2023 WETLAND HABITAT AND HYDROLOGY ANNUAL MONITORING REPORT FOR THE SAN ELIJO LAGOON RESTORATION PROJECT

Prepared for:

Nature Collective

Prepared by:

AECOM
Nordby Biological Consulting
and
Moffatt & Nichol

March 2025

TABLE OF CONTENTS

Chapter **Page**

LIST OF APPENDICES

LIST OF FIGURES

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

AA	assessment area
BSPP	Belding's savannah sparrow (in figures)
Cal-IPC	California Invasive Plant Council
CCC	California Coastal Commission
CDP	Coastal Development Permit
CI	confidence interval
CLT	California Least Tern (in figures)
cm	centimeters
cm^2	square centimeters
Corps	United States Army Corps of Engineers
CRAM	California Rapid Assessment Method
CSM	Carpinteria Salt Marsh (in figures)
I-5	Interstate 5
LFRR	light-footed Ridgway's rail
m	meter(s)
m^2	square-meter(s)
MC	main channel (in tables)
Monitoring Plan	*Wetland Habitat and Hydrology Monitoring Plan for the San Elijo Lagoon Restoration Project*
MUL	Mugu Lagoon (in figures)
N/A	not applicable
NAVD88	North American Vertical Datum of 1988
NP	not provided
OD	overdredge
PEP	plant establishment period
RWQCB	California Regional Water Quality Control Board
SEL	San Elijo Lagoon (in figures)
SELRP	San Elijo Lagoon Restoration Project
SNPL	Western Snowy Plover (in figures)
TC	tidal channel (in tables)
TIF	tidal inundation frequency
TJE	Tijuana Estuary (in figures)
TN	total nitrogen
TOC	total organic carbon
USFWS	United States Fish and Wildlife Service
>	greater than
<	less than
%	percent

This page intentionally left blank.

1. INTRODUCTION

1.1 PROJECT BACKGROUND

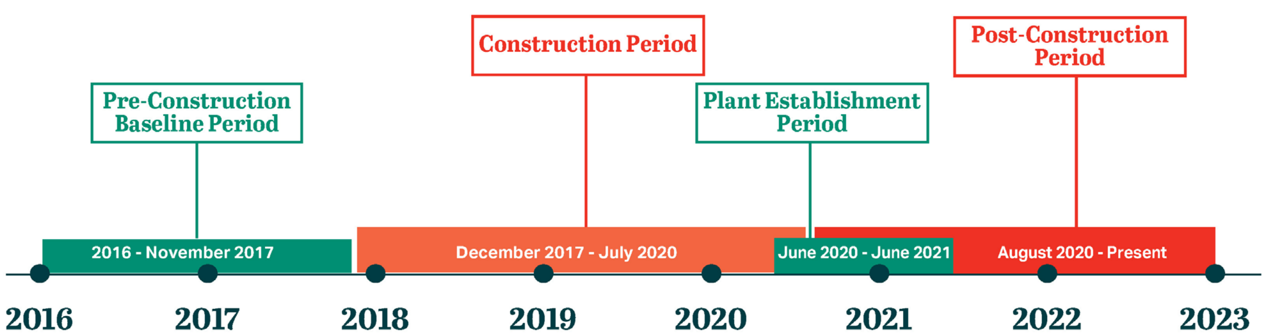
San Elijo Lagoon is a coastal wetland formed at the confluence of Escondido Creek and La Orilla Creek as they meet the Pacific Ocean. Located in the city of Encinitas, San Diego County, California, the lagoon provides habitat for sensitive, threatened, and endangered plants and animals, including resident and migratory wildlife. The San Elijo Lagoon Ecological Reserve is owned and managed by California Department of Fish and Wildlife, County of San Diego Parks and Recreation Department, and Nature Collective (formerly San Elijo Lagoon Conservancy). Lagoon functions became compromised over time, as development and infrastructure constraints affected the ecosystem, characterized in part by changes in the gradient of habitats within the lagoon (e.g., between unvegetated and vegetated intertidal habitats). The San Elijo Lagoon Restoration Project (SELRP) has been an effort to restore lagoon functions and services to the extent practicable given the current constraints of the surrounding development.

The SELRP has been implemented by Nature Collective, San Diego Association of Governments, and California Department of Transportation District 11 to enhance and restore the physical and biological functions and services of San Elijo Lagoon. These efforts included increasing hydraulic efficiency in the lagoon, improving pre-construction water quality impairments, and halting ongoing conversion of unvegetated wetland habitats (mudflat) to vegetated salt marsh with the goal of restoring a more connected gradient of balanced habitat types. Success of the restoration effort is being measured through the implementation of a monitoring program developed in coordination with various permitting and approval agencies, including California Coastal Commission (CCC), United States Army Corps of Engineers (Corps), United States Fish and Wildlife Service (USFWS), and California Regional Water Quality Control Board (RWQCB).

Construction for the SELRP began in December 2017 and was substantively completed in July 2020 with focused activities continuing to occur in discrete areas of the lagoon. Environmentally sensitive area fence installation and vegetation clearing occurred in the central and east basins during December 2017 through early March 2018 to avoid the light-footed Ridgway's rail (*Rallus obsoletus levipes*; LFRR) breeding season. Vegetation clearing in the west basin occurred in December 2018. Throughout 2018 and 2019, the overdredge (OD) pit was dredged, followed by excavation of the channel side slopes and mudflat areas and channel dredging with disposal to the OD pit. Grading of transitional areas and the nest site also occurred, along with pedestrian bridge installation, construction of the inlet revetment, trail installation, and planting and irrigation. Demobilization was initiated, with final site cleanup, staging area/access/dike removal, and demobilization completed in mid-2020; some minor remedial grading also occurred in the main channel and nest site to complete the project through late 2020. Planting in the restoration areas and substantive construction activities were completed in July 2020, and the 240-working day plant establishment period (PEP) was initiated in June 2020. The 240-working day PEP was completed in June 2021 and determined successful.

To assess the responses to the construction activities and changes to the habitat in San Elijo Lagoon, monitoring and data collection are grouped into three discrete periods: the "pre-construction baseline period" from 2016 through 2017, "construction period" from 2018 through July 2020, and "post-construction period" starting in August 2020 (Figure 1-1). For some metrics that rely more heavily on spring data (e.g., avian species), the first year of post-construction may be considered to be 2021. For other metrics relying on data collection during the fall (e.g., fish), 2020 may be considered the start of the post-construction period. For the purposes of this Annual Monitoring Report, a "post-construction year" follows the same dates as a calendar year. More specific information is included under the discussion for each metric. For the purposes of reporting a 4-year running average herein, construction and post-construction years have been combined into a "construction/post-construction period," which includes the years 2018 through 2021, when information is available. These data provide complementary information related to performance standards and construction/post-construction monitoring results documented as part of the monitoring program as set forth in *Wetland Habitat and Hydrology Monitoring Plan for the San Elijo Lagoon Restoration Project* (Monitoring Plan) (Nature Collective 2020).

Figure 1-1. San Elijo Lagoon Restoration Project Timeline



1.2 REPORTING REQUIREMENTS

This Annual Monitoring Report summarizes the status of the SELRP post-construction in 2023 (Year 3). Metrics included in this Annual Monitoring Report are defined in the SELRP Monitoring Plan prepared for the project. The Monitoring Plan includes both relative and absolute metrics. Relative metrics compare post-restoration conditions to reference wetlands in the region. Absolute standards require that the variable of interest be evaluated only within San Elijo Lagoon. Absolute standards compare post-construction conditions to pre-construction conditions or the project design. Absolute standards are not compared to reference wetlands. Absolute performance standards for the SELRP are divided into two general categories:

- Project design absolute performance standards have been developed based on the SELRP design in order to meet the project objectives. For example, topography or habitat cover variables have pre-determined goals based on the final design and restoration plans or as-built conditions. These standards are not dependent on pre-restoration conditions.
- Pre-restoration absolute performance standards were developed based on the pre-restoration condition of the lagoon. These standards ensure the SELRP does not negatively impact pre-existing positive ecological attributes of San Elijo Lagoon. The standards are used to determine if post-restoration conditions are similar to pre-restoration conditions.

This Annual Monitoring Report documents conditions in the lagoon post-construction. It is framed to be consistent with the Monitoring Plan, *Wetland Habitat and Hydrology San Elijo Lagoon Baseline Monitoring Report* (AECOM 2020a), and anticipated Annual Monitoring Reports to facilitate reference between the documents. Table 1-1 summarizes the specific resources monitored for success of the SELRP as well as performance standards for each of the 13 broad physical and biological variables.

Table 1-1. Monitoring Plan Variable Summary

Chapter	Variable	Variable Type	Final Performance Standard	Status of Monitoring
2	Topography	Project Design Absolute	Habitat areas are within 10% of the design acreage. There are no large-scale variations from design elevations.	Active; supplemental monitoring in 2023
3	Bathymetry	Project Design Absolute	Habitat areas for subtidal habitat are within 10% of the design acreage. There are no large-scale variations from the design elevations.	Active; supplemental monitoring in 2023
4	Tidal Elevation	Project Design Absolute	Habitat areas must be within 10% of the designed habitat area targets in response to tidal inundation frequency (TIF). Predicted seawater residence time must remain on average shorter than 7 days in the central basin and 9 days in the east basin, as estimated using a numerical hydrodynamic model (such as RMA) to indicate the first-order water quality.	Active; monitored in 2023
5	Habitat Areas	Project Design Absolute	Habitat areas are within 10% of the final approved habitat distribution (acreage) (CCC) including 57 to 73 acres of low marsh (USFWS)	Active; monitored in 2023

Chapter	Variable	Variable Type	Final Performance Standard	Status of Monitoring
6.1	Vegetative Cover	Project Design Absolute	Meet the 5- and 10-year absolute performance standards defined in the Final Restoration Plan, as detailed in Table 6-1 of the Monitoring Plan.	Active; monitored in 2023
6.2	California Cordgrass *(Spartina foliosa)* Canopy Architecture	Relative	Not significantly worse than the mean value (i.e., 4-year running average of the mean proportion of the stems measuring greater than [>] 90 centimeters [cm] at the lowest performing reference wetland).	Active; monitored in 2023
6.3	Exotics	Project Design Absolute	No more than 0% coverage by California Invasive Plant Council (Cal-IPC) "Invasive Plant Inventory" species of "high" or "moderate" threat and no more than 5% coverage by other exotic/weed species.	Active; monitored in 2023
7	Water Quality	Relative	Not significantly worse than the mean value (i.e., 4-year running average of the mean number of consecutive hours with dissolved oxygen) at the lowest performing reference wetland.	Active; monitored in 2023
8	Benthic Invertebrates	Relative	Not significantly worse than the mean value (i.e., 4-year running average of benthic invertebrate densities and number of species) at the lowest performing reference wetland.	Active; monitored in 2023
9	Sediments	Not Applicable	There is no specific performance standard associated with this variable; collected to inform water quality and benthic invertebrate standards.	Active; monitored in 2023
10	Fish	Relative	Not significantly worse than the mean value (i.e., 4-year running average of fish densities and number of species) at the lowest performing reference wetland.	Active; monitored in 2023
11.1	LFRR	Pre-Restoration Absolute	4-year running average of density and lagoon-wide abundance of LFRR individuals is within 95% or greater of the pre-construction survey data (2016 and 2017).	Active; monitored in 2023
11.2	Western Snowy Plover and California Least Tern	Pre-Restoration Absolute	4-year running average number of western snowy plover and California least tern individuals observed per survey/month is within 95% or greater of the pre-construction survey data (2016 and 2017).	Active; monitored in 2023

Chapter	Variable	Variable Type	Final Performance Standard	Status of Monitoring
11.3	Belding’s Savannah Sparrow	Pre-Restoration Absolute	4-year running average of the density of Belding’s savannah sparrow individuals is within 95% or greater of the pre-construction survey data (2016 and 2017).	Active; monitored in 2023
12	Wetland Function (California Rapid Assessment Method [CRAM])	Pre-Restoration Absolute	Post-restoration > or equal to the Baseline CRAM Attribute Score	Active; monitored in 2023
13	Eelgrass	Pre-Restoration Absolute	There are no permanent losses of eelgrass.	Completed
14	*Caulerpa*	Pre-Restoration Absolute	*Caulerpa* are absent from the project site.	Completed

Note:
% = percent

Per the Monitoring Plan, Annual Monitoring Reports will be completed as needed until Year 10 post-construction, after which a final monitoring report will be prepared and submitted. Monitoring and reporting beyond 10 years post-construction for the life of the project (defined as a minimum of 50 years) will be detailed in a Long-Term Management Plan

Detailed methods including data collection, monitoring frequency, analysis, and performance standards are discussed in the Monitoring Plan, which is summarized below. Additional details regarding the overview of past and current monitoring are included in Chapter 15 below.

This page intentionally left blank.

2. TOPOGRAPHY

2.1 PERFORMANCE STANDARD

Topography is a project design absolute monitoring variable and, as such, is not held to comparisons with reference wetlands for the purposes of determining success of the SELRP. Performance standards shall be considered met if post-construction monitoring results show no large-scale variations from design elevations, and habitat areas are within 10% of the design habitat distribution.

2.2 APPROACH

Per the Monitoring Plan, target elevations for low, mid-, and high salt marsh habitats, as well as wetland to upland transition zone habitat, must be met to achieve succesful restoration. The establishment and maintenance of vegetation coverage representative of these habitat types reflect that target elevations have been met. Habitat mapping in the lagoon, as described in Chapter 5 below, is used to assess the success of topography.

Post-construction monitoring was conducted in October 2020 to establish the post-construction topography at the site, per the Monitoring Plan Year 0 requirement. This survey established the baseline post-construction topography that will be used to identify substantial changes in the future that could affect the ability of the desired habitats to become established. The Monitoring Plan outlined topography post-construction monitoring would be conducted during Years 2, 5, and 10; however, supplemental monitoring was conducted in November 2023 to assess whether the project had undergone major topographic change that could affect habitat areas. The 2023 supplemental survey focused on the tidal inlet area and did not cover the whole site. Both the 2020 and 2023 surveys were conducted using aerial imagery and were supplemented with traditional ground surveys by KDM Meridian, Coastal Frontiers Corporation, and Moffatt & Nichol. Topography in the three basins (west, central, and east) was mapped to 1-foot contours using digital aerial imagery. Elevation contours were produced in digital computer-aided design format. A complete description of the survey methodology is provided in the Monitoring Plan.

2.3 RESULTS

Target habitats to confirm if the topographic performance standard is met include low, mid-, and high salt marsh habitats, as well as wetland to upland transition zone habitat, as noted in the Monitoring Plan. Table 2-1 below identifies the target acreage for those habitat categories, as presented in Chapter 5 below, and confirms whether the 2023 mapped acreage is within the required range for the performance standard.

Table 2-1. Topographic Target Habitat Distribution

Habitat Type	Target Acres	Acres -/+ 10%	Acres Mapped in 2023	Habitat Distribution Achieved (within -/+ 10%)
Intertidal Mudflat	32 to 47	28.8/35.2 to 42.3/51.7	39.6	Yes
Intertidal Salt Marsh[1]	293 to 308	263.7/322.3 to 277.2/338.8	303.3	Yes
Transitional[2]	7	6.3/7.7	7.1	Yes

Notes:
-/+ = minus or plus
[1] Intertidal salt marsh includes low, mid-, and high salt marsh habitats. Range is due to the uncertainty of the converted low marsh areas in the OD pit.
[2] Transitional habitat acreage has been updated to reflect refinements in the geographic information system information.

The topographic survey conducted in 2020 documents the topography of the lagoon immediately following construction (Figure 2-1) and reflects the changes to topography that resulted as part of the construction process per the project design. As noted above, topography surveying is only required in Years 2, 5, and 10, as substantial changes are not anticipated from year to year. The topgraphic survey conducted in 2022 (Year 2) is shown on Figure 2-2 to document whether the design elevations have been maintained. The elevation differences between 2020 and 2022 are represented on Figure 2-3. Although a 2023 survey was not required, a supplemental survey was completed in 2023 in a focused area of the lagoon (Figure 2-4). The elevation differences between the 2020 and 2023 focused area are represented on Figure 2-5.

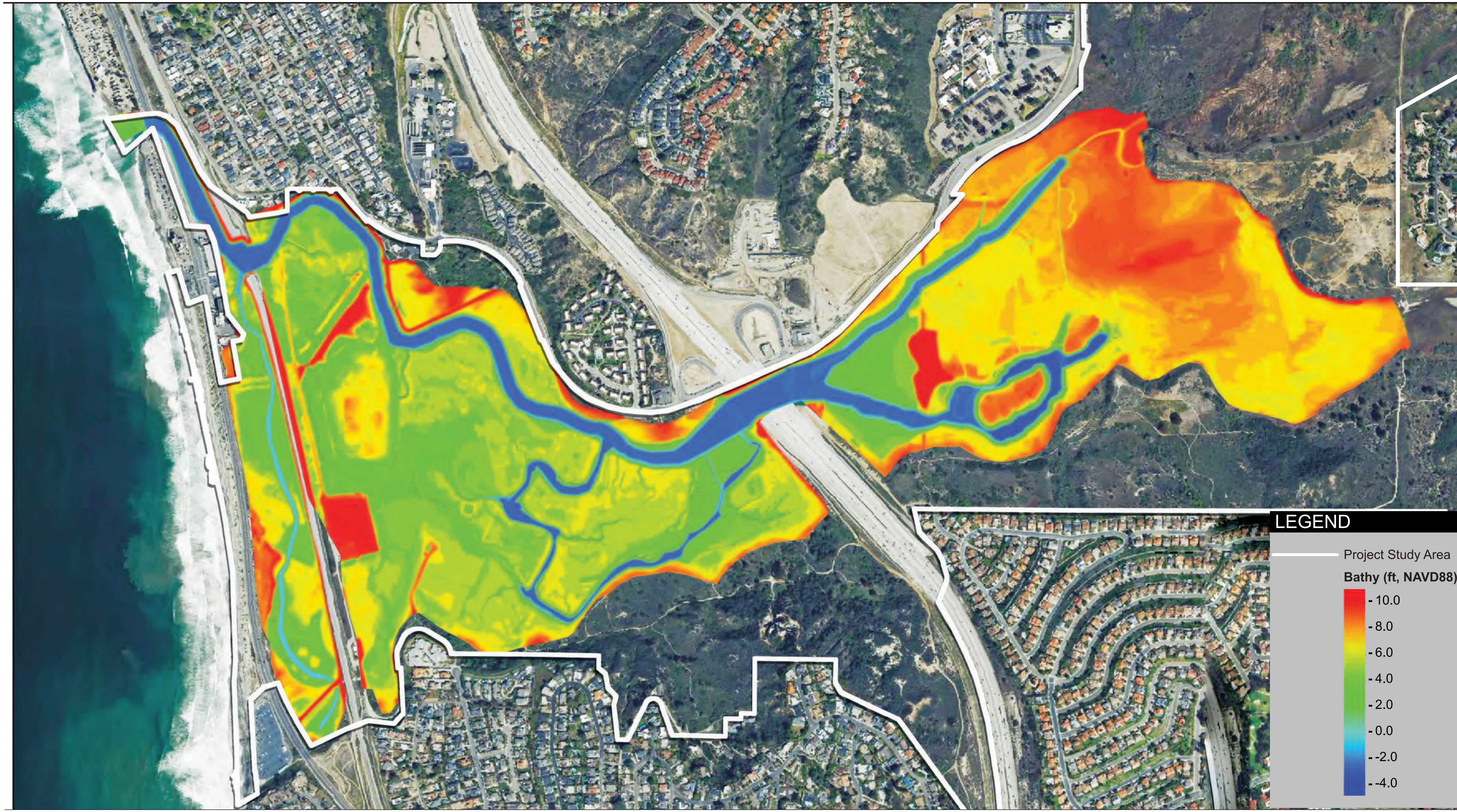
2.4 DISCUSSION

Habitat establishment determines whether target elevations for topography have been attained. The correct elevations are critical for restoration success and drive habitat establishment. As shown in Table 2-1, habitat areas for 2023 were within 10% of the planned habitat range for those habitat types used for the topographic performance standard. Areas for habitat types are discussed in more detail in Chapter 5 below.

The immediate post-construction project site was quite variable in its topography (Figure 2-1), with the majority of the restoration site between +2 feet and +6 feet North American Vertical Datum of 1988 (NAVD88). Areas east of Interstate 5 (I-5) are higher and range from +6 feet to +10 feet NAVD88. The restoration site in 2022 (Figure 2-2) did not undergo major topographic changes across the lagoon, with elevations remaining generally consistent with the 2020 design elevations. The 2022 survey showed the OD pit has settled in comparison to 2020 elevations. The final surface elevation of the OD pit will be verified in future topgraphic surveys. The supplemental survey conducted in 2023 focused on only a portion of the project near the inlet area due to shoaling, and specific discussion is included in the following bathymetry section. As future surveys take place of the entire project footprint per the Monitoring Plan, annual monitoring reports will address subsequent activities and whether they result in changes that affect the ability of habitat to establish as designed.

In 2023, the topographic performance standard was met, as habitat areas for the metric mapped in 2023 fell within 10% of the design habitat acreage, and no large-scale variations from the topography design elevations had occurred.

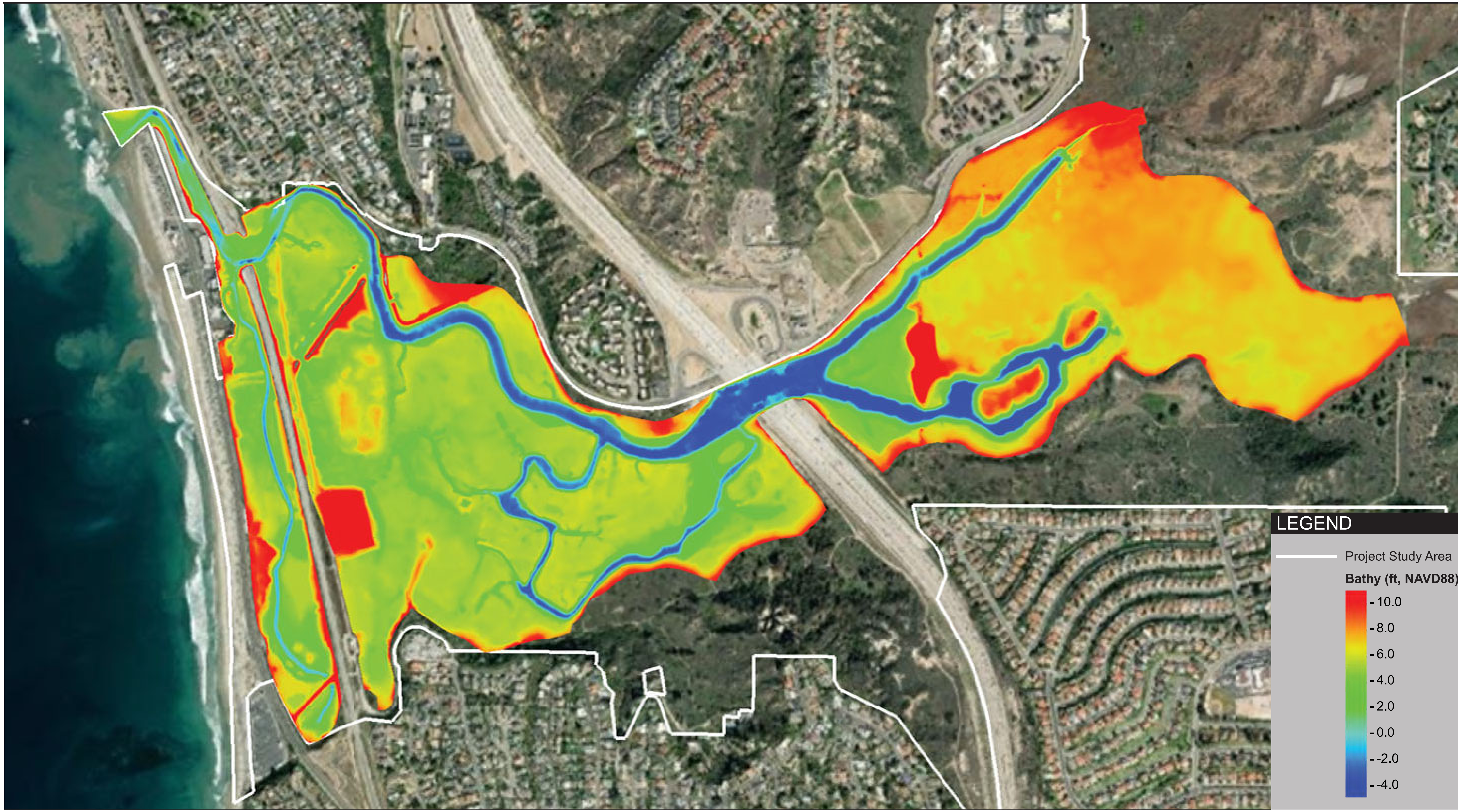
This page intentionally left blank.



Source: Moffatt & Nichol 2022

NO SCALE

Figure 2-1
San Elijo Lagoon Post-construction 2020 Topography/Bathymetry



Source: Moffatt & Nichol 2022

NO SCALE

Figure 2-2
San Elijo Lagoon Post-construction 2022 Topography/Bathymetry

Source: Moffatt & Nichol 2022

NO SCALE

Figure 2-3
San Elijo Lagoon Elevation Differences Between 2020 and 2022 Topography/Bathymetry

COORDINATE TABLE

POINT	NORTHING	EASTING	ELEV	DESCRIPTION
159	1949789.42	6246194.98	10.46	S MW KDMCP .00A
161	1949997.80	6246182.61	13.98	S HUB .00N
162	1950067.55	6246444.17	11.96	S HUB .00N
166	1950174.26	6246094.63	15.42	S GWH .00N
167	1950354.06	6245987.48	10.70	S GWH .00N
168	1950532.81	6245886.80	13.89	S 2X2N .00NG
169	1950897.67	6245743.97	17.51	S 2X2N .00N
170	1949954.54	6246706.02	5.86	S 60D .00N

SURVEYOR'S STATEMENT

THIS TOPOGRAPHIC MAP IS FOR THE PURPOSE OF DETAILING CONTOURS WITHIN THE TIDAL INLET CHANNEL AND IS NOT A BOUNDARY SURVEY. AT THE TIME OF THIS SURVEY, SPECIFIC DETAILS OF PROPOSED IMPROVEMENTS ARE NOT KNOWN.

THE TOPOGRAPHIC INFORMATION SHOWN HEREON WAS COMPILED FROM GROUND & AERIAL sUAV SURVEY PERFORMED ON NOVEMBER 8TH AND 9TH, 2023.

HORIZONTAL DATUM: CALIFORNIA COORDINATE SYSTEM OF 1983, CCS83, ZONE 6, CSRS NAD83(NSRS2007) 2009.00 EPOCH

VERTICAL DATUM: NAVD88

THIS MAP WAS MADE BY ME OR UNDER MY DIRECTION IN NOVEMBER 2023.

11/20/2023

RICHARD C. MAHER, P.L.S. 7564 — DATE

THIS DOCUMENT PRELIMINARY UNLESS SIGNED

Source: KDM, Meridian 11/2023

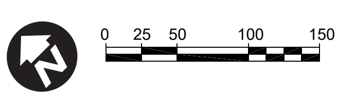


Figure 2-4
Tidal Inlet Topography

Source: KDM, Meridian 11/2023

NO SCALE

Figure 2-5
Inlet Elevation Differences Between 2020 and 2023 Topography/Bathymetry

This page intentionally left blank.

3. BATHYMETRY

3.1 PERFORMANCE STANDARD

Like topography, bathymetry is a project design absolute monitoring variable and is not subject to comparisons with reference wetlands. Performance standards shall be considered met if post-construction monitoring results show no large-scale variations from the design elevations, and subtidal habitat areas are within 10% of the design acreage. Success is determined by subtidal habitat areas and their similarity to the design (i.e., within 10%).

