Appendix 4: Methods for Developing Goal 1 Objectives

of the *Wetlands on the Edge: The Future of Southern California's Wetlands Regional Strategy 2018*

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The following document explains how data from the past, the present, and the future were used to develop quantitative objectives for Goal 1.

Mapping of Habitat Distributions

Historical Habitat Distribution

Historical habitat distribution was referenced from the Historical Wetlands of the Southern California Coast: An Atlas of US Coast Survey T-Sheets, 1851-1889 report (Figure 1A). Mapping was implemented by the Southern California Coastal Water Research Project (SCCWRP), the San Francisco Estuary Institute (SFEI) and the Center for Geographic Studies at California State University, Northridge (CSUN). Some systems (e.g., Tijuana, Northern San Diego Lagoons) have undergone more extensive analysis of historical sources which have updated the historical habitat mapping from this source.

Present Habitat Distribution

Contemporary habitat mapping was developed by Southern California Wetland Mapping Project (SCWMP) (2013), which utilizes the Cowardin classification system (Cowardin et al 1979) and follows National Wetlands Inventory (NWI) standards. Figure 1B lists the classes that were extracted from the SCWMP dataset and the crosswalk used for the historical mapping.

The Cowardin classification system utilized by the SCWMP (2013) layer does not distinguish between intertidal flats and salt pannes and, therefore, in the present habitat mapping (Figure 1B) no salt panne areas are shown in the profile maps (except for Tijuana). To better compare the historical habitat conditions to the present day, additional analysis could be conducted to separate out salt pannes from intertidal flats. For example, if estuarine unvegetated wetlands within the SCWMP (2013) dataset have no direct connection to subtidal water, then they could be reclassified as 'salt pannes' and then QAQCed by wetland managers for a contemporary 'salt panne' layer (similar to Tijuana).

Table 1. Sources for (A) historical and (B) present habitat distribution mapping

	Habitat Distribution	Time period Depicted	Source	Attribute Field	Original source classification	Crosswalk classification
A	*Historical Habitat*	1851-1889	SCCWRP, SFEI, CSUN (2014)	Web_Class	Subtidal Water	Subtidal
					Intertidal Flat	Intertidal Flat
					Vegetated Wetland	Tidal Marsh
					Salt/Unvegetated Flat	Salt Pannes
B	*Present Habitat*	2005	SCWRP 2013	Q1_Simp_Class	Subtidal Water	Subtidal
					Estuarine Unvegetated Wetland	Intertidal Flat
					Estuarine Vegetated Wetland	Tidal Marsh

Future Habitat Distribution

The impacts of sea-level rise on coastal wetlands were analyzed through a modeling effort (Appendix 3). This analysis relied on current wetland maps, sea-level rise predictions, and available migration space within undeveloped lands.

Mapping Developed Land

The extent of wetland migration space with sea-level rise will vary depending upon the constraint of the surrounding development. The SAP suggested 'book ending' possible scenarios for calculating potential future wetland areas and suggested having two options: 1) omitting developed areas and 2) including all areas regardless of land-use (unconstrained by development). Initially areas of development were identified using the 2011 National Land Cover Database and 2015 California Protected Areas Database datasets, however the resolution of these datasets was insufficient at this scale of mapping. Therefore, aerial imagery was directly referenced and areas that were observed to be developed were digitized as polygons and excluded from area calculations. These areas are labeled 'constrained by developed areas'. If areas within the 'wetland boundary' were not developed then it was assumed that those areas could be available for future wetland or transition zones and are referred to as 'unconstrained by development'.

It was decided by the SAP that planted/cultivated lands would also be included in the available migration space although there is uncertainty about the future dedication of these lands to future marsh. Some croplands may be as valuable as the built environment and might be subject to the same degree of protection from sea level rise. Saltwater intrusion due to sea level rise, the cost of building and maintaining levees, and an increased frequency of extreme flood events could eventually render these lands unsuited for agriculture (National Research Council 2012). Adding these croplands into the category of undeveloped lands could significantly increase the estimated amount of space potentially available to accommodate transition zone migration.

