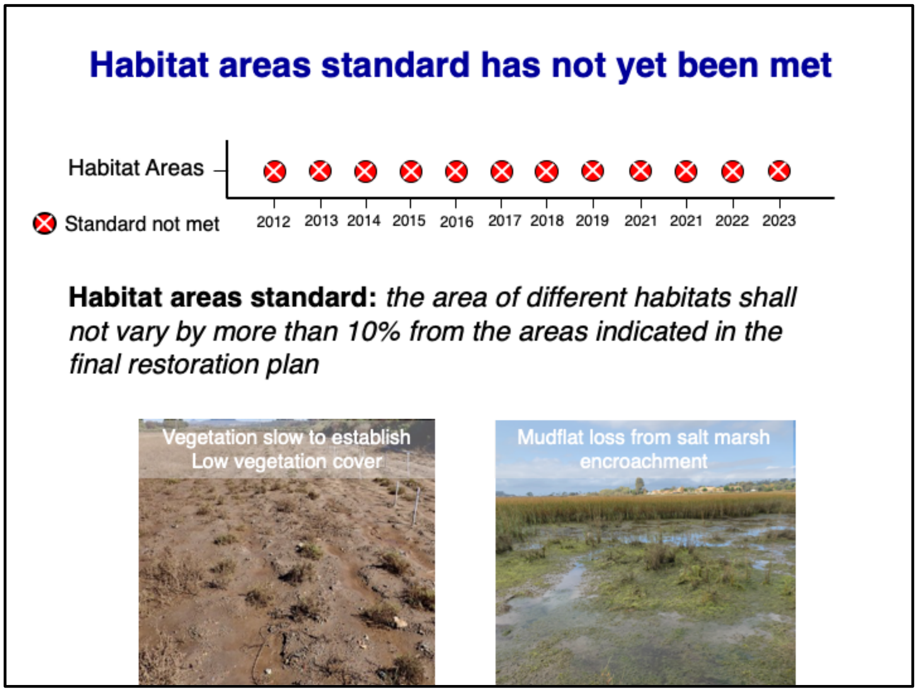
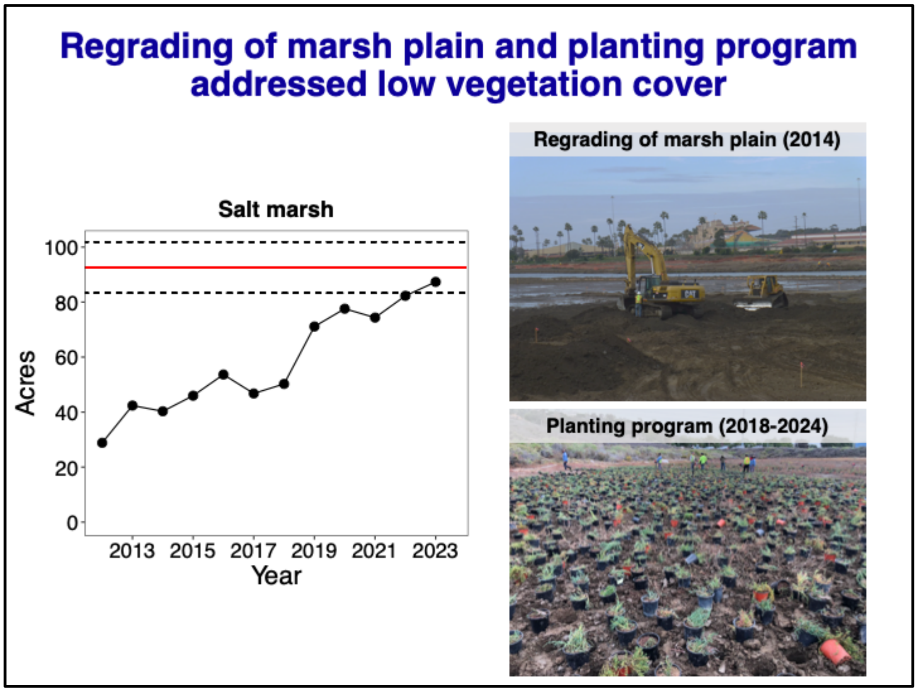
Causes and consequences of habitat conversion at San Dieguito Wetlands

May 9, 2024
SONGS Mitigation Monitoring Project
Marine Science Institute, University of California Santa Barbara

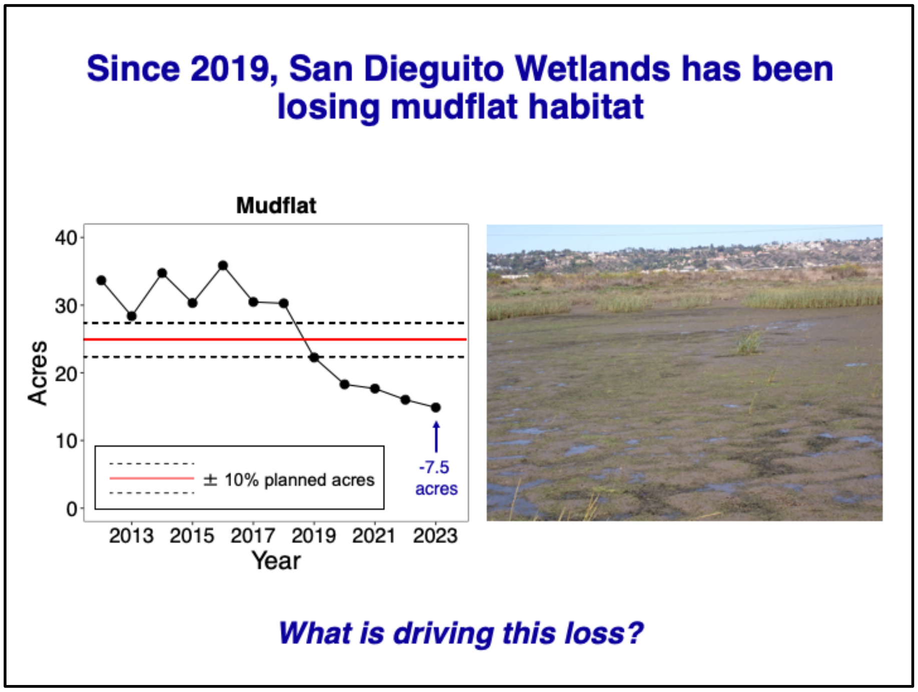
- This presentation will explore the causes and consequences of habitat conversion at San Dieguito Wetlands



- As a reminder from the prior presentation, the absolute standard for Habitat Areas has not yet been met.
- This standard requires that the area of different habitats shall not vary by more than 10% from the areas indicated in the final restoration plan
- The fact that this standard has not yet been met has been driven by different factors over the course of the project, including low vegetation cover in the early stages of the project and more recently, mudflat loss from salt marsh encroachment.

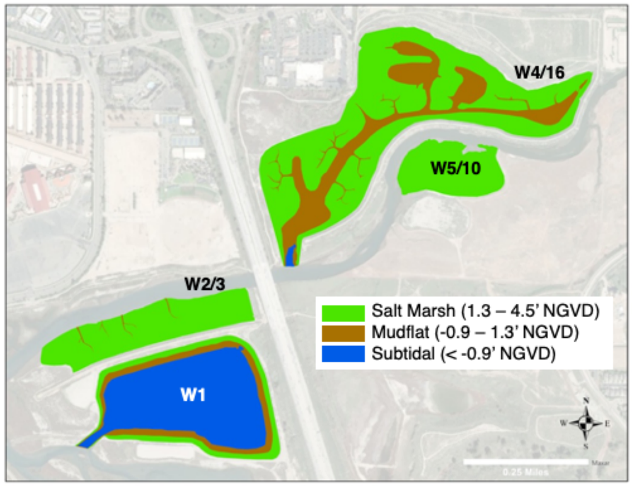


- Initial underperformance in this standard was tied to slow development of salt marsh vegetation. Vegetation is expected to take time to establish, and substantial efforts have aimed to increase salt marsh acreage at San Dieguito. Notably, the marsh plain was regraded in 2014 to support vegetation development. Additionally, an ongoing planting program and associated field experiments have increased vegetation cover at the wetland over time. Together these efforts have contributed to San Dieguito meeting the minimum required salt marsh acreage for the first time in 2023.



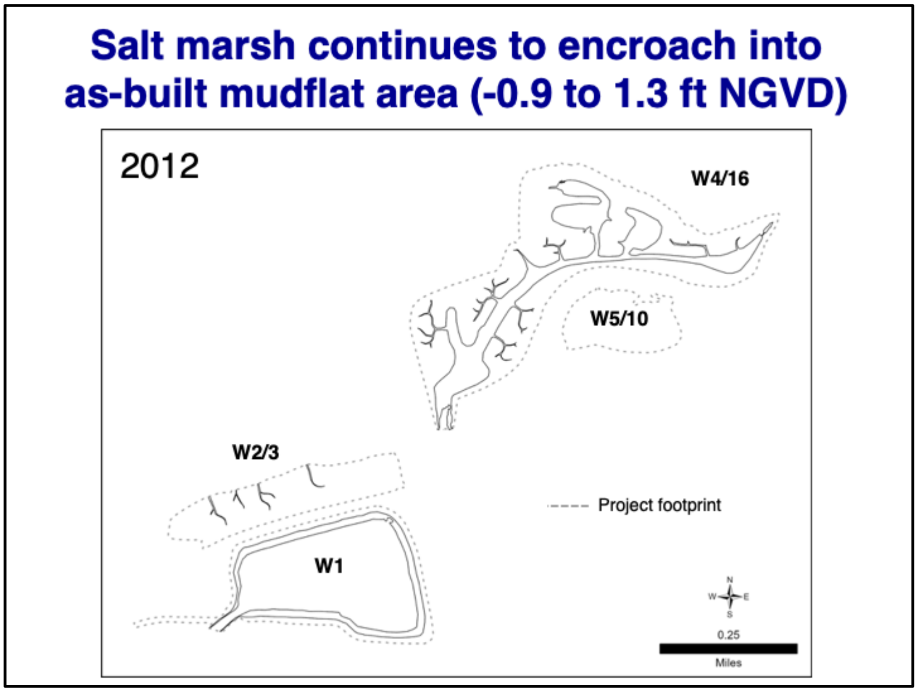
- However, since 2019, the San Dieguito Wetlands has been losing mudflat habitat, and in 2023, the project was 7.5 acres short of the minimum required area of mudflat. To address this underperformance, we have been exploring what factors are driving this habitat loss.

