

Final

DEL MAR LOCAL COASTAL PROGRAM AMENDMENT

San Dieguito Lagoon Wetland Habitat Migration Assessment

Prepared for
City of Del Mar

August 2018



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EXECUTIVE SUMMARY

As discussed in the City of Del Mar’s Draft Sea-level Rise Adaptation Plan, existing wetland habitats within the San Dieguito Lagoon will be inundated more frequently with sea-level rise and vegetated wetland habitats (e.g., high, mid, and low salt marsh) will be “drowned out” and convert to intertidal mudflats and subtidal habitat. Lagoon wetland habitats could also potentially migrate to higher elevation areas around the lagoon and upstream along the San Dieguito River with sea level rise (SLR). In the absence of areas for wetland habitats to migrate to or other adaptation measures, vegetated wetland habitats, functions, and species could potentially be lost within the San Dieguito Lagoon.

As part of the Del Mar Local Coastal Program (LCP) Amendment to address sea level rise, storm surge, and coastal flooding, this Lagoon Wetland Habitat Migration Assessment was prepared to model and assess San Dieguito River Lagoon¹ (San Dieguito Lagoon) habitat conversion and migration using the Environmental Protection Agency’s Sea Level Affecting Marshes Model (SLAMM).. As sea level rises, the model interprets the balance of higher water levels against accretion (the slow buildup of sediment) to determine where habitats are likely to move in the future. The model is based on a digital elevation model of the area, available data on existing habitats, and the current-day mean tide level and tide range. Sea-level rise scenarios are then used to estimate the future tide levels, and habitats are determined based on ground elevations relative to the tides. This study used four sea-level rise scenarios – 1.0 foot, 2.0 feet, 3.2 feet, and 5.5 feet – to capture a range of potential sea-level rise scenarios between now and the end of the century.

In general, geography and existing development constrain San Dieguito Lagoon marsh habitats in Del Mar and do not permit much habitat migration with SLR. Within the City of Del Mar, the primary opportunity for improving marsh habitat resiliency is the potential to convert/restore the North County Transit District’s (NCTD)s stormwater detention and seasonal wetland area south of the San Dieguito River (between the railroad bridge and Jimmy Durante Boulevard) to salt marsh habitat with sea-level rise. Within the Del Mar Fairgrounds, restoration of the south overflow lot to salt marsh has already been completed. The east overflow lot has the potential to convert to salt marsh with sea-level rise; however, this would conflict with the existing use of the east overflow lot for Fairgrounds parking. There are options for migration east of I-5, but elevations and freshwater influence limit the inland incursion of saline habitats. East of I-5, high SLR could convert uplands to salt marsh and connect lower-elevation seasonal wetland areas

¹ Note: A small portion of the Los Peñasquitos Lagoon falls within the City of Del Mar; however, habitat change with sea-level rise at Los Peñasquitos Lagoon is not addressed in this report. ESA has performed an assessment of habitat migration with SLR for the Los Peñasquitos Lagoon Foundation, which can be found in the Los Peñasquitos Lagoon Enhancement Plan (ESA 2015).

adjacent to the highway to the lagoon. This would not begin naturally until sea level rises about 3.5 feet, unless the San Dieguito Lagoon W-19 Restoration Project planned by the San Dieguito River Park Joint Powers Authority provides lower-elevation pathways to these adjacent areas that allow habitat migration earlier.

The City of Del Mar's Draft SLR Adaptation Plan identifies three potential wetland habitat adaptation measures:

- Allow/facilitate wetland conversion and transgression
- Sediment placement
- Wetland expansion/restoration

This Habitat Migration Assessment and the findings summarized above identify the primary opportunities and considerations for San Dieguito Lagoon wetland conversion, transgression, and expansion/restoration with SLR. Given that the majority of existing salt marsh habitats are projected to convert to tidal flat and open water with SLR, sediment placement to maintain existing salt marsh habitats may warrant further consideration as a sea-level rise adaptation measure.

This Habitat Migration Assessment also identifies and discusses other potential policy-based adaptation measures that the City of Del Mar could consider to protect potential habitat migration areas within the City and to provide habitat corridors, which include: identifying potential conservation areas, limiting allowable uses, applying zoning setbacks, securing conservation easements, and potentially acquiring land.

SECTION 1

Introduction

As discussed in the City of Del Mar’s Draft Sea-level Rise Adaptation Plan, existing wetland habitats within the San Dieguito Lagoon will be inundated more frequently with sea-level rise and vegetated wetland habitats will be “drowned out” and convert to intertidal mudflats and subtidal habitat. Lagoon wetland habitats could also potentially migrate upstream to higher elevation areas along the San Dieguito River with sea level rise.

Over the past two decades, geospatial modeling tools have been developed to forecast changes in coastal wetland habitats in response to SLR. These tools include the Environmental Protection Agency’s Sea Level Affecting Marshes Model (SLAMM), which simulates the dominant processes involved in coastal wetland migration and conversions (referred to collectively as “evolution”) with long-term SLR. The basis of the model is a decision tree that maps out how quantified linkages between habitat response and SLR will drive habitat locations across a landscape, considering the effects of coastal elevations, SLR, accretion and erosion, and freshwater inflow. The model calculates habitat areas and maps habitat distribution over time based on inputs of existing vegetation, topography, accretion rates, and SLR. Tools like SLAMM can be used in watershed management to identify restoration and conservation opportunities for changing coastal habitats.

This report includes a summary of lagoon processes governing habitat evolution in San Dieguito Lagoon (Section 2), the application of SLAMM to assess habitat evolution with SLR (Sections 3 and 4), and the implications of this assessment to adaptation strategies available to the City of Del Mar (Section 5).

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SECTION 2

Conceptual Model of San Dieguito Lagoon Processes

The following sections describe a conceptual model of San Dieguito Lagoon processes that are modeled by SLAMM. This conceptual model provides the basis for the SLAMM model inputs used in the assessment, which are discussed in Section 3.

2.1 Tides

Salt marsh and intertidal habitats establish within zones corresponding to tidal inundation. Tides and tidal inundation within the lagoon are, therefore, important processes affecting habitats. Lagoon tides are driven by ocean tides that propagate through the lagoon inlet and channels, which affect tidal heights in the lagoon relative to tidal heights in the ocean (e.g., through tidal muting or damping).

The San Diego coast experiences mixed semidiurnal tides, with two high and two low tides of unequal heights each day. There is also monthly variation in tidal range, with higher tidal ranges (spring tides) generally occurring during full and new moons and lower tidal ranges (neap tides) occurring between full and new moons. Along the San Diego coast, tides exhibit strong spring-neap tide variability; spring tides exhibit the greatest difference between high and low tides, while neap tides show a smaller-than-average range. The spring-neap tides also vary on an annual cycle, with the highest spring tides occurring in June–July and December–January and the weakest neap tides occurring in March–April and September–October.

2.2 Lagoon Mouth Processes

Processes at the San Dieguito Lagoon mouth (where lagoon meets the ocean) are complex and lead to dynamic conditions that vary over time. Waves push sand into the mouth and tidal flows transport sand both in and out of the mouth. Generally, lagoon mouths for lagoon systems like San Dieguito Lagoon can open and close over the course of the year based on sediment supply, wave action, and river discharge, and this affects seasonal water levels in the lagoon. However, the mouth of San Dieguito Lagoon is dredged to remain open throughout the year. Because open lagoons such as San Dieguito Lagoon are always connected to the open ocean, they generally exhibit less seasonal variation in water level and experience tides closer to those of the open ocean, since the inlet provides less of a flow constriction. Since the completion of the San Dieguito Lagoon Restoration by Southern California Edison (SCE) and San Diego Gas and Electric (SDG&E) for the San Onofre Nuclear Generating Station (SONGS) Mitigation in 2011

and associated mouth maintenance dredging by SCE/SDG&E has been implemented, high tides within San Dieguito Lagoon have generally matched ocean high tides, while low tides have been damped (elevated) to varying degrees based on the varying amount of sand accumulation in the lagoon mouth (see the City of Del Mar Coastal Sediment Management Plan, ESA 2018).

2.3 Topography and Accretion/Erosion

Land elevations within the lagoon determines the frequency of tidal inundation, which in turn determines soil moisture and salinity. These factors affect the type of vegetation that can establish and persist. Land elevation can change due to gradual accumulation of sediment (accretion) or loss of sediment (erosion). If the topography changes due to accretion or erosion (or restoration/grading), the habitat types change in response. The lagoon receives sediment from its watershed and tributary creeks.

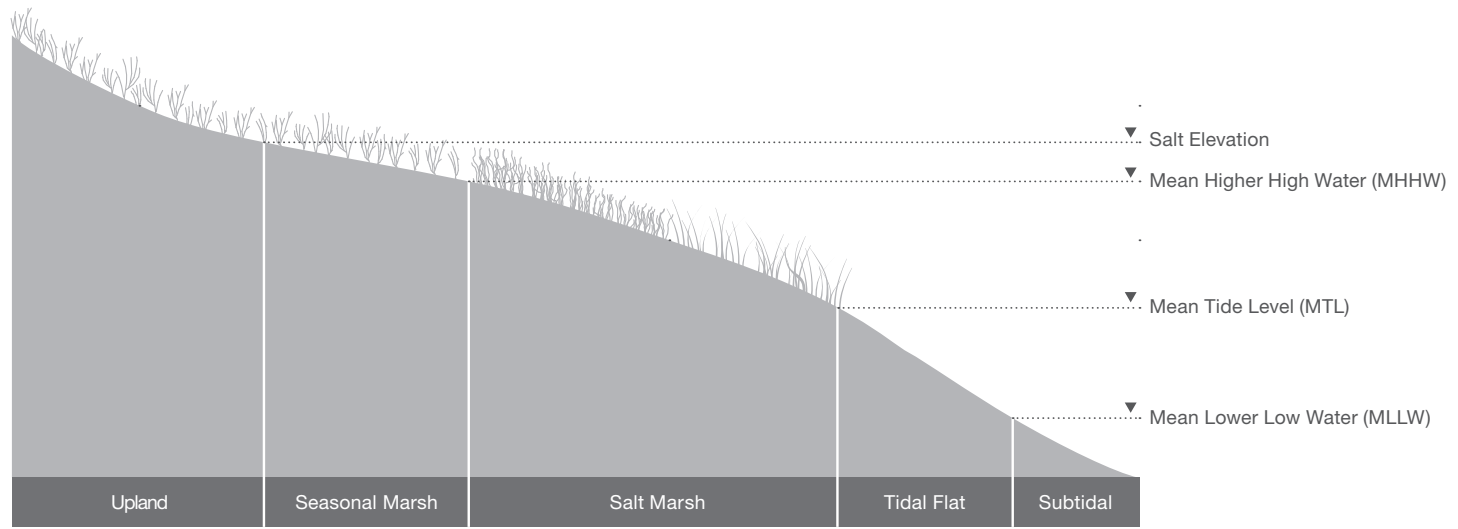
2.4 Freshwater Inflow

Riparian, freshwater marsh, and brackish marsh habitats form in areas influenced by freshwater inflows. These areas of freshwater influence are either inundated solely by freshwater or are characterized by tidal mixing of ocean water and freshwater inflows, creating brackish salinities. The influence of freshwater determines what type of vegetation can establish and persist in that area. If the extent of freshwater inundation increases, the extent of riparian, freshwater marsh, and brackish marsh habitats will increase at the expense of salt marsh and transitional areas. Conversely, if the area of freshwater influence is reduced (i.e., the tidal extent is increased), the extent of freshwater habitats will be reduced over time. Sources of freshwater flows entering the lagoon consist of stormwater, dry weather flows, and groundwater.