3.2 APPROACH

Mapping of subtidal habitat area in the lagoon, as described in Chapter 5 below, is used to assess the success of this metric.

Post-construction monitoring was completed by Coastal Frontiers in October 2020 to establish the post-construction bathymetry at the site, per the Monitoring Plan Year 0 requirement. This survey established the baseline post-construction bathymetry that will be used to identify substantial changes in the future that could affect the ability of desired habitats to become established in the lagoon. The Monitoring Plan outlined bathymetry post-construction monitoring would be conducted in Years 2, 5, and 10; however, because of the shoaling that occurred in 2022, supplemental monitoring was conducted in November 2023 (Year 3) to assess whether the project has undergone major bathymetric change that could affect the channel capacity. The 2023 supplemental survey focused on the tidal inlet area and did not cover the whole site. The 2020 and 2023 bathymetric data were obtained using a survey-grade digital acoustic echosounder operated from a small boat and focused on subtidal areas. Bathymetry was obtained along pre-established channel-perpendicular transects spaced at a nominal interval of 100 feet. A real-time kinematic global positioning system base-rover set was used to determine the horizontal position of each sounding, as well as the water surface elevation (relative to NAVD88). The soundings were merged with the topographic data described in Chapter 2 above and used to develop a digital elevation model. A complete description of the survey methodology is in the Monitoring Plan.

3.3 RESULTS

Table 3-1 identifies the design acreage for subtidal habitat categories, as presented in Chapter 5 of this Annual Monitoring Report, and confirms whether the 2023 mapped acreage falls within the required range for the performance standard.

Table 3-1. Bathymetry Target Habitat Distribution

Habitat Type	Target Acres	Acres -/+ 10%	Acres Mapped 2023	Habitat Distribution Achieved (within -/+ 10%)
Tidal Channels and Basins (Subtidal)	62	55.8/68.2	60.5	Yes

The bathymetric survey conducted in 2020 documented the bathymetry of the lagoon immediately following construction (Figure 2-1) and reflects changes to the bathymetry and channels that resulted as part of the construction process per the project design. Immediately following construction, the bathymetry varied throughout the site from the ocean to the east of I-5. Subtidal elevations were approximately +1.6 feet NAVD88 in the lagoon, with tidal channel depths ranging from -2 to -4 feet NAVD88. As noted above, bathymetry surveying is required in only Years 2, 5, and 10, as substantial changes are not anticipated from year to year. The bathymetry survey conducted in 2022 (Year 2) is shown to document whether design elevations have been maintained (Figure 2-2). The elevation differences between 2020 and 2022 are represented in Figure 2-3. At the time of the 2020 survey, the channel underneath the I-5 bridge was still under its construction-phase configuration, consisting of a narrow channel (about 44 feet wide) confined by sheet pile walls. The channel was then widened per the proposed dimensions, and the 2022 survey reflects the final configuration (Figure 2-2). Acreage does not include areas in the I-5 right-of-way; therefore, continued construction during 2020 did not affect acreage results. Although a 2023 survey was not required, due to inlet closures, a supplemental survey was completed in 2023 in a focused area of the lagoon (Figure 2-4). The elevation differences between the 2020 and 2023 focused area are represented on Figure 2-5.

3.4 DISCUSSION

Subtidal habitat area determines whether the performance standard for bathymetry has been met. The correct elevations are critical for channel capacity and lagoon function. As shown in Table 3-1, habitat areas for 2023 are within 10% of the design acreage for the subtidal habitat area used for the bathymetric performance standard. Areas for habitat types are discussed in more detail in Chapter 5 below.

In contrast to topography, bathymetry represents areas that are inundated 100% of the time, occur at lower elevations, and are more heavily influenced by hydraulic forces in the lagoon. Bathymetry was expected to evolve beginning immediately after construction. It is expected that sediment in the tidal channels becomes mobile post-construction, and scour and deposition in the tidal channel network occur as a more stable equilibrium condition establishes. In 2020 immediately following construction, the proposed main channel was deepened to -4 feet NAVD88. It was also widened, from its pre-construction condition of between 50 to 100 feet wide, to between 100 and 200 feet wide in some areas as designed. In 2022, the restoration site (Figure 2-2) did not undergo major bathymetric changes across the lagoon, with elevations remaining generally consistent with the 2020 design elevations; however, some focused shoaling occurred on the west side of the lagoon, causing the channel east of the railroad bridge to infill and narrow as shown in Figure 2-3. Due to the shoaling, a supplmental focused survey was completed in 2023 (Figure 2-3) which showed even further sediment accumulation compared to 2022 and 2020, spreading throughout the channels in the west basin and central basin (Figure 2-5). The accelerated sedimentation and shoaling at the railroad bridge in 2023 was possibly exacerbrated by the heavy rainfall from storm events in 2022 and 2023. The storm events resulted in prolonged high water levels which likely increased the sediment load in the lagoon, as sediment delivered from upstream may have deposited in the main channel of the lagoon. However, subtidal habitat acreages were not affected.

In 2023, the bathymetry performance standard was met, as subtidal habitat areas mapped in 2023 are within 10% of the design habitat acreage. While the 2023 supplemental survey showed there has been substantial variation in the focused tidal inlet area, the survey did not cover the entire project area to determine if the elevational variation is large-scale across the lagoon, and habitat is still establishing as designed. Because bathymetry monitoring is not required annually, success of the standard is tied to habitat which is monitored every year. Therefore, in the years that full bathyemtry surveys are not conducted (i.e., 2023), the performance standard is considered met if the habitat performance standard is met. However, if shoaling of the inlet is not addressed, there may be further negative effects to bathymetry in future years. Future annual monitoring reports will address subsequent activities and whether they result in changes that affect the ability of habitat to establish as designed.

This page intentionally left blank.

4. TIDAL ELEVATIONS

4.1 PERFORMANCE STANDARD

Tidal elevation is a project design absolute monitoring variable and, therefore, is not compared to reference wetlands. Performance standards include the following metrics:

1. Habitat areas must be within 10% of the designed habitat area targets in response to TIFs; and
2. Predicted seawater residence time must remain on average shorter than 7 days in the central basin and 9 days in the east basin, as estimated using a numerical hydrodynamic model (such as RMA) to indicate first-order water quality.

4.2 APPROACH

Tidal elevation data were collected during 2023 to calculate both the TIF relationship with habitat areas and the estimated tidal residence time in each lagoon basin (Appendix A). Station locations are presented in the Monitoring Plan. Two tide gauge locations in the main channel, that were initially included, were eliminated to avoid redundancy. These locations included one at the northern end of the utility road and one south of Ocean Cove Drive. Tidal elevations are anticipated to vary over time, depending on inlet condition, as well as sedimentation in the channels. The performance standards were established to rely on longer-term variations in tidal elevations that could affect the lagoon function and habitat establishment, rather than short-term variability that is a result of natural processes within an estuarine system.

Habitat was mapped in 2023, as discussed in Chapter 5 below, and both topographical and tidal elevation data were used to confirm the predicted TIF of various habitat types in the lagoon.

Modeling of tidal residence time was calculated for 2023 using the Adaptive Hydraulics Modeling System developed by the Corps Engineering Research and Development Center.

4.3 RESULTS

Water level and velocity measurements during 2023 revealed temporal variability and indications of the long-term effects of restoration construction on tidal amplitudes and velocities in the lagoon. Results were also indicative of the effects of shoaling in the west basin on tidal dynamics throughout the system. Post-construction tidal parameter measurements during 2020 through 2023 have shown that tidal conditions are mostly similar throughout the lagoon. This indicates that generally the changes to the lagoon from the SELRP increased (or at least were equal to) the tidal exchange relative to the pre-restoration conditions throughout the lagoon. However, in 2023, tidal muting was exacerbated as a result of sedimentation and accelerated shoaling compared to prior year conditions. This resulted in a smaller range of tidal amplitudes throughout the lagoon than previous years since construction began.

The TIF analysis provides the frequency of inundation statistics over specific elevation thresholds at a given location. This analysis is an extremely beneficial tool for planning marsh restoration activities and habitat designs. The inundation frequency is an indicator of the time period that a site is under seawater, which determines the elevations at which specific marsh habitats will be established and the area and distribution of specified wetland habitats in the watershed. For example, low marsh (cordgrass) establishes at elevations where the TIF is between 20% and 40% of the time.

Based on TIF data, habitat elevations in 2023 were typically slightly higher than designed, with lower-lying habitats such as mudflats and low-marsh more greatly affected. This indicates that specific habitat experienced longer periods of inundation when compared to recent years. In the longer term, this could affect habitat distribution and will continue to be monitored. Even though habitat elevations were higher in 2023, habitat areas remain within 10% of the final design habitat distribution, discussed further in Chapter 5 below. The tidal elevation performance standard is considered met if target habitat areas are within 10% of the design acreage for the project, and the residence times remain within the durations outlined in the Monitoring Plan in each lagoon basin.

Table 4-1 identifies the target acreage for various habitat types, as presented in Chapter 5 of this Annual Monitoring Report, and confirms whether the 2023 mapped acreage is within the required range for the performance standard. As vegetation continues to establish in restored areas of the lagoon (e.g., OD pit), acreages may continue to shift until they reflect specific TIF conditions.

Table 4-1. Target Elevation Distribution Results

Habitat Type	Target Acres	Acres -/+ 10%	Acres Mapped in 2023	Habitat Distribution Achieved (within -/+ 10%)
Tidal Channels and Basins (Subtidal)	62	55.8/68.2	60.5	Yes
Intertidal Mudflat[1]	32 to 47	28.8/35.2 to 42.3/51.7	39.6	Yes
Intertidal Salt Marsh[1]	293 to 308	263.7/322.3 to 277.2/338.8	303.3	Yes
Transitional[2]	7	6.3/7.7	7.1	Yes
Total	**409**	**368.1/449.9**	**410.5**	**Yes**

[1] Intertidal mudflat and salt marsh ranges are due to the uncertainty of the converted low marsh areas in the OD pit.
[2] Transitional habitat acreage has been updated to reflect refinements in geographic information system information.

The estimated residence time for 15 locations throughout the various basins of San Elijo Lagoon in 2023 is provided in Figure 4-1 and Table 4-2.

Figure 4-1. Estimated Residence Time (days) in San Elijo Lagoon for 2023

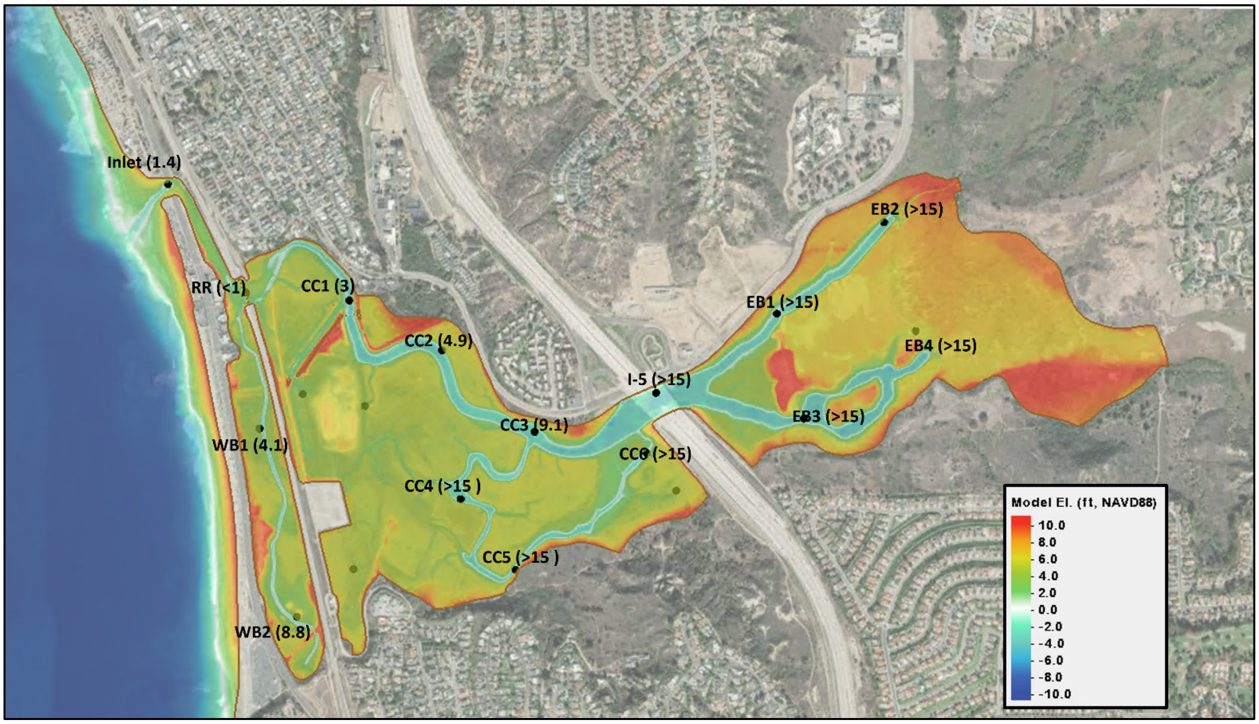


Table 4-2. Estimated Residence Time in San Elijo Lagoon for 2023

Basin	Location	Residence Time (Moving Average Days)
West Basin	Inlet	1.4
	RR	0.5
	WB1	4.1
	WB2	8.3
Central Basin	CC1	3.0
	CC2	4.9
	CC3	9.1
	CC4	22.0
	CC5	22.1
	CC6	23.1
East Basin	I-5	24.3
	EB1	26.4
	EB2	26.1
	EB3	27.9
	EB4	29.0

Note: RR = railroad

Table 4-3 summarizes the average residence time for each basin of San Elijo Lagoon in 2023 per the project performance standard. Numerical modeling analyses for seawater residence time are provided in Appendix A.

Table 4-3. Average Residence Time per Basin in San Elijo Lagoon

Basin	Average Residence Time Target	2023 Average Residence Time	Performance Standard Met
West Basin	N/A	3.6 days	N/A
Central Basin	<7 days	14.4 days	No
East Basin	<9 days	26.7 days	No

Note: N/A = not applicable

4.4 DISCUSSION

In 2023, natural phenomena affecting the lagoon physical conditions and morphology occurred that were unprecedented during the post-restoration monitoring period (since 2020). The two primary phenomena were multiple large rain events observed in the early winter months and accelerated sedimentation/shoaling observed in the west basin around the railroad bridge, tidal inlet channel, and lagoon mouth. Dredging operations were conducted in May 2023 to widen and deepen areas near the mouth of the lagoon, which led to temporary increases in tidal range throughout the lagoon once completed. However, despite the dredging, tidal muting of both low and high tides has rapidly increased. This trend was observed at tide gauge stations throughout the lagoon in 2023.

The overall decrease in tidal range was most likely due to morphological changes at the mouth of the lagoon and intensified shoaling at the railroad bridge and inlet channel. Data collected at monitoring stations throughout the year suggested increasing tidal muting continued to occur throughout 2023, especially after July. In 2023, the annualized tidal ranges were the lowest on record at monitoring sites since restoration began in 2017. It was also clear that the tidal range in the lagoon steadily diminished over time from the beginning to the end of the year, which was especially evident after the completion of the mouth and inlet channel dredge clearing in early June. This was unprecedented both in terms of the degree of system-wide tidal muting and water level trend phenomena (i.e., the conspicuous, steadily increasing muting trend over 6 months) that has not occurred in the lagoon since restoration. Additionally, the decreased tide ranges were similar throughout the lagoon (both the east and west basins), regardless of the location relative to the inlet shoaling. This result indicates that the shoaling in the tidal inlet channel between United States Highway 101 and the railroad bridge results in upstream muting at the monitoring location sites. If this shoaling persists or worsens into 2024, habitat may be affected. Dredging of and clearing accumulated sediment from in the tidal inlet channel, mouth, and railroad bridge areas are likely required for habitat acres to continue to be within their designed target ranges in the future.

Continued monitoring of the effects of shoaling underneath the railroad bridge should take place until, during, and after dredging occurs to minimize negative effects on the wetland ecosystem and/or hydraulic function in the lagoon.

As expected, residence time in the lagoon increased with distance from the inlet, ranging from <1 day at the inlet of the lagoon to >15 days at the far eastern end of the model domain. This can be explained by the hydrodynamics and the mechanisms in which transport of constituents (e.g., the water tracer) occurs at the different regions of the lagoon. Close to the inlet, tidal current velocities are the highest, and transport primarily follows the mean tidal currents. Ebb tidal currents flush out waters and flood tidal currents bring in water from the open coast. Meanwhile, farther from the inlet, tidal current velocities have drastically reduced at the far eastern end of the lagoon, and even in the central basin. In this area of the lagoon, diffusion is more relevant, which is the transport given by much more smaller-scale flow processes. Residence times in the lagoon increased in 2023, except for a few locations closest to the inlet. The effects of shoaling in the lagoon circulation is apparent from the increase in residence times from 2022 to 2023. Based on the modeling results, strong inflow and outflow currents near the inlet in previous years favored rapid flushing of tracer concentrations, resulting in relatively short residence times (<6 days) at locations in the west and central basins of the lagoon. However, for the 2023 model updates, the shoaled morphology of the tidal inlet and surrounding areas decreases the tidal exchange, resulting in longer times for tracers to be flushed out of the lagoon. In 2023, the west basin average and east basin averages exceeded the threshold of 7 days and 9 days, respectively. Residence time values in the west and central basins have increased similar to what they were in pre-restoration conditions.

While habitat areas mapped in 2023 are within 10% of the design habitat acreage, the tidal elevations performance standard was not met because the average residence time in the central and east basins was not shorter than 7 days and 9 days, respectively. Residence times exceed pre-restoration values for 11 of the 15 locations. Weakened tidal ciculation has resulted from the shoaled morphology near the inlet area. Continued monitoring of the effects of sedimentation and shoaling will take place until dredging can occur to minimize potential negative effects on the wetland ecosystem and/or hydraulic function.

This page intentionally left blank.

5. HABITAT AREAS

5.1 PERFORMANCE STANDARD

The attainment of predicted habitats, including subtidal, intertidal mudflats, intertidal salt marsh, and transitional areas, is an absolute monitoring variable specific to two separate permit/approval requirements, is based on design target elevations, and is not compared to reference wetlands. The CCC Coastal Development Permit (CDP) conditions stipulate that areas of different habitats not vary by more than 10% from the final approved design habitat distribution for the performance standard to be met. The overall project design habitat distribution is shown on Figure 5-1. Target habitat acreages specific to the performance standard and for CCC requirements are identified in Table 5-1 and shown on Figure 5-2.

Table 5-1. Target Habitat Distribution

Habitat Type	Target Acres
Tidal Channels and Basins (Subtidal)	62
Intertidal Mudflat[1]	32 to 47
Intertidal Salt Marsh[1]	293 to 308
Transitional[2]	7
Total	**409**

[1] Intertidal salt marsh and mudflat ranges are due to the uncertainty of the converted low marsh areas in the OD pit.
[2] Transitional habitat acreage has been updated to reflect refinements in the geographic information system information.

A performance standard specific to the low marsh target acreage has also been established pertinent to only the USFWS requirements. For the performance standard to be met (USFWS), low marsh must total between 57 and 73 acres. Low marsh target acreage encompasses the lagoon as a whole because it is focused on species support, including planted areas, areas anticipated to convert over time, and existing low marsh.

5.2 APPROACH

Vegetation mapping was completed throughout the project area by AECOM during the summer of 2023. Habitats were classified based on the dominant and characteristic plant species, plant physiognomy, and soil in accordance with *Draft Vegetation Communities of San Diego County* (Oberbauer et al. 2008), as described in Appendix B. Subtidal, intertidal mudflat, and intertidal salt marsh habitats were then categorized based on the criteria identified in the San Dieguito Wetlands Restoration Project (low marsh, mid-marsh, and high marsh have been combined). Areas in the project OD pit that remain unvegetated but are anticipated to ultimately convert to vegetated marsh are identified separately and will be categorized as a specific habitat type as conversion occurs. A complete description of survey methodology is in the Monitoring Plan.

5.3 RESULTS

Habitat mapping for 2023 is shown on Figure 5-3 and indicates a minor decrease of tidal mudflat and an increase of intertidal salt marsh due to the expansion of low salt marsh. The acreage of each target habitat and performance standard for each target habitat are compared in Table 5-2.

Table 5-2. Target Habitat Distribution Results

Habitat Type	Target Acres	Acres -/+ 10%	Acres Mapped in 2023	Habitat Distribution Achieved (within -/+ 10%)
Tidal Channels and Basins (Subtidal)	62	55.8/68.2	60.5	Yes
Intertidal Mudflat[1]	32-47	28.8/35.2 to 42.3/51.7	39.6	Yes
Intertidal Salt Marsh[1]	293 to 308	263.7/322.3 to 277.2/338.8	303.3	Yes
Transitional	7	6.3/7.7	7.1	Yes
Total	**409**	**368.1/449.9**	**410.5**	**Yes**

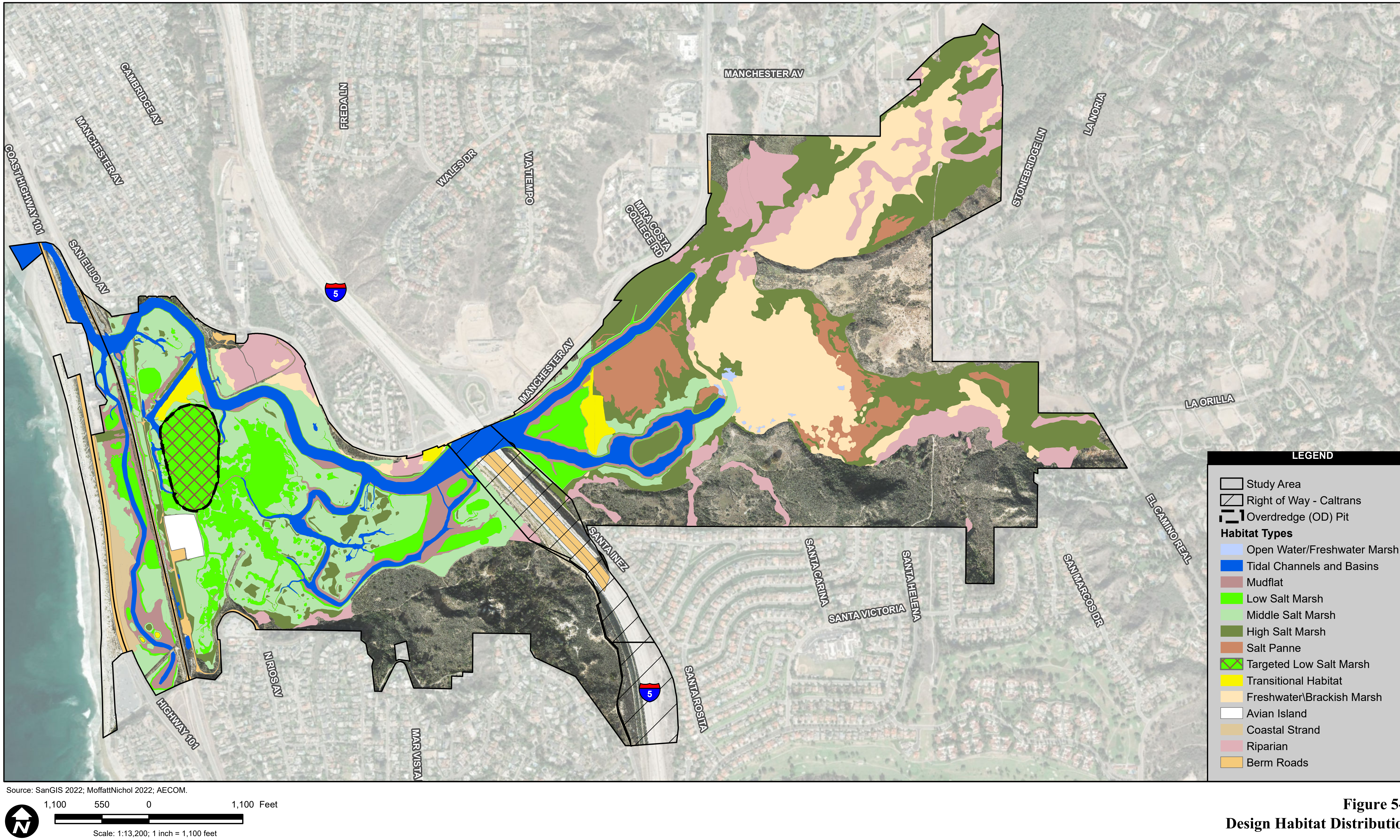
Note:
[1] Intertidal salt marsh and mudflat ranges are due to the uncertainty of the converted low marsh areas in the OD pit.

With respect to the USFWS performance standard specific to low marsh, habitat mapping conducted in 2023 resulted in a total of 72.5 acres of low salt marsh. The increase of 6.4 acres of low salt marsh from 2022 to 2023 was due to the expansion of cordgrass in areas that were previously mapped as mudflat and/or the unvegetated portion of the OD pit. The acreage of target acres for low salt marsh and mapped low salt marsh are compared in Table 5-3.

Table 5-3. Target Low Marsh Acreage Results

Habitat Type	Target Acres (Outside of OD Pit)	Target Acres (Inside of OD Pit)	Total Target Acres[1]	Target Acreage Achieved
Low Marsh (Performance Standard)	58	15	57 to 73	N/A
2023 Low Marsh	67.9	4.6	72.5	Yes

Note:
[1] Biological Opinion total target acreage requirement of low marsh is a range of 57 to 73 acres.



Source: SanGIS 2022; MoffattNichol 2022; AECOM.