As-built habitat areas (2012)

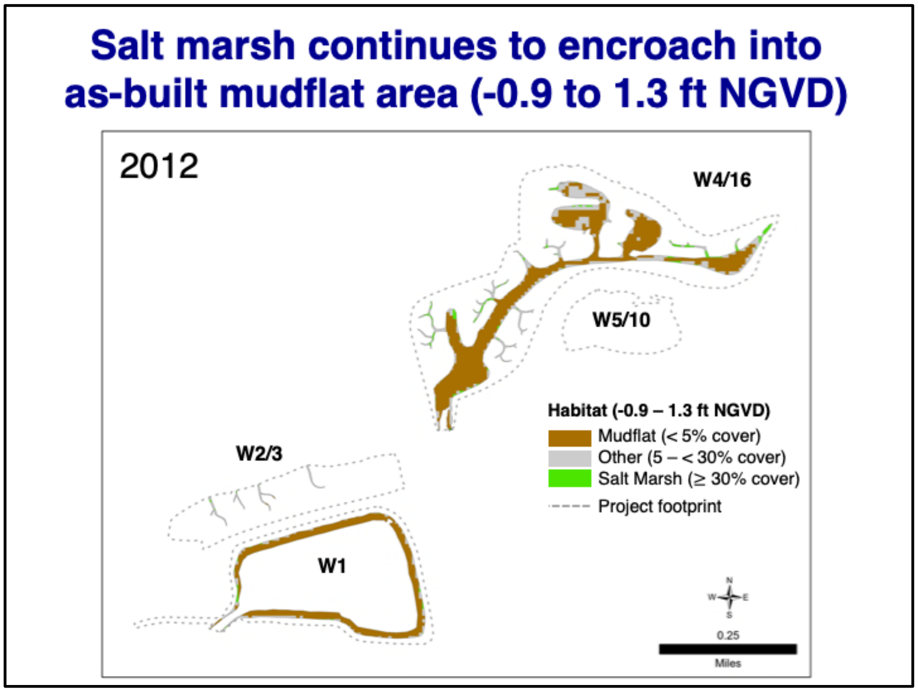


Habitat	Acres planned	Acres built
Mudflat	24.9	26.6

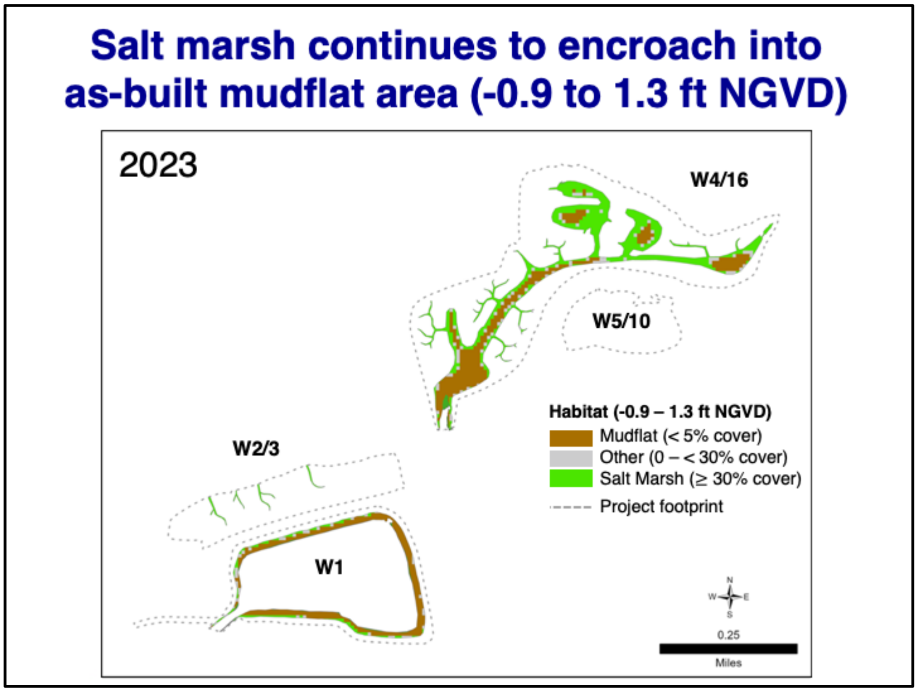
- Shown here is the as-built habitat area of the wetland immediately post-construction in 2012.
- The initial restoration plan included 24.9 acres of planned mudflat and 26.6 acres of the wetland were built to be mudflat between the elevation of -0.9 and 1.3 feet NGVD, as shown here in brown.



- To orient you to this map, we've outlined the project footprint for each module with dotted lines. The area of focus for this analysis is the as-built mudflat area, which ranges in elevation from – 0.9 to 1.3' NGVD, which are shown by the black lines. We're now going to color within this area the different habitats that were present in 2012.

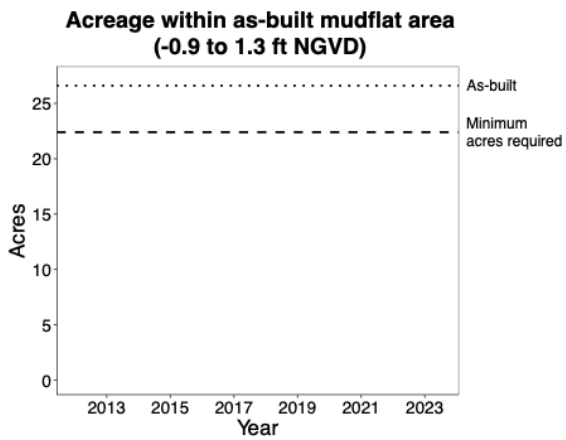


- In 2012, mudflat made up most of the as-built mudflat area, as you can see by the areas shaded in brown.

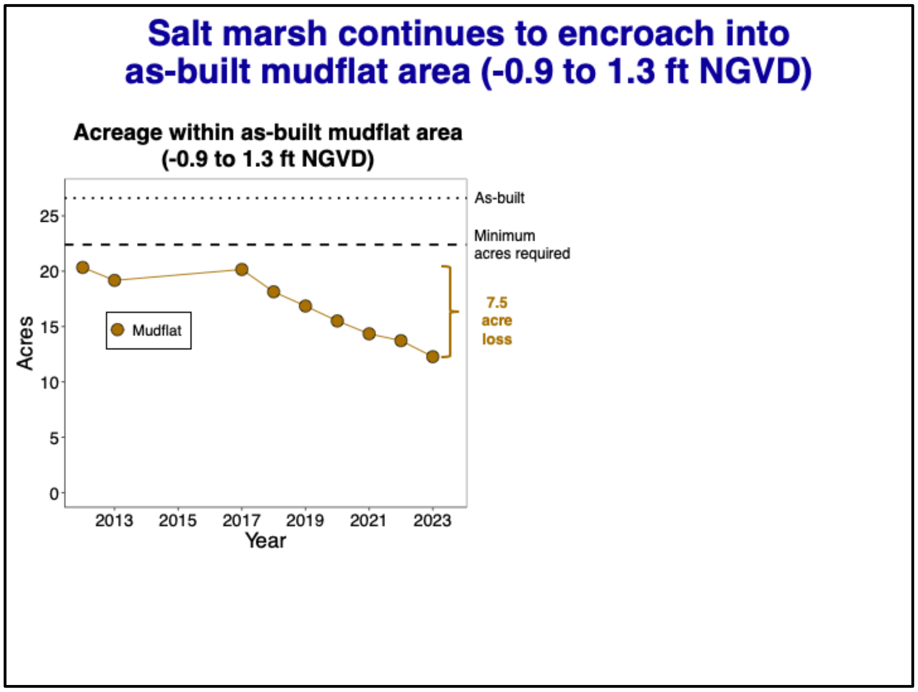


- However, as you can see in the 2023 map, some of the area built as mudflat has converted to salt marsh over the last twelve years, particularly in the W4/16 module.
- Much of the salt marsh encroachment into planned mudflat habitat is the marsh cordgrass, *Spartina foliosa.*

