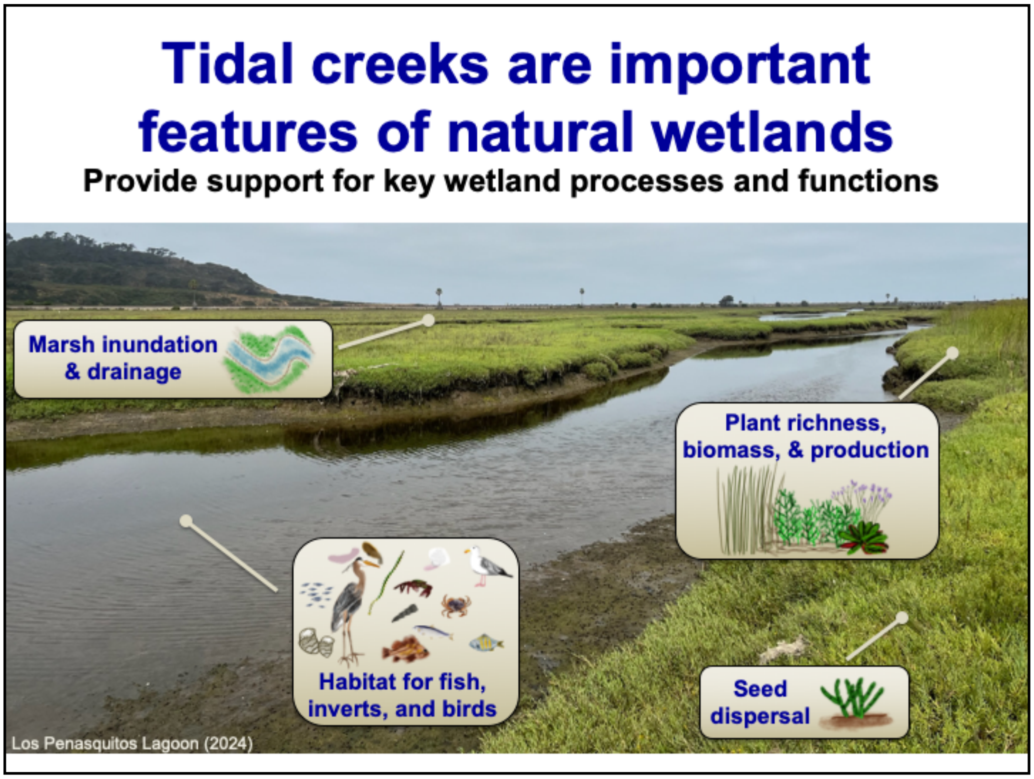
Causes and consequences of tidal creek loss at San Dieguito Wetlands

Annual Review Workshop for SONGS Wetland Mitigation

May 6, 2025
SONGS Mitigation Monitoring Project
Marine Science Institute, University of California Santa Barbara

Good morning everyone. Thank you Rachel for setting up this next talk so nicely. The talk I will be presenting is on the causes and consequences of tidal creek loss and San Dieguito Wetlands.



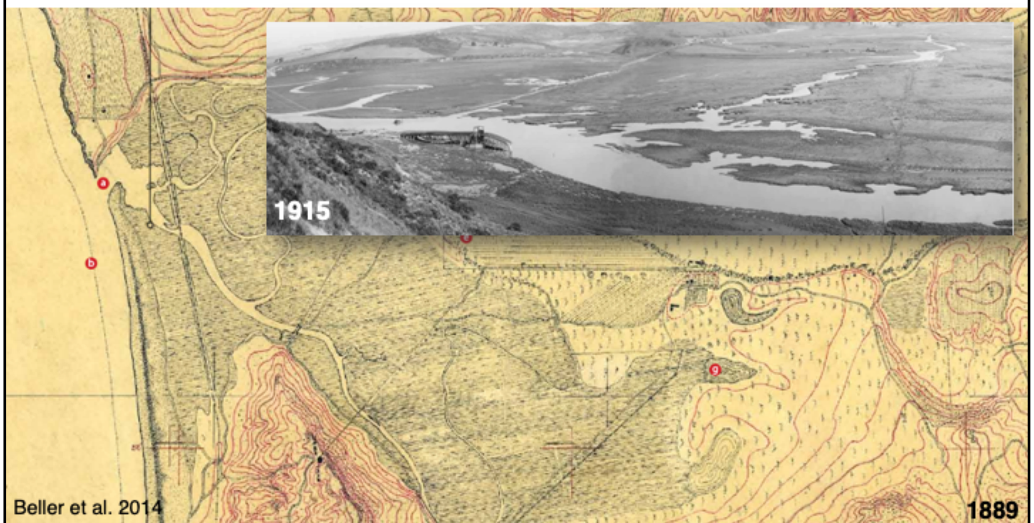
First, I want to acknowledge the importance of tidal creeks as key features of natural wetlands, providing support for key wetland processes and functions from marsh inundation and drainage to habitat for fish, inverts, and birds, enhancing plant richness, biomass, production, and seed dispersal.

How tidal creeks fit into the SONGS Permit objectives

- Permit (CDP 6-81-330A) objectives, designed to guide the restoration plan state that the restored wetland…
  - *"Provides maximum overall ecosystem benefit…e.g.,* ***regionally scarce habitat, potential for local ecosystem diversity****."*
  - *"Provides substantial* ***fish habitat*** *compatible with other wetland values at the site"*
- Permit explicitly calls out tidal creeks as a suggested sampling location for assessing numerous standards

The SONGS permit objectives were designed to guide the restoration plan and required that the restoration provide the maximum overall ecosystem benefit including regionally scare habitat and potential for local ecosystem diversity as well as fish habitat– all of which tidal creeks provide. Additionally, the permit explicitly calls out tidal creeks as a suggested sampling location for assessing numerous standards and this is reflected in the wetland monitoring plan that was a derivative of the SONGS permit.

