



# Pacific Sardine stock structure workshop - Habitat model to optimize sampling of the northern stock of Pacific Sardine

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1- Institute of Marine Sciences, University of California Santa Cruz,

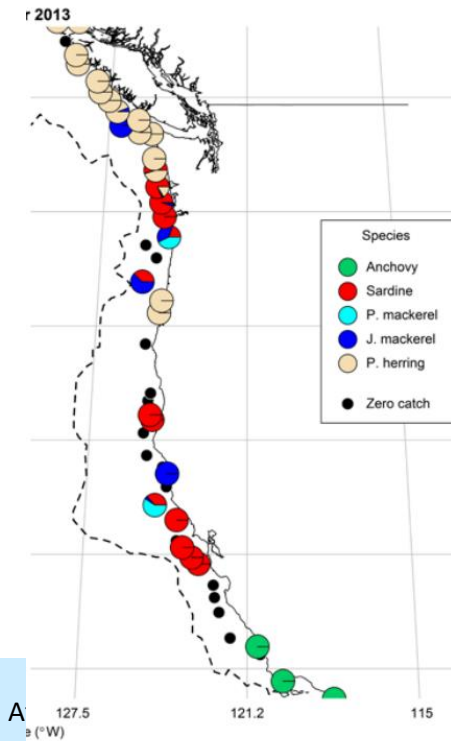
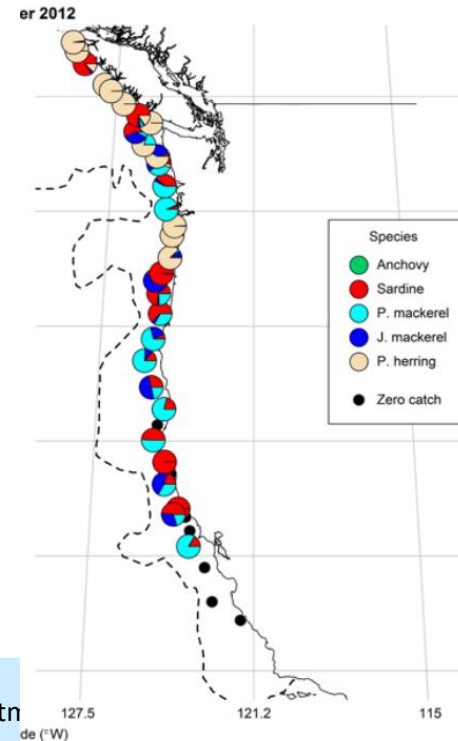
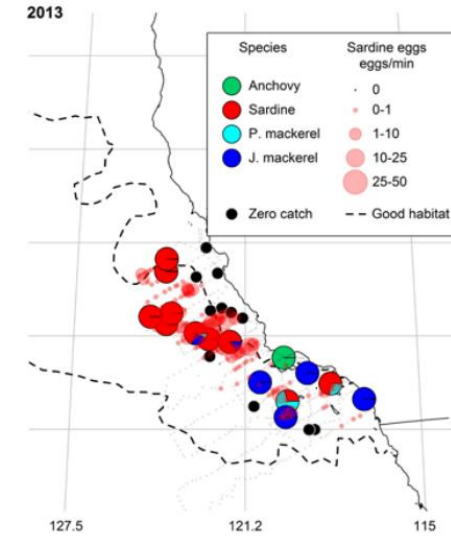
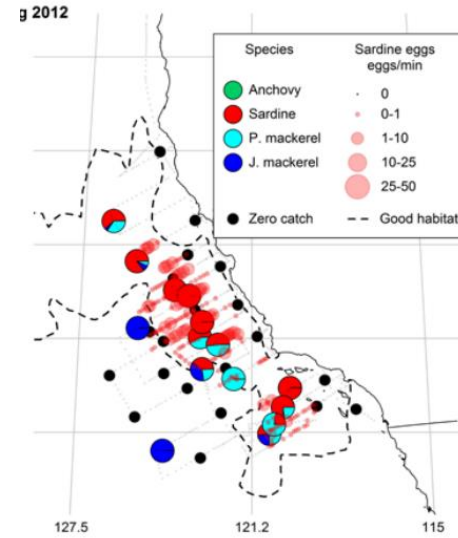
2 - Fisheries Resources Division, Southwest Fisheries Science Center

*Draft work presented to the PFMCC SSC CPS subcommittee, March 20-21 2023.*

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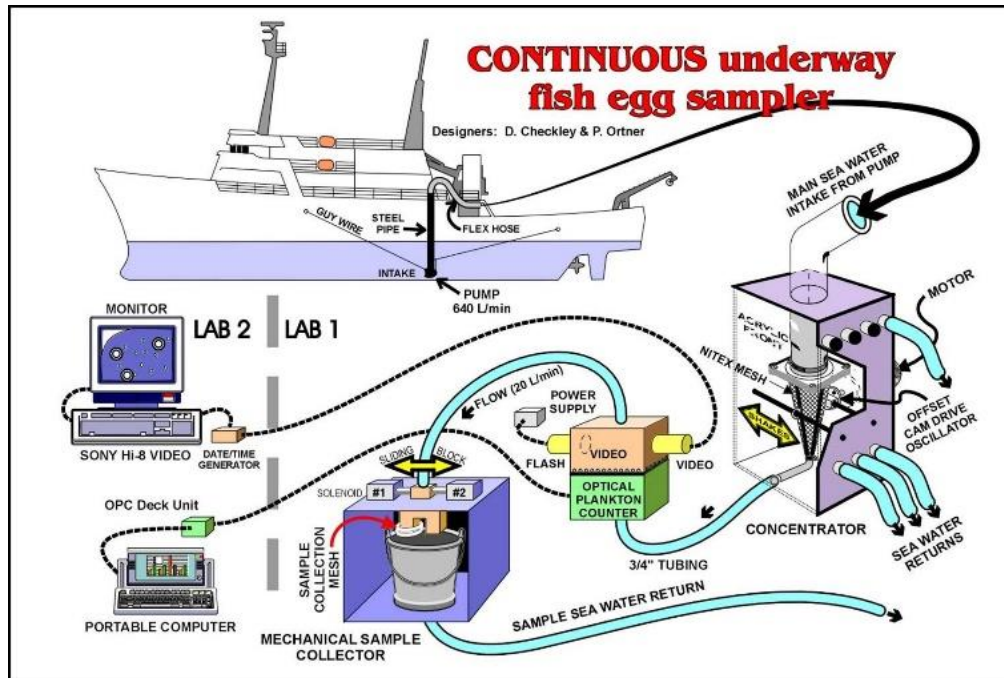
# The Northern stock of Pacific Sardine

- Three accepted stocks of Pacific Sardine in the Northeastern Pacific: Northern, Southern and the Gulf stocks.
- Northern stock refers to those sardine that spawn primarily in the spring off Southern and Central California, and whose adults perform seasonal migrations between northern Baja and Canada when the stock is abundant.
- The Northern stock is managed by PFMCC CPS FMP
- The Northern stock was fished in 1930-1940s and 2000-2015

