

Appendix C. Past and Current Management of Selected Tidal Wetland Sites

Maps and photographs of wetland sites can be found at <http://www.elkhornslough.org/tidalwetlandproject>.

Site 1. Parsons Slough/South Marsh Complex

Acreage/Location

The Parsons Slough/South Marsh Complex (including Five Fingers) is located on the southeastern area of Elkhorn Slough. The entire complex is approximately 429 acres (174 hectares) in size and the main areas are dominated by mudflat areas with some subtidal creeks, fringing tidal marsh, and created tidal marsh islands.

Past Human Activities (Modifications/Restoration/Management)

In the past, the Parsons Slough/South Marsh Complex was dominated by tidal salt marsh and tidal creeks. In 1872, a railroad was built along the western side of this area and this railroad embankment blocked off the connections of about half a dozen tidal creeks. Railroad bridges were constructed over two of the main tidal creeks (mouth of Parsons Slough and just south of Hummingbird Island) allowing these connections to remain open. In 1902, a group of San Francisco businessmen purchased the land of South Marsh and started the Empire Gun Club. By 1913, this group created a number of large, artificial freshwater ponds (converted from tidal marsh) in the South Marsh area using earthen dams to enclose the areas and pipes to convey water from freshwater springs for the purpose of encouraging waterfowl prized for hunting. A few large, artificial freshwater ponds had also been created in Parsons Slough for duck hunting by 1913. One of these large ponds was created by blocking off four of the six fingers of Parsons Slough with an earthen dam.

In the 1920s, J. Henry Meyer purchased the South Marsh property and the Elkhorn Dairy was established. By 1956, the entirety of South Marsh was enclosed with large levees, cleared, leveled, and drained, converting the tidal marsh and duck ponds to pastureland for dairy cattle. This diking blocked one of the two remaining tidal creeks to South Marsh just south of Hummingbird Island and separated South Marsh from Parsons Slough (except for 1-2 areas in the levees that look like they may have had some sort of water control structures that could have been used as drainage during heavy rain events). Another levee, constructed across the mouth of Parsons Slough between 1949 and 1956, completely removed the remaining major tidal creek and marsh areas from tidal exchange. This levee may also have contained some sort of water control structure such as a flap gate that could have been used to facilitate drainage of water out to the main slough during this time. The draining of the tidal marsh areas in the Parsons Slough/South Marsh Complex between 1931 and 1956 caused the marsh sediment to dry out, compact, decompose, and subside by several feet. Between 1956 and 1980, a levee breach opened four of the six fingers of Parsons Slough and allowed flood waters to drain into Parsons and the main slough.

In 1980, part of Elkhorn Slough (including the majority of the Parsons Slough/South Marsh Complex) was purchased and designated as a National Estuarine Sanctuary. The Elkhorn Slough National Estuarine Research Reserve (Reserve), as it is now known, is one of a network of 27 protected areas nationwide that were established for long-term research, education and stewardship through federal-state partnerships. The Reserve is owned and managed by the California Department of Fish and Game (CA DFG) in partnership with the National Oceanic and Atmospheric Administration (NOAA).

Soon after the Reserve was designated, planning efforts were started with the purpose of returning the grazing land of South Marsh to wetland. The proposed plan consisted of creating four experimental tidal salt marsh (including tidal creeks, mudflats, and islands) areas at two different scales behind levees and dams (that could be manipulated), two smaller freshwater wetlands, and causeways for public access on 50 acres. Sediment would have to be excavated to create the tidal creeks and built up (with gradual slopes) to create vegetated, tidal marsh. In order to restore tidal exchange to the salt marsh areas, it was proposed that the Parsons Slough-South Marsh levee (just north of the Parsons Mouth levee) would be breached. This wetland plan was submitted for permit approval in 1981.