Mapping Marsh Migration Zones

We determined how much existing development affects the restoration footprint planning first by completing a primarily "topographic" analysis of "areas that will be inundated by our future tides (i.e., the 24-inch and 66-inch sea level rise scenarios) and areas that will become potential wetlands. Then, we acknowledged that some of these developed areas will be “protected” (raised or with levees) whereas others may choose to “retreat”, and assumed that some developed areas may become available for future use.

Mapping of Transition Zone

Mapping methodology varied for three different designated types of transition zones. For hillslope transition zones, the lower boundary of the transition zone was first determined using Highest Observed Water Level (HOWL), or by using OCOF flooding extents to incorporate sea level rise. The upper boundary was 500m out from the lower end of the transition zone. The land use layer was then overlapped to identify undeveloped areas that could be restored or conserved to support transition zone habitats. For riverine/stream transition zones, the extent of tidal and fluvial flooding were modeled using RIPZET (SFEI 2015), FEMA maps (https://www.fema.gov/national-flood-hazard-layer-nfhl), or other available data and tools. The outer boundary was determined by adding 50m of width beyond the extent of flooding. For cliff/bluff transition zones, the upper boundary was extended 50m from the edge of the cliff/bluff. If the change in slope was more than 500m from the lower extent of the transition zone, the transition zone was determined using the hillslope method. See more detailed information on transition zone mapping methodology in Appendix 9.

Methodologies for Objectives

Objective 1: Restore Wetland Area

The historical, present and future wetland area were calculated based on the mapping methodology described above. The future values incorporated existing wetland area plus the potentially restorable area, which included the undeveloped area that will be tidally inundated after 24 inches of sea level rise (assuming hydraulic connectivity is restored).

Objective 2: Restore Wetland Size

The size distributions of historical, present and future estuarine systems in each of the subregions were calculated for each system or system fragment. Historical values were calculated using historical estuarine wetland area, and present day values using existing estuarine wetland area. Future values were calculated using existing estuarine area plus the potential restorable area (the undeveloped area that will be tidally inundated after 24 inches of sea-level rise, assuming hydraulic connectivity is restored). Table 2 shows past, present and future acreages for all individual systems, excluding harbors and bays.

Table 2. Historical, present and future acreages for each individual wetland system. Acreages include flat and vegetated tidal marsh. Open harbors and bays were excluded from this table.