San Dieguito Lagoon historically supported tidal creeks



It’s important to also note that San Dieguito historically possessed tidal creeks that were later lost during development of the surrounding watershed.

Presence of tidal creeks included in reference site selection

Mugu Lagoon

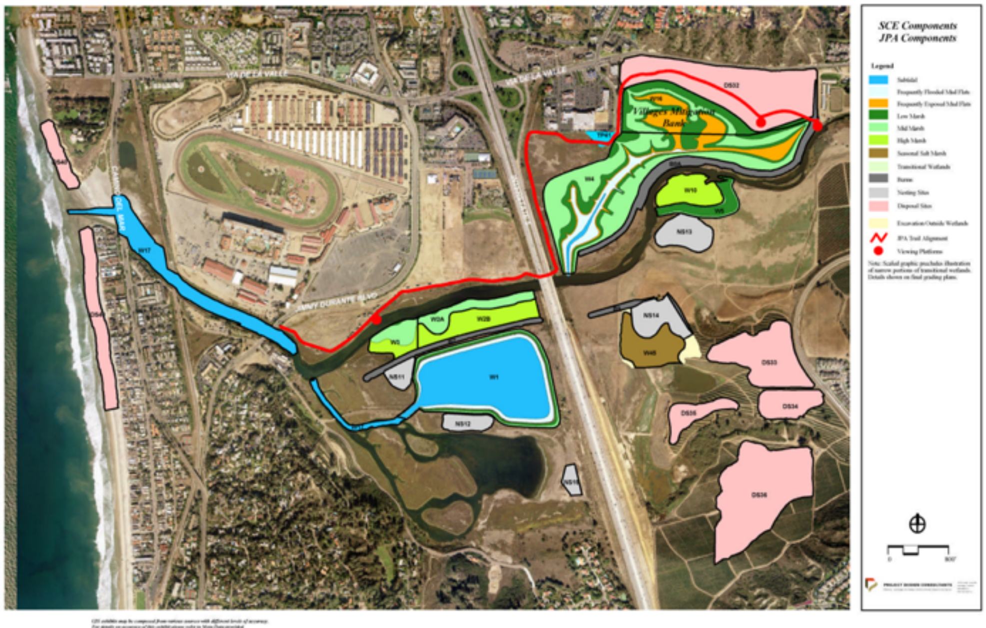
Carpinteria Salt Marsh

Los Penasquitos Lagoon

Tijuana Estuary

And reference sites were chosen based on the criteria Mark mentioned in the first talk (relatively undisturbed, locally within SCB, and tidal). But also, the reference sites were chosen in part because they possess tidal creeks—an important attribute because richness and abundance of invertebrates and fish are relative standards that are measured in tidal creeks at all the monitored wetlands.

Restoration plan included precursor creeks

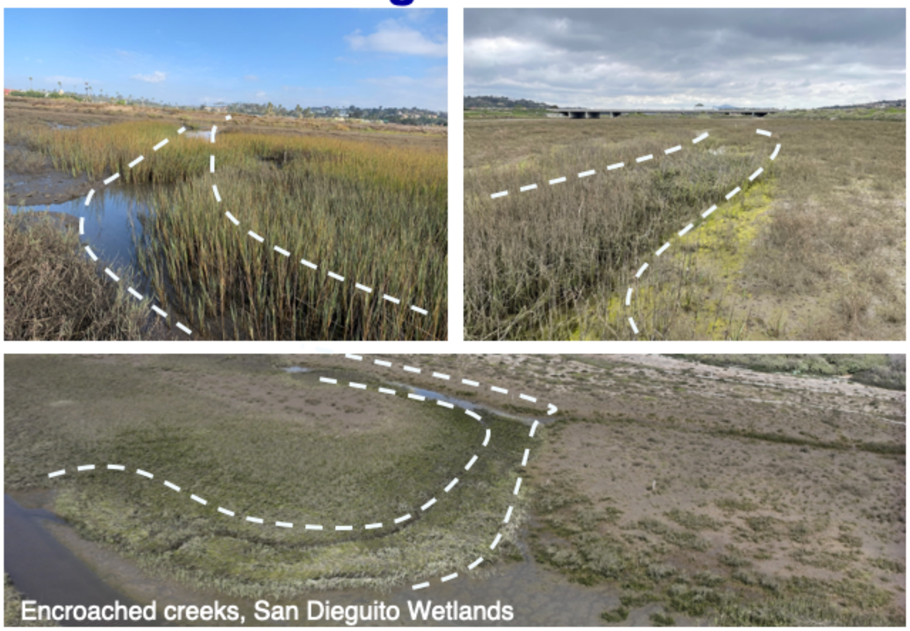


The Final Restoration Plan for SDW included design elements typical of tidal wetlands in the region, including mudflat, vegetated salt marsh and a subtidal basin. Not included were tidal creek networks per se, but rather “nicks” that were proposed to evolve into tidal creeks over time.

