



# **ECOSTRESS Surface Temperature Applications in the San Francisco Estuary**

ECOSTRESS Science and Applications Team  
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- Highly altered system, 1100 miles of levees
- Hub of California's water supply
- Largest Pacific side estuary, and part of a world biodiversity hotspot
- Receives 40-50% of streamflow generated by Sierra Nevada



Reduction in  
freshwater outflows

Entrainment losses  
to water diversion

High outflows

Changes in food  
organisms

Toxic substances

Disease, predation,  
invasive species

*Hypomesus  
transpacificus*  
aka “Delta Smelt”



Reduction in  
freshwater outflows

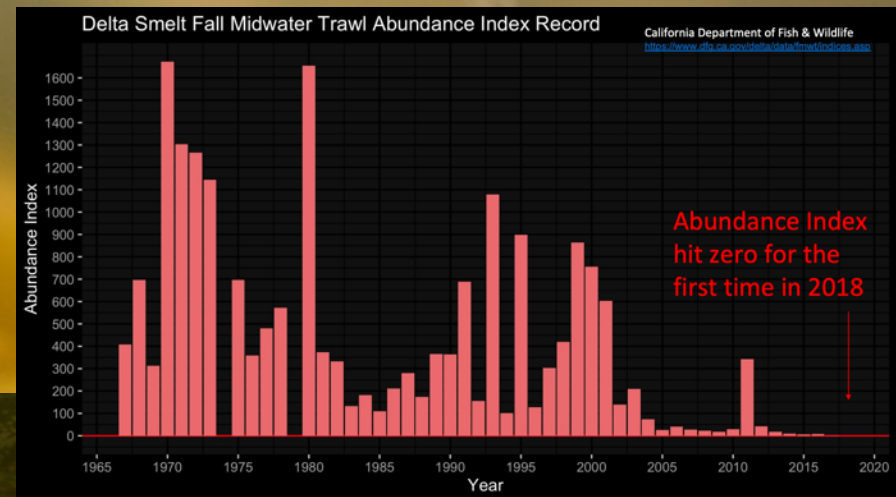
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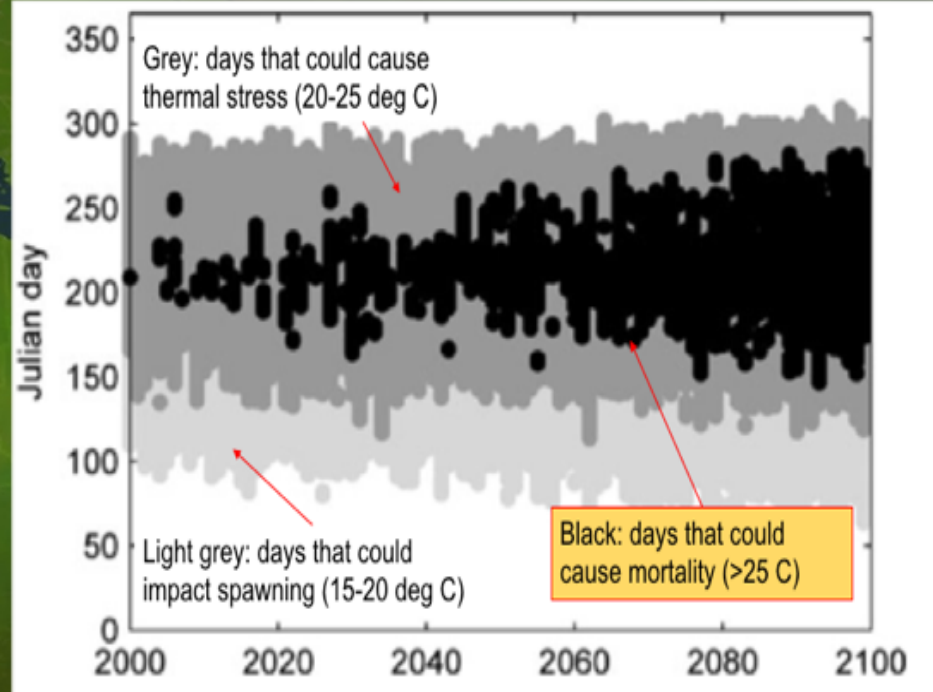
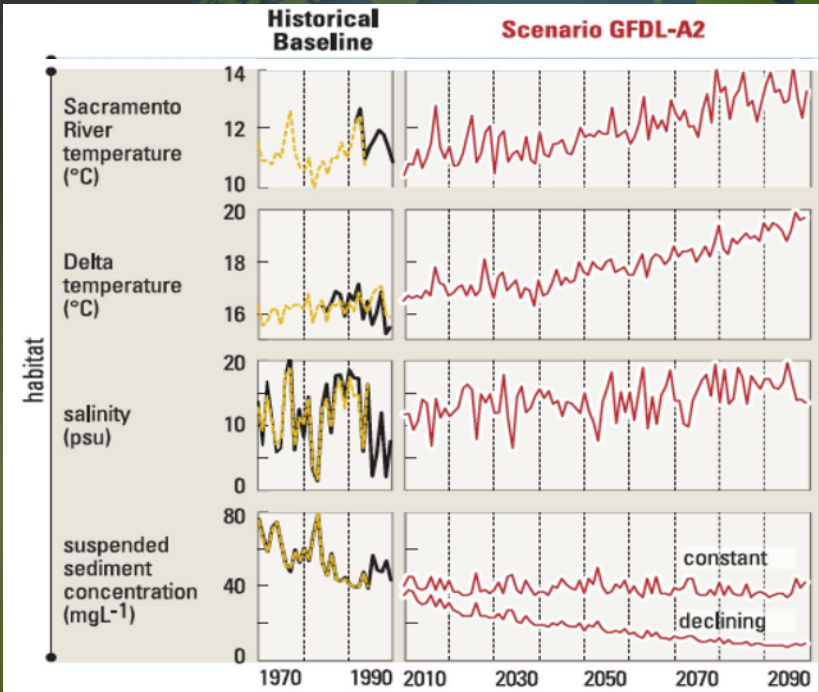




