ISLAND PONDS MITIGATION MONITORING AND REPORTING YEAR 10 – 2015

PREPARED BY:

Santa Clara Valley Water District

U.S. Fish and Wildlife Service—
Don Edwards National Wildlife Refuge

TABLE OF CONTENTS

Page No.

EXECUTIVE SUMMARY E-1
1.1 INTRODUCTION 1
1.2 PROJECT BACKGROUND 1
1.3 PROJECTS WHICH REQUIRED MITIGATION 1
Initial Stewardship Plan (ISP) 1
Stream Maintenance Program (SMP) 2
Lower Guadalupe River Project (LGRP) 2
1.4 ISLAND PONDS MITIGATION SITE 3
Site Description 3
Mitigation Monitoring 3
Performance Criteria 5
1.5 CONTACTS 6
2.1 MONITORING METHODS 7
2.2 ON-SITE MONITORING 7
2.2.1 Aerial Photography (District) 7
2.2.2. Biennial Aerial Photography Vegetation Mapping (Refuge) 7
2.2.3 Ground-Based Quantitative Vegetation Sampling (District) 7
2.2.4 Channel Network Evolution Monitoring (Refuge) 8
2.2.5 Levee Breach and Outboard Marsh Channel Geometry (District) 8
2.2.6. Wildlife Monitoring (Refuge) 8
2.3 OFF-SITE MONITORING 10
2.3.1 Accelerated Deterioration of the Town of Drawbridge (District) 10
2.3.2 Fringe Marsh Scour in Coyote Creek 10
3.1 MONITORING RESULTS 12
3.2 ON-SITE MONITORING 12
3.2.1 Biennial Aerial Photography Vegetation Mapping (Refuge) 12
3.2.2 Ground-Based Quantitative Vegetation Sampling (District) 13
3.2.3. Channel Network Evolution Monitoring (Refuge) 15
3.2.4. Levee Breach and Outboard Marsh Channel Geometry (District) 16
3.2.5 Wildlife Monitoring (Refuge) 16
3.3 OFF-SITE MONITORING 17
3.3.1 Accelerated Deterioration of the Town of Drawbridge (District) 17
3.3.2 Fringe Marsh Scour in Coyote Creek (District) 17
4.0 DISCUSSION 19
5.0 REFERENCES 21
6.0 LIST OF PREPARERS 23
7.0 FIGURES 24
8.0 APPENDICES

LIST OF TABLES

Table 1-1. Mitigation Monitoring Schedule for the Island Ponds – Responsible Party, Monitoring Duration, Frequency and Timing.
Table 3-1. Comparison of Established Marsh Vegetation at the Island Ponds from 2006 – 2015
Table 3-2. Quantitative Vegetation Sampling of Pond Surfaces (Marsh Plain) in 2015
Table 3-3. Channel Networking in Island Ponds from 2006-2015
Table 3-4. Pond Breach Widths (feet) over Time
Table 3-5. Marsh Loss (acres) from Scour of Outboard Channels
Table 3-6. Fringe Marsh Scour (acres) over Time
Table 3-7. Fringe Marsh Accretion (acres) over Time
Table 4-1. Extent of Vegetation Establishment in Pond A21 from 2012-2015

LIST OF FIGURES

Figure 1. Vicinity Map- Location of the Island Ponds Restoration Site
Figure 2. Digitized Vegetation from Satellite Imagery in Pond A21, Comparison over Several Years
Figure 3. Digitized Vegetation from Satellite Imagery in Pond A20, Comparison over Several Years
Figure 4. Digitized Vegetation from Satellite Imagery in Pond A19, Comparison over Several Years
Figure 5. Channel Geometry in Pond A21 Borrow Ditch, 2015 Compared to Previous Years
Figure 6. Channel Geometry in Pond A20 Borrow Ditch, 2015 Compared to Previous Years
Figure 7. Channel Geometry in Pond A19 Borrow Ditch, 2015 Compared to Previous Years
Figure 8. Salt Marsh Harvest Mouse Trapping Results at Pond A21 Borrow Ditch, 2015
Figure 9. Locations of Audio and Visual Confirmation of Ridgway's Rails, Pond A21 in July 2015
Figure 10. Marsh Gain and Loss from Scour of Outboard Channels, 2010-2015

APPENDICES

Appendix A. Site Photos
Appendix B. Wildlife Survey Reports
Appendix C. Pond A21 Levee Erosion Data and Photographs

EXECUTIVE SUMMARY

The Santa Clara Valley Water District (District) and the U.S. Fish and Wildlife Service Don Edwards National Wildlife Refuge (Refuge) implemented the Island Ponds Restoration Project to fulfill two goals:
1) to initiate ecological restoration activities as described in the South Bay Salt Pond Initial Stewardship Plan (ISP), and 2) to satisfy the tidal marsh mitigation needs of both the Refuge for the ISP, and the District for the Stream Maintenance Program and the Lower Guadalupe River Project.

Breaching of the Island Ponds (Ponds A19, A20, and A21) occurred in March 2006. Five breaches were cut to allow tidal waters to inundate the ponds and begin the process of restoration. In the Restoration and Mitigation Monitoring Plan for the Island Pond Restoration Project (RMMP), the District and the Refuge agreed to conduct monitoring to track the progress of the restoration. This report presents the Year 10 (2015) monitoring results for both the District and the Refuge.

Ten years after breaching, sediment is continuing to accumulate and consolidate to form acceptable substrate for vegetation colonization in all three Ponds. Vegetation growth has shown a rapid expansion; currently approximately166 acres of marsh vegetation has collectively established in the three ponds, which represents a 15% increase from last year. In Pond A21 alone, approximately118 acres of marsh vegetation has established, with an average total cover of 75.85%. Based on criteria outlined in the RMMP, Pond A21 has met the final success criteria for the mitigation project as a whole (75 acres at 75% vegetative cover). Coupled with the documentation in 2015 of salt marsh harvest mice along the borrow ditch of Pond A21 and the audio confirmation of a pair of breeding Ridgway's rails, this area has become functional marsh habitat for endangered species as well.

There has been a significant increase in channel network evolution in the ponds since the last time data were analyzed in 2010. The largest increase was in Pond A19, with approximately 7% (18 acres) of the pond surface exhibiting a network of drainage channels. This represents an 85% increase since 2010 for that pond. This is an excellent development in the trajectory of vegetation establishment in that pond, as in the RMMP the development of channel networks was highlighted as an important indicator of progress in the deposition of sediment and subsequent vegetation establishment as well as habitat for species such as Ridgway's rail. While Pond A19 still contains the least amount of vegetated marsh plain on the pond surface, it is likely that vegetation establishment will be rapid in subsequent years.

Vegetation composition on the marsh plain of all three ponds continues to be dominated by several native species, including perennial pickleweed and California cordgrass, and to a lesser extent, annual pickleweed. Vegetation on pond levee shorelines was more mixed; with perennial pickleweed and California cordgrass as well as some areas showing establishment of nonnative Salsola and small amounts of perennial pepperweed. As sediment accretion continues, management of nonnative vegetation may need to become a priority to prevent establishment of these or other invasive species on the marsh plain.

The levee shoreline of Pond A19 still contains a population of dwarf spikerush, a California Rare Plant Rank 4 species. This population was first noted in 2012.

Data collected from 2008 to 2015 indicate that deterioration along the inboard slope of the southeast levee of pond A21 (near the historic Town of Drawbridge) is still occurring. These measurements confirm the trend shown in previous surveys that the width of the pond levee is decreasing over time, with most locations experiencing more than two feet of lost girth since 2008. The total levee width however, is still more than 10 feet wide at its narrowest location. Levee height measurements have not changed greatly since 2009, indicating that the top of levee isn't experiencing rapid change. At this time, the levee doesn't appear to be at risk of failure; however, future evaluations and measurements should be conducted by the Union Pacific Railroad (UPRR) to confirm that the pond levee does not deteriorate further and potentially compromise the railroad levee.

1.1 INTRODUCTION

1.2 PROJECT BACKGROUND

In March 2006 the Santa Clara Valley Water District (District) and U.S. Fish and Wildlife Service (USFWS) Don Edwards National Wildlife Refuge (Refuge) restored tidal inundation to the 475-acre Island Pond Complex (the ponds). Five breaches were cut by an amphibious excavator along the south side of the ponds to allow tidal waters to inundate the ponds and begin the process of restoration. Two breaches (west and east) were cut in Pond A19 on March 7, 2006. A single breach was cut in Pond A20 on March 13, 2006. Two breaches (west and east) were cut in Pond A21, on March 21 and March 29, 2006, respectively.

This restoration approach is a minimally engineered, passive design, which relies on the natural sedimentation processes to restore the ponds to tidal marsh habitat and meet the project goals and objectives. The overall restoration goal is to successfully reestablish vegetation, promote re-colonization by benthic organisms and provide habitat for various wildlife species.

Restoration of the Island Ponds is a component of the Initial Stewardship Plan (ISP) for the larger South Bay Salt Pond Restoration Project (Life Science!, 2003). The District and the Refuge implemented the Island Ponds Restoration Project to fulfill two goals:

1. To initiate ecological restoration activities as described in the South Bay Salt Pond ISP.

2. To satisfy the tidal marsh mitigation needs of both the Refuge for the ISP and the District for the Stream Maintenance Program (SMP) and Lower Guadalupe River Project (LGRP).

In the Restoration and Mitigation Monitoring Plan for the Island Pond Restoration Project (RMMP), the District and the Refuge agreed to conduct long-term monitoring to track the progress of the restoration and to evaluate whether there were adverse effects from the project (USFWS et al., 2006). Mitigation monitoring activities were anticipated to continue for 15 years. This report presents the Year 10 (2015) monitoring results.

1.3 PROJECTS WHICH REQUIRED MITIGATION

Initial Stewardship Plan (ISP)

The ISP was created as an interim step to manage the ponds while a long-term plan was developed for the entire South Bay Salt Pond area. The main objectives of the ISP are to:

- cease commercial salt operations,

- introduce tidal hydrology to the ponds where feasible,

- maintain existing high quality open water and wetland wildlife habitat, including habitat for migratory and resident shorebirds and waterfowl,

- assure ponds are maintained in a restorable condition to facilitate future long-term restoration,

- minimize initial stewardship management costs,

- meet all regulatory requirements, especially discharge requirements to maintain water quality standards in the South Bay.

Taking into account the environmental effects of implementing the ISP based on the assessment in the EIR/EIS (Life Science!, 2004) and the associated permit requirements, the Refuge has agreed to restore unimpeded tidal inundation to approximately 475 acres at the Island Ponds and restore nine acres of tidal marsh specifically at Pond A21.

The permit file number for ISP activities which require tidal wetland mitigation is the San Francisco Bay Regional Water Quality Control Board - Order # R2-2004-0018.

Stream Maintenance Program (SMP)

The SMP allowed the District to implement routine stream and canal maintenance projects to meet the District's flood protection and water supply mandates in a feasible, cost-effective, and environmentally- sensitive manner. This program was also intended to assist the District in obtaining multi-year permits for these activities, the permit term of which was initiated in 2002 and culminated in 2012. The first SMP permit (2002-2012) applied to all of the District's routine stream maintenance, including three major types of activities: sediment removal, vegetation management, and bank protection, and commenced soon after the District received the permit in August 2002.

The SMP compensatory mitigation package included mitigation for impacts to 30 acres of tidal wetlands; 29 acres from sediment removal activities and one acre from vegetation management activities. Taking into account the assessment in the EIR/EIS and the associated permit requirements, the District has agreed to restore 30 acres within the Island Ponds to tidal marsh habitat as mitigation for implementation of the SMP.

Permit file numbers for SMP activities which require tidal wetland mitigation are:

- San Francisco Bay Regional Water Quality Control Board - Order # R2-2002-0028

- U.S. Army Corp of Engineers - Permit # 22525S

- California Department of Fish and Game – 1601 Lake and Streambed Alteration Agreement # R3-2001-0119

- U.S. Fish and Wildlife Service – Biological Opinion 1-1-01-F-0314

Lower Guadalupe River Project (LGRP)

The LGRP was constructed to convey design flood flows in the Lower Guadalupe River between Interstate 880, in downtown San Jose, and the Union Pacific Railroad Bridge in Alviso. The project was designed to balance the needs for flood-control structures and channel maintenance with the goal of protecting and enhancing environmental conditions and public access. LGRP construction began in April 2003.

The LGRP compensatory mitigation package includes mitigation for both temporary and permanent impacts to wetland vegetation. Taking into account the assessment in the

EIR/EIS and the associated permit requirements, the District has agreed to restore 35.54 acres to tidal marsh within the Island Ponds to mitigate for LGRP impacts.

Permit file numbers for LGRP activities which require tidal wetland mitigation are:

- San Francisco Bay Regional Water Quality Control Board - Order # R2-2002-0089
- U.S. Army Corp of Engineers - Permit # 24897S
- California Department of Fish and Game – 1601 Lake and Streambed Alteration Agreement # R3-2002-0732

1.4 ISLAND PONDS MITIGATION SITE

Site Description

The Island Ponds (Ponds A19, A20, and A21) are located at the extreme southern extent of the San Francisco Bay within Coyote Creek. The ponds are in Alameda County immediately north of the Santa Clara County line, in the City of Fremont (Figure 1). These ponds are part of a larger 25-pond system known as the Alviso Complex. Prior to their 2006 breaching, this complex contained 7,364 acres of pond habitat, 420 acres of salt marsh outboard of the pond levees, 896 acres of brackish marsh in the adjacent sloughs and creeks, as well as associated upland (levee) and subtidal habitats (HTH et al., 2005).

Solar salt production began at the Alviso Complex in 1929 and continued until the ponds were purchased by State and Federal Agencies in 2003. The Island Ponds were middle stage salt evaporator ponds with intermediate salinity levels. In March 2006, the District and the Refuge cut five breaches on the south side of the ponds to allow full tidal inundation and permit the ponds to passively restore to tidal marsh habitat.

Mitigation Monitoring

The District and the Refuge agreed to conduct a long-term monitoring program to track the progress of the Island Ponds restoration. The RMMP details the monitoring activities which are designed to track mitigation performance over a 15-year period (USFWS et al., 2006). The monitoring data will be compared from year to year to determine if the project is meeting performance criteria, permit requirements, and to provide data for adaptive management actions, if necessary.

Table 1-1 describes the monitoring schedule for the Island Ponds, including monitoring duration, frequency and timing. Table 1-1 also depicts the division of monitoring responsibilities between the District and the Refuge.

Table 1-1
Mitigation Monitoring Schedule for the Island Ponds – Responsible Party, Monitoring Duration, Frequency and Timing.

Responsible Party	Monitoring Activity	Year(s) for Each Monitoring Activity [1]	Frequency	Seasonal Timing
On-Site Monitoring				
District	Inundation regime	Years 1, 2, 3, 5, 10, and 15 (or until two monitoring cycles indicate that full tidal exchange has been achieved)	Completed Task 2006 - 2007	---
	Substrate development	a) Years 1 and 2	Completed Task 2006-2007	---
		b) Years 3 to 5	Completed Task 2010	---
		c) Year 6 to 30 acres of vegetation	30 acres of Vegetation Established in 2010-Task complete	---
	Levee breach and outboard marsh channel geometry[3]	Years 1, 2, 3, 5, 10, and 15	Annual	With aerial
	Aerial photo	a) Year 1 to 5, 10, and 15	Annual	Jul - Aug
		b) Year 7, 9, 11 … to end	Biennial	Jul - Aug
Refuge	Channel network evolution[3]	Years 1, 2, 3, 5, 10, and 15	Annual	With aerial
	Vegetation mapping[3]	Until mitigation achieved	Biennial	Jul - Aug[2]
	Ground-based quantitative vegetation sampling **(SCVWD agreed to perform this sampling in 2012, 2014 and 2015)**	Once 30 acres of vegetated area is established until 75 acres of 75% vegetation cover is achieved	Biennial	Jul - Aug[2]
	Invasive *Spartina* monitoring and control	Year 1 to 75% native vegetation cover	Annual	Sept - Nov
	Wildlife use (CLRA)	Begin when 30 acres native vegetation to detection	Annual	Jan - Apr 15
	Wildlife use (SMHM)	Begin at five acres contiguous suitable habitat, end at SMHM detected	Once every 5 years	Jun - Aug
	Wildlife use (shorebirds & waterfowl)	Years 1 to 5	Completed Task 2010	---

Off-Site Monitoring				
District	Rail bridge pier scour[4]	a) Years 1 to 5	Completed Task 2006-2008	---
		b) Years 1 to 5	Completed Task 2010	---
		c) Begin at implementation of corrective measures, end five years after	N/A	---
	Fringing marsh scour in Coyote Creek[3]	a) Years 1 to 5, Final year	Annual	With aerial
	Scour of levees opposite breaches[3]	a) Years 1 to 3	Completed Task 2006 – 2008	---
		b) If outboard marsh retreats to levees opposite breach, then three additional years from occurrence	N/A	---
	Rail line erosion	a) Years 1 to 5	Completed Task 2010	---
		b) Years 1 to 5	Completed Task 2010	
	Deterioration of Town of Drawbridge structures	a) Years 1 to 5	Completed Task 2010	---
Refuge	Water Quality	a) Adjacent to breaches – Year 1	Completed Task 2006	---
		b) Upstream & downstream of ponds – Year 1	Completed Task 2006	---

* (Grayed out tasks above are considered complete)

1 Projected time estimates to achieve performance criteria. Actual duration is dependent upon performance criteria and may vary.

2 If CLRA are detected, on-site vegetation monitoring is only allowed from Sept 1 to Jan 31.

3 Monitoring to use aerial photograph.

4 Bridge pier scour will continue to be monitored twice a year by the Union Pacific Railroad staff instead of additional monitoring being performed by this Project. (See Year 3-2008 monitoring report for additional details.)

This report presents the monitoring results collected during the Year 10 (2015) monitoring period. The data are presented in detail and are compared to the prior years' results as well as the overall project performance criteria identified in the RMMP (USFWS et al., 2006). Ground-based quantitative vegetation sampling was conducted in 2015 because results from 2014 indicated that the project was very close to meeting its performance criteria of percent cover and acreage of vegetated pond surface.

Performance Criteria

The performance criteria for the Island Ponds are specific to the mitigation needs of the Refuge and the District.

The performance criteria for the ISP mitigation are:

- Restore unimpeded tidal action to approximately 475 acres,
- Restore nine acres of vegetated tidal marsh located within a larger marsh area in Pond A21,
- Vegetation covers no less than 75% of the nine acres,
- Plant species composition consists of native tidal marsh species appropriate to the salinity regime, and
- Targets achieved within 15 years following levee breach.

The performance criteria for the SMP mitigation are:

- Restore 30 acres of vegetated tidal marsh located within a larger marsh area on the three Island Ponds,
- Vegetation covers no less than 75% of the 30 acres,
- Plant species composition consists of native tidal marsh species appropriate to the salinity regime,
- Presence of California clapper rail at the Island Ponds as detected by a positive response to rail call counts using USFWS Endangered Species Office approved survey protocols. (This performance criterion for the clapper rail mitigation requirement was established by the District through negotiations with the USFWS Endangered Species Office in December 2005.)
- Targets achieved within 15 years following levee breach.

The performance criteria for the LGRP mitigation are:

- Restore 35.54 acres of vegetated tidal marsh located within a larger marsh area on the three Island Ponds,
- Vegetation covers no less than 75% of the 35.54 acres,
- Plant species composition consists of native tidal marsh species appropriate to the salinity regime,
- Targets achieved within 15 years following levee breach.

1.5 CONTACTS

The District contact is Lisa Porcella, Santa Clara Valley Water District, 5750 Almaden Expressway, San Jose, CA 95118-3686. Tel: (408) 265-2607, ext. 2741.

The Refuge contact is Cheryl Strong, Don Edwards San Francisco Bay National Wildlife Refuge, 9500Thornton Avenue, Newark, CA 94560. Tel: (510) 557-1271

2.1 MONITORING METHODS

This section describes the methods used to carry out the Year 10 monitoring activities for both the District and the Refuge.