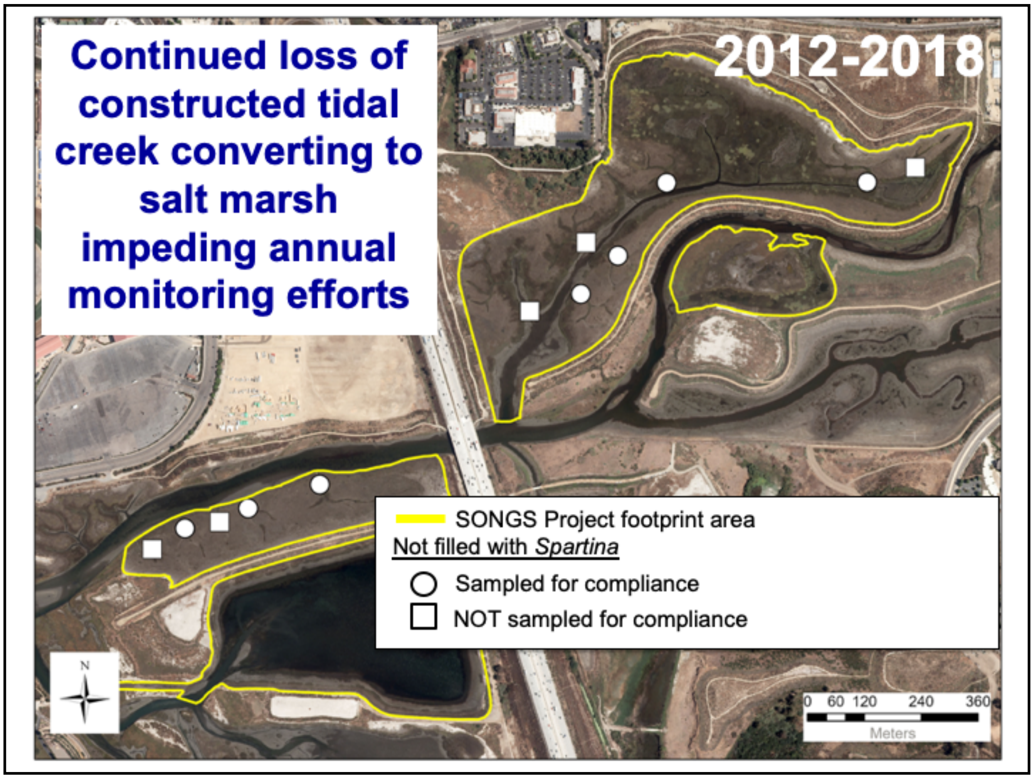
Tidal creeks were constructed at San Dieguito Lagoon (2006-2011)

Despite not being in the restoration plan, tidal creeks were constructed at different stages early on in the project in both W2/3 and W4/16.

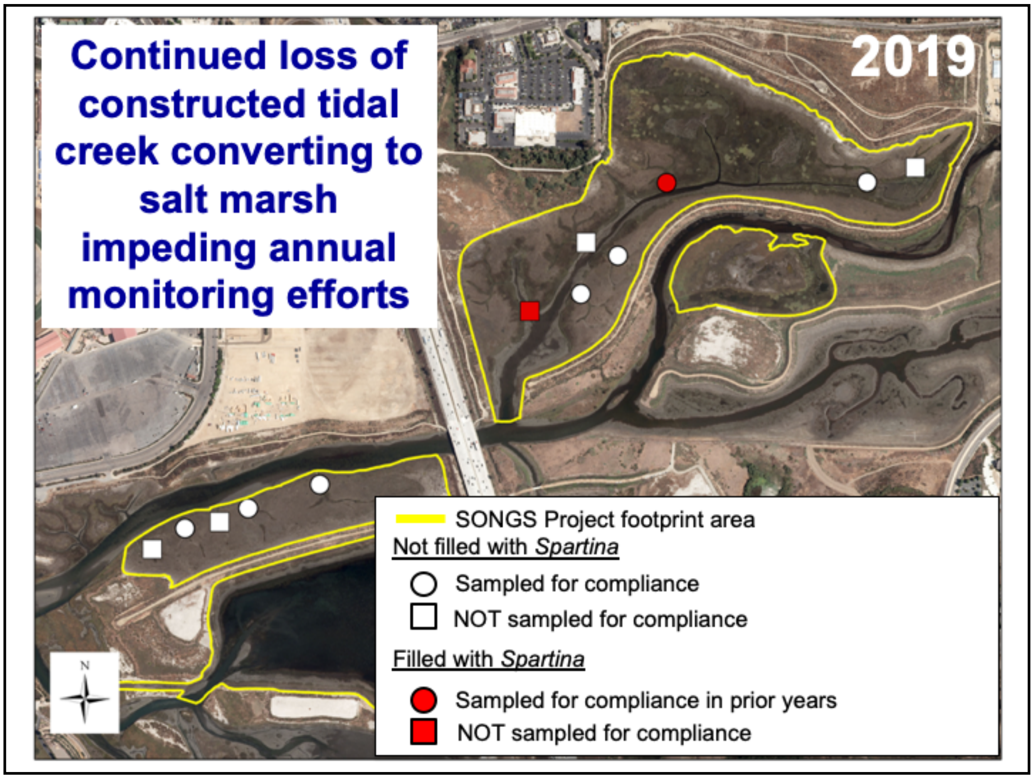
Tidal creeks are filling in with marsh vegetation