Figure 5-1
Design Habitat Distribution

Path: \\na.aecomnet.com\lfs\AMER\SanDiego-USSDG1\DCS\Projects_6058\60582908_SELRP_ConPh2\900-CAD-GIS\920 GIS\map_docs\mxd\Report\Annual\2022\Proposed Habitat Distribution_July2020.mxd, 8/1/2023, paul.moreno

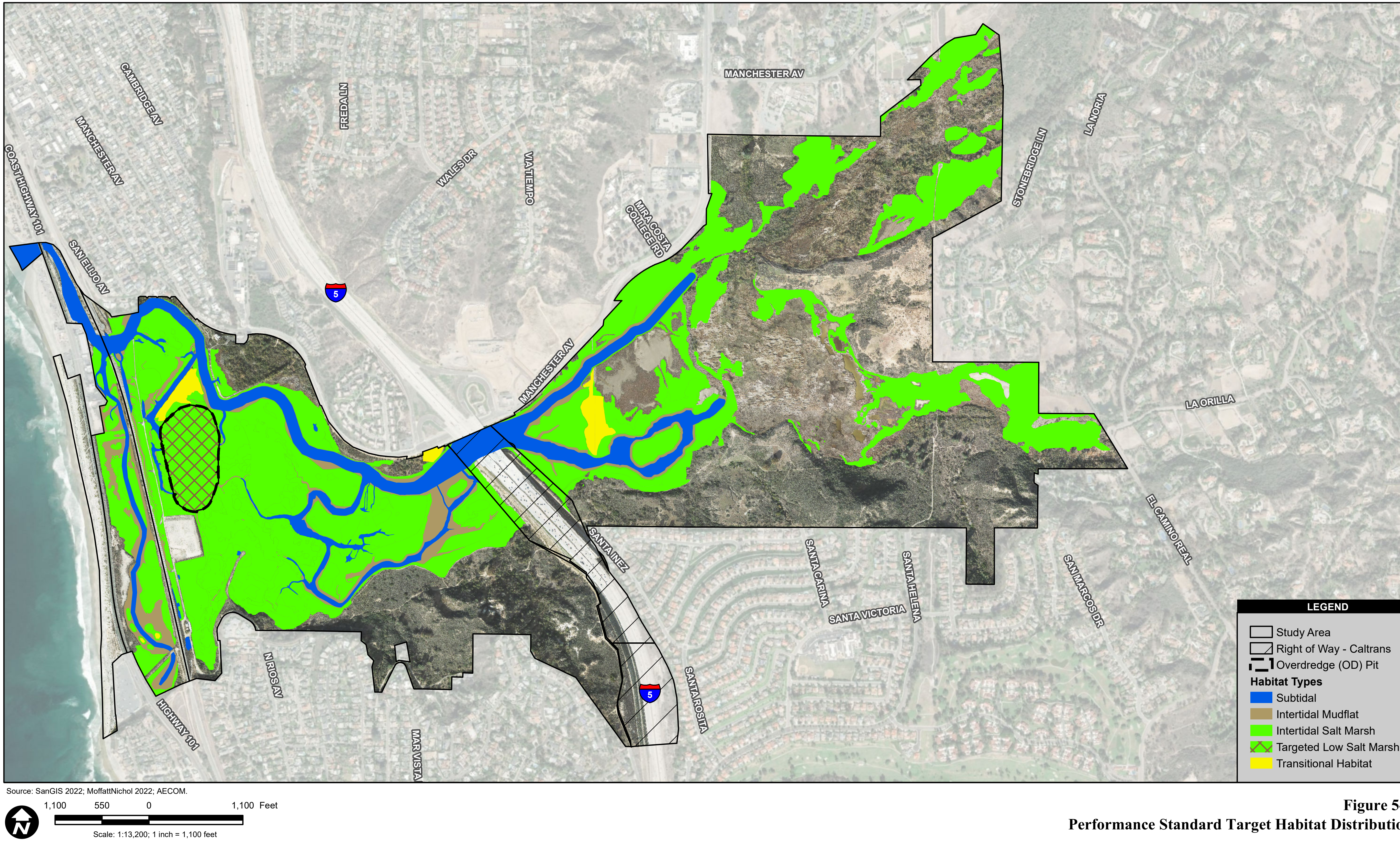
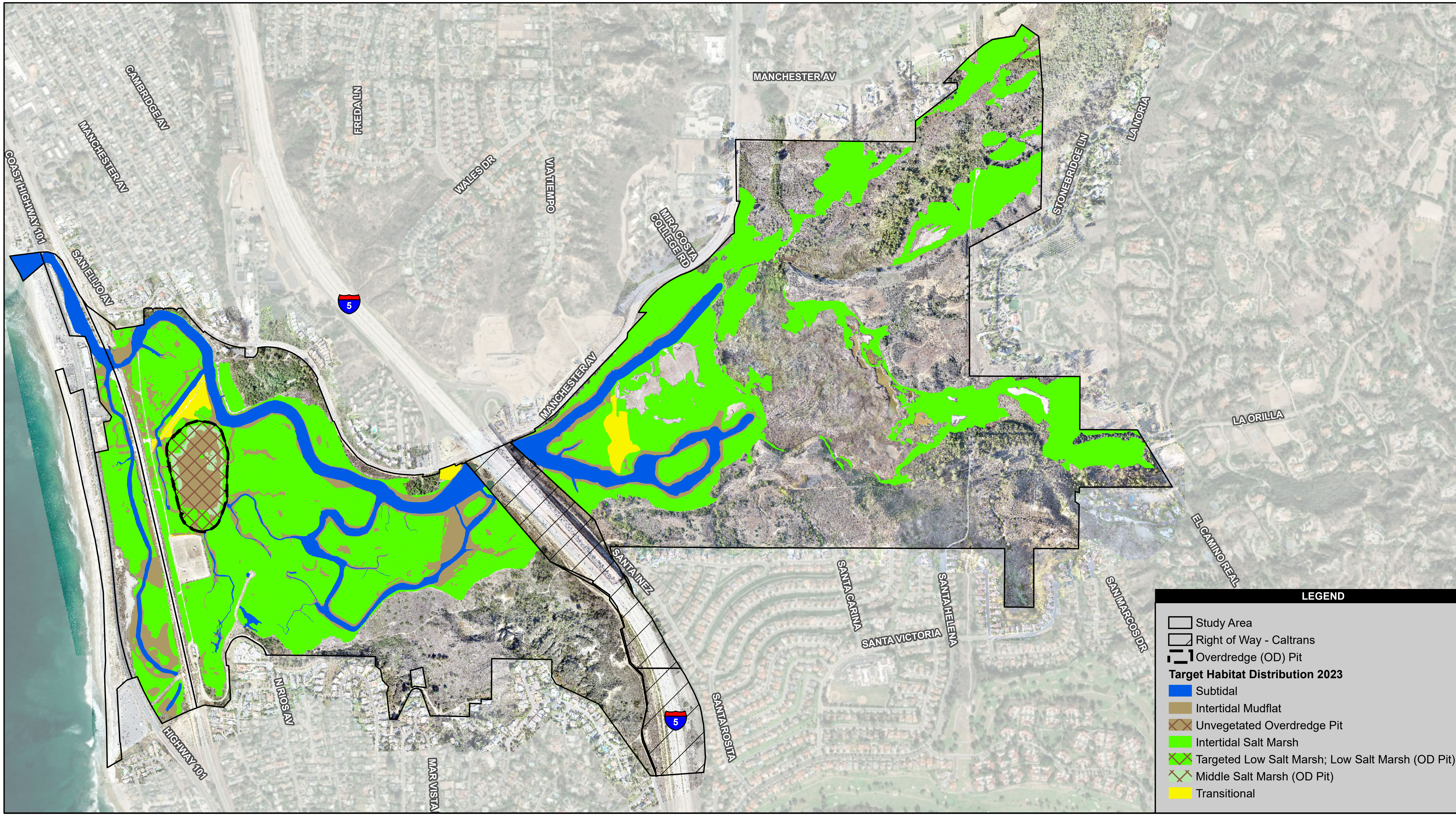


Figure 5-2
Performance Standard Target Habitat Distribution



Source: SanGIS 2022; MoffattNichol 2022; AECOM.

1,100 550 0 1,100 Feet

Scale: 1:13,200; 1 inch = 1,100 feet

Figure 5-3
Habitat Distribution 2023

Path: L:\DCS\Projects_6058\60582908_SELRP_ConPh2\900-CAD-GIS\920 GIS\map_docs\mxd\Report\Annual\2023\Target_Habitat_Types_2023_Tidal.mxd, 3/15/2024, paul.moreno

This page intentionally left blank.

5.4 DISCUSSION

Achieving habitat goals is dependent upon achieving the target goals of topography, bathymetry, and tidal elevation, which have been directly modified as part of the SELRP to ultimately alter habitat. Accordingly, habitat distribution must be within 10% of the target acreages presented in Table 5-1. Establishment and conversion of habitat are anticipated as the lagoon reaches equilibrium after the completion of restoration and are expected to result in shifts in acreage between intertidal salt marsh, brackish marsh, and unvegetated flats. Unvegetated areas planned as vegetated salt marsh in the OD pit have not initially been mapped as habitat and will continue to be monitored until they can be characterized as a specific habitat type once they have approximately 30% cover or can be confidently mapped as mudflat.

In 2023, the habitat area performance standard for tidal channels and basins, mudflat, intertidal salt marsh, and transitional habitat was met, as presented in Table 5-2.

In 2023, the performance standard for low marsh was met, as presented in Table 5-3.

While habitat acreages are still establishing as designed, the 2023 results of bathymetry and tidal range are a concern for the future health of the overall lagoon and may result in changes that affect the ability of habitat to establish as designed. Continued monitoring of the effects of sedimentation and shoaling will take place until dredging can occur to minimize potential negative effects on the wetland ecosystem.

This page intentionally left blank.

6. VEGETATION

6.1 VEGETATIVE COVER

6.1.1 Performance Standard

Vegetation cover is a project design absolute monitoring variable and is not subject to comparison with reference wetlands. Performance standards for vegetation cover address the post-construction 240-workday PEP, during which the contractor was responsible for maintaining plants as well as the performance standards necessary to meet longer-term habitat goals.

The interim yearly performance standards are absolute (Table 6-1) and require the separation of low marsh from the other marsh types (mid- and high marsh). Final standards will be considered met in the year when the Year 10 cover standards have been met.

Table 6-1. 10-Year Absolute Performance Standards

Milestone	Planted Low Marsh Native Cover (absolute)	Planted Mid- and High Marsh Native Cover (absolute)	Unplanted Marsh Native Cover (absolute)[1]	Planted Transitional Habitat Native Cover (absolute)	Species Diversity	Nonnative Cover (absolute)	Container Plant Survival
240-Workday PEP	N/A	N/A	N/A	N/A	N/A	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	100%
Year 1	5%	10%	N/A	10%	80% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)
Year 2	10%	20%	N/A	20%	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)
Year 3	20%	30%	N/A	35%	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)
Year 4	35%	45%	N/A	50%	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)
Year 5	45%	55%	30%	70%	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)

Milestone	Planted Low Marsh Native Cover (absolute)	Planted Mid- and High Marsh Native Cover (absolute)	Unplanted Marsh Native Cover (absolute)[1]	Planted Transitional Habitat Native Cover (absolute)	Species Diversity	Nonnative Cover (absolute)	Container Plant Survival
Year 6	50%	60%	30%	N/A	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed “high” or “moderate” threat species	80% (unless function has been replaced by recruitment)
Year 7	55%	65%	35%	N/A	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed “high” or “moderate” threat species	80% (unless function has been replaced by recruitment)
Year 8	60%	70%	40%	N/A	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed “high” or “moderate” threat species	80% (unless function has been replaced by recruitment)
Year 9	65%	75%	40%	N/A	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed “high” or “moderate” threat species	80% (unless function has been replaced by recruitment)
Year 10	70%	80%	45%	N/A	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed “high” or “moderate” threat species	80% (unless function has been replaced by recruitment)

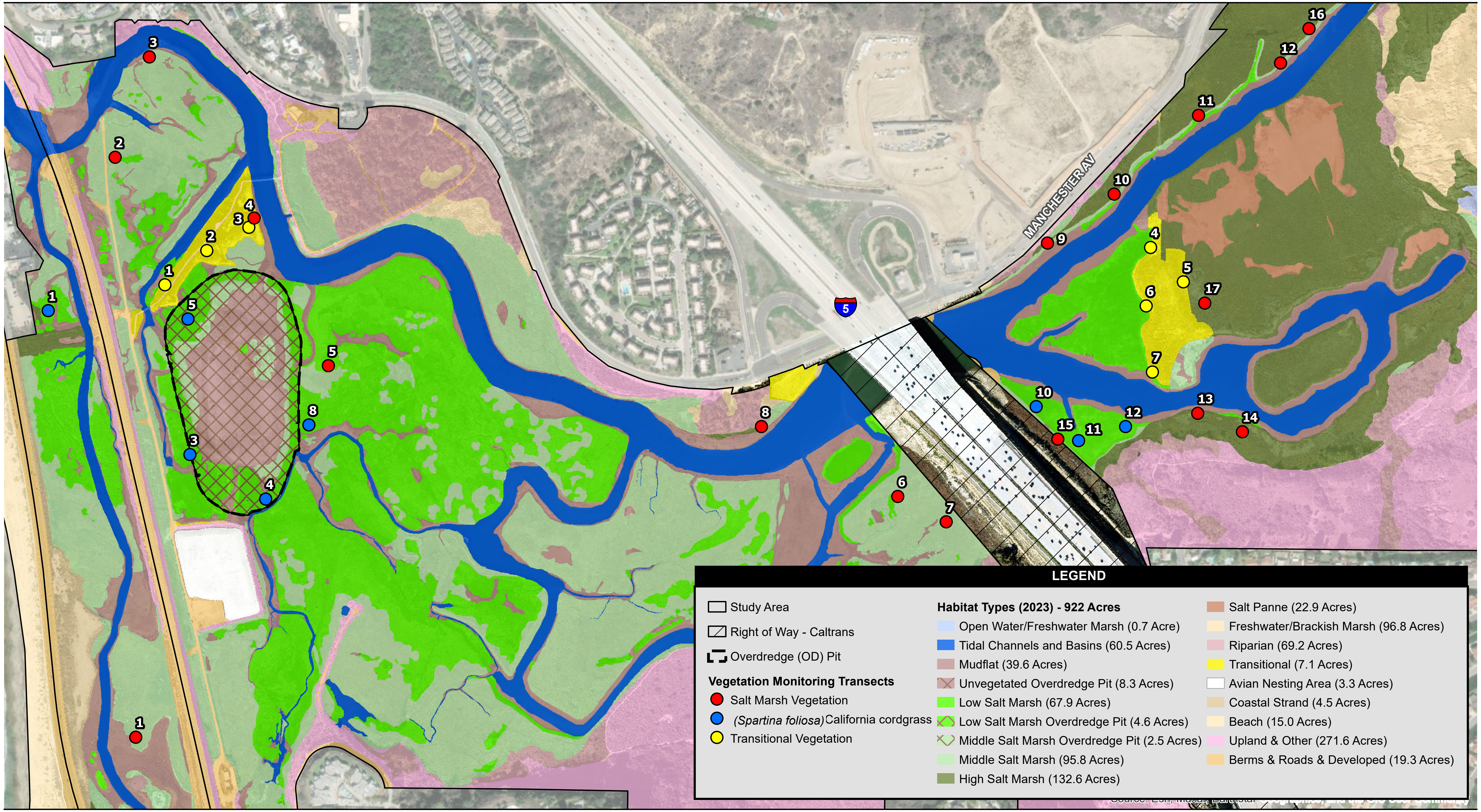
Note:
[1] Performance standards for low marsh and mid- to high marsh will be separated by the planned acreage for the respective habitat types.

6.1.2 Approach

Quantitative vegetation cover monitoring was conducted by biologists from AECOM and Nature Collective in the late summer of 2023 in areas impacted during dredging and grading operations where container plants were installed, as well as areas expected to convert from a pre-construction habitat type to salt marsh. Monitoring was conducted using 30-meter (m) point intercept transects, with a 2.5-m-wide plant diversity belt on both sides of the transect line, as described in the Monitoring Plan. During the Year 1 (2021) monitoring event, the number of transects and placement of transects were modified slightly from the Monitoring Plan to account for access issues (i.e., not accessible due to increase in channel width), ease of repeatability, and need to decrease impacts to sensitive wildlife species. Monitoring of the same transects was repeated in Year 3 (2023). Monitoring in mid- and high salt marsh habitat included one transect in the west basin, seven transects in the central basin, and nine transects in the east basin (Figure 6-1). Monitoring in the transitional areas included three transects in the central basin and four transects in the east basin (Figure 6-1). No vegetation cover transects were placed in low marsh to monitor for cover because low marsh was monitored using transects to measure California cordgrass canopy architecture, as discussed in Section 6.2 below. Total native cover and nonnative cover in each basin were determined by averaging the transect data in each basin. A complete description of survey methodology is in the Monitoring Plan.

6.1.3 Results

Transect data results from 2023 are summarized in Table 6-2 through Table 6-5. The total number of species (species richness) identified in the transects and 2.5-m-wide diversity belts was 42. A total of 32 native species and 10 nonnative species were recorded. Zero California Invasive Plant Council (Cal-IPC) listed “high” or “moderate” threat species were recorded in the transects while three species listed as "high" or "moderate" were found in the 2.5-m wide diversity belt. Detailed transect results by species are included in Appendix C.



Source: SanGIS 2022; MoffattNichol 2022; AECOM (2018-2022).

500 250 0 500 Feet

Scale: 1:6,000; 1 inch = 500 feet

Figure 6-1
Vegetation Transects Points with 2023 Habitats

Path: L:\DCS\Projects_6058\60582908_SELRP_ConPh2\900-CAD-GIS\920 GIS\map_docs\mxd\Report\Annual\2023\Veg Transects_11x17_with_2023_Habitats_single_pts.mxd, 3/15/2024, paul.moreno

This page intentionally left blank.

Table 6-2. Mid- and High Salt Marsh Transect Combined Planted and Unplanted Areas Monitoring Results

Basin	Native Species	Nonnative Species
	Average Absolute Cover	Average Absolute Cover
West[1]	100.00%	0.00%
Central	146.40%	0.00%
East	136.30%	9.84%
All Basins	*139.59%*	*4.05%*

1. Planting was not conducted in the west basin; percentage reflects transect data from unplanted areas.

Table 6-3. Planted Mid- and High Salt Marsh Transect Monitoring Results

Basin	Native Species	Nonnative Species
	Average Absolute Cover	Average Absolute Cover
West[1]	N/A	N/A
Central	173.80%	0.00%
East	183.10%	0.00%
All Basins	*177.80%*	*0.00%*

Note:
1. Planting was not conducted in the west basin.

Table 6-4. Unplanted Mid- and High Salt Marsh Transect Monitoring Results

Basin	Native Species	Nonnative Species
	Average Absolute Cover	Average Absolute Cover
West	100.00%	0.00%
Central	124.60%	0.00%
East	101.80%	17.21%
All Basins	*112.80%*	*6.89%*

Table 6-5. Transitional Transect Monitoring Results

Basin	Native Species	Nonnative Species
	Average Absolute Cover	Average Absolute Cover
Central	125.10%	0.00%
East	119.30%	4.90%
All Basins	*121.80%*	*2.80%*

6.1.4 Discussion

The vegetation cover success criterion is an absolute performance standard, and success for vegetation is based on meeting the criteria identified in Table 6-1. As presented in Table 6-6, Year 10 vegetation cover performance standards have been met in Year 3. The Year 10 performance standard for low marsh native cover has been met in Year 3 with cover estimated at >70%. In the low marsh areas, approximately 72.5 acres of the targeted 57 to 73 acres has an estimated cover of at least 70%. Low marsh cover is based on the aerial mapping for habitat assessment rather than transect data. Low marsh is also assessed using the California cordgrass canopy architecture performance standard described in Section 6.2 below. The Year 10 performance standard for planted mid- and high marsh native cover was met again in Year 3 with cover estimated at 177.80% (>80%). The Year 10 performance standard for unplanted mid- and high marsh native cover was met again in Year 3 with cover estimated at 112.80%. The Year 10 performance standard for planted transitional native cover was met again in Year 3 with cover estimated at 121.80% (>45%). As described in the Monitoring Plan, when monitoring for absolute cover, multiple species are recorded at each point if there is overlapping canopy or there are multiple species touching the same point that is recorded in a transect. This can occur at many different points in a transect, resulting in more than 100% cover. Additionally, Year 10 success critiera for species diversity, nonnative cover, and container plant survival have been met in Year 3. Zero of the nonnative species indentified in the monitoring transects were Cal-IPC listed “high” or “moderate” threat species. Table 6-6 shows a comparison to the specific vegetation performance standards.

In the 2021 and 2022 Annual Monitoring Reports, a brief discussion was included to support the discontinuation or reduction of vegetation cover monitoring after 2022 if the Year 10 vegetation cover performance standards had been achieved prior to Year 10. After vegetation monitoring in 2022, the SELRP team decided that an additional year of vegetation monitoring in 2023 would be conducted even though Year 10 vegetation performance standards had been achieved in Year 2. Because the 2023 (Year 3) data are consistent with the data collected in previous years and the performance standards are achieved, future vegetation monitoring will not occur in 2024 and will be discontinued.

Table 6-6. 10-Year Absolute Performance Standards Compared to 2023 Monitoring Results

Milestone	Planted Low Marsh Native Cover (absolute)	Planted Mid- and High Marsh Native Cover (absolute)	Unplanted Marsh Native Cover (absolute)[1]	Planted Transitional Native Cover (absolute)	Species Diversity	Nonnative Cover (absolute)	Container Plant Survival
240-Workday PEP	N/A	N/A	N/A	N/A	N/A	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	100%
Performance Standard Status	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**Achieved**	**Achieved**
Year 1	5%	10%	N/A	10%	80% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)
Performance Standard Status	**Achieved 30.0%**	**Achieved >80%**	**N/A**	**Achieved >70%**	**Achieved**	**Achieved**	**Achieved**
Year 2	10%	20%	N/A	20%	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)
Performance Standard Status	**Achieved 30.0%**	**Achieved >80%**	**N/A**	**Achieved >70%**	**Achieved**	**Achieved**	**Achieved**
Year 3	20%	30%	N/A	35%	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)
Performance Standard Status	**Achieved 30.0%**	**Achieved >80%**	**N/A**	**Achieved >70%**	**Achieved**	**Achieved**	**Achieved**
Year 4	35%	45%	N/A	50%	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)
Performance Standard Status	**Achieved >70.0%**	**Achieved >80%**	**N/A**	**Achieved >70%**	**Achieved**	**Achieved**	**Achieved**
Year 5	45%	55%	30%	70%	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)
Performance Standard Status	**Achieved >70.0%**	**Achieved >80%**	**Achieved >45%**	**Achieved >70%**	**Achieved**	**Achieved**	**Achieved**
Year 6	50%	60%	30%	N/A	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)
Performance Standard Status	**Achieved >70.0%**	**Achieved >80%**	**Achieved >45%**	**N/A**	**Achieved**	**Achieved**	**Achieved**
Year 7	55%	65%	35%	N/A	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)
Performance Standard Status	**Achieved >70.0%**	**Achieved >80%**	**Achieved >45%**	**N/A**	**Achieved**	**Achieved**	**Achieved**
Year 8	60%	70%	40%	N/A	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)

Milestone	Planted Low Marsh Native Cover (absolute)	Planted Mid- and High Marsh Native Cover (absolute)	Unplanted Marsh Native Cover (absolute)[1]	Planted Transitional Native Cover (absolute)	Species Diversity	Nonnative Cover (absolute)	Container Plant Survival
Performance Standard Status	**Achieved >70.0%**	**Achieved >80%**	**Achieved >45%**	**N/A**	**Achieved**	**Achieved**	**Achieved**
Year 9	65%	75%	40%	N/A	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)
Performance Standard Status	**Achieved >70.0%**	**Achieved >80%**	**Achieved >45%**	**N/A**	**Achieved**	**Achieved**	**Achieved**
Year 10	70%	80%	45%	N/A	Natural recruitment of multiple species in habitat types and 75% of the species planted present	<5% nonnative and 0% Cal-IPC listed "high" or "moderate" threat species	80% (unless function has been replaced by recruitment)
Performance Standard Status	**Achieved >70.0%**	**Achieved >80%**	**Achieved >45%**	**N/A**	**Achieved**	**Achieved**	**Achieved**

6.2 CALIFORNIA CORDGRASS (*SPARTINA FOLIOSA*) CANOPY ARCHITECTURE

6.2.1 Performance Standard

California cordgrass (*Spartina foliosa*) canopy architecture is a relative standard, which is used to compare the restored San Elijo Lagoon to similar measurements taken at reference wetlands. The restored wetland areas shall have a California cordgrass canopy architecture similar to reference wetlands. The relative performance standard will be considered met if the 4-year running average of the mean proportion of stems >90 cm is not significantly worse than the mean value at the lowest performing reference wetland. In the 2021 Annual Monitoring Report, Tijuana Estuary was the only reference wetland used for comparison; however, to stay consistent with the other relative standard metrics and because more data are available, Mugu Lagoon was included in 2023.

6.2.2 Approach

In 2021, transects measuring 20 m long were established in the areas of low marsh through construction and areas expected to convert to low marsh after construction. In 2022, it was recommended that the number of transects be reduced to a total of eight to reduce impacts to the overall lagoon system, including habitat and marsh birds (Figure 6-1). As a result of this recommendation, data from the eight transects are presented below. The transects include one transect in the west basin, four transects in the central basin, and three transects in the east basin. The number and height of cordgrass stems were assessed in 0.1-square-meter (m^2) (circular) quadrats placed over the cordgrass every 2 m along each transect (a total of 10 points along each transect). The maximum height (excluding flowering culms) of stems present in the quadrat was recorded, and the mean proportion of stems >90 cm in height was determined for each cordgrass stand. The eight transects presented include planted and unplanted areas in the west, central, and east basins (Figure 6-1). In addition to this change, some minor discrepanices were discovered in how different wetland mean proportional values were calculated, and data have now been standardized as follows: the proportion of stems >90 cm is calculated for each quadrat, and each transect average is calculated from those 10 quadrats. For a quadrat with zero stems, the proportion of stems >90 cm is given as 0.00 rather than undefined, based on the ecological relevance of including those data as unsuitable rather than omitting them because they are mathematically undefined. Omitting those data results in artificial increases in the average proportion of stems >90 cm.

6.2.3 Results

Table 6-7 summarizes the results of the eight California cordgrass transects monitored in San Elijo Lagoon. Appendix C includes individual transect data. In 2023, cordgrass stem density at eight transects in the west, central, and east basins ranged from 20.1 to 56.3 stems per 0.01 m^2 (average

29.61 stems per 0.01 m^2), and the proportion stems at those transects that were >90 cm in height varied from 0.01 to 0.52, averaging 0.23 overall (Table 6-8). Stem count data were also collected at Tijuana Estuary and Mugu Lagoon in 2023. The mean proportion of stems >90 cm tall was 0.56 for four transects at Tijuana Estuary and 0.00 for four transects at Mugu Lagoon (Table 6-8). The 3-year running average of the proportion of stems >90 cm tall at San Elijo Lagoon (0.16) was not significantly lower than the lowest performing wetland (Mugu Lagoon, at 0.00) (Table 6-8 and Figure 6-2).

