Too hot to handle? The potential effect of global warming on Longfin Smelt in the Delta and Suisun Bay

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Introduction

The Delta and Suisun Bay are important spawning and rearing habitats for Longfin Smelt. Utilizing climate change projections for these regions presents a suitable analysis on how global warming may affect spawning and rearing as well as the species abundance as a whole. By establishing known thermal physiological and behavioral thresholds for Longfin Smelt at the larval, juvenile, and adult phases (Table 1), we can project the approximate timing when locations within the Suisun Bay and Delta may become too warm for the species at each life stage under two different climate change scenarios.

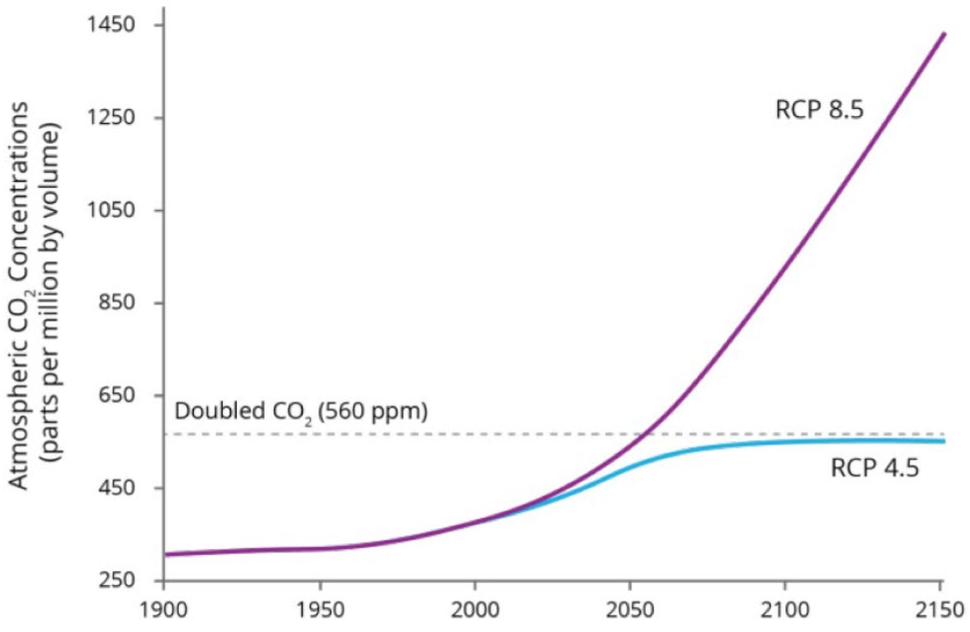


Figure 1: Emission of carbon dioxide under the RCP 4.5 and 8.5 scenarios. Source: Modified from van Vuuren et al. 2011, p. 17

Methods

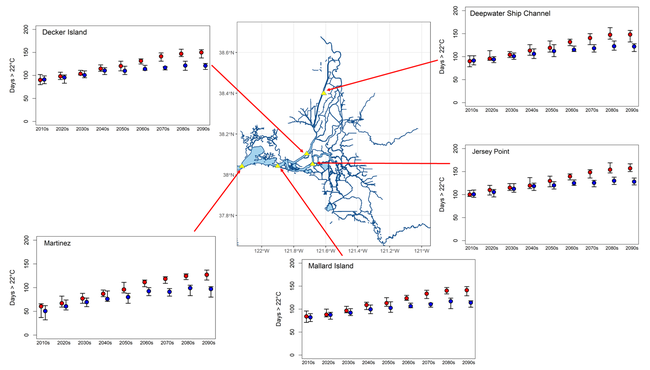
As part of the CASCaDE2 project, USGS has created downscaled climate change models to project water temperatures throughout the Delta and Suisun Bay through 2100 (Wulff *et al.* 2021). We selected 2 Representative Concentration Pathway (RCP) trajectories: RCP 8.5, which represents a high-end emissions scenario; and RCP 4.5 which represents a moderate scenario (van Vuuren *et al.* 2011; Figure 1). Each RCP has 10 global climate change models (GCMs), so we established the median of the 10 GCMs for each RCP.

Table 1: The known thermal ranges for Longfin Smelt in the San Francisco Estuary.