2.2 ON-SITE MONITORING

2.2.1 Aerial Photography (District)

Per the Adaptive Management Teams recommendations from 2010, satellite photographs were obtained for use in the Year 10 monitoring activities. The images were captured using the GeoEye-1satellite via Apollo Mapping Services, which offers high resolution, commercial satellite imagery with a geo-referenced horizontal accuracy of <4 m. The satellite achieves this accuracy by simultaneously acquiring 41 cm panchromatic and 1.65-meter 4-band multispectral imagery. Images were captured at approximately 12 noon at a moderately low tide on September 19, 2015 with an ONA (off-nader angle) of 0-20. Images were acquired in both color and infrared. The spatial extent of the images included all three Island Ponds as well as the northern and southern banks of Coyote Creek. For 2015, these images were used exclusively for the aerial photography vegetation mapping task (see Section 2.1.2 below).

2.2.2. Biennial Aerial Photography Vegetation Mapping (Refuge)

The RMMP states, “Vegetation monitoring will solely consist of biennial examinations of ortho-rectified aerial photographs until a minimum of 30 acres of vegetation has established in the project area.” This biennial requirement was last done in 2010 (Year 5) when > 30 acres of vegetation was mapped within the Ponds. For Years 7,9 and 10 (2012,2014 and 2015), quantitative ground based vegetation sampling was initiated in addition to the aerial photo mapping (see Section 2.1.3 below).

Satellite photography utilized for this task was captured in September 2015 (see section 2.1.1 above) and were examined by Refuge staff using GIS software to delineate and digitize the locations of plant colonization at the Island Ponds. Satellite imagery was used rather than aerial imagery due to the high cost of aerial flight photography in the Island Ponds location and the difficulty in setting out the flight crosses needed for orthorectification.

2.2.3 Ground-Based Quantitative Vegetation Sampling (District)

The RMMP states,” Once a minimum of 30 acres of vegetation establishes in the study area, biennial quantitative sampling will be initiated coincident with the aerial photo mapping”. The Year 5 (2010) results showed that > 30 acres of vegetation had established within the ponds. Since Year 7 (2012) the Refuge has continued the aerial photo mapping and the District has conducted ground based vegetation sampling to further refine the techniques discussed in the RMMP. Year 10 (2015) represents the third image mapping and ground based vegetation sampling effort.

The RMMP states that sampling will occur in native-dominated vegetation patches of 2 acres in size or larger with a minimum of 50% total vegetative cover (referred to as “qualifying patches”). A reconnaissance level survey of the Island Ponds prior to initiating the quantitative vegetation sampling effort indicated that by 2014 an abundance of marsh vegetation had established in Pond 21 on the marsh plain and there are no longer separate patches of vegetation but rather a

generally continuous mosaic of vegetation interspersed with mud flat of varying topography and side slough channels. Therefore, for the 2014 and 2015 sampling effort, rather than identifying and sampling qualifying patches a representative range of locations on the pond surface were selected and then randomly sampled. Quantitative sampling in 2015 was conducted across Pond 21in representative sections. Based on a review of the satellite imagery in 2015, some qualifying patches of vegetation had established in Pond 20 and the south and central sections were sampled. There were no qualifying patches located in Pond 19. Due to the focus of the sampling effort on the pond surfaces, there was no quantitative vegetation sampling of the levees in 2015.

Sampling was performed at low tide using a 1 meter square quadrat in October 2015. Total vegetative cover was measured and relative cover of each species present was documented to the nearest 5% cover category within each quadrat. Maximum vegetation height, percent bare soil and percent litter were also measured.

According to the RMMP, ground based vegetation monitoring is anticipated to continue on a biennial schedule until the success criterion is met (i.e., 75 acres at 75% vegetative cover) or sooner if, as the marsh develops, the sampling is deemed unnecessary (e.g., the aerial mapping is accurate enough), unsafe, or infeasible by the adaptive management team. Because results of the 2014 vegetation monitoring indicated that the project was very close to meeting the success criteria, monitoring was conducted again in 2015 even though it was not required this year.

2.2.4 Channel Network Evolution Monitoring (Refuge)

The Channel Network Evolution Monitoring Task (Task 5.2.3) for the Island Ponds is described in the RMMP as follows: “Monitoring will consist of extracting channel planform morphology from the aerial photographs collected periodically and rectified to ensure spatial comparability from photo to photo (see Aerial Photography, Section 5.2.8). Evolution of channel networks will be measured over time. Parameters to be measured include total surface area of channels and areas of expansion and loss. Monitoring results will be incorporated into a table showing, for each pond, the total pond acreage, total channel coverage, and percent of pond as channel. Maps will show the channel network in each year, the change from prior year that an aerial image was taken, and the change from the baseline.”

2.2.5 Levee Breach and Outboard Marsh Channel Geometry (District)

The levee breaches and channels through the outboard marsh were expected to erode in response to tidal scour until equilibrium conditions are achieved. The width of each levee breach and the total area of the outboard scour were measured in ArcMap using the 2015 satellite imagery. Breach widths were measured from east bank to west bank along the centerline of each levee, while the area of each outboard tidal channel was calculated by delineating the current marsh edge.

2.2.6. Wildlife Monitoring (Refuge)

The Wildlife Monitoring Task (Task 5.2.7) for the Island Ponds is described in the Mitigation Monitoring Plan (RMMP) as follows: “The Initial Stewardship Project anticipates that restoration of the Island Ponds to tidal marsh will provide long-term ecological benefits to native birds (particularly California clapper rails) and mammal species (particularly salt marsh harvest mice). In addition, the Santa Clara Valley Water District (SCVWD) has chosen presence of California

clapper rail as a performance criterion to measure success of their SMP mitigation requirements. Although there are no performance criteria or success criteria associated with the presence of other wildlife species, the project partners agreed it was prudent to incorporate a wildlife component into this monitoring program. Monitoring for bird and mammal species will reveal whether restoration of tidal exchange at the Island Ponds produce the anticipated benefits to native wildlife species."

A. **California clapper rail (now known as Ridgway's rail) monitoring** – Ridgway's rail surveys are conducted by Refuge staff and volunteers in marshes of the south bay, south of the San Mateo Bridge, to track annual changes in Ridgway's rail numbers for each marsh and to develop a rail population estimate for the south San Francisco Bay. This information is used to evaluate the success of current management and to focus future management efforts to benefit the Ridgway's rail.

Each survey involves trained observers walking on levees adjacent to the marsh to separate pre-determined listening stations (200 m apart) and recording location, time (military time), and type of each call on a datasheet (Figure 7) and map. Observers spend ten minutes at each station while conducting a "walking survey". At each station, the observer listens passively for 5 minutes, then broadcasts the Ridgway's rail recording for 1 minute, then listens passively for 4 more minutes before moving to the next station. Playback recordings are only used if rails do not vocalize after five minutes of passive listening at a station. If rails respond to the playback, the recording is stopped immediately. For most transects, there are three rounds of active callback surveys during the season.

Refuge staff surveyed three stations in Pond A21 on three occasions in 2015 for Ridgway's rails.

B. **Salt marsh harvest mouse monitoring** – Trapping for salt marsh harvest mice was conducted by the Refuge in Pond A21 on July 21-23, 2015. The trapping consisted of 100 Sherman live traps spaced at 10 meter intervals. Four transects of 25 traps were placed along the high marsh between the borrow ditch and the levee and transects were 200m apart. Traps were checked within an hour of sunrise and closed during the day to ensure that the animals were not in traps during the warmer hours of the day. Captured animals were processed and were then released at the location of capture, except for non-native house mice *(Mus musculus)*. All captured animals were identified by species, sexed, aged and hair-clipped. Fur samples from all small mammals were sent to Josh Ackerman for a USGS Mercury study. House mice were taken to Ohlone Humane Society in Newark for participation in the raptor feeding program. Detailed measurements were taken of all *Reithrodontomys* captured to distinguish between western harvest mouse (*R. megalotis)* and the salt marsh harvest mouse.

Capture efficiency (CE) as a relative abundance index was calculated by the number of new animals caught divided by number of trap nights, expended times 100. Trap nights were calculated by the number of traps open per night per trapping session (e.g. 400 traps nights represents 100 traps set for 4 nights). This method is used because of the high effort-low return on trapping and the great difficulty and great expense of obtaining dependable density estimates on a regular basis.

In addition to mouse trapping, vegetation measurements were taken along the mouse sampling transects at 25% of trap locations. At each plot a one-meter square PVC frame was placed so the northwest corner of the frame abutted the trap location. The frame was divided into quadrants and an observer made ocular estimates of plant species cover. Plant height measurements were made by randomly placing a meter stick in each quadrant, plus one random hit in the frame, and measuring the tallest plant closest to the stick. A total of five measurements per quadrant were made.

C. **Waterfowl and shorebird species** – The avian monitoring task has been completed. Quarterly avian monitoring began in Year 1 (2006) and continued through Year 5 (2010).

2.3 OFF-SITE MONITORING

2.3.1 Accelerated Deterioration of the Town of Drawbridge (District)

The RMMP states that Deterioration of the Town of Drawbridge will be assessed visually and that any evidence of accelerated erosion will be reported. The monitoring activities undertaken for this task consist of monitoring the integrity of the pond levees adjacent to the Town of Drawbridge. This requirement was anticipated to be completed in Year 5 (2010), however, monitoring of the eastern levee of Pond A21 has annually detected signs of levee erosion in this location. Therefore, it was agreed that monitoring in this location would continue until the erosion had stabilized or performance criteria for the overall project was met.

In 2008, field inspectors noted large amounts of debris and litter on top of a section of the Pond A21 levee in the southeast corner, mostly along the marsh vegetation and outboard slope interface. At that time, inspection staff interpreted the deposition of litter and debris as a sign that wave action and wind related run-up had caused floating trash to transfer from the pond area onto the levee surface. To establish an ability to accurately monitor erosion advancement from wave action and levee overtoppoing, a surveyed benchmark was installed in December 2008 in the southeast corner of Pond A21. An elevation was assigned to the benchmark which references the northwest abutment of the Coyote Creek railroad bridge. (The top of the benchmark is 4.55 ft lower than the bridge abutment.) Location stakes were installed to form a series of eight cross sections along the top of the levee and baseline elevations were gathered immediately adjacent to each stake. Annual site visits obtain elevations at each stake and document any changes.

On November 23, 2015, a Civil Engineer from the District performed the surveying work discussed above to collect surface elevation data at the eight cross section locations along the Pond A21 levee.

2.3.2 Fringe Marsh Scour in Coyote Creek

The RMMP outlined a concern that the larger tidal prism and associated increased velocities from the breaches at the Island Ponds could result in scour of the marsh along the margins of Coyote Creek. Therefore, monitoring of the fringe marsh is conducted periodically to document any spatial changes in the extent of the marsh and mudflats along Coyote Creek.

The extent of scour of the outboard fringe marsh along Coyote Creek was quantified by comparing the 2015 satellite imagery to the 2010 aerial imagery of the site. Changes in the extent of marsh or scoured mudflat were digitized using ArcMap. The analysis covered the eastern end of Pond A19 to the western end of Pond A21 as well as the marsh on both sides of

Coyote Creek and 200 ft of marsh upstream in Artesian Slough and the Coyote Creek Bypass Channel.

3.1 MONITORING RESULTS

This section describes the results of both the District and Refuge's 2015 (Year 10) monitoring activities.

3.2 ON-SITE MONITORING

3.2.1 Biennial Aerial Photography Vegetation Mapping (Refuge)

The Native Vegetation Development Task (Task 5.2.4) for the Island Ponds is described in the RMMP as an evaluation of the "progress in achieving the success criteria for tidal marsh restoration." To do so, vegetation establishment is monitored using aerial photographs and field sampling. This is a biennial requirement and was last done in 2014, but because we expected to reach our success criteria, we mapped it in 2015 as well.

Before the breaching in 2006, the Island Ponds had no established vegetation due to 99% of the total area covered with a hard salt crust gypsum layer (H.T. Harvey & Associates 2004). The Island Pond Complex had also become subsided since diking. It was anticipated that plant colonization would only occur when sedimentation reached appropriate marsh plain elevation. Vegetation established quicker at the Ponds than originally anticipated. Pond A21 was the first to document a substantial increase in marsh vegetation.

In 2015, salt marsh vegetation was mapped by digitizing from color infrared satellite photos (Figures 2-4). Total vegetation was approximately 165 acres and continues to show expansion from the baseline of 5.75 acres in 2006. Vegetation increased by 73% in 2007, 33% in 2008, 135% in 2010, 100% in 2012, 132% in 2014, and in 2015 it increased by 15% (Table 3-1). The rate of growth is slowing as A21 and even A20 appear almost fully vegetated now. A21 continues to have the highest vegetation acreage but had the smallest change from last year. Pond A20 had the highest gain from last year with an approximate gain of 50%. Based on the satellite photo, it too now looks almost fully vegetated; however, field observations showed that substantial portions of the pond are still unvegetated and didn't meet the minimum 2 acre quantitative sampling criteria. Pond A19 continues to show modest increases in vegetation as more patches develop throughout the interior of the pond. Conditions for marsh vegetation establishment appear to be approaching ideal levels, and it is expected to fill in over the next few years.

TABLE 3-1
Comparison of Established Marsh Vegetation (from Digitized Imagery) at the Island Ponds from 2006 – 2015.

Year	Pond	Acreage of Salt Marsh Vegetation	Percent Change in Acreage from Previous Year Mapped
2006	A19	2.99	
	A20	1.56	
	A21	1.20	
	Total	**5.75**	
2007	A19	5.10	70.6
	A20	2.20	41.0
	A21	2.65	120.8

Year	Pond	Acreage of Salt Marsh Vegetation	Percent Change in Acreage from Previous Year Mapped
	Total	**9.96**	**73.2**
2008	A19	6.07	19.0
	A20	2.93	33.2
	A21	4.29	61.9
	Total	**13.29**	**33.4**
2010	A19	6.42	5.77
	A20	3.18	8.53
	A21	21.59	403.3
	Total	**31.19**	**134.7**
2012	A19	8.65	34.74
	A20	5.21	63.84
	A21	48.39	124.13
	Total	**62.25**	**99.58**
2014	A19	12.63	46.01
	A20	22.40	329.94
	A21	109.45	126.18
	Total	**144.48**	**132.10**
2015	A19	14.05	11.24
	A20	33.49	49.51
	A21	117.95	7.77
	Total	**165.50**	**14.54**

3.2.2 Ground-Based Quantitative Vegetation Sampling (District)

The vegetation success criteria for the Island Ponds states that "74.54 acres of vegetated tidal marsh habitat must be restored to satisfy the mitigation requirements of the District and the Refuge." In addition it is specified that vegetation should cover no less than 75% of the 74.54 acres and the plant species composition should consist of native tidal marsh species.

The vegetated interior of the Island Ponds site is overwhelmingly dominated by native vegetation; therefore, the term total cover below refers to total native vegetative cover. A total of 216 quadrats were sampled in Pond A21 and A20 in 2015 (141 quadrats in Pond A21 and 75 quadrats in Pond A20). As mentioned previously, the levee slopes were not sampled in 2015. (Table 3-2). Average total marsh vegetation cover was high (>65%) in both sampled ponds.

Pond A21

A range of representative areas were sampled in 2015 within the vegetated marsh plain of Pond A21, for a total of 141 quadrats on the pond surface (Table 3-2). Average total cover for Pond A21 was 75.85%, meeting the final vegetation success criteria identified in the RMMP. Average percent bare soil was 24.22% in 2015. There was no litter recorded in any quadrat in 2015 on the pond surface. Average maximum vegetation height was 29.44 inches (Table 3-2).

Dominant species on the pond surface/marsh plain included perennial pickleweed (*Salicornia pacifica*; former name: *S. virginica*) and California cordgrass (*Spartina foliosa*). In the western section of the marsh, where one species was dominant, the other was usually a close

sub-dominant and in some areas the two species were co-dominant. In the eastern section of the Pond A21 marsh plain, annual pickleweed (*Salicornia depressa*) was prevalent along with cordgrass, with lesser amounts of perennial pickleweed. This is likely due to the eastern portion of the marsh plain functioning as a still-developing marsh with a higher incidence of annual pickleweed as an early-successional species; the west end of the marsh filled in first with vegetation and is now dominated by perennial marsh species (Appendix A, Photos 1-3).

Pond A20

For the first time, the surface of Pond A20 had qualifying patches of vegetation which were quantitatively sampled. A total of 75 quadrats were sampled in the southern section of the pond surface, which had the majority of vegetation establishment (near the breach). Dominant vegetation in Pond A20 consisted of cordgrass and annual pickleweed (Table 3-2, Appendix A, Photos 4 and 5). Within the qualifying patches sampled, average total cover of vegetation was 68.13%, with 32% bare ground and no litter. Average maximum vegetation height was 25.02 inches. Average relative cover was 40.40%.

Pond A19

There were no qualifying patches of vegetation located on the pond surface in Pond A19, which is still mostly unvegetated. There were some isolated patches of cordgrass establishing in the pond, and an abundance of shorebirds on the mudflats at low tide (Appendix A, Photo 6).

As in 2012 and in 2014, the special status plant (California Rare Plant Rank 4) dwarf spikerush (*Eleocharis parvula*) was found on the mud shore of the northwest levee of Pond A19 (Appendix A, Photos 7-9). In 2015 the population looked larger and more extensive than in previous years; however, it was still found in only one section of the pond margin along the borrow ditch.

Table 3-2
Quantitative Vegetation Sampling of Pond Surfaces (Marsh Plain) in 2015

Location[1]	Total # of Quadrats	Average Total % Cover	Average % Bare Ground	Average % Litter	Average Max Veg Height (in)	Dominant Species[2]	Average Relative % Cover
Pond A21	141	75.85	24.22	0	29.44	SPFO, SAPA	39.32
Pond A20	75	68.13	32.0	0	25.0	SPFO, SADE	40.40

[1] Pond A19 had no qualifying patches for quantitative sampling.
[2] SPFO = Spartina foliosa; SAPA = Salicornia pacifica; SADE = Salicornia depressa

3.2.3. Channel Network Evolution Monitoring (Refuge)

In 2015 the Island Pond channels expanded compared to the prior mapping done in 2010. Many channels widened and some new channels were added, substantially increasing overall channel acreage by about 79% in the three ponds (Table 3-3). This follows smaller annual increases of 3.8%, 1.5%, and 11.4% in 2008, 2009, and 2010. The greatest increase in channel geometry as a percentage of pond surface was in Pond A19, with 18 acres of channels representing 7% of the pond surface and an 85% increase from 2010.

Surprisingly, the lowest amount of channel acreage was in Pond A20, with only 3% (2 acres) of the pond surface occurring as a network of channels, a 41% increase from the last time data were collected. Pond A20 was also noteworthy in that the majority of vegetation establishing on the pond surface was located across from the breach on the south side of the pond. Figures 5–7 show the GIS generated channels from previous years along with the new or widened channels added in 2015.

Table 3-3
Channel Networking in Island Ponds from 2006-2015

Year	Pond	Pond Acreage	Total Channel Acreage	Percent Pond as Channel	% Change in Acreage from Previous Year
2006	A19	265	8.74	3.30	
	A20	63	0.85	1.35	
	A21	147	3.02	2.05	
		Total	**12.61**		
2007	A19	265	8.74	3.30	0
	A20	63	0.85	1.35	0
	A21	147	3.02	2.05	0
		Total	**12.61**		**0**
2008	A19	265	9.06	3.42	3.64
	A20	63	1.01	1.60	18.52
	A21	147	3.02	2.05	0
		Total	**13.09**		**3.81**
2009	A19	265	9.20	3.47	1.55
	A20	63	1.04	1.65	2.97
	A21	147	3.05	2.07	1.0
		Total	**13.29**		**1.53**
2010	A19	265	9.78	3.69	6.3
	A20	63	1.44	2.29	38.46
	A21	147	3.58	2.44	17.38
		Total	**14.8**		**11.36**
2015	A19	265	18.11	6.83	85.17
	A20	63	2.03	3.22	40.97
	A21	147	6.27	4.27	75.14
		Total	**26.41**		**78.45**

3.2.4. Levee Breach and Outboard Marsh Channel Geometry (District)

The 2015 satellite imagery was used to analyze the current width of each breach compared to the 2010 widths. Table 3-4 shows breach widths over time since 2006. Changes in breach width from 2010 to 2015 ranged from 1 ft in the east breach of Pond A21 to 13 feet in the west breach of Pond A19. Breaches have in some ponds resulted in localized sediment accretion and vegetation establishment on the marsh plain in the vicinity of the breach (eg. Pond A20, vegetation development in southern extent of the pond surface).