Table 6-7. 2023 California Cordgrass Transect Results Using Eight Transects at San Elijo Lagoon

Metric	San Elijo Lagoon	Tijuana Estuary	Mugu Lagoon
Density of Stems per 0.1 m^2 (Average)	29.61	NP	NP
Proportion of Stems >90 cm tall per 0.1 m^2 (Average)	0.23	0.56	0.00

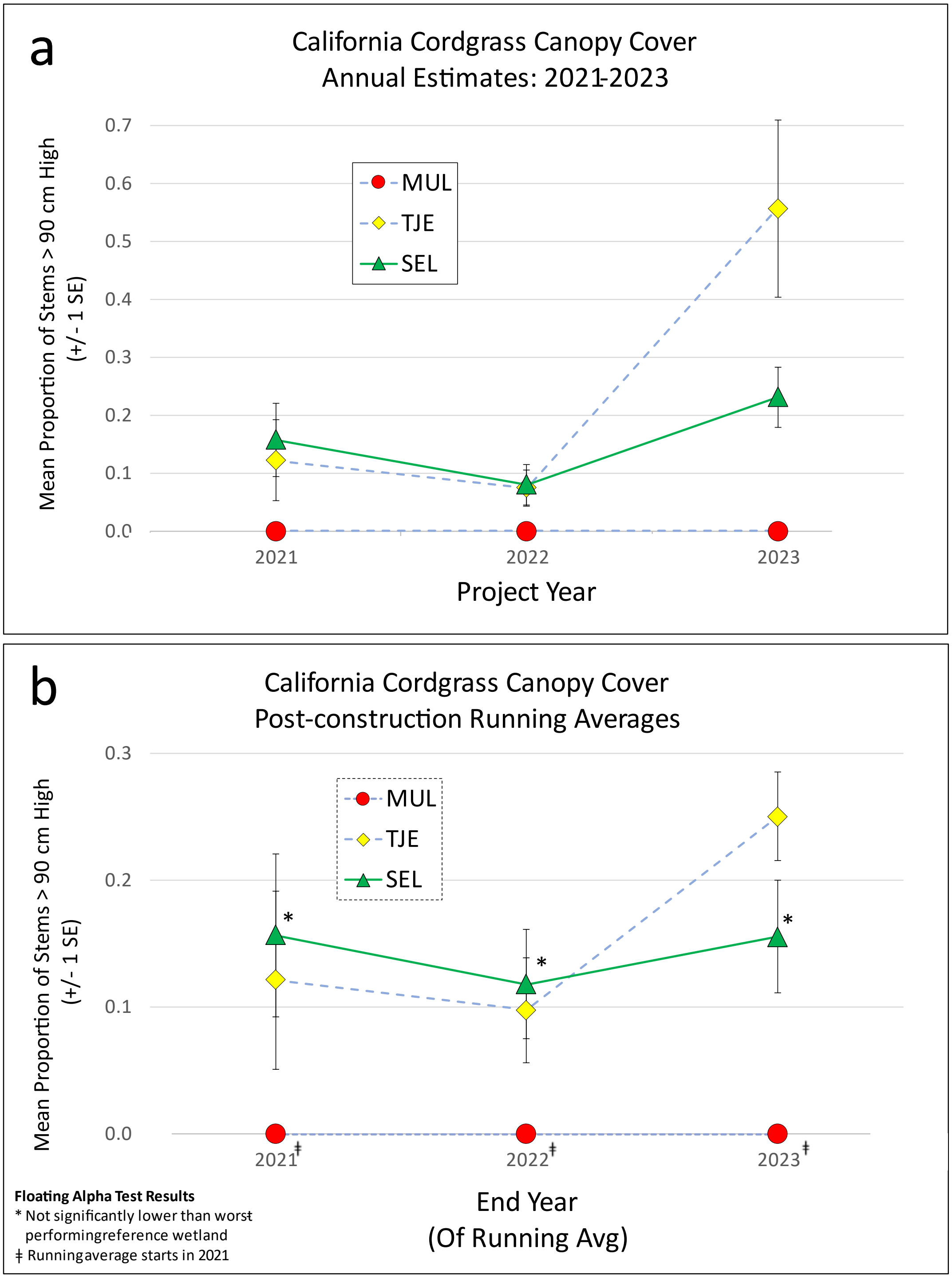
Note:
NP = not provided

Table 6-8. San Elijo Lagoon, Tijuana Estuary, and Mugu Lagoon California Cordgrass Transect Results Using Eight Transects at San Elijo Lagoon

End Year of Running Average	Sampling Station	California Cordgrass Cover Post-construction Running Averages: Proportion Stems >90 cm Tall per 0.1 m^2		
		San Elijo Lagoon	Tijuana Estuary	Mugu Lagoon
2023	California cordgrass_01	0.01	N/A	0.00
	California cordgrass_02	N/A	N/A	0.00
	California cordgrass_03	0.16	0.26	0.00
	California cordgrass_04	0.10	0.24	0.00
	California cordgrass_05	0.10	0.34	N/A
	California cordgrass_06	N/A	0.17	N/A
	California cordgrass_07	N/A	N/A	N/A
	California cordgrass_08	0.44	N/A	N/A
	California cordgrass_09	N/A	N/A	N/A
	California cordgrass_10	0.18	N/A	N/A
	California cordgrass_11	0.14	N/A	N/A
	California cordgrass_12	0.12	N/A	N/A
	California cordgrass_13	N/A	N/A	N/A
	California cordgrass_14	N/A	N/A	N/A
	California cordgrass_15	N/A	N/A	N/A
	Overall Average (SE)	**0.16 (0.04)**	**0.25 (0.04)**	**0.00 (0.00)**

Note:
SE = Standard Error

Figure 6-2. California Cordgrass Canopy Cover Comparing Eight Transects at San Elijo Lagoon to Two Reference Wetlands



MUL = Mugu Lagoon; TJE = Tijuana Estuary; SEL = San Elijo Lagoon

6.2.4 Discussion

Unlike other relative standard metrics, California cordgrass cover was compared to only California cordgrass cover values at Tijuana Estuary in 2021. However, following the 2021 Annual Monitoring Report, data collected for Mugu Lagoon were available annually, and this 2023 Annual Monitoring Report compares San Elijo Lagoon data to both Tijuana Estruary and Mugu Lagoon for the years 2021 through 2023. Also, in 2022, the decision was made to reduce the number of transects analyzed for performance standard evaluation at San Elijo Lagoon from 15 to eight transects (see discussion in 2022 Annual Report, Section 6.2.4 for discussion). Thus, the peformance standard for California cordgrass is evaluated using the results from eight transects at San Elijo Lagoon in comparison with comparable data collected from two reference wetlands, Tijuana Estuary and Mugu Lagoon.

In 2023, the 3-year running average of proportion of California cordgrass canopy cover >90 cm high at San Elijo Lagoon was 0.156, which was not significantly lower than the 0.00 value at the lowest performing reference wetland (Mugu Lagoon). The 2023 running average is based only on 3 years; the performance standard requires a 4-year running average and, thus, cannot be evaluated in 2023. However, these values are meant to provide an early indicator of California coordgrass canopy cover.

The 2023 San Elijo Lagoon average density of stems per quadrat was 29.61, which was an increase of 1.38 stems per quadrat from the 2022 average density of 28.23 stems per quadrat. This increase in stem density actually helped contribute to an overall decrease in the average proportion of stems >90 cm high because most of the new stems are shorter in height. The proportion of stems >90 cm high has remained relatively stable at San Elijo Lagoon since 2021 and had been comparable to the proportion observed at Tijuana Estuary. However, in 2023, the proportion of stems >90 cm high at Tijuana Estuary was more than twice that at San Elijo Lagoon. Importantly, the high value at Tijuana Estuary was driven by a single stem on Transect 5, which was >90 cm high. In fact, it was the only cordgrass stem recorded on the entire transect, which resulted in the proportion of stems >90 cm being 1.00. If that transect is omitted from the sample, the average proportion of stems >90 cm high at Tijuana Estuary in 2023 would be 0.41 instead of 0.56; the 3-year running average from 2021 to 2023 would be 0.18 instead of 0.25 and, thus, still comparable to the SELRP 3-year running average of 0.16.

After a 4-year running average is obtained for California cordgrass canopy, the discontinuation of monitoring California cordgrass canopy may be considered for a number of reasons. California cordgrass monitoring results in collateral damage to the habitat, which is temporal but still present. This damage is from the direct impacts of trampling the cordgrass along the transects and disturbance to LFRR supported in the cordgrass areas of San Elijo Lagoon. Support of LFRR is another performance standard used to evaluate success of the project. If avian monitoring indicates that LFRR are present in these areas, or the LFRR performance standards are being achieved, the height of California cordgrass is not specifically necessary to confirm for suitability of LFRR nesting purposes. Additionally, if the required acreage of low marsh has been achieved consistent with the habitat area performance standard, then this may be sufficient to determine that LFRR have enough area to maintain populations. While some of the transects in San Elijo Lagoon are located in areas of existing cordgrass, several are in areas that may convert over time. Conversion to low marsh containing California cordgrass may never occur, as some of these areas are surrounded by mid-marsh habitat, and the species composition may be such that these areas continue to convert to habitat more dominated by species such as pickleweed (*Salicornia pacifica*). Because other metrics reflect successful support of the key target species of LFRR, it may be prudent to eliminate monitoring in the lagoon to reduce collateral impacts to LFRR.

6.3 EXOTICS

6.3.1 Performance Standard

Exotics are a project design absolute monitoring variable and are not subject to comparison with reference wetlands. Conditions included in the CCC CDP and the USFWS Biological Opinion state that important functions of the restored wetland shall not be impaired by exotic species, including 0% coverage by Cal-IPC "Invasive Plant Inventory" species of "high" or "moderate" threat and no more than 5% coverage by other exotic/weed species. Should such species exceed the thresholds, they will be removed.

6.3.2 Approach

While exotic plant species are not anicipated to colonize the low and mid- intertidal salt marsh areas to be restored by the SELRP, it is likely that such species could invade high salt marsh and transition areas. Surveys of vegetative cover in restored areas described in Section 6.1.2 above, including the 2.5-m-wide diversity belt along each side of the transects for species composition, were conducted in 2023 to inform the monitoring program on the presence of exotic species. A complete description of survey methodology is in the Monitoring Plan.

6.3.3 Results

In the west and central basins, zero nonnative plant species occurred along the marsh transects or 2.5-m-wide diversity belts. In the east basin, zero nonnative plant species occurred along the marsh transects or 2.5-m-wide diversity belts in the planted areas, while the total estimate of nonnatives detected in the transects and 2.5-m-wide diversity belts in the unplanted areas was 6.89%. When the marsh transects and 2.5-m-wide diversity belts were averaged, the total estimate of nonnative species was 4.05%. In the central and east basins transitional habitat transects, nonnative plant species were estimated at 2.80%. The total nonnative cover recorded along transects is presented in Table 6-2 through Table 6-5. In total, two nonnative species were identified in the marsh transects or the 2.5-m-wide diversity belt (Table 6-9).

Table 6-9. Nonnative Species Detected in Marsh Transects

Scientific Name	Common Name	Cal-IPC Classification
Atriplex prostrata	fat hen	Not listed
Chenopodium murale	nettle leaf goosefoot	Not listed

6.3.4 Discussion

Of the nonnative species identified in the transects, zero Cal-IPC listed "moderate" or "high" threat species were detected in the transects. The performance standard requires 0% coverage by Cal-IPC "Invasive Plant Inventory" species of "high" or "moderate" threat and no more than 5% coverage by other exotic/weed species. In all transects, weed species had an average cover of 3.7%, which is less than the performance standard of 5%. Therefore, the performance standard for exotics has been achieved as the cover of invasive plants with a "high" threat is 0%. Monitoring for invasive species will continue, and species with "moderate" or "high" threat ratings will be removed as they are identified. Detailed species results are presented in Appendix C.

7. WATER QUALITY

7.1 PERFORMANCE STANDARD

Water quality is a relative standard, which is used to compare the restored San Elijo Lagoon to similar measurements taken at reference wetlands. The final relative performance standard will be considered met if the 4-year running average of the mean number of consecutive hours with dissolved oxygen (<3 parts per million) is not significantly worse than the mean value at the lowest performing reference wetland.

7.2 APPROACH

To calculate the relative performance metric for the SELRP, one continuous-monitoring data sonde was deployed near the inlet (Nature Center Sonde) to be analyzed for success following construction. A complete description of survey methodology is in the Monitoring Plan.

The criterion for event duration determines whether two readings are considered unique events or the same event. A 1-hour envelope was used to classify hypoxic events in proximity to each other as one event. The start and end of an event must be at least 1 hour apart to signal an event is complete. Otherwise, readings triggering the threshold value are considered the same event. Table 7-1 illustrates how events are categorized and event duration is calculated. No other filtering of the data was performed. The duration of each hypoxic event was quantified and then averaged across the total number of events (i.e., mean hypoxic duration). There are numerous events of only a single reading (15 minutes) that did not have other hypoxic readings within an hour of that event occurring.

Table 7-1. Example Hypoxic Event Duration Calculation[1]

Reading	1	2	3	4	5	6	7	8	9	10	11	12	13		
Time (hr)	0	0.25	0.5	0.75	1	1.25	1.5	1.75	2	2.25	2.5	2.75	3		
Examples														# Events	Duration (hr)
A	3.84	3.57	3.29	3.01	1.84	1.77	1.51	1.84	3.99	5.59	6.24	6.56	6.68	1	1
B	3.5	3.22	3.14	3.05	2.99	2.97	3.12	2.42	2.53	2.65	3.08	3.07	2.92	1	1.5
C	4.53	4.16	3.71	3.29	2.97	3.7	5.08	5.26	5.79	2.59	3.28	3.38	3.27	2	.25 (for both)

[1] Gray highlights represent hypoxic events (i.e., dissolved oxygen threshold of <3.0 milligrams per liter)

7.3 RESULTS

The post-construction mean hypoxic event duration at San Elijo Lagoon and the three reference wetlands in 2023 is provided in Figure 7-1a, and the post-construction running averages are provided in Table 7-2 and Figure 7-1b. These post-construction values represent 3 years of data at the time of this report preparation. In 2023, the mean hypoxic event duration running average at

San Elijo Lagoon was 2.70 hours (Table 7-2), which was not signficantly longer in duration than the lowest performing reference wetland (Tijuana Estuary) (Figure 7-1b). Appendix D details water quality data collected at the Nature Center station.

Table 7-2. 2023 Mean Hypoxic Event Duration Post-construction Running Averages for San Elijo Lagoon and Reference Wetlands

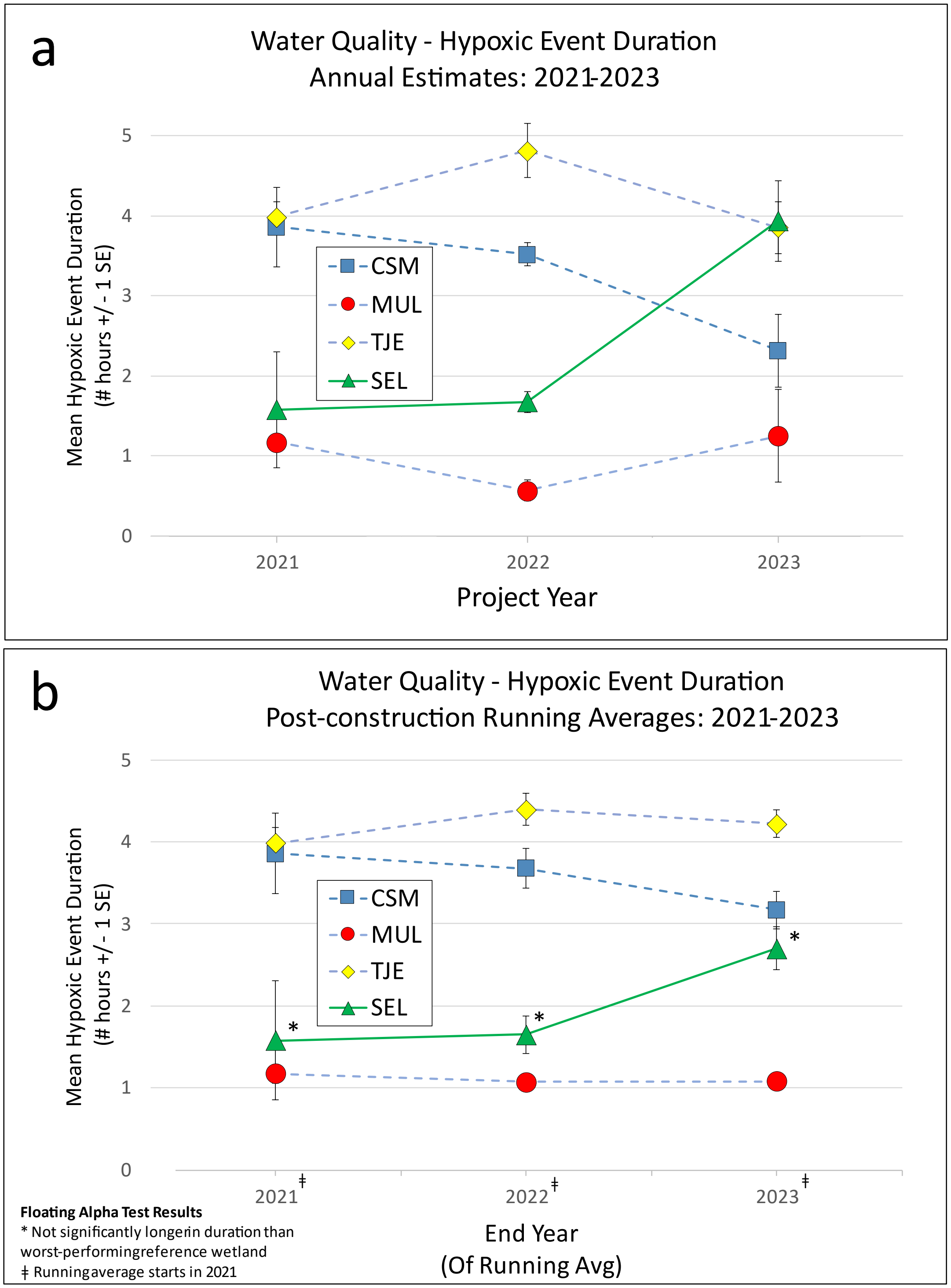
Year(s)	Mean Hypoxic Event Duration Post-construction Running Averages: # of Hours (+ - SE)			
2021 to 2023	Carpinteria Salt Marsh	Mugu Lagoon	Tijuana Estuary	San Elijo Lagoon
	3.17 (0.23)	**1.08 (0.10)**	**4.22 (0.17)**	**2.70 (0.27)**

7.4 DISCUSSION

The 2023 hypoxic event duration at San Elijo Lagoon was 3.94 hours, which was markedly higher than the 2021 and 2022 averages (1.58 hours and 1.68 hours, respectively) and was longer than the reference wetlands in 2023. Nonetheless, the 3-year running average hypoxic event duration at San Elijo Lagoon of 2.70 hours was not significantly longer than at Tijuana Estuary (the lowest performing reference wetland) (Table 7-2). The high average event duration at San Elijo Lagoon in 2023 was in part due to one event that was 83.25 hours in duration; however, the total time comprised by hypoxic events in 2023 at San Elijo Lagoon (1,008.25 hours) was also much greater than observed in 2021 or 2022 (134.25 and 362.00, respectively). The increase in duration and total amount of hypoxic events at San Elijo Lagoona relative to 2021 and 2022 could be attributed to the continued decrease in tidal range from 2021 to 2022, as discussed in Chapter 4 above.

These data represent the third year of water quality data post-construction and, therefore, cannot be used to evaluate the performance standards. However, the data provide an early indicator of how restoration has impacted water quality. This metric will continue to be monitored, and running averages will be generated for San Elijo Lagoon and the reference wetlands to quantitatively evaluate the performance standards.

Figure 7-1. 2021-2023 Mean Hypoxic Event Duration Post-construction Running Averages for San Elijo Lagoon and Reference Wetlands



CSM = Carpinteria Salt Marsh

This page intentionally left blank.

8. BENTHIC INVERTEBRATES

8.1 PERFORMANCE STANDARD

Benthic invertebrate community composition is a relative standard, which is used to compare the restored San Elijo Lagoon to similar measurements taken at reference wetlands. The relative performance standard will be considered met if the 4-year running average of the benthic invertebrate density and number of species at San Elijo Lagoon are not significantly worse than the mean value at the lowest performing reference wetland. Running averages are calculated for each year post-construction to provide an early indicator of San Elijo Lagoon's performance relative to the reference wetlands.

8.2 APPROACH

During the post-construction monitoring period, benthic invertebrate populations were sampled in the fall of 2023. Eighteen sampling stations were located in tidally influenced areas throughout the lagoon, with nine sampling stations located in main channels and nine sampling stations located in tidal channels. The sampling station locations are presented in the Monitoring Plan; while changes in channel topography and sedimentation may necessitate slight adjustments to the placement of the sampling stations over time, the locations remain generally consistent. Appendix E includes precise sampling locations for 2023. Of the 18 sampling stations, historical locations that were tidally influenced prior to construction activities in 2017 (i.e., main channel sampling stations 1 through 6 and tidal channel sampling stations 1 through 6) were incorporated into the overall monitoring summary and are used for performance standard evaluations. Performance standard analysis is conducted at the wetland level and is not separated by main channel or tidal channel locations. Benthic invertebrate data from the 12 sampling stations (six each at the main channel and tidal channel) at each reference wetland were, therefore, also combined to calculate wetland-level benthic invertebrate density and species richness. Locations east of I-5 (i.e., main channel and tidal channel sampling stations 7 through 9 shown in Appendix E) are considered contigency locations and are not included in the performance metric evaluations.

Benthic invertebrate sampling was conducted for both epifauna and infauna. Sampling consisted of counting individuals in quadrats and cores. Invertebrates captured during fish sampling were also counted for purposes of estimating species richness. Density was standardized to the number of individuals per 100 square cm (cm^2) for each quadrat/core and then averaged across quadrats/cores at a given sampling station. Species richness was standardized to the number of unique species per sampling location (i.e., quadrats and cores combined). Additionally, unique species of macroinvertebrates captured during the seine and enclosure trapping associated with the fish assemblage surveys are also included in the species richness metric; however, these species are not included in the invertebrate density metric. A complete description of survey methodology is in the Monitoring Plan.

8.3 RESULTS

Detailed summaries of the survey results for 2023 are provided in Appendix E.

Benthic Invertebrate Density

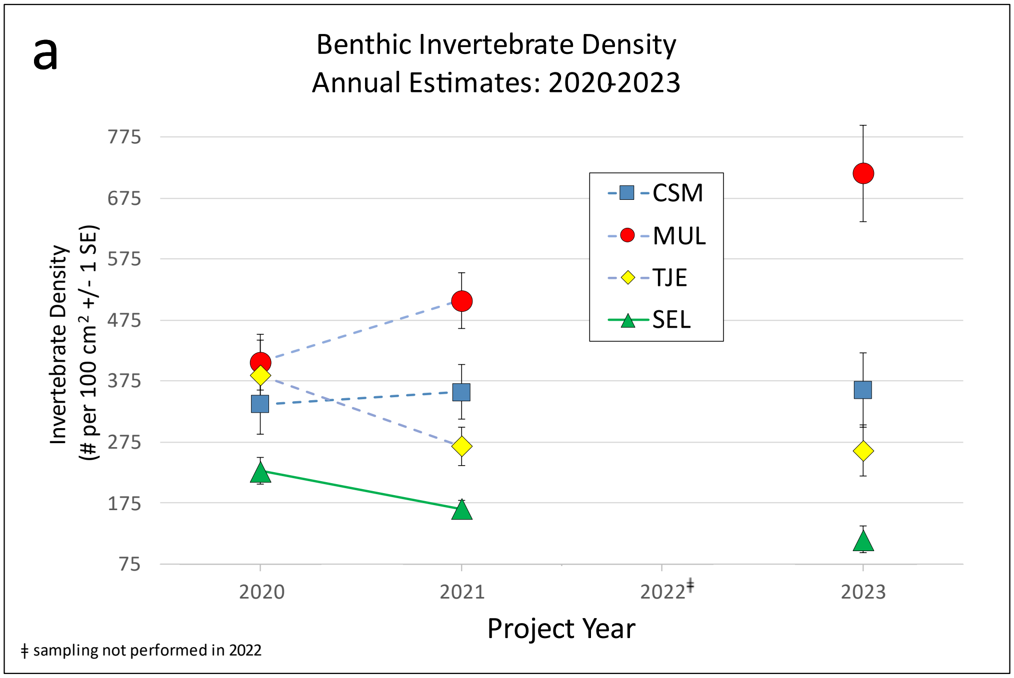
Post-construction annual estimates of benthic invertebrate density at San Elijo Lagoon and the three reference wetlands for 2023 are provided in Figure 8-1a. Post-construction running averages of benthic invertebrate density at San Elijo Lagoon and the reference wetlands for 2023 are provided in Figure 8-1b and Table 8-1. In 2023, the running average of benthic invertebrate density at San Elijo Lagoon (169.91 individuals/100 cm^2) was significantly lower than the lowest performing reference wetland (Tijuana Estuary at 304.47 individuals/cm^2) (Figure 8-1b).

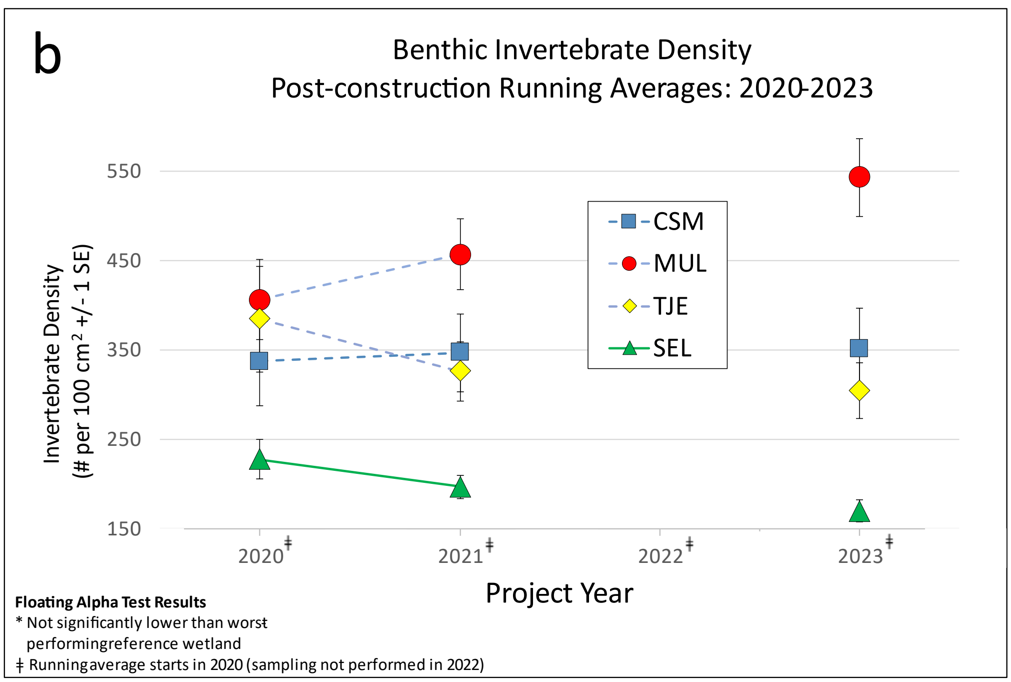
Table 8-1. 2023 Benthic Invertebrate Density Post-construction Running Averages for San Elijo Lagoon and Reference Wetlands

Year(s)	Sampling Station	Benthic Invertebrate Density Post-construction Running Average (# Individuals/100 cm^2)			
		Carpinteria Salt Marsh	Mugu Lagoon	Tijuana Estuary	San Elijo Lagoon
2020	MC1	217.93	235.41	236.42	127.68
	MC2	276.66	513.11	309.37	273.59
	MC3	317.03	439.21	356.38	187.70
	MC4	186.25	428.46	485.42	381.14
	MC5	319.75	434.91	56.00	254.14
	MC6	252.81	283.21	480.37	157.60
	TC1	308.64	348.92	155.60	283.77
	TC2	298.70	560.53	830.33	134.81
	TC3	250.08	606.98	380.57	185.68
	TC4	465.50	626.32	432.71	297.12
	TC5	834.14	133.65	581.19	182.78
	TC6	316.06	262.21	308.38	268.21
	Overall Average (SE)	**336.96 (49.41)**	**406.08 (45.14)**	**384.4 (58.62)**	**227.85 (22.17)**
2020–2021	MC1	172.59	295.38	339.23	125.70
	MC2	272.38	509.80	403.45	223.58
	MC3	287.17	450.68	287.28	226.68
	MC4	234.50	480.15	415.12	273.93
	MC5	319.85	506.35	146.08	219.13
	MC6	374.75	507.91	340.00	176.86
	TC1	281.89	390.08	141.78	257.00
	TC2	394.31	651.89	543.99	149.09
	TC3	283.20	493.29	327.65	141.27
	TC4	391.38	656.62	283.41	201.55
	TC5	776.97	175.30	421.24	174.38
	TC6	374.22	361.33	266.33	194.20
	Overall Average (SE)	**346.93 (43.68)**	**456.56 (39.57)**	**326.30 (33.04)**	**196.94 (13.21)**
2020-2023[1]	MC1	142.80	369.33	303.32	99.89
	MC2	239.68	560.61	323.49	181.16
	MC3	281.05	628.25	264.75	177.37
	MC4	244.37	595.48	358.29	222.69
	MC5	375.17	541.01	135.74	186.19
	MC6	434.74	436.72	422.10	142.35
	TC1	265.32	442.08	157.12	206.06
	TC2	425.27	653.30	522.74	117.32
	TC3	304.47	557.07	327.93	126.95
	TC4	290.22	907.43	218.51	181.78
	TC5	749.66	353.29	359.13	154.53
	TC6	467.59	470.77	260.48	242.63
	Overall Average (SE)	**351.7 (45.3)**	**542.95 (43.38)**	**304.47 (31.3)**	**169.91 (12.46)**

Notes: MC = main channel; TC = tidal channel
[1] Sampling was not performed in 2022; averages are based on 2020, 2021, and 2023.