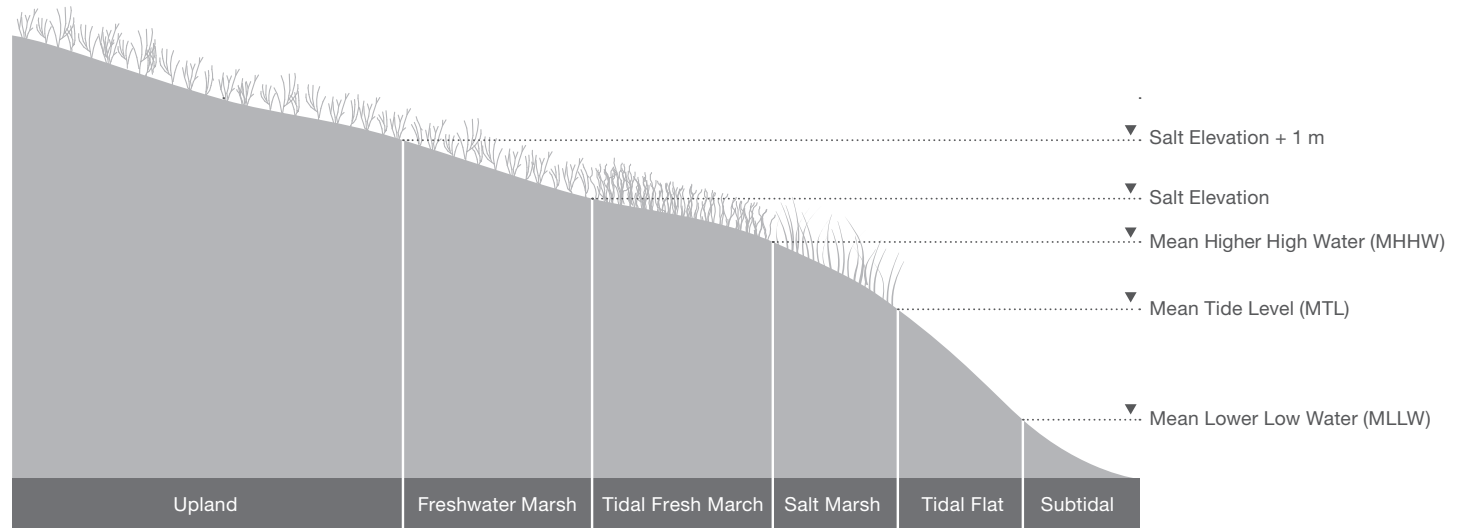
2.5 Habitat Zones

Lagoon habitat zones can be defined for different areas within the lagoon based on the elevation of the area relative to tidal datums (tidal water levels), which reflect the frequency of tidal inundation, and whether the area is within the zone of freshwater influence (Figure 1). SLAMM uses an additional datum called the “salt elevation,” which is based on the extent of existing salt marsh (6.36 feet NAVD) and is just below the highest astronomical tide (HAT, 6.95 feet NAVD). The existing lagoon is home to freshwater marsh, seasonal marsh, salt marsh, tidal flats, ponded/mudflat areas, and open water.

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Habitat Zones Outside of Freshwater Influence



Habitat Zones Within Area of Freshwater Influence

SOURCE: ESA, 2018

Del Mar Local Coastal Program Amendment

Figure 1
Conceptual Habitat Elevation Zone Model



2.6 SLR

SLR is expected to be a major driver of habitat evolution at San Dieguito Lagoon. Since most vegetation establishes in areas based on the local tidal inundation and salinity, habitats will evolve when the tides rise.

Historical trends in relative sea level are measured at tide gages, which capture relative vertical movements of land as well as changes in the global sea level. These records measure the local rates of SLR relative to the coast. The National Oceanic and Atmospheric Administration (NOAA) estimates that relative sea levels have been rising at a rate of 2.07 mm/year at the La Jolla tide gage (1924–2006).

The California Coastal Commission Sea Level Rise Policy Guidance (CCC 2015) provides guidance for California projects on how to use predictions of global SLR for long-term planning purposes. The guidance document recommends using the estimates provided by the National Research Council’s (NRC) report on *SLR for the Coasts of California, Oregon, and Washington* (2012) as a starting place to select values. The NRC (2012) document presents different SLR amounts over time for a range in global emissions scenarios. Table 1 presents the SLR amounts for the range of projections at the planning horizons of the NRC study. These SLR projections are defined relative to the year 2000.

TABLE 1
SEA LEVEL RISE PROJECTIONS BASED ON NRC (2012)

Emissions Scenario	2030	2050	2100
Low	2 in	5 in	17 in (1.4 feet)
Mid	6 in	11 in	37 in (3.1 feet)
High	12 in	24 in	66 in (5.5 feet)

NOTE: These estimates account for regionally published vertical land motion based on Los Angeles

Recently, the Ocean Protection Council (OPC) funded an update on SLR Guidance (Griggs et al. 2017). The recent study provides minor updates to the SLR amounts for the prior emissions scenarios, but also considers a more extreme scenario resulting in rapid SLR of almost 10 feet by 2100. However, the State of California is currently in a process to determine how and whether to update policy guidance to include the results of the recent study.

At the time of this study, the NRC SLR projections are considered “best available science” for/by the State of California. This report and the City of Del Mar’s Coastal Hazards, Vulnerability, and Risk Assessment (ESA 2016) were both prepared using the NRC report projections for SLR.

SECTION 3

SLAMM Inputs and Runs

3.1 Model Inputs

3.1.1 Topography and Bathymetry

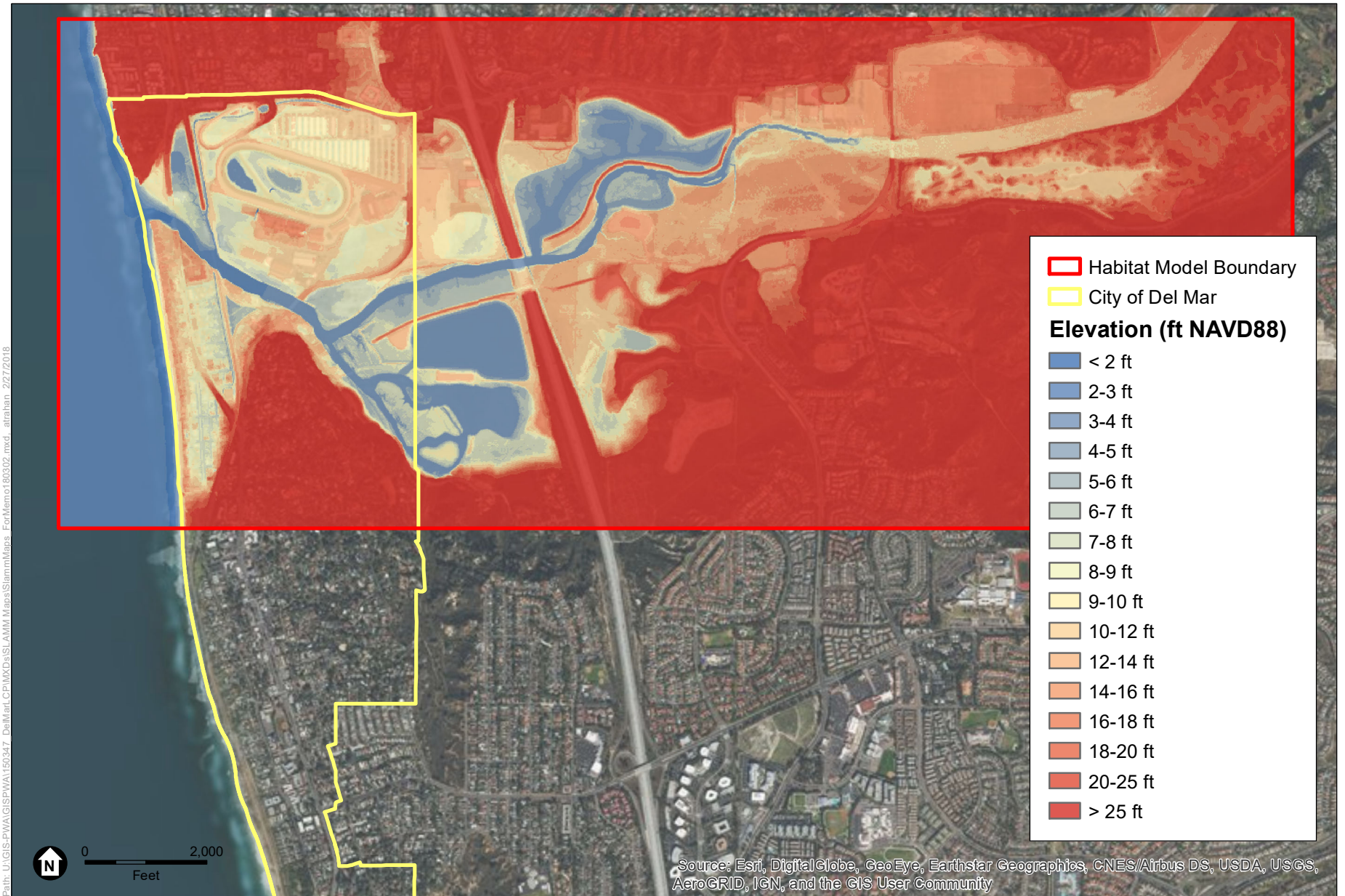
Topography is used in the model to determine which habitat will establish where. Figure 2 presents the existing topography of the beach and lagoon, which comes from the NOAA Sea Level Rise Viewer DEM (2016), a composite LiDAR surface provided by NOAA. Elevations (topography, tides, etc.) in this report are reported in feet relative to the North American Vertical Datum of 1988 (NAVD), which is a reference system against which elevation measurement are made and the current datum used in the United States.

