San Francisco Bay Ecotone Conservation and Management Decision Support System (DSS)

Performance Report (June 2015)

submitted by

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SAN FRANCISCO BAY BIRD OBSERVATORY

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Project Overview

Work began in January, 2012 and was originally to be completed by March 2013. Unfortunately, due to budgetary constraints and other delays, modeling and fieldwork were not completed in the pilot area until the beginning of 2014. Project deliverables were posted to the Climate Common in early 2015. Overall, we reached the majority of identified objectives, outlined below, despite limited resources.

Our definition and characterization document provides an excellent foundation for understanding transition function, its important role for obligate fauna, and habitat characteristics. The document was not only effectively utilized to characterize and map Transitions (aka Ecotones) for the GIS based suitability model but is also being used by other conservation and management organization within SF Bay to guide restoration efforts. In addition our GIS based modeled distributions of current Transitions demonstrated a high degree of correspondence with both field and lab observations. We also modeled Transitions' under 61cm and 167cm of Sea Level Rise (SLR)[1], the high 2050 and high 2100 predictions from the National Research Council [1], using a simplistic bathtub model. The distribution of Transitions indicates a potential "squeezing" or loss of these habitats as marshes migrate landward and a significant reduction of potential tidal elevations to support ecosystem function. Once we modeled the distributions of current Transitions, we created GIS based metrics for 4 out of the 6 indicators identified in our habitat characterizations. We utilized these metrics to rank and prioritize the restoration potential of patches mapped as Transitions. The current distribution of Transitions was modeled throughout SF bay but due to the geographic extent of LIDAR available at the time of analysis, the northeastern portion of Suisun Bay is missing from the model. In addition, since the focus of the pilot project was on the south bay, only Transitions from Point Richmond south were ranked and prioritized. We expanded the geographic extent of the pilot area (originally to be just the "south bay" below san mateo bridge) to include potential transitions from Point Richmond south to San Jose.

1 National Research Council (2012). Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past. Present and Future. *National Academies Press.* Washington DC. 2012.

The final DSS is comprised of the following components:

(1) Critical Tidal Marsh Ecosystem Habitats at the Bay's Margin (Thomson et al. December 2013) – a technical description & characterization document
(2) GIS database containing:
    (a) modeled distribution of current Transitions,
    (b) modeled distribution of Transitions w/ 61cm SLR;
    (c) modeled distribution of Transitions w/ 167cm SLR; Transitions ranked and prioritized for "restoration Potential"
(3) Poster, Slideshow, and Webinar
(4) Project Description and GIS database (via Data Basin) available online at California Climate Commons (http://climate.calcommons.org/dataset/san-francisco-bay-estuarine-terrestrial-transitional-zone-decision-support-system)

<u>Project Objectives</u>

1. Define and characterize the biotic and abiotic elements of transitional habitats (TH, aka tidal marsh ecotones)

The project team, led by lead ecologist, David Thomson, conducted an extensive literature review on the ecology of estuarine-terrestrial transition zone (herein referred to as Transitions). This focused on the functions that Transitions plays in tidal marsh ecosystem function. David reviewed both broader scientific literature as well as local applied science reports that helped to document the ecosystem function of Transitions as well as historic distribution within SF Bay. At the same, David convened an advisory group of regional experts including excerpts in estuarine ecology, obligate fauna and conservation management with input from our USFWs funder (John Klochak). One focus of the definition and characterization development was the importance of Transitions for obligate fauna, specifically Salt Marsh Harvest Mouse (SMHM) and Ridgeway's Rail (RWRA), as well as its importance in overall estuarine function. The advisory group included Dr Bibit Traut, the only known ecologists to have written on estuarine function of Transitions, Dr Howard Shellhammer, the premier scientist studying SMHM, Dr Corey Overton, who at the time was studying the ecology of Ridgeway's rails, as well as Dr Laura Valoppi, lead scientist for the South bay Salt Pond Restoration Project, which is in the process to restoring more than 15,000 acres of ex-salt ponds to functioning estuarine habitats. We also included a floral palette for restoring Transitions within SF bay as an attachment to the technical document. It's difficult to precisely characterize the historic flora of Transitions, but would be a mix of local estuarine and upland species.

The result of both the literature/document review and interviews with the advisory committee resulted in a technical document that both defined and characterized Transitions with regards to functions required by obligate fauna and aspects of tidal marsh ecosystem resiliency to climate change. Within this document, Transitions were characterized by a number of indicators of “Transitional habitat function” from which metric were derive for evaluating those particular indicators. These included both biotic (eg habitat structure) and abiotic (eg patch width, size and shape) elements. These indicators and metrics were utilized in remaining stages of the project to identify, map and rank Transitional patches throughout the estuary. With the help of tidal marsh ecosystem specialists throughout the region we drafted a thorough description of tidal marsh-terrestrial transition zones. This document contains a detailed characterization of of the physical and biological properties of transition zones with respect to the functions of the tidal marsh ecosystem and needs for obligate fauna. A list of habitat indicators were developed based on these functions and utilized to map their distribution and assess their quality. These indicators were then combined with threats, notably sea level rise, for ranking and prioritizing TZH for protection or restoration. Key indicators, and associated functions, are summarized below:

- Elevation in relation to tides
  - high tide refugia for obligate fauna, SLR adaptation
- Depth (width and slope of transitional zone)
  - distance needed by tidal marsh fauna and flora, SLR adaptation
- Size and Shape
  - as needed by tidal marsh fauna and flora, overall function
- Adjacent Habitats and Connectivity
  - as needed by tidal marsh fauna and flora, overall function
- Plant Community (not used in DSS)
  - high tide refugia, overall function
- Soils and Hydrology (not used in DSS)
  - as needed by tidal marsh flora, overall function

The final Transitions definition and characterizations document can be found online at **The Climate Commons** (http://climate.calcommons.org/dataset/san-francisco-bay-estuarine-terrestrial-transitional-zone-decision-support-system).

2. Map current extent of TH using a GIS-based suitability model

The width of transitional habitat is largely determined by the extent of the irregularly-flooded tidal zone, which modifies the salinity of the soil, and the consequent distribution of flora. The first component of the transitional zone decision support was to map the potential transitional zone based on tidal and elevation constraints. High resolution Lidar (1 meter) was combined with tidal rasters created from NOAA tidal gauge datasets. Two tidal rasters (converted to NAVD88) were generated from the tidal gauges data to assist with mapping the lower and upper limits of Transitions: (1) interpolated surface of MHHW (using ~ 40 tidal gauges) and (2) a trend surface of the difference between MHHW and HOWL (using around ~16 tidal gauges) to account for tidal variability throughout the estuary. The Lidar elevation data was merged with the MHHW surface in ArcGIS so elevation represented elevation relative to MHHW for the entire SF Bay. The "range" of potential Transitions was identified as .31 meters above MHHW as the lower limit to HOWL + .27 meters as the upper limit. Raster output from the first order model was converted to vector polygons, simplified and adjacent polygons were merged. Final raster results were divided into "tidal and non-tidal based on "levee on" (tidal) and "levee off" (non-tidal) boundaries provided by PRBO.

Potential tidal elevations modeled to predict Transitions using this approach were ground truthed using a mapping grade GPS. There was a high degree of correlation between the location and distribution of predicted Transitions and field based characteristics of these locations. Sites were visited in south, central and north bays. The majority of these sites were slightly overlapping and above high marsh and slightly overlapping with upland (where existing) as anticipated. The majority (although not all) of potential Transitions in the south bay exist on levee flanks. Certain sites, such as within San Pablo Bay National Wildlife Refuge along Sears Point Rd in the north bay, seemed slightly shifted off from expectations (on top of levees as supposed to flanks). This could be due to georeferencing issues of Lidar or the precisions of tidal models. Predicted distributions of Transitions were also checked in the lab using high resolution imagery (Ikonos - June, 2011 and Google Earth - *various*) and also showed a high degree of correlation with expected tidal elevation that were identified as corresponding to Transitions.

In addition to mapping the current distribution of Transitions based in tidal elevation, we also successfully mapped the distribution of Transitions under two Sea Level Rise scenarios for 2050 and 2100 (61 cm and 167 cm).

3. Identify and estimate "needed area" of TH

The "need" for transition zone related to the presence of adjacent (or proximal) marsh (and upland) as well as the distribution of obligate fauna. The adjacency of both functioning marsh and upland were used to rank and prioritize Transitions for restoration. However, the health of distinct Transitional patches derived in Objective E2 above, were ranked according to adjacent land cover types including marsh and uplands. The size of areas needed for each extant marsh (or alternatively to support obligate fauna) was determined to be outside of the scope of the plot project. That said, Transitional patches that rank as high priorities for restoration are also patches that have existing adjacent tidal marshes (and possibly upland). However, where the GIS suitability models ranks small and/or low quality Transitions adjacent to large (or even medium/small) marshes, there is still likely a need in these locations. We recommend, that the GIS datasets be utilized by quantifying need of a given management (or other) geographic unit such as Eden Landing ecological reserve, a site specific restoration area or parcel.

4. Identify Criteria for prioritizing areas for TH restoration

5. Identify Criteria for prioritizing areas for TH protection

During the development of the GIS based suitability model to rank Transitional patches according to their potential for restoration or protection, we realized that any Transitions outside of a protected area (eg open space, wildlife refuge, etc.) were in need of protection. As a result, we focused our effort on identifying and ranking areas for restoration outside of protected areas. What became clear as we interacted with the wider scientific and conservation community, was the *type of restoration* varied greatly. Certain locations where the Transitions were poor and ranked very low, required the *creation* of Transitions (i.e. "needed area") while certain Transitional patches which ranked very high might need restoration or perhaps just *enhancement*. As a result, our criteria and mapping efforts utilized the criteria to prioritize Transitional patches for restoration and not protection. These patches were identified as "within or outside" of a protected area but not ranked separately.