# Water temperature is a critical factor, possibly the most important, governing habitat suitability in aquatic and estuarine systems

*Cloern et al 2011*

*Wagner et al 2011*



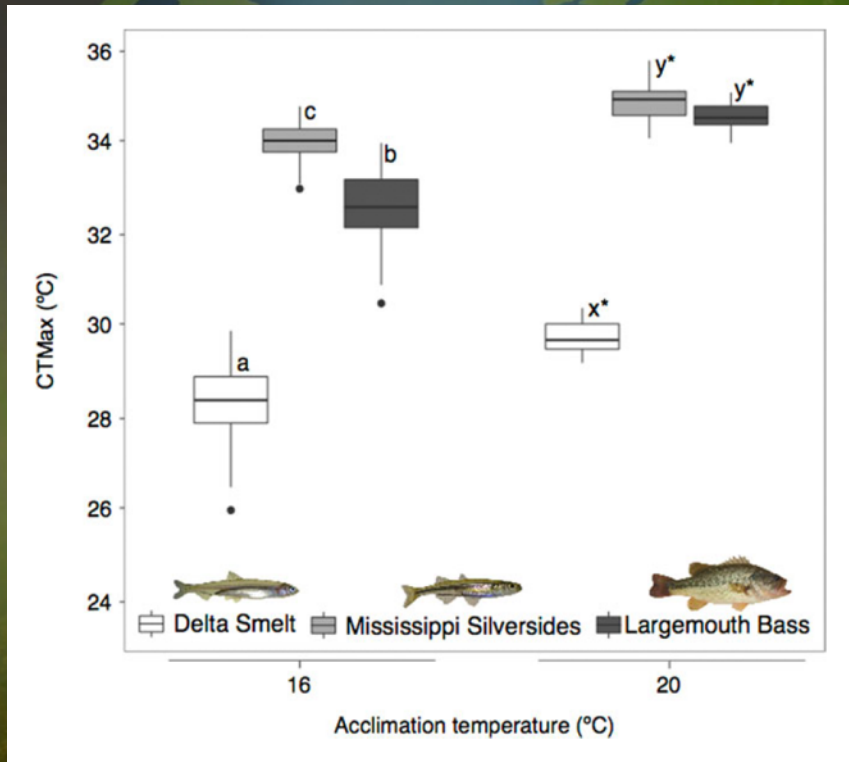
Temperatures in Delta habitat projected to increase



Along with increases in conditions that are considered lethal to the Delta Smelt s

# Parallel Project Using Landsat Work

We are actively investigating Landsat series in a parallel project and linking remotely sensed temperature to thermal tolerances of invasive fish species and the Delta smelt.

