altered natural flow regimes at Horseshoe Pond, impeding both natural outflow from the pond and inflow from the ocean during storm and high tide events.
- Nutrient overloading into the system has resulted in eutrophic conditions, indicated by massive algal blooms and wide variances in dissolved oxygen concentration. Periods of anoxia killed several hundred three-spine stickleback in the spring of 2001.
- Up until January 2002, the three-spine stickleback (*Gasterosteus aculeatus*) was the only fish species in Horseshoe Pond, presumably because other fish species were eliminated by previous anoxic events and the concrete spillway prevented upstream migration of marine fish. Previously, fish that tried to move up into Horseshoe Pond became trapped in ponded water between the beach and spillway and later expired when the water dried up. Since wash-out of a section of the dam in January 2002 during an extreme high water event, staghorn sculpin have been documented within the Pond, indicating movement of marine fish into the site.
- The pond now has salinity levels ranging from 0 to 35 parts per thousand. This high range in salinity is not ecologically suitable to many species. Without treatment, the pond conditions will remain highly variable and not likely support many species.
- Upland vegetation and invasive dune species, including iceplant and European beach grass, have replaced rare native dune habitat.
- The quarry, ranch roads, earthen dam, and concrete spillway associated with Horseshoe Pond are blights on the landscape, degrading aesthetic and visual resources of the PRNS. Miscellaneous debris around the dam, left over from the ranching operation, contributes to these impacts.

Restoration of aquatic and dune habitats have been identified as high priority objectives by the PRNS in both the General Management Plan (1980) and the Resource Management Plan (1990). This project will complement restoration projects currently in progress by the PRNS, including the Coastal Watershed Enhancement Project, the Giacomini Wetland Restoration Project, and the Abbotts Dune Restoration Project.

2.0 Project Specifications and Implementation Plan

As noted, the project is pending Environmental compliance. The initial scoping resulted in only a single comment. It is assumed for the purpose of this document that the preferred alternative will be the approved alternative for implementation. This section provides description and implementation plans for the five restoration components associated with the dam facility. The other project component, post-project monitoring, is described under Section 3 of this document.

Restoration components include:

- Removal of the concrete spillway structure and fill,
- Removal of the western most 500 feet of the dam and linkage channel,
- Recontouring and closeout of the access road and quarry adjacent to the dam, and
- Recontouring and enhancement actions on two abandoned waste lagoons for California red-legged frog habitat.

Construction Window

The month of August has been identified as the preferred time period for construction. Weather and tide conditions are commonly more stable, consistent and predictable in the summer. Construction activities on the dam would be initiated one week after the highest tide cycle when overwash through the east channel is likely to occur. In 2002, the east channel and the pond area mostly dried out by August, and was only

rewetted by the extreme high tides. Alternative construction windows would be available during low tide cycles of July and September.

This timing is also important as it occurs after the pond edges dry, allowing for better access by equipment and excavation around the west side of the dam (proposed removal area and outflow channel). Excavation under these conditions will allow for more complete and cleaner removal of normally muddy materials.

Project Sequencing

The project includes five specific treatment locations. The treatments are identified and described in the order which they should be implemented.

Equipment

The project will require heavy equipment including at least:

- excavator with 1-2 yard capacity bucket,
- D-5 bulldozer,
- 10-yard dump truck, and
- loader

Depending on conditions, a water truck will likely be required to control dust and to improve compaction on the quarry recontour site.

Concrete Spillway Removal

The road leading down from D-Ranch and across the front of Horseshoe Pond will access the concrete spillway and associated berm spanning the current outflow channel. Mechanized equipment might impact an area within 20-ft. of both sides of the spillway, a total of approximately 0.27-acres. The dimensions of the concrete spillway are 60-ft.x12-ft.x3-ft. The concrete spillway will be broken up and completely removed from the site, including all reinforcing rip-rap material. Remnants of the spillway will be stockpiled behind the dairy barns at the D-Ranch facility prior to transfer to a local landfill.

The remaining crossing fill will be excavated to the surrounding grade. Approximately 90-yd³ of earthen material flanking the spillway will be excavated and removed as well. This material will be retained within the Project Site at the quarry and used in additional restoration efforts there. Any material not deemed suitable for quarry restoration will be removed from the project area to the D-Ranch staging point and later transported to the Seashore Maintenance stockpile area.