6. Prioritize TH areas for protection

7. Prioritize TH areas for restoration

A major use of the characterization report was to identify indicators that could be used to map and rank the restoration potential of Transitions. We identified the 3 most salient (and practical) indicators to be used in our GIS based suitability model. These included: (1) Transition width; (2) Transition Size and Shape; and (3) adjacent habitat (w used land cover and land use data).

Although some high resolution vegetation data was available for the south bay, we determined that the necessary resolution for including in the suitability model across the entire SF bay was not available and therefore did not include it our analysis. In addition, available soils data was too coarse to be valuable for ranking. However, we did obtain some measure of local hydrology by assessing (a0 whether a given Transitional patch was connected to tidal influence and/or (b) whether it was connected to freshwater or tidal wetlands.

Patch Metrics (width, size and shape)

Once the polygons were simplified and combined, patch metrics were calculated for each potential transitional zone polygon. These include:

- Mean Width
    - calculated as surface area / maximum length (diameter of smallest circumscribing circle)
- Area (Size)
- Shape (linear to compact)
    - calculated as ratio of patch area to the area of the smallest circumscribing circle.

Adjacent Land Cover and Land Use

The focus on the DSS is to identify, map, and rank transitional patches between tidal wetlands and uplands. Consequently, the (a) proportion of shared boundary for adjacent land cover(s); and (b) area (i.e. size) of these same adjacent land covers were quantified in ArcGIS for each transitional polygon “patch” mapped in Step 2. Land cover types included: tidal wetland, terrestrial wetland, urban, “upland”, rangeland, agriculture, forestland, and water. Transitional patches adjacent to both wetland and uplands were given the highest positive indicator values while patches adjacent to urban land cover were given negative indicator values. Indicator values for adjacent land cover assigned to transitional patches were weighted based on both the proportion (>= 50% of shared boundary given the highest weight) and area (50 acres of land cover given the highest value). We used land cover data from the SFEI BAARI dataset (for wetlands), USDA's CalVeg dataset, and NOAA's CCAP.

Each transitional patch was also assigned a land use (e.g. residential, commercial, industrial, parks, etc.) at the parcel level. Information about land use(s) designations assist land managers in determining the feasibility for restoring or protecting potential transitional parcels – the geographic unit utilized by land managers and planners. In addition to land use, potential transitional patches were also identified as currently within (or outside) tidal areas.

Indicators values were summed into a combined index representing potential value to tidal marsh ecosystem management. Both potential existing transitional patches (“levee on”) and potential accommodation space (“levee off”) were assigned index values.

8. Report and Document Decision Support System and Distribute TH Prioritization and Distribution Maps

The DSS currently consists of the definition/characterization document, the GIS database and outreach material including a poster, slideshow and webinar. Unfortunately, we did not have enough funds to write up a full report of our methods and results, As of the writing of this Final Report, we are still in the midst of documenting our work in a full report containing a full description and accounting of our results and methods. However, we have presented the results of this pilot project at a number of scientific conferences including the State of the Estuary, Bay-Delta Conference, and Restoring America's Estuaries (RAE). In addition, we have presented the methods and results to a variety of regional conservation groups including the South Bay Salt Pond Restoration Project Management Team, the San Francisco Bay Joint Venture, and the State Coastal Conservancy. The three components of the DSS produced from the pilot study include (1) the Transitions definition/characterization report; (2) GIS datasets containing Transitions distribution and rankings (via Data Basin), AND (3) poster, slideshow and webinar have been all made available online via the California Climate Commons.

Figure 1: Current *Potential* Transition Zone in SF Bay (shown in yellow) . Figure below includes both tidal and non-tidal locations as well as Pilot Study Area (shown in red)