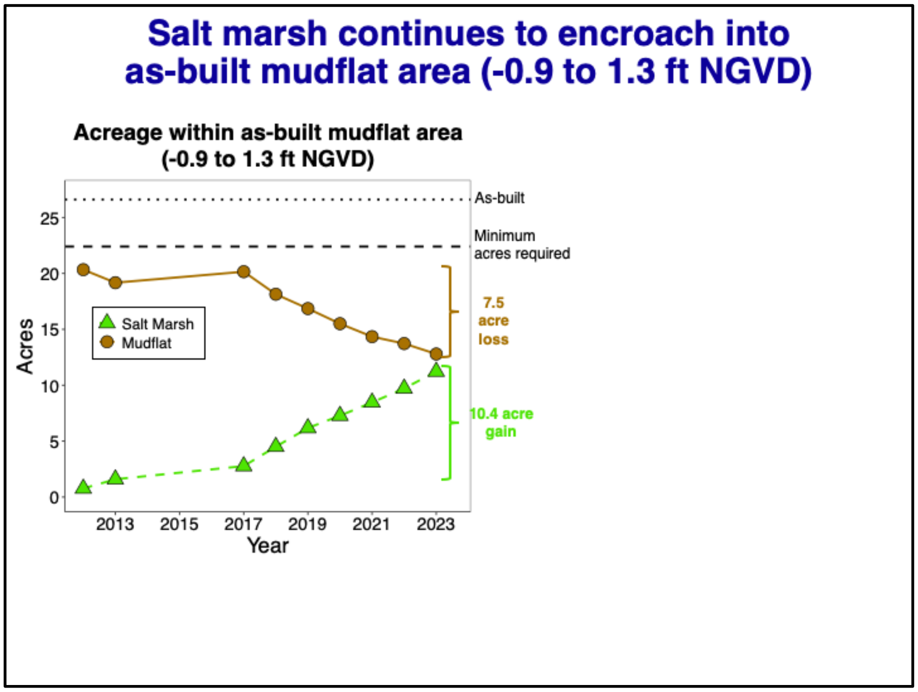
Salt marsh continues to encroach into as-built mudflat area (-0.9 to 1.3 ft NGVD)



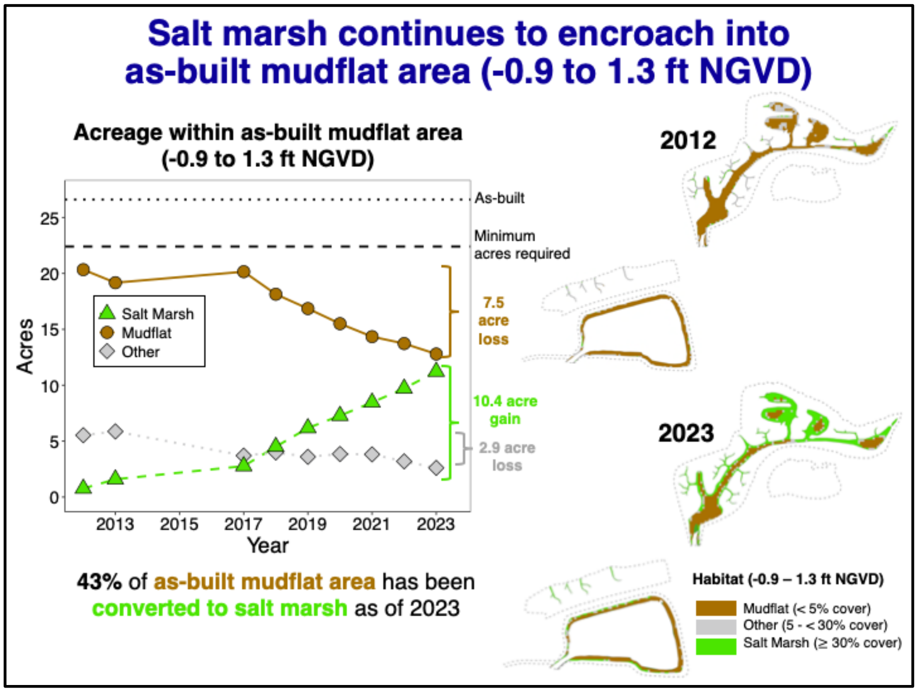
- Here, we will show a time series of the acreage of different habitats located within this as-built mudflat area, which is delineated by elevations between -0.9 ft and 1.3 ft NGVD. The dotted line indicates the total as-built mudflat area (which is 26.6 acres) and the dashed line indicates the minimum required acres of mudflat (which is 22.4 acres)



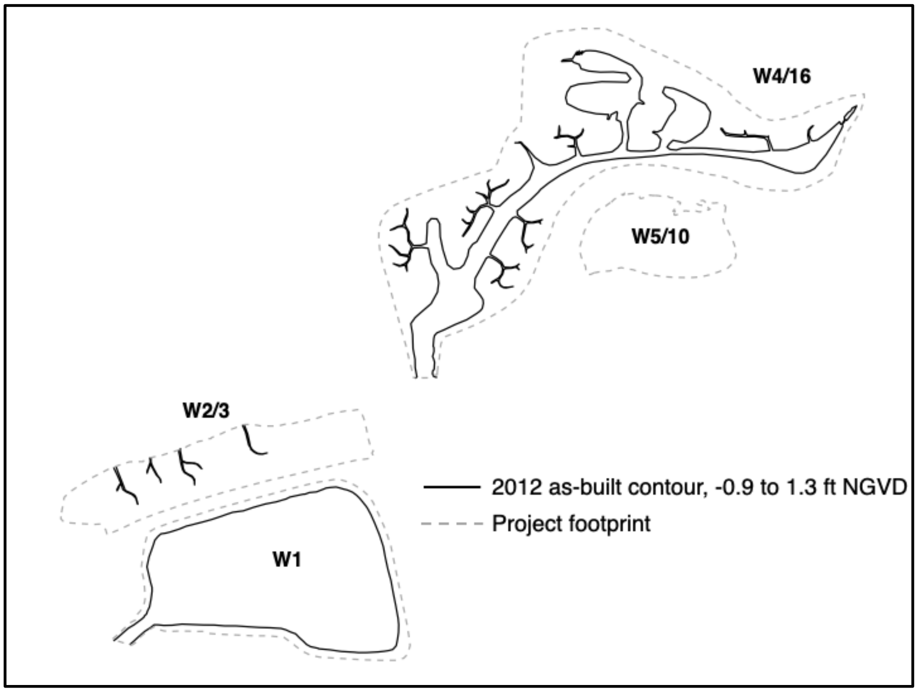
- We begin by showing the time series for mudflat located within the as-built mudflat area between -0.9 and 1.3 ft NGVD. Since 2012, mudflat acreage has declined by 7.5 acres within as-built mudflat habitat from 20.3 acres to 12.8 acres.



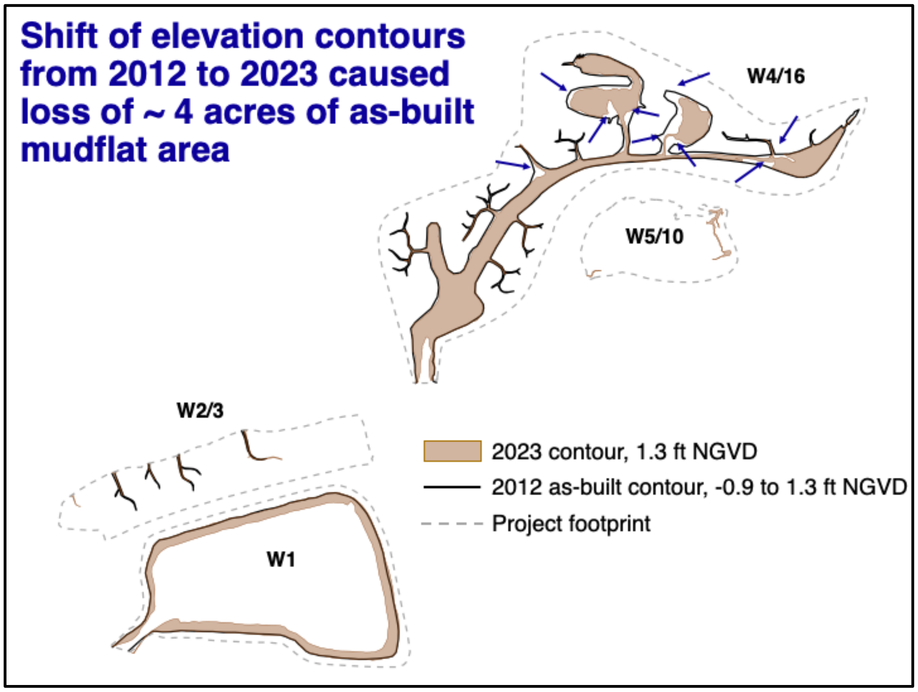
- In contrast, there has been a 10.4 acre increase in salt marsh within built mudflat habitat areas from 0.8 to 11.2 acres.