Table 3-4
Pond Breach Widths (feet) Over Time

Breach by Pond	Breach Width 2006	Breach Width 2007	Breach Width 2008	Breach Width 2009	Breach Width 2010	Breach Width 2015
A19 East	110	122	140	147	147	156
A19 West	22	28	32	34	37	50
A20	76	82	89	89	89	91
A21 East	32	37	45	45	46	47
A21 West	76	79	95	96	100	112

The 2015 satellite imagery was used to analyze the extent of marsh scour along the pond boundaries from 2006 to 2015 (Table 3-5). Erosion of the outboard tidal channels remains gradual, with incremental marsh loss from 2010 to 2015 of 0.13 acres. The exception in 2015 was the outboard marsh in the vicinity of the east breach of Pond A21, which showed a slight accretion rather than scour. Total marsh loss to date, including loss associated with construction impacts, is 1.52 acres.

Table 3-5
Marsh Loss (acres) from Scour of Outboard Channels

Breach	Marsh Scour 2006	Marsh Scour to 2010	Marsh Scour to date (2015)	Incremental Marsh Scour-2010-2015
A19 East	0.05	0.07	0.10	0.03
A19 West	0.05	0.06	0.08	0.02
A20	0.55	0.59	0.67	0.08
A21 East	0.33	0.38	0.35	-0.03
A21 West	0.25	0.29	0.32	0.03
Totals	**1.23**	**1.39**	**1.52**	**0.13**

3.2.5 Wildlife Monitoring (Refuge)

Full reports of the monitoring of salt marsh harvest mouse and Ridgway's rail conducted by the Refuge in 2015 are located in Appendix B.

Salt Marsh Harvest Mouse monitoring- Pond A21 was trapped for three nights, resulting in

the capture of 63 new animals, plus an additional 10 recaptures. Species caught included salt marsh harvest mice, western harvest mice, harvest mice with intermediate traits, deer mice (*Peromyscus maniculatus*) and non-native house mice (Figure 8). House mice were the most abundant species (37 individuals), followed by harvest mice (salt marsh, western, and intermediate traits (4, 7, and 7 individuals caught respectively)) and deer mice (8 individuals). Four new salt marsh harvest mouse were captured for a capture efficiency of 1.3%.

Vegetation height at Pond A21 averaged 15.7 in (40 cm) across all plots. Pickleweed was the dominant species, averaging 91% cover across all plots, and occurred in all 25 plots. California cordgrass (*Spartina foliosa*) was found in 7 of 25 plots and additional plants documented include fat hen, alkali heath, perennial pepperweed (*Lepidium latifolium*) and salt marsh dodder (*Cuscuta salina*).

Ridgway's rail monitoring – Refuge staff surveyed three stations in Pond A21 on three occasions in 2015 and recorded no Ridgway's rails. However, during small mammal trapping in July, a minimum of one duet (2 breeding rails) were heard on July 23, 2015. These are noted as RIRA, with the associated call, in Figure 9. While Figure 9 indicates additional audio and visual documentation of rails over several survey periods, for reporting purposes the duet heard on July 23, 2015 confirms that there was a minimum of two rails in Pond A21.

3.3 OFF-SITE MONITORING

3.3.1 Accelerated Deterioration of the Town of Drawbridge (District)

On November 23, 2015 a civil engineer from the District performed the surveying work to collect surface elevation data at the eight cross section locations established along the Pond A21 levee. The collected data are summarized in Appendix C.

The offset measurements taken in this location show an overall reduction in total levee width of a couple of inches to two feet at one cross section during the last twelve months.

A comparison of the data collected in November 2015, December 2014, August 2012, October 2011 and December 2008 shows minor, yet consistent degradation of the height of levee surface, averaging less than 2 inch of lost levee material. Lateral measurements taken at this location show continued loss of earthen material along the inboard slope of Pond A21. This inboard levee slope consists of a vertical edge, approximately 2 – 3 feet in height, with debris, slumped material, and newly growing pickleweed along the toe. The total loss of levee width at the eight survey locations since 2008 ranges from two feet to over 4 feet at two of the cross sections.

3.3.2 Fringe Marsh Scour in Coyote Creek (District)

The fringe marshes of Coyote Creek that are adjacent to the Island Ponds are showing signs of scour in some locations and accretion in others (Figure 10). Total collective marsh loss since 2008 is 1.21 acres, and total marsh accretion is 1.81 acres (Tables 3-6, 3-7). As in previous years, the north bank of Coyote Creek shows more accretion than the south bank. The north bank also showed more marsh scour in 2015. Collectively the north bank showed an accretion of 0.55 acres of marsh, and the south bank had gained 0.05 acres of marsh (calculating accretion minus scour).

Table 3-6
Fringe Marsh Scour (acres) Over Time

Location	2008	2009	2010	2015
North Bank Coyote Creek	0.26	0.44	0.68	0.69
South Bank Coyote Creek	0.43	0.52	0.57	0.52
Total Scour	**0.69**	**0.96**	**1.25**	**1.21**

Table 3-7
Fringe Marsh Accretion (acres) Over Time

Location	2008	2009	2010	2015
North Bank Coyote Creek	0.29	0.32	0.32	1.24
South Bank Coyote Creek	0.11	0.16	0.36	0.57
Total Accretion	**0.40**	**0.48**	**0.68**	**1.81**

4.0 DISCUSSION

Both vegetation mapping (digitizing) from the 2015 satellite image and field- based quantitative vegetation sampling indicate that an abundance of marsh vegetation has established on the Pond A21 marsh plain over the past 3 years (Table 4-1). Not only has the total vegetated extent of the pond surface increased substantially, but vegetative cover has become much denser as well. There are no longer separate patches of vegetation but rather a generally continuous mosaic of marsh vegetation interspersed with mud flat of varying topography and side slough channels. At approximately 118 acres of vegetated pond surface and an average of 75.85% total percent vegetation cover, Pond A21 has met the final success criteria for the mitigation project as a whole (75 acres at 75% vegetative cover). Coupled with the documentation of salt marsh harvest mice along the borrow ditch of Pond A21 and the audio confirmation of a pair of breeding Ridgway's rails, this area has become functional marsh habitat for endangered species as well.

Table 4-1
Extent of Vegetation Establishment in Pond A21 from 2012-2015

Year	Total Acres of Vegetation[1]	Average Total % Cover[2]	Average % Bare Soil[2]	Average % Litter[2]
2012	48.39	42.59	54.68	2.73
2014	109.45	71.40	28.60	0
2015	117.95	75.85	24.22	0

[1] Approximate; based on photo interpretation of aerial and satellite imagery
[2] From quantitative field sampling

Across all three ponds, sediment is continuing to accumulate and consolidate to form acceptable substrate for vegetation colonization. For the first time in 2015, Pond A20 had qualifying patches of vegetation large enough (2 acres or larger) to sample quantitatively. The vegetation establishing on the pond surface is at the southern end of the pond near the breach. Pond A19, while still predominantly unvegetated, does show a substantial increase in marsh vegetation establishment on the pond surfaces since 2012. Currently approximately 166 acres of marsh vegetation has collectively established in the three ponds, which represents a 15% increase from last year (2014).

There has been a significant increase in channel network evolution in the ponds since the last time data were analyzed in 2010. The largest increase was in Pond A19, with approximately 7% (18 acres) of the pond surface exhibiting a network of drainage channels. This represents an 85% increase since 2010 for that pond. This is an excellent development in the trajectory of vegetation establishment in that pond, as in the RMMP the development of channel networks was highlighted as an important indicator of progress in the deposition of sediment and subsequent vegetation establishment as well as habitat for species such as Ridgway's rail. While Pond A19 still contains the least amount of vegetated marsh plain on the pond surface, it is likely that vegetation establishment will be rapid in subsequent years.

Vegetation composition on the marsh plain of all three ponds continues to be dominated by several native species, including perennial pickleweed and California cordgrass, and to a lesser extent, annual pickleweed. As in past years, vegetation on pond levee shorelines was more

mixed; with perennial picklweed and California cordgrass as well as some areas showing establishment of non-native Salsola and small amounts of perennial pepperweed. As sediment accretion continues, management of non-native vegetation may need to become a priority to prevent establishment of these or other invasive species on the marsh plain.

Data collected from 2008 to 2015 indicate that deterioration along the inboard slope of the southeast levee of pond A21 (near historic Town of Drawbridge) is still occurring. These measurements confirm the trend shown in previous surveys that the width of the pond levee is decreasing over time, with most locations experiencing more than two feet of lost girth since 2008. The total levee width however, is still more than 10 feet wide at its narrowest location. Levee height measurements, however, have not changed greatly since 2009, indicating that the top of levee isn't experiencing rapid change. At this time, the levee doesn't appear to be at risk of failure; however, future evaluations and measurements should be conducted by the Union Pacific Railroad (UPRR) to confirm that the pond levee does not deteriorate further and potentially compromise the railroad levee.

5.0 REFERENCES

1. Foxgrover, A. C., S. A. Higgins, M. K. Ingraca, B. E. Jaffe, and R. E. Smith. 2004. Deposition, erosion, and bathymetric change in South San Francisco Bay: 1858-1983. U.S. Geological Survey, Reston, VA. U.S. Geological Survey Open-File Report 2004-1192; available at http://pubs.usgs.gov/of/2004/1192/

2. French, J. R. 1993. Numerical simulation of vertical marsh growth and adjustment to accelerated sea-level rise, North Norfolk, U.K. Earth Surface Processes and Landforms 18:63-81.

3. Gross, E. 2003. Alviso Island Pond Breach Initial Stewardship Plan Study. Appendix K of the Environmental Impact Report/Environmental Impact Statement for the South Bay Salt Ponds Initial Stewardship Plan. Report to Cargill Salt, December, 2003.

4. HTH (H.T. Harvey & Associates) and PWA (Philip Williams & Associates, Ltd.). 2005. Island Ponds (Ponds A19, A20, A21) Tidal Marsh Establishment Projections. Report to the Santa Clara Valley Water District, January, 2005.

5. HTH (H.T. Harvey & Associates), PWA, EDAW, and Brown & Caldwell. 2005. South Bay Salt Pond Restoration Project. Biology and Habitats Existing Conditions Report. Report to California State Coastal Conservancy, U.S. Fish & Wildlife Service, and California Department of Fish and Game, March 2005.

6. Jaffe, B., and A. Foxgrover. 2006. Sediment deposition and erosion in South San Francisco Bay, California from 1956 to 2005. U.S. Geological Survey, Reston, VA. U.S. Geological Survey Open-File Report 2006-1287; available at http://pubs.usgs.gov/of/2006/1287

7. Krone, R. B. 1987. A method for simulating historic marsh elevations. Pages 316-323 in N. C. Krause, editor. Coastal Sediments '87. American Society of Civil Engineers, New York, NY.

8. Life Science! 2003. South Bay Salt Ponds Initial Stewardship Plan. Report to the U.S. Fish & Wildlife Service and California Department of Fish and Game, March, 2003.

9. Life Science! 2004. Environmental Impact Report/Environmental Impact Statement for the South Bay Salt Ponds Initial Stewardship Plan. Report to the U.S. Fish & Wildlife Service and California Department of Fish and Game, March, 2004

10. Morris, J. T., P. V. Sundareshwar, C. T. Nietch, B. Kjerfve, and D. R. Cahoon. 2002. Responses of coastal wetlands to rising sea level. Ecology 83:2869-2877.

11. SCVWD (Santa Clara Valley Water District). 2006a. Tidal Wetland Mitigation/ Restoration (Island Ponds) Cross Sections Pond A19 & A20 Design Plans. February 8, 2006.

12. SCVWD (Santa Clara Valley Water District). 2006b. Tidal Wetland Mitigation/ Restoration (Island Ponds) Cross Sections Pond A21 Design Plans. February 8, 2006.

13. SCVWD (Santa Clara Valley Water District) & USFWS (U.S. Fish & Wildlife Service), Don Edwards National Wildlife Refuge. 2013. Island Ponds Mitigation Monitoring and Reporting Year 7- 2012. January 2013.

14. SCVWD (Santa Clara Valley Water District) & USFWS (U.S. Fish & Wildlife Service), Don Edwards National Wildlife Refuge. 2009. Island Ponds Mitigation Monitoring and Reporting Year 3 – 2008. January 2009.

15. USFWS (U.S. Fish & Wildlife Service), Don Edwards National Wildlife Refuge, and Santa Clara Valley Water District. 2006. Restoration and Mitigation Monitoring Plan for the Island Ponds Restoration Project.

16. Williams, P. B., and M. K. Orr. 2002. Physical evolution of restored breached levee salt marshes in the San Francisco Bay estuary. Restoration Ecology 10:527-542.

6.0 LIST OF PREPARERS

This report was prepared by the following staff:

USFWS Don Edwards National Wildlife Refuge

Ivette Loredo
Cheryl Strong
Rachel Tertes

Santa Clara Valley Water District

Janell Hillman
Ripen Kaur
Lisa Porcella

7.0 FIGURES

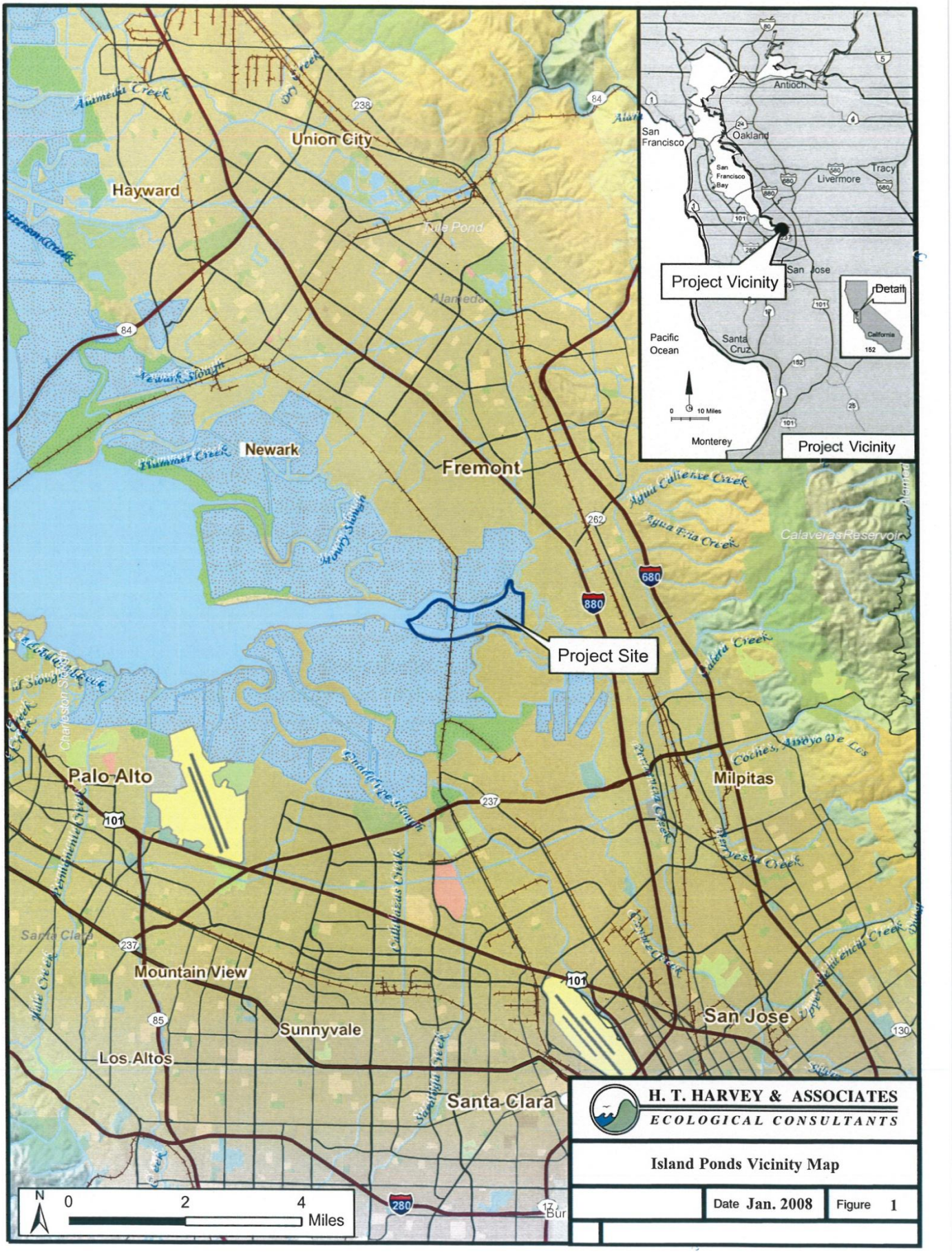


Figure 1. Island Ponds Vicinity Map

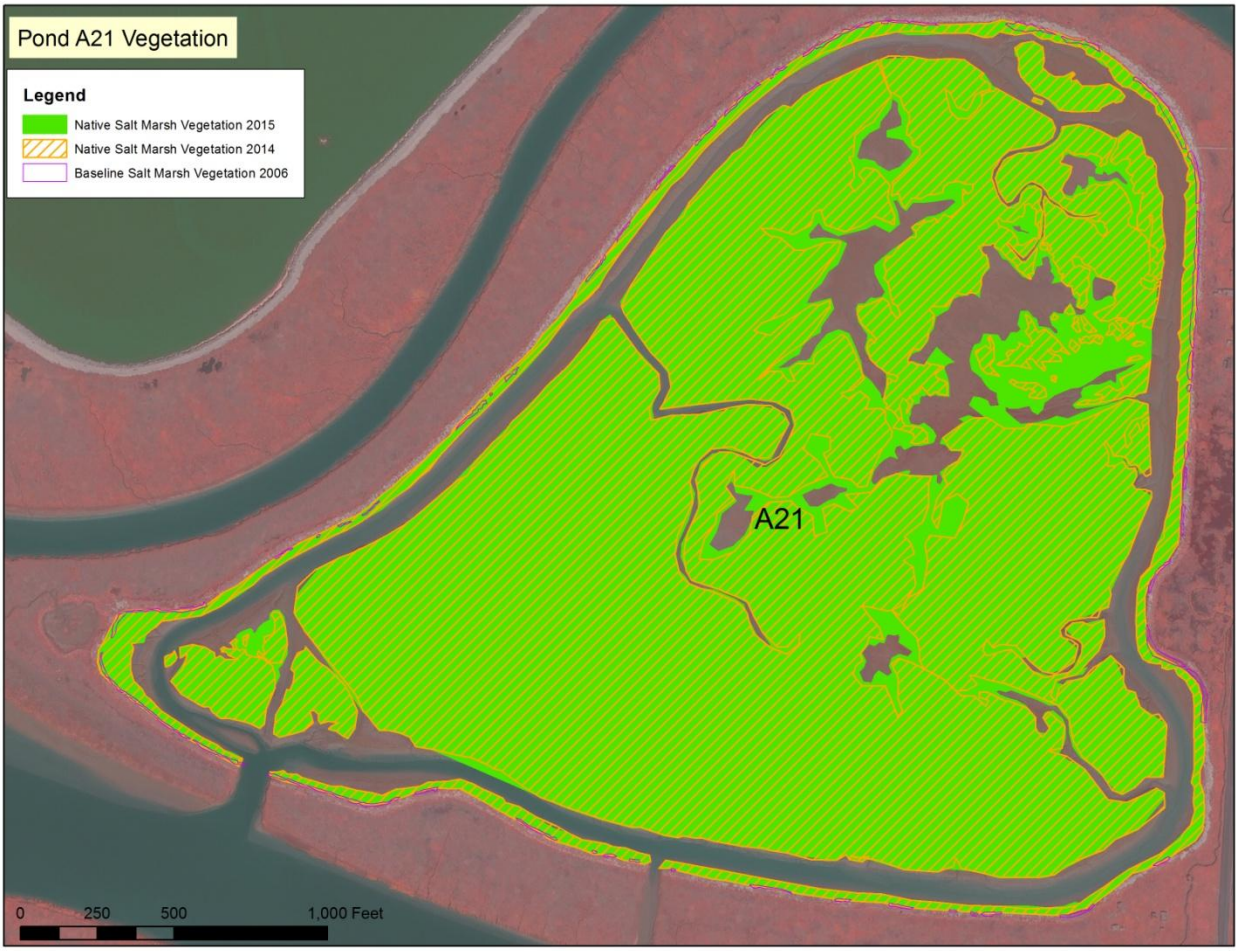


Figure 2. Digitized Vegetation from Satellite Imagery in Pond A21, Comparison over Several Years