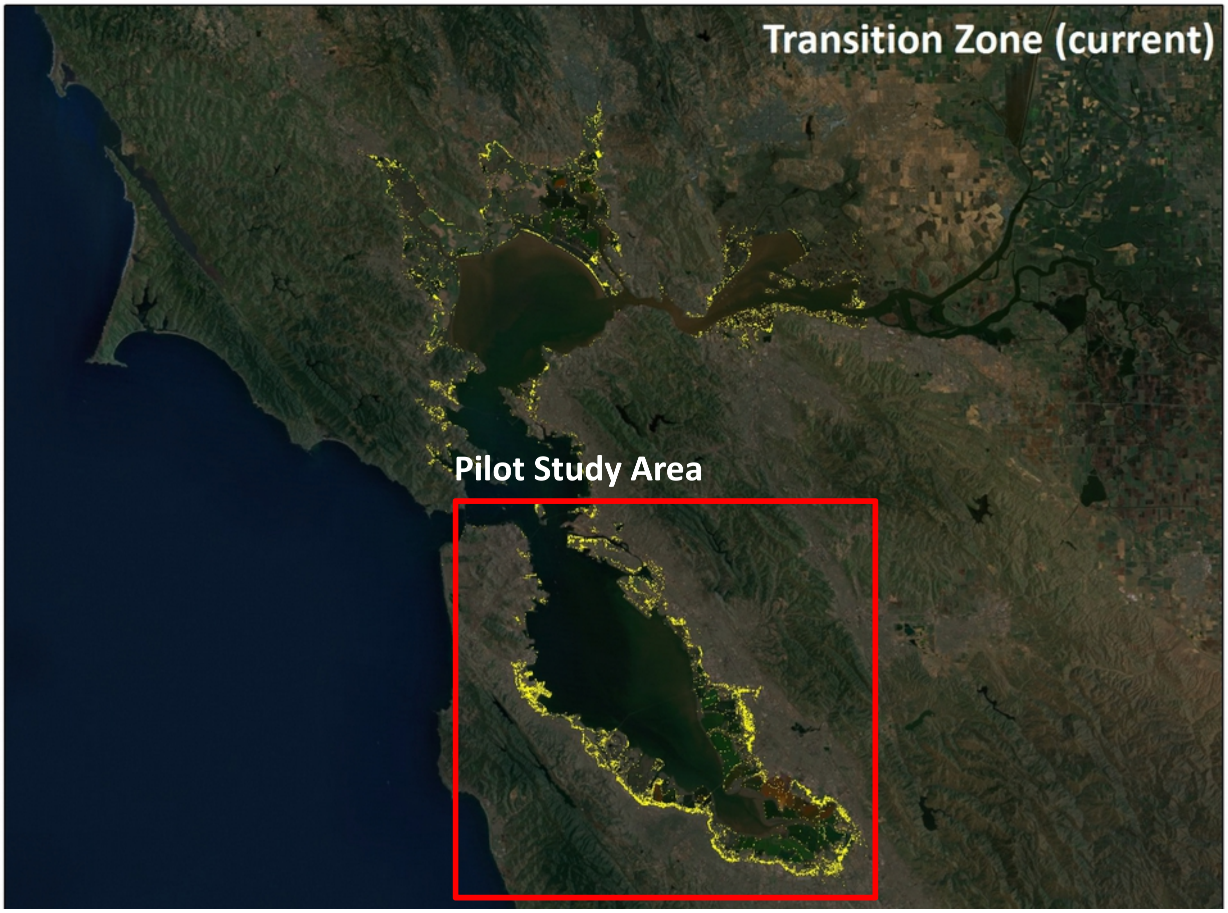
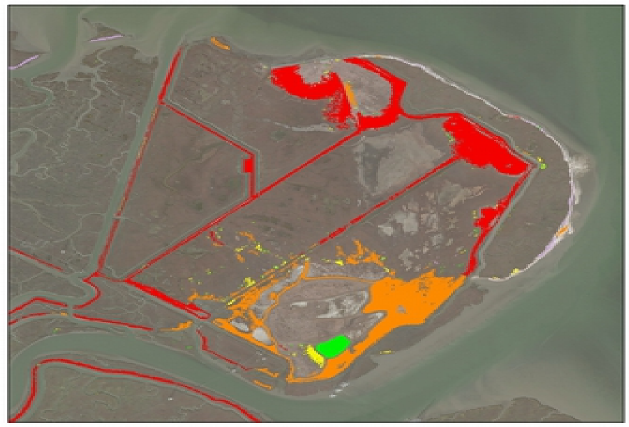


Figure 2a: Shape Metric (linear to compact) example at Outer Bair island. The more "compact" or core area a transition zone polygon has, the higher the ranking.



Shape Metric (red = linear; orange = mixed; green = compact)

Figure 2a: Shape Metric (linear to compact) example at Outer Bair island. The more "compact" or core area a transition zone polygon has, the higher the ranking.

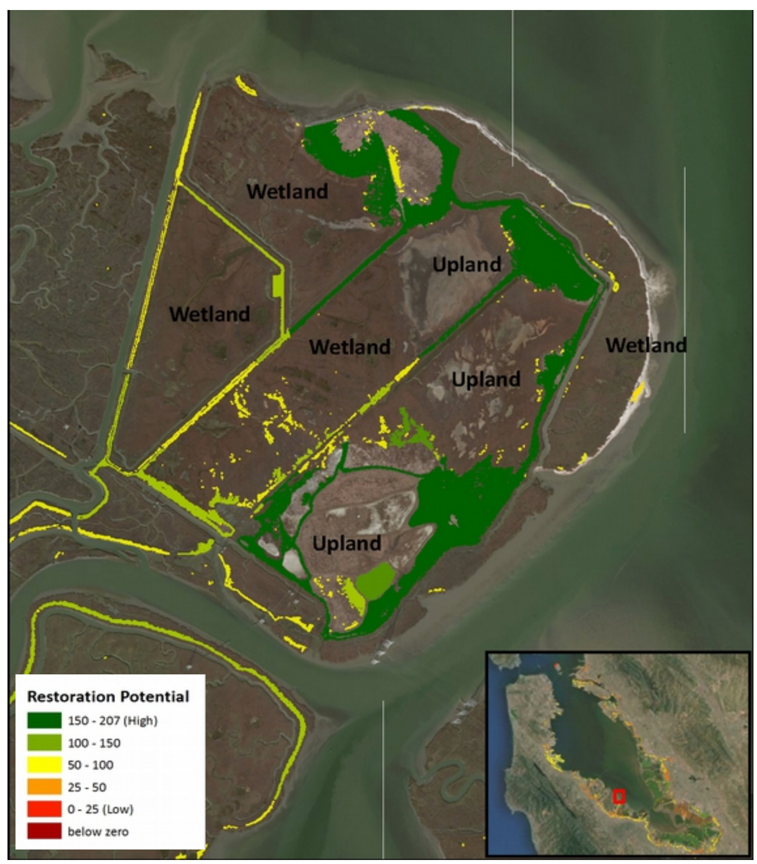


Figure 3: Restoration Potential of potential Transition Zone Habitat (current). Indicators values for Step 2 to Step 5 were summed into a combined index representing restoration potential . Both potential existing transitional patches (“levee on”) and potential accommodation space (“levee off”) were assigned index values.