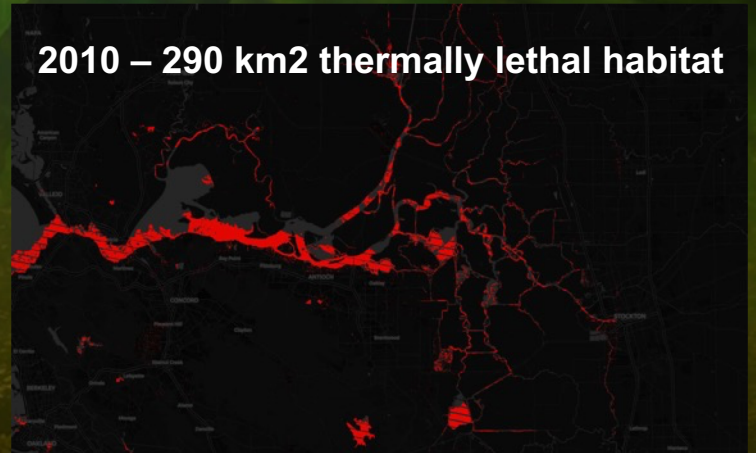


Davis et al. 2019

1995 70 km<sup>2</sup> of thermally lethal habitat



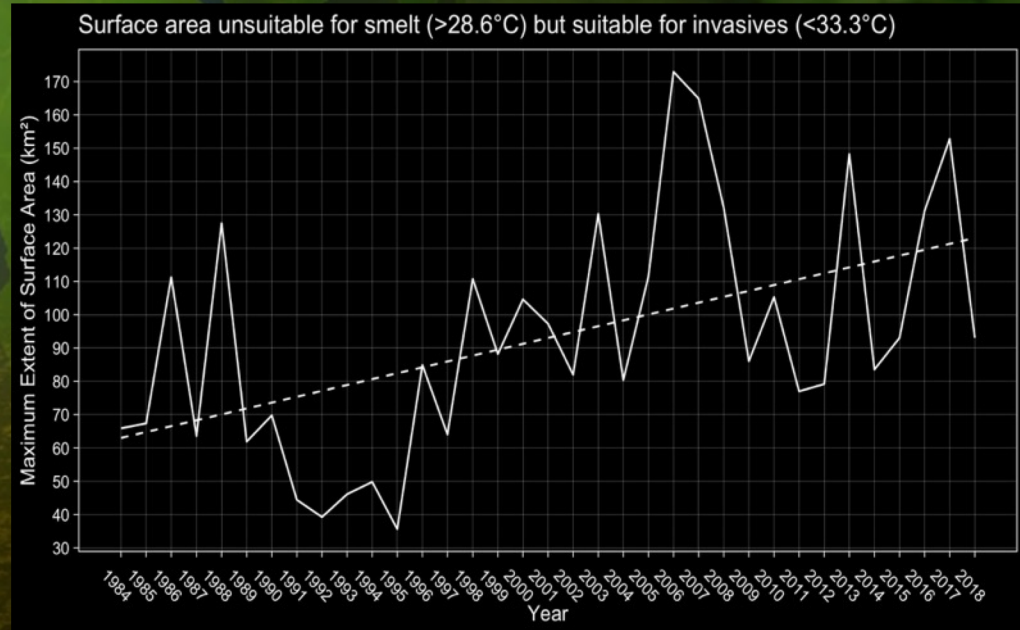
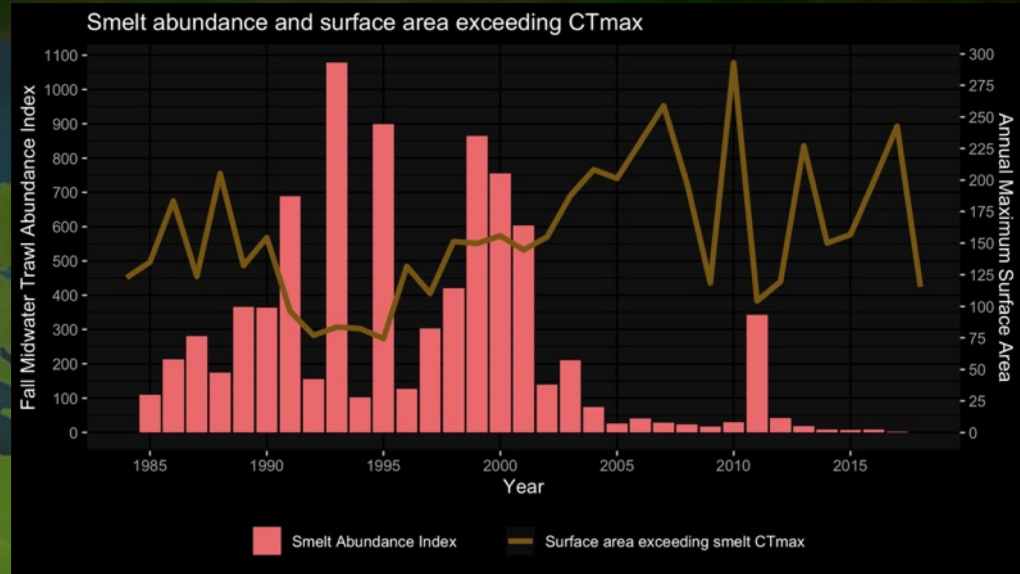
2010 – 290 km<sup>2</sup> thermally lethal habitat