Figure 3. Digitized Vegetation from Satellite Imagery in Pond A20, Comparison over Several Years

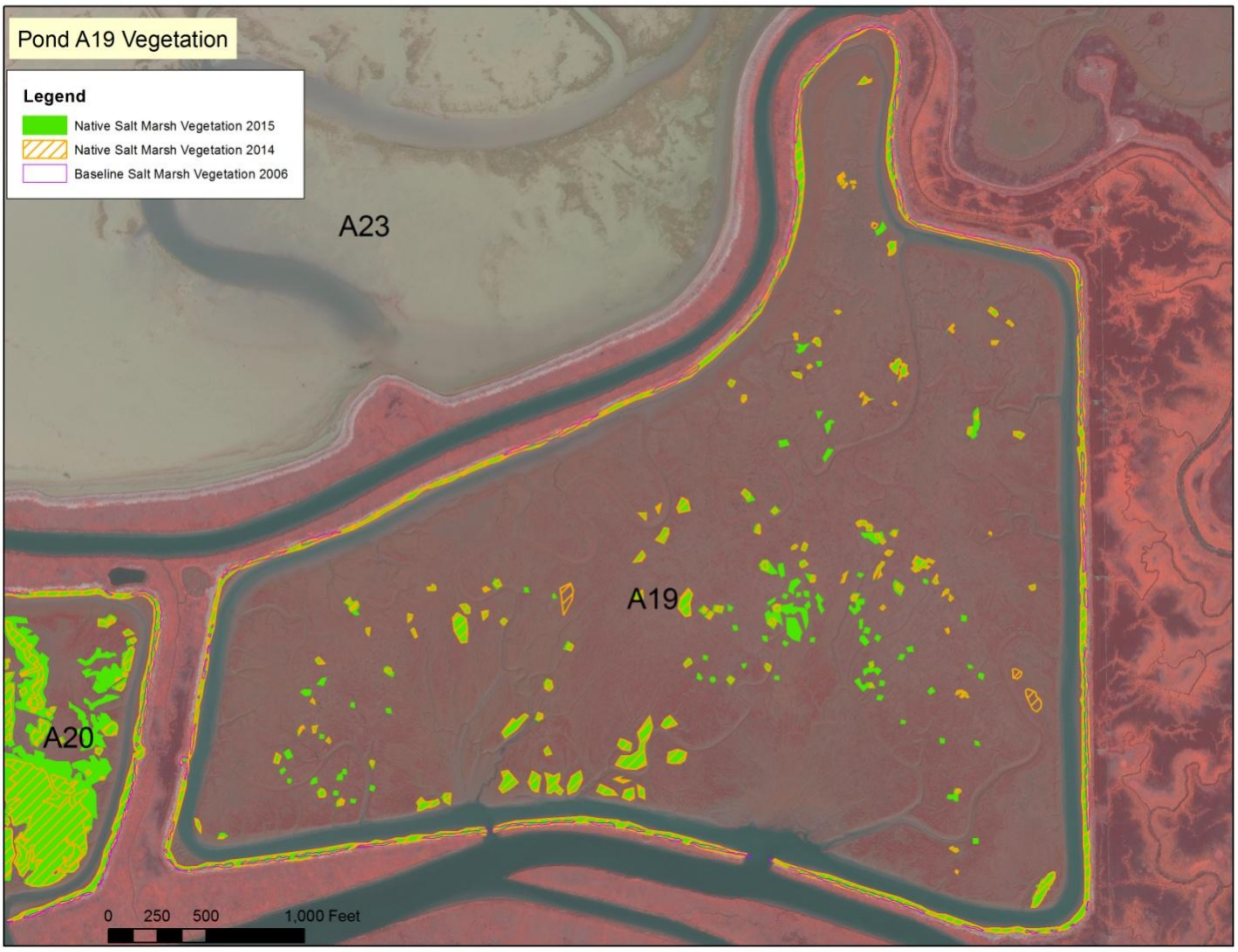


Figure 4. Digitized Vegetation from Satellite Imagery in Pond A19, Comparison over Several Years

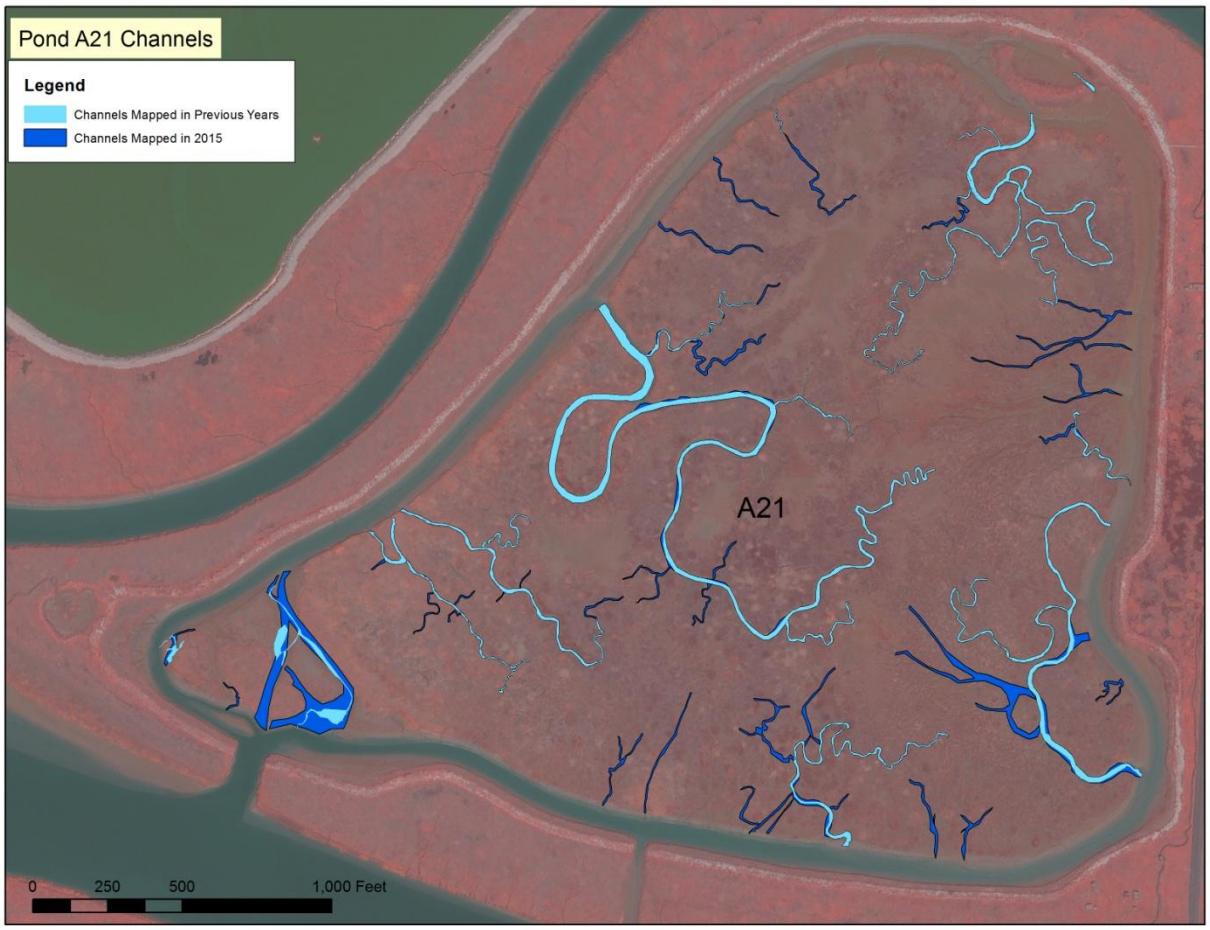


Figure 5. Channel Geometry in Pond A21, 2015 Compared to Previous Years

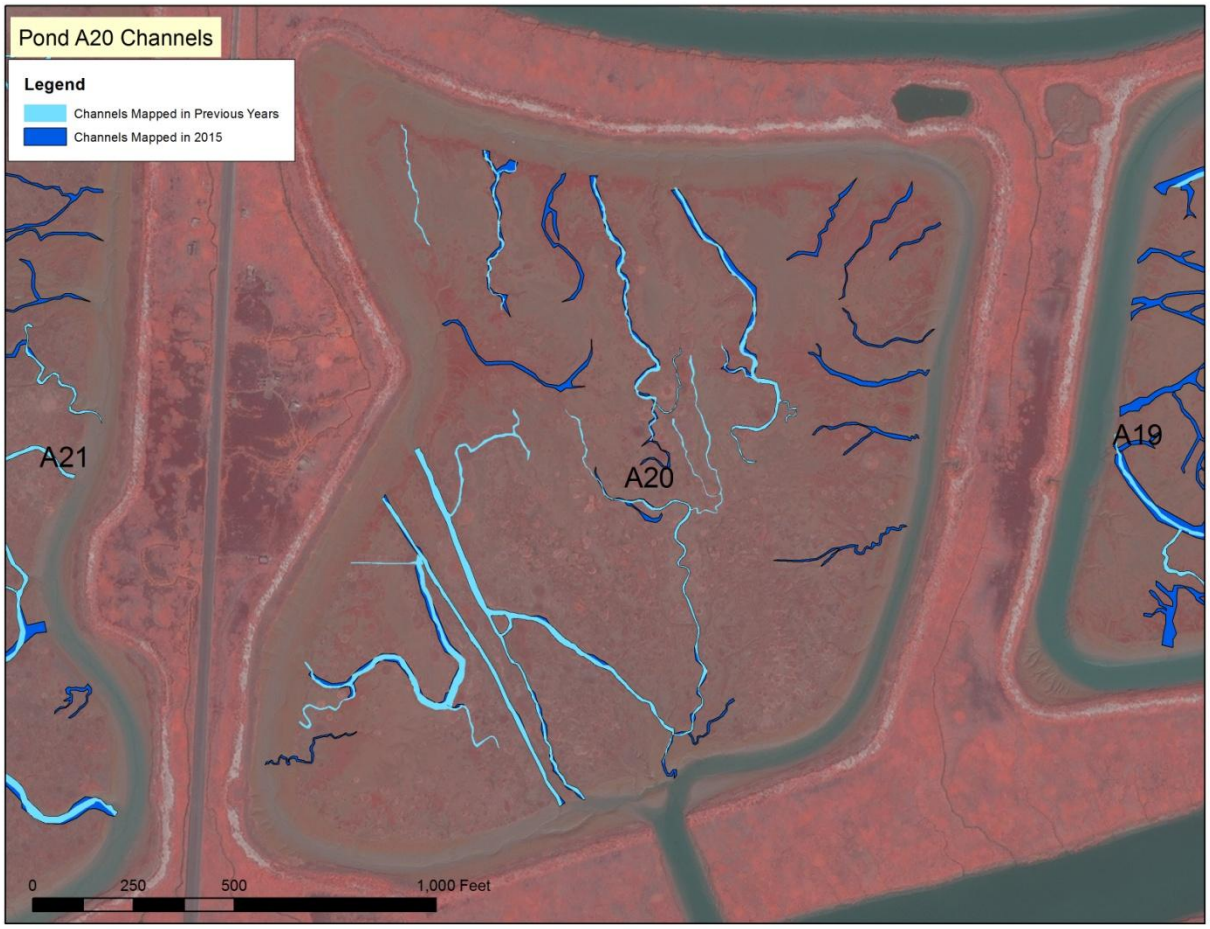


Figure 6. Channel Geometry in Pond A20, 2015 Compared to Previous Years

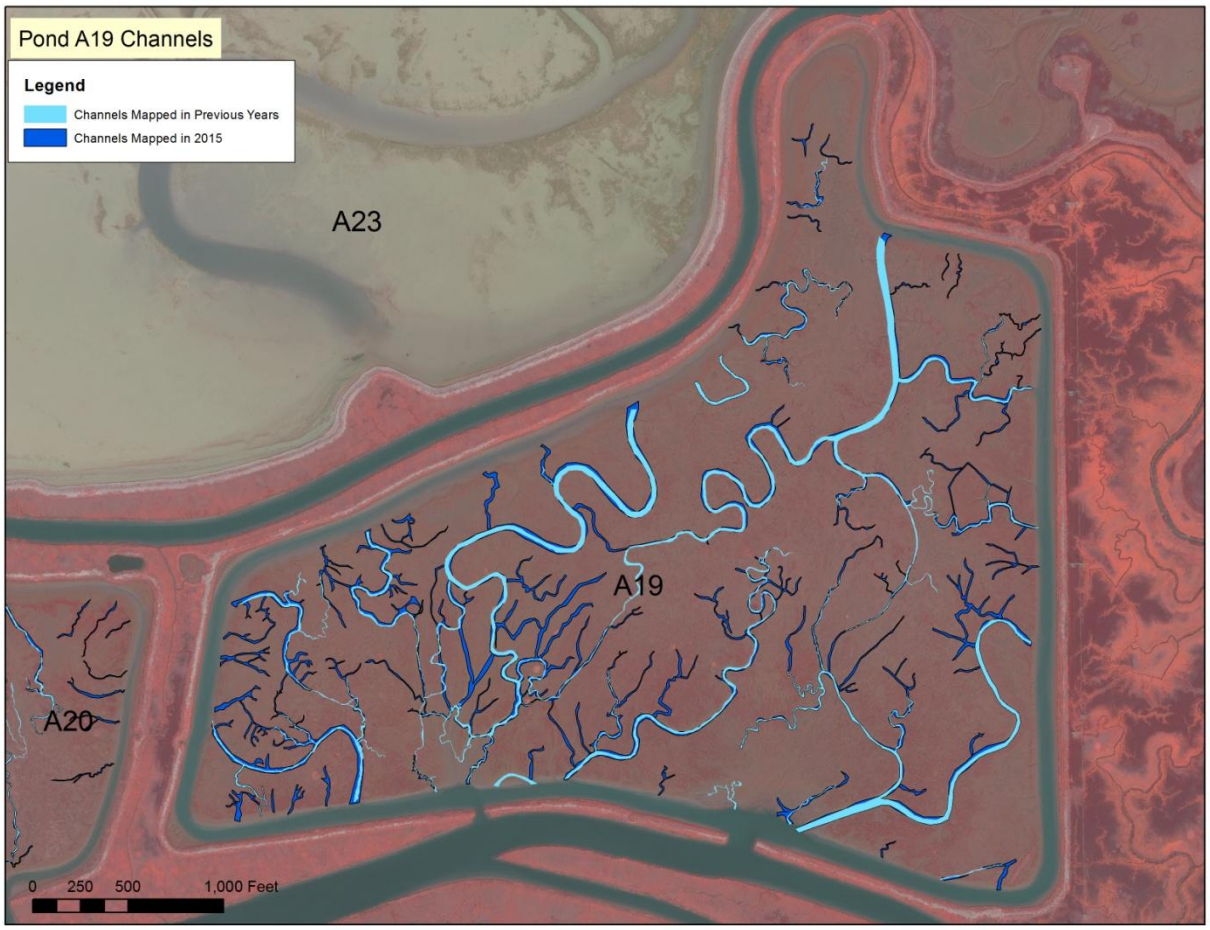


Figure 7. Channel Geometry in Pond A19, 2015 Compared to Previous Years

Figure 8. Salt Marsh Harvest Mouse Trapping Results at Pond A21 Borrow Ditch, 2015

Figure 9. Locations of Audio and Visual Confirmation of Ridgway's Rails, Pond A21 in July 2015

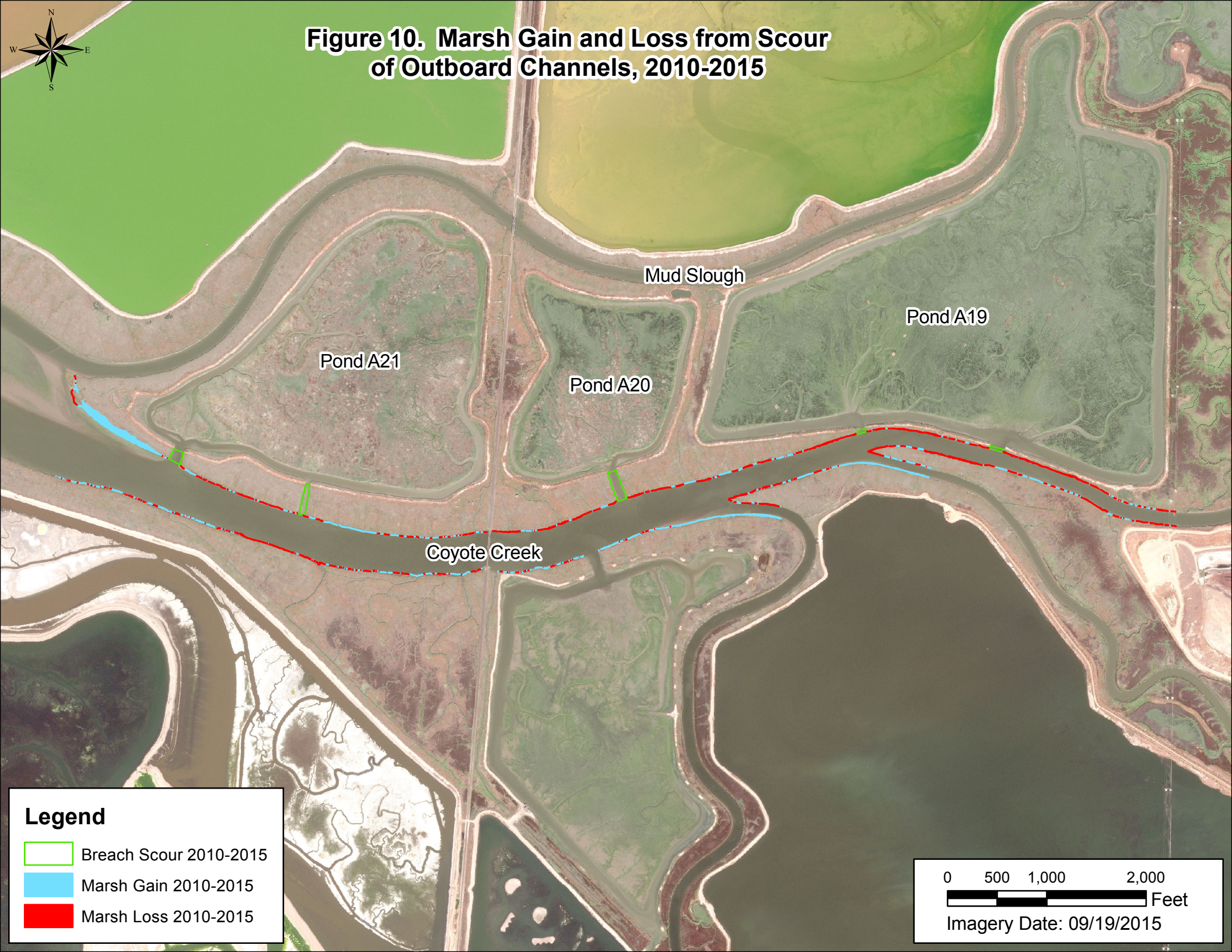


Figure 10. Marsh Gain and Loss from Scour of Outboard Channels, 2010-2015
N
W
E
S
Mud Slough
Pond A19
Pond A21
Pond A20
Coyote Creek
Legend
Breach Scour 2010-2015
Marsh Gain 2010-2015
Marsh Loss 2010-2015
0
500
1,000
2,000
Feet
Imagery Date: 09/19/2015

APPENDIX A

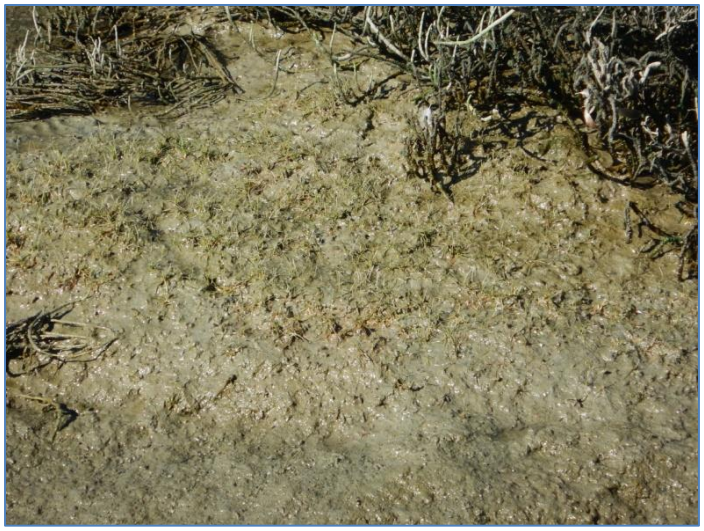
SITE PHOTOS

Photos 1 and 2. Pond A21 marsh plain.