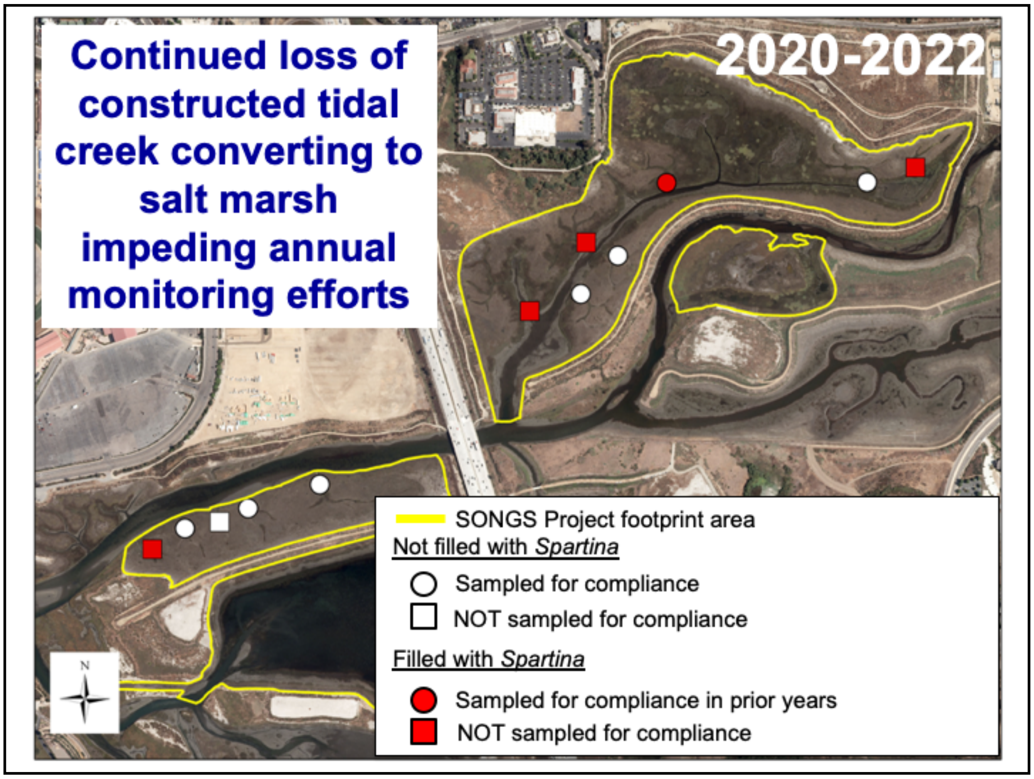
But, since 2019, we have been observing these constructed tidal creeks filling in with sediment and marsh vegetation as shown here.



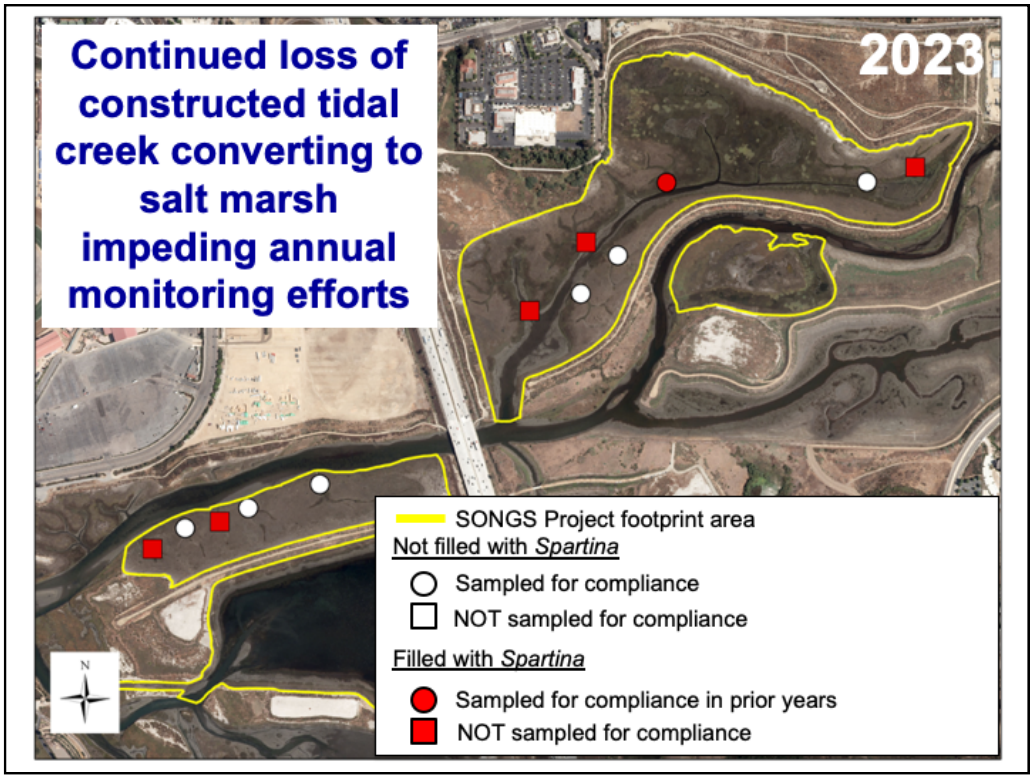
I'm going to walk through the changes in the tidal creeks at San Dieguito over time. Here, the shapes on the map indicate tidal creeks that are or have been sampled for compliance versus constructed, but not sampled for compliance. A total of six tidal creeks are sampled for compliance at SDW and the three reference sites. You can see here that form 2012-2018, all of the available creeks were intact.