The resulting topography and bathymetry (underwater terrain elevations) were converted to 5-meter cells to provide a spatial resolution that is consistent with the vegetation mapping (Section 3.1.2). Spatial models always involve a balance between high spatial resolution to capture detailed behavior or changes, and model run time, which increases as the resolution increases. The selected cell size was deemed to provide enough detail for this analysis, while keeping run times short.

3.1.2 Habitat Mapping

To evaluate how habitats will evolve over time, existing conditions habitat mapping is needed. A habitat map was created by combining the National Wetlands Inventory (NWI 2016) data with a map of imperviousness (National Land Cover Database, Xian et al. 2011) to delineate between developed and undeveloped upland. Upland areas were further differentiated by use of San Diego County land use data (SANDAG 2016) and ESA's understanding of the site. Additionally, ESA added the restored wetlands units from the San Onofre Nuclear Generating Station (SONGS) San Dieguito Lagoon Restoration project to the mapping because the NWI did not include them. The habitat map is shown in Figure 3 with the SONGS restoration units labeled for reference. The recently restored (2017) Del Mar Fairgrounds south overflow lot was not included because habitat mapping was not yet available (see discussion in Section 4.1).

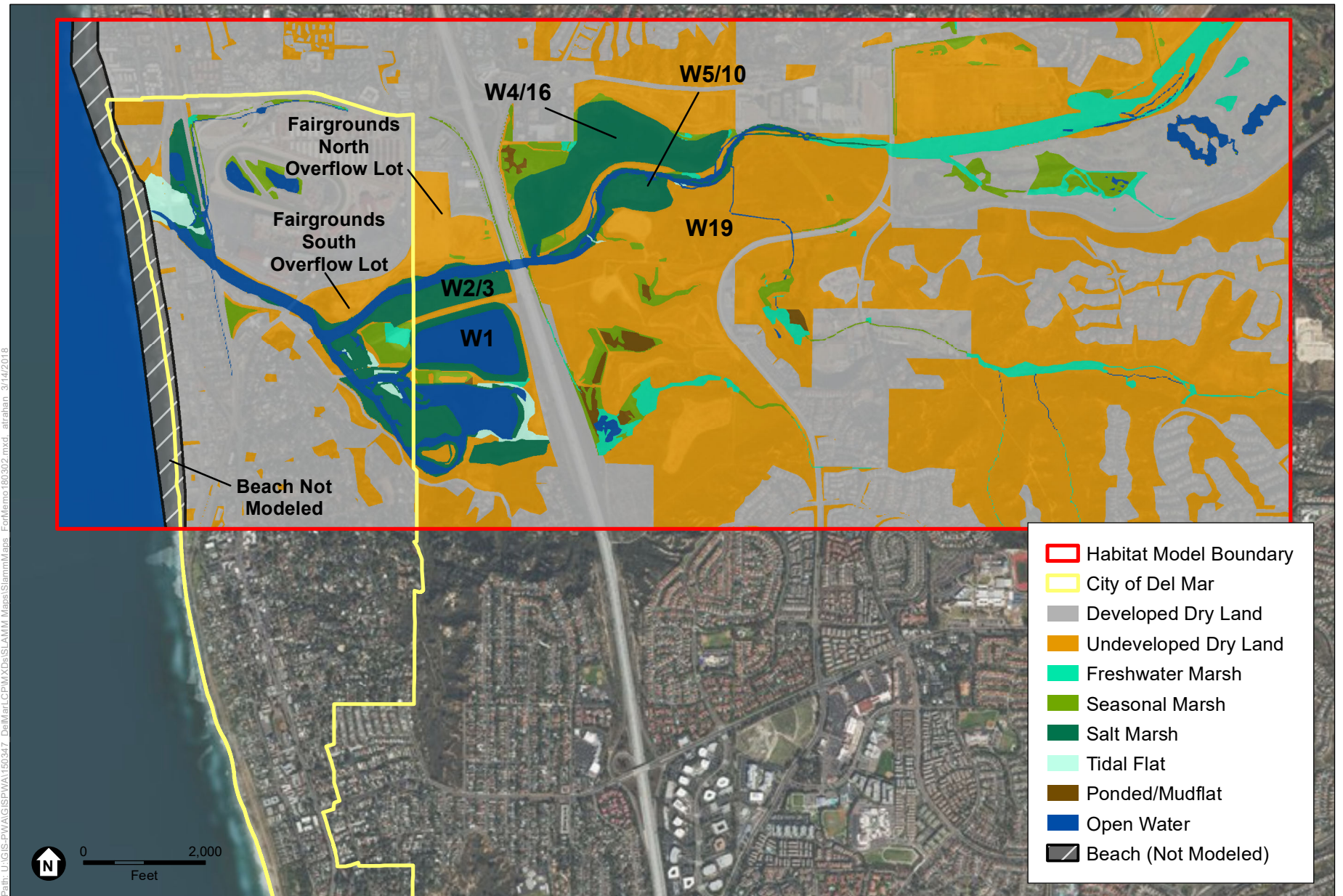
Vegetation was categorized into habitat types according to the SLAMM NWI habitat cross-walk. The SLAMM categories were further simplified to represent the habitat types in San Dieguito Lagoon and at Del Mar Beach.



SOURCE: NOAA 2016

Del Mar LCP Amendment

Figure 2
 SLAMM Inputs
 Existing Topography



SOURCE: ESA 2018
Basemap, ESRI 2018

Del Mar LCP Amendment

Figure 3
SLAMM Inputs
Existing Habitats

3.1.3 Tidal Water Levels

Tidal Datums

Tidal datums are used within the model as an input to the habitat evolution decision tree. For example, mean low water (MLW) is the boundary between open water and tidal flat, because it indicates the elevation at which land is always inundated (during an average day). If land is below MLW, it is assumed to be open water; if land is just above, it is tidal flat.

The model uses NOAA tidal datums for La Jolla, CA. An additional “salt elevation” datum is used to set the limit between freshwater habitats. The salt elevation is set to 6.36 feet NAVD, based on average the 30-day high tide elevation from 2010 to 2015. These tidal datums yield a great diurnal tide range of 5.3 feet in the open ocean; however, the lagoon experiences a damped low tide. When ocean water levels drop, water exits the lagoon through the inlet, but it is constricted by the inlet, and when the inlet bed is higher than the open-ocean low tide level, water is trapped in the lagoon, and the water level in the lagoon never reaches the low tide level seen in the open ocean (i.e. at Del Mar Beach). This leads to a lower tide range (3.9 feet) in the lagoon, with high tides that match ocean high tides and low tides that are elevated (damped) above ocean low tides. To account for the reduced tide range and low-tide damping in the lagoon, the mean tide level (MTL) in the lagoon was raised to 3.2 feet NAVD and the tidal range was reduced to 3.9 feet. Thus, the modeled lagoon tides match open ocean high tides and have low tides that are about 1.5 feet higher than ocean low tides.

Tidal datums are calculated by NOAA based on average water levels over a tidal epoch, or 19-year period. Current tidal datums are based on the 1983-2001 tidal epoch.

Mean higher high water (MHHW) is the average of the single highest tide each day over the tidal epoch.

Mean high water (MHW) is the average of the two high tides each day over the tidal epoch.

Mean tide level (MTL) is the average of MHW and mean low water (MLW).

Mean sea level (MSL) is the average of hourly water levels over the tidal epoch.

MLW is the average of the two lowest tides each day over the tidal epoch.

Mean lower low water (MLLW) is the average of the single lowest tide each day over the tidal epoch.

TABLE 2
TIDAL DATUMS USED IN THE MODEL

	Elevation at La Jolla (feet NAVD) ¹	Elevation used in SLAMM for San Dieguito Lagoon (feet NAVD) ²
MHHW	5.13	5.1
MHW	4.41	
MTL	2.56	3.2
MSL	2.54	
MLW	0.71	
MLLW	-0.19	1.3

¹ NOAA Tides and Currents gauge at La Jolla, CA. Station ID: 9410230

² Based on SLAMM model inputs developed by ESA for this assessment from a review of available lagoon tide data.

SLR Projections

The rate of SLR is projected to accelerate in the future. Table 3 includes projected future SLR from NRC (2012) for the mid-range and the high-range SLR scenarios. The mid-range SLR scenario is based on reducing fossil fuel use, with a balance between fossil fuels and alternative energy sources; whereas the high-range SLR scenario assumes intensive fossil fuel use will continue in the future. The NRC SLR projections are considered “best available science” for/by the State of California.

TABLE 3
SEA LEVEL RISE PROJECTIONS RELATIVE TO THE YEAR 2000

	2030	2050	2070	2100
Mid SLR	5 in	12 in	20 in (1.7 feet)	37 in (3.1 feet)
High SLR	12 in	24 in	38 in (3.2 feet)	66 in (5.5 feet)

3.1.4 Accretion and Erosion Rates

As sea level rises, marshes naturally adapt through sediment accretion, which raises the ground surface elevation. Accretion rates have been studied extensively in the Tijuana Estuary, a high-sediment system, and to a lesser degree in San Elijo Lagoon, a more representative system. Results of these studies have been gathered and synthesized for SLAMM for San Diego Bay (Gersberg 2014), which provides regional marsh accretion rates, beach sedimentation rates, and freshwater accretion rates. Furthermore, ESA (2015) developed accretion rates for Los Peñasquitos Lagoon based on Cole & Wahl (2000). These rates were used in the Del Mar SLAMM model and are summarized in Table 4.