**Observation 1:**  
Increases in thermally  
unsuitable habitat  
appear to correspond  
with smelt declines.

**Observation 2:** We are  
only observing increases in  
lethal conditions for the  
delta smelt, but not for the  
invasive fish which have  
higher thermal tolerances.



## Applications Questions for ECOSTRESS Project

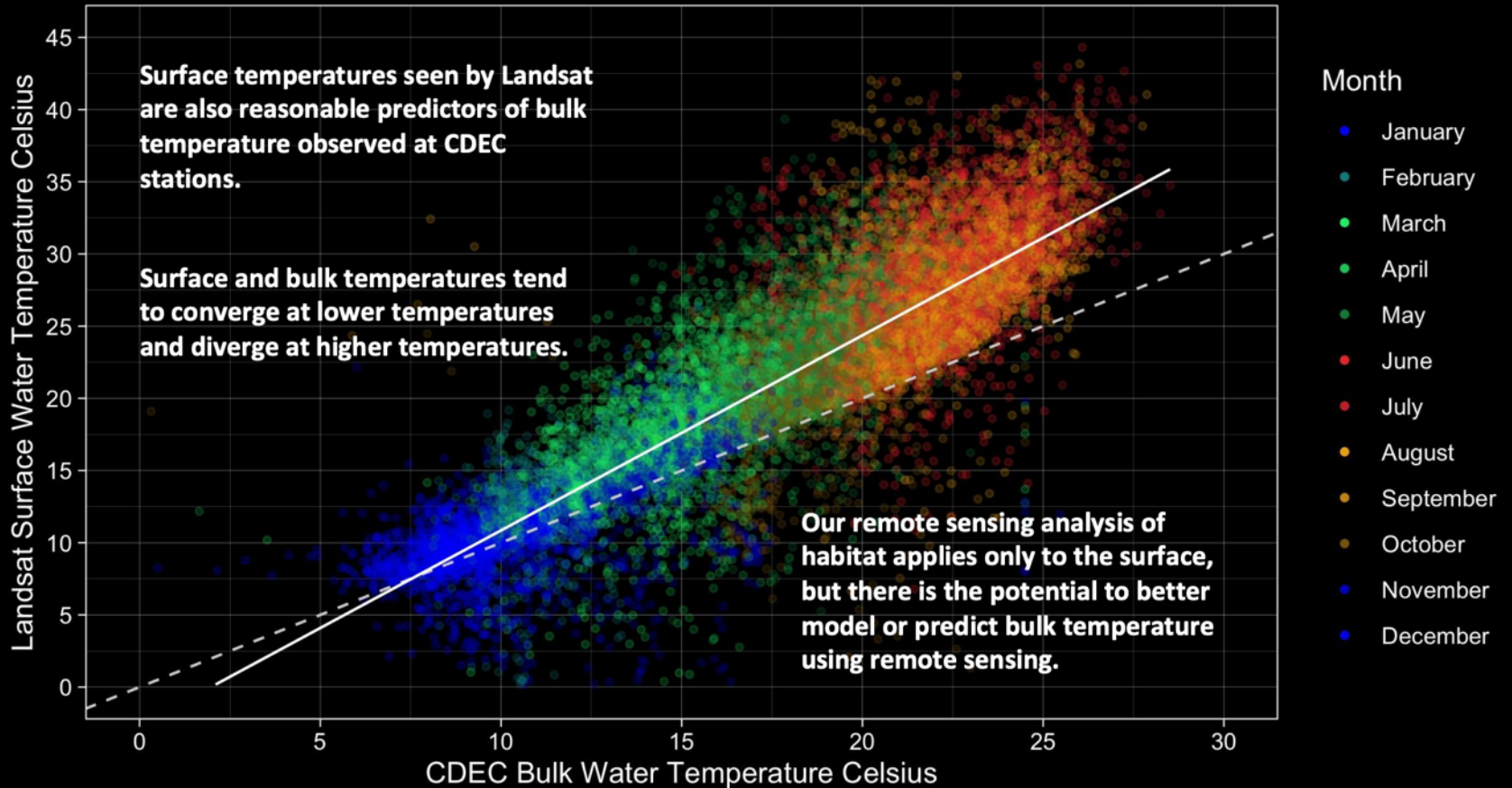
- How representative is surface temperature to bulk temperature?
- How can we use this to inform improvements to habitat quality via water operations?