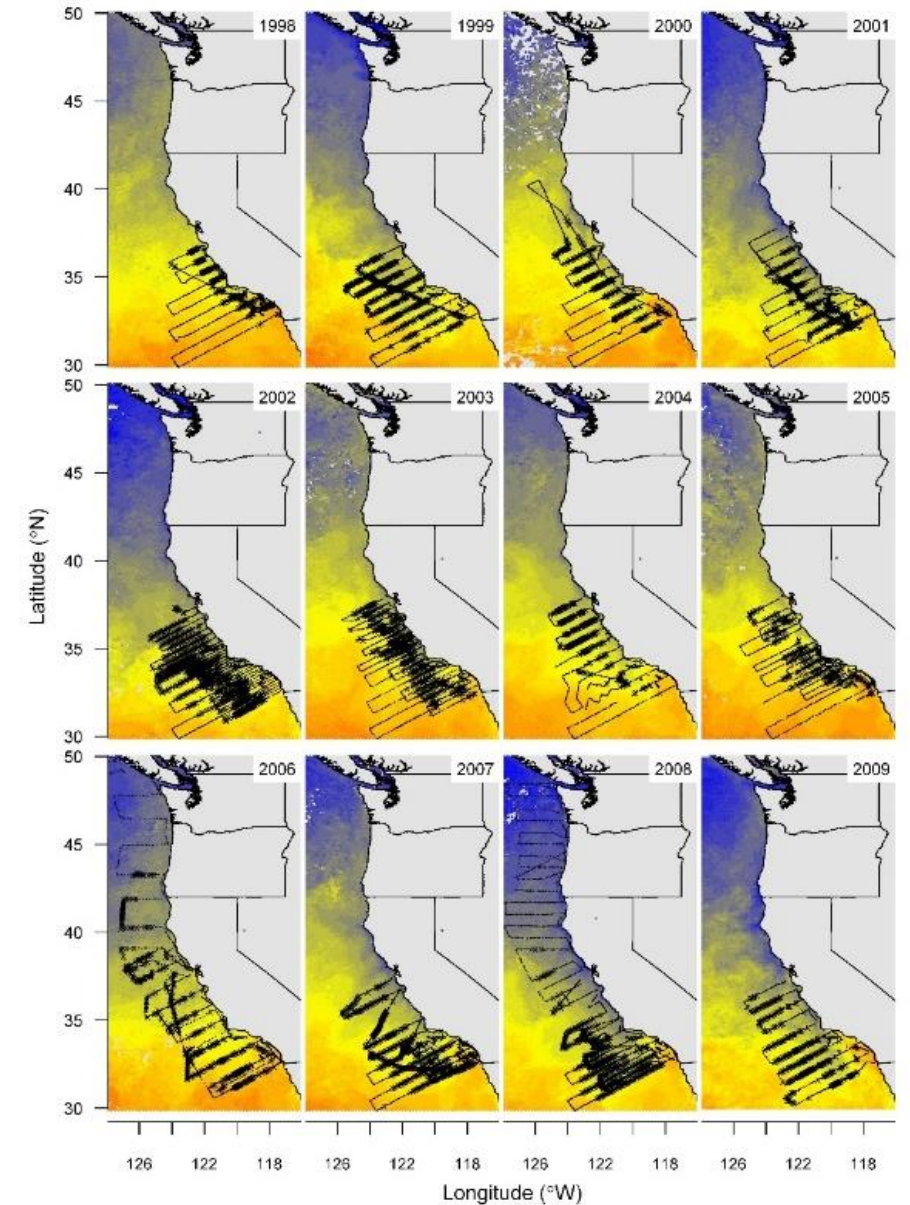


# Northern stock habitat model – Zwolinski et al 2011

- Built on high-resolution sardine egg presences and concomitant environmental information