In developing accretion rates for the San Diego Bay SLAMM model, Gersberg (2014) notes that the accretion rates from San Elijo Lagoon, while most representative, are likely biased high, quoting Thum et al. (2000), “This is approximately 2 to 3 times the historical sedimentation rate, and can be attributed to accelerated soil erosion due to urban development and farming inland.” This trend of high accretion during periods of inland development, followed by declining accretion rates as inland areas are stabilized and experience less erosion has also been observed at Los Peñasquitos Lagoon (ESA 2015), and it is expected to occur at San Dieguito Lagoon, as well. Thus, the accretion rates published by Gersberg (2014) and used in this study, while the most representative of available data, are expected to be the high end of potential accretion rates, and the habitat evolution modeled in this report may therefore occur with lower amounts of sea-level rise (i.e., may occur sooner).

TABLE 4
ACCRETION RATES BY HABITAT

	Accretion Rate (mm/yr)	Source
Freshwater Marsh	5.9	Gersberg, 2014
Salt/Brackish Marsh	6.1	Gersberg, 2014
Tidally-Dominated	4.6	ESA, 2015

Rising sea level also causes horizontal beach erosion, but shoreline erosion and transgression are complex and non-linear processes with both dynamic, short-term components and permanent, long-term components. The Sediment Management Plan (ESA 2018) addresses the dynamic complexities of sediment supply and beach erosion in Del Mar in detail.

3.1.5 Freshwater Inflow

SLAMM allows the definition of freshwater-influenced areas for systems with a freshwater inflow, as opposed to those with only tidal influence. These areas convert more slowly into saltmarsh habitats, passing first through Tidal Fresh Marsh (c.f. Figure 1). In this study, the portion of the San Dieguito River located upstream of El Camino Real and the Del Mar Horse Park was defined as freshwater-influenced.

3.2 Model Runs

Table 5 presents the scenarios that were run in SLAMM to investigate habitat evolution in the San Dieguito Lagoon area (with SLR. NRC Medium and High rates of SLR were evaluated using the assumption that habitats will not migrate into existing developed areas.

TABLE 5
RUN CATALOG

Run	SLR	Protect Development
Run 1	Medium (37 in)	Yes
Run 2	High (66 in)	Yes

SECTION 4

Results and Conclusions

The model runs in Table 5 allowed for comparisons between different SLR scenarios. Below, Section 4.1 presents the model “validation” of existing habitat types. Sections 4.2 presents the results for sensitivity runs on SLR.

4.1 Model Validation

The SLAMM results were compared to existing habitats to check the model assumptions for the habitat evolution decision tree. Current topography and existing tidal datums were input to the model with no SLR to model the existing conditions as of the date when existing habitats were observed (2002) and to validate the model. Table 6 presents habitat acreages from the 2016 mapped vegetation (NWI) and from the 2016 modeled habitats.

TABLE 6
COMPARISON BETWEEN MAPPED HABITATS AND SLAMM-PREDICTED (I.E. MODEL STEP ZERO) HABITATS

Habitat	Mapped Habitat (ac)	Modeled Habitat (ac)	Difference	
			(ac)	%
Developed Dry Land	1,711	1,711	0.0	0%
Undeveloped Dry Land	1,348	1,339	-9.5	-1%
Freshwater Marsh	94	94	0.0	0%
Seasonal Marsh	89	87	-2.0	-2%
Salt Marsh	185	195	10.6	6%
Tidal Flat	19	19	0.3	1%
Ponded/Mudflat	13	13	0.0	0%
Ocean Beach	50	50	0.4	1%
Open Water	386	387	0.2	0%

When the mapped vegetation is input to the model, some habitats change, since actual vegetation does not always follow the rules of the model. For example, SLAMM converts undeveloped upland to freshwater or irregularly-flooded marsh based on the elevations from the topography. In the San Dieguito Lagoon, SLAMM allows this conversion in the Del Mar Fairgrounds south overflow lot, which has been restored since the 2016 wetland mapping, so is appropriately expected to be marsh in the near-term. Note that the available LiDAR topography data used for this assessment was collected before the south overflow lot restoration. The south overflow lot was therefore input to SLAMM as undeveloped upland for consistency with the pre-restoration

topography input to the model. This explains the 6% discrepancy between the 2016 wetland mapping and the total salt marsh area predicted by SLAMM under current conditions. Aside from the restored marsh in the south overflow lot, the model validation shows that SLAMM is able to recreate the existing habitat acreages with an error of 2 percent or less.

4.2 Projected Habitat Change with Sea-Level Rise

Table 7 presents the habitat acreages with different levels of SLR in the Del Mar and San Dieguito Lagoon area, which are mapped in Figures 4 through 7. Note that at the west end of W1, there is an elevated area for bird nesting. This area was classified in SLAMM as “Freshwater forested/scrub,” which is depicted in the same color as freshwater marsh areas in Figures 3-7. Because the area is relatively high and because it classified as forested/scrub, it evolves similarly to Undeveloped Dry areas (orange in the figures), rather than the low-lying freshwater marsh.

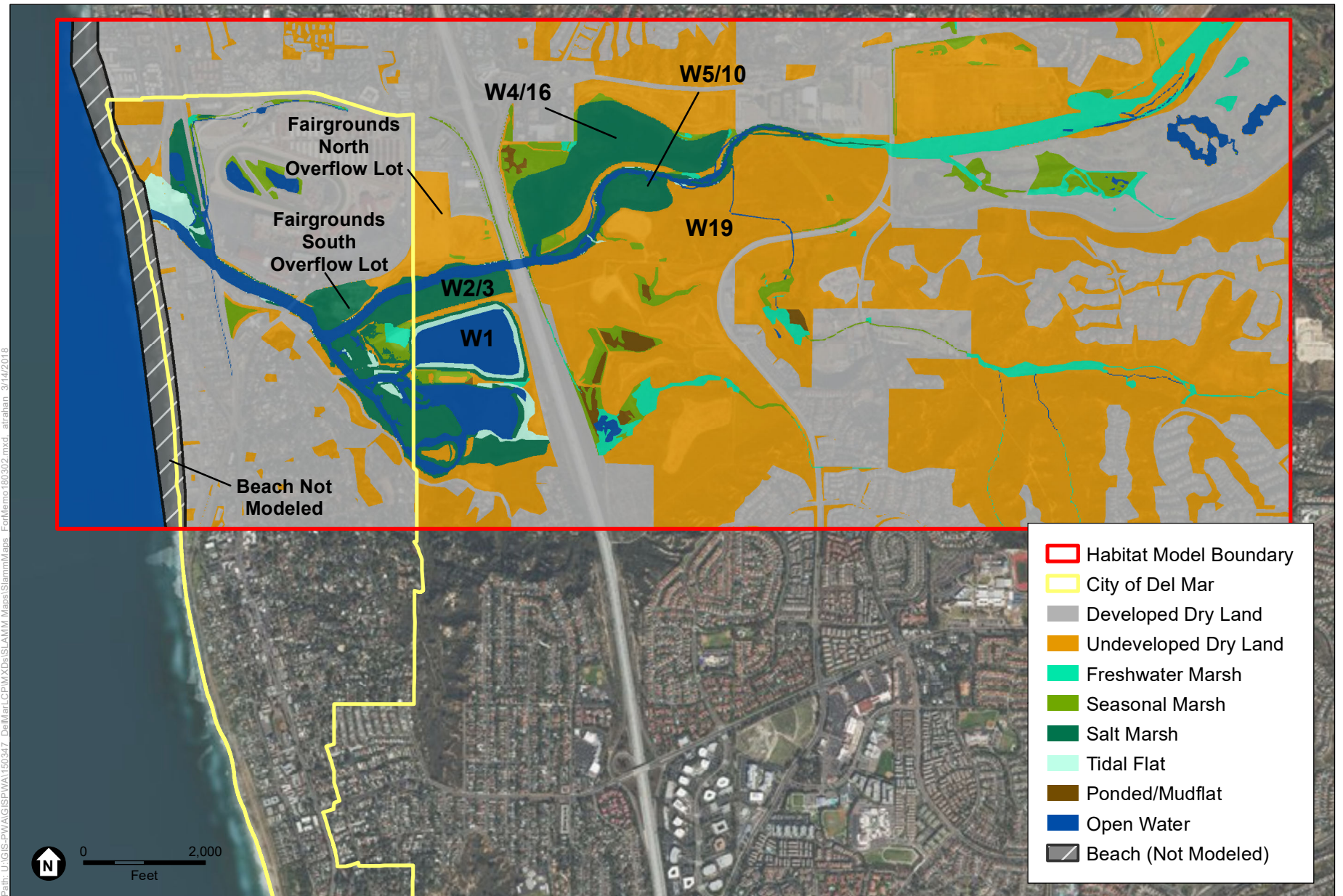
The developed dry land area remains constant with increasing amounts of SLR, since the model was run assuming development is protected, while undeveloped dry land decreases as habitats migrate to higher elevations. Since the freshwater marsh is almost exclusively higher in the watershed along the San Dieguito River, it experiences little change, while seasonal marsh, lower in the watershed steadily converts to salt marsh habitats. Salt marsh increases with 1 foot of SLR, as low-lying dry land near the lagoon converts, but then decreases with 2 or more feet of SLR, as the low, flat salt marsh areas convert to tidal flat more rapidly than the steep edges of the lagoon convert to salt marsh. The total area of salt marsh increases with 5.5 feet of SLR because portions of Del Mar Fairgrounds east overflow lot, seasonal marsh in W4/16, uplands in W19, and the area east of I-5 and south of the San Dieguito River convert to salt marsh in the model. As discussed further below, the conversion of these areas to salt marsh with SLR depends on actions by the Del Mar Fairgrounds, W19 Restoration Project, and others. Tidal flats increase until water levels are very high (+5.5 feet), at which point some areas convert to open water.

With 1 foot of SLR, salt marsh around the edges of W1 begins to convert to tidal flat, leaving a small ring of salt marsh (Figure 4) until 3.2 feet of SLR is reached (Figure 6). With 2 feet of SLR, much of W4/16 converts to tidal flat and the channel south of W5/10 converts to tidal flat as well (Figure 5). Additionally, the east overflow parking lot of the Del Mar Fairgrounds begins to convert to salt marsh under 2 feet of SLR. Because this area does not show up as developed land in the habitat mapping, it is allowed to convert to marsh. However, the Fairgrounds may decide to protect this area and not allow conversion.