Soils and banks left exposed following removal of the spillway will be compacted, but not revegetated, so as allow adjacent wetland vegetation to naturally fill into these areas. The area surrounding the concrete spillway has a low percent slope and minimal water velocities. No erosion issues are expected.

This portion of the project will require the excavator and dump truck. All site recontouring and compaction can be accomplished with the excavator.

Re-establishment of Historic Channel

In order to restore the historic channel at the west end of the dam, a 500-foot section of the dam will be removed. This component of the dam is entirely composed of earthen material excavated from the quarry when the dam was originally built. Material will be returned to the quarry for restoration of this site.

Although the historic channel was a wide sand flat (Figure 2), saltgrass (*Distichlis spicata*) and rushes (*Juncus lesueurii* and *Scirpus pungens*) have revegetated the area and will need to be partially cleared to recreate the channel from the pond to the beach. Mechanized equipment will impact a total area of approximately 2.25-acres in order to restore the historic channel.

The excavator will work upstream and downstream of the dam to excavate a small 'starter' channel through the historic overwash area. This work would be conducted within the project footprint. The excavator

would work from the lower area and move excavated material up to the dam. The fill would be loaded into the dump truck with a loader and transported to the quarry. Compaction and recontouring at the quarry will be performed with the bulldozer and finished with the excavator (see next section).

Specifications for this channel are not substantial. The channel head should be lower than the outlet to the east. In addition, the excavation will concentrate mainly on removal of the stabilizing vegetation. As noted, the inlet was a wide sandy area. The objective is to facilitate a similar condition through removal of recently recruited vegetation.

The 500-foot section of dam will be excavated last. The excavator will operate from the dam and dig down approximately 2 feet below surrounding contours, or until the bottom of fill material is identified. The dam was constructed by pushing material out on to the sandy beach. It is likely that fill material has spread out and down into the surrounding, sand substrate. The excavator will directly load the dump truck. Through most of the operation, turning and transit of the dump truck will be reasonable. The last section of the dam removal will require the dump to back down to the excavation location. If not feasible, the loader could be used to move some material upslope to a waiting dump.

Restoration of Quarry and Road Close-out

The road access to the dam will no longer be necessary once restoration is complete. The road, within 200 yards of the dam, will be recontoured and closed. The quarry will be recontoured using a bulldozer and excavator. Material excavated from the dam will be compacted on the quarry site and recontoured. The quarry will be recontoured to look similar to surrounding slope conditions. Fill will be placed using eight-inch lifts, and compacted with the tracks of the dozer. A water truck may be made available to wet soils for compaction.

Additional material will be compacted on the inboard side of the roadbed using the bulldozer. Finish work and topsoiling will be conducted by the excavator. The fill portion of the road prism will be excavated and spread over the top of the newly placed road fill. Topsoiling is intended to inoculate the treated area with locally derived and seeded soils.

Erosion control on the regraded sites will include actions to break up and prevent the formation of long flow paths. Regrading actions will leave some roughness in the soil and bio-logs or similar treatments will be installed at contour to detain concentrated flow. Natural revegetation of the site will be augmented with shrubs recovered from the removal areas. The area will be monitored for growth of invasive non-native plant species. Such species would be targeted for removal.

Potential Red-Legged Frog Mitigation Site 1

Site 1 was built for and used as a waste lagoon until the dairy closed in 1998. Though stored manure was removed and levees breached in 1998, the pond remains severely impacted by the organic materials remaining within the facility. The pond is lined by clay with a very steep and high levee on all sides with little to no habitat value. The pond is up to eight feet deep. Because it was a waste lagoon, the only source of water to the pond is from rainfall. Currently rainwater keeps the ponds wet most of the year, with small isolated pockets remaining through the summer. The lifespan of the restored pond facilities will be very long, as there is no source of sediment to fill the pond in over time. The viability of the pond as habitat is high considering the fact that it has yet to dry despite low rainfall conditions.