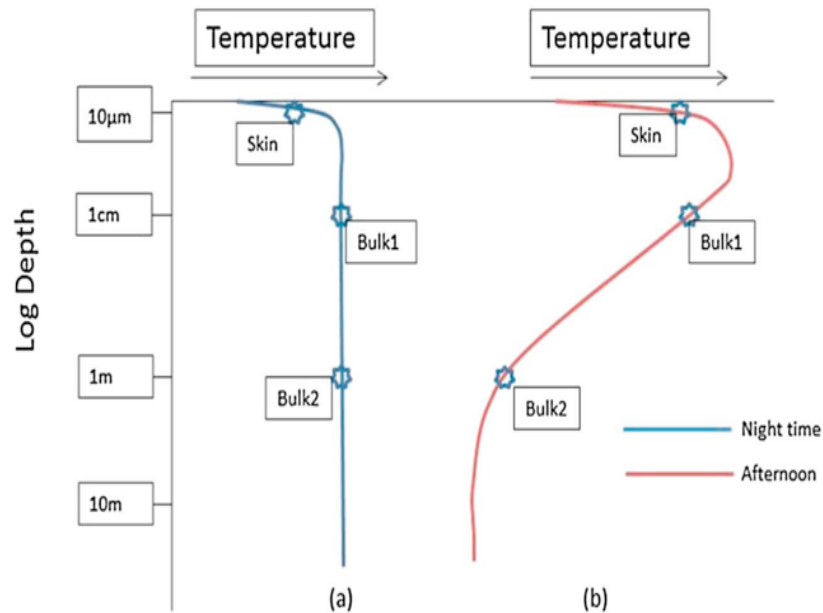
### We proposed to:

- Evaluate ECOSTRESS Surface Temperature relative to Bulk Temperature Measurements
- Leveraging the diurnal sampling, characterize the variability of the skin effect
- With the station data, apply ECOSTRESS estimates of bulk temperature to support management actions
- Deliver ECOSTRESS products to our partners at 34N for vis/user services