With 3.2 feet of SLR, most of W4/16 is tidal flat, the edge of W2/3 has begun to convert to tidal flat, and W1 is almost entirely open water. With 5.5 feet of SLR, most of the Fairgrounds undeveloped land has converted to salt marsh, W1 and W4/16 are largely open water, and W2/3 and W5/10 are mostly tidal flat. Salt marsh also begins to expand east of I-5 and south of the river, although parts of this habitat are disconnected to tidal flow, so could be seasonal marsh habitat as rain and stormwater pond and evaporate.

TABLE 7
HABITAT ACREAGES IN SAN DIEGUITO LAGOON REGION WITH RISING SEA LEVEL

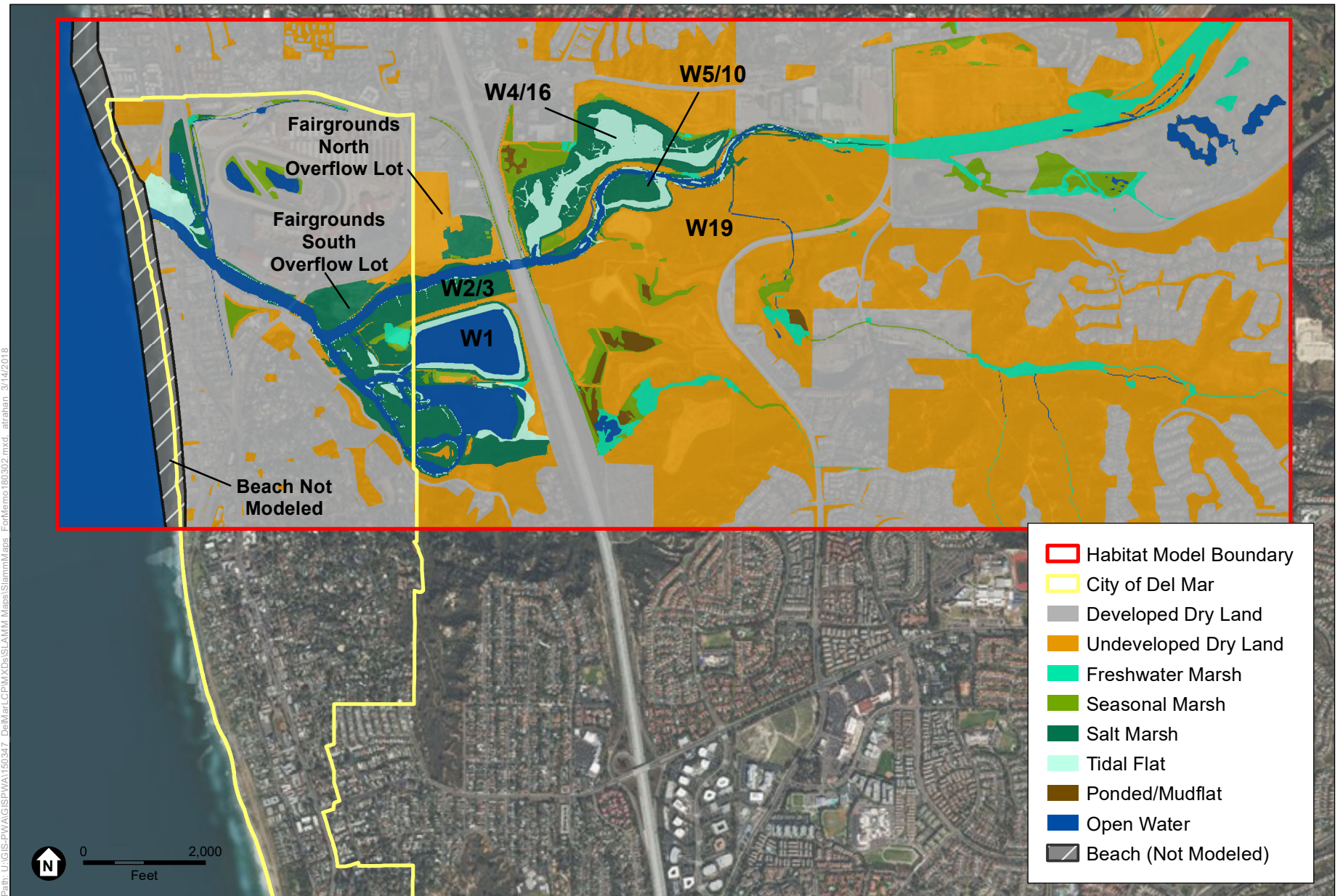
Habitat*	Modeled Existing Conditions	+ 1.0 foot SLR	+ 2.0 feet SLR	+ 3.2 feet SLR	+ 5.5 feet SLR
Developed Dry Land	1,711	1,711	1,711	1,711	1,711
Undeveloped Dry Land	1,348	1,328	1,309	1,286	1,199
Freshwater Marsh	94	94	94	95	94
Seasonal Marsh	89	85	81	71	50
Salt Marsh	185	199	177	175	215
Tidal Flat	19	27	72	90	73
Ponded/Mudflat	13	13	13	11	2
Open Water	386	388	408	434	536



SOURCE: ESA 2018
Basemap, ESRI 2018



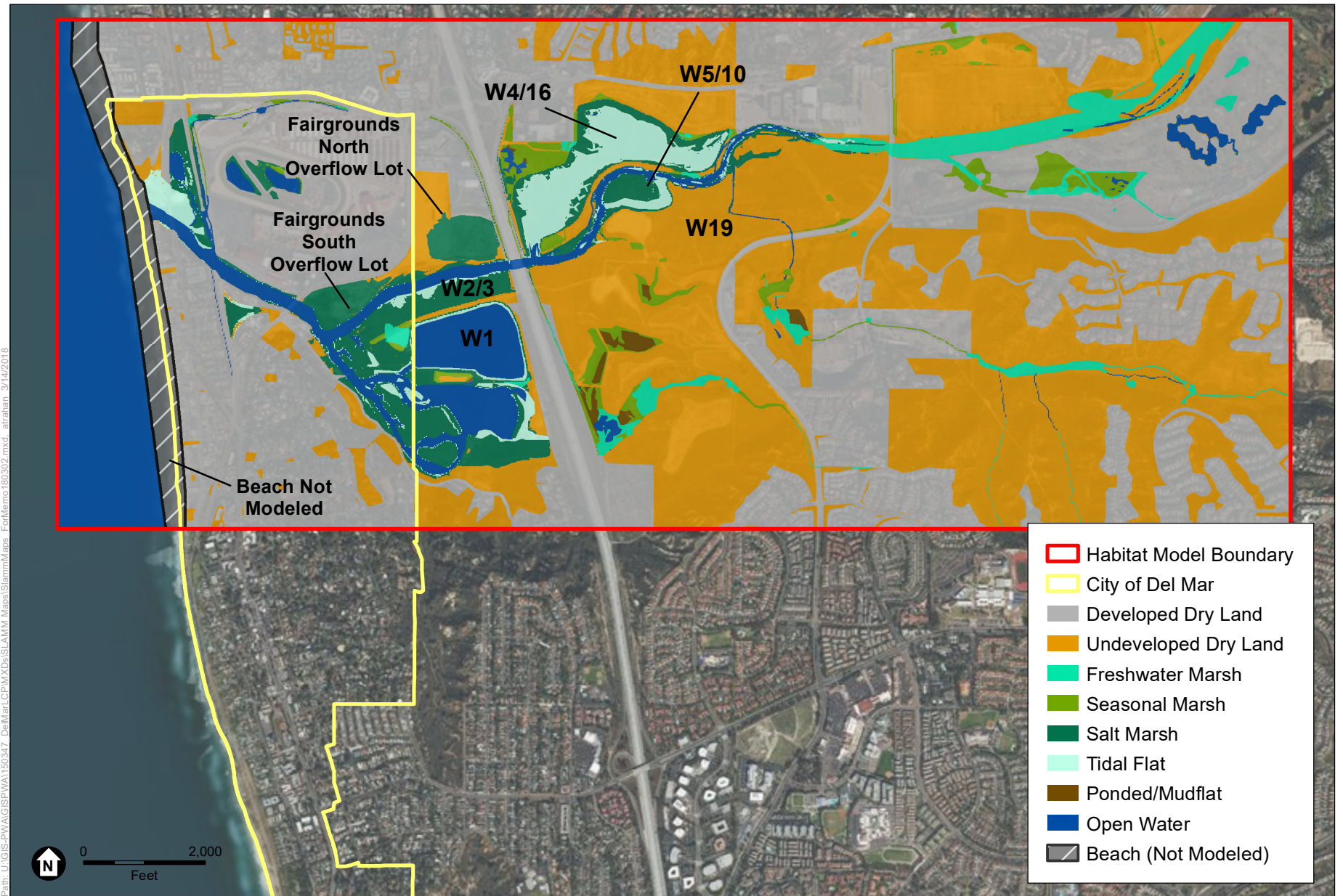
Del Mar LCP Amendment
Figure 4
SLAMM Results
Habitats with +1.0 foot SLR