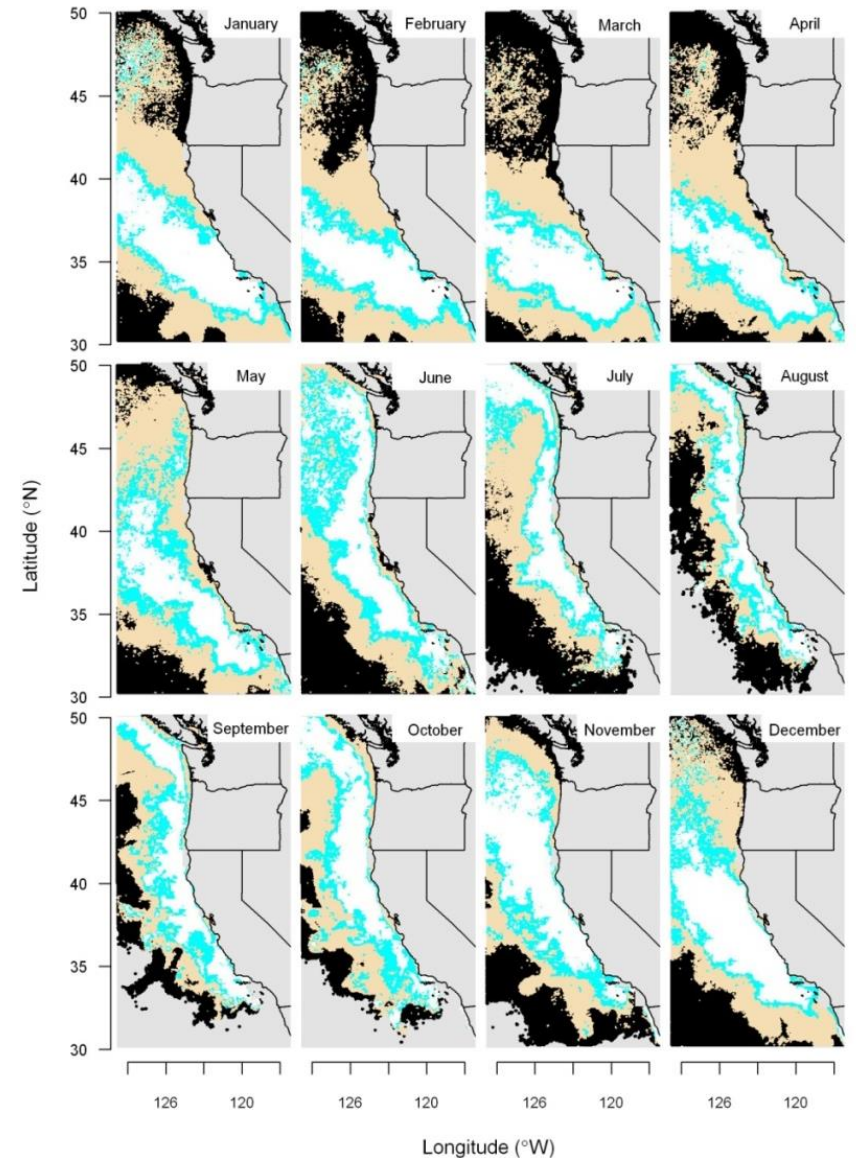
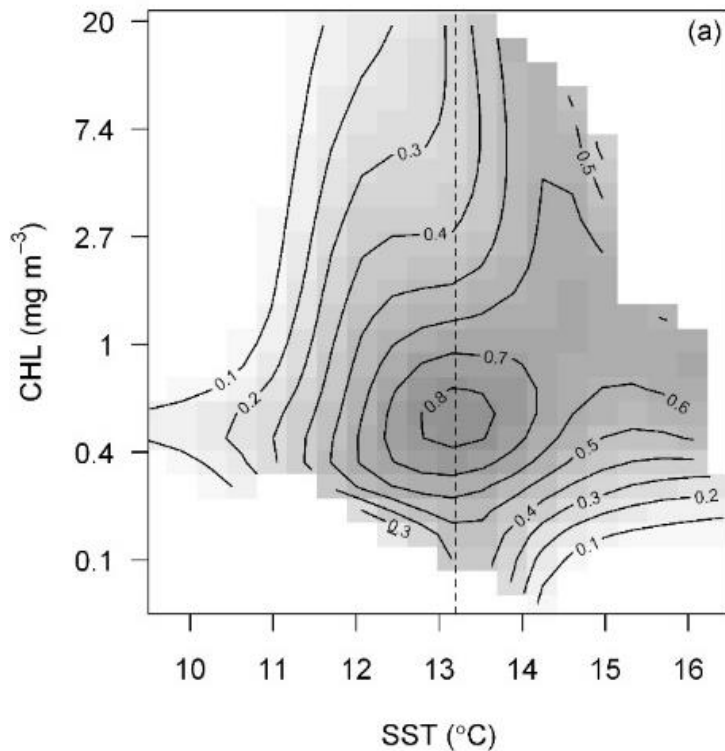
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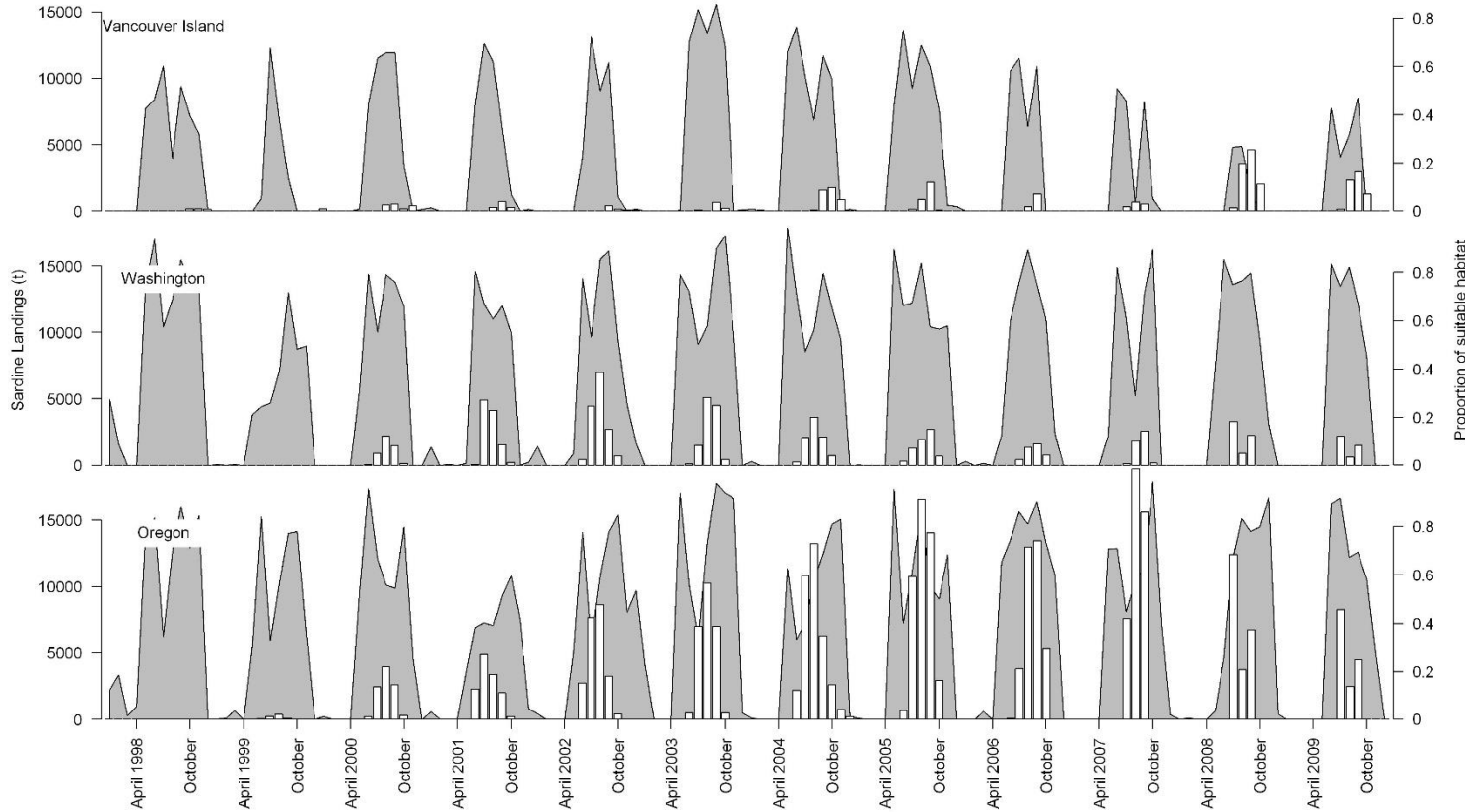
# Northern stock habitat model – Zwolinski et al 2011

- SST and Chlorophyll-a concentration delineate the habitat of the northern stock of Pacific Sardine
- The modelled habitat shows a seasonal pattern