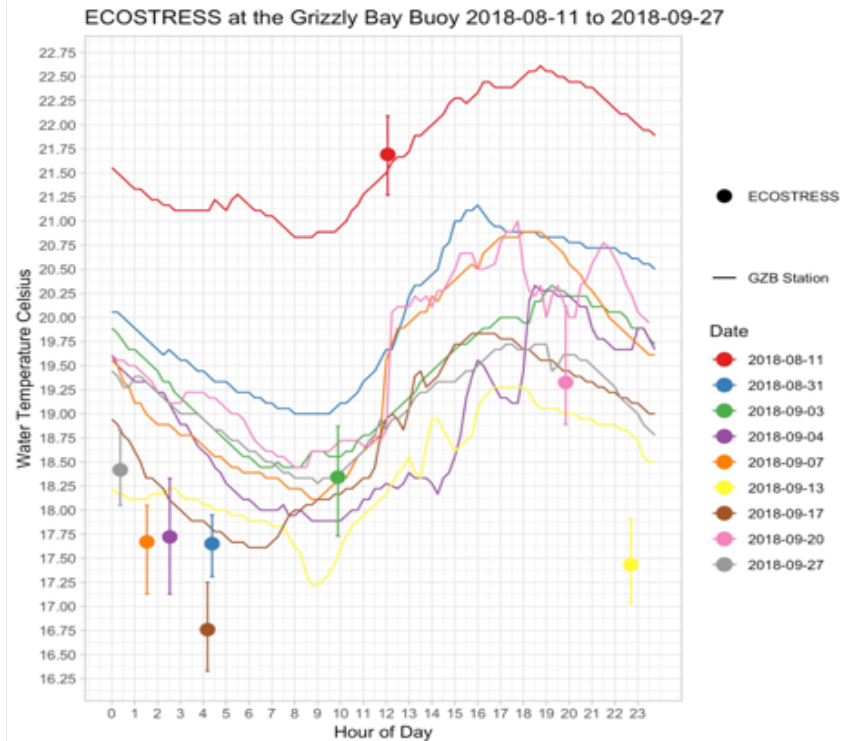


## Landsat 5, 7, 8 Surface Temperature & CDEC Bulk Temperature 1997-2019



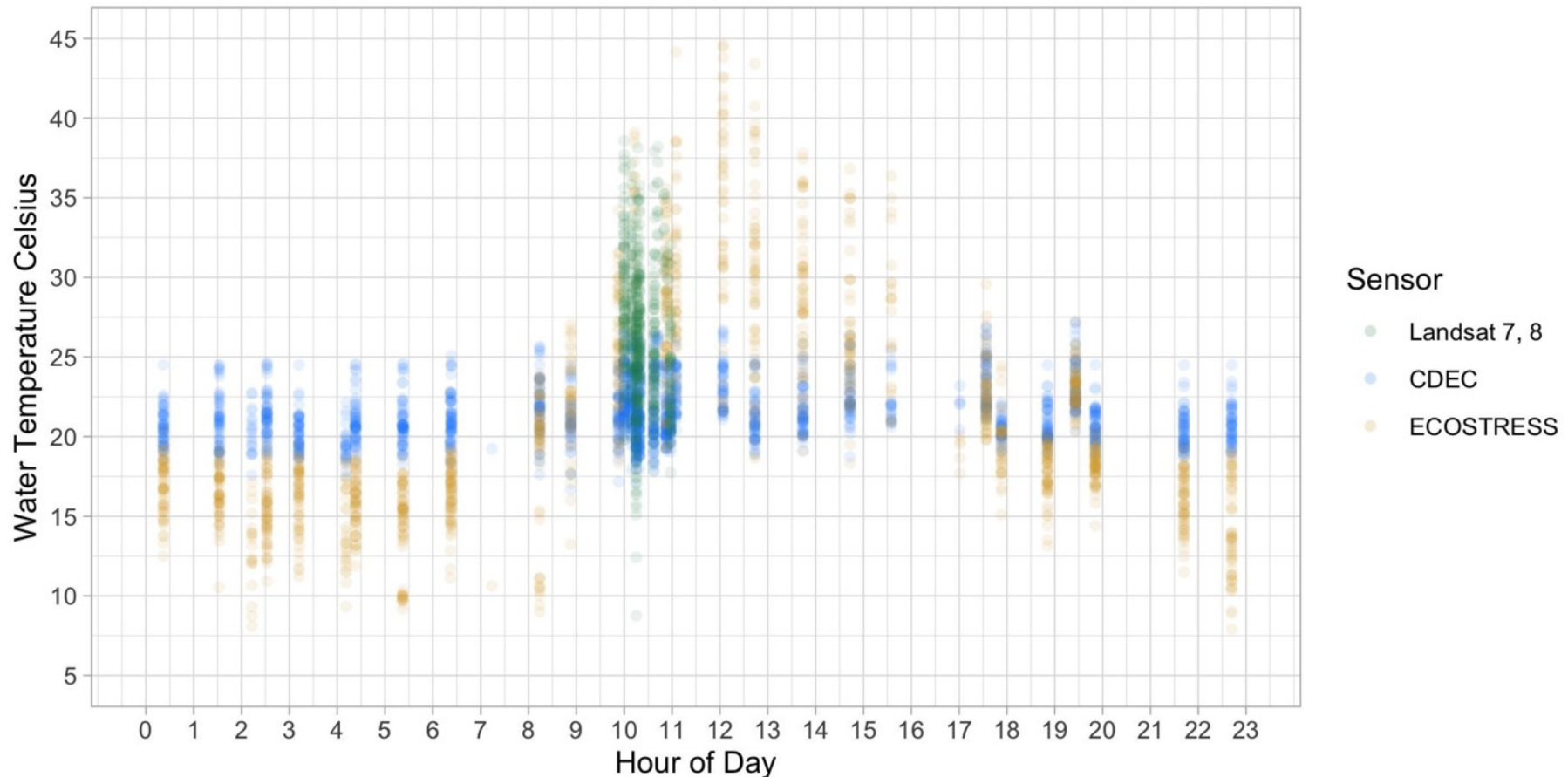


**LAKE TAHOE:** TEMPERATURE PROFILE NEAR THE SURFACE OF A WATER BODY, WITH REPRESENTATIONS OF THE SKIN EFFECT IN THE (A) EVENING VERSUS IN THE (B) AFTERNOON.





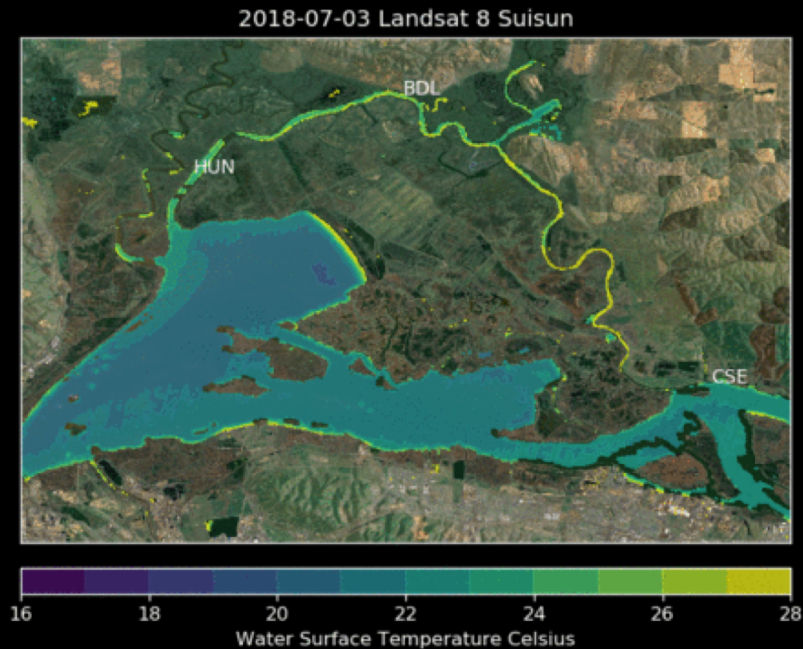
## Summer 2018 ECOSTRESS & Landsat 7, 8 Water Surface Temperature with Co-Indicent CDEC Bulk Water Temperature



- We see here a lot of Landsat acquisitions at about 1030AM, which reasonable matchup.
- Variable sampling of ST from ECOSTRESS allows us to begin investigating patterns in diurnal variability of water temperature and skin effect in the Delta. This will be important for timing restoration actions pertaining to water operations

# Future Work with Control Gates

Examining changes in bulk and surface temperature in Suisun Marsh during an experimental continuous control gate operation in 2018.



How can temperature data be used to monitor and mitigate changes in thermally suitable habitat?