Photo 3. Quadrat sampling on the Pond A21 marsh plain.


Photos 4 and 5. Pond A20 marsh plain.

Photo 6. Pond A19 pond surface at high tide.



Photos 7 and 8. Dwarf spike rush (*Eleocharis parvula*) along the borrow ditch shoreline of Pond A19.

Photo 9. Habitat of dwarf spike rush along the borrow ditch shoreline of Pond A19.

APPENDIX B

WILDLIFE SPECIES SURVEY REPORTS

2015 ACTIVITIES INVOLVING THE SALT MARSH HARVEST MOUSE AT DON EDWARDS SAN FRANCISCO BAY NWR

Contact: Rachel Tertes, Wildlife Biologist

INTRODUCTION

The 2015 trapping effort for salt marsh harvest mice (*Reithrodontomys raviventris)* involved two very different age classes of tidal marsh habitat; pre-historical marsh at Newark Slough and nine year old marsh at Pond A21.

Newark Slough is a pre-historical marsh and fully tidal slough that is approximately 5 miles long and flows from Thornton Avenue out to San Francisco Bay. In 1978, a mark recapture study was conducted to document salt marsh harvest mice prior to construction of two pedestrian bridges as part of an internal Section 7 consultation. In 2015, we used the historical maps to place the traps in similar locations and grids, however due to changes in the marsh, traps were only placed in areas deemed suitable habitat and safe from inundation.

Pond A21 is a newly restored 265 acre marsh. It is one of the Island Ponds, located in the Alviso Pond Complex that was breached in 2006, as part of Initial Stewardship Plan of the South Bay Salt Pond Restoration Project. Salt production in the Island Ponds began in 1929 and continued as middle stage evaporator ponds with intermediate salinity levels until 2003 when land ownership was transferred to the Refuge. Prior to breaching, Pond A21 was devoid of vegetation. But within 6 months, sediment began to accumulate and marsh began to grow. Crustaceans such as mysid shrimp appeared in large numbers offering foraging opportunities for birds and Federal candidate longfin smelt were documented. This was the first trapping effort conducted at Pond A21.

Objectives of the 2015 trapping were: 1) document the continued presence of salt marsh harvest mouse in a pre-historical tidal marsh (Newark Slough) 2) document the presence of salt marsh harvest mice in a newly restored marsh (Pond A21) and 3) relate these to current vegetation and water conditions if possible.

This report summarizes the results of small mammal trapping at the Newark Slough in June and Pond A21 in July 2015.

METHODS

Newark Slough and Pond A21 are both located on the Don Edwards San Francisco Bay National Wildlife Refuge, Alameda County.

Newark Slough

The portion of Newark Slough that was surveyed is adjacent to the Refuge Headquarters, between the two Newark Slough pedestrian bridges (Figure 1). The areas surveyed in Newark Slough in 2015 correspond to Newark Slough I ("Red Cabin Marsh") and Newark Slough III from the 1978 study.

In Newark Slough, the trapping consisted of 75 Sherman live traps spaced at 10 meter intervals. Three clusters of transects were laid out to sample suitable pickleweed habitat, and where parallel, they were spaced 10 meters apart (Figure 1). The three areas trapped were centered around the Hunter's Cabin and northern pedestrian bridge (A Traps), the southern pedestrian bridge (C Traps) and the marsh between the two pedestrian bridges (B Traps). In addition to marsh, the transition zone along the levee was also surveyed in each cluster. Newark Slough was trapped from June 23-25, 2015 for a total of 225 trap nights.

Pond A21

Pond A21 is located at the confluence of Coyote Creek and Mud Slough and also shares a boundary with an active Union Pacific Railroad and the historic town of Drawbridge (Figure 2). Pond A21 is accessed by vehicle by way of Warm Springs Seasonal Wetland Unit and Pond A22/A23. Once at Pond A23, the site is accessed by foot by crossing the railroad bridge into the historic town of Drawbridge and then across a dilapidated foot bridge to the Pond A21 levee.

In Pond A21, the trapping consisted of 100 Sherman live traps spaced at 10 meter intervals. Four transects of 25 traps were placed along the high marsh between the borrow ditch and the levee and transects were 200m apart. Pond A21 was trapped from July 21-23, 2015 for a total of 300 trap nights.

Small Mammals

Traps within each line were spaced 10 meters apart and baited with a combination of birdseed, walnuts, and peanut butter. Two bearded dragon pellets were placed in each trap in the event a shrew was caught. A small handful of Polyester pillow filling was placed in each trap to reduce heat loss throughout the night. Wooden shingles were placed on traps in sparsely vegetated areas for shading and camouflage or underneath traps to provide more surface area when placing traps in vegetation. Traps were checked within an hour of sunrise and closed during the day to ensure that the animals were not in traps during the warmer hours of the day.

Captured animals were processed and were then released at the location of capture, except for non-native house mice *(Mus musculus)*. All captured animals were identified by species, sexed, aged and hair-clipped. See Figure 3 for a side by side comparison of some of the different species. All *Reithrodontomys* were individually hair-clipped and their teeth were checked for grooves (Figure 4). Fur samples from all small mammals were sent to Josh Ackerman for a USGS Mercury study. House mice were taken to Ohlone Humane Society in Newark for participation in the raptor feeding program. Detailed measurements were taken of all *Reithrodontomys* captured and the following table was used to distinguish between western harvest mouse (*R. megalotis)* and the salt marsh harvest mouse (Table 1, Shellhammer & Padgett-Flohr 2002). Some individuals with intermediate traits can only be identified to genus. All handling, processing and identification of salt marsh harvest mice were done by Refuge biologists: Joy Albertson, Cheryl Strong and Rachel Tertes.

Capture efficiency (CE) is a relative abundance index and was calculated by the number of new animals caught divided by number of trap nights, expended times 100. Trap nights is calculated by the number of traps open per night per trapping session, e.g. 400 traps nights represents 100 traps set for 4 nights (Service 2013). This method is used because of the high effort-low return

on trapping and the great difficulty and great expense of obtaining dependable density estimates on a regular basis (Service 2010).

Table 1. Traits used to distinguish between salt marsh and western harvest mice

CHARACTERISTIC	SCORE		
	0	**1**	**2**
Tail tip	Blunt	Intermediate	Pointed
Color Pattern of tail (not hair)	Unicolored	Intermediate	Bicolored
White hairs on vent of tail	None	Few	White Hairs
Tail diameter at 20mm from body	≥ 2.1 mm	2.0 mm	≤ 1.9 mm

Total Score = 1-3 Salt Marsh Harvest Mouse (*Reithrodontomys raviventris)*
= 4-5 Harvest Mouse with Intermediate Traits (*Reithrodontomys spp.)*
= 6-8 Western Harvest Mouse (*Reithrodontomys megalotis)*

Vegetation

Vegetation data were collected on June 18 and July 29, 2015 by Rachel Tertes and Sal Sainz. Vegetation measurements were taken along the mouse sampling transects at 25% of trap locations. The location of the first plot was generated randomly and from there, plots were systematically spaced at every fourth trap site. At each plot a one-meter square PVC frame was placed so the northwest corner of the frame abutted the trap location. The frame was divided into quadrants by string to improve the estimates of vegetation cover. The observer made ocular estimates of species cover. Height measurements were made by randomly placing a meter stick in each quadrant, plus one random hit in the frame, and measuring the tallest plant closest to the stick. A total of five measurements per quadrant were made.

RESULTS

Small Mammals

Newark Slough was trapped for three nights in June, resulting in the capture of 19 new animals, plus an additional 1 recapture (Table 2). Pond A21 was trapped for three nights, resulting in the capture of 63 new animals, plus an additional 10 recaptures. Species caught included salt marsh harvest mice, western harvest mice, harvest mice with intermediate traits, deer mice (*Peromyscus maniculatus*, Figure 5) and non-native house mice. Table 2 displays the breakdown of species caught per day, both new and recaptures, by location and overall. Figures 6, 7 and 8 display the distribution and species of small mammals caught throughout the survey. The most abundant species captured at Newark Slough were house mice followed by salt marsh harvest mice. At Pond A21, house mice were the most abundant species, followed by harvest mice (salt marsh, western, and intermediate traits) and deer mice.

We trapped for 225 trap nights in June and 300 trap nights in July (Table 3). We decided not to use "Actual" trap nights in 2015 to maintain consistency with methods used 1978 to make results comparable. Actual number of trap nights is calculated by number of traps open per night per trapping session minus ½ the number of "closed but empty" traps, as decided by the Salt Marsh Harvest Mouse working group.

Table 2. Small Mammal Captures at Newark Slough and Pond A21

		RERA		RESP		REME		MUMU		PEMA		TOTAL CAPTURE	
		new	recap	new	recap	new	recap	new	recap	new	recap	new	recap
Newark Slough	3 nights in June	5	1	1	0	0	0	13	n/a	0	0	19	1
Pond A21	3 nights in July	4	0	7	1	7	0	37	6	8	3	63	10

RERA	Reithrodontomys raviventris	Salt Marsh Harvest Mouse
RESP	Reithrodontomys species	Harvest Mouse w/Intermediate traits
REME	Reithrodontomys megalotis	Western Harvest Mouse
PEMA	Peromyscus maniculatus	Deer Mouse
MUMU	Mus musculus	House Mouse

Table 3. Calculating Trap Nights

	Traps set Day 1	Traps set Day 2	Traps set Day 3	Total Trap Nights
Newark Slough	75	75	75	225
Pond A21	100	100	100	300

At Newark Slough, five new Salt Marsh Harvest Mice were captured for a capture efficiency of 2.2% (Table 4). At Pond A21, four new salt marsh harvest mouse were captured for a capture efficiency of 1.3%.

Table 4. 2015 Salt Marsh Harvest Mouse Capture Efficiencies

	Newark Slough	A21
2015	2.2%	1.3%

House mice were released on site at Pond A21 after capture on July 21, but in subsequent days were transported to Ohlone Humane Society. Three house mice were euthanized on July 21, 2015 due to overall unhealthy appearance. On July 22, 2015, one western harvest mouse was found dead inside a Sherman live trap at 6:30am, when we were processing animals. It appeared to have been caught in the door. The trap was checked for malfunctions and appeared to function properly. We processed the animal for measurements and took pictures.

The salvaged western harvest mouse was labeled and placed in a freezer to be later deposited at the California Academy of Science. SFBNWR-23.1 Section 20(e) lists the Cal Academy as a designated repository for preserved specimens from the Refuge Complex.

Vegetation
At Newark Slough, vegetation height averaged across all plots was 35 cm. Pickleweed (*Sarcocornia pacifica*) was the dominant species, averaging 73% cover across all plots, and occurred in all 19 plots. Alkali heath (*Frankenia salina)* averaged 22% cover across all plots and additional plants documented include fat hen (*Atriplex patula*), saltgrass (*Distichlis spicata*), gumplant (*Grindelia humilis*), and jaumea (*Jaumea carnosa).*

Vegetation height at Pond A21 averaged 40 cm across all plots. Pickleweed was the dominant species, averaging 91% cover across all plots, and occurred in all 25 plots. California cordgrass (*Spartina foliosa*) was found in 7 of 25 plots and additional plants documented include fat hen, alkali heath, perennial pepperweed (*Lepidium latifolium*) and salt marsh dodder (*Cuscuta salina*).

DISCUSSION

Small Mammals

Newark Slough
Several surveys were conducted along Newark Slough in the 1970's and 1980's (Service 1978, Gilroy and Shellhammer 1980, Newcomer 1982, Shellhammer *et al.* 1985). Species caught in previous years included salt marsh harvest mice, California voles (*Microtus californicus*), house mice, and shrews *(Sorex* sp.). Similar to 1978, just harvest mice and house mice were caught in 2015. When we compare the similar locations of the 1978 and 2015 survey, the capture efficiencies of salt marsh harvest mice are similar at 2% and 2.2% respectively. However when we consolidate the various mouse trapping efforts along Newark Slough from 1978 to 2015, capture efficiencies of harvest mice range from 0 to a high of 3.8% and trapping locations span a much larger portion of Newark Slough.

Table 5. Capture Efficiencies at Newark Slough, 1978-2015

Year	Trap Nights	Capture efficiency	RERA
1978	450	2%	9
1980	665	0.15%	1
1982	950	3.80%	36
1983	300	1.30%	4
1984	600	0	0
1985	800	0.75%	6
2015	225	2.20%	5

Pond A21
Prior to the breach in 2006 and subsequent restoration of marsh plants, Pond A21 hasn't had vegetation since before it became a salt pond in 1929. Without vegetation, small mammals were restricted to levees and possibly using the dry pond bottom as a travel corridor. This was the first small mammal survey conducted at Pond A21 and the first survey to document the presence of

salt marsh harvest mice in Pond A21. Mice that recolonized Pond A21 may have traveled from nearby marshes such as Drawbridge Marsh, Triangle Marsh, Coyote Creek and Mud Slough.

Genetics and Mercury

South San Francisco Bay has both western and salt marsh harvest mice living in similar habitats and this overlap continues to pose challenges to researchers in identification. Genetic studies that are currently underway by researchers at U.C. Davis and San Francisco State University may help shed lite on the distribution of these two sympatric species. The Refuge continues to partner with genetic researchers with a goal of removing subjectivity when determining harvest mouse species, as well.

Vegetation

Newark Slough

Vegetation survey methodology has been incomplete and inconsistent throughout the various mouse trapping efforts in Newark Slough so we cannot make direct comparisons. Newcomer's (1982) vegetation survey methodology was the most similar to the 2015 methods, with the difference being data collection at 20% of traps, rather than 25% used in 2015. Averaging the vegetation data from 1982 Newark Site's one and three (similar in trap locations in 2015), there appears to be a reduction in plant structure (height) but an increase in plant diversity between the two sampling years (Table 6). However plant heights and species were only identified in areas where mouse traps were placed and may not represent the overall structure of plant assemblage present at Newark Slough. In 2015, traps were not placed uniformly throughout the marsh plain, rather they were focused in areas with higher plant structure to prevent flooding. While the 1982 survey may have followed a similar practice, it was not documented and I hesitate to make any assumptions.

Table 6. Vegetation Survey Results from 1982 and 2015 at Newark Slough

		Percent Cover									
Year	Avg. plant height	pickle weed	alkali heath	fat hen	dodder	Australian salt bush	salt grass	gum plant	jaumea	standing dead	Bare ground
1982	51cm	47	6	40	8	T					T
2015	35cm	73	22	T			T	T	T	T	

T=less than 5%

Plant species that were documented in Newark Slough in mouse trapping locations included pickleweed, alkali heath, fat hen, Australian salt bush, salt grass, gum plant, jaumea, California sea lavender, dodder, perennial pepperweed (*Lepidium latifolium*), California cordgrass *(Spartina foliosa)*, big bulrush (Bolboschoenus robustus), bulrush (*Typha* sp)., and unidentified grass (Service 1978, Gilroy and Shellhammer 1980, Newcomer 1982, Shellhammer *et al*. 1985).

Pond A21

In 2006, Pond A21 was considered essentially devoid of plants with just 1.2 total acres of vegetation (PWA 2007). Two years later, native vegetation increased to four acres, the majority of which was pickleweed growing adjacent to the levees, along the borrow ditches as well as a

few areas within the pond interiors. No invasive plant species were found within the Island Ponds, however, seven patches of invasive *Spartina alterniflora* hybrids were treated by the Invasive Spartina Project along the south-western outboard levee of Pond A21 using helicopter broadcast spraying (SCVWD 2009). By 2014, vegetation at Pond A21 had expanded to 110 acres and provided 71% total cover. The dominant species were perennial pickleweed and California cordgrass and the average maximum vegetation height was 93cm (SCVWD 2015).

The vegetation surveys associated with mouse trapping appear to be representative of the pond-level vegetation surveys conducted by Santa Clara Valley Water District. The discrepancy in vegetation height may be explained by the Refuge purposely positioning traps in vegetation that was high enough to prevent flooding but structurally sound enough to hold mouse traps. We experimented with putting traps in California cordgrass initially, but as the wind and tides moved the stems, the traps fell. Therefore traps were purposely placed in areas with pickleweed and therefore were shorter in stature.

Newsworthy:
The discovery of salt marsh harvest mice and breeding California Ridgway's rails (see 2015 RIRA endangered species report) at Pond A21 was featured in the following publications:
San Jose Mercury News http://www.mercurynews.com/science/ci_28807544/endangered-species-return-restored-salt-pond,
December 2015 Estuary News http://www.sfestuary.org/wp-content/uploads/2015/12/Estuary-Dec2015-v6-final-web-JM.pdf
Cover article of the Winter 2015 edition of the San Francisco Bay National Wildlife Refuge Complex Tidelines, Volume 38, Number 4
http://www.fws.gov/uploadedFiles/Region_8/NWRS/Zone_2/San_Francisco_Bay_Complex/Tideline_%20Winter15.16.pdf
U.S. Fish and Wildlife Service Field Notes
http://www.fws.gov/fieldnotes/regmap.cfm?arskey=36334
South Bay Salt Pond Restoration Project September 2015 Newsletter, Volume 34
http://www.southbayrestoration.org/news/e-newsletters/sep-2015/

In addition, a photographer from National Geographic shadowed the mouse trapping efforts at Newark Slough and will hopefully be featured in an upcoming Spring National Geographic issue.

CONCLUSION

1. Newark Slough has maintained a population of salt marsh harvest mice for at least the past 37 years,
2. Salt marsh harvest mice are not evenly distributed throughout Newark Slough,
3. Newark Slough has a diverse and predominately native assemblage of tidal marsh species.
4. Salt marsh harvest mice are present at Pond A21 for the first time since it was diked for salt production in 1929.

REFERENCES:

Gilroy and Shellhammer. 1980. Trapping survey of salt marsh harvest mice in the marshes of South San Francisco Bay during the summer of 1980. Unpublished Final Report submitted to the San Francisco Bay National Wildlife Refuge. 27p.

Newcomer. 1982. Trapping survey of salt marsh harvest mice in the marshes of South San Francisco Bay during 1982. Unpublished Final Report submitted to the San Francisco Bay National Wildlife Refuge. 25p.

Padgett-Flohr, Gretchen. 2001. Final Report: Small Mammal Trapping Don Edwards San Francisco Bay National Wildlife Refuge, Newark, CA, Summer, 2001. Unpublished Final Report by Rana Resources. 13p.

Philip Williams & Associates, Ltd. (PWA). 2007. Island ponds mitigation monitoring and reporting year 1- 2006. PWA REF. # 1864

Santa Clara Valley Water District (SCVWD). 2009. Island ponds mitigation monitoring and reporting year 3- 2008.