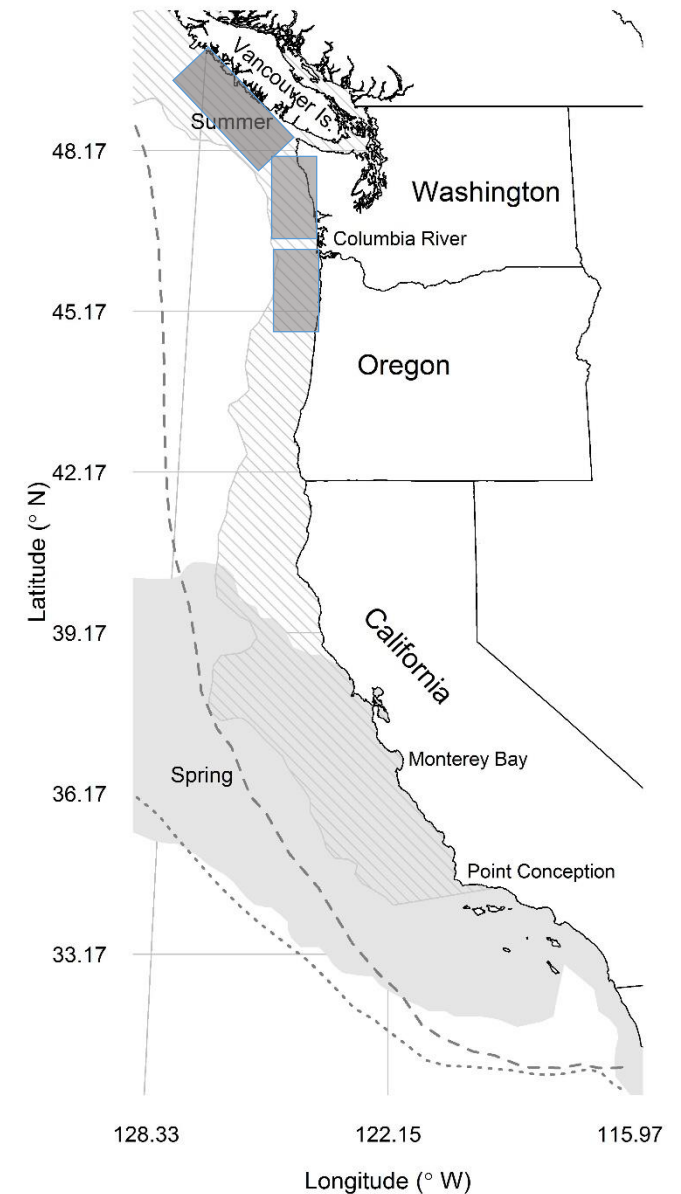


# Northern stock habitat predicts migrations and landings

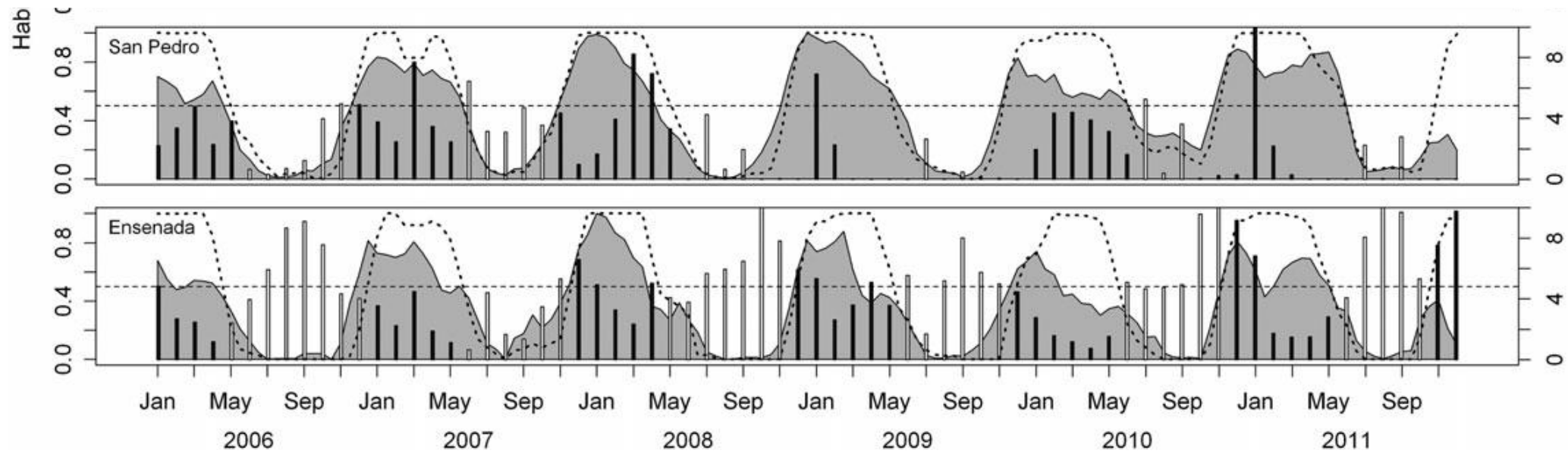
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- Suitable habitat precedes the landings of the Northern stock in the Pacific Northwest



# Pacific Sardine landings – SST cutoff, Demer and Zwolinski 2014



- SST proxy for habitat in fishing area
- Monthly, 3-point running mean of SST index
- Index: % area with SST higher than 16.7 °C
- If index > 50%, landings are attributed to the southern stock