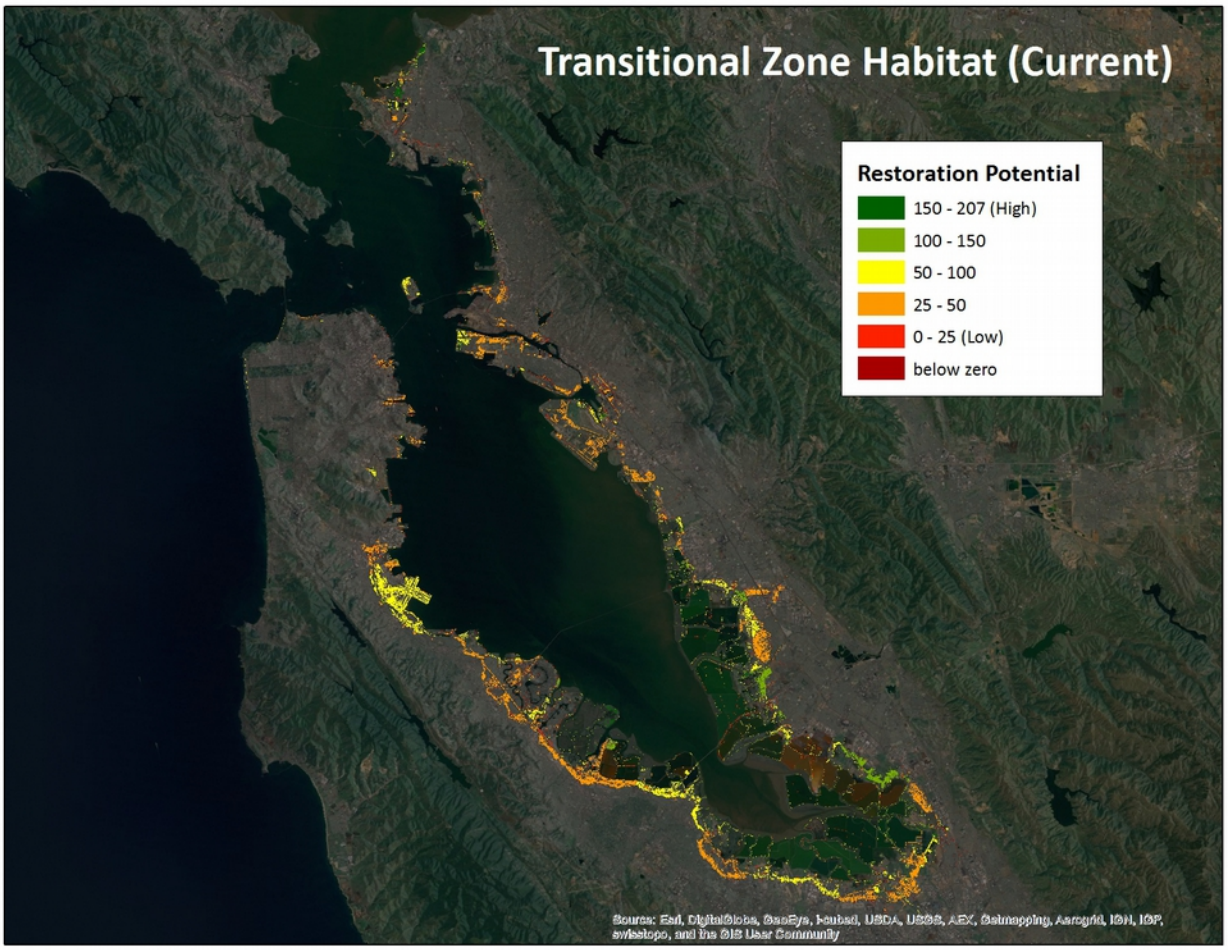


Figure 4: Final Restoration Potential at Bair Island with Index Breakdown comparing restoration potential of two transition zones .