_____. 2015. Island ponds mitigation monitoring and reporting year 9- 2014.

Shellhammer, H. S., V. Jennings, V. Johnson, S. Muench, and M. Newcomer. 1985. Studies of the salt marsh harvest mouse (Reithrodontomys raviventris) in marginal and other sites in the south San Francisco Bay, 1983-1985. Report prepared for the California Department of Fish & Game. 60p.

Shellhammer, H., & Padgett-Flohr, G. E. 2002. Data collection protocols surveying for the salt marsh harvest mouse (Reithrodontomys raviventris), California vole (Microtus californicus), and other small mammals: San Francisco Estuary Institute.

U.S. Fish and Wildlife Service (Service). 1978. Salt marsh harvest mouse captured and marked under permit no. PRT 2-1229. Unpublished Data

_____2010. Salt marsh harvest mouse (*Reithrodontomys raviventris*) 5-Year Review: Summary and Evaluation, prepared by Sacramento Fish and Wildlife Office, Sacramento, California.

_____ 2013. Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California. Sacramento, California. Xviii + 605 pp.

Figure 1. Overview Map: Newark Slough

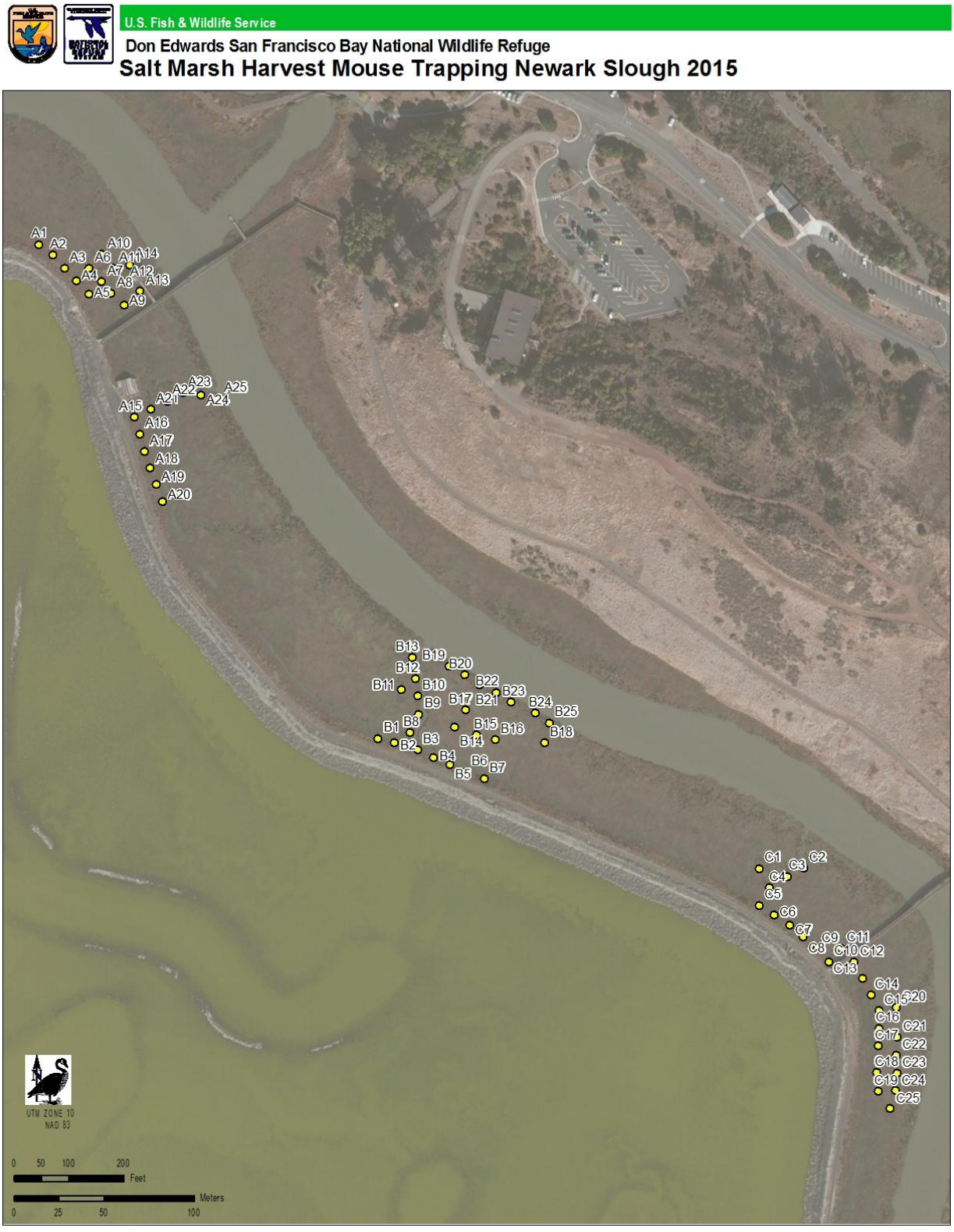


Figure 2. Overview Map: Pond A21

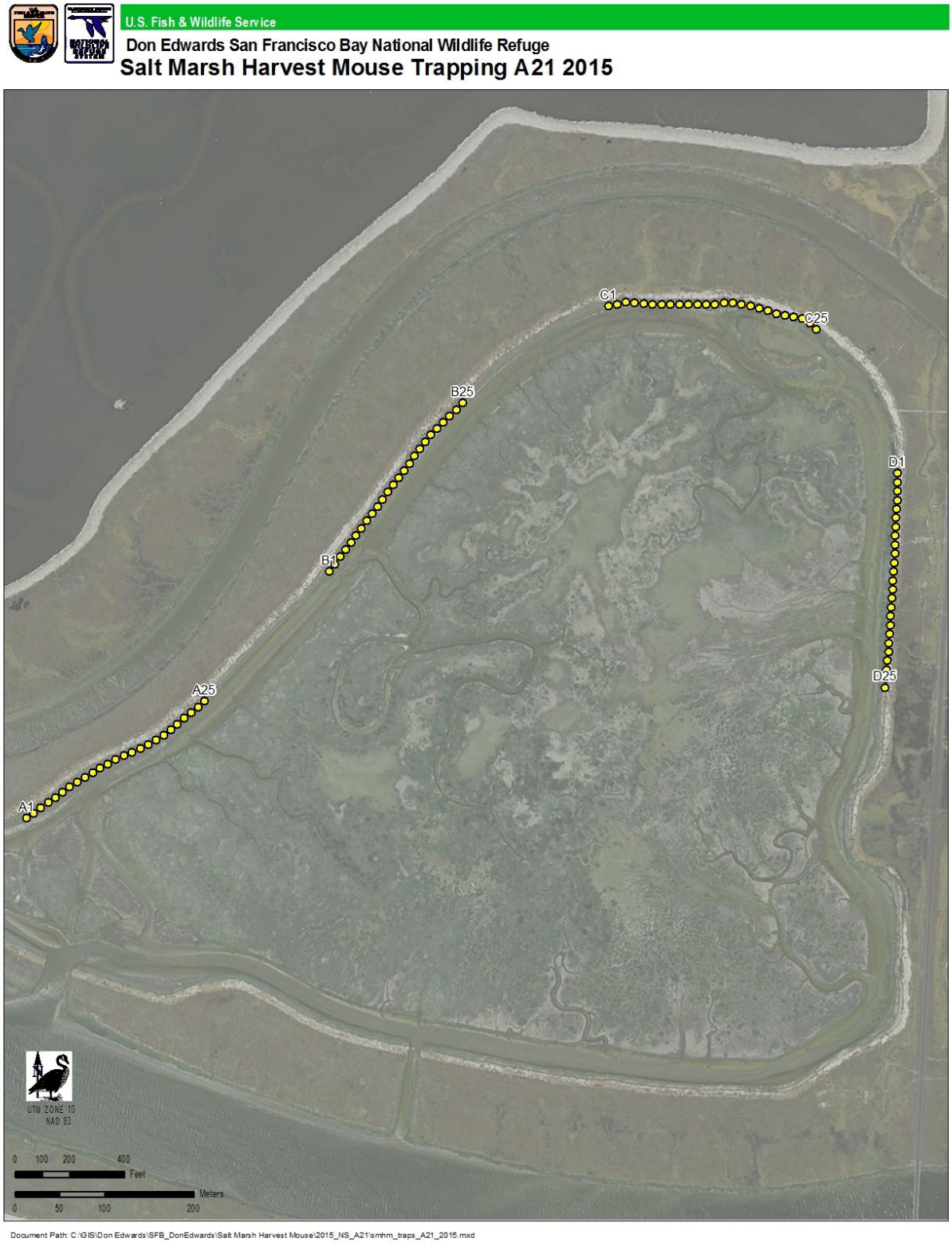


Figure 3. Side by side comparison: A. adult Western Harvest Mouse (left) and adult Salt Marsh Harvest Mouse (right), B. Juvenile Western House Mouse (left) and adult Salt Marsh Harvest Mouse (right), and C. Adult Salt Marsh Harvest Mouse (left) and adult House Mouse (right).

A.

B.

C.

Figure 4. Grooved incisors of Harvest Mice

Figure 5. Deer Mouse

Figure 6. Small Mammal Captures at Newark Slough

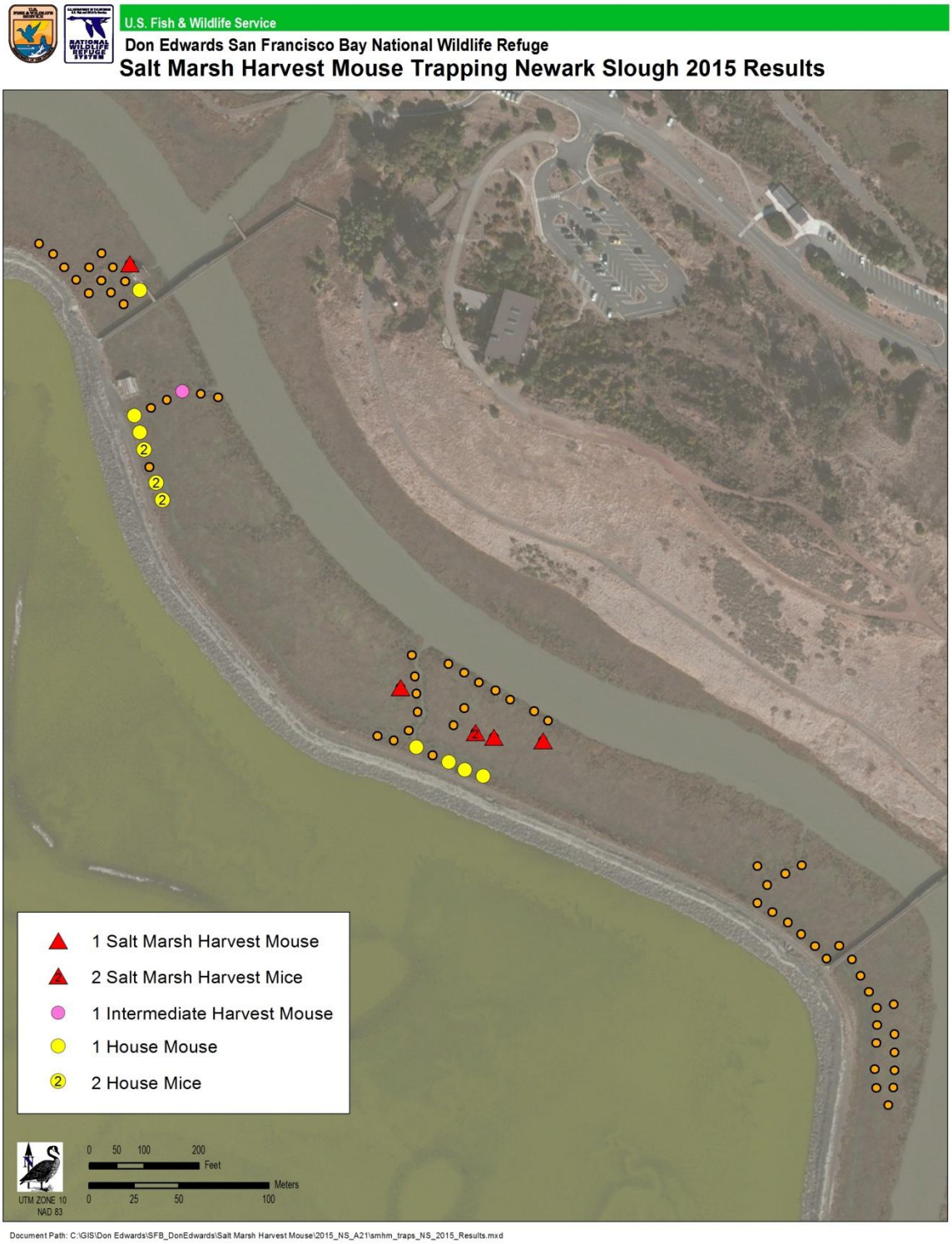


Figure 7. Harvest Mouse Captures at Pond A21

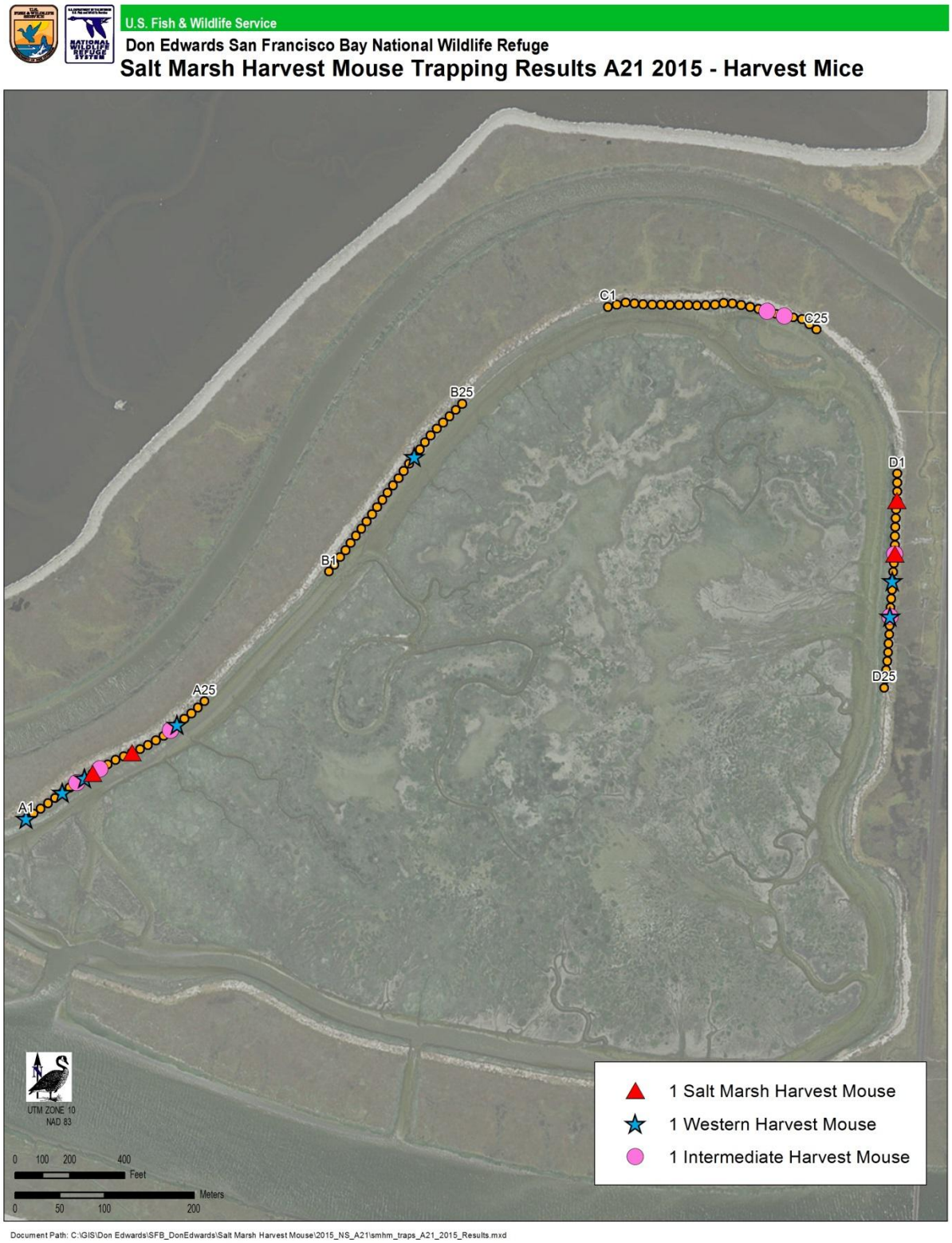
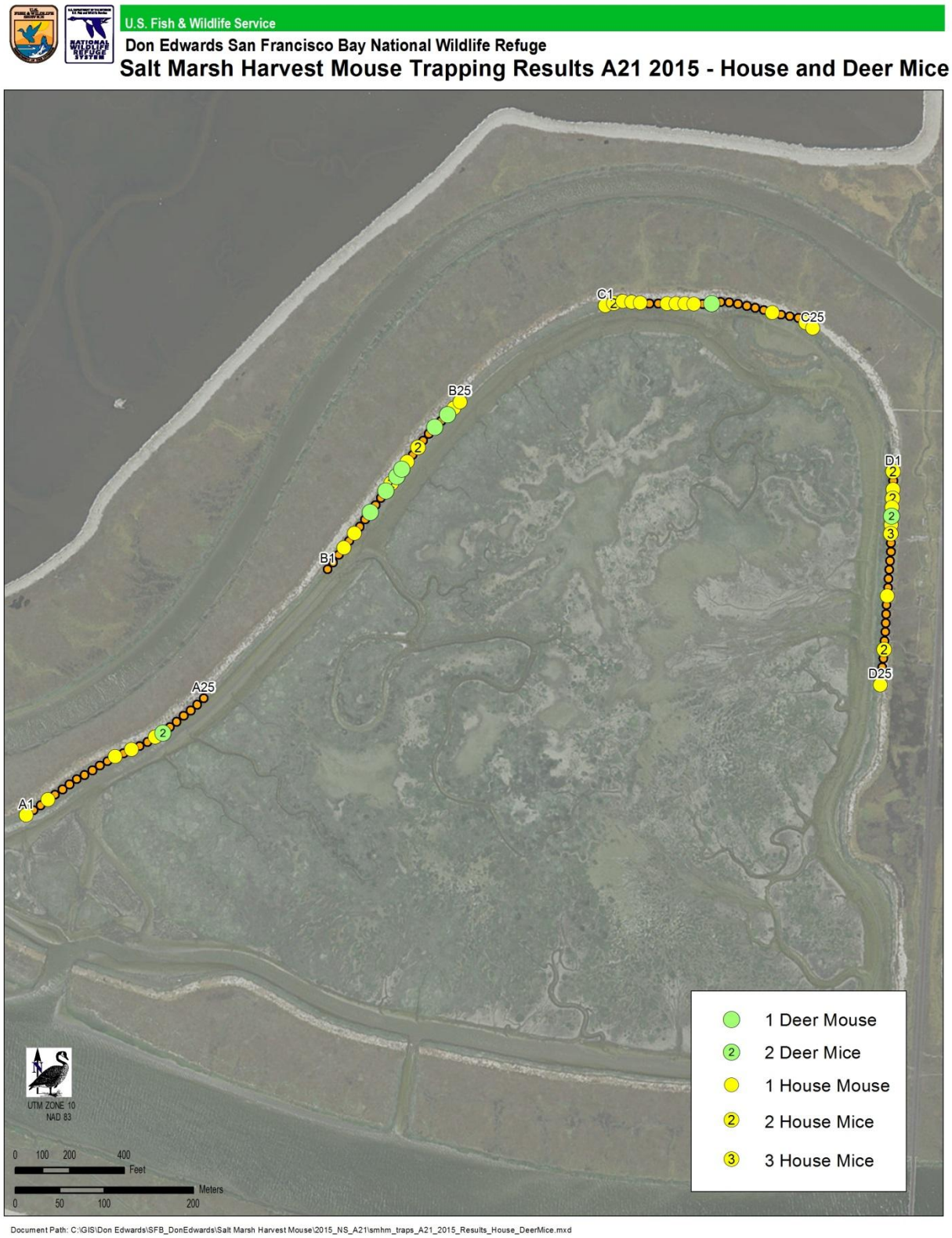


Figure 8. Non Target Small Mammal Captures at Pond A21



2015 ACTIVITIES INVOLVING THE CALIFORNIA RIDGWAY'S RAIL DON EDWARDS SAN FRANCISCO BAY NATIONAL WILDLIFE REFUGE

Contact: Rachel Tertes

INTRODUCTION

The California clapper rail (*Rallus longirostris obsoletus*) was listed as federally endangered in 1973. In 2014, the AOU renamed it the California Ridgway's rail (*Rallus obsoletus obsoletus).* The historic distribution of the California Ridgway's rail was restricted to the tidal marshlands of coastal California from Humboldt Bay in the north to Morro Bay in the south. It occurred formerly at Humboldt Bay, Tomales Bay, Elkhorn Slough, Monterey Co., and Morro Bay, San Louis Obispo, Co. Presently, California Ridgway's rail populations are restricted to fragmented salt marshes in San Francisco Bay, which have been reduced by 85% from their original extent.