During winter of 1982-1983, the Parsons Mouth levee breached during a storm event allowing tidal waters to enter both South Marsh and Parsons Slough. There was an attempt to curb the flooding, but the currents were too strong. Even though some of the earthwork had already started in the South Marsh project site, the preparations had to be delayed and eventually when conditions allowed, water was pumped out to finish construction work. During this time, the proposed project plans were changed to a series of straight channels and habitat islands (as we see today) that would receive tidal exchange (changing the focus of this project from more of a replicated experimental approach to a wetland enhancement approach). During the spring and summer of 1983, these new proposed plans were resubmitted for permit approval (as amendments), went out for bid, and channel and island construction began. In the fall of 1983, the Parsons Slough-South Marsh levee was breached restoring tidal exchange to this area. Since that time, pickleweed established on the tops of the islands and small-scale plantings were done in the high marsh areas of South Marsh. Bank erosion has significantly decreased the width and length of these habitat islands since they were first constructed.

Because of severe land subsidence that occurred during the years that the wetland was drained and used as pasture, the average land elevation in the Parsons Slough/South Marsh Complex is now approximately 2.4 feet (0.7 meters) below what can support marsh vegetation. Apart from a few constructed tidal marsh islands and fringes of tidal marsh adjacent to upland areas, this land elevation currently supports mudflat habitat.

Current Management/Ownership

The majority of the Parsons Slough/South Marsh Complex (except for a few tips of Five Fingers) is owned and managed by the California Department of Fish and Game as part of the Elkhorn Slough National Estuarine Research Reserve in partnership with NOAA.

Site 2. North/Estrada Marsh Complex

Acreage/Location

The North/Estrada Marsh Complex is located on eastern side of Elkhorn Slough. This marsh complex is separated from the main system by a railroad embankment and tide gates. North Marsh, approximately 124 acres (50 hectares), is dominated by a mix of open water, mudflat, and fringing salt marsh habitat that is currently managed with a muted tidal range through the use of tide gates. Estrada Marsh, approximately 46 acres (19 hectares), is covered mostly with pickleweed and open mud pannes. North Strawberry Marsh is approximately 8 acres (3 hectares) and South Strawberry Marsh is approximately 5 acres (2 hectares).

Past Human Activities (Modifications/Restoration/Management)

In 1869, Elkhorn Road was constructed on the east side of North/Estrada Marsh Complex, and it, at least minimally, reduced tidal exchange into Campagna and Strawberry Marshes.

A railroad, built in 1872 along the west side of North/Estrada Marsh Complex, blocked three of the four tidal creek connections (one to Estrada Marsh, three to North Marsh) from the main channel of Elkhorn Slough. The remaining tidal creek opening is under a railroad bridge with an open trestle.

In 1902, the Empire Gun Club purchased the land of the North/Estrada Marsh Complex. By 1913, this group created a number of large, artificial freshwater ponds (converted from tidal marsh) in the North/Estrada Marsh Complex using earthen dams to enclose areas and pipes to convey water from freshwater springs for the purpose of encouraging waterfowl prized for hunting. Between 1913 and 1931, landowners removed the southern half of North Marsh from tidal exchange by enclosing it with large levees so it could be drained. A levee was built separating Estrada Marsh from North Marsh between 1937 and 1949. By 1956, the entire North/Estrada Marsh Complex (including North and South Strawberry and Campagna Marshes) was removed from tidal exchange by a series of levees. One of these levees (with a horseshoe-

shape) blocked off the remaining large tidal creek connection from the main Elkhorn Slough system. This levee may have contained a water control structure such as a flap gate that allowed freshwater to enter Elkhorn Slough during flood events, but did not allow tidal waters to enter this area. The draining of the tidal marsh areas during this time caused the marsh sediment to dry out, compact, decompose, and subside by, on average, 1.9 feet (0.6 meters).

The California Department of Fish and Game acquired North Marsh in 1980 and Estrada Marsh in 1993 as part of the Elkhorn Slough National Estuarine Research Reserve. Soon after the Reserve was designated, CDFG managers began discussing the possibility of restoring tidal flow to 124 acres (50 hectares) of reclaimed North Marsh lands to enhance habitat by excavating tidal creeks, creating habitat islands, and grading to add topographic features. The plan was to have the maximum tidal inundation possible without flooding Elkhorn Road to the east by adding tide gates to the previously blocked culverts in the horseshoe-shaped levee by the railroad bridge. During major storms in December of 1982, the horseshoe-shaped levee failed causing Elkhorn Road to flood. Monterey County then raised the road in 1985 to mitigate the effects of flooding. That same year, contractors were hired to replace the failing water control structures. Once this work was completed, tidal action was returned in the summer of 1986, through four new tide gates.