Figure 8-1. 2020–2023 Benthic Invertebrate Density at San Elijo Lagoon and Reference Wetlands





Notes:

a. Annual estimates of benthic invertebrate density (+- SE) for San Elijo Lagoon (SEL) and reference wetlands (CSM = Carpinteria Salt Marsh; MUL = Mugu Lagoon; TJE = Tijuana Estuary). Appendix E includes complete data from 2020 and 2021.

b. Running average of benthic invertebrate density (+- SE) for SEL and reference wetlands (CSM, MUL, and TJE). Appendix E includes complete data from 2020 and 2021.

Benthic Invertebrate Species Richness

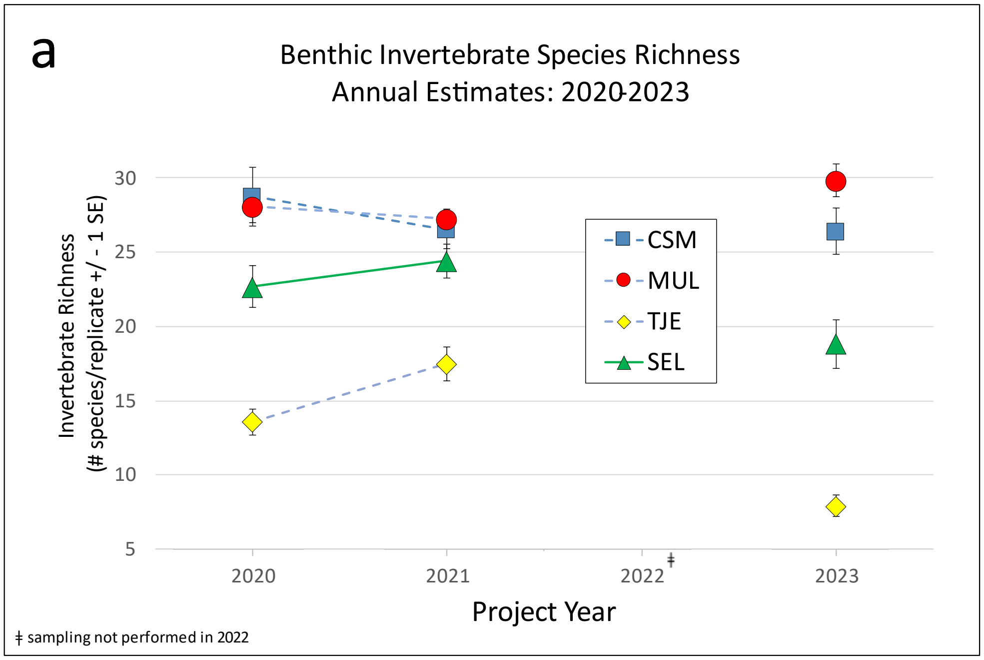
Post-construction annual estimates of benthic invertebrate species richness at San Elijo Lagoon and the three reference wetlands for 2023 are provided in Figure 8-2a. Post-construction running averages of benthic invertebrate species richness at San Elijo Lagoon and reference wetlands for 2023 are provided in Figure 8-2b and Table 8-2. In 2023, the running averages of benthic invertebrate species richness at San Elijo Lagoon were not significantly worse than the lowest performing reference wetland (Figure 8-2b).

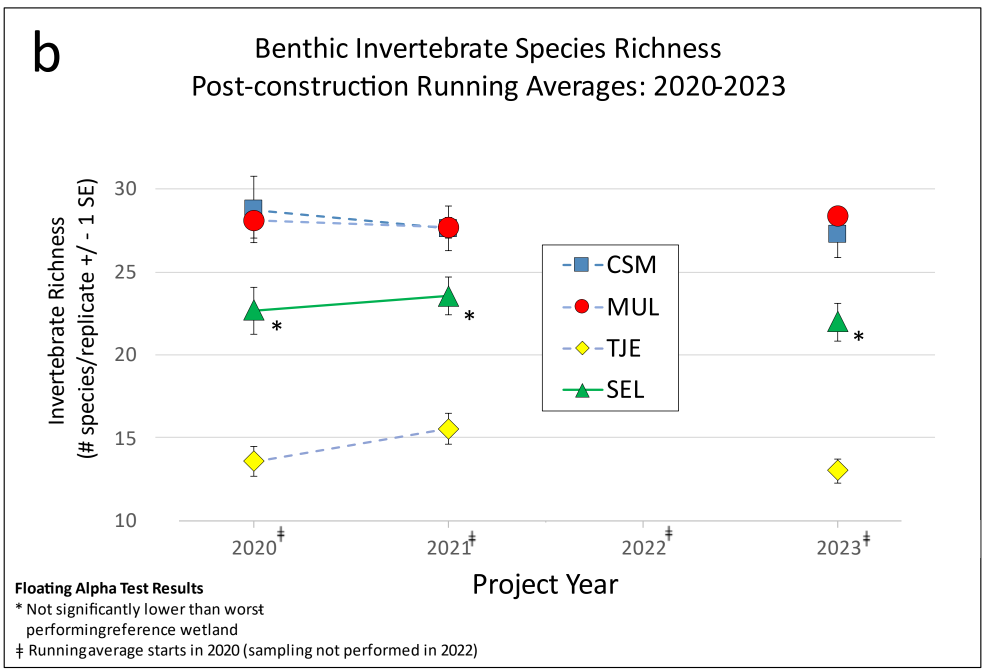
Table 8-2. 2020–2023 Benthic Invertebrate Species Richness Post-construction Running Averages for San Elijo Lagoon and Reference Wetlands

Year(s)	Sampling Station	Benthic Invertebrate Species Richness Post-construction Running Average (# Species/Location)			
		Carpinteria Salt Marsh	Mugu Lagoon	Tijuana Estuary	San Elijo Lagoon
2020	MC1	27.00	34.00	20.00	25.00
	MC2	40.00	24.00	13.00	25.00
	MC3	28.00	26.00	16.00	22.00
	MC4	29.00	25.00	13.00	30.00
	MC5	30.00	31.00	11.00	18.00
	MC6	27.00	33.00	14.00	22.00
	TC1	41.00	24.00	18.00	20.00
	TC2	18.00	29.00	13.00	24.00
	TC3	31.00	25.00	12.00	27.00
	TC4	30.00	29.00	12.00	13.00
	TC5	26.00	25.00	9.00	18.00
	TC6	18.00	32.00	12.00	28.00
	Overall Average (SE)	**28.75 (2.00)**	**28.08 (1.07)**	**13.58 (0.88)**	**22.67 (1.40)**
2020–2021	MC1	25.00	31.00	20.50	26.00
	MC2	34.50	24.50	17.00	26.00
	MC3	29.00	27.50	19.00	25.00
	MC4	28.50	27.50	13.00	27.50
	MC5	29.00	29.50	14.50	19.00
	MC6	30.50	29.50	16.00	24.00
	TC1	32.50	28.00	20.50	24.00
	TC2	20.50	28.00	15.50	25.00
	TC3	27.00	24.50	13.00	25.00
	TC4	30.50	27.00	12.50	15.50
	TC5	26.50	25.00	10.00	17.50
	TC6	18.00	30.00	15.00	28.00
	Overall Average (SE)	**27.63 (1.36)**	**27.67 (0.62)**	**15.54 (0.94)**	**23.54 (1.16)**
2020–2023[1]	MC1	23.67	30.00	18.00	24.33
	MC2	32.67	27.33	14.00	25.33
	MC3	28.67	30.00	14.33	24.00
	MC4	28.67	26.33	10.67	24.33
	MC5	29.33	30.33	13.00	17.00
	MC6	30.67	29.33	13.67	21.00
	TC1	32.00	27.67	15.00	24.67
	TC2	19.00	27.33	13.33	23.00
	TC3	29.33	27.33	11.33	26.33
	TC4	27.67	27.33	10.67	14.67
	TC5	26.33	25.67	8.67	15.33
	TC6	18.67	32.00	13.33	23.67
	Overall Average (SE)	**27.22 (1.33)**	**28.39 (0.55)**	**13 (0.7)**	**21.97 (1.17)**

[1] Sampling was not performed in 2022; averages are based on 2020, 2021, and 2023.

Figure 8-2. 2020–2023 Benthic Invertebrate Species Richness at San Elijo Lagoon and Reference Wetlands





Notes:

a. Annual estimates of benthic invertebrate species richness (+- SE) for SEL and reference wetlands (CSM, MUL, and TJE). Appendix E includes complete data from 2020 and 2021.

b. Running average of benthic invertebrate species richness (+- SE) for SEL and reference wetlands (CSM, MUL, and TJE). Appendix E includes complete data from 2020 and 2021.

8.4 DISCUSSION

Benthic invertebrate communities are expected to take several years to establish following restoration. Sampling from Years 0, 1, and 3 is intended to provide data points to see where benthic invertebrate recovery is starting from. The post-construction benthic invertebrate populations are expected to remain relatively low due to dredging activities, at least for the short term. As tidal flow improves and vegetation returns, the habitat at San Elijo Lagoon should become more heterogeneous and should support a greater number of benthic invertebrate species. Benthic invertebrate sampling will resume in 2025, and the results will be published in the 2025 Annual Monitoring Report.

9. SEDIMENTS

9.1 PERFORMANCE STANDARD

Sediment quality information is being collected for information only and does not have a specific associated performance standard. In the event benthic invertebrate populations or water quality performance standards are not met, sediment quality information will be used to help identify whether there is continued presence of historical high-nutrient sediments and/or whether they continue to affect metrics with performance standards. Monitoring for grain size is also supplemental to nutrients and may be referenced for adaptive management actions if nutrient levels appear improved, but benthic invertebrate populations are not establishing as anticipated.

9.2 APPROACH

Post-construction sampling for sediment quality will continue until water quality and benthic invertebrate performance standards have been met. In the fall of 2023, sediment samples were collected from the upper, middle, and lower tidal elevations at the same 18 sampling stations where invertebrate communities were assessed. The locations of the sampling stations are presented in the Monitoring Plan; while changes in channel topography and sedimentation may necessitate slight adjustments to the placement of the sampling stations over time, the locations are generally consistent with the originals. Total nitrogen (TN), total organic carbon (TOC), and sediment grain size were analyzed. TN and TOC are reported as percentages by dry weight basis of the dried sediment samples. A complete description of survey methodology is in the Monitoring Plan.

9.3 RESULTS

The 2023 soil reports are provided in Appendix F. In 2023, TOC ranged from 0.11% to 2.43% and averaged 0.94%. In 2023, TN was moderate at 0.09% on average (ranged from 0.07 % to 0.11%). In 2023, the soil textures ranged from medium sand to silt; the average soil texture was silt, and sand was mostly fine to very fine.

9.4 DISCUSSION

The results above are for contextual information in interpreting the other performance standards, such as water quality and benthic invertebrates, that are part of the monitoring requirements of the restoration. The average distribution of sediment grain sizes and the composition of TOC and TN between the tidal channel and the main channel were similar.

This page intentionally left blank.

10. FISH

10.1 PERFORMANCE STANDARD

Fish community composition is a relative standard, which is used to compare the restored San Elijo Lagoon to similar measurements taken at reference wetlands. The relative performance standard will be considered met if the 4-year running average of fish density and number of species at San Elijo Lagoon are not significantly worse than the mean value at the lowest performing reference wetland. Running averages are calculated for each year post-construction to provide an early indicator of San Elijo Lagoon's performance relative to the reference wetlands.

10.2 APPROACH

Fish habitat established by restoration efforts was primarily composed of shallow subtidal channels. Intertidal channels are expected to evolve and can be added to the post-construction monitoring program upon their development. For the purposes of this monitoring program, fish monitoring in the main channel/basins habitats was confined to shallow (-1.5 to -3.6 feet National Geodetic Vertical Datum of 1929) subtidal habitats. Fish measurements were collected in the fall of 2023 to avoid nesting activities of the federally endangered LFRR. Fish data were collected using two methods: seining and enclosure traps. The locations of the sampling stations are presented in the Monitoring Plan; while changes in channel topography and sedimentation may necessitate slight adjustments to the placement of the sampling stations over time, the locations are generally consistent with the originals. Appendix E includes precise sampling locations for 2023. Of the 18 sampling stations, historical locations that were tidally influenced prior to construction activities in 2017 (i.e., main channel sampling stations 1 through 6 and tidal channel sampling stations 1 through 6) were incorporated into the overall monitoring summary and are used for performance standard evaluations. Performance standard analysis is conducted at the wetland level and is not separated by main channel or tidal channel locations. Fish data from the six main channel and six tidal channel locations were combined to calculate overall fish density and species richness values for San Elijo Lagoon and for each of the reference wetlands. Locations east of I-5 (i.e., main channel and tidal channel sampling stations 7 through 9 shown in Appendix E) are considered contingency locations and are not included in the performance metric evaluations.

Density was standardized to number of individuals per m^2 for both seining and enclosure trap data. Species richness was standardized to the number of unique species per sampling location. The averages for enclosures and seines are summed to produce a combined estimate of total density (average number per m^2) for each sampling location. A complete description of survey methodology is in the Monitoring Plan.

10.3 RESULTS

A detailed summary of the survey results for 2023 is provided in Appendix E.

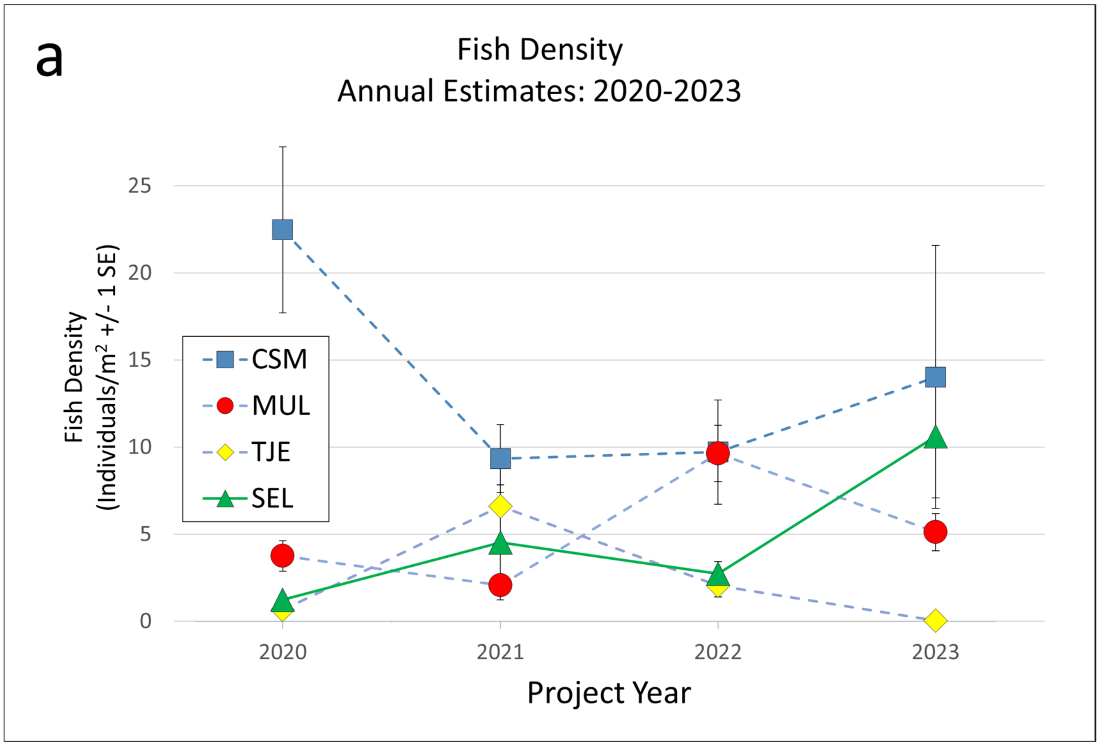
Fish Density

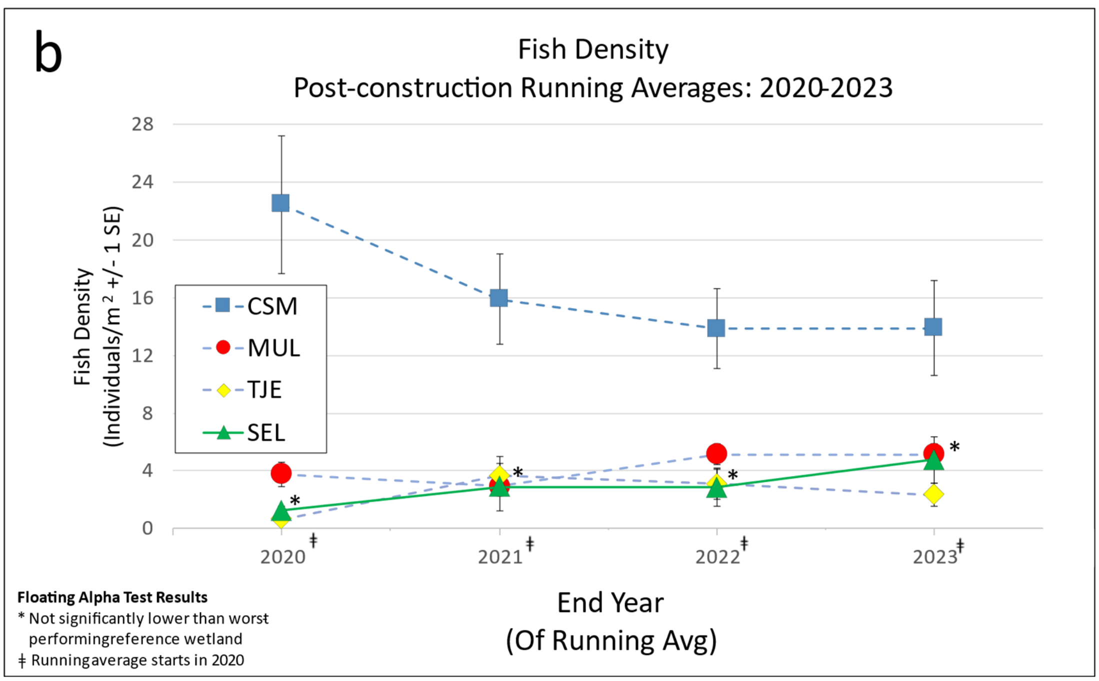
Post-construction annual estimates of fish density at San Elijo Lagoon and the three reference wetlands for 2023 are provided in Figure 10-1a. Post-construction running averages of fish density at San Elijo Lagoon and reference wetlands for 2023 are provided in Figure 10-1b and Table 10-1. In 2023, the running average of fish density at San Elijo Lagoon was not significantly worse than the lowest performing reference wetland (Figure 10-1b).

Table 10-1. 2020–2023 Fish Density Post-construction Running Averages for San Elijo Lagoon and Reference Wetlands

Year(s)	**Sampling Station**	**Fish Density Post-construction Running Average (# Individuals/m^2)**			
		Carpinteria Salt Marsh	Mugu Lagoon	Tijuana Estuary	San Elijo Lagoon
2020–2023	MC1	1.81	10.51	2.07	18.97
	MC2	4.82	3.02	1.67	9.62
	MC3	11.12	3.48	5.75	1.31
	MC4	14.35	5.03	0.73	1.17
	MC5	6.58	5.33	1.44	0.80
	MC6	11.87	1.74	0.97	0.67
	TC1	8.20	5.55	9.91	1.26
	TC2	44.16	3.27	1.66	7.31
	TC3	16.41	3.49	0.76	9.11
	TC4	5.19	8.71	0.59	2.81
	TC5	24.46	5.92	1.97	2.19
	TC6	17.68	5.68	0.50	2.07
	Overall Average (SE)	13.89 (3.31)	5.14 (0.72)	2.34 (0.8)	4.77 (1.6)

Figure 10-1. 2020–2023 Fish Density at San Elijo Lagoon and Reference Wetlands





Notes:
a. Annual estimates of fish density (+- SE) for SEL and reference wetlands (CSM, MUL, and TJE). Appendix E includes complete data from 2023.
b. Running average of fish density (+- SE) for SEL and reference wetlands (CSM, MUL, and TJE). Appendix E includes complete data from 2023.

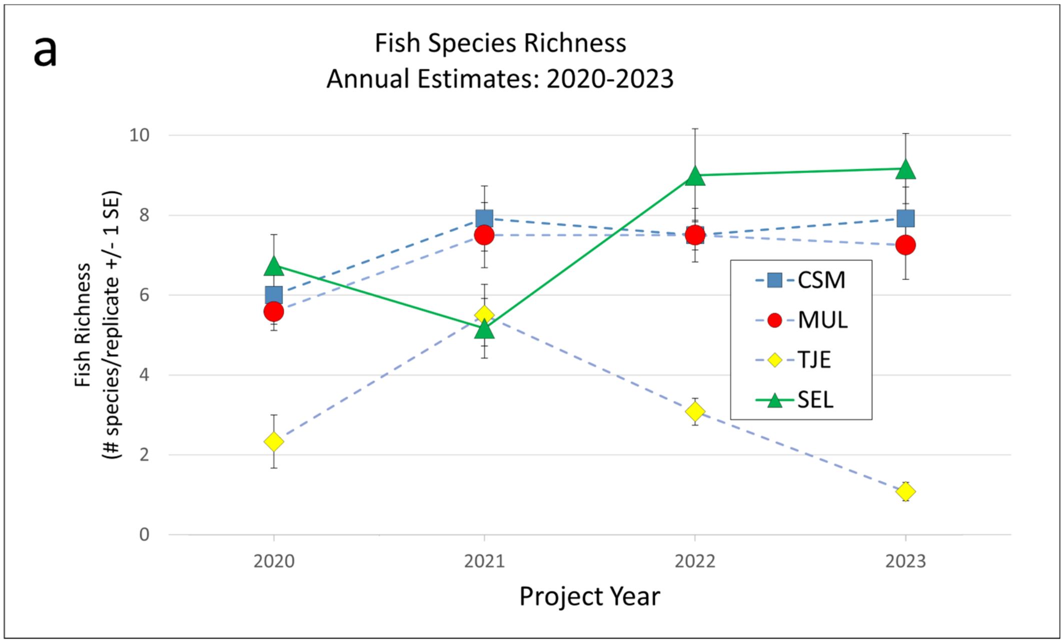
Fish Species Richness

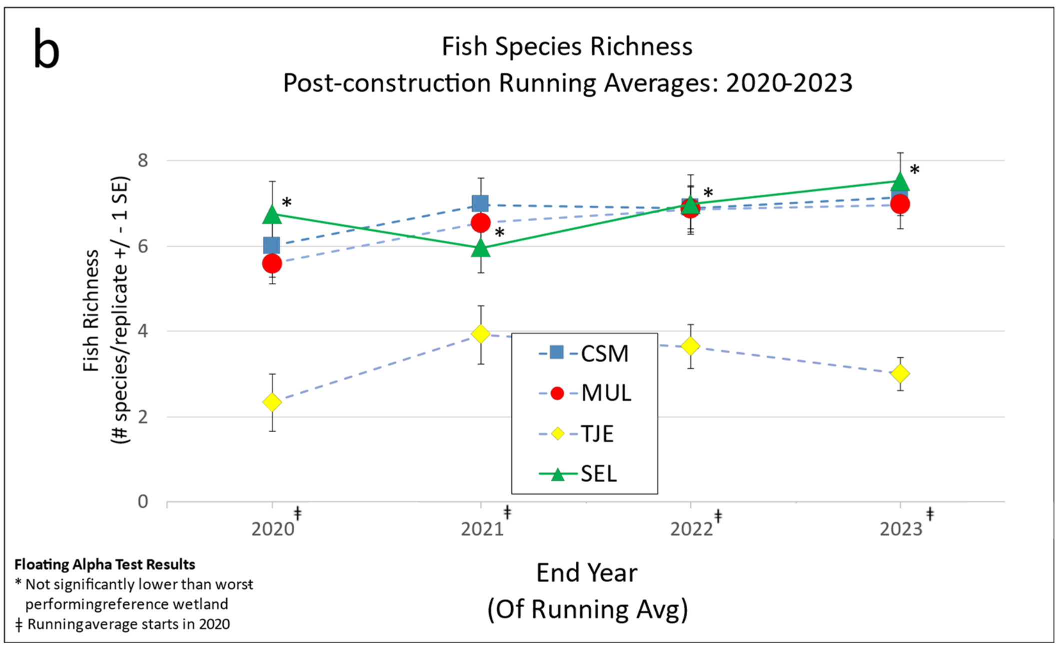
Post-construction annual estimates of fish species richness at San Elijo Lagoon and the three reference wetlands for 2023 are provided in Figure 10-2a. Post-construction running averages of fish species richness at San Elijo Lagoon and reference wetlands for 2023 are provided in Figure 10-2b and Table 10-2. In 2023, the running average of fish species richness at San Elijo Lagoon was not significantly worse than the lowest performing reference wetland (Figure 10-2b). Fish species richness annual estimates were highest at San Elijo Lagoon in 2023 compared to the reference wetlands (Figure 10-2a).

Table 10-2. 2020–2023 Fish Species Richness Post-construction Running Averages for San Elijo Lagoon and Reference Wetlands

Year(s)	Sampling Station	Fish Species Richness Post-construction Running Average (# Species/Location)			
		Carpinteria Salt Marsh	Mugu Lagoon	Tijuana Estuary	San Elijo Lagoon
2020–2023	MC1	6.75	5.25	4.50	11.00
	MC2	7.75	5.00	3.50	11.00
	MC3	7.00	8.50	2.50	7.50
	MC4	6.50	6.00	2.50	6.75
	MC5	7.00	6.75	3.50	5.25
	MC6	7.50	5.50	2.25	5.25
	TC1	9.00	8.00	6.50	6.00
	TC2	7.50	5.75	2.50	9.00
	TC3	6.25	7.25	2.00	10.00
	TC4	5.00	12.00	2.25	4.75
	TC5	10.25	7.25	2.25	5.70
	TC6	5.25	6.25	1.75	8.00
	Overall Average (SE)	**7.15 (0.42)**	**6.96 (0.56)**	**3.00 (0.39)**	**7.52 (0.66)**

Figure 10-2. 2020–2023 Fish Species Richness at San Elijo Lagoon and Reference Wetlands





Notes:
a. Annual estimates of fish species richness (+- SE) for SEL and reference wetlands (CSM, MUL, and TJE). Appendix E includes complete data from 2023.
b. Running average of fish species richness (+- SE) for SE) and reference wetlands (CSM, MUL, and TJE). Appendix E includes complete data from 2023.

10.4 DISCUSSION

Fish Density

Fish density post-construction running averages at San Elijo Lagoon increased from 2.83 individuals/m^2 in 2022 to 4.77 individuals/m^2 in 2023 while the density at Tijuana Estuary decreased from 3.09 individuals/m^2 in 2022 to 2.34 individuals/m^2 over the same period (Figure 10-1b), making Tijuana Estuary the lowest performing of the reference wetlands in 2023. Based on results of the floating alpha comparison, the post-construction running average of fish density at San Elijo Lagoon was not signficantly worse than that observed at Tijuana Estuary. The performance standard for fish density is formally met in 2023 for the first time because the 2023 running average is the first to be composed of 4 years of fish density data (2020 to 2023).

Fish Species Richness

Fish species richness at San Elijo Lagoon increased slightly from 9.00 species/replicate in 2022 to 9.17 species/replicate in 2023 while the density at Tijuana Estuary decreased from 3.08 species/replicate in 2022 to 1.08 species/replicate over the same period (Figure 10-1a), making Tijuana Estuary the lowest performing of the reference wetlands in 2023. As a result, San Elijo Lagoon had the highest running average in 2023 (7.52 species/replicate) and Tijuana Estuary had the lowest running average (1.75 species/replicate). Based on results of the floating alpha comparison, the post-construction running average of fish species richness at San Elijo Lagoon was not signficantly worse than observed at Tijuana Estuary. The performance standard for fish species richness is formally met in 2023 for the first time because the 2023 running average is the first to be composed of 4 years of fish density data (2020 to 2023).