# Pacific Sardine landing separation - Conclusions

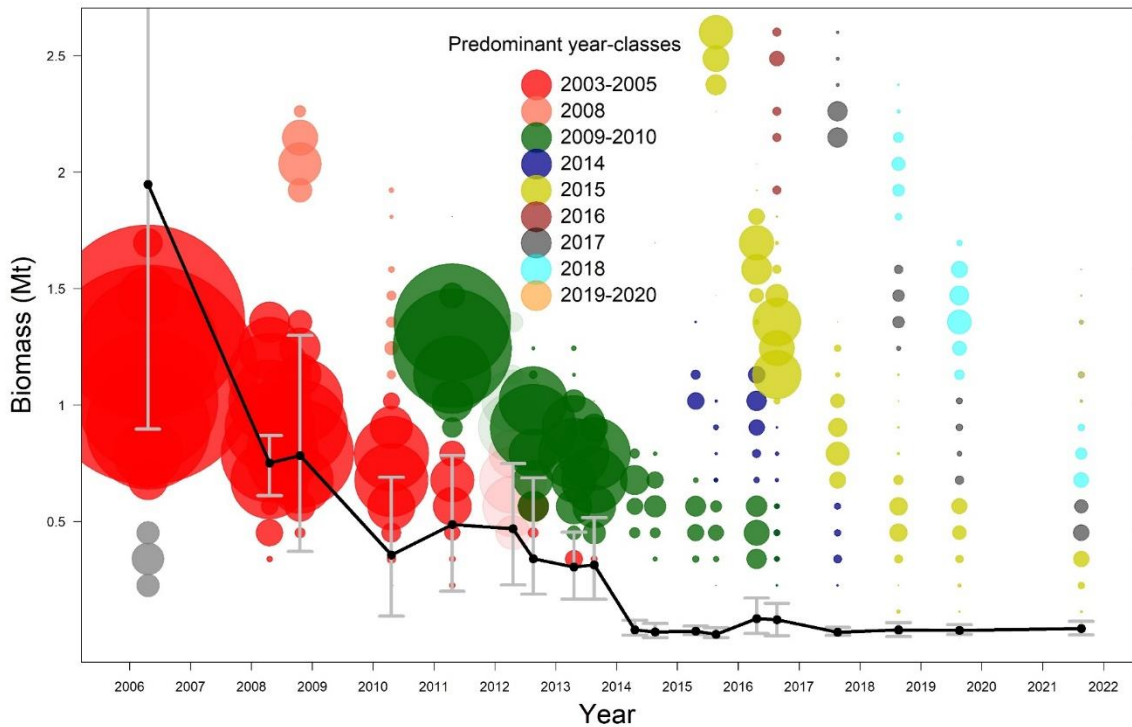
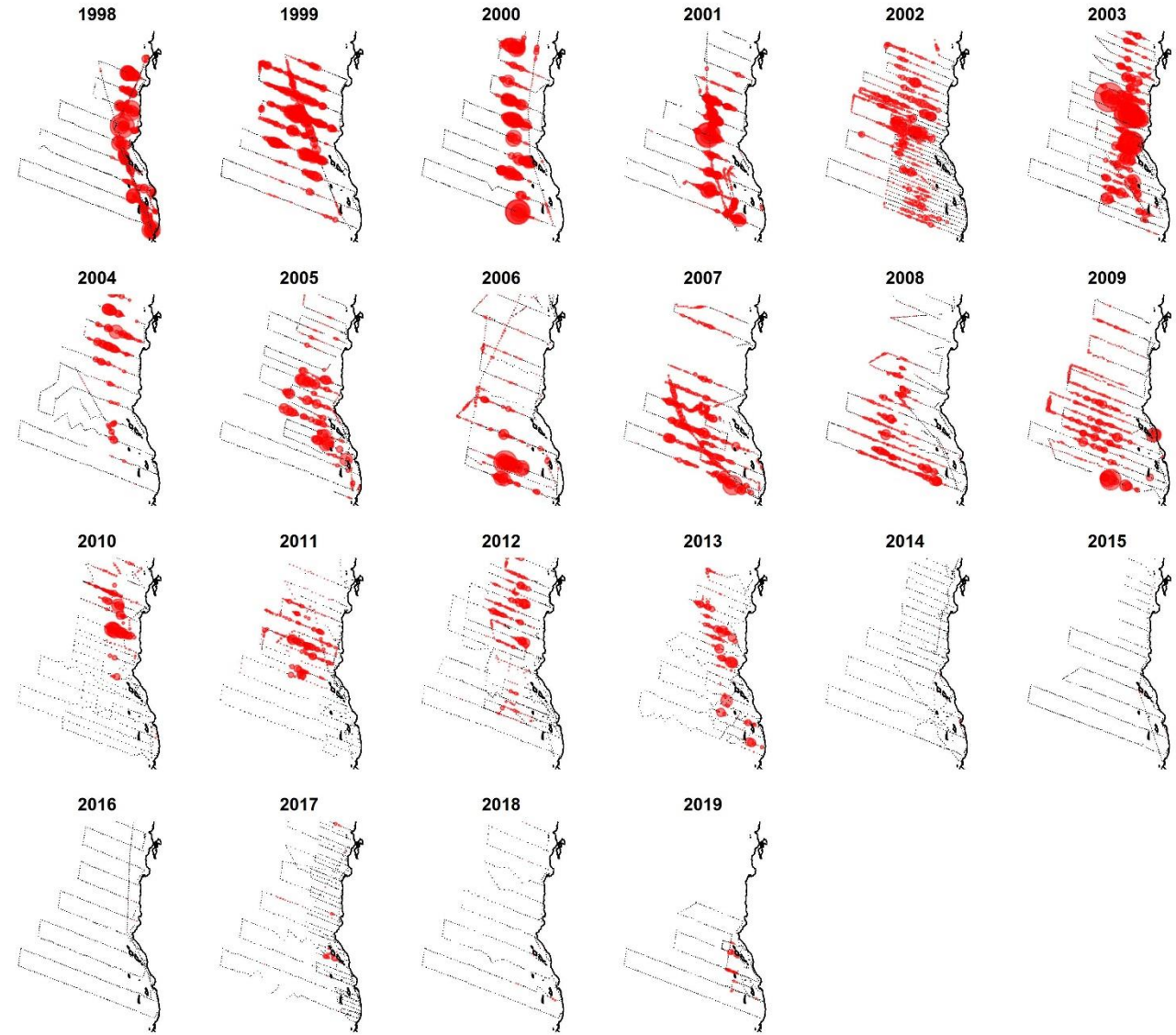
- *“Ultimately, the choice of index used to differentiate landings from the northern and southern stocks depends on acceptable risk. For example, if a transition SST of 16.7 C is assumed, all of the landings from the northern stock may be retained, but some of the southern stock landing may be falsely attributed to the northern stock. “*
- *“If the potential habitat index is used, an average of 10% of the northern stock landings may be excluded, but it is less likely that southern stock landings will be included. “*

Demer and Zwolinski, 2014



# Collapse of the Northern stock and contraction of its spawning migration

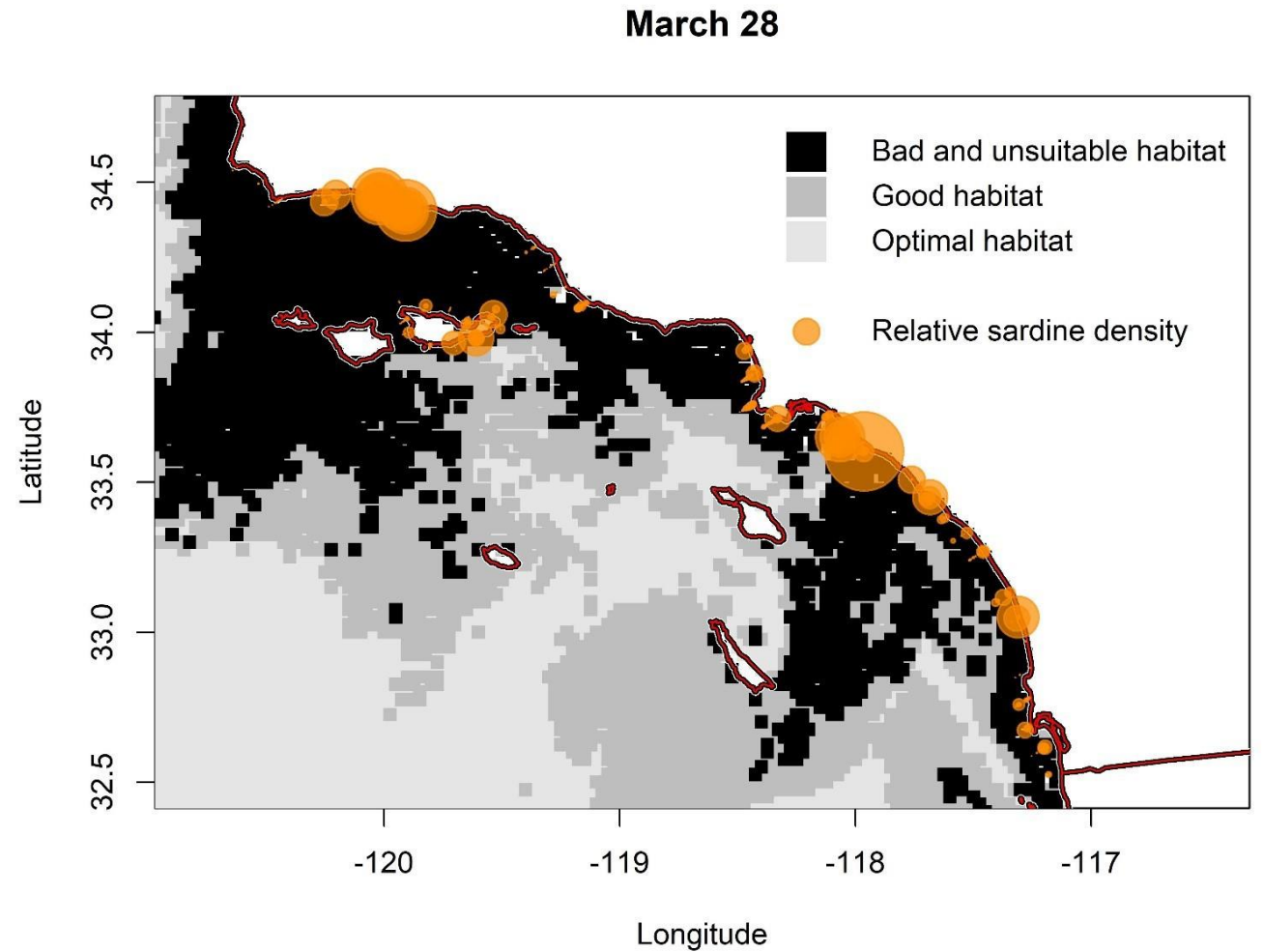
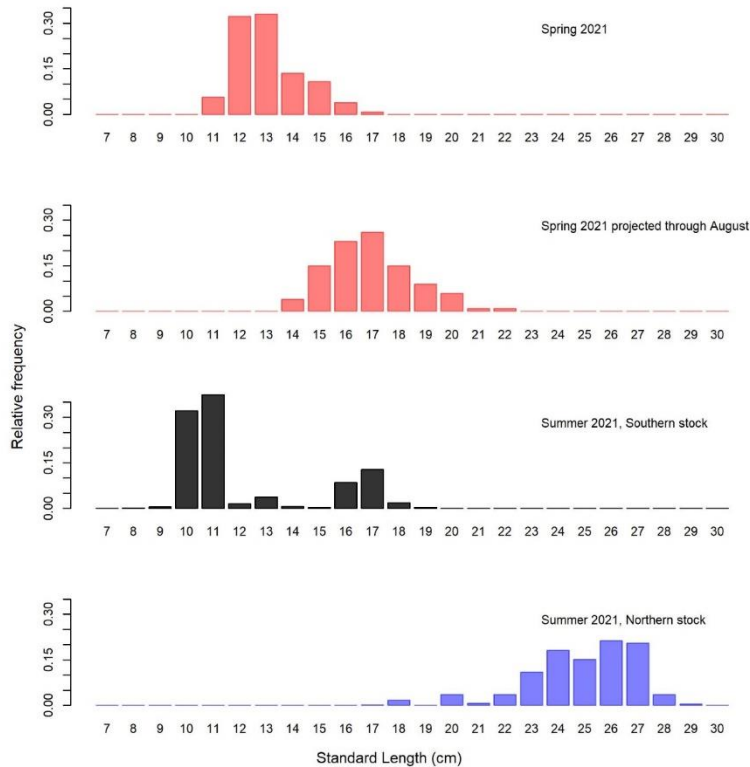
- Virtually no spawning in the SCB since 2014
- Extended residency of Sardine off Northern California, Oregon, and Washington
- In the meantime the Southern stock fishery is providing record yields