The restoration and enhancement of this site includes the regrading of pond walls to a lower elevation and slope. Currently the levees are at a 2:1 grade, and can be graded out to a 4:1 slope using the bulldozer. Work on the levees would involve the regrading of 4,500 cubic yards of material. The levees are overgrown with non-native weed and thistle species. Topsoil from the area adjacent to the levees (to be covered) would be stored and spread over the regraded areas. Willow sprigs will be planted along the edge of the pond to provide cover and habitat to aquatic species.

The site is in a relatively flat area and surrounded by heavy grass cover. Erosion is not a concern in the first year. The site will be monitored for growth of non-native invasive weed species. These species would be targeted and removed by Seashore staff.

Potential Red-Legged Frog Mitigation Site 2

Site 2 was historically used as a waste lagoon and was abandoned in the 1980s when the larger facility (Mitigation Site 1) was expanded. The site lies at the base of a small drainage leading down from the ranch and empties into the main stream feeding the west arm of Horseshoe Pond. The road leading to the site is severely degraded with the gullies feeding in to the west arm of the pond. The pond site is currently filled with rich organic material. Restoration of this site will involve excavation and removal of fill and restoration of the levee surrounding the pond.

Treatment would be conducted using the excavator to clean out the pond and the bulldozer to stabilize and strengthen the levee. The road-gully repair and recontour will be completed using the bulldozer.

This is a much smaller pond than Site 1. The average depth of the restored pond will not exceed five-feet. Grading around the pond will insure that rainfall is the primary source of water into the pond. Rich organic material would be removed from this site and transported to the main D-Ranch Complex. This material currently supports a wide variety of non-native weeds. A treatment for the soil is to compost it on the D-Ranch site for use in later years.

2.1 Specifications

The original conception of the project included implementation by the Seashore Maintenance staff. Constraints related to timing and permitting may require the Seashore to contract construction. The Seashore is working with the US Army Corps Rapid Response team with other projects, and considers them as a viable option depending on timing.

Archeological site evaluations discovered a Coast Miwok Indian midden site capped by the eastern portion of the dam. Based on discussions with Coast Miwok Indian representatives, implementation of the project will require at minimum, an archeological resources monitor. Additional field surveys on the west portion of the dam have been completed. These surveys did not reveal any archeological resources within the proposed channel restoration area.

Restoration will include excavation and recontouring of the dam, quarry, and RLF mitigation sites. Extensive gullies flowing to the west arm of the pond will be repaired as part of the work. Road deconstruction will be conducted on approximately 500 meters of road, leading to the dam, and the west arm of the pond.

The restoration associated with this project intends to restore natural process. Simple construction specifications are identified for each of the restoration tasks. Avoidance areas will be identified based upon presence or potential of rare plant species, and the known Coast Miwok midden site.

Surveys of the restored outflow channel on the west side will be conducted to insure that the west outflow channel is lower than the existing channel to the east. The intent is to influence winter outflow and tidal action through the new (and historic) outlet, allowing the eastern spillway area to fill in naturally. Benchmarks will also be installed and monitored on a regular basis in order to quantify geomorphic change and response to this new lagoon pattern.

2.2 Study Tasks, Organization, and Schedule

Compliance:

The project scoping was initiated in summer 2002. Ecological documentation completed to date includes Cowardin wetland delineation, botanical surveys (including rare plants), shorebird, waterfowl, and terrestrial bird surveys, wildlife observations, water quality monitoring, fish sampling, and topographic surveys. Cultural compliance surveys have been conducted through the Sonoma State University Anthropological Services Program. Projected completion of the draft Environmental Assessment is January 2003.

Work involving the dam removal will require permits under the Clean Water Act from both the US Army Corps of Engineers (Section 404), the California Regional Water Quality Control Board (Section 401), and the California Coastal Commission (Coastal Act Consistency Determination). Park staff has completed a U.S. Army Corps wetland delineation and report in preparation for consultation with the U.S. Army Corps of Engineers. A Cowardin wetland delineation has been completed and will be used for compliance through the California Coastal Commission and the NPS DO 71 Wetland Statement of Findings.