Based on surveys conducted 1971-1975, there was an estimated a population of 4200-6,000 rails with 55% in the South Bay, 38% in the Napa marshes, and the remaining 8% in other North Bay and outer coast marshes. By the mid-1980's, on the basis of breeding and winter population estimates, approximately 1200-1500 California Ridgway's rails remained, with greater than 80% of the population found in the south San Francisco Bay. By 1988, populations were estimated to have declined to 700 rails, with one of the primary causes of this decline being predation caused by the introduction of the red fox. In 1990-91 the bay-wide population was estimated as low as 300-500 individuals.

In response to the fox predation, the Refuge completed and implemented a Predator Management Plan and Environmental Assessment in 1991 and revised it in 2012. In addition, an Avian Predator Management Plan was completed and implemented in 2012. The initiation of the 1991 predator management program was followed by a rebound in Ridgway's rail numbers, with over 800 Ridgway's rails counted in 1993. Winter surveys conducted in 1997-98 estimated the South Bay populations to be 650-700 individuals (USFWS unpubl. data). Subsequent years saw population declines in the south bay to 500-600 birds. Recent Bay wide control of invasive cordgrass, *Spartina alterniflora,* has had mixed initial effects to rail populations (McBroom 2011). In areas dominated by native marsh vegetation, such as Mowry/Dumbarton region, Ridgway's rail populations have remained steady with the removal of cordgrass. However, areas that were dominated by invasive cordgrass may have decreased cover for rails until native vegetation is restored and therefore have decreased rail numbers. The 2009-2011 average total population was estimated to be about 1,167 individuals (range 954 to 1426) (Liu *et al*. 2012).

SURVEY METHODS

Ridgway's rail surveys are conducted by Refuge staff and volunteers in marshes of the south bay, south of the San Mateo Bridge, to track annual changes in Ridgway's rail numbers for each marsh and to develop a rail population estimate for the south San Francisco Bay. This information is used to evaluate the success of current management and to focus future management efforts to benefit the Ridgway's rail. In conjunction with these surveys, observers record other rail species and both avian

and mammalian predators. Two types of rail survey methods are used to collect population data, the winter high tide survey and the breeding season call count survey.

Winter High Tide Surveys

The objective of winter high tide surveys is to estimate winter population size of Ridgway's rails in airboat-accessible South Bay marshes targeting: Greco Island, Bair Island Mowry, Dumbarton, Newark Sl., Charleston Slough/Mountain View/Stevens Ck/Guadalupe Sl, Hooks Island, Bird Island and Palo Alto Harbor. Airboat surveys are conducted during 3 winter high tide periods (November - January) with a goal of inventorying each accessible Ridgway's rail populated marsh at least once every 2-3 years. Typically, each boat crew consists of a driver and two observers, with one observer recording rail observations on a marsh map. Marsh totals are calculated after the entire marsh has been surveyed. The marsh is surveyed in parallel transects and high cover such as gumplant is searched.

Breeding Season Call Count Surveys

Standard Protocol

Breeding season call counts follow the methods of Zembal and Massey (1981) and the Service Draft Protocol (2009). There are several objectives for call count surveys: 1. Determine breeding population of Ridgway's rails in selected marshes. 2. Determine presence/absence of breeding rails in proposed project areas (e.g. Alameda Flood Control Channel). 3. Evaluate response of rails to restoration efforts (e.g., LaRiviere Marsh). 4. Assess rail population status in areas inaccessible to airboats (e.g. Mayhew's Landing). Surveys are conducted in the pre-breeding and early breeding season, when Ridgway's rail call frequency is highest, between mid-January and mid-April. Surveys are conducted one hour before to one after sunrise or sunset. Contiguous portions of each marsh are censused on successive mornings/evenings if possible. Repeat surveys are conducted at least two weeks apart.

Each survey involves trained observers walking on levees adjacent to the marsh to separate pre-determined listening stations (200 m apart) and recording location, time (military time), and type of each call on a datasheet (Figure 7) and map. Each transect consists of three to eight stations. Observers spend ten minutes at each station while conducting a "walking survey". At each station, the observer listens passively for 5 minutes, then broadcasts the Ridgway's rail recording for 1 minute, then listens passively for 4 minutes before moving to the next station. Playback recordings are only used if rails do not vocalize after five minutes of passive listening at a station. If rails respond to the playback, the recording is stopped immediately. For most transects, there are three rounds of active callback surveys. When surveys are paired with the Pilot Protocol, passive surveys are used. Passive surveys have 2 rounds of no playback and the third round with playback. The other exception is LaRiviere Marsh.

One survey location has modified protocols due to its small size and dense population of rails. At LaRiviere Marsh, near the Refuge Headquarters, 5 stationary stations, rather than "walking surveys" are utilized. Trained observers spend one and a half hours at each station passively listening for rails. Playback recordings are not used. Observers record each rail by location, time, and type of each call on a datasheet and map. After surveys have been completed, observers compare maps and triangulate rail locations to prevent double counting.

Pilot Protocol

The Refuge also participated in the Pilot Marsh Bird Surveys coordinated by USFWS Inventory and Monitoring Program. The revised protocol follows the guidance for playback duration from the Standardized North American Marsh Bird Monitoring Protocol (Conway 2011). The revised multi-species marsh bird survey protocol targets ten marsh bird focal species for data collection: California Ridgway's Rail, California Black Rail, Sora, Virginia Rail, American Bittern, American Coot, Common Moorhen, Pied-billed Grebe, Least Bittern and Yellow Rail. Playback will be broadcast for the first five of these species during each of three surveys within a year, which is expected to result in higher detection probabilities for these species. The revised protocol slightly increases the amount of Ridgway's Rail playback (old protocol: 60 sec/site/year; new protocol: 90 sec /site/year) and changes the timing (old protocol: 60 sec on third visit; new protocol: 30 sec on each of three visits) in order to increase cumulative detection probability, which is expected to yield less variable abundance estimates and provide improved inferences about Ridgway's Rail population trends.

The length of an individual visit (10 minutes) and the season during which the surveys are conducted (January 15-April 15) will remain the same as the current protocol. Pilot protocol surveys are paired with passive protocol surveys (see above). The revised protocol is designed for easily estimating detection probability, which is critical at sites where invasive *Spartina* is being removed because changes in habitat structure are likely to alter rail detection probability. Finally, the revised protocol is based on the Standardized North American Marsh Bird Monitoring Protocols (Conway 2011), allowing data to be shared more easily for larger-scales analyses.

RESULTS

Winter High Tide Surveys

One high tide survey was conducted during the 2014-2015 season (Table 1). The primary area surveyed was Mowry Region. Two boats surveyed Mowry Marsh North and covered approximately 30-40% of the marsh. The marsh was very slow to flood and receded fast after the high tide. Seven to eight Ridgway's Rails, one Virginia Rail and one Sora were observed. At least 9 shrews were recorded. Predators observed during these surveys included great egrets, snowy egret, western gull, Northern harriers, great blue heron and rats. On January 21, 2015, tides were not sufficient to flood Mowry Marsh and no Ridgway's Rail survey was conducted. Instead, staff used the airboat to conduct reconnaissance for the "Mystery Goo" in Mowry Marsh, Dumbarton Marsh, and along the Bay edge up to the Refuge fishing pier. One dead and one sick waterfowl were retrieved and submitted to the wildlife response effort but were later deemed unrelated to the "Mystery Goo."

Breeding Season Call Count Surveys

In 2015, 27 call count surveys using standard protocols and four surveys using pilot protocol were conducted, between 23 January and 9 April. Call count surveys were conducted by Refuge staff and volunteers in marshes on the east side of South Bay in the Coyote Hills, Mowry/Dumbarton, and Eden Landing (previously Baumberg) regions. A summary of call count results using the standard protocol is provided in Table 2 and attached maps (Figures 1-5). Survey results from Pilot Protocol surveys are compiled by USFWS Inventory and Monitoring Program and a report with analysis of results will be prepared by Point Blue.

East Bay

a) Eden Landing region (San Mateo Bridge to Whale's Tail South)

Whale's Tail South:
Refuge staff surveyed CDFW's Whale's Tail South Marsh on three occasions and recorded a minimum two duets (four breeding birds) and two clatters (two to four breeding birds), one kek (un-mated male) and one kek-hurrah for a total of eight to ten Ridgway's rails.

b) Coyote Hills region (Ecology Marsh to Ideal Marsh)

Alameda County Flood Control Channel:
Three rounds of surveys by Refuge staff in Alameda County Flood Control Channel (AFCC) at stations 11-18 and stations 32-34 detected zero rails. However rails were detected within AFCC (near the mouth) during surveys of Ecology Marsh, including one duet (two breeding birds) and one clatter (one to two breeding birds) for a total of three to four Ridgway's rails. Olofson Environmental, Inc. surveyed AFCC station's 19-31 on four occasions and did not detect rails.

Ecology Marsh:
Three rounds of standard protocol surveys and two rounds of Pilot Protocol surveys in Ecology Marsh were conducted in 2015. For standard protocol, a minimum of three clatters (three to six breeding rails) were detected and for Pilot Protocol, a minimum of one duet (two breeding birds) and one clatter (one to two breeding rails) were detected. We also detected a minimum of seven black rails and one sora.

Ideal Marsh:
Only two rounds were conducted at Ideal Marsh in 2015. Surveys were attempted on April 14 and April 20, but cancelled due to high wind. Ideal Marsh had a minimum four duets (eight breeding birds), two clatters (two to four birds) and one kek-hurrah (one unmated) for a total of 11 to 13 Ridgway's rails.

c) Mowry/Dumbarton region (Dumbarton Bridge to Albrae Slough)

LaRiviere Marsh:
Three rounds of surveys were conducted at LaRiviere Marsh and recorded a minimum of three duets (six breeding rails), two clatters (two to four breeding rails) and one kek (unmated male for a total of nine to 11 Ridgway's rails.

Mayhews Landing:
ISP surveyed Mayhews Landing this year and detected zero rails.

Pond A21:
Refuge staff surveyed three stations in Pond A21 on three occasions and recorded no Ridgway's rails. However during small mammal trapping in July, a minimum of one duet (2 breeding rails) were heard on July 23, 2015.

SOUTH BAY SUMMARY

Mowry Marsh requires very high tides, in addition to a low pressure system, to fully flood and create optimum conditions for airboat surveys. There were mediocre tides (6.9 ft. at Golden Gate) and pressure system (1013-1024 Hg) for airboat surveys at Mowry Marsh in 2015 and so only a portion of the marsh was surveyed. A maximum of 44 Ridgway's rails were counted during breeding season call count surveys, an increase from 36 in 2014 and 3rd lowest count in the past nine years (Figure 6). The Refuge is actively working with partner agencies and local researchers to increase the rail population, improve survey methodology, implement the 2013 Tidal Marsh Recovery Plan, and restore tidal marsh through restoration efforts like breaching Inner Bair Island and the South Bay Salt Pond Restoration Project.

LITERATURE CITED

Conway, C. J. 2011. Standardized North American Marsh Bird Monitoring Protocol. Waterbirds, 34(3):319–346.

Liu, L., Wood, J., Nur, N., Salas, L., & Jongsomjit, D. 2012. California Clapper Rail (Rallus longirostris obsoletus) Population monitoring: 2005-2011 *PRBO Technical Report to the California Department of Fish and Game*. Petaluma, CA: PRBO Conservation Science.

McBroom, J. 2011. 2010 California Ridgway's Rail surveys for the San Francisco Invasive *Spartina* Project. Report prepared by Olofson Environmental, Inc for the California Coastal Conservancy

U. S. Fish and Wildlife Service. 2009. Draft Protocol for Ridgway's rail breeding season call count surveys. Sacramento Field Office- Endangered Species Branch, Sacramento, CA.

Zembal, R. and B. Massey. 1981. A census of the light-footed Ridgway's rail in California. Western Birds 12:87-99.

Table 1. 2014/2015 Winter High Tide Airboat Survey Results

Region	Location	RIRA	VIRA	SORA	% marsh surveyed	Date
Mowry/Dumbarton Region	Mowry Marsh North	7-8	1	1	30-40	1/20/15
	TOTAL	**7-8**	**1**	**1**	**30-40**	1/20/15

Table 2. 2015 Ridgway's Rail Breeding Season Call Count Surveys Conducted By USFWS

AREA	LOCATION	Minimum Breeding	Maximum Breeding	Unmated	Visual	Maximum Ridgway's rails
EDEN LANDING						
	Whale's Tail South	6	8	2	0	10
	AREA SUBTOTAL	**6**	**8**	**2**	**0**	**10**
COYOTE HILLS						
	Alameda County Flood Control Channel	3	4	0	0	4
	Ecology Marsh (1-14)	3	6	0	0	6
	Ideal Marsh (1-26)	10	12	1	0	13
	AREA SUBTOTAL	**16**	**22**	**1**	**0**	**23**
MOWRY						
	La Riviere Marsh	8	10	1	0	11
	A21	0	0	0	0	0
	AREA SUBTOTAL	**8**	**10**	**1**	**0**	**11**
SOUTH BAY TOTALS		30	40	4	0	44

Detection Type	Description	Number of Rails	
		Min	Max
C	Clatter (breeding bird)	1	2
D	Duet (pair of breeding birds)	2	2
K	Kek (unmated male)	1	1
KKB/KB/B*	Kek Burr (unmated female)	1	1
V	Visual	1	1

Figure 1: Call Count Survey Summary at LaRiviere Marsh. Map courtesy of ISP.

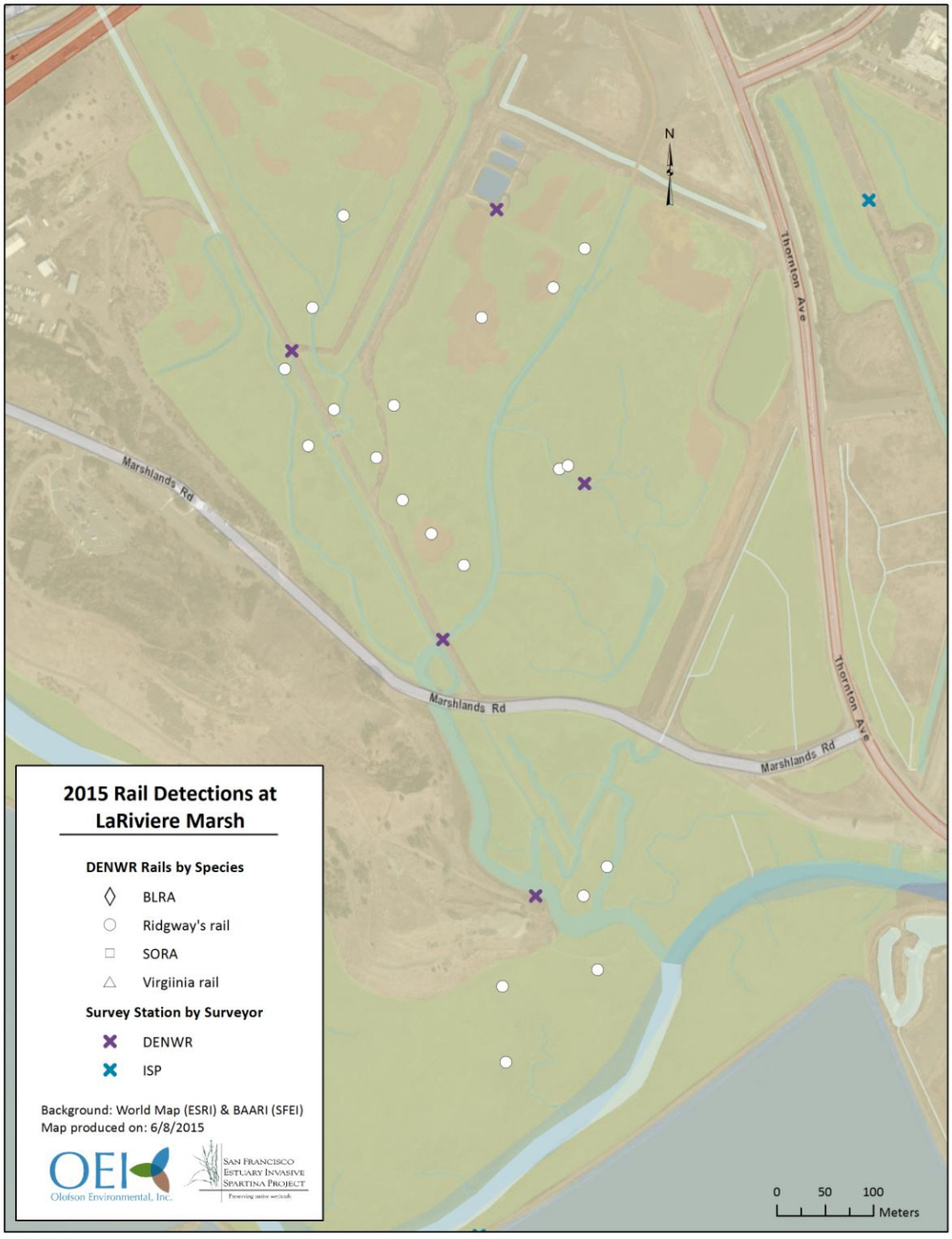


Figure 2: Call Count Survey Summary at Alameda County Flood Control Channel and Ecology Marsh (Pond 3). Map courtesy of ISP.