SOURCE: ESA 2018
Basemap, ESRI 2018



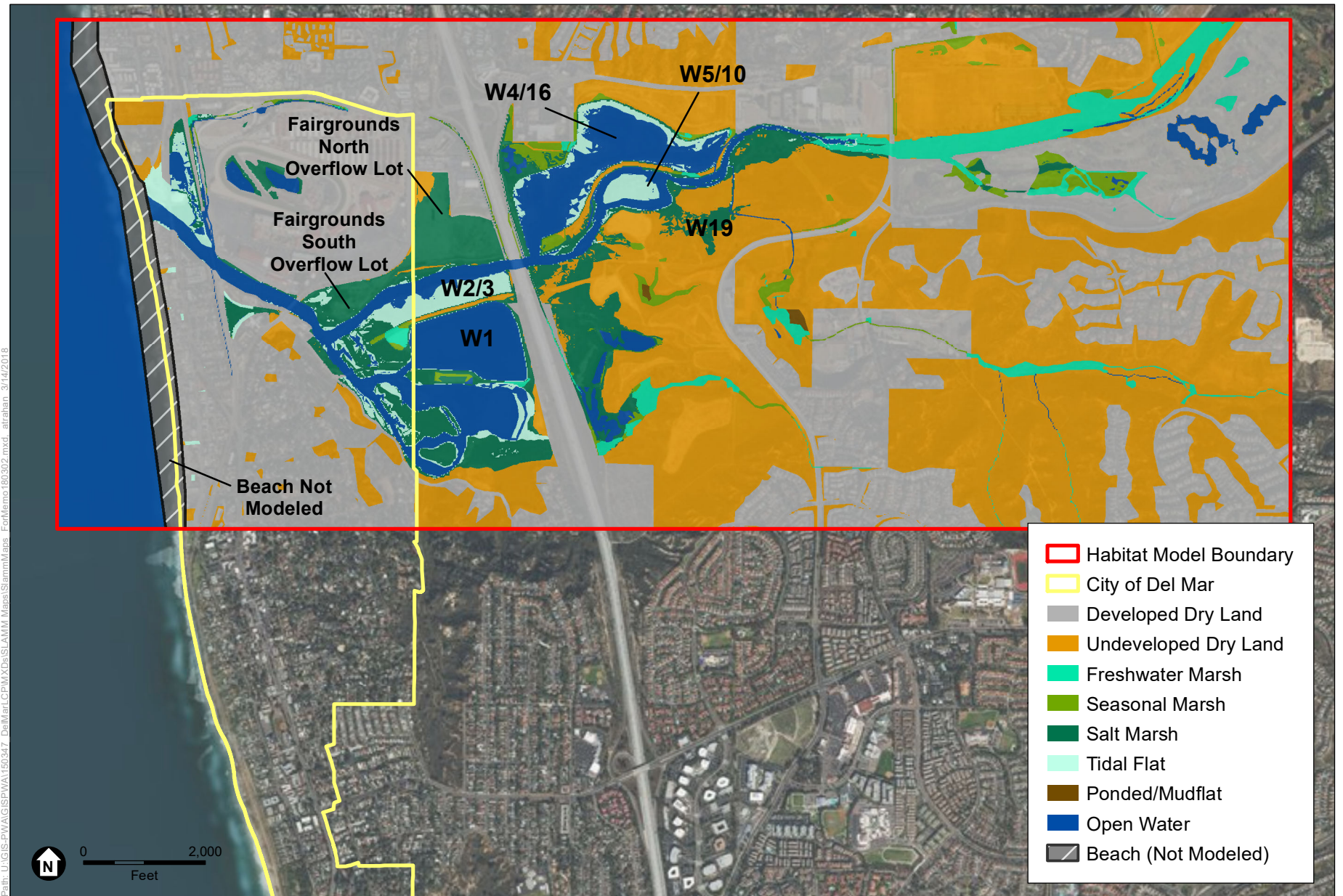
Del Mar LCP Amendment
Figure 5
SLAMM Results
Habitats with +2.0 feet SLR



SOURCE: ESA 2018
Basemap, ESRI 2018



Del Mar LCP Amendment
Figure 6
SLAMM Results
Habitats with +3.2 feet SLR



SOURCE: ESA 2018
Basemap, ESRI 2018



Del Mar LCP Amendment
Figure 7
SLAMM Results
Habitats with +5.5 feet SLR

Habitat areas for the portion of the study area in the City of Del Mar are presented in Table 8, with figures focusing on the area available in Appendix A. Most of Del Mar is developed and thus protected under the model assumption.

As discussed above (Section 3.1.2), the south overflow parking lot for the Del Mar Fairgrounds has been restored since the wetland mapping that was used in the modeling was completed. The model results show this area converting to salt marsh with 1 foot of SLR. There are some additional low-lying areas between the Fairgrounds and the San Dieguito River that could convert to salt marsh as well, if habitat is allowed to migrate into these areas. The tidal flat areas are relatively stable except under extreme SLR (+5.5 feet), at which point salt marsh adjacent to San Dieguito River converts to tidal flats, increasing the tidal flats acreage and dropping the total salt marsh acreage.

Specifically, at the mouth of the lagoon, open water habitat increases over time at the expense of tidal flat and ocean beach. By 5.5 feet of SLR, much of the salt marsh north of the lagoon mouth and west of the Jimmy Durante Boulevard bridge (owned by the State Lands Commission) has converted to tidal flat.

The triangle of land south of the river between the railroad and Jimmy Durante Boulevard is mapped as seasonal wetland under existing conditions. With 3.2 feet of SLR, this area will be at elevations appropriate for salt marsh, and with a tidal connection and flood control measures, could be restored to create additional habitat.

TABLE 8
HABITAT ACREAGES WITHIN CITY OF DEL MAR WITH RISING SEA LEVEL

Habitat*	Modeled Existing Conditions	+ 1.0 foot SLR	+ 2.0 feet SLR	+ 3.2 feet SLR	+ 5.5 feet SLR
Developed Dry Land	496.4	496.4	496.4	496.4	496.6
Undeveloped Dry Land	65.8	51.4	47.8	43.4	35.9
Freshwater Marsh	3.2	3.2	3.2	3.2	2.6
Seasonal Marsh	17.5	14.6	11.5	4.0	2.2
Salt Marsh	38.0	54.2	58.5	65.3	52.1
Tidal Flat	13.3	13.2	14.6	16.4	28.0
Open Water	273.5	274.5	291.7	302.8	318.5

Although there are a few areas within the City of Del Mar where habitat migration could occur, the opportunities for restoration are almost exclusively upstream (east) of the Del Mar city limit. Options for the City of Del Mar are addressed in the following sections.

4.3 Migration Assessment Conclusions

The general habitat trends in the San Dieguito Lagoon area are described in Section 4.2, but there are a few locations that merit additional discussion. First, the NCTD's triangle-shaped stormwater

detention and seasonal wetland area south of the San Dieguito River between the railroad and Jimmy Durante Boulevard has the potential to convert and support salt marsh habitat with sea-level rise. This area could potentially be restored to salt marsh habitat that would be resilient with up to 5.5 feet of SLR. Planning the conversion/restoration of this area to salt marsh would involve planning flood management improvements around the southern perimeter of the area. This area could be restored to resilient salt marsh in conjunction with other SLR adaptation measures identified in the City of Del Mar's Draft Sea-level Rise Adaptation Plan, such as relocating the City of Del Mar's Public Works Yard (located between the river and this wetland area) and construction of a "living levee" to reduce river flood risks.

Second, as discussed in Section 3.1.2, the Del Mar Fairgrounds have completed a restoration project in the south overflow parking lot. With +1.0 foot SLR, SLAMM converts the area from undeveloped dry land to salt marsh, so the model recognizes habitat transgression through the area, but the topography does not include grading and channels from the project.

Third, the Del Mar Fairgrounds also owns an east overflow parking lot north of San Dieguito River between the Fairgrounds and I-5. This area is largely open space and could be allowed to convert to habitat without much grading (i.e., the land is at appropriate elevations for salt marsh) as sea level rises. The SLAMM model indicates this would begin to happen with +2.0 feet SLR, with the area being almost fully converted to Salt Marsh with +5.5 feet SLR. The 22nd District Agricultural Association has an existing Coastal Development Permit to use this lot, but the permit is time-limited for the lower third of the lot. If the Fairgrounds parking needs could be met elsewhere, restoration of this parcel could be considered when the current permit expires in 2023.

Fourth, the San Dieguito River Park Joint Powers Authority is planning the W19 Restoration Project to restore approximately 141 acres of additional San Dieguito Lagoon wetland habitat east of the City of Del Mar and I-5. The proposed restoration is not included in the model, but would provide additional salt marsh when implemented. Note that excavation to restore salt marsh in W19 may result in the restored areas converting to tidal flat and open water with SLR, which would reduce the area of salt marsh modeled with SLR.

Fifth, the upland and seasonal marsh areas east of I-5 and south of the river in the City of San Diego has the potential to convert to salt marsh habitat with SLR, which would improve the resiliency of San Dieguito Lagoon wetland habitats with SLR. Further investigation and coordination with the City of San Diego would be needed to further assess and plan for habitat migration in this area.

Sixth, there is a relatively high-elevation (about 7.5 feet) island at the south end of the lagoon, west of I-5, which currently supports salt marsh species, despite that the island's elevation is above high tide. SLAMM results indicate that this area will remain salt marsh with SLR (even as high as +5.5 feet SLR), providing a degree of resilience to the site.

It is important to note that the accretion rates used for this assessment (see Section 3.1.4) are based on available data for San Elijo Lagoon from the recent past, when urban development and farming in the watershed are likely to have increased sedimentation and accretion rates. Future accretion rates in San Dieguito Lagoon may be lower than modeled because sedimentation rates

may be lower now (and in the future) than sedimentation rates that occurred following watershed development. With a lower accretion rate, the trends and processes described in this report are still projected to occur, but would occur with less sea-level rise (i.e., sooner) because lower accretion rates would be outpaced sooner by rising sea level.

In conclusion, geography and existing development constrain San Dieguito Lagoon marsh habitats in Del Mar and do not permit much habitat migration with SLR. Within the City of Del Mar, the primary opportunity for improving marsh habitat resiliency is the potential to convert/restore the City's stormwater detention and seasonal wetland area south of the San Dieguito River to salt marsh habitat with sea-level rise. Within the Del Mar Fairgrounds, restoration of the south overflow lot to salt marsh has already been completed. The east overflow lot has the potential to convert to salt marsh with sea-level rise; however, this would conflict with the existing use of the east overflow lot for Fairgrounds parking. There are options for migration east of I-5, but elevations and freshwater influence limit the inland incursion of saline habitats. East of I-5, high SLR could convert uplands to salt marsh and connect lower-elevation seasonal wetland areas adjacent to the highway to the lagoon. This would not begin naturally until sea level rises about 3.5 feet, unless the W-19 Restoration Project provides lower-elevation pathways to these adjacent areas that allow habitat migration earlier.

The City of Del Mar's Draft SLR Adaptation Plan identifies three potential wetland habitat adaptation measures:

- Allow/facilitate wetland conversion and transgression
- Sediment placement
- Wetland expansion/restoration

This Habitat Migration Assessment and the discussion above identifies the primary opportunities and considerations for San Dieguito Lagoon wetland conversion, transgression, and expansion/restoration with SLR. Given that the majority of existing salt marsh habitats are projected to convert to tidal flat and open water with SLR, sediment placement to maintain existing salt marsh habitats may warrant further consideration as a sea-level rise adaptation measure. As discussed in the Draft SLR Adaptation Plan, the first such sediment placement project on the West Coast was completed in April 2016 at the Seal Beach Wetlands (USFWS 2016 and 2017). Sediment placement could be assessed further as a potential adaptation measure for San Dieguito Lagoon. Appropriate sources of sediment would need to be identified (e.g., fine grained sediment) and may be limited within the San Dieguito Lagoon.