Like many structures used in marsh management, the North Marsh levee and tide gates have required a great deal of maintenance, repair, and continued, intensive management over the years. Repairs have included the rebuilding of the main levee after a washout in the early 1990s; the replacement of several rusted tide gate stems; and repair to gate hinges. Maintenance has included the annual placement of several tons of sandbags on top of the levee to prevent overtopping by extreme high tides; the building up of levee elevation using dirt and large riprap; annual cleaning of gate flaps and removal of fallen riprap by SCUBA divers; and monthly maintenance of all tide gate stems. Ongoing management involves the opening and closing of tide gates to adjust water levels.

The earthen levee separating North Marsh and Estrada Marsh partially eroded in the summer of 2003, resulting in a narrow creek (approximately 1 m wide) between the two wetlands. This creek has restored a minimal amount of tidal flow to Estrada, but it is currently too small to allow for full tidal exchange. Currently, tidal flow enters Estrada, but does not appear to drain. Instead, ponded tidal water evaporates over the summer months, resulting in seasonally hypersaline conditions throughout much of the Estrada marsh.

Current Management/Ownership

North Marsh is owned and managed by the California Department of Fish and Game as part of the Elkhorn Slough National Estuarine Research Reserve in partnership with NOAA. Estrada Marsh is also owned and managed by the California Department of Fish and Game, but is not part of the Reserve system.

Site 3. Azevedo Marsh Complex

Acreage/Location

The Azevedo Marsh Complex is located on the eastern side of Elkhorn Slough, approximately 4.5 miles from the mouth. These marshes are named Northern Azevedo Pond (12.2 acres), Middle Azevedo Pond (6.3 acres), and Southern Azevedo Pond (2.3 acres). In some reports, the Northern Azevedo Pond (NAP) is further divided into north and south sections.

Past Human Activities (Modifications/Restoration/Management)

The Azevedo Marshes are separated from the main system by a railroad embankment (built in 1872). There are openings under the railroad embankment that contain four wooden box culverts (three contain 8-15 inch diameter pipes) located in Northern Azevedo Pond-North site, Northern Azevedo Pond-South site, Middle Azevedo Pond, and Southern Azevedo Pond.

There is also an earthen, horseshoe-shaped levee on the east side of the railroad culverts at the NAP North site (which seems ready to fail and is definitely overtopped at high tide). It is likely that the levees were built to prevent tidal inundation to farmland after the Harbor mouth was constructed and to provide greater control of freshwater drainage.

The 135-acre (55-hectare) Azevedo Agriculture and Natural Resource Site was purchased in 1991 by the Monterey County Agricultural and Historic Lands Conservancy (MCAHLC) and The Nature Conservancy (TNC) through a State Coastal Conservancy (SCC) grant (included both wetlands and uplands). The reason for this acquisition was to protect agricultural and natural resources on the site by developing a working farm and research site to evaluate methods to reduce impacts from agriculture on resources areas in a cost effective and practical manner. Agricultural use was pulled back from the edges of these pocket marshes for the establishment of 100-ft wide vegetated buffers strips from 1994 to 1995. Since the 1990's, sediment basins and other erosion control improvements have been installed at the Azevedo sites and continue to be installed as needed. In 1993 an *Enhancement Plan for the Azevedo Marshes: Hydrologic Elements* report was prepared by Robert Coats of Philip Williams & Associates, Ltd. for The Nature Conservancy. Then, in February 2000, an *Azevedo Agricultural and Natural Resource Site Management Plan* for the MCAHLC and SCC (in cooperation with TNC and the Elkhorn Slough Foundation) was prepared by Laurel Marcus and Associates. These plans recommended wetland enhancement activities for Northern and Southern Azevedo Ponds, and that a plan for these activities would be developed.