System Name	Subregion	Historical Acreage	Present Acreage	Future Acreage
Damsite Canyon	Santa Barbara Coast	0	0	0
Arroyo San Augustin	Santa Barbara Coast	0	0	0
Arroyo de las Aguas	Santa Barbara Coast	0	0	0
Arroyo el Bulito	Santa Barbara Coast	0	0	0
Canada del Agua	Santa Barbara Coast	0	0	0
Canada del Santa Anita	Santa Barbara Coast	0	0	1
Hollister Ranch Creek	Santa Barbara Coast	0	0	0
Canada del la Gaviota Creek	Santa Barbara Coast	14	0	3
Arroyo Quemado	Santa Barbara Coast	0	0	0
Tajiguas Creek	Santa Barbara Coast	8	0	0
Canada del Refugio	Santa Barbara Coast	23	0	0
Las Llagas Canyon Creek	Santa Barbara Coast	0	0	0
Eagle Canyon Creek	Santa Barbara Coast	0	1	1
Tecolate Canyon Creek	Santa Barbara Coast	0	0	3
Bell Canyon Creek	Santa Barbara Coast	3	2	1
Devereux Lagoon	Santa Barbara Coast	0	29	5
UCSB Lagoon	Santa Barbara Coast	0	1	3
Goleta Slough	Santa Barbara Coast	724	172	410
Arroyo Burro Creek Estuary	Santa Barbara Coast	0	0	3
Mission Creek Lagoon	Santa Barbara Coast	111	2	59
Sycamore Creek	Santa Barbara Coast	6	0	3
Andree Clark Bird Refuge	Santa Barbara Coast	11	0	0
Arroyo Paredon Creek	Santa Barbara Coast	0	0	3
Carpinteria Salt Marsh	Santa Barbara Coast	290	192	236
Carpinteria Creek	Santa Barbara Coast	1	0	0
Rincon Creek	Santa Barbara Coast	0	0	0
Ventura River Estuary	Ventura Coast	17	8	108
San Buena Ventura	Ventura Coast	0	2	0
Santa Clara River Estuary	Ventura Coast	46	178	370
McGrath Lake	Ventura Coast	6	2	0
Ormond Beach	Ventura Coast	108	27	722
Mugu Lagoon	Ventura Coast	2702	1695	4324
Big Sycamore Canyon	Santa Monica Bay	0	1	4
Arroyo Sequit	Santa Monica Bay	0	0	0
Trancas Lagoon	Santa Monica Bay	0	0	0
Dume Lagoon	Santa Monica Bay	0	1	8
Solstice Canyon	Santa Monica Bay	0	0	0
Malibu Lagoon	Santa Monica Bay	37	19	37
Las Flores Canyon	Santa Monica Bay	0	0	0
Topanga Creek	Santa Monica Bay	0	0	0

Ballona Lagoon	Santa Monica Bay	17	5	14
Ballona Creek	Santa Monica Bay	56	0	21
Ballona Wetlands	Santa Monica Bay	414	160	314
Del Rey Lagoon	Santa Monica Bay	9	0	24
Los Angeles River	San Pedro Bay	318	4	83
Alamitos Bay	San Pedro Bay	1122	32	262
Los Cerritos Wetlands	San Pedro Bay	645	0	393
Los Cerritos Channel	San Pedro Bay	8	0	21
San Gabriel River	San Pedro Bay	77	1	18
Anaheim Bay	San Pedro Bay	1201	646	789
Wintersburg Channel	San Pedro Bay	52	0	17
Bolsa Bay	San Pedro Bay	146	47	166
Bolsa Chica Fully Tidal	San Pedro Bay	1115	92	217
Huntington Beach Wetlands	San Pedro Bay	726	93	468
Santa Ana River	San Pedro Bay	31	17	101
Santa Ana Wetlands	San Pedro Bay	194	58	334
Upper Newport Bay	San Pedro Bay	750	440	587
Creek at Corona Del Mar Beach	San Pedro Bay	0	0	0
Los Trancos Canyon	San Pedro Bay	0	0	0
Aliso Creek Estuary	San Pedro Bay	3	0	0
Salt Creek	San Pedro Bay	0	0	0
San Juan Creek	San Diego Coast	1	0	52
Camino Capistrano	San Diego Coast	0	0	0
San Mateo Lagoon	San Diego Coast	61	9	108
San Onofre Creek	San Diego Coast	6	2	6
Las Flores Creek	San Diego Coast	4	4	3
Aliso Canyon Creek	San Diego Coast	12	6	0
French Lagoon (Canyon)	San Diego Coast	15	11	0
Cockleburr Canyon	San Diego Coast	1	4	0
Santa Margarita Estuary	San Diego Coast	385	281	504
San Luis Rey Estuary	San Diego Coast	22	10	84
Loma Alta Slough	San Diego Coast	44	1	8
Buena Vista Lagoon	San Diego Coast	280	105	146
Agua Hedionda	San Diego Coast	297	114	122
Batiquitos Lagoon	San Diego Coast	555	320	283
San Elijo Lagoon	San Diego Coast	527	453	482
San Dieguito Lagoon	San Diego Coast	595	453	499
Los Penasquitos Lagoon	San Diego Coast	488	377	371
North Mission Bay Wetlands	San Diego Coast	247	69	77
San Diego River Estuary	San Diego Coast	500	144	214
Sweetwater Marsh	San Diego Coast	1047	369	382
Otay River Estuary	San Diego Coast	1661	1306	1155

Objective 3: Restore Wetland Archetype Distribution

We identified seven coastal archetypes in the region: small creeks, open bays, small lagoons, intermediate estuaries, large perennially open lagoons, and large river valley estuaries. A ful description of the methodology for developing these archetypes can be found in Appendix 2 - Wetland Classification).