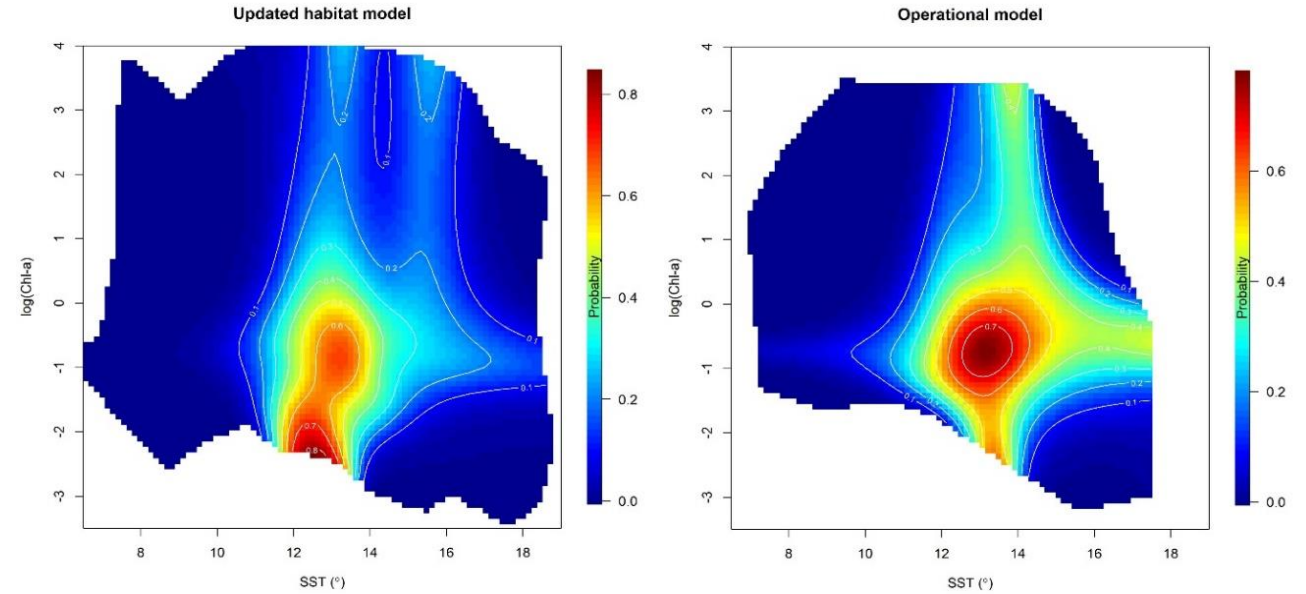
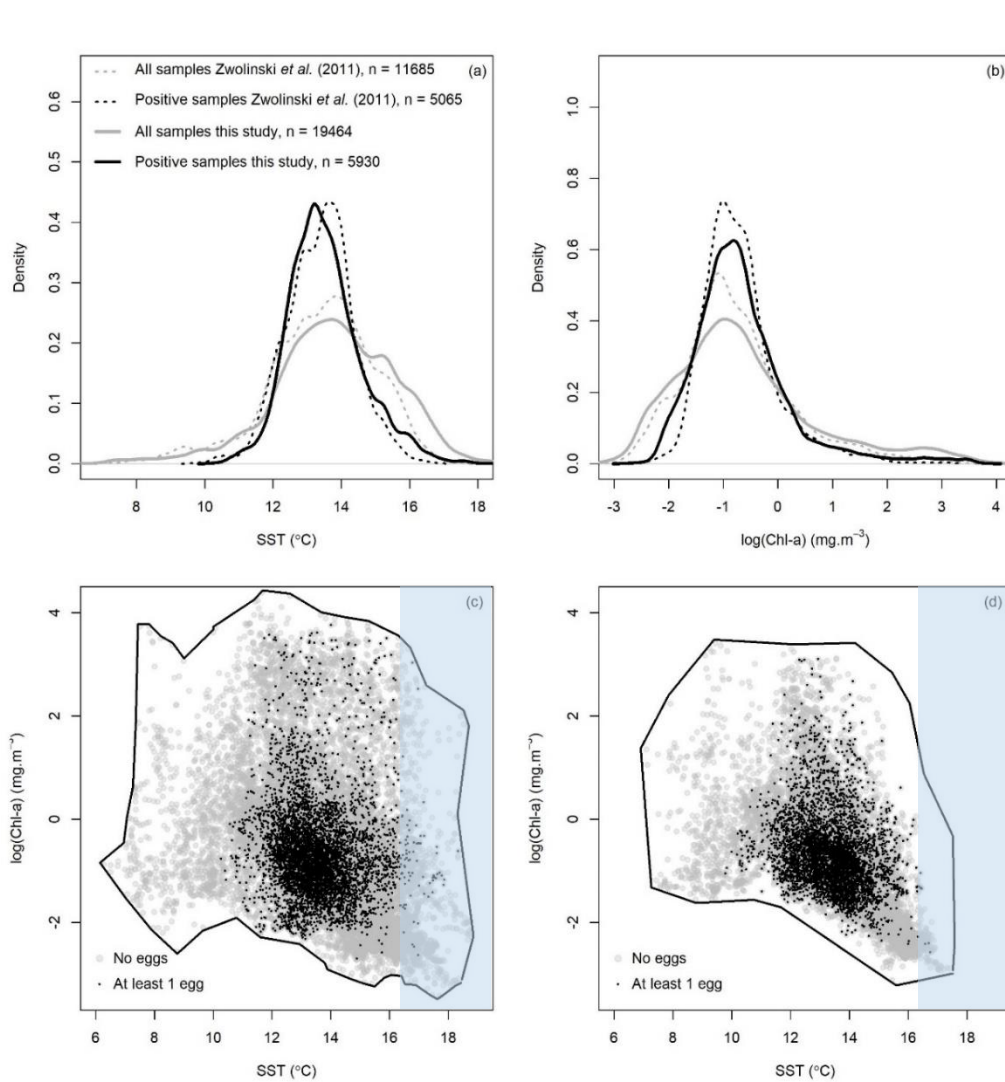