Current Management/Ownership

TNC owns the Azevedo Marsh Complex (21 acres/9 hectares). TNC and MCAHLC jointly own the adjacent upland areas (114 acres/45 hectares). TNC's lands are managed by ESF.

ESF, with approval from TNC, is currently funded (by the State Coastal Conservancy from Port of Santa Cruz Mitigation and Proposition 50 funds) to restore and enhance Azevedo North and South Azevedo Marshes. The wetland enhancement project aims to reduce tidal erosion and conserve/create marsh habitat. The project plans have been permitted and the implementation of the proposed wetland enhancement and restoration activities will likely be completed by spring 2008.

Site 4. Blohm-Porter Marsh Complex

Acreage/Location

The Blohm-Porter Marsh Complex, located at the head of Elkhorn Slough, is approximately 246 acres (100 hectares) between Elkhorn Road and Blohm Road.

Past Human Activities (Modifications/Restoration/Management)

A railroad embankment and bridge was built in 1872 between the Blohm-Porter Marsh Complex and the main channel of Elkhorn Slough. A wooden bridge, constructed in the past to permit passage over the Blohm-Porter Marsh Complex, allowed tidal and freshwater exchange.

Cattle have grazed parts of the Blohm-Porter Marsh Complex since the mid 1800's. In the 1940s, a large earthen dam was constructed at the southern end of this area for the purpose of impounding freshwater and restricting tidal inundation to the northern areas. Around the same time, it was observed that water tables were being lowered by land use which reduced the flow and presence of freshwater springs and altered surface flows from Carneros Creek.

The construction of the Harbor in 1947 increased tidal inundation to the Blohm-Porter Marsh Complex. Around 1951, a linear section of Blohm-Porter Marsh was filled for the construction of Elkhorn Road for its present-day alignment creating a permanent berm that obstructed tidal water exchange. Culverts and flap gates were purchased by the Moss Landing Harbor District Commission and installed by Monterey County

under the road to allow one-way flow from Blohm-Porter Marsh to Elkhorn Slough. In the early 1980s, Monterey County performed maintenance work on this berm to build up the road and also likely repaired the water control structure. The 1989 earthquake destroyed the flap gates and caused the road to subside. From 1989 to 1995, tidal waters regularly flooded the Blohm-Porter Marsh Complex (beyond the extent that received tidal inundation just prior to the Harbor construction in 1947). In 1996, Monterey County Public Works installed new culverts and flap gates under Elkhorn Road with state and federal funding.

Current Management/Ownership

Monterey County is responsible for maintaining Elkhorn Road and associated culverts. The Nature Conservancy owns and the Elkhorn Slough Foundation (ESF) manages the majority, 159 acres (64 hectares), of the Blohm-Porter Marsh Complex. ESF also holds a conservation easement on 35 acres (14 hectares) in this area. Fifty-two acres (21 hectares) of Blohm-Porter Marsh are not under any conservation protection. In the past few years, Mosquito Abatement has periodically cleared the flap gates of debris and non-native tubeworm reefs to keep the flap gates functional to reduce mosquito populations.

Site 5. Bennett Slough/Struve Pond Marsh Complex

Acreage/Location

The Bennett Slough/Struve Pond Marsh Complex is located northeast of the mouth of Elkhorn Slough. The entire complex is approximately 140 acres (57 hectares) in size and includes the old Elkhorn Slough mouth area north of Jetty Road, Bennett Slough (around the Salt Ponds), Bennett Ponds, and Struve Pond. The main areas are dominated by tidal mudflats, salt marsh, and tidal creeks and also contain tidal brackish marsh and freshwater ponds.