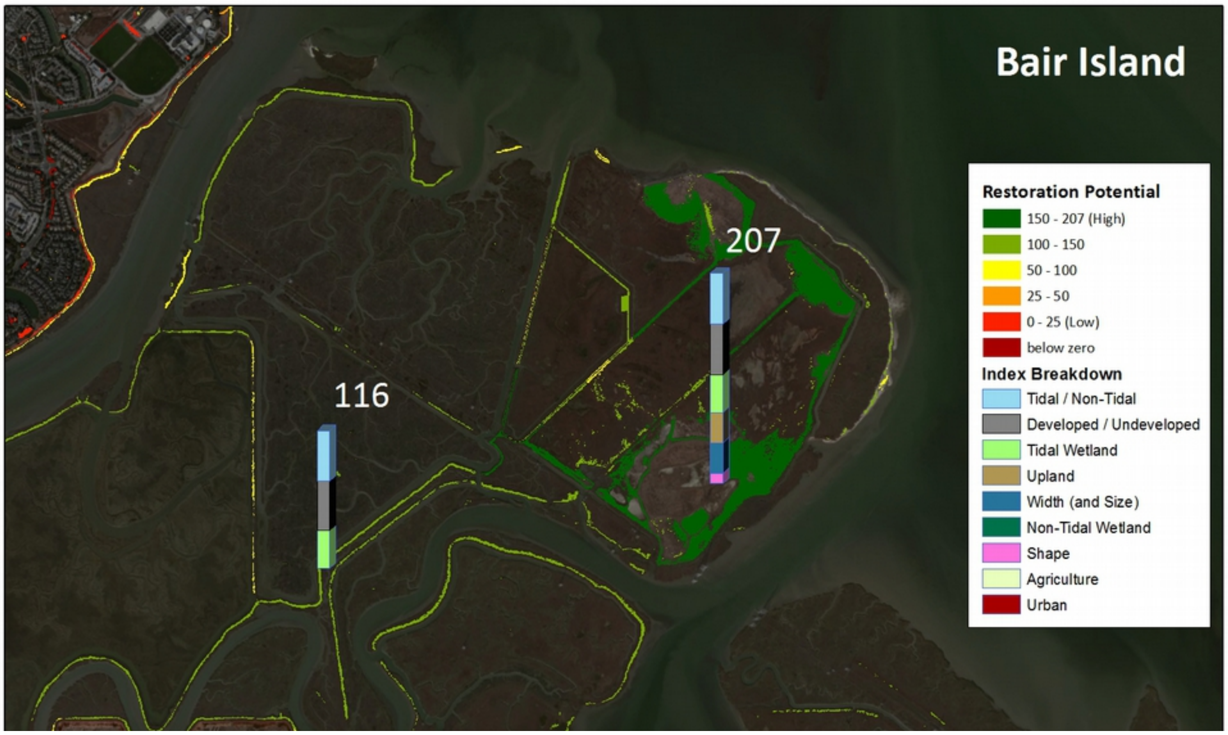


Figure 5a: Current Distribution of *potential* Estuarine-Upland Transitions (based on tidal elevation modeling of current MHHW)