4.4 Additional Considerations

The City of Del Mar's Adaptation Plan includes management of flood risk through beach replenishment, channel dredging, and possibly the construction of levees along the river. The City of Del Mar's Sediment Management Plan further assesses beach replenishment and channel dredging. The wetland habitat adaptation measures discussed above, including restoring areas of salt marsh, are expected to be compatible with other adaptation measures described in the

Adaptation Plan and Sediment Management Plan. Restoring certain areas to marsh may require a new levee/berm around the landward edge of the marsh. If the area provides stormwater detention/retention and/or flood management functions, these functions would need to be considered in the design of the restoration.

Groundwater management may also have an impact on future restoration and evolution of existing marshes. The Sustainable Groundwater Management Act (2014) requires groundwater basin management and the Olivenhain Municipal Water District is considering development of a management program. Management of groundwater in the area could affect salinity, and therefore habitat. Groundwater hydrology and salinity could be considered further for future management and restoration studies.

Currently, SCE/SDG&E conduct habitat monitoring of the SONGS restoration site. Coordination with the SONGS researchers is recommended to understand best practices for restoration as well as habitat trends over time.

SECTION 5

Management and Adaptation Measures

There are a variety of adaptation measures the City of Del Mar can consider putting into place to protect the few habitat migration areas available in the city and to provide habitat corridors. The following are a suite of adaptation measures that could be considered for Del Mar and surrounding areas:

5.1 Identify Potential Conservation Areas

Although not much land is available for habitat migration within the City of Del Mar, potential habitat areas can be identified for conservation as needed to maintain viability of the habitat types that are projected to be impacted by SLR. Existing habitat corridors should be prioritized to help connect larger areas of wildlife habitat and maintain the long term viability of wildlife populations that otherwise could be disconnected and potentially lost as a result of surrounding development, roads, and structures. Conservation of potential habitat corridors should account for the proximity to existing development, the habitat species likely to utilize the corridor, best practices regarding adequate setbacks or buffer widths appropriate to the species present to ensure minimal impacts, and whether reasonable development area can be maintained on affected property, where applicable.

5.2 Limit Allowable Uses

Currently, the City of Del Mar limits allowable uses surrounding the San Dieguito Lagoon through a variety of open space, floodway, and floodplain policies within the Environmental Management section of the Del Mar Community Plan. The City also uses various zoning regulations within the Del Mar Municipal Code to protect sensitive resources adjacent to the lagoon including the Floodway Zone, Floodplain Overlay Zone, Open Space Overlay Zone, Lagoon Overlay Zone, and Bluff, Slope, and Canyon Overlay Zone.

If desired, the City can process a Community Plan amendment to designate new habitat conservation areas on a map (with corresponding habitat buffer policies) as a means to accommodate future habitat migration adjacent to the San Dieguito Lagoon. Protection of conservation areas can also be implemented through a Zone Code amendment to expand on existing overlay zones or create new regulations that limit allowable uses. The plan amendment and code amendment changes described would also require a Local Coastal Program amendment and would involve a public hearing process. Consideration would need to be made regarding the current land use designations and allowed uses to avoid a property takings.

5.3 Zoning Setbacks

The City can choose to amend the Zoning Code to apply minimum setbacks as needed to limit the extent of development activity in areas designated for habitat migration corridors. This approach can be used to ensure that proposed new development would avoid encroachment or avoid impacts to the movement of fish and wildlife through the designated corridor.

5.4 Conservation Easements

Conservation easements (building restricted easements) could be applied as a condition of permit approval to portions of properties within a designated conservation area in order to establish limits on activities and structures within the easement. Establishment of conservation easements is similar to land acquisition (described in Section 5.5) except that it would not require ownership of land to be transferred to the City or a conservation non-profit. It also allows portions of property to be set aside for conservation purposes rather than the purchase of an entire parcel. Conservation easements require willing participation by the property owner and could be costly. In some cases, property owners may be willing to volunteer land towards conservation. The City could also consider creating incentives to encourage owners to voluntarily establish a conservation easement (i.e. increased densities or transfer of development rights).

5.5 Potential Land Acquisition

Purchasing property and placing a permanent protective easement on the property in perpetuity is one of the most effective ways to set aside land to allow for species migration. This measure requires identification of suitable lands, purchasing of property from willing sellers, establishment of a protective easement, possible restoration of the property (e.g., demolition of existing structures, reestablishment of native plantings, etc.), and ongoing maintenance of the property. Property acquisition is one of the costliest approaches to protecting land for habitat migration and is usually achieved through a variety of funding mechanisms or partnership with non-profit or state resource agencies. Property acquisition requires a willing seller.

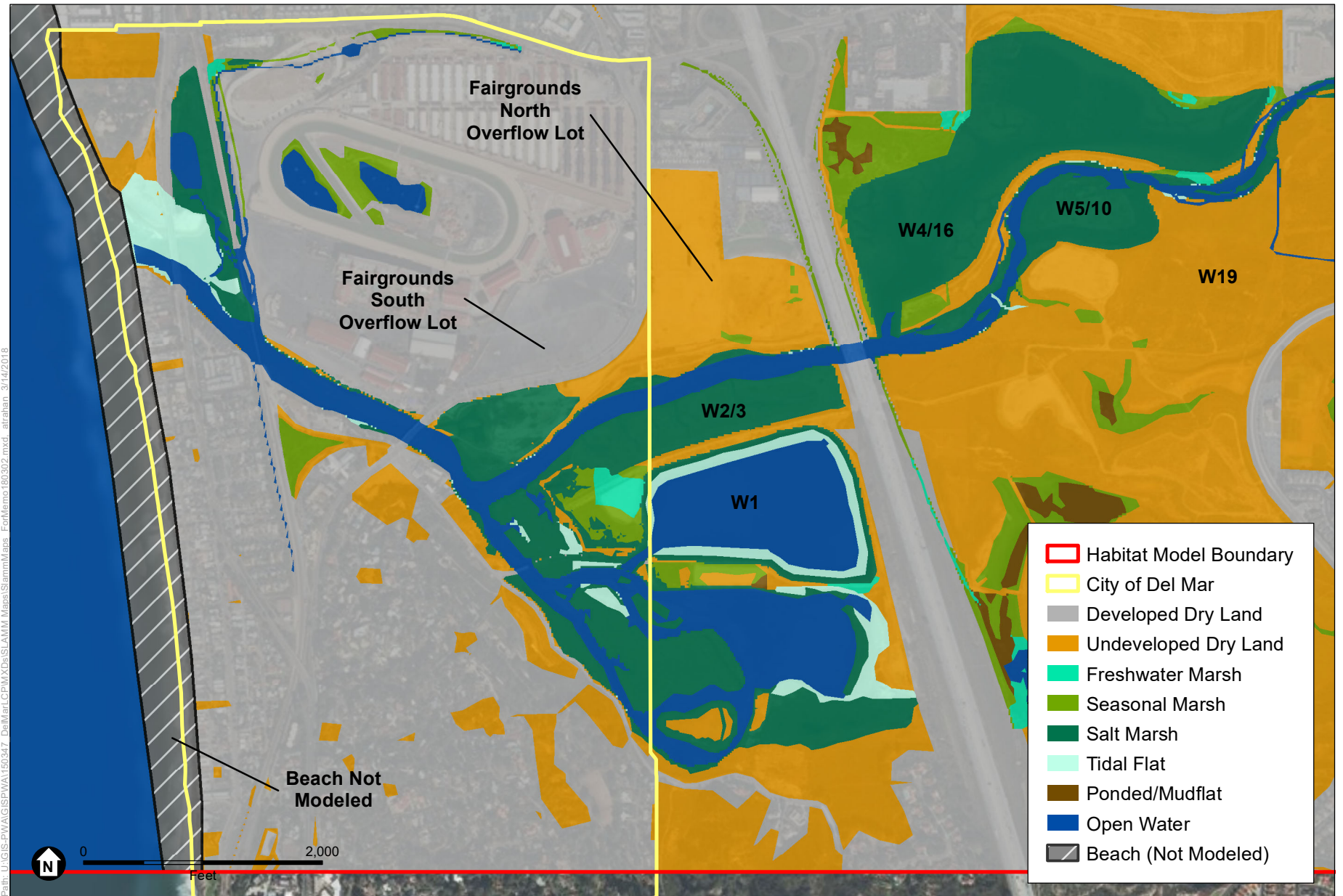
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APPENDIX A