Past Human Activities (Modifications/Restoration/Management)

Prior to the 1850s, the Bennett Slough channel meandered around 216 acres (87 hectares) of tidal wetlands (today's western Salt Ponds) connecting to the main Elkhorn Slough channel near the old mouth and about a half mile east of the coast highway crossing. Before the 1860s, the coast highway crossed northwest Bennett Slough with a bridge. Around 1890, a narrow gauge railroad embankment and bridge was constructed between Bennett Slough and the old Elkhorn Slough mouth and was used until 1929. By 1914, an access road was constructed through the salt marsh in today's western Salt Ponds. The Monterey Bay Salt Works company constructed earthen levees to dike and drain hundreds of acres of tidal marsh by 1931. These levees blocked off the main eastern connection of the Bennett Slough channel. During the same time, levees were also constructed blocking the tidal creek and marshes in Bennett Slough's northeastern edges (currently referred to as Bennett Ponds) and northern channel, and to north of Bennett Slough (creating ponds). The coast highway was also reconfigured by 1931 and road embankments with culverts were built between Bennett Slough and Struve Pond and on the western edge of Bennett Slough which decreased the tidal influence to these areas.

The construction of the Moss Landing Harbor in 1947 rerouted the Elkhorn Slough mouth to the south causing the old mouth connection to Monterey Bay to close by 1956. The construction of the Jetty Road embankment and culvert, built during this same time, also reduced tidal flow to Bennett Slough. Before 1956, an earthen levee was constructed in Struve Pond by landowners to convert this area to a freshwater pond for hunting purposes. This levee reduced tidal exchange to the northern section of Struve Pond. The endangered Santa Cruz long-toed salamander (*Ambystoma macrodactylum croceum*) probably started to breed in Struve Pond and the northern section of Bennett Slough in the 1950s and consisted of hundreds of individuals in the 1970s (U.S. Fish and Wildlife Service 1999). In addition, during a survey at Struve Pond in March 2006, staff at the National Estuarine Research Reserve observed salinity levels of 5-6 ppt in the main pond, and salinity levels of 1-3 ppt in small shallow areas at the edge of the main pond (Wasson and D'Amore, unpublished data). The endangered tidewater goby has now been found in Struve Pond. Increased salinity levels in Struve Pond were found in mid-1980s which could have been caused by levee breaches during winter storms near the Salt Ponds (Rainey 1985).

The 1989 earthquake caused Jetty Road to collapse which temporarily increased tidal exchange to Bennett Slough. In 1990 a *Restoration Plan for Gibson's Landing Marsh and Lower Bennett Slough* was prepared by Robert Coats of Philip Williams & Associates, Ltd. recommending a four-culvert design under Jetty Road and a flap gate in the culvert under Highway 1. California State Parks applied for permits with a project proposal to repair the road and install four culverts with two tide gates (to reduce inundation time of vegetated areas) under Jetty Road to replace the single culvert in order to reestablish public access and enhance tidal action in Gibson's Landing Marsh (area north of Jetty Road) and Bennett Slough. The California Coastal Commission required a six-culvert design as part of the permit conditions (3-90-104) and California State Parks completed the project in the fall of 1991 and replaced the single culvert with a six-culvert system to make the tidal exchange greater than the 1947-1989 conditions.

Due to this change, Struve Pond is currently converting back to tidal brackish habitat rather than the freshwater conditions that existed there from the 1940s to 1980s. According to the 1999 *Santa Cruz Long-Toed Salamander Draft Revised Recovery Plan*, this endangered species has not been found in these lower Bennett Slough areas since 1985 likely due to increased salinity levels. The endangered tidewater goby has now been found in Struve Pond in recent research activities by staff at the National Estuarine Research Reserve. The wetland area north of Jetty road may be currently experiencing marsh loss from increased inundation and tidal erosion since 1991.

Current Management/Ownership

Jetty Road and the associated culverts are owned and managed by California State Parks. The area north of Jetty Road is owned primarily by the Moss Landing Harbor District and also by State Parks and private landowners. Most of the Bennett Slough area is owned and managed by California Department of Fish and Game as part of the Moss Landing Wildlife Area. Struve and Bennett Ponds are privately owned and managed. The Nature Conservancy has an easement on a portion of Struve Pond because of the endangered Santa Cruz long-toed salamander. The culverts under Highway 1 are maintained by the California Transportation Department (Caltrans).