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Some Challenges in Classifying Habitats with Model Predictions using Hard Suitability Thresholds

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Talking Points

- ❑Habitat Suitability Analyses
- ❑Role of Modeling
- ❑Quantifying Habitat Suitability in Suisun Marsh
- ❑Some Challenges

Habitat Suitability Analyses

- Common analyses in restoration and rehabilitation projects

- This talk: Habitat suitability for Delta Smelt in Suisun Marsh

- Goal
  - to improve the recruitment, growth and survival of Delta Smelt
    - by implementing actions designed to increase the quantity and quality of Delta Smelt abiotic habitat and food supply

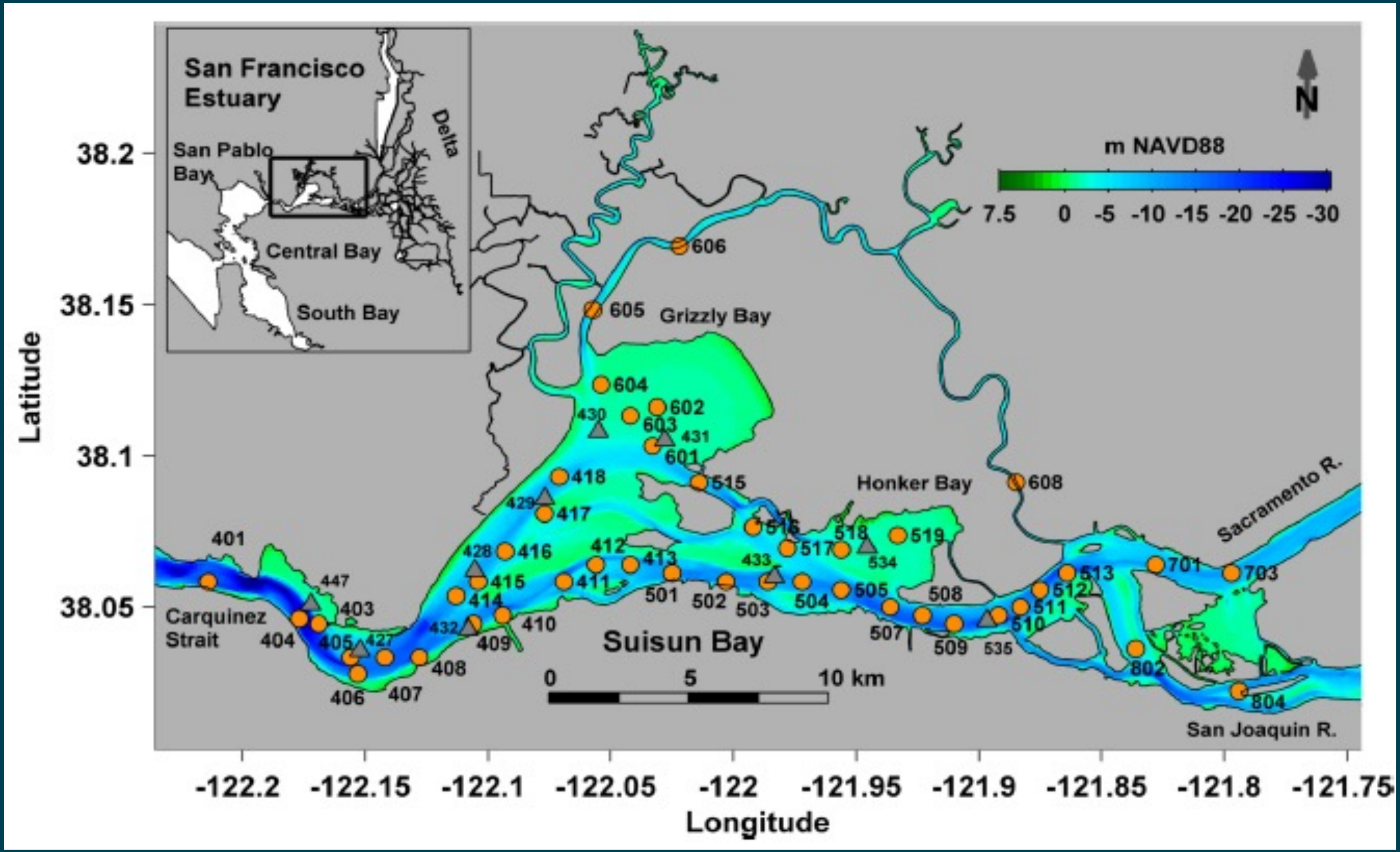
- Approach
  - Various actions including hydrodynamic modeling to improve spatiotemporal resolution of habitat assessment