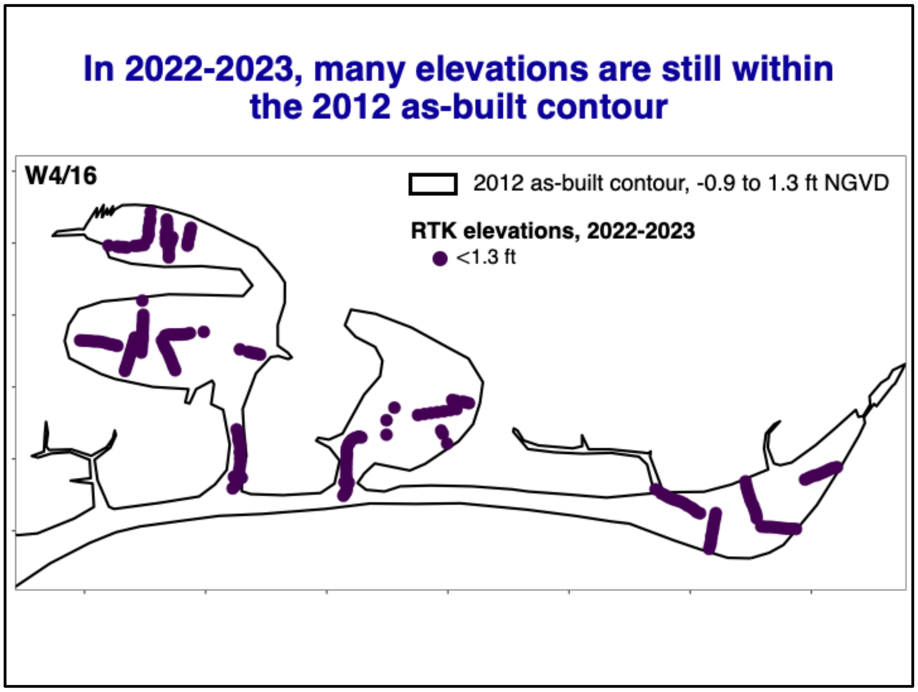
- Over this same time period, there has been a 2.9 acre decrease in other habitat within built mudflat habitat from 5.5 to 2.6 acres, which contributed marginally to the loss of built mudflat habitat.
- Overall, these changes mean that 43% of as-built mudflat area has been converted to salt marsh as of 2023, as 11.2 acres out of the 26.6 as built acres are salt marsh.
- These time series support the transition that we previously observed in the maps (shown on the right), in that there has been substantial salt marsh encroachment into areas built to be mudflat from 2012 to 2023.



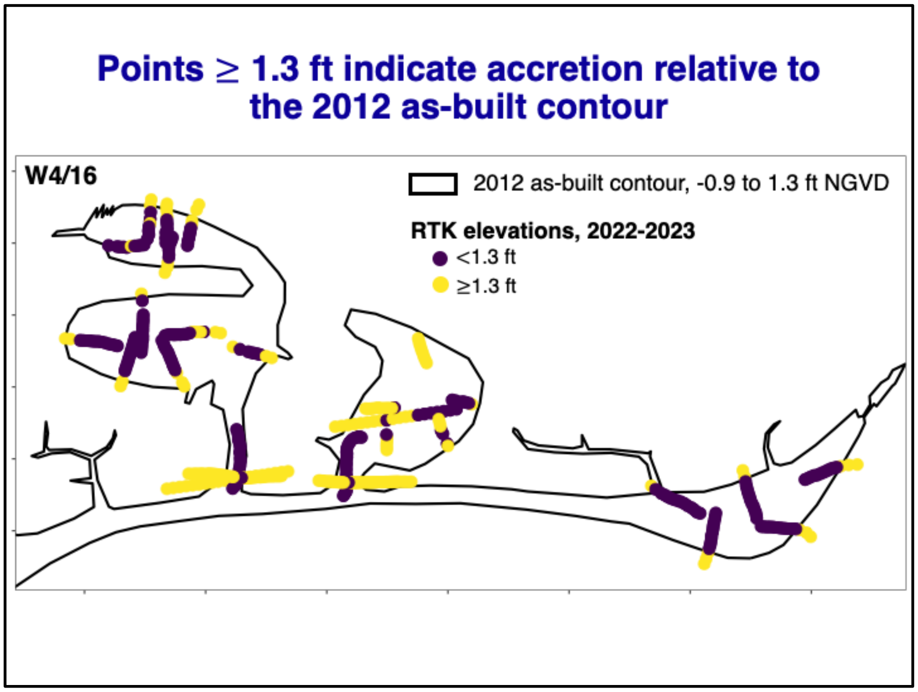
- A possible explanation for this loss of mudflat is related to changes in elevation such as accretion. The solid black lines shown here represent the as-built contour from 2012, as shown here by the solid black lines.



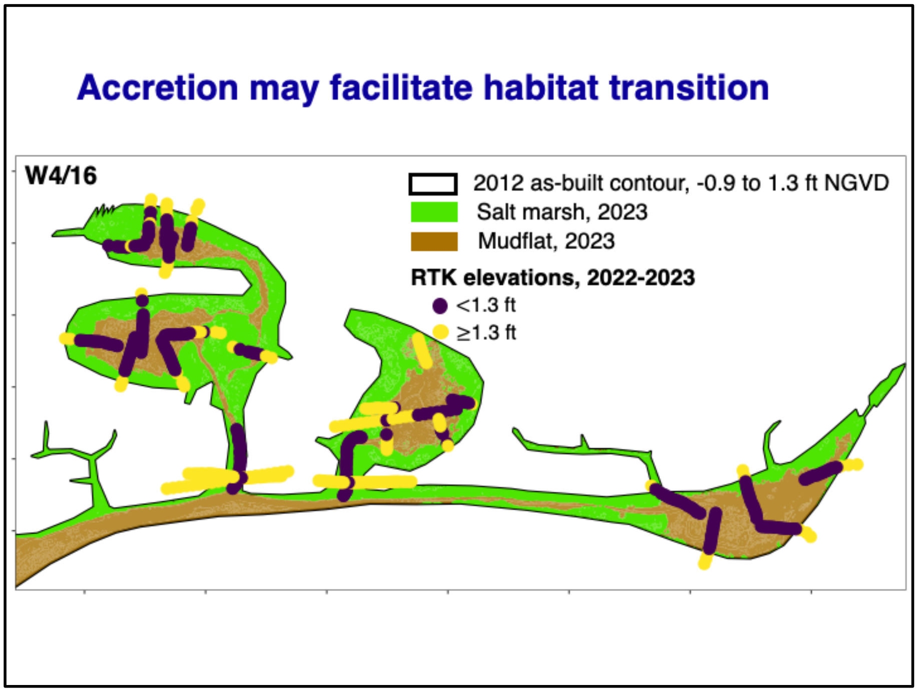
- To assess whether these contours have changed over time, we re-measured the contours in 2023, as shown in brown.
- From 2012 to 2023, the as-built mudflat area has decreased by ~4 acres since construction. Most of contraction has occurred in the W4/16 module, with the arrows indicating areas of elevation contour contraction.
- We now will focus on this module to show results of some of our targeted field elevation surveys where we assessed elevation change relative to the as-built condition.



- In 2022 and 2023 we conducted RTK elevation surveys to evaluate whether elevations within the contour had changed relative to as-built contour.
- Each purple point here represents an elevation measurement that was less than 1.3 feet NGVD. In 2022-2023, many elevation are still within the 2012 as-built contour.

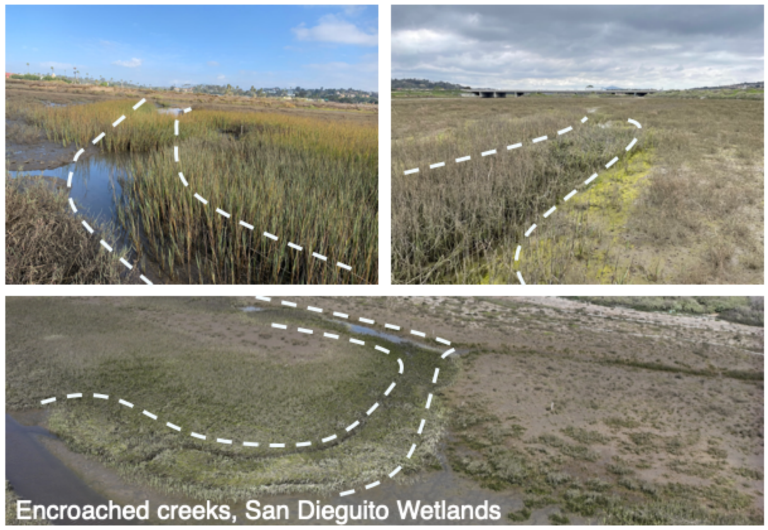


- We now include points that were measured to be equal to or greater than 1.3 feet NGVD within the as-built contour. These points indicate accretion relative to the 2012 as-built contour.