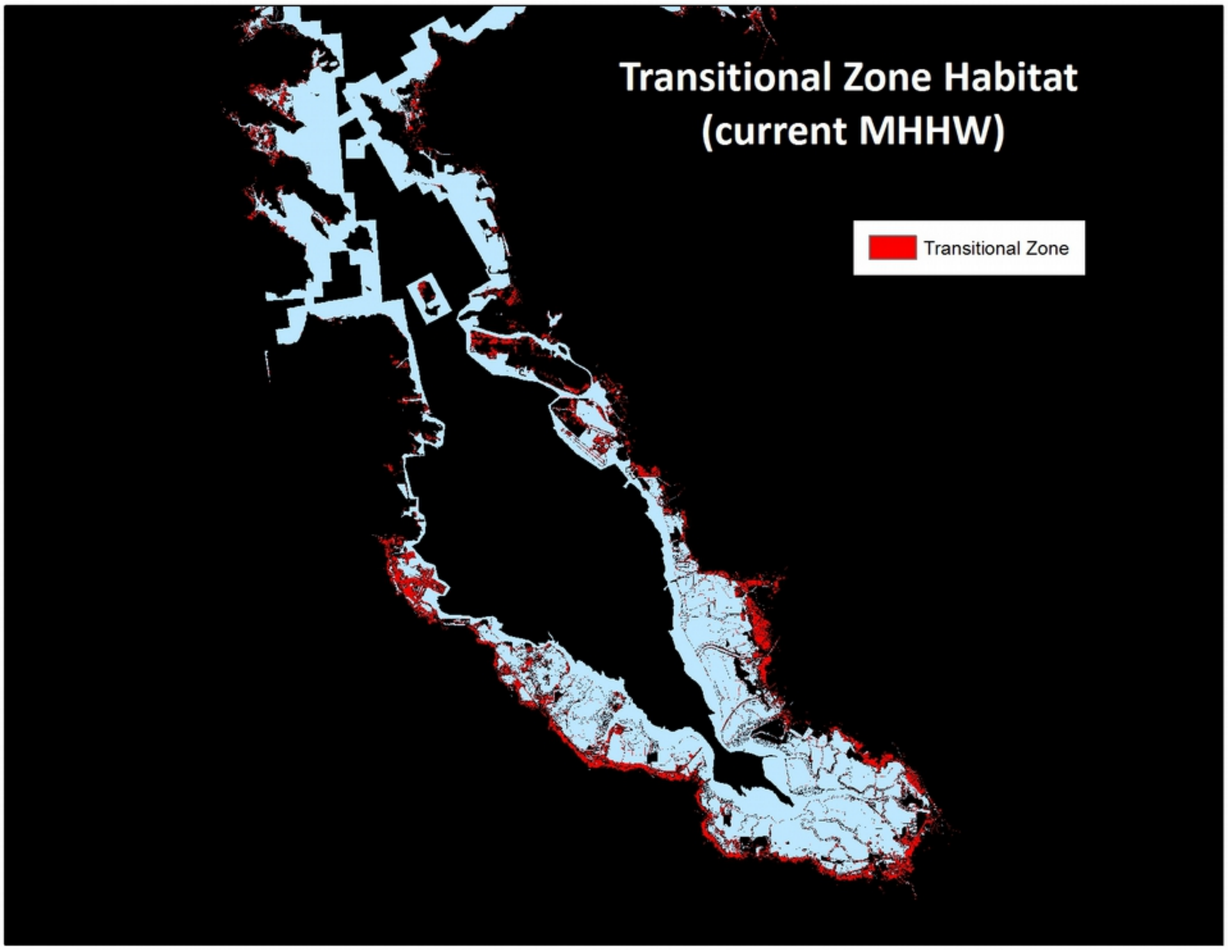


Figure 5b: Distribution of *potential* Estuarine-Upland Transitions w/ 61 cm of Sea Level Rise (based on tidal elevation modeling of current MHHW)

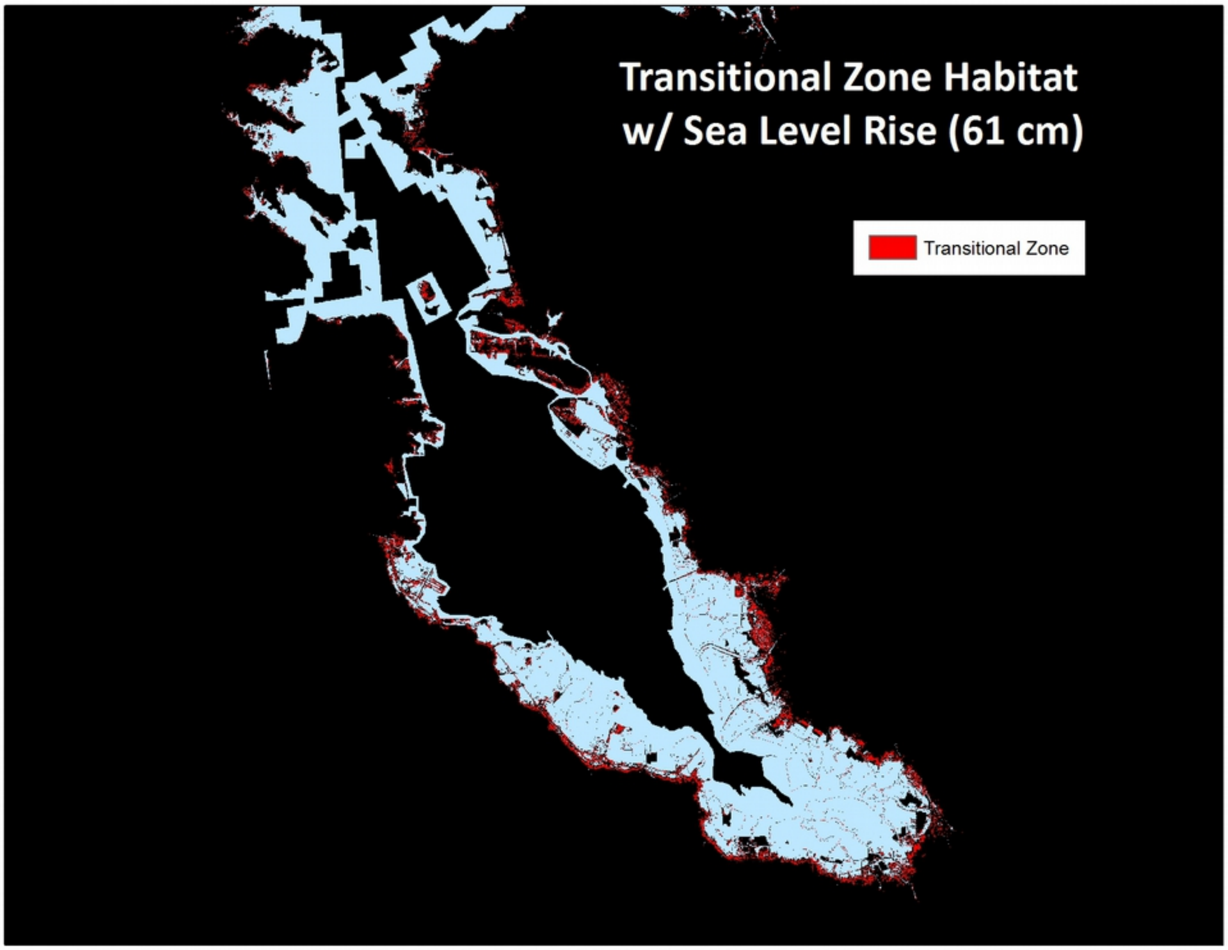


Figure 5c: Distribution of *potential* Estuarine-Upland Transitions w/ 167 cm of Sea Level Rise (based on tidal elevation modeling of current MHHW)