Habitat Suitability Analyses

- Habitat Suitability Indices for Delta Smelt
  - Common parameters based on past studies
    - Salinity
    - Temperature
    - Turbidity
    - Current Speed

Role of Hydrodynamic Modeling

- ❑ Metrics are developed from discrete measurement
- ❑ Numerical models fill in data in space and time



Bever et al. (2016)

Quantifying Habitat Suitability

For our work:

We considered

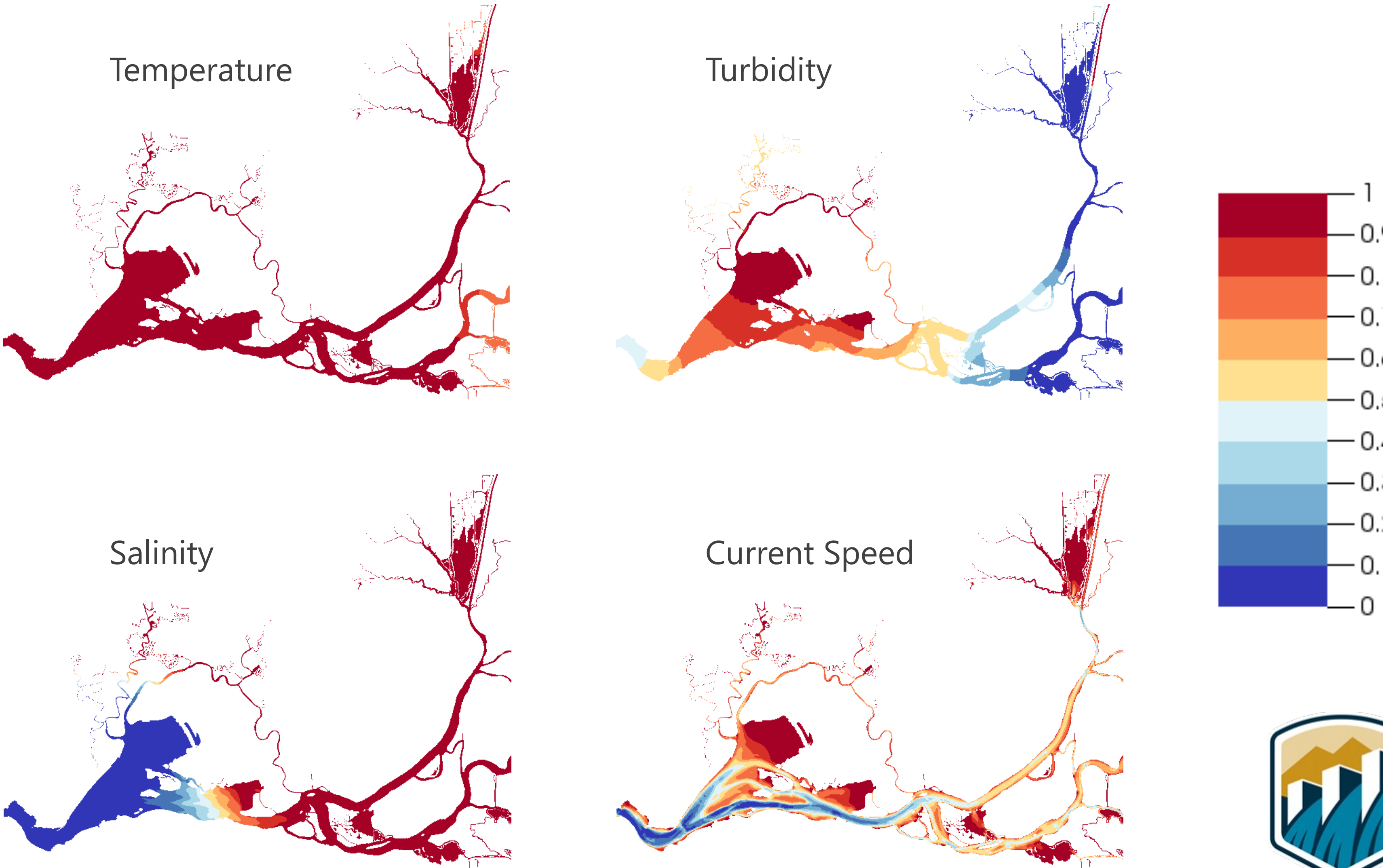
- Fixed Deterministic Thresholds
  - Salinity < 6 PSU
  - Turbidity > 12 NTU
  - Temperature < 24°C

- Bever et al. (2016) regression equations
  - 0.67S + 0.33V, Secchi Depth < 0.5 m
  - (0.67S + 0.33V) x 0.42, Secchi Depth > 0.5 m