# Sardine sampled in the SCB in spring 2021 – in bad habitat

- Sardine were found nearshore, in bad Northern stock habitat
- Relatively small sardine, likely juvenile
- These sardine recruited locally to the Southern stock



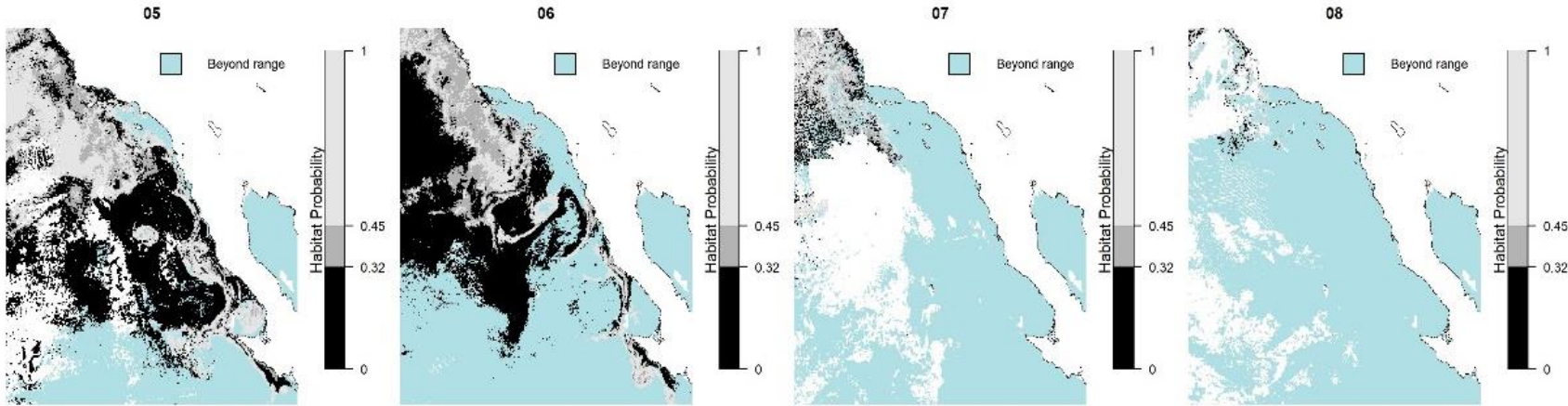
# Northern stock habitat model – update 2022



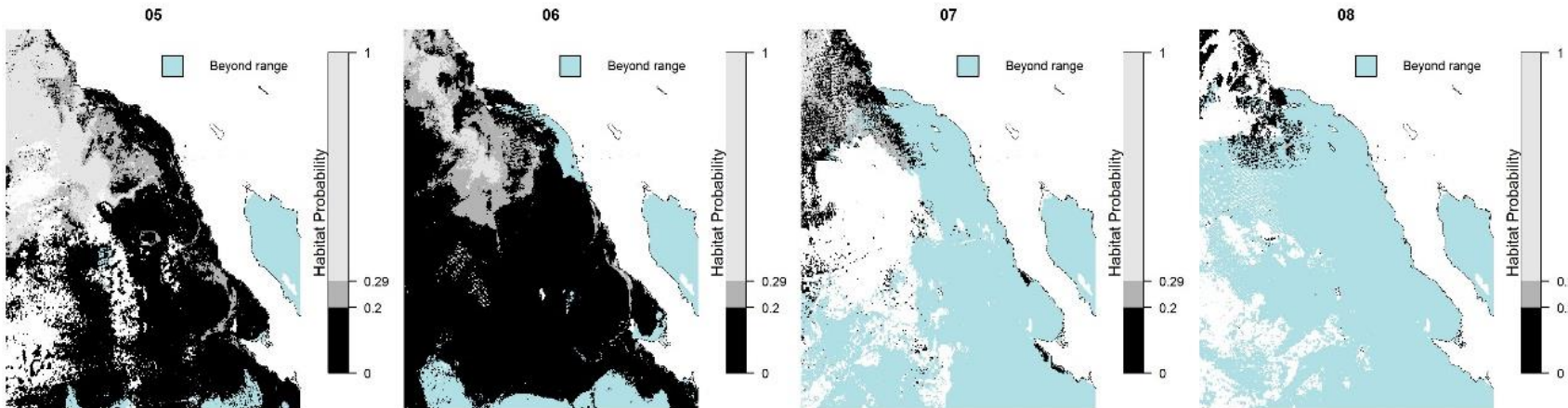
- Expanded data set through 2019 has a wider environmental footprint, especially at the transition SST between the two stocks
- The model is essentially the same at the core, but it's better defined at higher SSTs

# Northern stock habitat model comparison - 2021

Draft work presented to the PFMC SSC CPS subcommittee, March 20-21 2023.