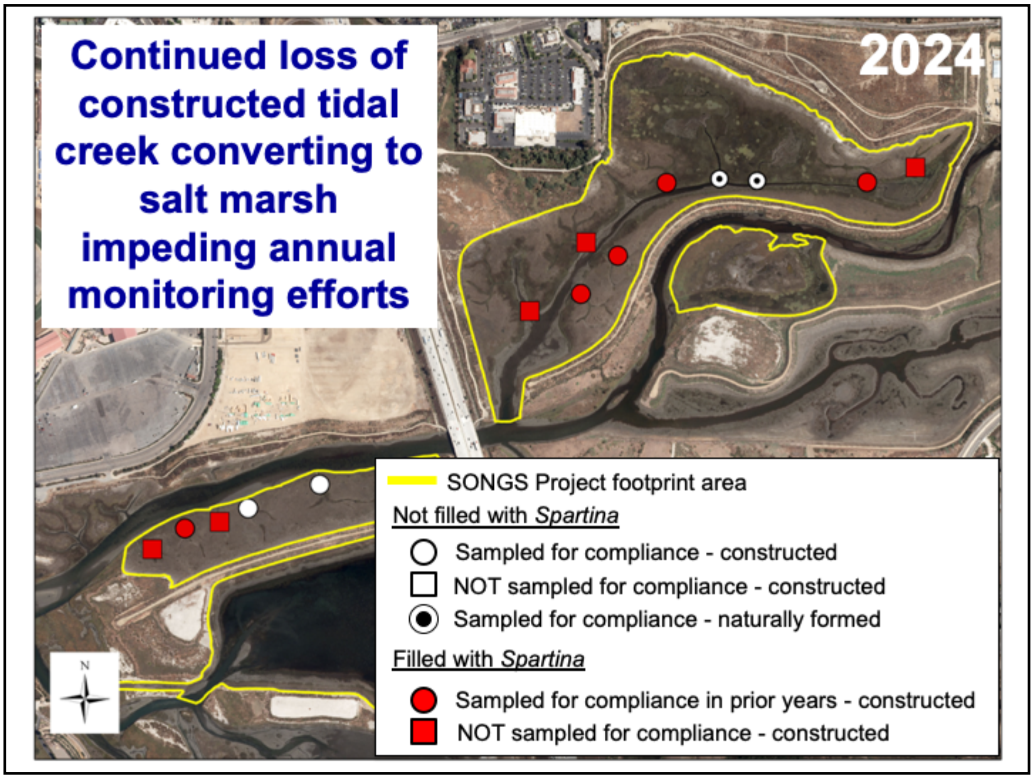
By 2019, two of the constructed creeks had filled in with Spartina, preventing future monitoring.



From 2020-2022, an additional 3 tidal creeks transitioned to salt marsh and no longer serve as creek habitat



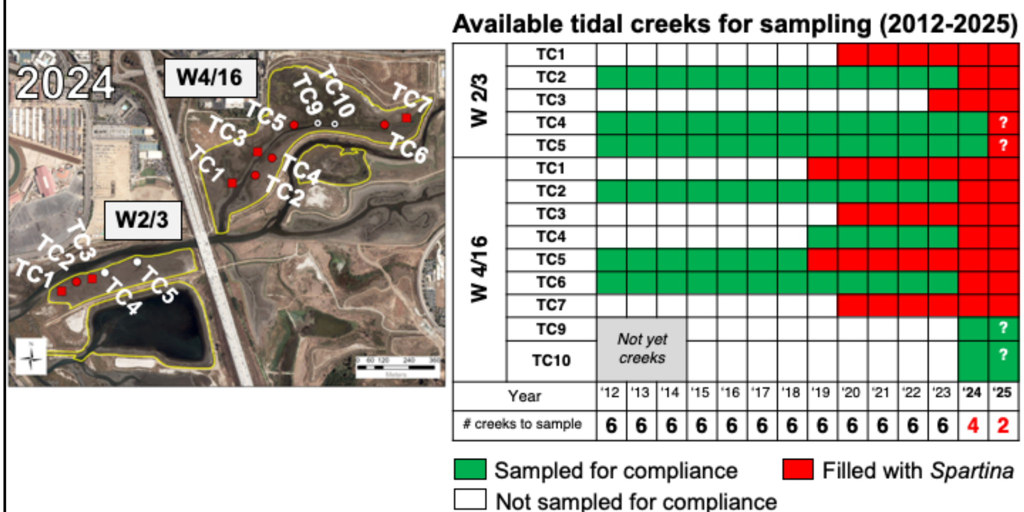
In 2023, we lost an additional constructed creek to salt marsh encroachment



And this past year, all but two constructed creeks remained. This led us to include two naturally-formed tidal creeks in W4/16 in our compliance monitoring, as highlighted in Rachel's talk.