Section 7 consultation is required under the U. S. Fish and Wildlife Service (USFWS). The federally threatened California red-legged frog (CRLF) has been documented along the banks of the pond. In preparation for Section 7 consultation with the USFWS, US Geological Survey – Biological Resource Division (USGS-BRD) staff based out of Point Reyes conducted CRLF adult, egg-mass, and tadpole surveys in 2001 and 2002. A biological assessment was developed based upon these findings and submitted to the USFWS in July 2002. The Seashore is awaiting consultation on this project.

Project actions will not be initiated until completion of the FONSI as required by NEPA and Director's Order 12.

Schedule

The schedule is based upon the compliance proceedings. As noted the Seashore has initiated consultation and will be following up with agencies.

The target time for implementation of this project is August, though most work could occur between July and September of 2003. The majority of the work would take 2 weeks, with an additional week for staging and closeout.

Organization

The project is coordinated through the water resources and restoration branch, within the Division of Resource Management at Point Reyes National Seashore. Implementation will be coordinated through this branch, with either the Seashore Maintenance staff or an outside contractor.

3.0 Post-Project Monitoring

As part of the planning process, through outside grant funding, pre-project monitoring has been conducted on the Horseshoe Pond Project site. This includes wildlife, vegetation, wetland, and water quality surveys. The post-project monitoring would be a continuation of this monitoring to determine the ecological response to the restoration. In any manner, this will be a coarse level of monitoring, but will be of enough detail to qualitatively, and in some cases quantitatively (water quality and geomorphic benchmarks for example) describe restoration response and recovery. The monitoring protocol that has been conducted already is similar to that undertaken as part of the Giacomini Wetland Restoration Project. Implementation of post project monitoring will be conducted through the Giacomini wetland ecologist and the original site monitor.

Physical Monitoring

Short-term and long-term physical surveys will be conducted as part of the post-project monitoring program. Short-term surveys will focus on monitoring erosion control procedures. This will include photo-monitoring of regraded sites and performance monitoring of erosion control procedures. Long-term physical monitoring will be focused on beach, channel, and lagoon process. This will include regular surveys of beach and channel condition as well as photo-monitoring from a series of established locations.

Proposed intensive

Physical surveys of the dam and beach have been conducted seasonally. Post construction surveys will define new elevations and allow for detailed hydrologic and geomorphic monitoring. It is likely that some excavation of the pond area near the west side will be necessary to initiate tidal action and flow through the west side. The outlet from the east side will likely revegetate and stabilize over time.

Physical survey benchmarks will be established on site and monitored on a seasonal and annual basis. In addition, the area of the dam is within the USGS LIDAR survey area, and will also be flown in spring 2003 using the new EAARL technology.

Ecological Monitoring

The restoration of Horseshoe Pond will offer a myriad of long-term monitoring components and research questions to explore. Pre and post restoration monitoring is imperative, as the plans to restore estuarine systems altered by dams or levees require an understanding of the existing versus the potential ecological productivity of these constructed impoundments. Monitoring and research methods developed at Horseshoe Pond will be used in the long-term evaluation of other wetland and estuarine restoration projects at Point Reyes, including the Giacomini Wetland Restoration and the Coastal Watershed Enhancement Project.

Ecological resources selected as long-term monitoring components at Horseshoe Pond include waterfowl and shorebirds, fish, California red-legged frogs, benthic and epibenthic invertebrates, plankton, and water quality. All of these resources have been or will be inventoried prior to restoration either as data for inclusion in the Environmental Assessment or for general pre-restoration inventories. Data collection methods following restoration will be analogous to methods used before restoration in order to collect comparable data by which to analyze the effects of restoration.

PRNS has identified waterbirds and shorebirds as indicator species for long-term monitoring, and contracted the Point Reyes Bird Observatory to conduct an inventory of waterbirds and shorebirds at Horseshoe Pond and other sites in 1999. Public concern has been raised as to the impact of any changes in the current conditions at Horseshoe Pond on water and shorebird use. In response to this concern, we have surveyed water and shorebirds within Horseshoe Pond monthly since April 2001 and will continue to do so through the course of the project. These surveys may additionally be used to elucidate relationships between lower and upper trophic levels during the course of our research.