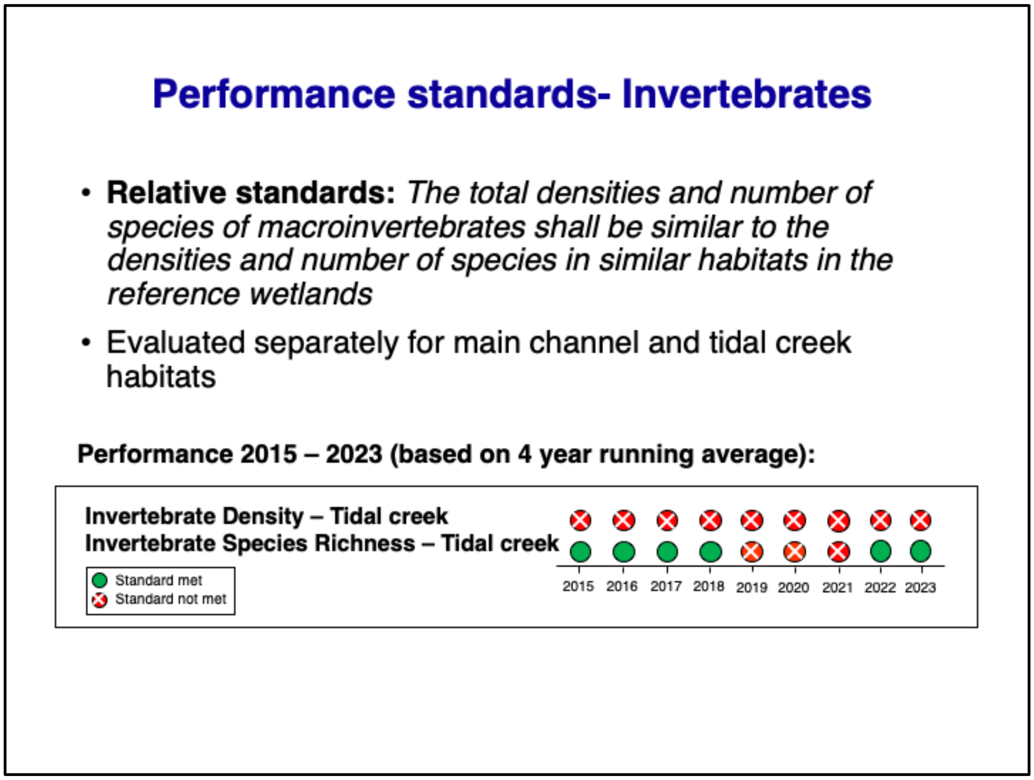


- Together, these changes in elevation may have facilitated salt marsh encroachment and habitat transition.
- This map shows an overlay of the vegetation classification for 2023 relative to the 2012 as-built contour.
- Looking at the purple points that are below 1.3 feet, we see that many points measured to be less than 1.3 feet are now vegetated in areas that were built to be mudflat. Thus, at San Dieguito Wetland, vegetation is able to survive below the planned lower limit of vegetation.
- Many of the yellow points that are above 1.3 feet also overlap with encroached salt marsh vegetation. These results also suggest that salt marsh will likely be able to encroach further into built mudflat areas.

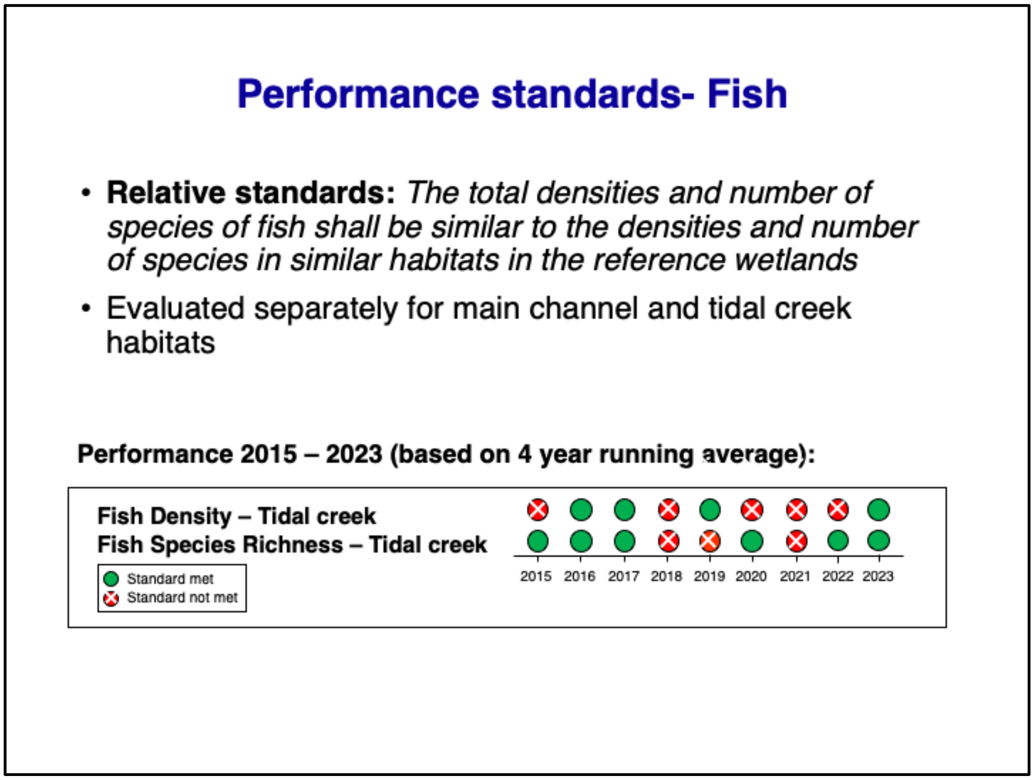
Salt marsh is also encroaching into tidal creeks


Encroached creeks, San Dieguito Wetlands

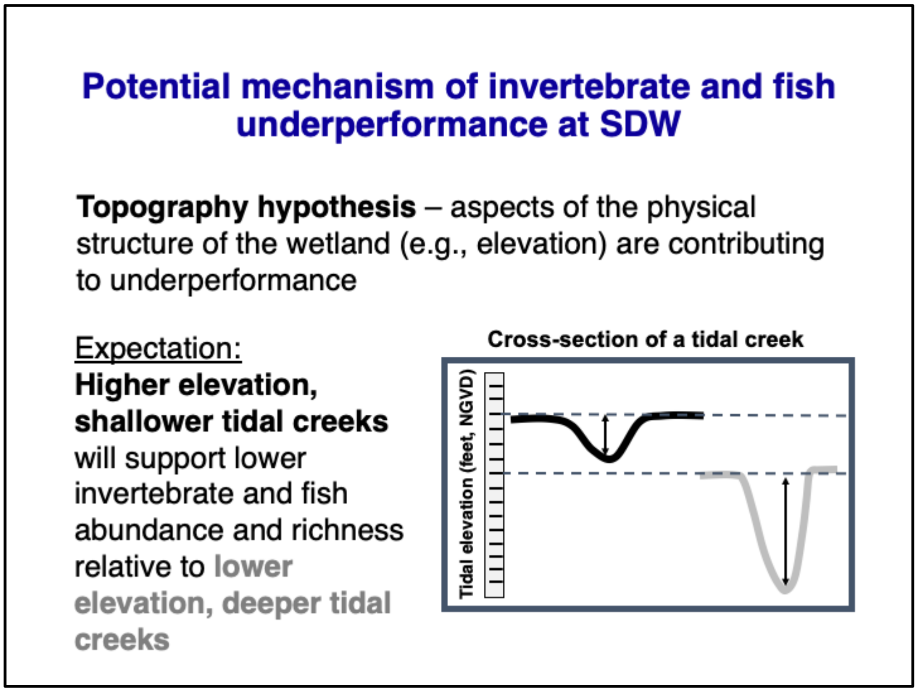
- In addition to encroaching into built mudflat areas, salt marsh is also encroaching into tidal creeks.
- As you can see here, salt marsh is moving into areas that were constructed to be tidal creeks, filling in the boundaries of these creeks to merge with the marsh plain.
- We measure invertebrate and fish performance standards within these creeks and it is possible that salt marsh encroachment could influence the outcomes at San Dieguito Wetlands for these performance standards.
- Invertebrate and fish abundance and richness are four standards that have not been met consistently over time, so we wanted to explore in more detail how elevation changes and salt marsh encroachment affect invertebrate and fish performance at San Dieguito Wetlands.



- This slide reviews the relative standards for invertebrates.
- These standards requires that the total densities and number of species of macroinvertebrates in SDW be similar to the densities and number of species in main channel and tidal creek habitats in the reference wetlands.
- The densities of invertebrates have consistently underperformed in tidal creeks in San Dieguito Wetland relative to the reference wetlands.

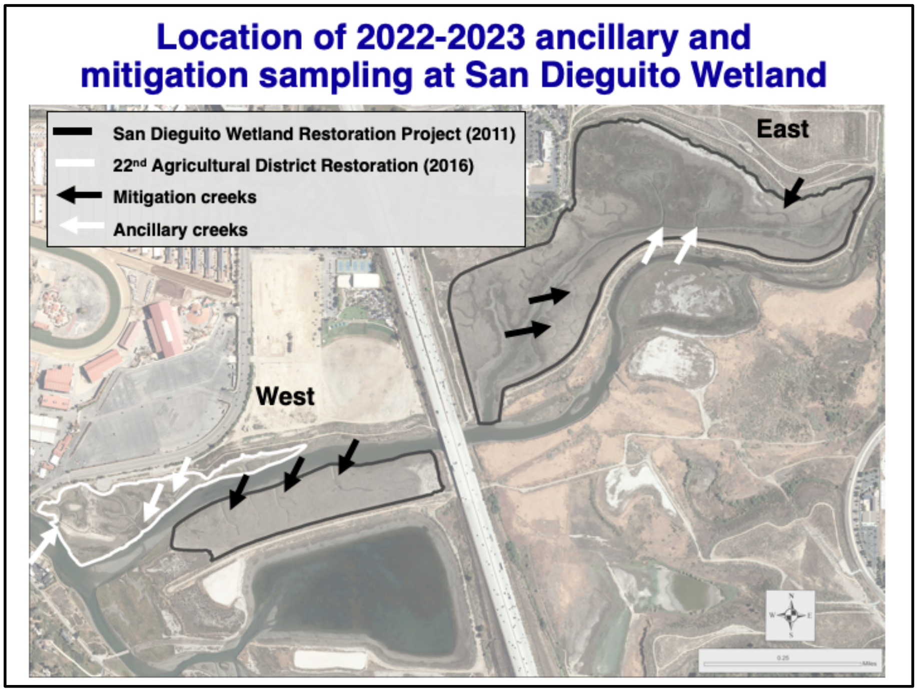


- The relative standard requirement for fish is the same as that for invertebrates, i.e. the densities and number of species of fish shall be similar in San Dieguito to the reference wetlands.
- Fish have met the relative standard more consistently than invertebrates, but salt marsh encroachment have heightened our concern about these standards.