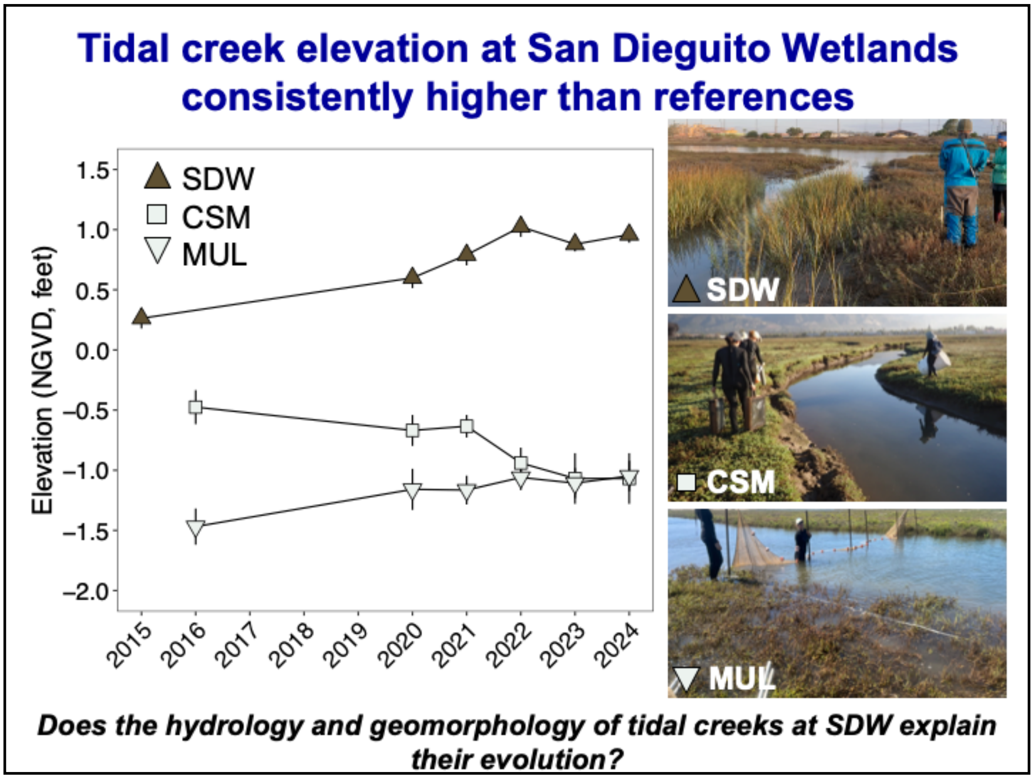
2024 was the first year we did not have 6 tidal creeks to sample at SDW

In 2025, we expect only naturally-formed creeks to be sampleable



Why is salt marsh encroaching into constructed tidal creeks?

The map on the left shows the labeled constructed and naturally-formed creek status in 2024. The table on the right shows a time series from 2012 to 2025 for all creeks, constructed and naturally-formed. Green indicates creeks that were sampled for compliance, white indicates creeks not sampled for compliance, and red indicates creeks filled with Spartina and unable to be sampled. The naturally-formed creeks, TC 9 and TC10, were planned as frequently flooded mudflat and, based on aerial imagery, did not appear to scour into tidal creeks until around 2015. These two naturally-formed creeks were not sampled for compliance until 2024. 2024 was the first year we did not have the full sample size of 6 tidal creeks at SDW used across all wetlands in years prior to assess the four tidal creek standards. Next year, we anticipate only the naturally-formed creeks to remain sampleable. Over the past few years we have been trying to identify the mechanisms driving the conversion of tidal creeks to salt marsh habitat.



In looking at a time series of elevation data collected from the deepest points along the sampled creeks from 2015 to 2024, we see that tidal creek elevation at San Dieguito Wetlands, shown as the brown triangles, has been consistently higher than the two reference wetlands plotted. This led us to ask, does the hydrology and geomorphology of tidal creeks at SDW explain their evolution?

Creek geomorphology trajectory compared to modeled equilibrium

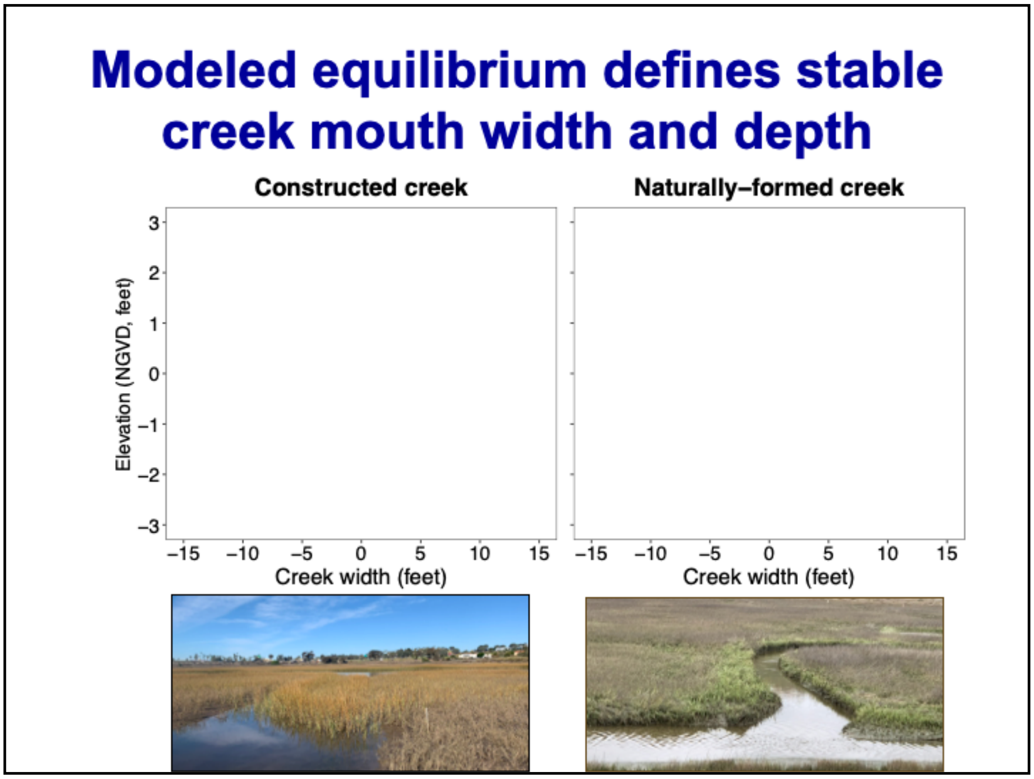
Hydraulic geometry relationships* used to determine equilibrium for:

Constructed creeks

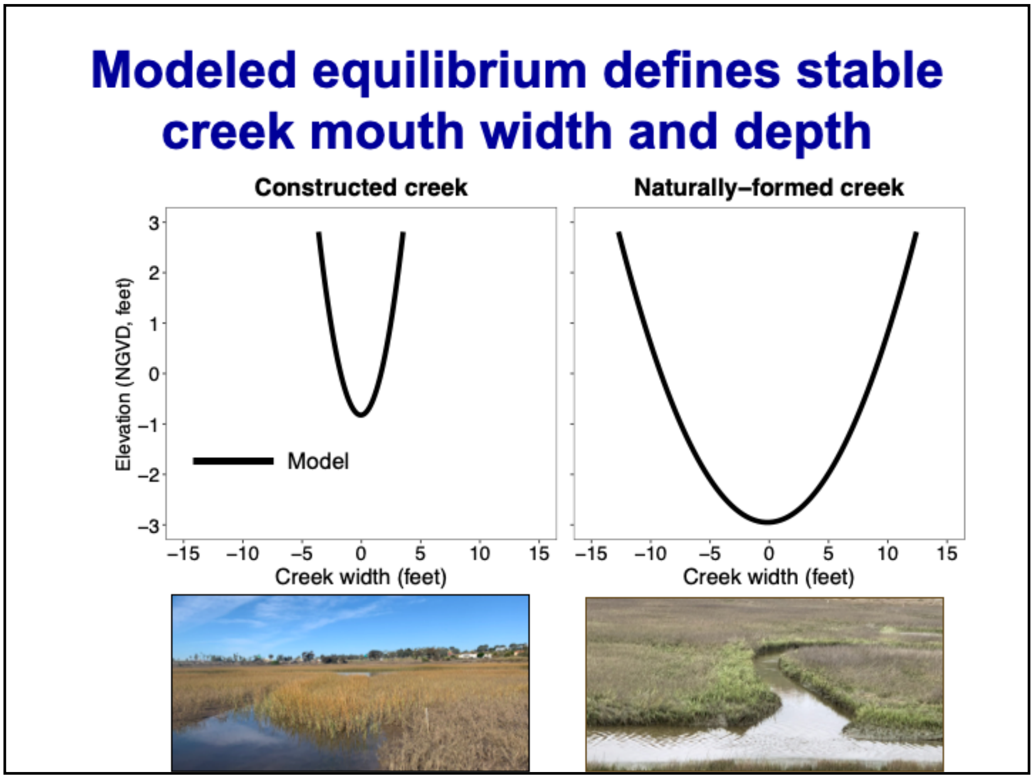
Naturally-formed creeks

*Data from 17 California salt marshes used to predict the configuration of mature tidal creeks (PWA 1995, Williams et al. 2002)

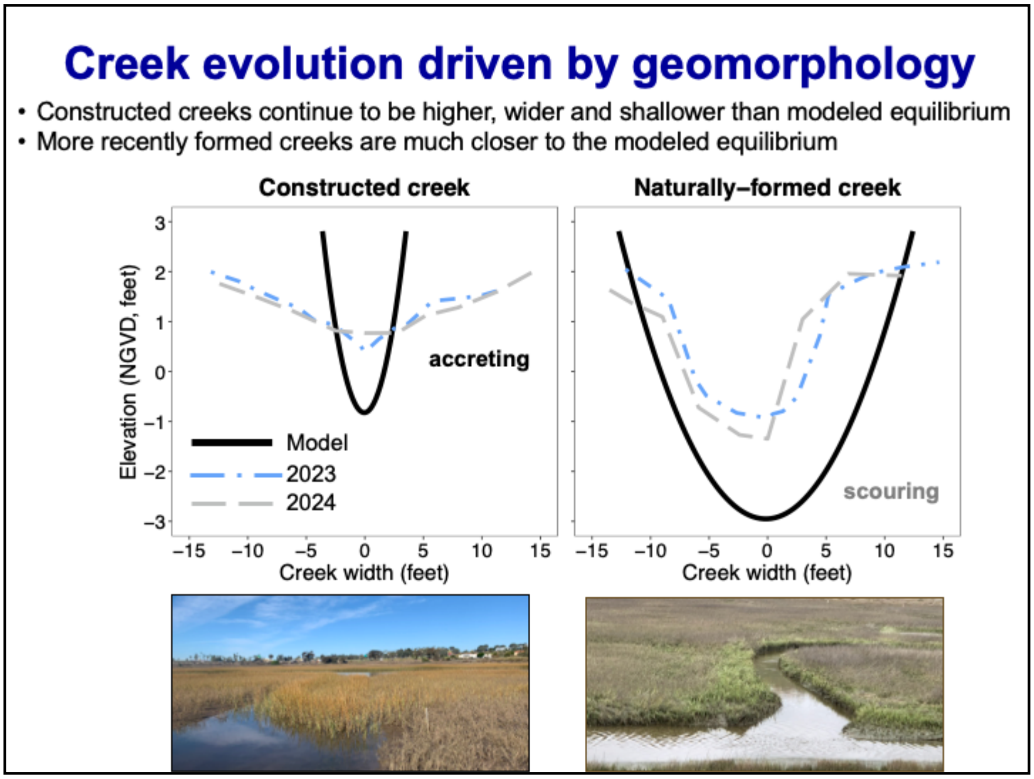
To answer this question, we worked with geomorphologists and hydrologists to model the equilibrium state of both the constructed and naturally-formed tidal creeks. Or, put more simply, using data from numerous wetlands in CA, and the specific catchment area for individual creeks, the creek width and depth required for stable tidal creeks was modeled.