Fish sampling methods will model work conducted in other shallow water environments within the region. Within selected sampling areas, a six-paneled, floating, variable-mesh gill net will be deployed, coupled with four folding minnow traps. The gear will be fished for approximately 18 hours. Supplemental beach seining where possible along select areas of the pond edge may document additional fish species present, particularly flat fish. Preliminary net and trap sets in July 2001 caught only one species, three-spine stickleback, revealing a very depleted fish diversity in the pond.

Infaunal invertebrates will be sampled using a hand-coring device. We will use an available corer, developed by the Sonoma County Water Agency, which is 45-cm long, 15-cm in diameter, and samples to a depth of 20-cm. Field trials will determine the number of replicates needed from each sampling grid and whether or not specimens should be enumerated from a sub-sample. Epibenthic invertebrates will be collected with litterbags filled with native wetland vegetation.

Horseshoe Pond falls within critical habitat designation for the federally threatened California red-legged frog. Despite salinity levels as high as 14 ppt, RLFs have indeed been documented along the banks of the pond and associated source streams. Surveys for the RLF will continue as part of the post-restoration monitoring program.

High phytoplankton productivity and eutrophication within the pond has resulted from historically high nutrient loading from the associated dairy and lack of mixing with the marine environment. Chlorophyll *a* concentration will be used as an indicator of phytoplankton standing stock. We will retain a subsample in order to identify dominant species to the lowest possible taxonomic level. The zooplankton community has

likely been severely altered by the damming of Horseshoe Pond and may respond dramatically to restoration. We will sample zooplankton vertically using a conical tow net with 60-µm mesh size. Samples will be preserved in 70% ethanol and enumerated using a dissecting microscope in accordance with standard pipette methods.

Water quality data have been collected at Horseshoe Pond since October 2000 at six sample sites. Salinity, dissolved oxygen, conductivity, specific conductance, pH, and water temperature are measured approximately twice per month with hand held field instruments. Laboratory analysis (Brelje and Race Laboratories, Inc., Santa Rosa) of fecal and total coliform, ammonia, orthophosphate, nitrate, and nitrite occurred in October 2000, January 2001, and March 2001 in cooperation with the PORE Water Quality Monitoring Program. Continued water quality monitoring will be critical in determining if habitat for aquatic species has been improved following restoration.

Biological data collected during the course of this study will be cataloged in a Microsoft Access database. Information on species newly documented within Point Reyes National Seashore will be forwarded to the Network Inventory and Monitoring coordinator for addition to the NPSpecies database. Documents produced through the course of this project will be added to the NRBib database and linked to species occurrence records in NPSpecies.

4.0 Budget

The bulk of the requested project costs will be applied towards actual restoration of the pond and associated watershed. The budget request also includes funds for an archaeological monitor representing the Federated Indians of Graton Rancheria that will be on site during the construction phase of the project. Implementation will likely be contracted out to a private construction company through the US Army Corps Rapid Response Team, with site oversight provided by NPS staff.

The project and budget is broken into six major tasks, including monitoring. The attached budget estimates treatment costs for each of the project tasks. This will be used to evaluate the contract bid process.

Post-project monitoring will be conducted by graduate level students. The recruiting would be conducted through the Pacific Coast Learning Center and the oversight provided by the PORE Water Resources Branch.

Materials needed for conducting the ecological and physical evaluation of the pond will be provided by PORE. Additional equipment has been purchased through the PRNSA donation account. PORE will also cover costs of some water quality laboratory analysis through the Water Quality Monitoring Program.

Table 1. Budget outline for Horseshoe Pond Restoration

Item	FY03	FY04
Site restoration		
Mob/Demobilization	\$5,000	
Task 1: Removal and disposal of concrete dam	\$4,000	
Task 2: Excavation of dam	\$13,000	
Task 3: Recontour & Closeout Quarry and access road	\$8,000	
Task 4: Recontour and Enhance Mitigation Pond Site 1	\$8,000	
Task 5: Recontour and Enhance Mitigation Pond Site 2	\$10,000	
Miwok Indian Site Monitor during dam work (\$400 per day)	\$2,000	
Task 6: Post-restoration ecological evaluation	\$12,500	\$12,500
Total	\$62,500	\$12,500