Objective 4: Habitat Diversity

The habitat profile is based upon historical mapping. The proportion of tidal flats and marsh was calculated for the larger systems from an analysis of the historical mapping recorded in T-sheets. Tidal flats included all unvegetated flats, including salt flats and salt pannes, as well as mud and sand flats. Habitat profiles were averaged by subregion and archetype for the archetypes historically present in each subregion. Small creeks and small lagoons were not analyzed as the snapshot provided by historical mapping shows them to be highly variable in their habitat diversity.

Objective 5: Wetland-Upland Transition Zone

Opportunities to restore and create upland transition zones were identified by overlaying maps of topography, wetland habitat and development. Areas adjacent to existing wetlands that were above tidal inundation and undeveloped have been considered as potential transition zone. The length of perimeter along which existing wetlands were adjacent to existing or potential transition zones were estimated from aerial imagery.

Objective 6: Restore Hydrological Connectivity

The habitat profile of the fragmented system is based on its historical archetype. The hydrologic connectivity will be defined by inundation regime based on historical tidal characteristics (range, extent and residence time) and mouth closure frequency, and also water and sediment inflow based on the present day tidal wetland areas and future demand of sediment to match sea level rise.

Objective 7: Wetland Condition

There are several rapid assessment methods that can be used to assess wetland condition. Objective 7 has been developed using the California Rapid Assessment Method (CRAM) based on the WRAMP approach (WRAMP website 2017).

The condition profile for the region, as shown by the Cumulative Distribution Function (CDF) (Figure 2), can be used to set performance criteria for projects at the regional scale. (California Wetland Monitoring Workgroup 2008, Collins and Stein 2018). Unless projects score above the 50th percentile score for the region, they degrade its condition profile. To improve the condition profile, projects should score above the 50th percentile. Higher scores for larger projects will improve the profile more because they represent more of the wetland resource.

To develop a condition profile, project scores are plotted on the CDF for the wetland type. The CDF can be developed using existing appropriate CRAM scores taken from the eCRAM database.

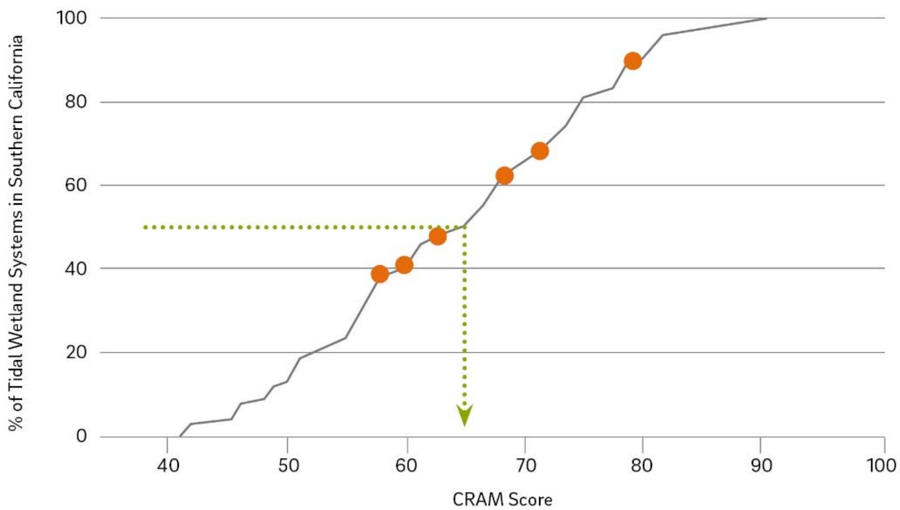

Figure 1. Cumulative Distribution Function (CDF) of the overall condition of coastal wetlands in Southern California derived from a 2008 probabilistic ambient survey using CRAM, showing a 50th percentile CRAM score of 65. Orange dots represent projects.