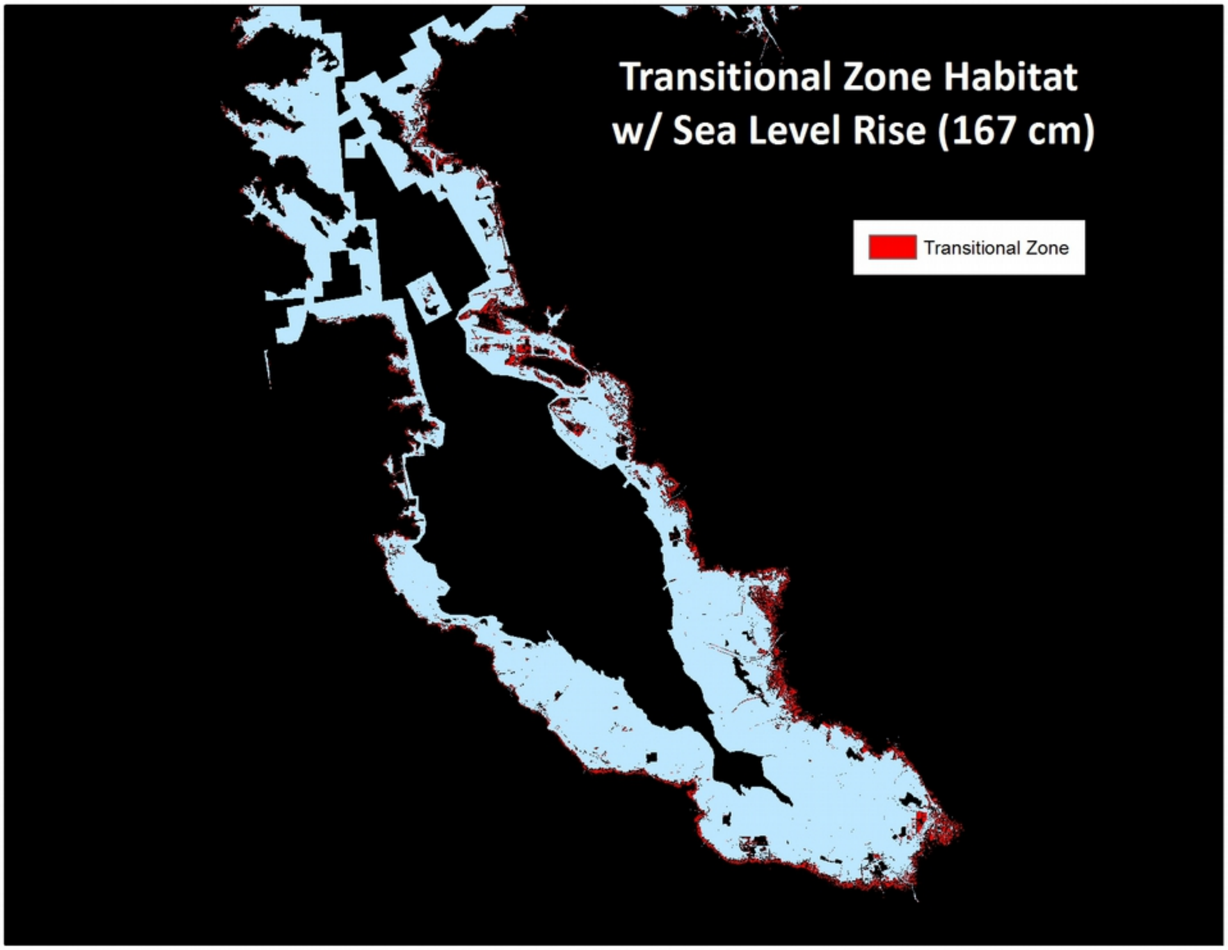


Figure 6: Distribution of current, 2050 and 2100 *potential* Estuarine-Upland Transitions within BEGHU sub-regions

		Transition Zone Habitat (sq km)					
Subregion		**Current**		**High NRC SLR 2050 (61 cm)**		**High NRC SLR 2100 (167 cm)**	
		tidal	non-tidal	tidal	non-tidal	tidal	non-tidal
North Bay	inside	7.50	8.79	1.33	4.90	0.25	3.06
	outside	-	2.86	0.00	2.21	0.00	4.32
Suisun	inside	6.80	3.42	1.07	1.53	0.12	0.88
	outside	-	0.69	0.00	0.57	0.00	1.01
Central Bay	inside	1.61	18.86	1.20	16.42	0.52	11.68
	outside	-	1.03	0.00	2.16	0.00	4.34
South Bay	inside	3.90	14.97	1.78	8.45	0.28	3.27
	outside	-	20.75	0.00	17.37	0.00	19.06