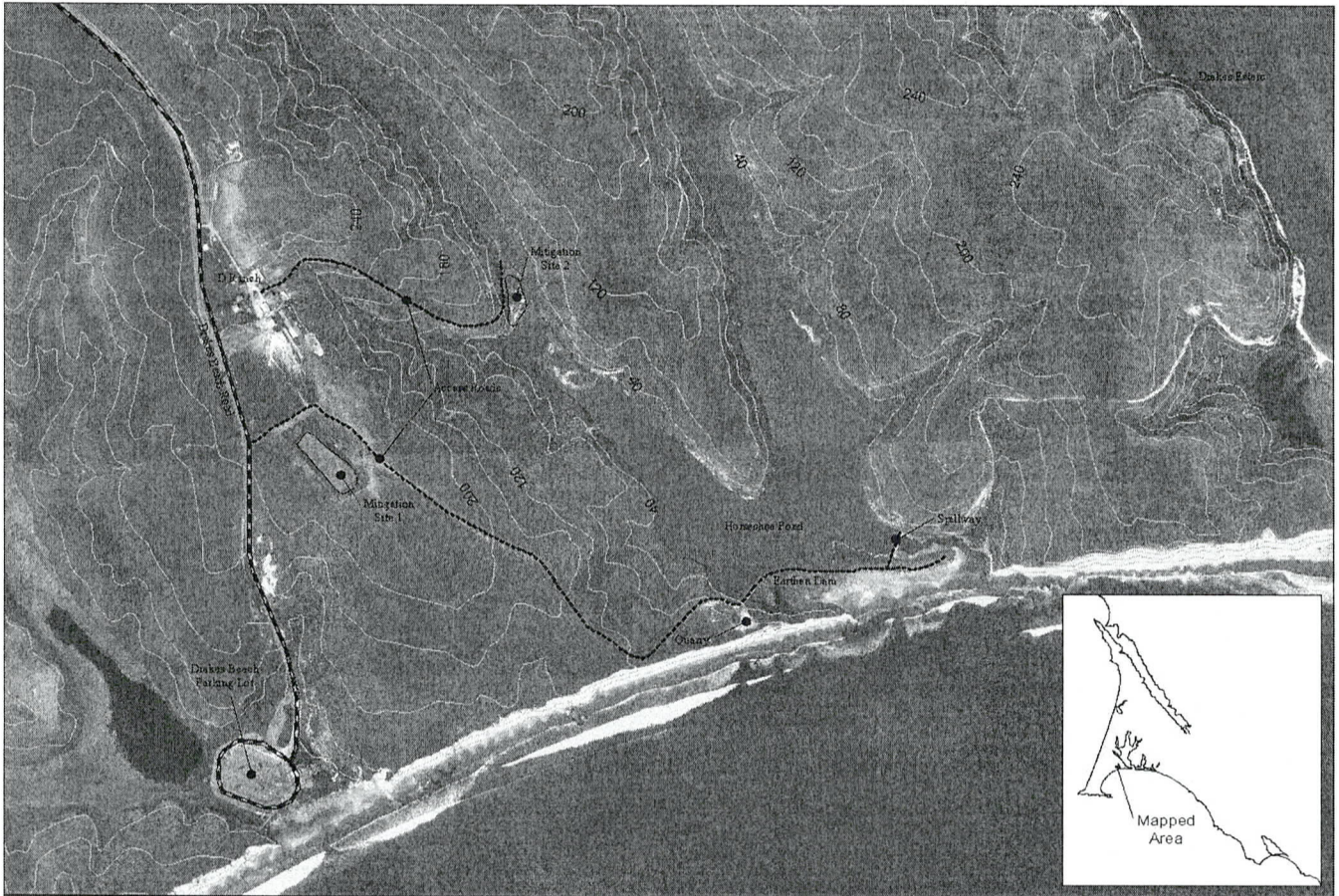


Figure 1. Horseshoe Pond Restoration Site.



Point Reyes
National Seashore





Figure 2. Horseshoe Pond Restoration Site – December, 1941.



Figure 3. Horseshoe Restoration Project Area.