Restored wetlands will evolve over time, and the wetland condition should be improving with age. The trajectory of improvement can be assessed using a Habitat Development Curve (HDC) based on CRAM (California Wetland Monitoring Workgroup 2008) (Figure 3). HDC's are produced by plotting the wetland condition of many systems against wetland age and reference condition. When the HDC is based on CRAM, it quantifies the rate of habitat development as the increase in CRAM scores over times. HDC's exist for coastal, riverine, and depressional wetlands.

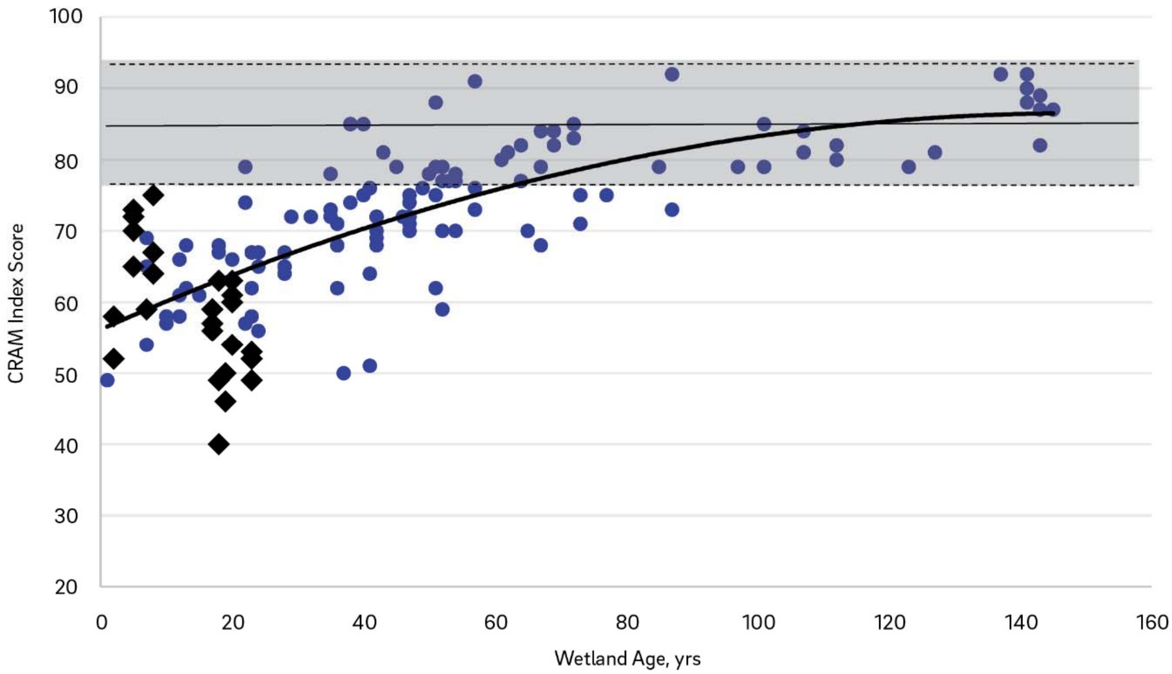

Figure 2. Habitat Development Curve (HDC) for coastal wetlands of California, based on a 2008 probabilistic survey of natural wetlands and projects. Grey area represents the reference envelope based on CRAM scores in Southern California reference sites. Blue dots represent natural sites across California and black diamonds represent coastal wetland restoration projects in Southern California.

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