Thermal Range	Biological Importance	Citation
Up to 12°	Larval development/catches	Yanagitsuru *et al.* 2021; Grimaldo *et al.* 2017
Up to 14°	Spawning limit	Wang *et al.* 2007; Tempel and Burns 2021
15°-18°	Peak juvenile catch	Jeffries *et al.* 2016
20°	Physiological thermal stress	Jeffries *et al.* 2016
Over 22°	Not detected	Baxter *et al*. 2010

Results

Projected Number of Days above Thermal Tolerance



Projected Number of Days below Spawning Limit

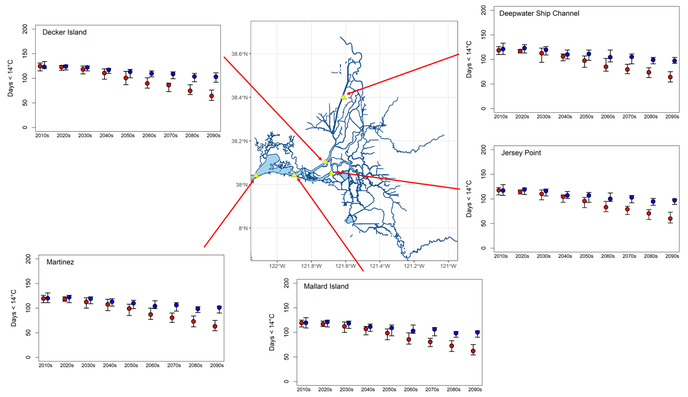


Figure 2: Maps of the projected number of days above thermal tolerance (22°C) and below the spawning limit (14°C) at Martinez in Suisun Bay, Mallard Island at the confluence, Decker Island at the lower Sacramento River, Jersey Point at the lower San Joaquin River, and the Deepwater Shipping Channel at the North Delta under both the RCP 8.5 (red circles) and RCP 4.5 (blue circles) scenarios. Map source: Bashevkin and Barros 2021

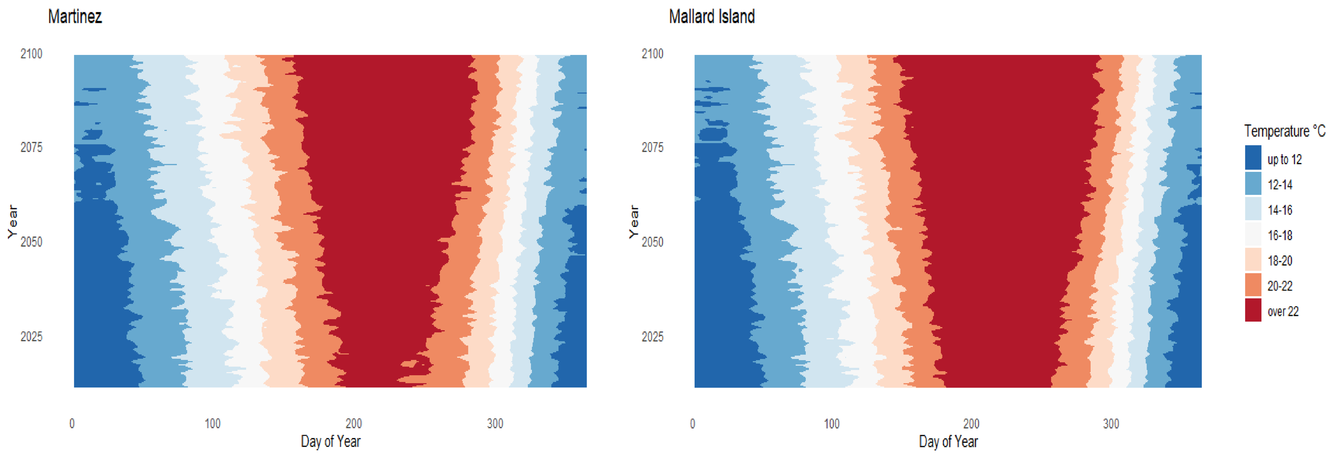


Figure 3: Heat map of the temperature increases over time at Martinez (Suisun Bay) and Mallard Island (Confluence) from 2010-2100 under the RCP 8.5 scenario.

Conclusion

- Climate change is expected to significantly raise water temperature throughout Suisun Bay and the Delta
- Suisun Bay number of days above 22 °C (Longfin Smelt adult tolerance) could more than double
- For all regions, number of days below 12 °C for larval rearing could decrease to zero by 2075, resulting in complete extirpation
- Spawning temperature window may shorten over time, leading to a constricted spawning window
- Resulting increases in water temperatures as a result of global warming could mean extended summer-like conditions when Suisun Bay and the Delta would be inhospitable for the fish.

Acknowledgements

This project would not have been possible without the contributions from Marissa Wulff with USGS, who spearheaded the water temperature data projections. We are especially grateful for the expert input provided by the late and great Larry Brown, as well as Longfin Smelt SSA Core Team members Steven Detwiler, Mike Eakin, and Jim Hobbs.