Original – Large areas beyond the environmental range of the training set

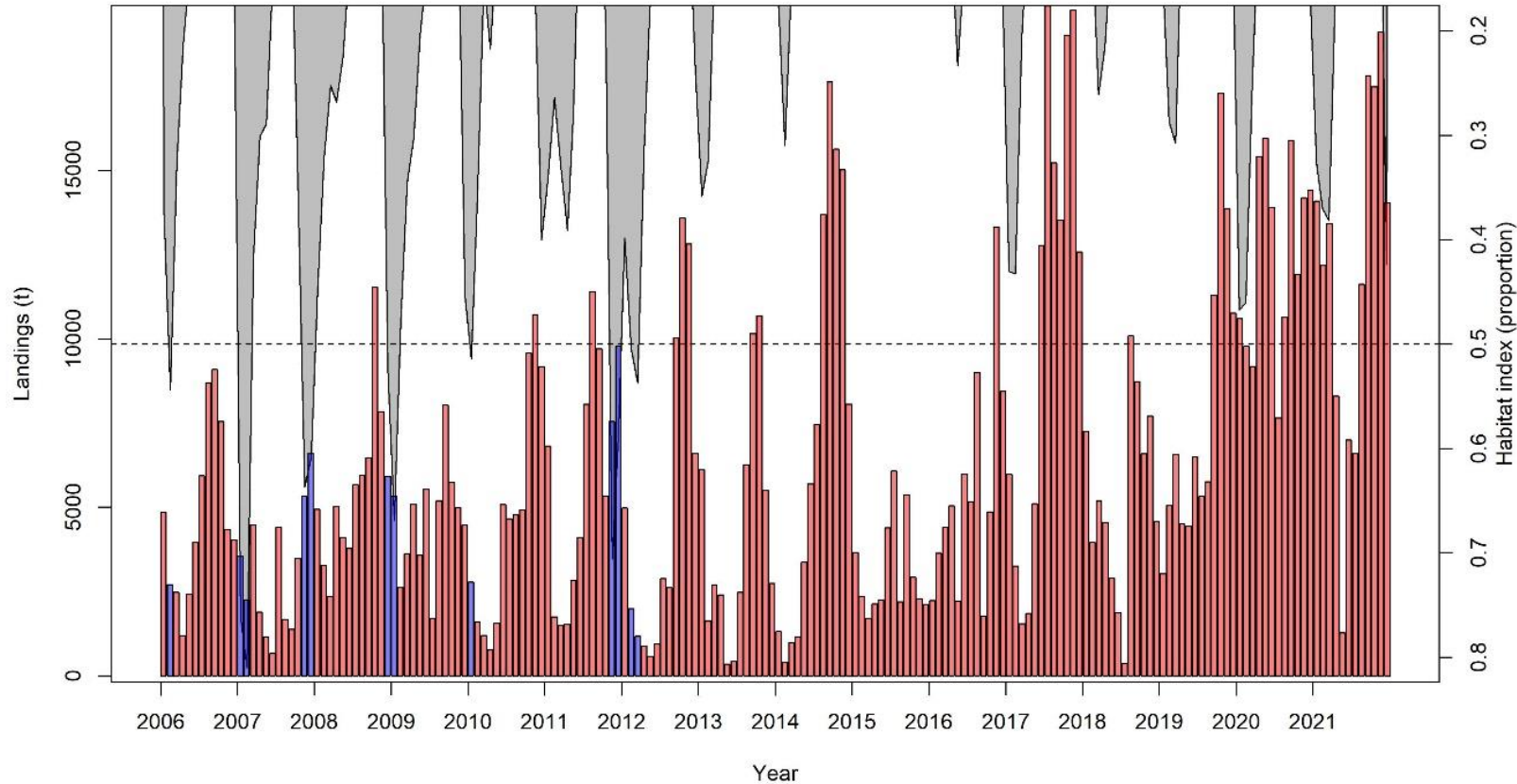


Updated – Larger areas of low habitat probabilities



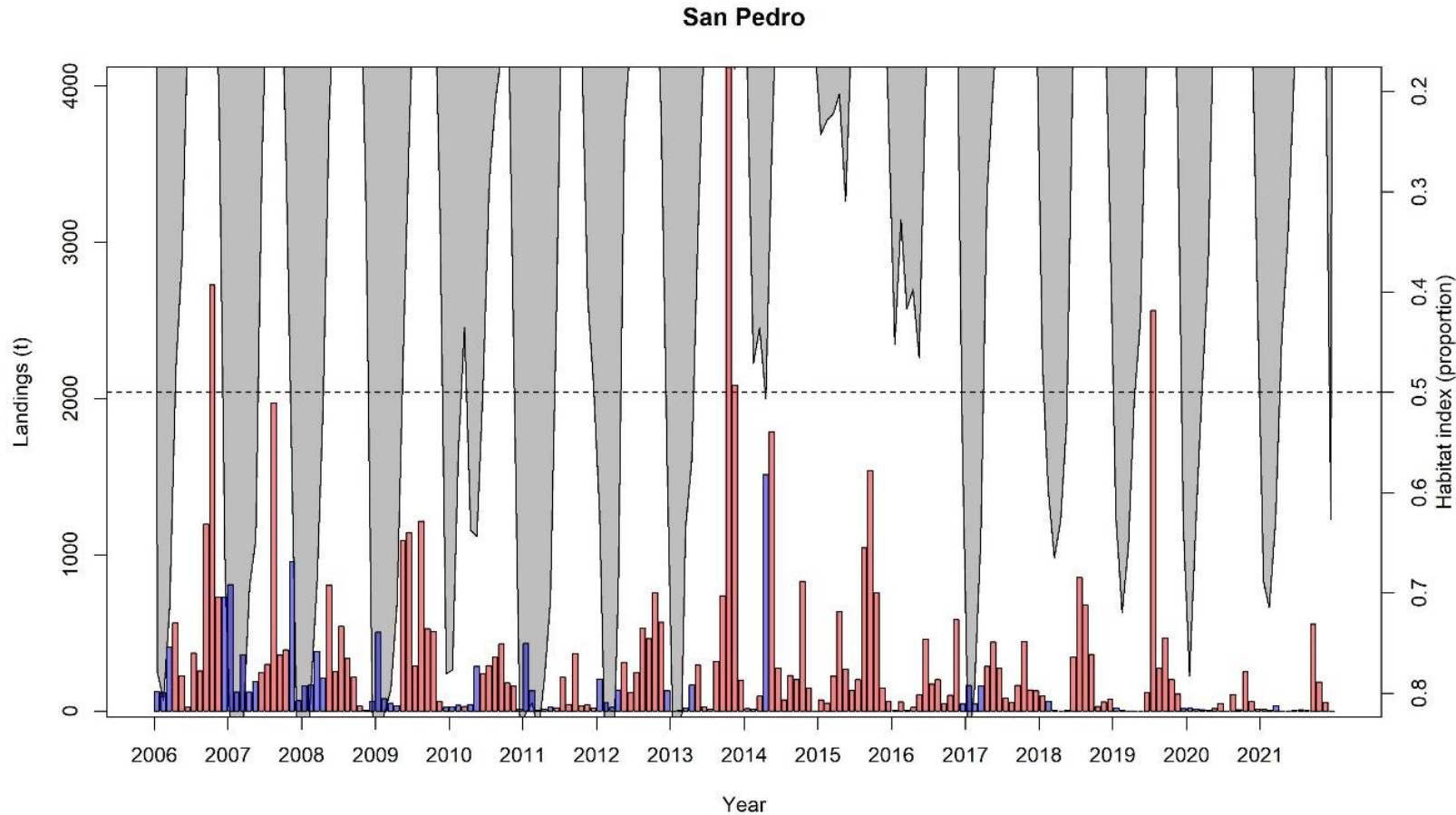
# Northern stock habitat model – habitat cutoff defined to exclude Ensenada Landings in 2020 and 2021

Ensenada



- Habitat index threshold was selected to exclude landings from Ensenada in 2020 and 2021
- It retains 95% of all the egg abundance in the training set
- No northern stock landings in Ensenada since 2012
- Uncertainties about the catch location persist

# Northern stock habitat model – habitat cutoff defined to exclude Ensenada Landings in 2020 and 2021 applied to San Pedro landings



- The habitat index applied to San Pedro indicates coherence with the months of lower landings
- The region for the index calculation is static, but could be refined with information on fishing effort