Over the 4 years of post-construction surveys, San Elijo Lagoon has had the highest fish species richness of all reference wetlands in 3 of the 4 years of post-construction surveys, while Tijuana Estuary has had the lowest annual average in 3 of the 4 years. Annual fish species richness estimates at San Elijo Lagoon have shown a trend to increase during this time, reaching a peak of 9.17 species/replicate in 2023 (Figure 10-2a).

11. BIRDS

11.1 BREEDING MARSH BIRDS

11.1.1 Performance Standard

The monitoring of breeding marsh birds is a "pre-restoration absolute" monitoring variable and is not compared to reference wetlands for purposes of determining success of the SELRP. Pre-construction data and construction/post-construction data metrics are compared using the floating alpha method described in Sections 2.1.2 and 2.2.2 of the Monitoring Plan. Performance standards for LFRR are provided below.

> **Interim standard**: Construction/post-construction 4-year running average density and number of individuals 75% or greater than that of pre-construction survey data (2016, 2017) by Year 7 post-construction

> **Final standard**: Construction/post-construction 4-year running average density and number of individuals 95% or greater than that of pre-construction survey data (2016, 2017) by Year 10 post-construction

Running averages are used to account for annual population variability. Standards will not be considered met until the performance standards are met for 3 consecutive years, as described in the Monitoring Plan. Data on five other "focal" marsh bird species are presented to provide additional insight into the health and condition of the lagoon but are not assessed as part of the performance standards.

11.1.2 Approach

The focus of these surveys is to estimate density and abundance for the federally and state endangered LFRR. The objective of the LFRR surveys is to provide a replicable survey method that can act as a reliable abundance index to monitor for changes in the LFRR population size in San Elijo Lagoon over time. An additional five "focal" marsh bird species that are generally considered wetland specialists were also recorded, if present: Virginia rail, least bittern, American bittern, common gallinule, and pied-billed grebe. The focal bird species results are intended to provide an index of relative abundance of key marsh bird species other than LFRR. These other focal bird species have utility as indicator species for assessing wetland ecosystem quality (Conway 2011) and even though they are not included in the performance standards, their continued presence will be another gauge of project success.

Breeding marsh bird surveys were conducted from March 16 through June 9, 2023. LFRR data were collected within a 200-meter radius of survey points using independent double-observer methods (Nichols et al. 2000).

Detailed information regarding the approach and the results of avian monitoring for 2023 are included in Appendix G.

11.1.2.1 Light-footed Ridgway's Rail

An independent double-observer survey approach (Nichols et al. 2000) was used for surveys, meaning two ornithologists were present for each survey, and the two ornithologists recorded data independently of each other. The double-observer approach allows for estimation of detection probabilities between observers and improves overall detection probabilities to yield more precise estimates of abundance than if a single observer were used. Detection probabilities were estimated from each of the six surveys conducted from mid-March through early June of 2023 to derive LFRR estimates and abundance values. LFRR abundance and the associated 95% upper and lower confidence limits were calculated separately for each of the six surveys, using a closed mark-recapture model (Huggins 1991). Model-averaging was used to generate LFRR estimates and confidence intervals (CIs) for 2016 through 2023 in this 2023 Annual Monitoring Report.

Survey Area Density Estimates

Annual LFRR survey area density estimates were calculated by dividing the model-generated estimate of LFRR abundance in the survey area by the total acreage of "preferred" habitat in the survey area for each year, as described in Appendix G.

Lagoon-wide Abundance Estimates

To estimate the LFRR population size for the lagoon (i.e., lagoon-wide abundance estimate), including both surveyed and unsurveyed areas, LFRR density estimates and associated CIs were multiplied by the total acreage of preferred habitat across the lagoon, as described in Appendix G.

11.1.2.2 Other Focal Marsh Bird Species

Results for five other species of marsh birds are provided as the average number of individuals detected per survey. There was an insufficient number of detections for these other species to generate modeled estimates of abundance. For this reason, raw numbers of detected individuals are presented as an index reflecting relative abundance.

11.1.3 Results

Detailed summaries of the survey dates, survey times, survey personnel, and weather conditions for 2023 are provided in Appendix G.

11.1.3.1 Light-footed Ridgway's Rail

Survey Area Density Estimates

The locations of LFRR detections from the 2023 surveys are depicted in Appendix G. Based on results from the Huggins (1991) model, LFRR survey area density estimates for each of the six surveys conducted annually in 2020 to 2023 are presented in Table 11-1 with associated model-generated 95% CIs. Values represent the estimated number of individuals per acre of preferred habitat in the survey area. Average pre-construction baseline period LFRR density estimates are also presented for the surveys conducted in 2016 and 2017, as well as the 4-year construction/post-construction average.

Table 11-1. Summary of Survey Area Density Estimates for the Light-Footed Ridgway's Rail

Survey Number	LFRR Survey Area Density Estimates; # Individuals/Acre					
	2016–2017 Baseline Estimate[1]	2020 Estimate (95% CI)[2]	2021 Estimate (95% CI)[2]	2022 Estimate (95% CI)[2]	2023 Estimate (95% CI)[2]	4-year Construction/ Post-construction Running Average[3]
1	0.25	0.33 (0.31 to 0.35)	0.28 (0.27 to 0.29)	0.18 (0.17 to 0.18)	0.28 (0.27 to 0.28)	0.27
2	0.22	0.22 (0.22 to 0.22)	0.29 (0.27 to 0.3)	0.18 (0.17 to 0.18)	0.27 (0.26 to 0.27)	0.24
3	0.23	0.22 (0.21 to 0.23)	0.25 (0.25 to 0.26)	0.08 (0.07 to 0.08)	0.13 (0.13 to 0.14)	0.17
4	0.21	0.12 (0.11 to 0.12)	0.17 (0.16 to 0.18)	0.04 (0.04 to 0.05)	0.08 (0.07 to 0.08)	0.10
5	0.17	0.12 (0.12 to 0.12)	0.23 (0.23 to 0.24)	0.05 (0.05 to 0.06)	0.14 (0.13 to 0.14)	0.14
6	0.18	0.25 (0.24 to 0.26)	0.27 (0.26 to 0.28)	0.07 (0.07 to 0.08)	0.06 (0.06 to 0.06)	0.16
Overall Mean (95% CI)[4]	**0.21 (0.18 to 0.23)**	**0.21 (0.14 to 0.28)**	**0.25 (0.22 to 0.28)**	**0.10 (0.05 to 0.15)**	**0.16 (0.08 to 0.23)**	**0.18 (0.13 to 0.23)**

Notes:
[1] 2016 and 2017 pre-construction baseline averages from the SELRP baseline monitoring report (AECOM 2020a).
[2] Density estimates and 95% CIs for surveys 1 through 6 were calculated by dividing the model-generated LFRR abundance estimates (and associated confidence limits) in the survey area by the amount of preferred habitat in the survey area. Appendix G presents the acreage for each year.
[3] The six survey-specific density estimates in these columns were calculated as the mean of 2020 through 2023 density estimates and lack model-generated confidence limits.
[4] Overall mean estimates in this row were calculated as the mean of the six survey-specific estimates. Confidence limits for 95% CIs calculated as mean estimate +/- 1.96 times SE of the six estimates.

The 4-year construction/post-construction running average from 2020 to 2023 was 0.18 individuals/acre, which was lower than the pre-construction baseline average, and represented an increase from the previous 4-year running average by 0.01 individuals/acre (Table 11-1, Figure 11-1a, and Figure 11-1b). Results from the floating alpha testing method indicated the 4-year construction/post-construction running average was not significantly lower than the 75% of the pre-construction baseline mean or the 95% of the pre-construction baseline mean. Thus, as with 2021, both the interim and final performance standards were met for LFRR density, whereas only the interim performance standard was met in 2022 (Figure 11-1b).

Lagoon-wide Abundance Estimates

The lagoon-wide LFRR abundance estimate in 2023 was 42.48 individuals (Table 11-2) which was slightly lower than the 4-year construction/post-construction running average of 46.51 individuals (95% CI: 33.62 to 59.39) and markedly lower than the baseline average of 62.98 individuals (95% CI: 55.54–70.42) (Table 11-2). The 2023 lagoon-wide abundance estimate was the third lowest annual estimate of the 7-year project, and was about halfway between the lowest annual estimate of 26.70 individuals in 2022, and the baseline period average of 62.98 individuals (Table 11-2; Figure 11-2a and Figure 11-2b). Results from the floating alpha testing method indicated the 4-year lagoon-wide running average was not significantly lower than 75% of the pre-construction baseline mean, but was signficantly lower than 95% of the pre-construction baseline mean (Figure 11-2b). Therefore, as in 2021 and 2022 the interim performance standard was met for this metric, but the final performance standard was not for 2023.

Figure 11-1. LFRR Density Performance Standards Test Results

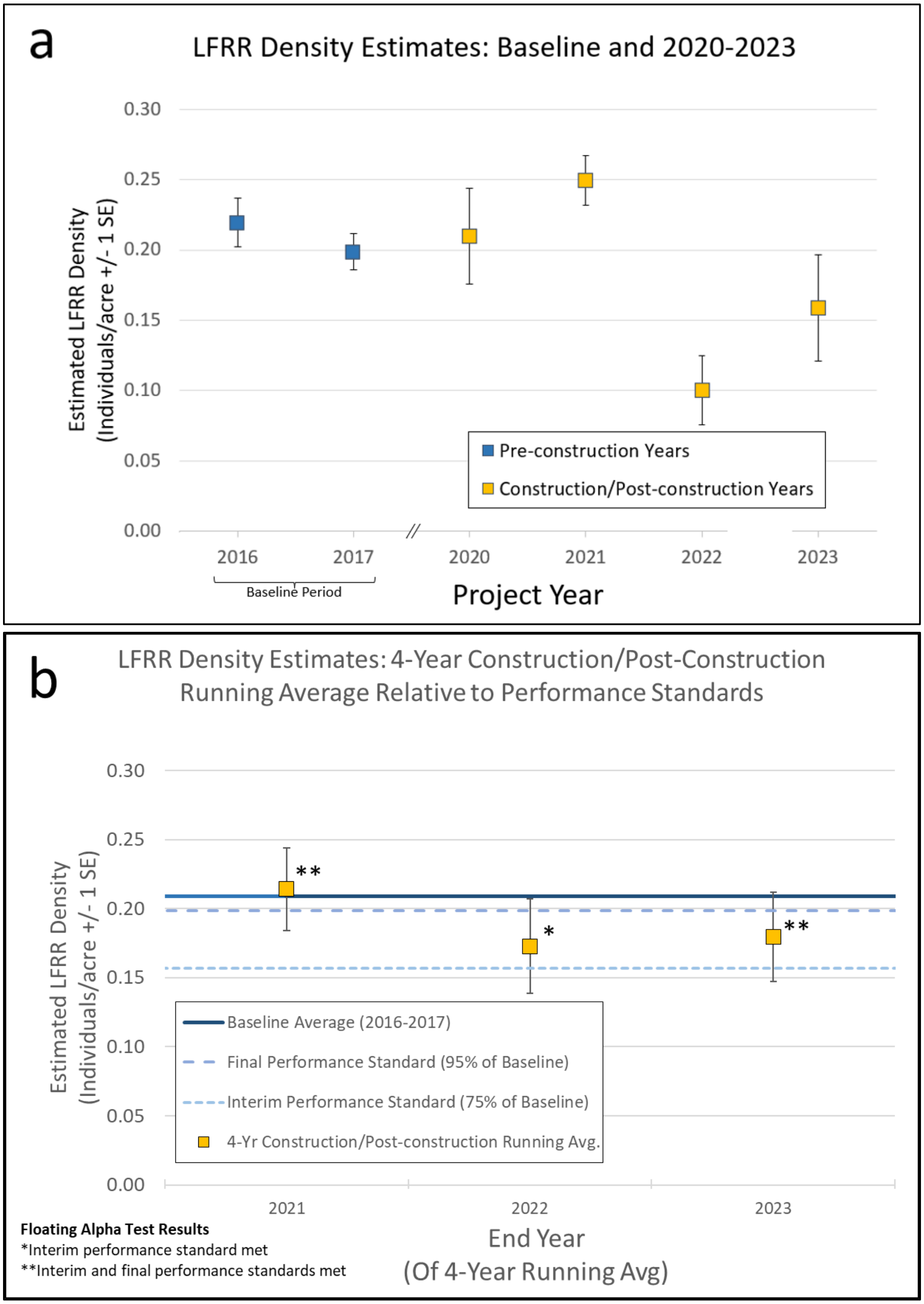
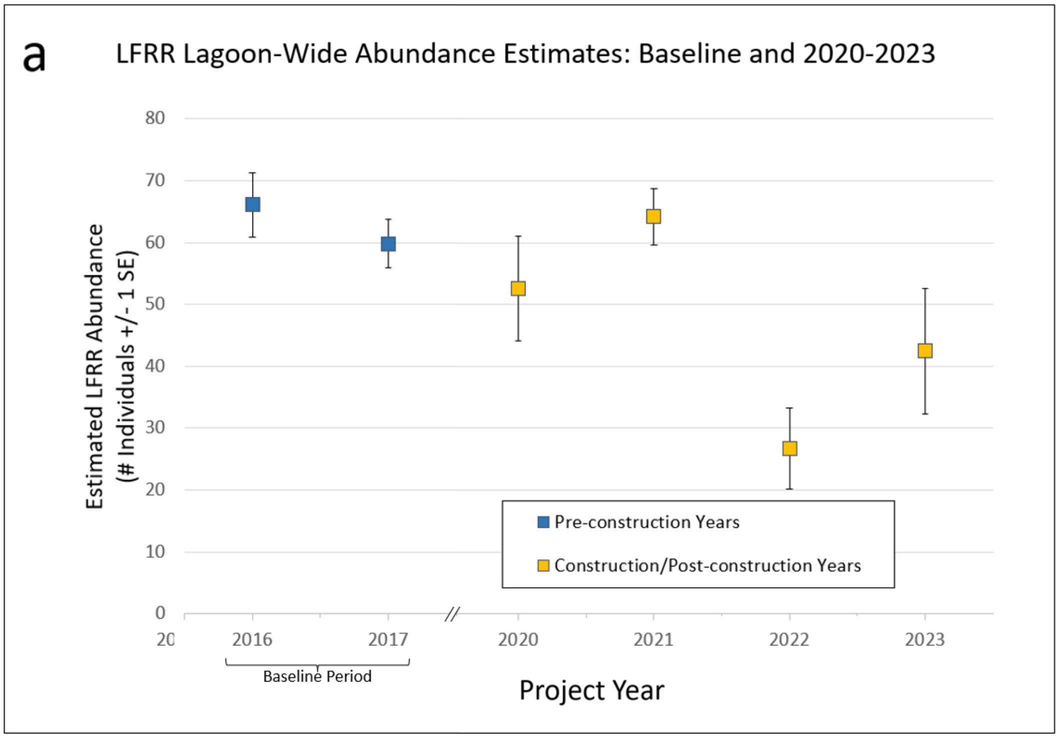


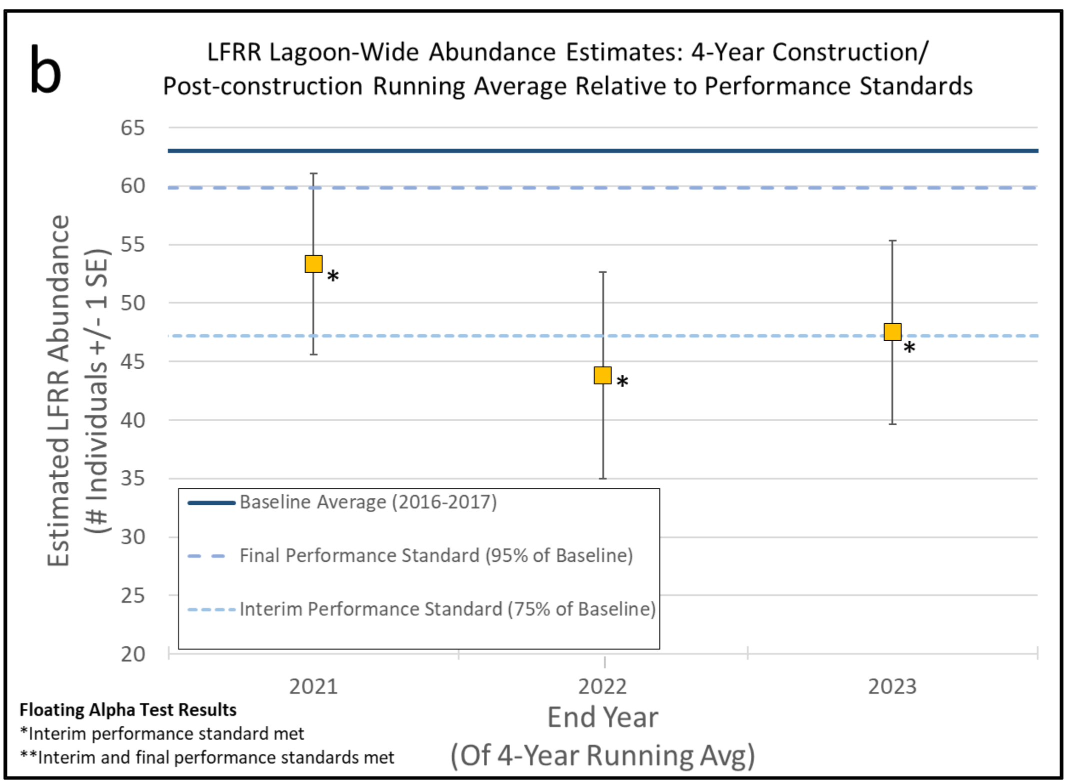
Table 11-2. Summary of Lagoon-wide Abundance Estimates for the Light-Footed Ridgway's Rail

Survey Number	LFRR Lagoon-wide Abundance Estimates					
	2016–2017 Baseline Estimate[1]	2020 Estimate (95% CI)[2]	2021 Estimate (95% CI)[2]	2022 Estimate (95% CI)[2]	2023 Estimate (95% CI)[2]	4-year Construction/Post-construction Running Average[3]
1	75.06	83.24 (78.87 to 87.62)	71.79 (69.44 to 74.15)	46.94 (44.98 to 48.90)	74.15 (72.22 to 76.08)	69.03
2	66.38	55.28 (54.32 to 56.25)	73.97 (70.28 to 77.66)	46.93 (44.98 to 48.88)	71.08 (68.78 to 73.37)	61.82
3	68.79	55.87 (53.48 to 58.27)	65.25 (63.04 to 67.47)	21.05 (19.74 to 22.36)	35.5 (34.09 to 36.91)	44.42
4	63.13	29.31 (28.44 to 30.18)	44.02 (42.28 to 45.76)	11.33 (10.40 to 12.26)	20.96 (19.95 to 21.97)	26.40
5	49.91	29.21 (28.92 to 29.50)	60.14 (58.41 to 61.88)	14.56 (13.51 to 15.62)	37.07 (35.74 to 38.39)	35.25
6	54.60	63.05 (59.56 to 66.54)	69.94 (68.00 to 71.89)	19.42 (18.19 to 20.65)	16.13 (15.21 to 17.05)	42.14
Overall Mean (95% CI)[4]	**62.98 (55.54 to 70.42)**	**52.66 (36.05 to 69.28)**	**64.19 (55.34 to 73.03)**	**26.70 (13.86 to 39.54)**	**42.48 (22.7 to 62.26)**	**46.51 (33.62 to 59.39)**

Notes:
[1] 2016 and 2017 pre-construction baseline averages from the SELRP baseline monitoring report (AECOM 2020a).
[2] Lagoon-wide abundance estimates and 95% CIs for surveys 1 through 6 were calculated by multiplying the model-generated LFRR density estimates for each year/survey (and associated confidence limits) by the amount of suitable preferred habitat across the lagoon that year. Appendix G includes the acreage for each year.
[3] The six survey-specific density estimates in these columns were calculated as the mean of 2020 through 2023 density estimates and lack model-generated confidence limits.
[4] Overall mean estimates in this row were calculated as the mean of the six survey-specific estimates. Confidence limits for 95% CIs calculated as mean estimate +/- 1.96 times SE of the six estimates.

Figure 11-2. LRFR Abundance Performance Standards Test Results





11.1.3.2 Other Focal Marsh Bird Species

As stated above, the focal marsh bird data represent the number of detections in the survey area and are not adjusted for the amount of suitable habitat or extrapolated to provide an estimate of the lagoon-wide abundance. Detections of focal marsh bird species recorded during the survey efforts are included in Table 11-3. On average, Virginia rails were the most commonly detected of the non-LFRR focal marsh bird species during the 2023 surveys, as has been the case for every year. There were no least bittern detections for the third consecutive year, but there was a common gallinule detection, which was the first since 2017. Other focal marsh bird species exhibited inter-annual variation, but the numbers were relatively consistent over time. The overall 2023 average of 13.67 individuals/survey is higher than the baseline period average of 10.00 individuals/survey (Table 11-3).

Table 11-3. Survey Detections of Other Focal Marsh Bird Species

Focal Species Common Name	Average Number Detected per Survey (Standard Error)				
	2016–2017 Baseline[1]	2020[2]	2021[2]	2022[1]	2023[1]
Virginia Rail	6.00 (1.41)	6.83 (1.58)	5.50 (1.82)	6.17 (2.66)	9.00 (1.48)
Least Bittern	0.33 (0.17)	0.17 (0.17)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
American Bittern	0.75 (0.48)	2.33 (0.71)	0.83 (0.48)	0.50 (0.22)	1.33 (0.61)
Common Gallinule	0.08 (0.08)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.17 (0.17)
Pied-billed Grebe	1.75 (0.38)	1.83 (0.70)	2.33 (0.42)	2.50 (1.02)	3.17 (1.11)
All Species[3]	**10.00 (2.49)**	**11.17 (2.80)**	**8.67 (1.65)**	**9.17 (3.38)**	**13.67 (3.38)**

Notes:
[1] 2016 and 2017 pre-construction baseline averages from the SELRP baseline monitoring report (AECOM 2020a)
[2] Mean and SE for 2019 to 2022 averages were calculated from the number of individuals detected during the six surveys.
[3] Values are based on the survey-specific totals (number of individuals of all focal species) detected for surveys 1 through 6 in each year or combination of years.

11.1.4 Discussion

As marsh bird surveys continue to be conducted during the post-construction phase of the project, a running average will be calculated for the 4 most recent years of construction/post-construction surveys and compared to the pre-construction baseline abundance levels to evaluate performance standards as described in the Monitoring Plan.

11.1.4.1 Light-footed Ridgway's Rail

The 2023 LFRR data yielded a density estimate of 0.16 individuals/acre. The 4-year construction/post-construction running average of 0.18 individuals/acre was 0.01 individuals/acre higher than the pre-construction baseline average, and both the interim and final performance standards were met. These density estimates resulted in lagoon-wide abundance estimates of 42.48

individuals in 2023 and a 4-year construction/post-construction lagoon-wide abundance running average of 46.51 individuals, compared to 62.98 individuals for the pre-construction baseline period. The 4-year construction/post-construction lagoon-wide abundance running average increased from 43.83 individuals in 2022 to 46.51 individuals in 2023. This increase occurred in part due to an increase in LFRR abundance from 2022 to 2023, but also because the 4-year running average in 2023 no longer includes 2019, when LFRR abundance was particularly low (31.77 individuals). Results from the floating alpha testing method indicated the 4-year construction/post-construction lagoon-wide abundance running average was not significantly lower than 75% of the pre-construction baseline value, but it was significantly lower than 95% of the pre-construction baseline value. Therefore, while the interim performance standard for LFRR abundance was met, the final performance standard was not.

The lagoon-wide abundance estimate generated by AECOM for 2023 was higher than the 2022 estimate, whereas data collected by Zembal and Hoffman indicated a reduction from 49 breeding pairs in the lagoon in 2022 to 41 pairs in 2023 (Zembal and Hoffman 2023). These numbers represent a sharp decrease from the record high of 78 pairs that Zembal and Hoffman reported in the lagoon in 2021 (Zembal and Hoffman 2021). In 2023, Zembal and Hoffman also recorded continued declines across San Diego County, in which eight subpopulations declined from 2022 to 2023 compared to only four that increased, with a net loss of 49 breeding pair detections (Zembal and Hoffman 2023). Althought LFRR numbers at San Elijo Lagoon increased from 2022 to 2023 based on AECOM surveys, the 2023 estimates are still low compared to the baseline period. This decline mirrors county and state-wide patterns of reduced LFRR detections (Zembal and Hoffman 2023). The general decrease in estimated LFRR numbers at San Elijo Lagoon in 2023 could be a product of either reduced detections (e.g., due to reduced breeding activity and less vocalizing behavior), or actual decreases in the number of individuals in the lagoon (e.g., due to normal population cycling, an increase in predator activity, or sea-level rise causing more frequent nest inundation). There are some indications that the numbers reflect an actual decrease in the lagoon population. Zembal and Hoffman (2022 and 2023) suggested that loss of habitat due to more frequent and extreme high water events was at least partly responsible for the declines in LFRR across San Diego County. Predator control efforts from 2018 through 2023 have targeted potential LFRR nest-predators in the lagoon, including racoons, Virgina opossums, and non-native rats. However, raptor predation appears to be the primary source of mortality for juvenile rails (Sawyer 2024), indicating that raptors may play an important role after chicks have left the nest.

11.1.4.2 Other Focal Marsh Bird Species

Due to the low number of detections for each of these species, survey estimates were not corrected for detection probabilities, so the reported numbers probably underestimate the true abundance of focal marsh bird species. Thus, abundance estimates are not directly comparable to the modeled abundance estimates of LFRR. Focal marsh birds are not included in the project’s performance standards but are surveyed as additional indicators of the lagoon’s condition.

The overall average of 13.67 focal marsh bird individuals/survey in 2023 was higher than the baseline period average of 10.00 individuals/survey. With the exception of least bittern, which has not been detected in the lagoon since 2020, detections of all other focal marsh birds increased in 2023, including the first detection of a common gallinule since 2017. Other focal marsh bird species are not included in the project's performance standards but are surveyed as additional indicators of the lagoon's condition. Post-construction surveys will continue to monitor numbers of these birds moving forward.

11.2 WATERBIRD SURVEYS, INCLUDING WESTERN SNOWY PLOVER AND CALIFORNIA LEAST TERN

11.2.1 Performance Standard

The monitoring of waterbird species (e.g., seabirds, waterfowl, shorebirds, and wading birds) that use open water and mudflat habitats in the SELRP study area is a pre-restoration absolute monitoring variable. Pre-construction baseline data (defined as those data collected in 2016 and 2017, as summarized in the AECOM 2020 baseline monitoring report) and construction/post-construction data metrics are compared using the "floating alpha" method described in Sections 2.1.2 and 2.2.2 of the Monitoring Plan. Other waterbird species, (i.e., birds that utilize open water, mudflat, and sand habitat, excluding western snowy plovers [*Charadrius nivosus nivosus*] and California least terns [*Sternula antillarum browni*]) are monitored to provide additional insight into the health and condition of the lagoon but are not included in the performance standards. Performance standards for western snowy plovers and California least terns are provided below:

> **Interim standard**: Construction/post-construction 4-year running average number of individuals 75% or greater than that of pre-construction survey data (2016–2017) by Year 7 post-construction
>
> **Final standard**: Construction/post-construction 4-year running average number of individuals 95% or greater than that of pre-construction survey data (2016–2017) by Year 10 post-construction

Running averages are used to account for annual population variability. Standards will not be considered met until performance standards are met for 3 consecutive years, as included in Section 2.3 of the Monitoring Plan.

In addition, documentation of western snowy plover or California least tern nesting in the west, central, or east basins would be considered a success because nesting by these species has been absent or sporadic in the lagoon. In 2015, one successful nesting event was observed on Cardiff Beach; however, the beach area nesting conditions are not expected to change as a result of restoration efforts. *Western Snowy Plover and California Least Tern Nest Monitoring and*

Management Plan for the San Elijo Lagoon Restoration Project (AECOM 2017) describes actions to be taken to monitor and manage the nest area being designed as part of the SELRP.