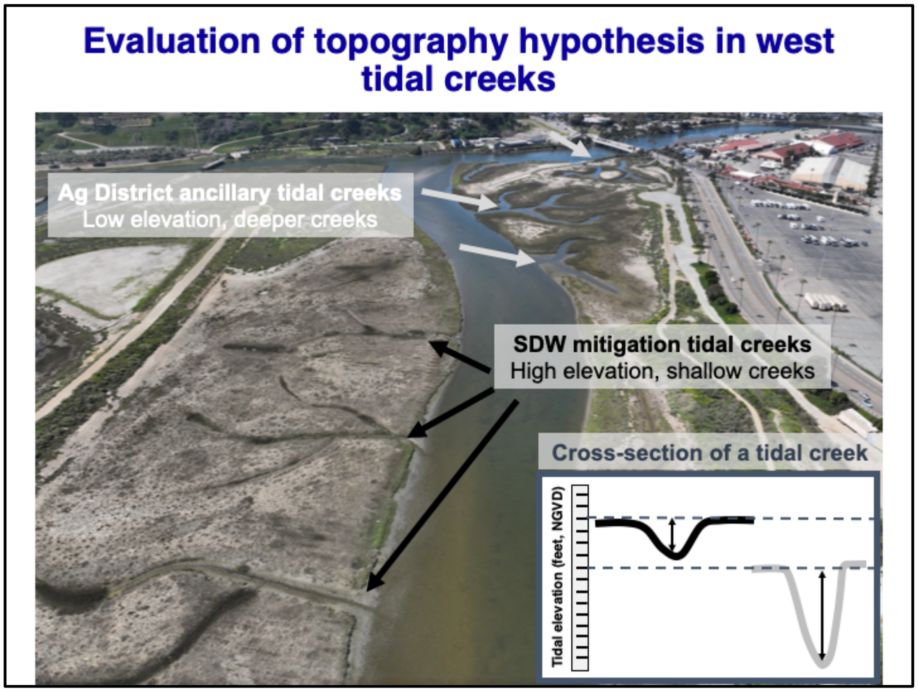


- We were particularly interested in how topography could affect invertebrate and fish relative standards.
- The topography hypothesis proposes that aspects of the physical structure of the wetland, such as tidal creek elevation, are contributing to the deficit of invertebrates and fish.
- We expected that higher elevation, shallower tidal creeks (shown on the left of the conceptual diagram) will support lower fish and invertebrate abundance and richness relative to lower elevation, deeper tidal creeks (shown on the right) .
- As discussed previously, salt marsh has encroached into tidal creeks, suggesting that tidal creeks at San Dieguito Wetlands are at a higher elevation than the reference sites, which could affect invertebrate and fish use of tidal creeks.

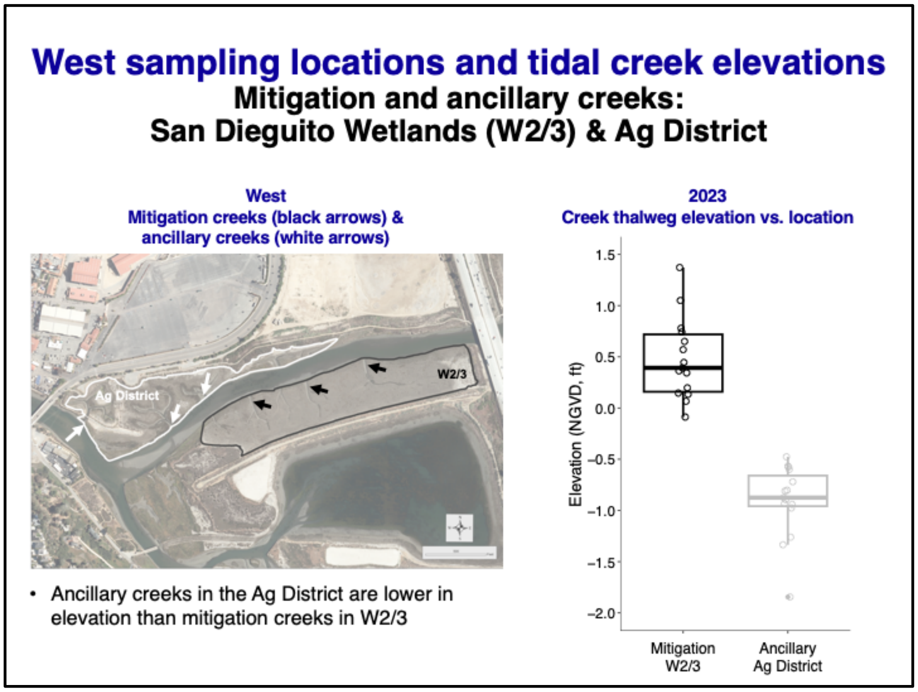
- To evaluate the topography hypothesis, in addition to our regular mitigation monitoring, over the last two years, we have also measured elevation and sampled fish and invertebrates in ancillary tidal creeks with different geomorphologies.
- These tidal creeks are located on both the west and east sides of the San Dieguito Wetland.
- In both locations, we targeted ancillary tidal creeks located within the San Dieguito Lagoon that appeared deeper and lower elevation than the tidal creeks constructed for the San Dieguito Wetland Restoration project.



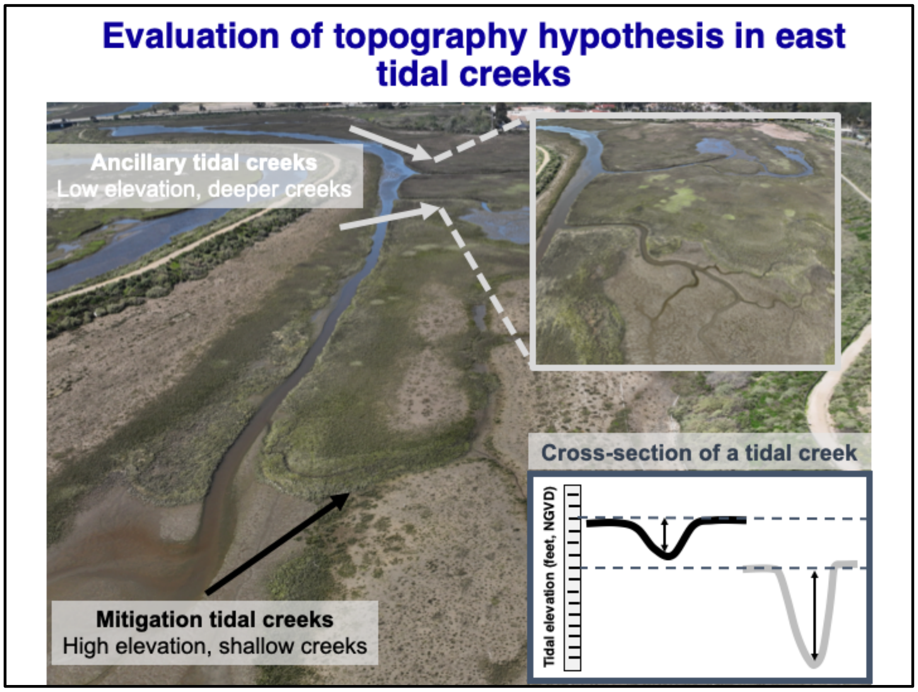
- On the west side of the highway, the black arrows show the mitigation creeks that we currently sample for performance monitoring.
- In 2022 and 2023, we also sampled ancillary creeks shown with grey arrows within the 22nd Agricultural District Restoration, which is an 8-year old restoration project located across the river channel from the San Dieguito Wetland Restoration Project.
- On the east side of the highway, the black arrows show the mitigation creeks that we currently sample for performance monitoring.
- In 2022 and 2023, we also sampled ancillary creeks that have naturally developed to feed the mudflats of the San Dieguito Wetland Restoration Project.



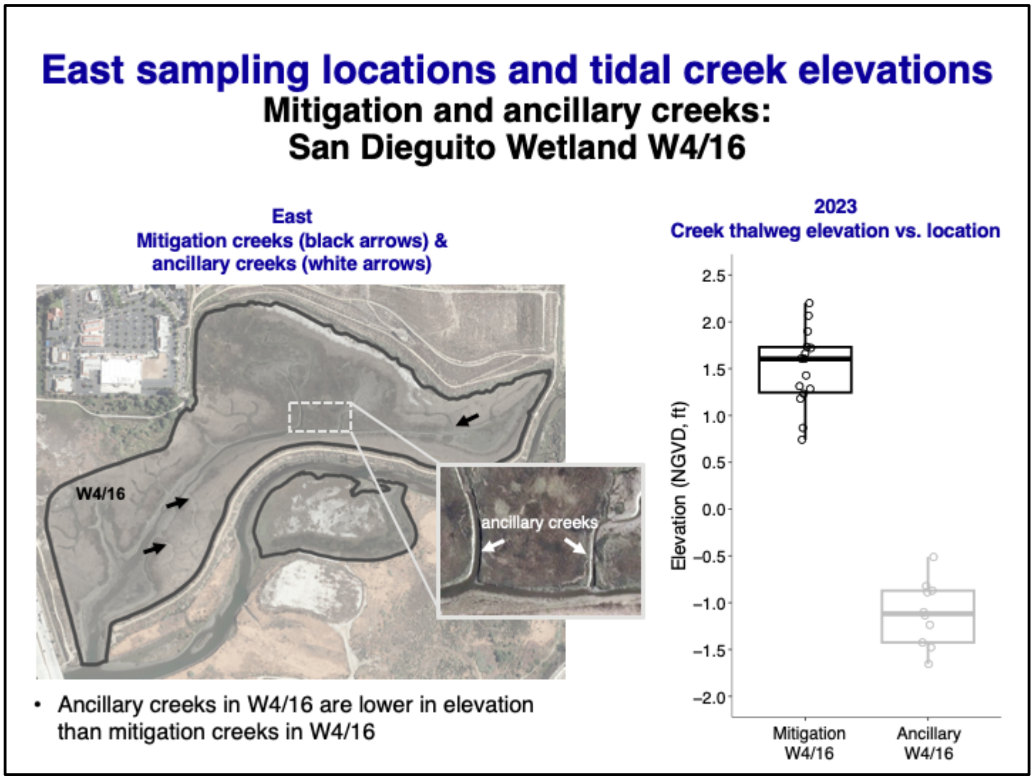
- Beginning with the tidal creeks on the west side of the highway, it is clear that on the same tide, Ag District ancillary creeks are filled with water in comparison to the empty SDW mitigation creeks on the other side of the river channel.
- The expectation is that invertebrate and fish density and richness would be higher in the ancillary creeks compared to the mitigation creeks if elevation is contributing to the differences among wetlands.