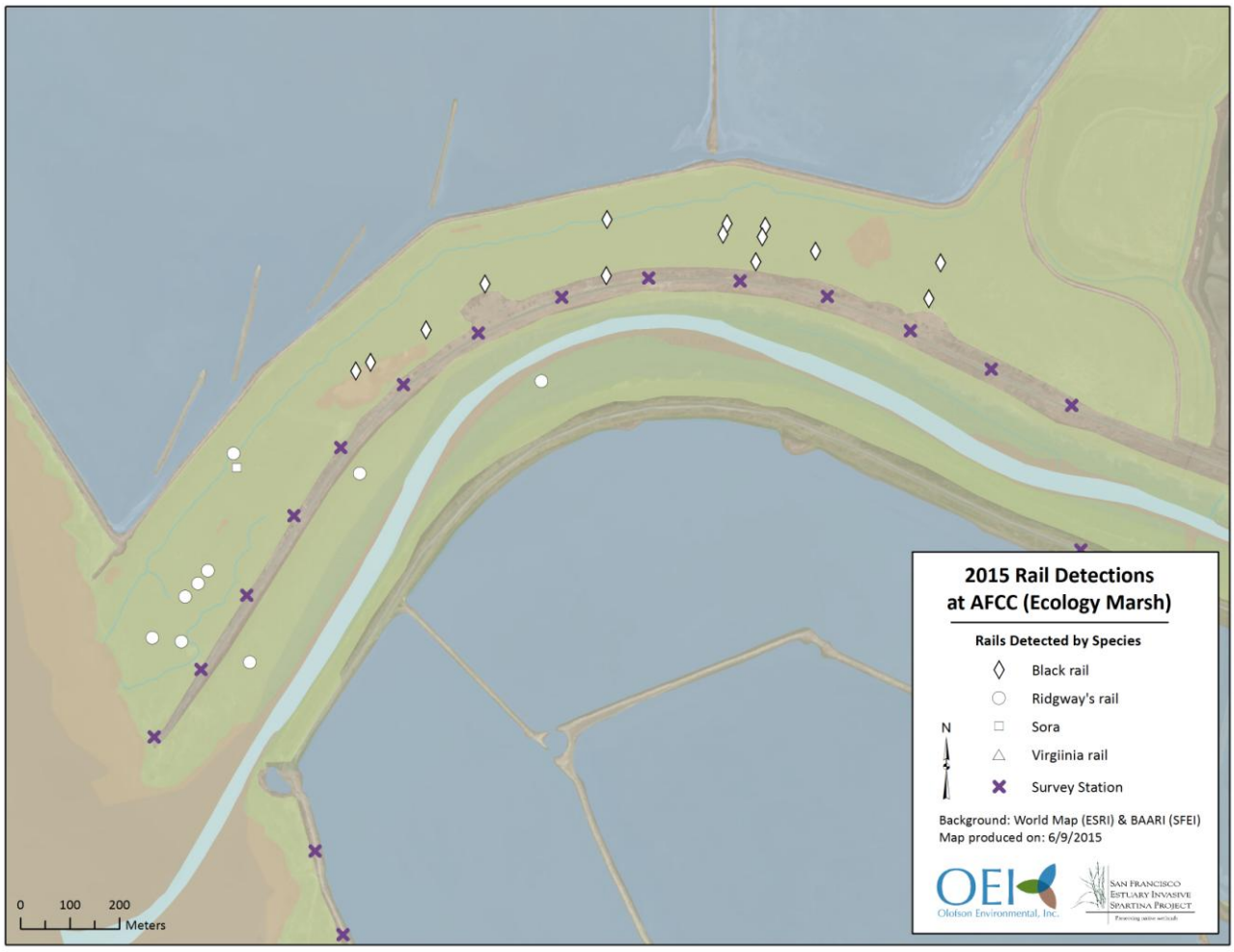


Figure 3: Call Count Survey Summary at Ideal Marsh South. Map courtesy of ISP.

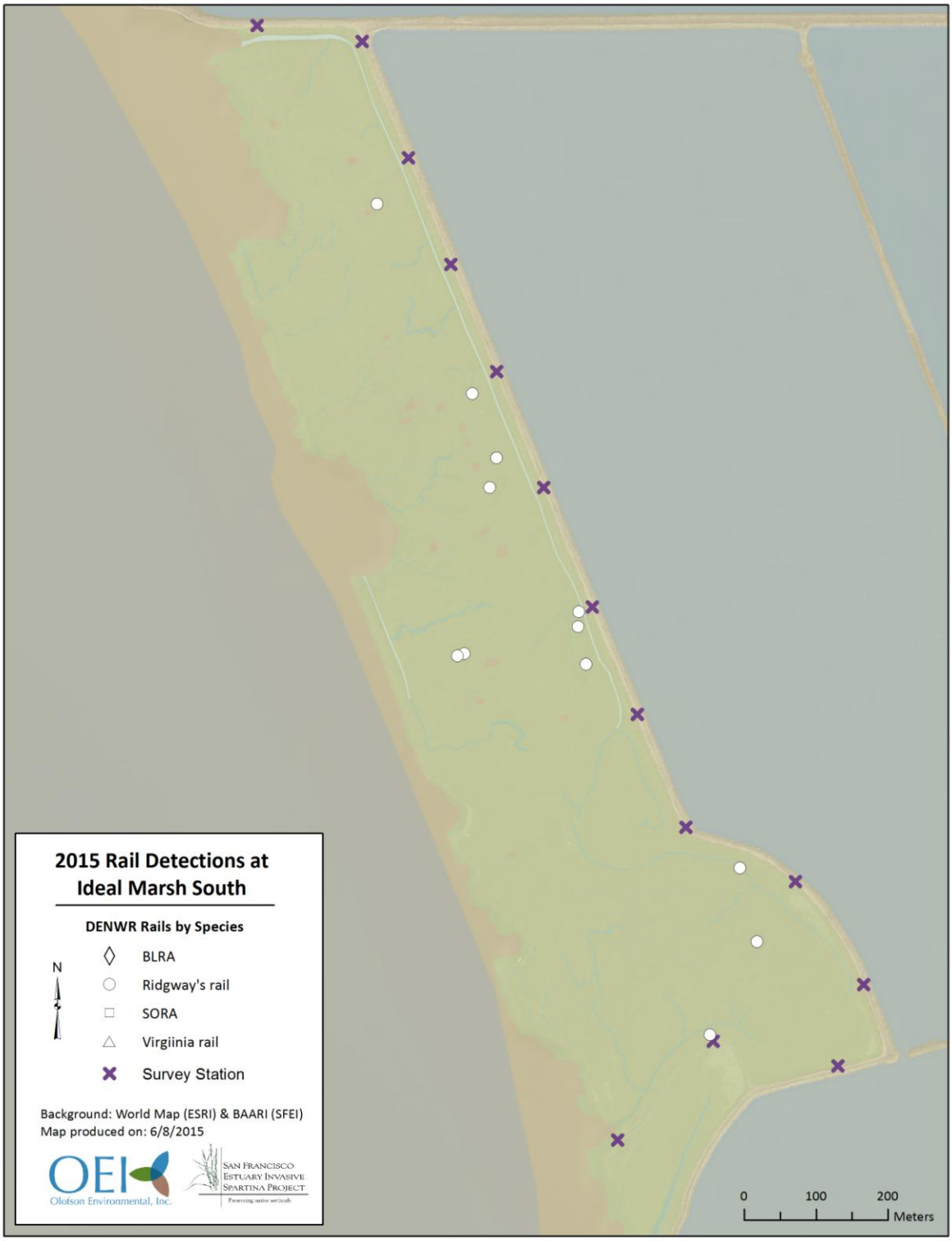


Figure 4: Call Count Survey Summary at Whale's Tail South. Map courtesy of ISP.

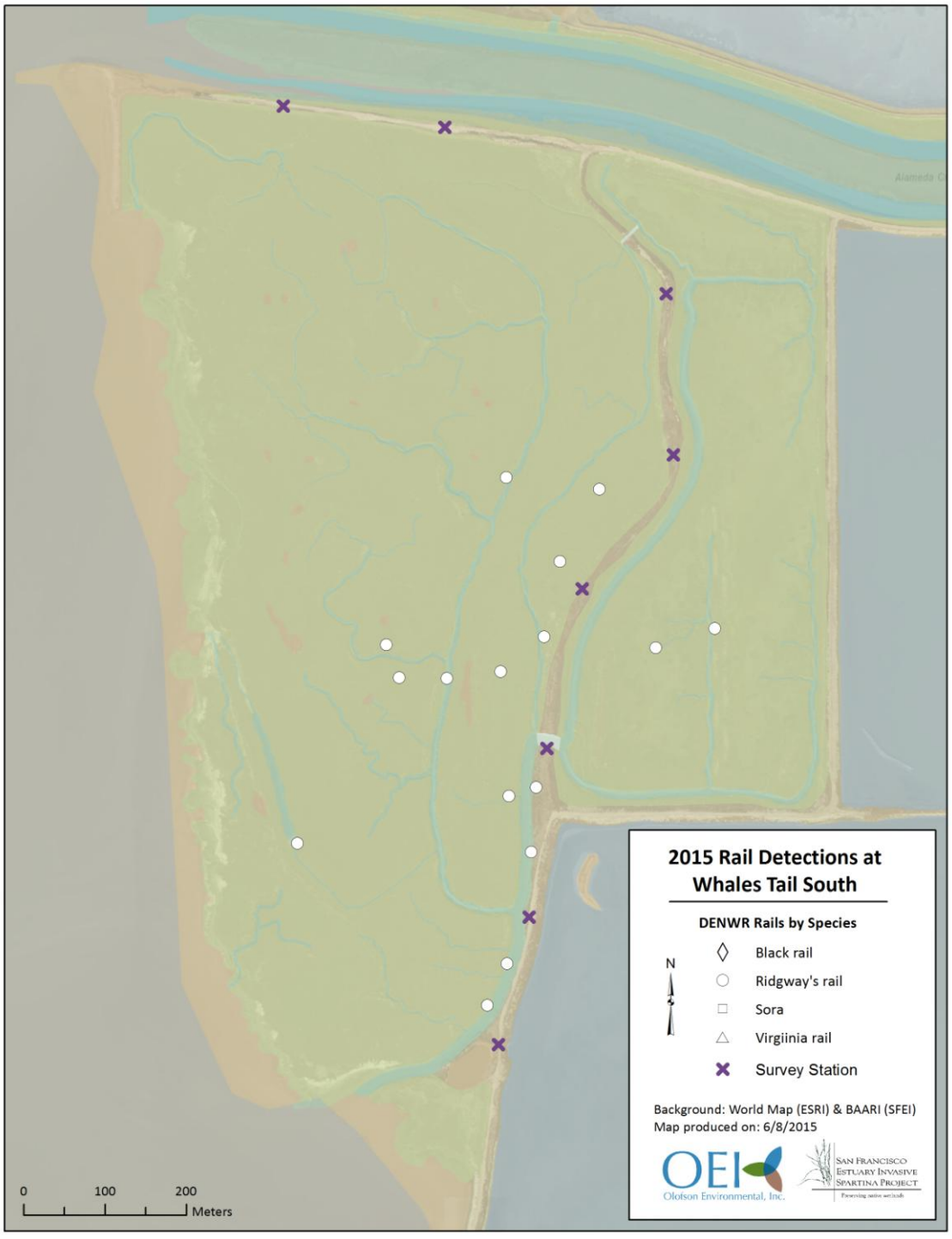


Figure 5: Ridgway's Rail Detections Post-Call Count Survey Window at Pond A21.

Figure 6. Nine Year Trend-Ridgway's Rail Breeding Season Call Count Surveys Conducted By the Service

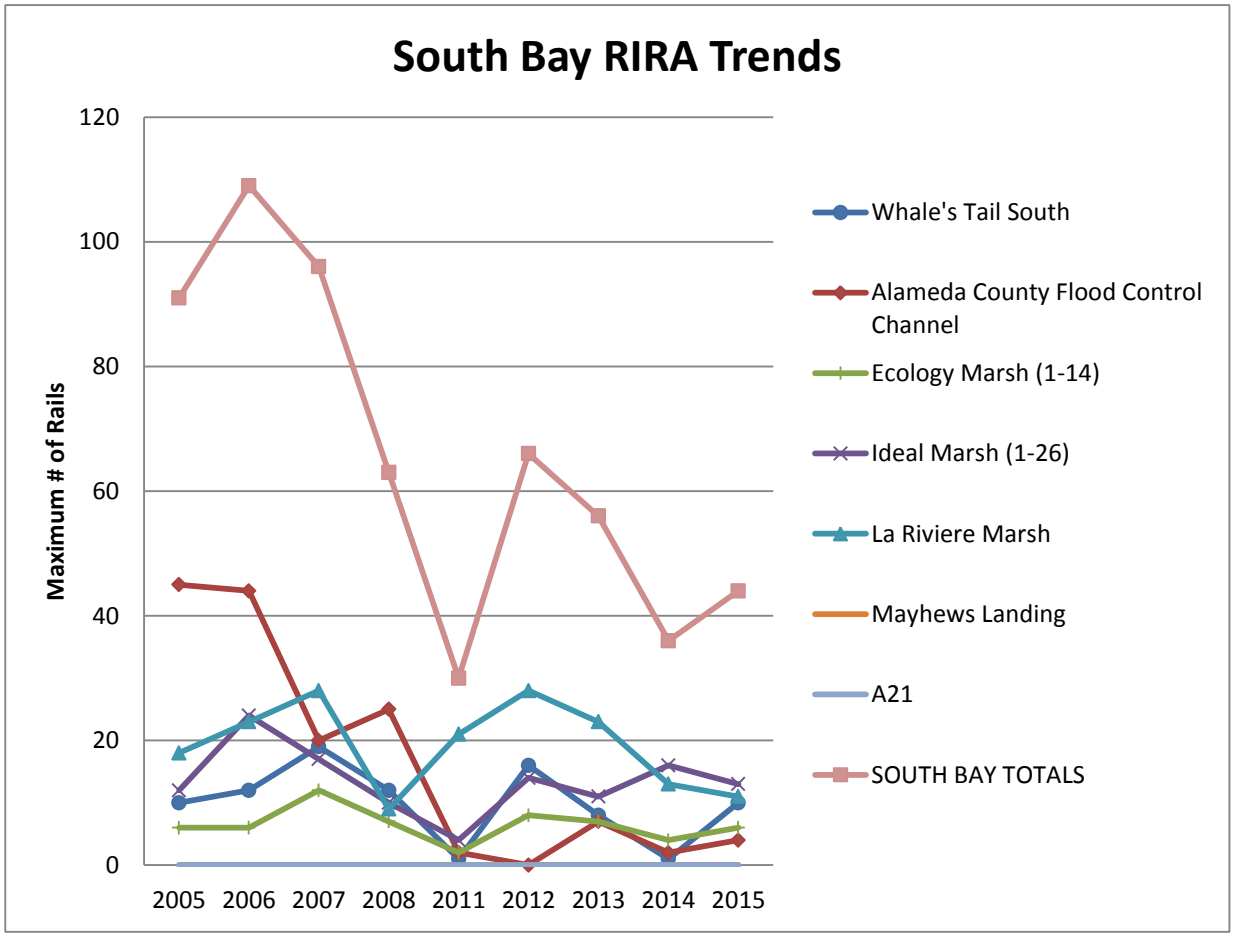


Figure 7: 2015 Don Edwards San Francisco Bay National Wildlife Refuge Standard Protocol Data Sheet

Observer_____ **Target Site Code(s)**_____ **Visit**_____ **Date** (e.g., 5-May-2011)_____

Add'l observers_____**Site Name(s)**_____ **Single or Multiple observer survey (circle 1)**

Map Ref. Letter -OR- Note #	Station ID -OR- Bird Species	Start Time (24-hour)	Bearing (°)	Distance (m)	Distance aid*	Min 1 - Passive	Min 2 - Passive	Min 3 - Passive	Min 4 - Passive	Min 5 - Passive	Min 6 – CLRA or passive	Min 7 - Passive	Min 8 - Passive	Min 9 - Passive	Min 10 - Passive	(Y/N) Outside time?	(Y/N) Outside site?	(Y/N) Counted @ other station?	Wind speed (mph)	Temperature (°C)	Sky code**	Noise (dBA/dBC)	Noise code***

Site Notes: _____

V visual	*Distance Aid: **0** none **1** range finder **2** distance bands on aerial photo **3** surveyor flags tied to vegetation **Sky: **0** clear or a few clouds **1** partly cloudy or variable sky **2** cloudy or overcast **4** fog or smoke **5** drizzle **6** rain **8** showers ***Noise: **0** none **1** faint **2** moderate **3** loud **4** intense

Clapper Rail:
C clatter
K kek
B kek-burr
KH kek-hurrah
SK squawk
P purr
CH churr

Black Rail:
kkd ki-ki-doo
gr grrr
cht churt
tch tch (laugh)

Virginia Rail:
G grunt
T tick-it
KI kicker
kiu kiu/squawk
kk kikik

Sora:
WH whinny
PW per-weep
KEE keep

American Bittern:
pl pump-er-lunk
cp chu-peep
ko kok

** Cross out any species that were not surveyed due to surveyor being overwhelmed **

American Coot:
hu hic-up
hk honk
bu burr-up

Common Moorhen:
wo wipe-out
gu giddy-up

Least Bittern:
coo coo
kak kak
ert ert

Yellow Rail:
cc click-click
ca cackle
whz wheeze

Pied-billed Grebe:
ow owhoop
hy hyena

APPENDIX C

POND A21 LEVEE EROSION DATA & PHOTOGRAPHS

Island Ponds Tidal Mitigation Project

Date of survey 11/23/2015 Survey data by: R. Kaur, C. Leal and R. Wolff

Notes:

1. Spreadsheet represents elevations taken to monitor Pond 21 levee height where wave action appears to be overtopping southeastern corner of pond
2. Eight sections are being monitored, all within 100 +/- feet of each other
3. Wooden stakes (usually 2, 3 at one location) were installed at each section where elevations adjacent to the stakes were taken
4. Measurements were taken between stakes and the pond side edge of levee in order to monitor how quickly the pond side of the levee is eroding.
5. Photos of each section were taken to identify stake locations and section numbers.
6. A benchmark was installed using a metal "T" stake.
7. The T-stake elevation was established by surveying an "X" on the northwest railroad bridge abutment, calling the abutment elevation 10.00 (ten)
8. If RR abutment is elev 10.0, then T-stake benchmark elevation is 5.42 feet

Field Data:

Height measured at bridge (from tripod location 1)= 2.14 feet
Height measured at T-stake(from tripod location 1)= 6.74 feet
Calculated elevation at T-stake= 5.4 feet
Height measured at T-stake(from tripod location 2)= 5.18 feet

Section #	2008 ground surface elevation adjacent stake near pond	2015 ground surface elevation adjacent stake near pond	change in elevation between 2008 and 2015 for stake near pond	2008 offset between pond and stake nearest pond (ft)	2012 offset between pond and stake nearest pond (ft)	2014 offset between pond and stake nearest pond (ft)	2015 offset between pond and stake nearest pond (ft)	change in offset between 2008 and 2012 for stake near pond	change in offset between 2012 and 2014 for stake near pond	change in offset between 2014 and 2015 for stake near pond	Average change in offset between 2008 and 2015 for stake near pond	2008 ground surface elevation adjacent middle stake	2015 ground surface elevation adjacent middle stake	change in elevation between 2008 and 2015 for middle stake	2015 offset between pond and middle stake (ft)	2008 ground surface elevation adjacent stake near marsh	2015 ground surface elevation adjacent stake near marsh	change in elevation between 2008 and 2015 for stake near marsh	offset between pond and stake nearest marsh (ft)
1	6.53	6.32	(0.22)	5.25	1.92	1.33	0.92	(3.33)	(0.59)	(0.42)	(1.44)					5.69	5.66	(0.03)	12.92
2	6.31	6.28	(0.03)	7.33	3.58	3.00	4.42	(3.75)	(0.58)	1.42	(2.92)					5.61	5.63	0.02	17.71
3	6.32				1.50							6.43	6.35	(0.08)	7.83	5.54	5.64	0.10	17.08
4	6.39	6.33	(0.06)	5.00	2.67	2.33	2.33	(2.33)	(0.34)		(2.67)					5.44	5.44	0.00	18.38
5	6.39			1.83				(1.83)								5.5			0.00
6	6.44	6.32	(0.12)	3.17	2.42	1.17	1.00	(0.75)	(1.25)	(0.17)	(2.17)					5.45			0.00
7	6.68	6.56	(0.12)	8.00	5.42	3.42	1.58	(2.58)	(2.00)	(1.83)	(6.42)					5.58	5.53	(0.05)	11.92
8	6.94	6.74	(0.20)	6.00	3.75	3.25	3.29	(2.25)	(0.50)	0.04	(2.71)					5.49	5.44	(0.05)	16.67

NOTES/OBSERVATIONS:

1. most elevations were slightly lower than elevations taken in year 2008, indicating very minor changes in top of levee elevations

2.Comparing offsets between first stake and pond stake over 7 years (from 2008 to 2015), indicate a loss of levee on pond side at all stations with max loss at 6.42 feet at station 7

3. As expected offsets between first stake and pond contnued to decrease from from erosion, most offsets indicate additional loss of levee material on pond side with max loss of 1.83 feet at station 7 during the past 11 months
4. pond stake in section 3 is missing
5. both pond and marsh stakes in section 5 are missing
6. marsh stake in section 6 is missing

2008 photo of Benchmark "T-stake" location lkg northerly

2008 photo of Benchmark "T-stake" location lkg westerly

2015 photo looking westerly

2015 photo looking northerly