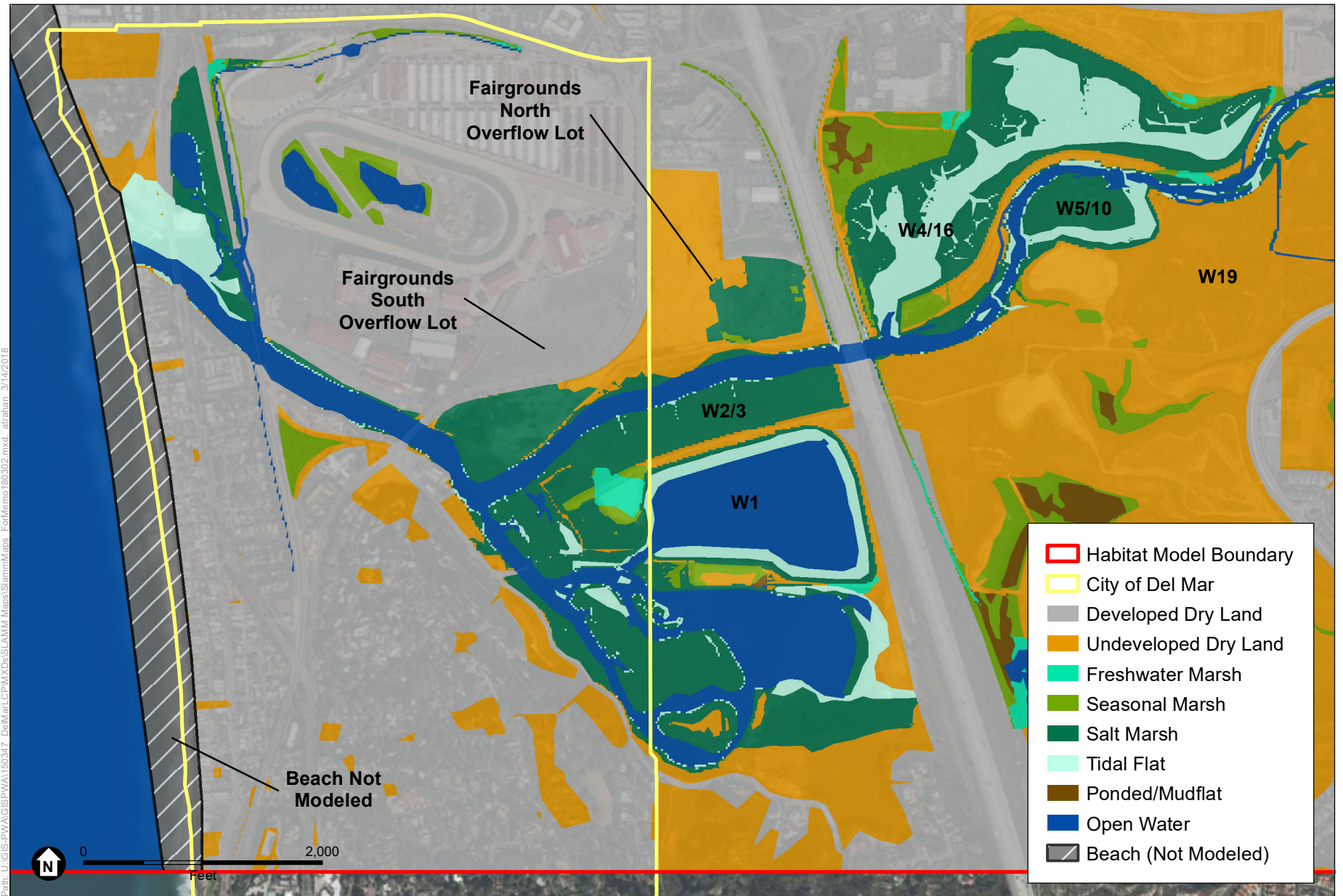
Habitat Evolution Figures for City of Del Mar



SOURCE: ESA 2018
Basemap, ESRI 2018



Del Mar LCP Amendment
Figure A-1
SLAMM Results in City of Del Mar
Habitats with +1.0 foot SLR

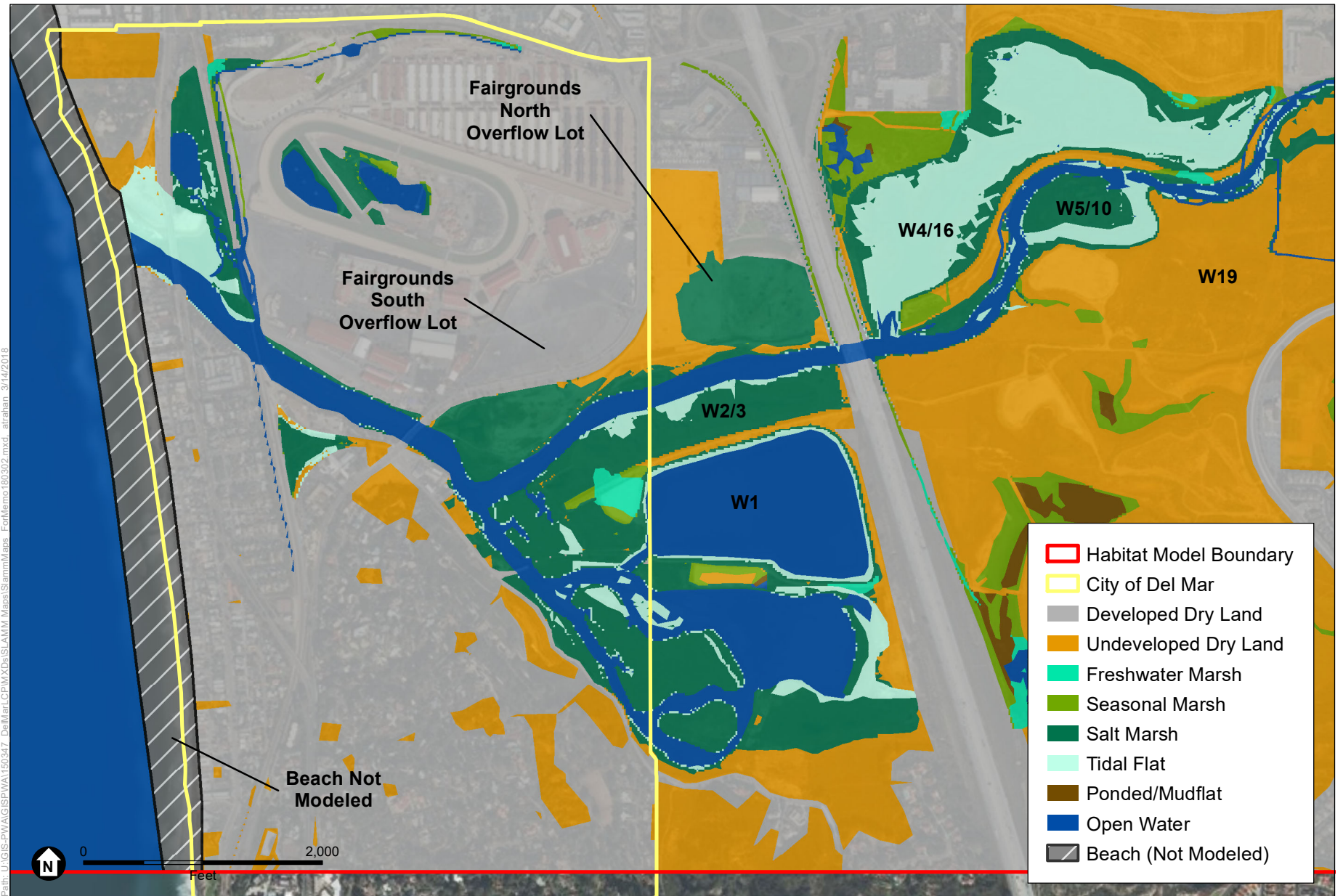


SOURCE: ESA 2018
Basemap, ESRI 2018



Del Mar LCP Amendment

Figure A-2
SLAMM Results in City of Del Mar
Habitats with +2.0 feet SLR

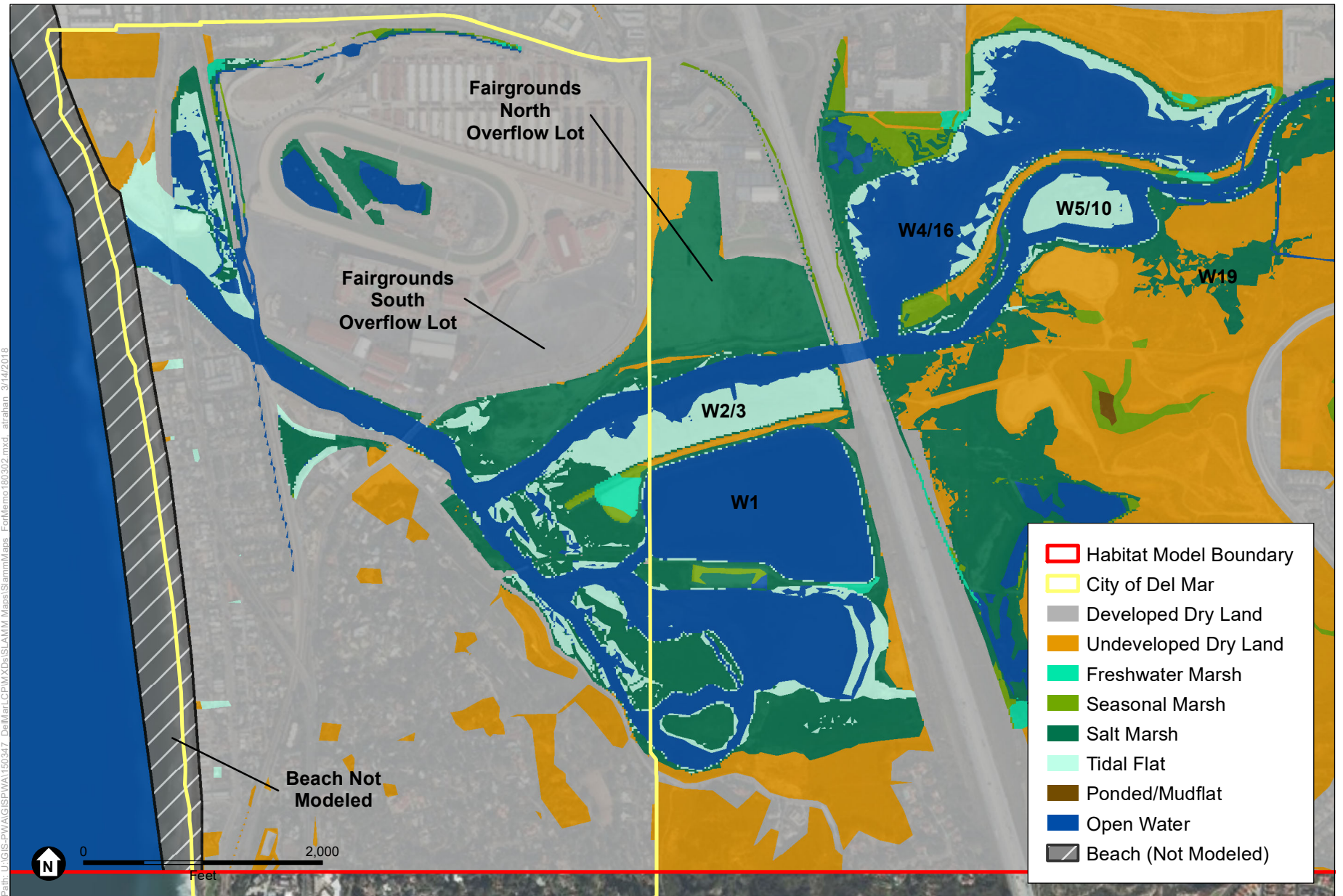


SOURCE: ESA 2018
Basemap, ESRI 2018



Del Mar LCP Amendment

Figure A-3
SLAMM Results in City of Del Mar
Habitats with +3.2 feet SLR



SOURCE: ESA 2018
Basemap, ESRI 2018



Del Mar LCP Amendment
Figure A-4
SLAMM Results in City of Del Mar
Habitats with +5.5 feet SLR