Point Reyes
National Seashore



0 50 100 150 200 Meters



Figure 4. View looking towards the oceanside of Horseshoe Pond.

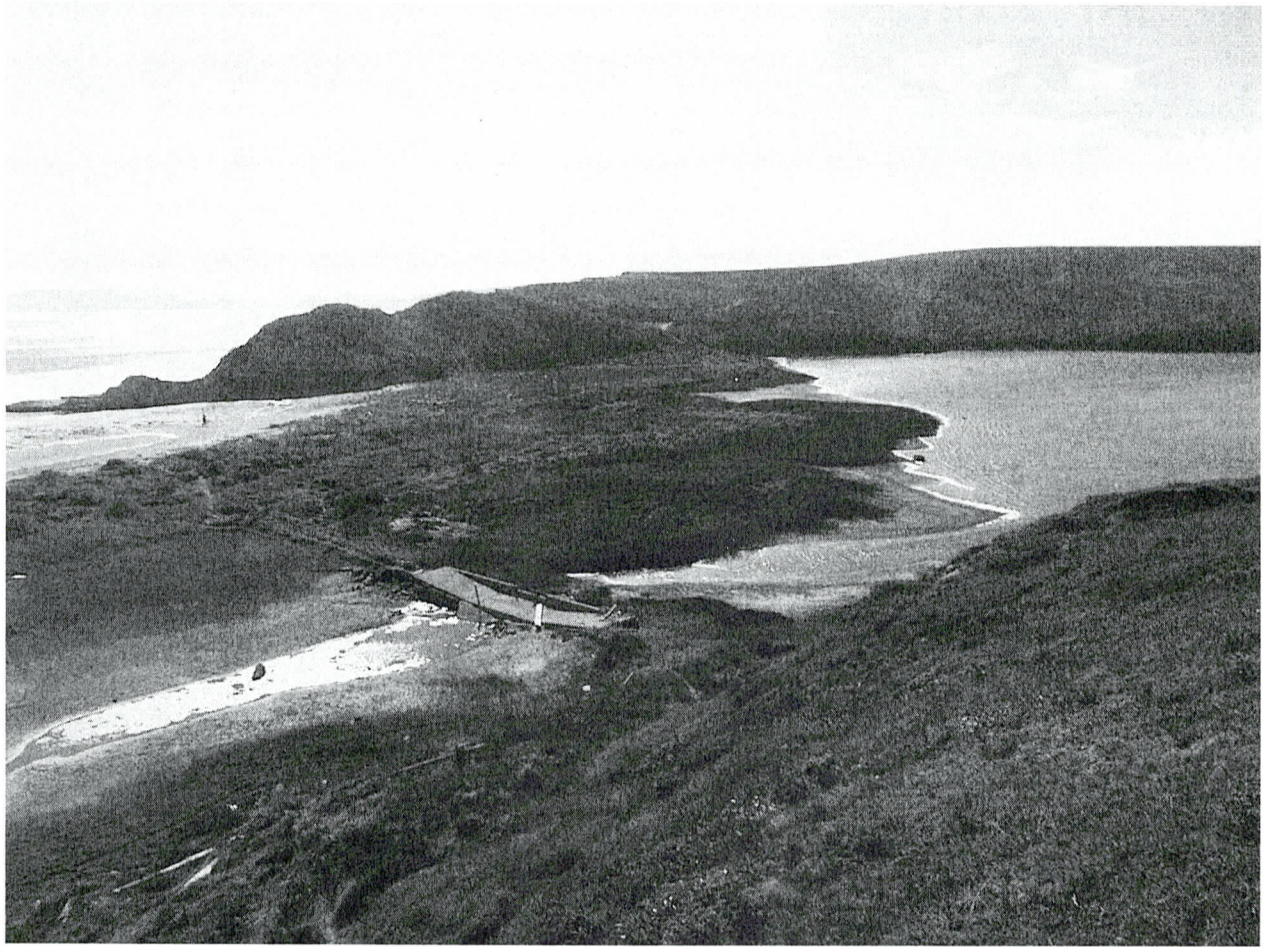


Figure 5. View of the concrete spillway in the southeast corner of Horseshoe Pond.



Figure 6. Spillway Breach - January 2002.