Here we are going to show the modeled creek geomorphology for two example tidal creeks, a constructed creek on the left and a naturally-formed creek on the right. On the x-axis, we have the creek width in feet and on the y axis, elevation in feet, NGVD. Again, these models predict the mature configuration for an individual creek based on estimates of the volume of water it drains.



The modeled equilibrium for both constructed and naturally-formed creeks are plotted given the amount of water expected to drain from each creek. These curves represent a stable width and depth for the mouth of these two creek types.



Next, we are overlaying the measured creek geomorphology from 2023 shown as blue dash-dot lines and 2024 as grey long-dash lines. You can see that the constructed creeks on the left are are much higher, shallower and wider than the modeled equilibrium in black. Alternatively, the naturally-formed creeks are trending towards the modeled equilibrium by narrowing and deepening towards the black lines. To summarize, constructed creeks are accreting and naturally-formed creeks are scouring. These naturally-formed creeks scoured from an area planned as mudflat, meaning it was graded to be above -0.9’ NGVD and at or below 1.3’ NGVD.

Conclusions

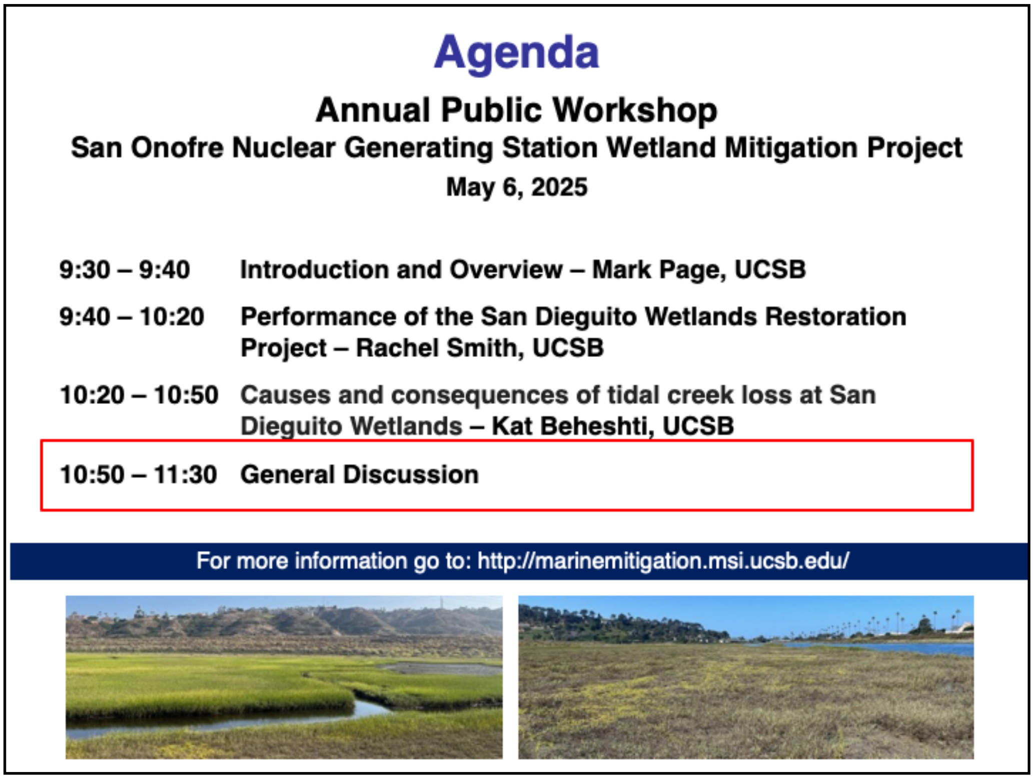
- Constructed tidal creeks are filling in with vegetation and converting to low salt marsh
- Constructed tidal creek loss is expected to continue
- Ability to sample tidal creek relative standards severely compromised
- Creek geomorphology contributing to conversion of tidal creeks to salt marsh
  - Design of constructed creeks was too wide, high, and shallow
  - Unlikely constructed creeks will reach modeled equilibrium in near term

To summarize—the constructed tidal creeks are filling in with vegetation and converting to low salt marsh and this creek loss is expected to continue. This continued loss is compromising our ability to sample tidal creek relative standards. The data we have suggests that the geomorphology is contributing to conversion of constructed tidal creeks to salt marsh. These results indicate that the design of the constructed tidal creeks were too high, wide and shallow and it’s unlikely they will be able to reach the equilibrium state in the near future.

Plans for 2025

- In consultation with geomorphologists and hydrologists, provide CCC with information needed to evaluate potential adaptive management options
- Review modeling to determine optimal location, density, and design for constructed tidal creeks
- Determine how to evaluate tidal creek standards given constructed tidal creek loss at SDW

To finish, we'd like to provide an overview of our plans for 2025 focused on tidal creeks. In consultation with geomorphologists and hydrologists, we will provide CCC with information needed to evaluate potential adaptive management options and review modeling results to determine optimal location, density, and design for tidal creeks. Finally, we will be working with CCC and our SAP to determine how to evaluate tidal creek standards in 2025, given the loss of tidal creeks at SDW.



With that, I'd like to call Mark and Rachel back up to answer any questions our audience may have.