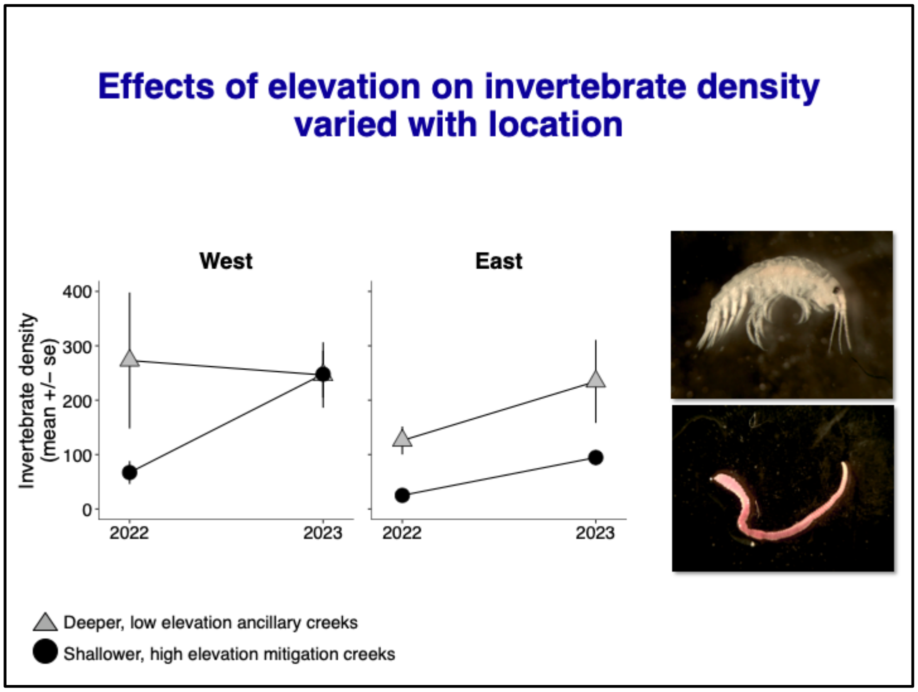
- For the west sampling locations, we first measured the elevation of both the mitigation and ancillary tidal creeks. The figure on the right shows the elevation of the thalweg, or the lowest elevation, of the sampled creeks.
- The median thalweg elevation of the ancillary Ag District creeks is 1.3 ft feet lower than those of migitation creeks in W2/3.



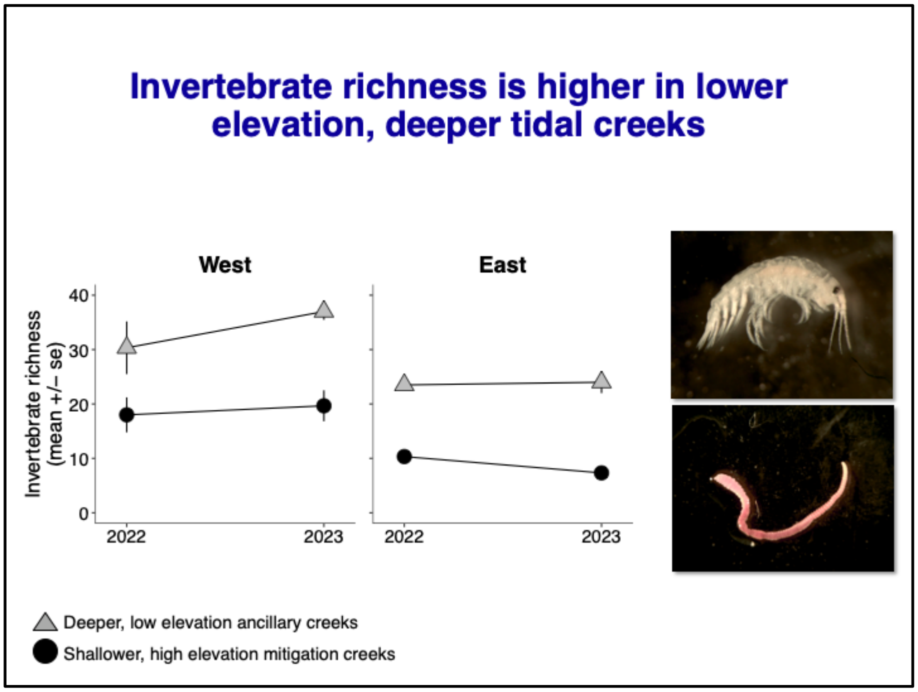
- On the east side of the highway, we also sampled in two ancillary creeks that have developed naturally to feed the mudflat.
- It is clear that on the same tide, these ancillary creeks are more filled with water relative to the empty, mitigation tidal creeks that we regularly monitor. This zoom in of the ancillary tidal creeks shows how much deeper the creeks are relative to the currently monitored tidal creeks.



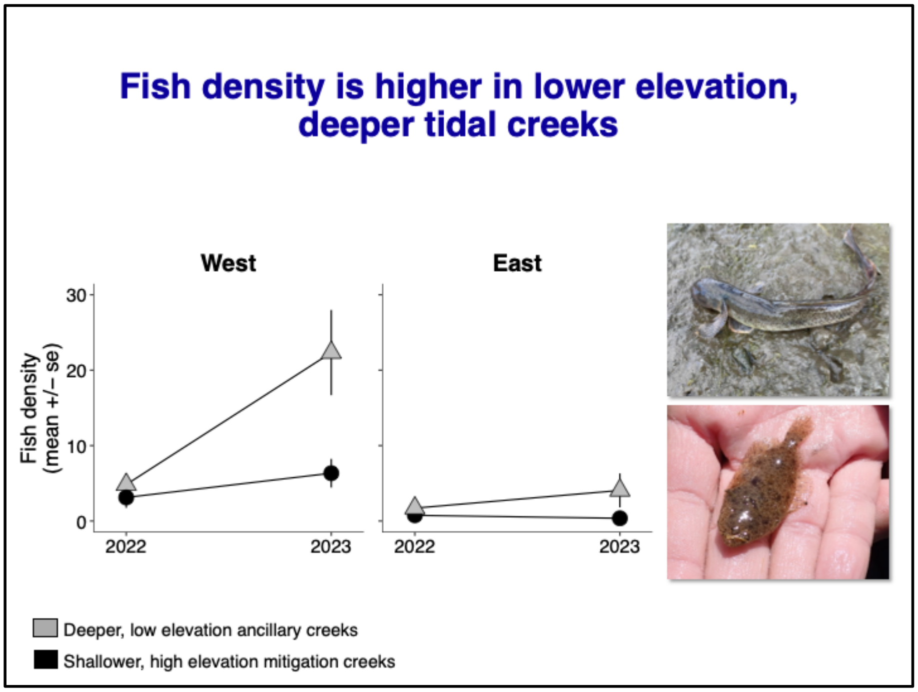
- On the east side of the highway, we also measured the elevation of both the mitigation and ancillary tidal creeks. The figure on the right shows the elevation of the thalweg, or the lowest elevation, of the sampled creeks.
- The median thalweg elevation of the ancillary creeks is 2.7 ft feet lower than the mitigation creeks.