11.2.2 Approach

Waterbird surveys focused on birds that utilize open water, mudflat, and sand habitat, including western snowy plovers and California least terns. A complete description of survey methodology for waterbird surveys is in the Monitoring Plan. Each survey yielded a census of waterbirds observed in the west, central, and east basins of the lagoon. Abundances of two species, western snowy plover and California least tern, were calculated as the lagoon-wide average of individuals observed per survey by month, as well as the average number observed per survey in each basin. These values were then used to calculate an overall per-survey average for each year. Observations of other waterbird species were grouped into specific taxonomic orders and summarized as both the number of individuals in each cohort observed per survey by month for each basin and an overall per-survey average for each year. The detailed approach, as well as results such as lists of the species associated with each taxonomic order detected during the surveys in 2023, are provided in Appendix G.

Surveys were conducted January through December, with one survey conducted per month during January, February, October, November, and December, and at least two surveys conducted per month during March through September. Because California least terns overwinter in Central and South America and breed in southern California during May and July, results for California least terns are provided for the months of April through September; the species is generally not present at the lagoon outside of these months.

11.2.3 Results

Detailed summaries of the survey dates, survey times, survey personnel, and weather conditions for 2023 are provided in Appendix G.

When multiple surveys were conducted in a month for a given year, the mean number of individuals detected across surveys conducted within that month was calculated. The mean number of individuals detected per survey during each month was used to evaluate temporal variation in abundance (across seasons and years), and to calculate the overall annual average abundance metrics. Survey results from 2023 are also summarized by lagoon basin in Appendix G.

11.2.3.1 Western Snowy Plover

Survey results for western snowy plovers from 2023, a 4-year running average of the construction/post-construction period (2020 to 2023), as well as the baseline period (2016 and 2017) are summarized in Table 11-4. In 2023, western snowy plovers were detected in the lagoon in eight of the 19 surveys, with an overall monthly average of 8.29 individuals/survey. The high count of this species was recorded during January, with 32 birds detected during that month. No western snowy plovers were detected in the lagoon after April, with the exception of August, in which 12 western snowy plovers were detected during both surveys. The mean number of detections per survey in 2023 (8.29 individuals/survey) was higher than the baseline average and the 4-year construction/post-construction running average by 8.02 and 3.58 individuals/survey, respectively. The mean number of western snowy plovers detected in each lagoon basin and the birds' locations in the lagoon are provided in Appendix G.

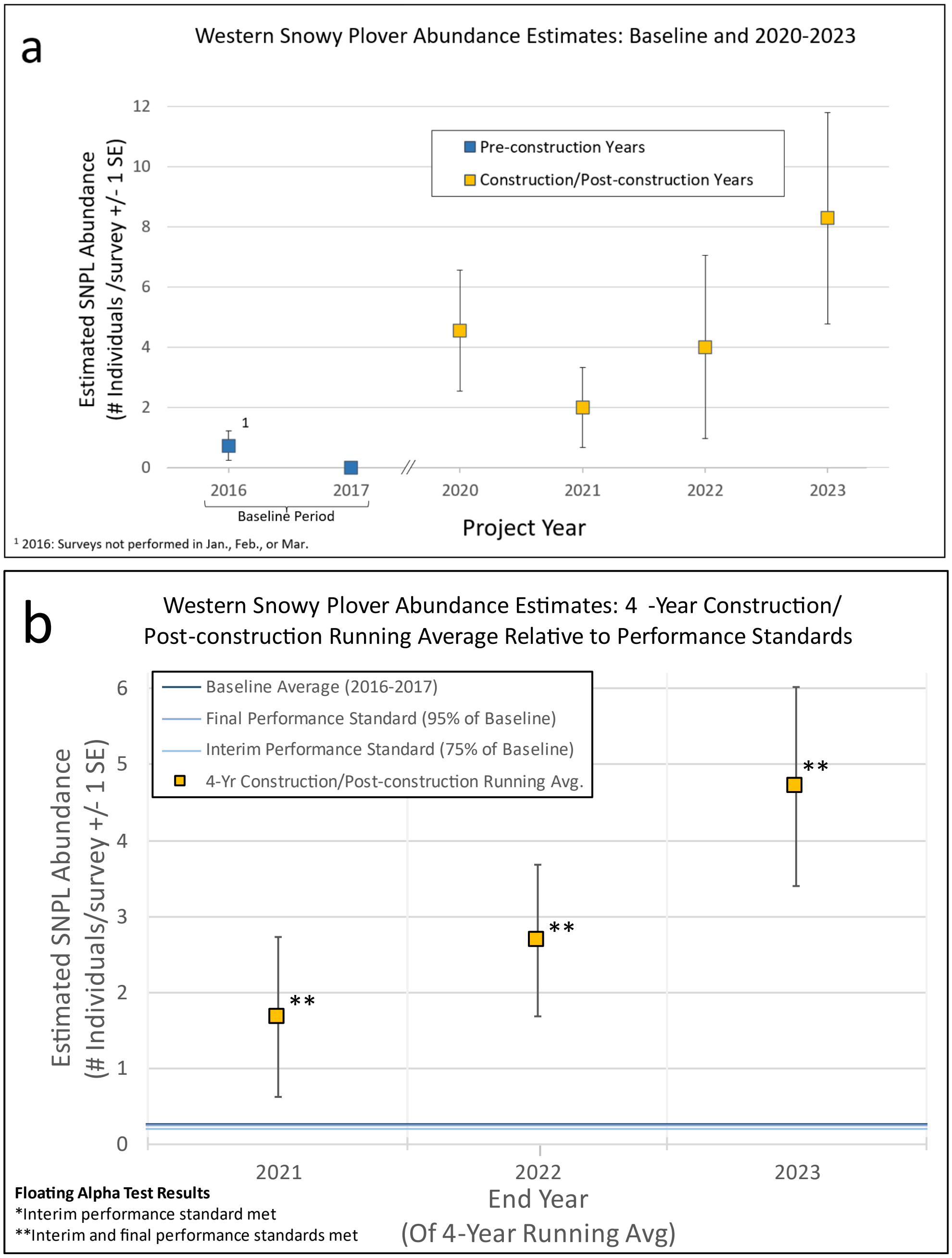
Results from the floating alpha testing method indicated the 4-year construction/post-construction average was not significantly lower than 75% of the pre-construction baseline mean, nor was it significantly lower than 95% of the pre-construction baseline mean (Table 11-4, Figure 11-3a, and Figure 11-3b). Thus, both the interim and final performance standards were met for western snowy plover abundance for 3 consecutive years (2021 to 2023; Figure 11-3b).

Table 11-4. Summary of Western Snowy Plover Results by Month

Monthly Averages (Mean # Individuals/Survey)						
Month	**2016–2017 Baseline**	**2020**	**2021**	**2022**	**2023**	**4-year Construction/ Post-construction Running Average[1]**
Jan	0.00	18.00	0.00	36.00	21.50	21.50
Feb	0.00	0.00	0.00	0.00	5.25	5.25
Mar	0.00	0.00	0.00	0.00	7.13	7.13
Apr	0.00	0.00	0.00	0.00	1.50	1.50
May	0.00	0.00	0.00	0.00	0.00	0.00
Jun	0.00	0.00	0.00	0.00	0.00	0.00
Jul	0.00	0.50	7.50	0.00	2.00	2.00
Aug	0.00	0.00	0.50	0.00	3.13	3.13
Sep	1.25	3.00	1.00	0.00	1.00	1.00
Oct	2.00	5.00	0.00	0.00	1.25	1.25
Nov	0.00	10.00	0.00	1.00	2.75	2.75
Dec	0.00	18.00	15.00	11.00	11.00	11.00
Overall Average (SE)	**0.27 (0.19)**	**4.54 (2.01)**	**2.00 (1.33)**	**4.00 (3.05)**	**8.29 (3.52)**	**4.71 (1.79)**

[1] The 4-year construction/post-construction running average is from 2020 to 2023.

Figure 11-3. Western Snowy Plover Abundance Performance Standards Test Results



Note: SNPL = Western Snowy Plover

11.2.3.2 California Least Tern

Results from California least tern surveys are provided for the months of April through September because the species is generally not present on their breeding grounds outside of this date range. Results from the pre-construction baseline period and 2020 to 2023 surveys are summarized by month below (Table 11-5). During 2023, no California least terns were detected during the 12 California least tern surveys from April through September, resulting in a mean number of birds detected per survey of 0.00 individuals. This average was not only lower than the baseline average of 0.86 individuals/survey, but was also lower than each other year of this project, as 2023 was the only year in which no California least terns were detected during surveys.

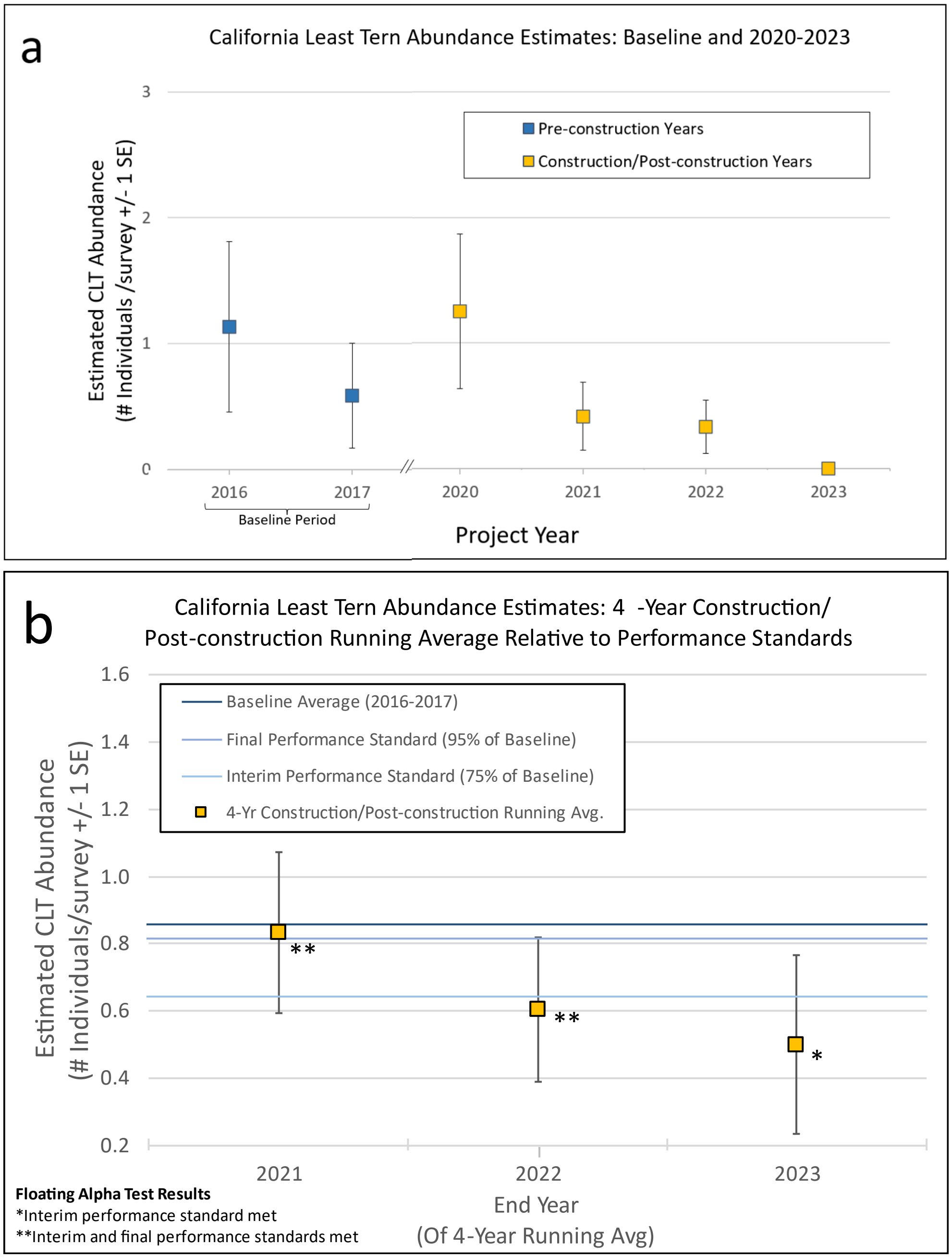
Results from the floating alpha testing method indicated the 4-year construction/post-construction average was not significantly lower than 75% of the pre-construction baseline mean, but was significantly lower than 95% of the pre-construction baseline mean. Thus, the interim performance standard for California least tern abundance was met in 2023, but the final performance standard was not met (Figure 11-4b).

Table 11-5. Summary of California Least Tern Results by Month

Monthly Averages (Mean # Individuals/Survey)						
Month	**2016–2017 Baseline**	**2020**	**2021**	**2022**	**2023**	**4-year Construction/ Post-construction Running Average[1]**
Apr	0.00	0.00	0.00	0.00	0.00	0.00
May	1.40	1.50	0.00	0.00	0.00	0.38
Jun	3.35	3.50	1.00	1.00	0.00	1.38
Jul	0.40	2.50	1.50	1.00	0.00	1.25
Aug	0.00	0.00	0.00	0.00	0.00	0.00
Sep	0.00	0.00	0.00	0.00	0.00	0.00
Overall Average (SE)	**0.86 (0.55)**	**1.25 (0.62)**	**0.42 (0.27)**	**0.33 (0.21)**	**0.00 (0.00)**	**0.50 (0.26)**

Note:
[1] The 4-year construction/post-construction running average is from 2019 to 2022.

Figure 11-4. California Least Tern Abundance Performance Standards Test Results



Note: CLT = California Least Tern

11.2.3.3 Other Waterbird Species

Results from the pre-construction baseline period and 2020 to 2023 surveys are summarized by month below (Table 11-6). Averaged across the three lagoon basins, the mean number of waterbirds detected in 2023 was 495.83 individuals/survey. Waterbird detections in 2023 were approximately 140 individuals/survey higher than the baseline average of 355.8 individuals/ survey, and increased slightly from 2022 when the average was 463.54 individuals/survey (Table 11-6). As with other years, waterbird numbers tended to be lower during the months of May through August, coincident with the time that most winter migrants are away at breeding grounds farther north.

Table 11-6. Summary of Waterbird Results by Month

Monthly Averages (Mean # Individuals/Survey)					
Month	**2016–2017 Baseline**	**2020**	**2021**	**2022**	**2023**
Jan	509.5	1,275.0	1,284.0	859.0	789.0
Feb	857.0	1,310.0	1,476.0	857.0	930.0
Mar	458.5	690.0	729.5	748.0	819.0
Apr	328.8	501.0	349.5	340.0	374.0
May	181.3	412.0	143.0	119.0	95.5
Jun	148.9	258.5	88.0	78.5	146.5
Jul	154.8	595.5	316.0	163.0	169.5
Aug	262.0	424.5	446.5	196.5	321.0
Sep	286.8	621.0	471.5	368.5	320.5
Oct	186.5	868.0	821.0	268.0	538.0
Nov	549.8	1,717.0	692.0	888.0	625.0
Dec	682.8	1,572.0	1,146.0	677.0	822.0
Overall Average (Standard Error)	**355.8 (72.7)**	**853.71 (141.76)**	**663.58 (129.49)**	**463.54 (91.66)**	**495.83 (85.66)**

The two orders of birds most frequently observed during waterbird surveys were the Anseriformes (waterfowl) and Charadriiformes (shorebirds, gulls, and terns). Waterbirds belonging to these two taxonomic orders comprised more than 80% of all observations in each year.

11.2.4 Discussion

11.2.4.1 Western Snowy Plover

During 2023, western snowy plovers were observed in the lagoon at higher levels than previous year of this study (Table 11-4). The number of individuals detected per survey in 2023 was more than double of that observed in 2022 (8.29 individuals/survey versus 4.00 individuals/survey, respectively), and was almost eight individuals/survey higher than the baseline average (0.27 individuals/survey). Both the interim and final performance standards were met for western snowy plover abundance in 2023 (Figure 11-3a and Figure11-3b). The final performance standard has now been met for 3 consecutive years (2021 to 2023).

Patterns of western snowy plover detections among the lagoon basins across years have varied and are detailed in Appendix G. In 2023, western snowy plover detections occurred in the central basin and the west basin, with no detections in the east basin. The majority of detections were in the west basin, reversing a trend of the past few years for more birds to be detected in the central basin. Construction-related dredging activities initially resulted in an increase in the amount of open mudflat suitable for foraging in the central basin (i.e., the OD pit), and recently this has been transitioning to drier, sandier conditions. Western snowy plovers generally favor sandy substrate for foraging, but they will readily forage on mudflats and other unvegetated flats as well.

11.2.4.2 California Least Tern

California least terns were not detected in the lagoon in 2023, resulting in an average of 0.00 individuals/survey. The absence of the species in 2023 reduced the 4-year construction/post-construction average to 0.50 individuals/survey, which is 0.36 individuals lower than the baseline average of 0.86 individuals/survey. The interim performance standard for California least tern abundance was met in 2023, but the final performance standards was not met (Figure 11-4a and Figure 11-4b).

California least terns have become less abundant in the lagoon over the past several years and were not detected in 2023. Based on monthly counts conducted at the lagoon from 1973 to 1983, and again from 2002 to 2017, California least tern numbers were substantially higher 10 to 20 years ago, with monthly counts as high as 69 and 78 individuals in 2004 and 2007, respectively (Nature Collective 2020). Data from Patton Biological LLC and eBird were also examined; while AECOM did not detect California least terns during surveys, data from Patton and colleagues and eBird revealed continued usage of the lagoon by California least terns, with numbers as high as seven individuals. As further discussed in Appendix G, continued efforts to improve the nesting area in the lagoon and control predators could help attract California least terns and increase the nesting success of birds that nest there, which could bolster their numbers in the lagoon moving forward.

11.2.4.3 Other Waterbird Species

Waterbird surveys were designed to assess the abundance of waterbird species (e.g., seabirds, waterfowl, shorebirds, and wading birds) that use open water and mudflat habitats in San Elijo Lagoon. The 2023 survey numbers (495.83 individuals/survey) were slightly higher than observed in 2022 (463.54), and continued to be higher than baseline levels (355.8 individuals/survey). Waterbirds are not included in the project's performance standards but are surveyed as additional indicators of the lagoon's condition. Post-construction surveys will continue to monitor numbers of these birds moving forward.

11.3 BELDING'S SAVANNAH SPARROW

11.3.1 Performance Standard

The monitoring of Belding's savannah sparrows (*Passerculus sandwichensis beldingi*) is a "pre-restoration absolute" monitoring variable and is not compared to reference wetlands for purposes of determining success of the SELRP. Pre-construction data and construction/post-construction data metrics are compared using the "floating alpha" method described in Sections 2.1.2 and 2.2.2 of the Monitoring Plan. Performance standards for Belding's savannah sparrows are provided below:

> **Interim standard**: Construction/post-construction 4-year running average density 75% or greater than that of pre-construction survey data (2016–2017) by Year 7 post-construction
>
> **Final standard**: Construction/post-construction 4-year running average density 95% or greater than that of pre-construction survey data (2016–2017) by Year 10 post-construction

Running averages are used to account for annual population variability. Standards will not be considered met until performance standards are met for 3 consecutive years, as included in Section 2.3 of the Monitoring Plan.

11.3.2 Approach

The focus of these surveys was to estimate density for the state-endangered Belding's savannah sparrow. Baseline surveys (2016 and 2017) were conducted during the breeding season for the species, from April 11 through May 20, 2016 (six surveys) and March 20 through May 19, 2017 (four surveys). In 2018 and 2019, surveys were conducted from February 25 through May 14 (four surveys each year), and, in 2020 through 2023, surveys were conducted from March through May (four surveys).

Survey results are summarized according to the following four "survey periods" designed to enable grouping of survey results across four roughly equal time periods and to minimize the effects temporal variation may have on analysis results:

- Late February to mid-March,
- Late March to early April,
- Mid- to late April, and
- Early to mid-May.

When multiple surveys were conducted in a survey period for a given year, the mean number of individuals detected across surveys was calculated. The mean number of individuals detected per survey during each survey period was then used to evaluate temporal variation in abundance (across seasons and between years), and to calculate the overall average abundance metrics.

Belding's savannah sparrow detections were recorded at all distances from the survey transects measuring 100 m long located in suitable habitat and spread throughout the lagoon, following methods described in the Monitoring Plan (Nature Collective 2020). Initially, there were 19 transects (i.e., transects 1 through 19), with transects 1 through 4, 6, 9, and 11 through 15 surveyed only on one side due to the lack of sufficient suitable habitat on the other side. Between 2019 and 2021, transects 16 and 17 were not surveyed due to safety issues, but those transects were surveyed again beginning in 2022. Detailed summaries of the survey dates, survey times, survey personnel, and weather conditions are provided in Appendix G.

Survey data were analyzed using a distance sampling approach (Buckland et al. 2001), which applied the distances between the observer and each detected bird to control for differences in detectability. Based on results from the distance sampling model approach (Buckland et al. 2001) and data collected in previous years, detections beyond 75-m perpendicular distance from the transect were omitted from the analysis. An estimate of the density of Belding's savannah sparrow individuals was calculated for each survey as the number of individuals/acre across the survey area as a whole. The model selection process was revised following the 2020 season to better fit the distribution of the data. To ensure appropriate comparisons across years, this change was also applied to the previous years' data, resulting in modest changes to the annual estimates for the baseline and construction year periods (2020 Avian Monitoring Report [AECOM 2022a]).

11.3.3 Results

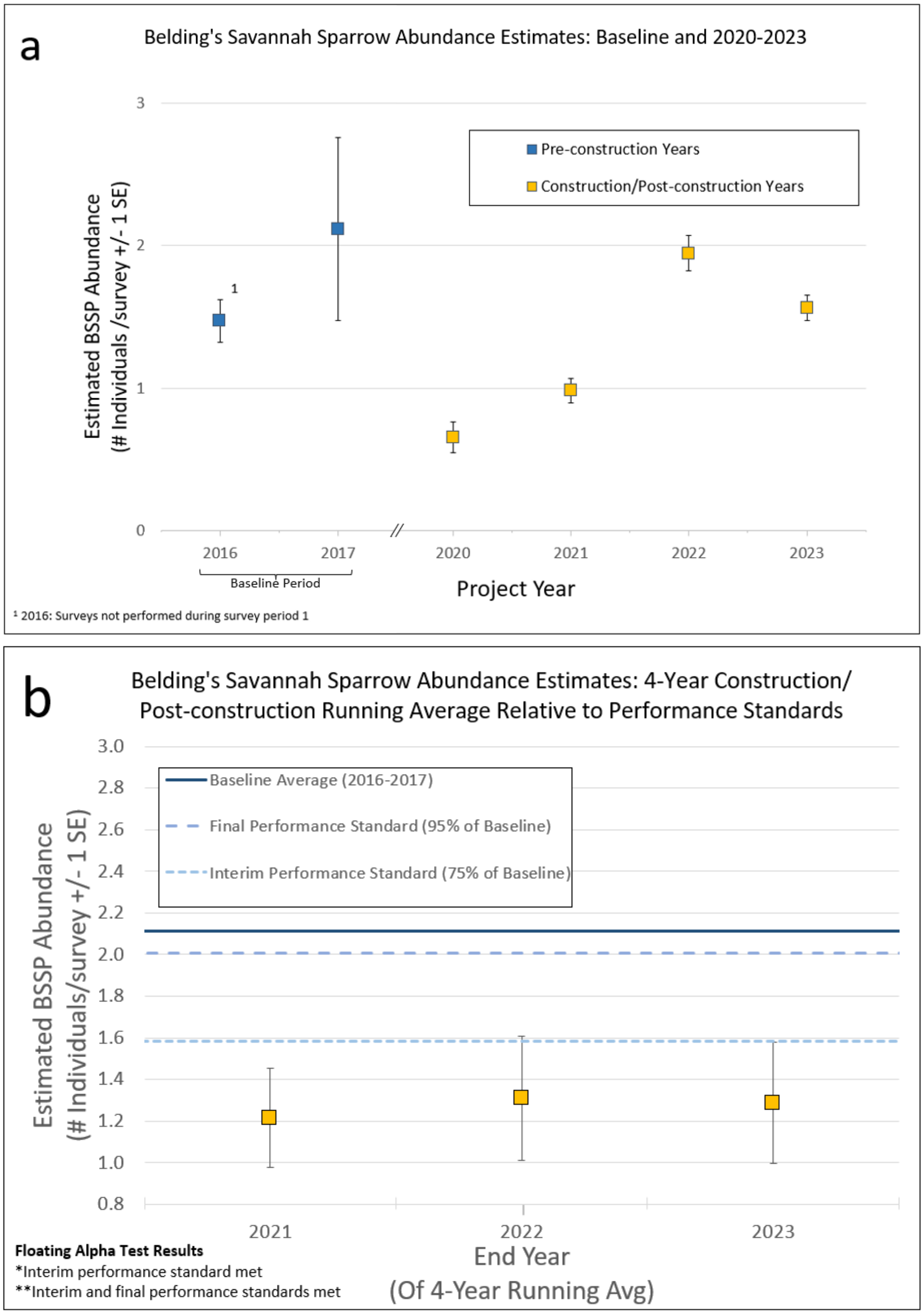
Belding's savannah sparrows were detected primarily in areas dominated by low, mid-, and high salt marsh in 2023, as shown in Appendix G. Belding's savannah sparrow density in the survey area in 2023 (1.56 individuals/acre) was slightly lower than in 2022 (1.95 individuals/acre). The 4-year construction/post-construction running average from 2020 to 2023 (1.29 individuals/acre) was still moderately lower than the 2016 and 2017 baseline average (2.11 individuals/acre) (Table 11-7). Results from the floating alpha testing method indicated the 4-year construction/post-construction running average was significantly lower than the 75% of the pre-construction baseline mean and the 95% of the pre-construction baseline mean (Table 11-7, Figure 11-5a, and Figure 11-5b). Thus, neither the interim nor the final performance standard was met for Belding's savannah sparrow density in 2023 (Figure 11-5b).

Table 11-7. Summary of Belding's Savannah Sparrow Results by Survey Period

Survey Period Averages (Density [Mean # Individuals/acre])						
Survey Period	**2016–2017 Baseline[1]**	**2020**	**2021**	**2022**	**2023**	**4-year Construction/ Post-construction Running Average[2]**
Late-Feb to Mid-Mar	4.03	0.89	1.07	1.92	1.37	1.31
Late-March to Early-Apr	1.61	0.38	1.18	2.18	1.78	1.38
Mid-Apr to Late-Apr	1.45	0.76	0.87	2.08	1.49	1.30
Early-May to Mid-May	1.36	0.59	0.82	1.61	1.61	1.16
Overall Average (Standard Error)	**2.11 (0.64)**	**0.66 (0.11)**	**0.98 (0.08)**	**1.95 (0.12)**	**1.56 (0.09)**	**1.29 (0.09)**

1 Pre-construction baseline values differ from those values reported in previous reports due to revised model selection approach in estimating survey area densities (Appendix G).
2 The 4-year construction/post-construction running average is from 2020 to 2023.

Figure 11-5. Belding's Savannah Sparrow Density Performance Standards Test Results



BSPP = Belding's savannah sparrow

11.3.4 Discussion

After a big jump in 2022 (1.95 individuals/acre), the estimated Belding's savannah sparrow density in the survey area regressed a bit towards the mean in 2023 (1.56 individuals/acre; Table 11-7 and Figure 11-5a). The 4-year running average in 2023 declined slightly from 1.31 individuals/acre to 1.29 individuals/acre. Neither the interim performance standard nor the final performance standard for Belding's savannah sparrow density was met in 2023 (Figure 11-5a and Figure 11-5b).

The 2023 estimate and the 4-year running average remain lower than the baseline average of 2.11 individuals/acre, but that high estimated density in the baseline period was heavily influenced by one unusually high estimate from the first survey in 2017 (see Baseline Monitoring Report [AECOM 2020b;] and 2020 Avian Monitoring Report [AECOM 2022a]). Aside from that high count in 2017, the density estimates have generally ranged from approximately 1.00 to 2.00 individuals/acre, with the exception of 2020 in which the four survey period estimates were below 1.00 individuals/acre (AECOM 2022a), and 2022 in which the density estimates were above 2.00 individuals/acre for two survey periods. The 4-year running average currently includes the two lowest years of survey density estimates of the study period (2020 and 2021 at 0.66 and 0.98 individuals/acre, respectively). The low density estimates in those 2 years are likely due to the loss of Belding's savannah sparrow suitable habitat that immediately followed the channel-widening efforts and the temporary removal of two highly productive transects (16 and 17). It is anticipated that the Belding's savannah sparrow numbers will remain closer to the running average moving forward, based on the improving habitat conditions and the reincorporation of transects 16 and 17.

12. WETLAND FUNCTION

12.1 PERFORMANCE STANDARD

Wetland function is an absolute monitoring variable and is not compared to reference wetlands for purposes of determining success of the SELRP. The individual assessment areas (AAs) CRAM scores and averaged lagoon CRAM score are used to compare post-restoration conditions to pre-restoration conditions and function of the lagoon. This average score serves as the reference for determining the success of the restoration activities. Table 12-1 contains the CRAM performance standards.

Table 12-1. CRAM Performance Standards

CRAM Score	Expected Results	Performance Standard	Year
Buffer and Landscape Context Attribute	Not expected to change, mostly outside the scope of the SELRP	Post-restoration equal to or exceed baseline CRAM attribute score	Year 5
Hydrology Attribute	Expected to increase slightly due to dredging and topography changes to increase tidal flow and flushing	Post-restoration equal to or exceed baseline CRAM attribute score	Year 5
Physical Structure Attribute	Expected to recover to equal or exceed Baseline condition	Post-restoration equal to or exceed baseline CRAM attribute score	Year 5
Biotic Structure Attribute	Expected to recover to equal or exceed the baseline condition	Post-Restoration equal to or exceed baseline CRAM attribute score	Year 5
Overall CRAM	**Expected to recover to equal or exceed the baseline condition**	**Post-Restoration equal to or exceed baseline CRAM attribute score**	**Year 5**

12.2 APPROACH

In September 2016, AECOM CRAM-certified practitioners conducted the pre-construction CRAM assessment. The CRAM assessment was performed following the current guidelines, version 6.1 (CWMW 2013a) and the fieldbook of the appropriate wetland module (CWMW 2013b; 2013c). There were 25 AAs used for the 2016 baseline condition assessment. In August 2023, AECOM and Nature Collective CRAM-certified practitioners conducted the Year 3 post-construction CRAM assessment. The CRAM assessment was performed following the latest guidelines, version 6.1 (CWMW 2013a) and the fieldbook of the appropriate wetland module (CWMW 2013b; 2013c). There were 24 AAs used for the 2023 post-construction assessment. The removal of one AA was necessary because the pre-restoration location of the AA was in a location that became entirely open channel post-restoration and was no longer a suitable AA. A complete description of survey methodology and CRAM assessment and scoring is in the Monitoring Plan.

Moreover, in accordance with the Clean Water Act Section 401 Certification requirements, photographs of the lagoon were taken to document pre-restoration and post-restoration conditions (Appendix H).

12.3 RESULTS

In 2016, CRAM scores ranged from a low of 60 to a high of 85. Two different wetland types, and therefore two different modules, were used for the assessment: estuarine and depressional. The majority of the AAs (20) were estuarine wetlands, found in the west, central, and western most portions of the east basin. However, five AAs in the east basin did not fit the CRAM definition of estuarine wetland and were assessed using the depressional module.

The 2016 pre-construction average scores for each CRAM attribute are provided in Table 12-2. Detailed results for each AA are provided in Appendix I.

Table 12-2. 2016 Average CRAM Attribute Scores by Wetland Type

Attribute	Estuarine	Depressional	Estuarine and Depressional (± SE)
Buffer and Landscape Connectivity	85.65	93.40	87.20 ± 2.23
Hydrology	58.70	79.80	62.92 ± 2.10
Physical Structure	71.00	45.20	65.84 ± 3.48
Biotic Structure	74.55	84.80	76.60 ± 2.04
Overall AA Score	**72.30**	**75.80**	**73.00 ± 1.21**

In 2023, individual AA CRAM scores ranged from a low of 63 to a high of 88. Following the pre-restoration methodology, two different wetland types, and therefore two different modules, were used for this assessment: estuarine and depressional. The majority of the AAs (19) were estuarine wetlands, found in the west, central, and western most portions of the east basin. However, five AAs in the east basin did not fit the CRAM definition of estuarine wetland and were assessed using the depressional module.

The highest scoring AA was C48, an estuarine AA in the central basin with a score of 88. The lowest scoring AAs were the estuarine AAs C33 (central basin) and W-4 (west basin) with a 64 and 63 overall score, respectively. The 2023 post-construction average scores for each CRAM attribute are provided in Table 12-3. Detailed results for each AA are provided in Appendix I.

Table 12-3. 2023 Average CRAM Attribute Scores by Wetland Type

Attribute	Estuarine	Depressional	Estuarine and Depressional (± SE)
Buffer and Landscape Connectivity	86.16	92.80	87.54 ± 2.28
Hydrology	60.53	80.40	64.67 ± 2.04
Physical Structure	71.26	50.20	66.88 ± 3.64
Biotic Structure	73.42	77.60	74.29 ± 2.49
Overall AA Score	**73.16**	**75.60**	**73.67 ± 1.18**

The average 2023 attribute scores and overall CRAM scores for the lagoon are provided in Table 12-4. Table 12-4 indicates that the lowest scores were received in the hydrology and physical structure attributes and associated metrics.

Table 12-4. Average Attribute and Overall CRAM Scores

CRAM Attribute	Pre-Restoration Average CRAM Score (%)	Year 3 Restoration Average CRAM Score (%)	Relative Change (%)
Buffer and Landscape Context	87	88	0.4%
Hydrology	63	65	2.4%
Physical Structure	66	67	1.4%
Biotic Structure	76	74	-2.7%
Overall CRAM Score	**73**	**74**	**0.9%**

12.4 DISCUSSION

The average overall CRAM scores varied slightly between pre- and post-restoration assessments (Table 12-4), suggesting that the restoration implementation activities had the anticipated effects on wetland condition across San Elijo Lagoon. The Hydrology attribute experienced the biggest positive change in average overall attribute score (+2.4%, Table 12-4) from pre-restoration conditions, with increases mainly in hydroperiod and hydrological connectivity metrics, whereas Biotic Structure scored the greatest decrease in the average overall attribute score from pre-restoration conditions with -2.7%, which increased compared to the -6.1% decrease in 2021. Positive changes in the Biotic Structure of individual AAs are anticipated as the restoration program progresses, resulting in smaller differences between pre- and post-restoration assessment in subsequent years.

Year 3 post-restoration CRAM score results confirmed the lack of significant change in Buffer and Landscape Context attribute/metric scores after restoration implementation. In the Hydrology attribute, water source is influenced by the level of development surrounding the lagoon and did not change after restoration. However, hydroperiod and hydrological connectivity metric scores increased after restoration, resulting in a 2.4% increase from pre-restoration conditions in the average overall Hydrology attribute. Areas that have been planted or are expected to convert and reside in one of these AAs are most likely to increase the attribute/metric scores for the Physical Structure and Biotic Structure attributes as the vegetation increases in cover and diversity; however, current wetland condition scores for these two attributes are still below the pre-restoration levels observed in 2016 (AECOM 2016).

Nearly 73% of CRAM metric/submetric scores recorded during Year 1 restoration for the SELRP AAs were A or B, almost matching the percentage observed during the pre-restoration CRAM monitoring in 2016 (70.5%). Other than a few outliers, current CRAM scores for the 24 AAs included in this analysis are consistent with the Year 3 post-restoration expectations. Besides Biotic Structure, CRAM Attributes and the Overall CRAM score during Year 3 assessments exceed pre-restoration scores. Based on the results of this CRAM analysis, the Buffer and Landscape Context and Hydrology attributes are not expected to change significantly, while the Physical Structure and Biotic Structure attributes are expected to increase in score as the vegetation in planted and areas expected to convert fills in.

When comparing the overall AA scores for estuarine and depressional wetland types between 2016 and 2023, the depressional scores are slightly higher than the estuarine scores for both years. If comparing the depressional scores between 2016 and 2023, the 2023 overall score is 0.20 points lower than in 2016. This is most likely related to several years of drought, as these AAs are in fairly high and dry locations that rely entirely on seasonal rain. These AAs will be affected only by the project improvements in the very long-term and sea level rise over time. When comparing the scores for the estuarine AAs between 2016 and 2023, the 2023 overall score is 0.86 higher than in 2026; therefore, the CRAM performance standard for the project is considered to be met.

13. EELGRASS

13.1 PERFORMANCE STANDARD

Eelgrass is an absolute standard in which pre-restoration conditions are compared to post-restoration conditions. If, after the post-restoration surveys are completed, eelgrass has reestablished and no permanent losses are documented, the project will have met performance standards. Pre-restoration conditions are shown in Table 13-1.

Table 13-1. Eelgrass Bed Metrics for Pre-construction Eelgrass Survey, October 2017

Location	Spatial Distribution	Eelgrass Areal Extent	Vegetated Cover	Percent Cover
San Elijo Lagoon	716 m^2	19 m^2	0.9 m^2	4.7%

13.2 APPROACH

Eelgrass monitoring was not conducted in 2023, as monitoring has been discontinued because the final performance standard has been met.

13.3 RESULTS

There are no eelgrass survey results for 2023, as the final performance standard has been met, and monitoring has been discontinued. The results of the 2021 Annual Monitoring Report documented that eelgrass had reestablished, and there were no permanent losses. The 2021 results are presented below in Table 13-2 for reference.

Table 13-2. Eelgrass Bed Metrics for Post-construction Eelgrass Survey, September 2021

Location	Spatial Distribution	Eelgrass Areal Extent	Vegetated Cover	Percent Cover
San Elijo Lagoon	7,907 m^2	743 m^2	221 m^2	29.7 %

13.4 DISCUSSION

Eelgrass has reestablished, and no permanent losses were documented according to the 2021 Annual Monitoring Report, as seen in Table 13-2; therefore, the final performance standard has been met. No further monitoring of eelgrass will be required.

This page intentionally left blank.

14. *CAULERPA*

14.1 PERFORMANCE STANDARD

Performance standards for *Caulerpa* are to confirm that *Caulerpa* is not present in the project site, and there would be no risk for introduction to other sites by project implementation.

14.2 APPROACH

Caulerpa surveys were not conducted in 2023, as monitoring has been discontinued because the final performance standard has been met.

14.3 RESULTS

Caulerpa was not detected during surveys in the project area in 2021, meeting the final performance standard.

14.4 DISCUSSION

As noted above, *Caulerpa* was not present in the project area in 2021; therefore, the final performance standard has been met. No further monitoring of *Caulerpa* will be required.

This page intentionally left blank.

15. SUMMARY OF PERFORMANCE

15.1 DETERMINING YEAR 3 SUCCESS

The status of the SELRP at the end of Year 3 (2023) is presented in Table 15-1 and Table 15-2 below. Performance standards for topography, bathymetry, habitat areas, vegetation cover, exotics cover, wetland function, and fish were met in 2023. Final standards for eelgrass and *Caulerpa* were met in 2021; therefore, monitoring was permanently discontinued in 2021. Avian performance standard thresholds for breeding marsh birds with a focus on LFRR, western snowy plover, and California least tern were also met in 2023, whereas performance standards for tidal elevations and Belding's savannah sparrows were not met in 2023. Performance standards for California cordgrass, benthic invertebrates, and water quality could not be formally evaluated yet, as additional years of data are needed to calculate the 4-year running average. Data are provided in Chapters 6.2 and 7 as an early indicator of how restoration has impacted metrics to date. This was the first time the 2023 running average for fish was composed of 4 years of data, and the fish species richness and density performance standard was formally met. Overall, the relative performance standards are based on less than 4-year running averages for some metrics, as noted. The results provided cannot determine success in relation to the relative performance standards, but suggest the SELRP is on track at this time to meet the performance standards in the future.

The ecological objectives of the project are to enhance the existing physical and biological functions and services of San Elijo Lagoon. Relative metrics in this Annual Monitoring Report (Table 15-1) are equally important to the success of the project. Some relative metrics have multiple components that are evaluated for performance (i.e., density and species richness for fish and benthic invertebrates), and to ensure these metrics do not disproportionately impact the overall performance assessments, these components have been weighted 0.50 in the relative performance evaluation (Table 15-1). Therefore, each relative metric (e.g., fish, water quality, and California cordgrass) receives equal weight in determining project success.

Table 15-1. SELRP Year 3 Post-Construction Relative Performance Standards

Relative Variable	Site Similar to Other Wetlands			
	San Elijo Lagoon	Tijuana Estuary	Mugu Lagoon	Carpinteria Salt Marsh
Water Quality[1]	Yes	No	Yes	Yes
Fish Density[2]	Yes	No	Yes	Yes
Fish Species Richness[2]	Yes	No	Yes	Yes
Invertebrate Density[1,3]	No	Yes	Yes	Yes
Invertebrate Species Richness[1,3]	Yes	No	Yes	Yes
California Cordgrass Canopy Architecture[1]	Yes	Yes	No	N/A[4]
Number of Standards Similar to Other Wetlands[5]	3.5	1.5	3	3
Weighted Prop[5]. of Standards Similar to Other Wetlands	0.88	0.38	0.75	1.00

Notes:
[1] Based on 3 years of post-construction data (final performance standard requires 4-year running average)
[2] Based on 4 years of post-construction data (final performance standard requires 4-year running average)
[3] Not sampled in 2022; value reflects data from 2020, 2021, and 2023 for locations; will be sampled again in 2025 (see Chapter 8 for details on sampling schedule)
[4] California cordgrass survey data not available at this wetland
[5] Density and species richness are each weighted 0.50 in the fish and benthic invertebrate metrics
Conclusion: San Elijo Lagoon met more standards than both Tijuana Estuary and Mugu Lagoon. Although these results are based on less than 4-year running averages, they suggest that the SELRP is on track during Year 3 post-construction to meet the relative performance standards in the future.

Table 15-2. Timeline of SELRP Overall Project Success

Permitting Agency	Variable	Year Performance Standard Met											
		0	1	2	3	4	5	6	7	8	9	10	Final Standard Met
CCC	Relative Performance Standards[1]	-	Yes[4]	Yes[4]	Yes[4]	-	-	-	-	-	-	-	-
	Project Design Absolute Performance Standards												
	Topography[3]	Yes	Yes	Yes	Yes	-	-	-	-	-	-	-	-
	Bathymetry[3]	Yes	Yes	Yes	Yes	-	-	-	-	-	-	-	-
	Tidal Elevations	-	Yes	No	No	-	-	-	-	-	-	-	-
	Exotic Cover	-	Yes	Yes	Yes	-	-	-	-	-	-	-	-
	Pre-Restoration Absolute Performance Standards												
	Breeding Marsh Birds: Light-Footed Ridgway's Rail Density	-	Yes	Yes	Yes	-	-	-	-	-	-	-	-
	Breeding Marsh Birds: Light-Footed Ridgway's Rail Abundance	-	Yes	Yes	Yes	-	-	-	-	-	-	-	-
	Western Snowy Plover	-	Yes	Yes	Yes	-	-	-	-	-	-	-	Yes
	California Least Tern	-	Yes	Yes	Yes	-	-	-	-	-	-	-	-
	Belding's Savannah Sparrow	-	No	No	No	-	-	-	-	-	-	-	-
USFWS/CCC	Habitat Areas	Yes	Yes	Yes	Yes	-	-	-	-	-	-	-	-
	Vegetation Cover[2]	-	Yes	Yes	Yes	-	-	-	-	-	-	-	Yes[5]
RWQCB	Wetland Function (CRAM)	-	Yes	-	Yes	-	-	-	-	-	-	-	-
Corps	Eelgrass	-	Yes	-	-	-	-	-	-	-	-	-	Yes[5]
Corps/USFWS	*Caulerpa*	-	Yes	-	-	-	-	-	-	-	-	-	Yes[5]

Conclusions by Year:

Year 0. Topography, bathymetry, and habitat areas standards met. Data not available for all other variables. Monitoring will continue for all variables.

Year 1. Relative performance standards, topography, bathymetry, tidal elevations, habitat areas, vegetation cover, exotic cover, breeding marsh birds with focus on light-footed Ridgway's rail, western snowy plover, California least tern, wetland function (CRAM), eelgrass, and *Caulerpa* standards met. Belding's savannah sparrow standard not met. Monitoring discontinued for eelgrass and *Caulerpa*. Monitoring will continue for all other variables.

Year 2. Relative performance standards, topography, bathymetry, vegetation cover, exotic cover, habitat areas, breeding marsh birds with focus on light-footed Ridgway's rail, western snowy plover, and California least tern standards were met. Tidal elevations and Belding's savannah sparrow standards were not met. Monitoring will continue for all other variables.

Year 3. Relative performance standards, topography, bathymetry, vegetation cover, exotic cover, habitat areas, breeding marsh birds with focus on light-footed Ridgway's rail, western snowy plover, and California least tern standards were met. Tidal elevations and Belding's savannah sparrow standards were not met. Monitoring will discontinue for Vegetation cover. Monitoring will continue for all other variables.

\- = data not available for that year

[1] Not all required to be met in a given year.

[2] 10-Year absolute performance standards are provided in Table 6-6 (Chapter 6 above) for Years 1 through 10. Year 10 vegetation cover performance standards have been met in Year 2 and Year 3. Because the 2023 data are consistent with the data collected in previous years and performance standards are achieved, future vegetation monitoring will not occur in 2024 and will be discontinued.

[3] It is assumed site conditions would not change frequently enough to necessitate annual surveys or negate previous survey results for topography and bathymetry. Success of both of these absolute standards is tied to habitat, which is being monitored during every year. Topography and bathymetry metrics will be considered met in the years between monitoring topography and bathymetry if the habitat performance standard is met. Therefore, if the topography and bathymetry standard was met during monitoring in Year 2 and Year 5 and the habitat standard was also met in Year 2 through Year 5, topography and bathymetry standards would be considered met during Year 2 through Year 5.

[4] Some performance standards may be evaluated based on running averages less than the required 4-year interval if the 4 years of data is not available.

[5] Metric will no longer be monitored.

16. ADAPTIVE MANAGEMENT RECOMMENDATIONS

16.1 RECOMMENDATIONS

Adaptive management as applied to ecological restoration is a systematic decision-making process in which the results of restoration activities are consistently monitored and evaluated to identify whether the restoration program is reaching its desired results. The process for adaptive management for each of the metrics being monitored in San Elijo Lagoon is ongoing with timelines and actions depending on the individual variable, as described in the Monitoring Plan. The monitoring protocol for each metric has been established to identify specific concerns associated with each variable early enough in the post-restoration phase to enable remedial measures to be taken if necessary and as feasible to achieve project success.

These annual monitoring reports evaluate and determine if the performance standards have been met and will continue to document monitoring results within the annual reports prepared at the end of each year. If performance standards have not been met for variables and monitoring trends indicate the specific function is not heading towards achieving success, adaptive management strategies will be identified and implemented. If necessary, Nature Collective will review the data with the relevant permitting and resource agencies, or with local experts, in an effort to devise a mutually agreed upon course of action to bring the particular variable into conformance with performance standards.

Restoration was completed for the SELRP in 2020, and this was the third complete year of post-construction data collection. The results discussed in this Annual Monitoring Report show the project is trending towards success for most metrics; however, this year has shown the continued decline of metrics affected by morphology changes in the lagoon. The continued sediment accumulation and shoaling have affected the tidal range resulting in increased residence times and increased duration and total of hypoxic water quality events. While habitat is still establishing consistent with the project design, if inlet and/or channel sediment accumulation is not addressed in a timely manner, there may be negative longer-term effects to the overall lagoon system and additional metrics (e.g., habitat areas, tidal elevations, water quality) may fail to meet success in future years. It is recommended that adaptive management dredging take place to maintain channel capacities that could affect tidal elevations and longer-term habitat establishment, as well as other metrics. Recommendations at this time also include revision of the following monitoring components. The SELRP team decided that an additional year of vegetation monitoring in 2023 would be conducted even though vegetation performance standards had been achieved through Year 10 in 2022, which represents Year 2. Because 2023 data are consistent with the data collected in previous years and performance standards are achieved, future vegation monitoring will not occur in 2024 and will be discontinued, as discussed in Section 6.1.4 above. The discontinuation of monitoring this California cordgrass canopy in future years may also be considered to reduce impacts to sensitive species present in the lagoon, as discussed in Section 6.2.4 above. The discontinuation of CRAM may also be considered, as the AAs will only be affected by the project in the very long-term and sea level rise over time. The SELRP team is also considering the potential of removing the outlier survey period from the Belding's savannah sparrow density estimate as discussed in Section 11.3.4.

16.2 ONGOING RESTORATION AND MAINTENANCE ACTIVITIES

Specified maintenance and monitoring will continue in Year 4 (2024) and through the remainder of the monitoring program. Ongoing activities include weeding and exotics removal, nest site and inlet maintenance, and predator control. Focused activities that may occur as adaptive strategies will be captured in the 2024 Annual Monitoring Report. Channel sediment accumulation is also being closely monitored, and strategies to address potential impacts to the lagoon are being actively explored. Consistent monitoring continues in the lagoon for other metrics as noted above as well. Additional focused activities may occur as the year progresses.

17. LIST OF PREPARERS

Table 17-1 includes a list of persons and organizations who participated in the monitoring program and/or preparation of this Annual Monitoring Report.

Table 17-1. List of Preparers

Chapter	Variable	Lead Author	Organization
1 to 14	General Report Preparation	Cindy Kinkade (Project Manager)	AECOM
		Kandiss Wise	AECOM
2	Topography	Chris Webb	Moffatt & Nichol
3	Bathymetry	Chris Webb	Moffatt & Nichol
4	Tidal Elevation	Chris Webb	Moffatt & Nichol
5	Habitat Areas	Aaron Andrews	AECOM
6.1	Vegetative Cover	Aaron Andrews	AECOM
6.2	California Cordgrass Canopy Architecture	Aaron Andrews	AECOM
6.3	Exotics	Aaron Andrews	AECOM
7	Water Quality	Nature Collective	Nature Collective
8	Benthic Invertebrates	Andres Deza	Nature Collective
9	Sediments	Nature Collective	Nature Collective
10	Fish	Andres Deza	Nature Collective
11.1	Breeding Marsh Birds with focus on light-footed Ridgway's rail	Michael Kuehn	AECOM
11.2	Waterbird Surveys, including Western Snowy Plover and California Least Tern	Michael Kuehn	AECOM
11.3	Belding's Savannah Sparrow	Michael Kuehn	AECOM
12	Wetland Function (CRAM)	Nature Collective	Nature Collective
13	Eelgrass	Nature Collective	Nature Collective
14	*Caulerpa*	Nature Collective	Nature Collective

This page intentionally left blank.

18. REFERENCES

AECOM 2016. San Elijo Lagoon Restoration Project. Pre-Restoration California Rapid Assessment Method Analysis. November.

AECOM. 2017. *Western Snowy Plover and California Least Tern Nest Monitoring and Management Plan for the San Elijo Lagoon Restoration Project*. Prepared for USFWS.

2022a. *2020 Avian Monitoring Report for the San Elijo Lagoon Restoration Project*. Prepared for the Nature Collective. June.

2020b. *Wetland Habitat and Hydrology San Elijo Lagoon Baseline Monitoring Report*. Prepared for Nature Collective.

Buckland, S. T., D. R. Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers, and L. Thomas. 2001. *Introduction to Distance Sampling – Estimating Abundance of Biological Populations*. Oxford University Press, Oxford.

California Wetlands Monitoring Workgroup (CWMW). 2013a. *California Rapid Assessment Method (CRAM) for Wetlands, User's Manual*, Version 6.1, p. 67.

2013b *California Rapid Assessment Method (CRAM) for Wetlands, Perennial Estuarine Wetlands Field Book*, Version 6.1, p. 38.

2013c *California Rapid Assessment Method (CRAM) for Wetlands, Depressional Wetlands Field Book*, Version 6.1, p. 43.

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

Huggins, R. M. 1991. Some Practical Aspects of a Conditional Likelihood Approach to Capture Experiments. *Biometrics* 47.

Nature Collective. 2020. *Wetland Habitat and Hydrology Monitoring Plan for the San Elijo Lagoon Restoration Project*. Prepared by AECOM, Nordby Biological Consulting, and Moffatt & Nichol.

Nichols, J. D., J. E. Hines, J. R. Sauer, F. W. Fallon, J. E. Fallon, and P. J. Heglund. 2000. A Double-Observer Approach for Estimating Detection Probability and Abundance from Point Counts. *Auk* 117: 393–408.

Oberbauer, T., M. Kelly, and J. Buegge. 2008. *Draft Vegetation Communities of San Diego County*. Based on "Preliminary Descriptions of the Terrestrial Natural Communities of California," R. F. Holland, Ph.D., October 1986. March.

Sawyer, K. A., C. J. Conway, T. Katzner, and K. M. Sliwa. 2022. *Survival, Movement, and Monitoring of Light-footed Ridgway's Rails. 2022 Annual Report*. Wildlife Research Report #2022-01. Idaho Cooperative Fish and Wildlife Research Unit, Moscow, ID.

Sawyer, K. A. 2024. *Survival and Habitat Selection of Light-footed Ridgway's Rails Differs Between Captive-released and Wild Juveniles: Effects of Time in Captivity, Release Date, and Tidal Stage.* 2024. Masters Thesis. Idaho Cooperative Fish and Wildlife Research Unit, Moscow, ID.

Zembal, R., and S. M. Hoffman. 2021. *Light-footed Ridgway's (Clapper) Rail in California, 2021 Season*. Final Report to U.S. Fish and Wildlife Service and California Department of Fish and Wildlife.

Zembal, R., and S. M. Hoffman. 2022. *Light-footed Ridgway's (Clapper) Rail in California, 2022 Season*. Final Report to U.S. Fish and Wildlife Service and California Department of Fish and Wildlife.

Zembal, R., and S. M. Hoffman. 2023. *Light-footed Ridgway's (Clapper) Rail in California, 2023 Season*. Final Report to U.S. Fish and Wildlife Service and California Department of Fish and Wildlife.

APPENDIX A

ANNUAL TIDAL WATER LEVEL AND VELOCITY MONITORING REPORT; WATER QUALITY ANALYSIS UPDATE FOR SAN ELIJO LAGOON RESTORATION PROJECT MEMORANDUM

APPENDIX B

HABITAT CLASSIFICATIONS

APPENDIX C

DETAILED TRANSECT AND QUADRAT RESULTS

APPENDIX D

WATER QUALITY DATA

APPENDIX E

SAN ELIJO LAGOON RESTORATION PROJECT POST-CONSTRUCTION FISH AND INVERTEBRATE ASSESSMENT

APPENDIX F

SEDIMENT ANALYTICAL REPORT

APPENDIX G

2023 AVIAN MONITORING REPORT FOR THE SAN ELIJO LAGOON RESTORATION PROJECT

APPENDIX H

SAN ELIJO LAGOON RESTORATION PROJECT PRE-RESTORATION AND POST-RESTORATION PHOTOPOINTS PHOTOLOG

APPENDIX I

SAN ELIJO LAGOON RESTORATION PROJECT YEAR 3 CALIFORNIA RAPID ASSESSMENT METHOD ANALYSIS