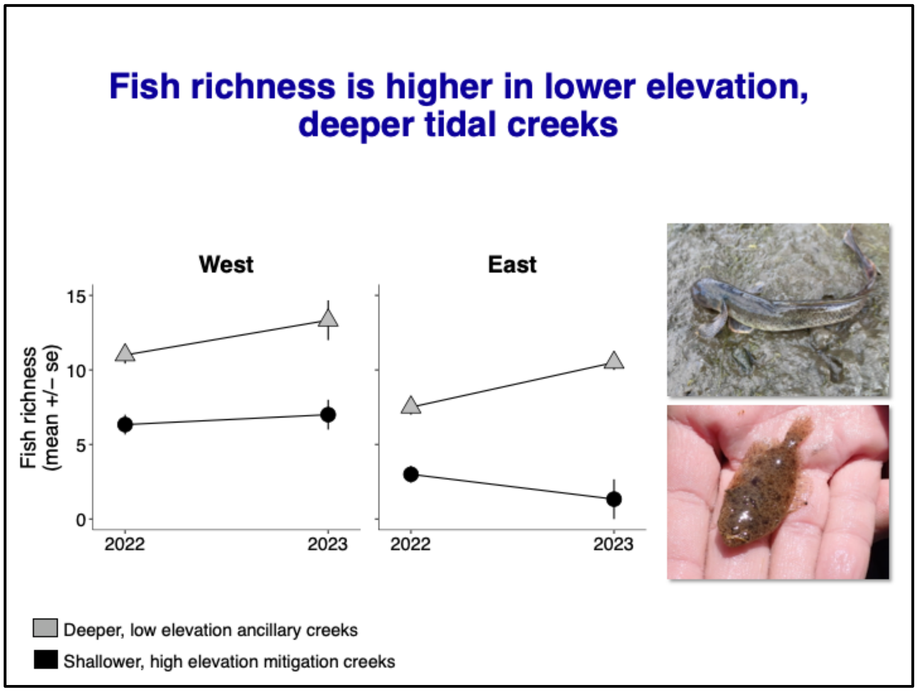
- We will now show the results for the invertebrate and fish ancillary sampling, beginning with invertebrate density. Data from deeper, low elevation ancillary creeks are indicated by the gray triangles and the shallower, high elevation mitigation creeks are indicated by the black circles.
- On the west side of the highway, mean invertebrate density was lower in shallow, high elevation mitigation creeks in 2022, but increased to match those of deeper, low elevation ancillary creeks in 2023.
- On the east side of the highway, invertebrate density was lower in shallow high elevation mitigation creeks relative to deeper low elevation ancillary creeks in both years, though there was an increasing trajectory over time in both sites.
- Invertebrate densities were lower in the East tidal creeks relative to the west tidal creeks, which could be due to either differences in larval supply or elevation.



- Moving onto invertebrate richness, on the west side of the highway, mean invertebrate richness was lower in shallow, high elevation mitigation creeks relative to deeper, low elevation ancillary creeks in both years.
- This pattern was consistent on the east side of the highway, and invertebrate richness was lower in the East tidal creeks relative to the west tidal creeks.



- Moving onto fish density, on the west side of the highway, mean fish density was lower in shallow, high elevation mitigation creeks relative to deeper, low elevation ancillary creeks in both years, though there was a substantial increase in fish density in both types of tidal creeks in 2023.
- Similarly, on the east side of the highway, mean fish density was lower in shallow, high elevation mitigation creeks.
- Fish density was lower in the East tidal creeks relative to the west tidal creeks. As for invertebrates, this pattern could be due to either larval supply or elevation.



- Lastly, on the west side of the highway, mean fish richness was lower in shallow, high elevation mitigation creeks relative to deeper, low elevation ancillary creeks in both years.
- This pattern was consistent on the east side of the highway, and fish richness was slightly lower in the East tidal creeks relative to the west tidal creeks.

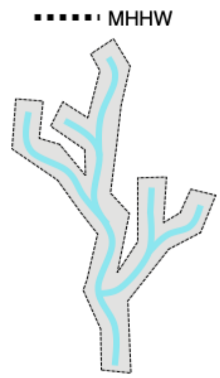
Salt marsh encroachment and underperformance of invertebrates and fish in tidal creeks suggest an issue with tidal creek design

Questions:

- Are tidal creek dimensions changing over time?
- How do current tidal creek configurations compare to creeks under presumed equilibrium conditions in natural mature marshes?

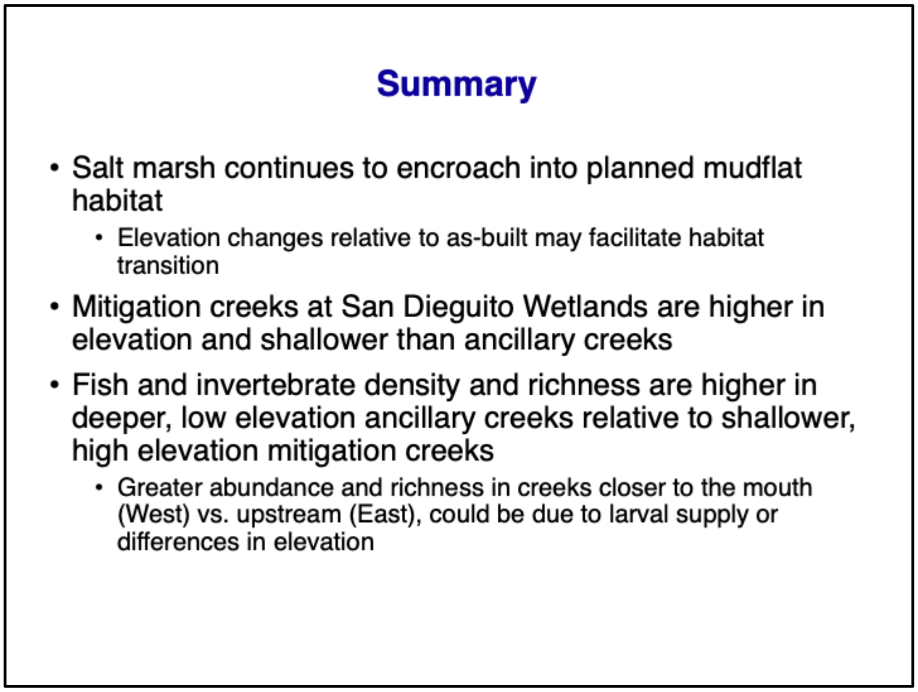
Approach:

- Use hydraulic geometry relationships from 17 California salt marshes to predict the configuration of mature tidal channels as a function of catchment volume below MHHW
- Compare model predictions to recent RTK elevation surveys

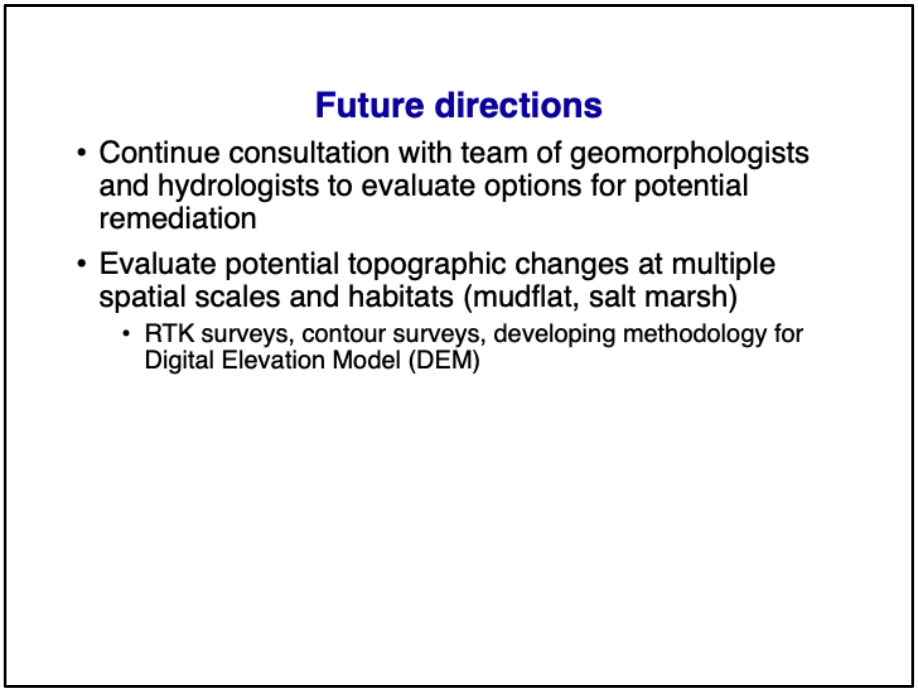


PWA 1995
Williams et al. 2002

- Salt marsh encroachment and underperformance of invertebrates and fish in tidal creeks suggest an issue with tidal creek design.
- Specifically, we were interested in 1) whether the tidal creek dimensions have changed over time and 2) How the current tidal creek configurations compare to creeks under presumed equilibrium conditions in natural mature marshes.
- We are working with consultants to model expected tidal creek tidal geomorphology based on catchment area using the following approach:
- We will use established hydraulic geometry relationships developed from 17 California salt marshes (3 in San Diego Bay, 14 in SF Bay) to predict the depth, width, and cross-sectional area of mature tidal channels as a function of catchment volume below MHHW (2.8 ft NGVD).
- We will then compare model predictions to recent RTK elevation surveys, which will enable us to answer these questions. We anticipate that these results will inform decisions about potential remediation.



- To summarize, salt marsh continues to encroach into planned mudflat habitat
  - Elevation changes relative to as-built may facilitate habitat transition
- Mitigation creeks at San Dieguito Wetlands are higher in elevation and shallower than ancillary creeks
- Fish and invertebrate density and richness are higher in deeper, low elevation supplemental creeks relative to shallower, high elevation monitored creeks
  - Greater abundance and richness in creeks closer to the mouth (West) vs. upstream (East), could be due to larval supply or differences in elevation



- Moving forward, we will:
- Continue consultation with team of geomorphologists and hydrologists to evaluate options for potential remediation
- Evaluate potential topographic changes at multiple spatial scales and habitats (mudflat, salt marsh)
    - RTK surveys, contour surveys, developing methodology for Digital Elevation Model (DEM)

Agenda

Annual Public Workshop

San Onofre Nuclear Generating Station Wetland Mitigation Project

May 9, 2024

1:30 – 1:40	Introduction and Overview – Mark Page, UCSB
1:40 – 2:30	Performance of the San Dieguito Wetlands Restoration Project – Kat Beheshti, UCSB
2:30 – 3:00	Causes and consequences of habitat conversion at San Dieguito Wetlands– Rachel Smith, UCSB
3:00 – ?	General Discussion

For more information go to: http://marinemitigation.msi.ucsb.edu/