  - RMA (2021) adaptation to include temperature
    - (0.67S + 0.33V) x T

Suisun Marsh General Patterns - Desirable Good, Not Desirable

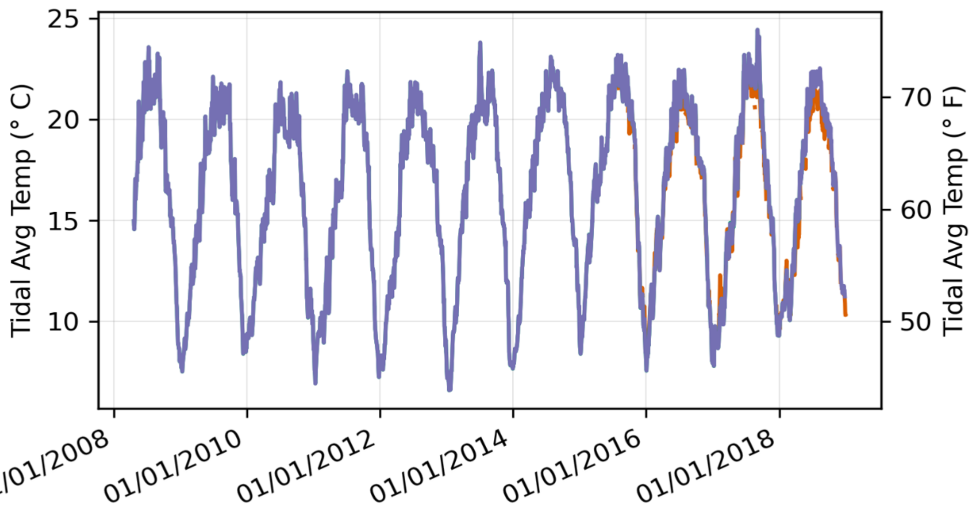
July 2020

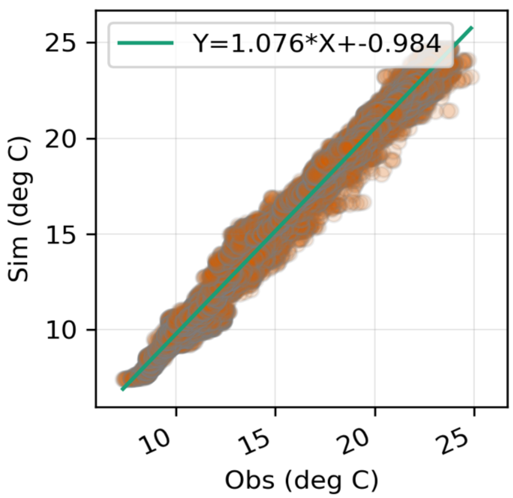


Quantifying Habitat Suitability

SCHISM Model Predictions

-Honker Bay





Observed

SCHISM

NSE = 0.98

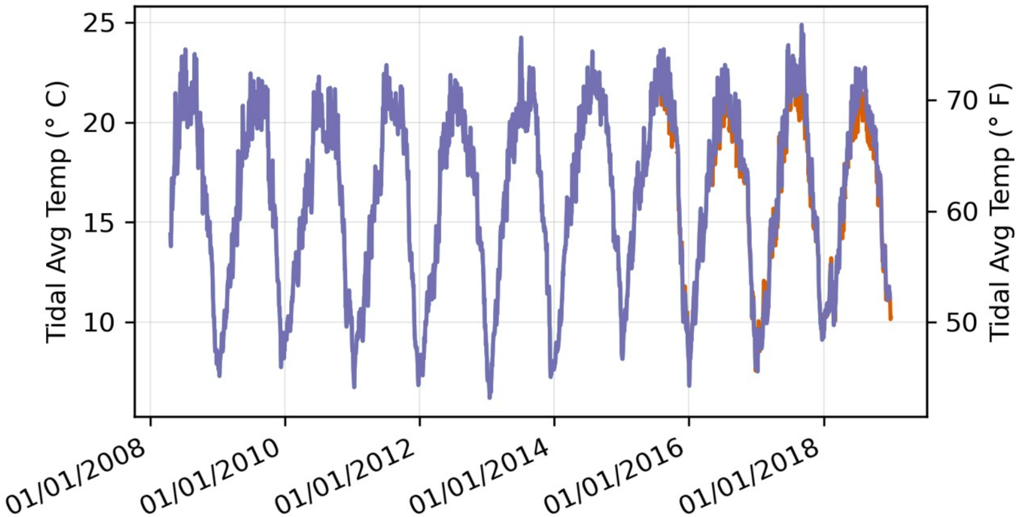
Bias = 0.30

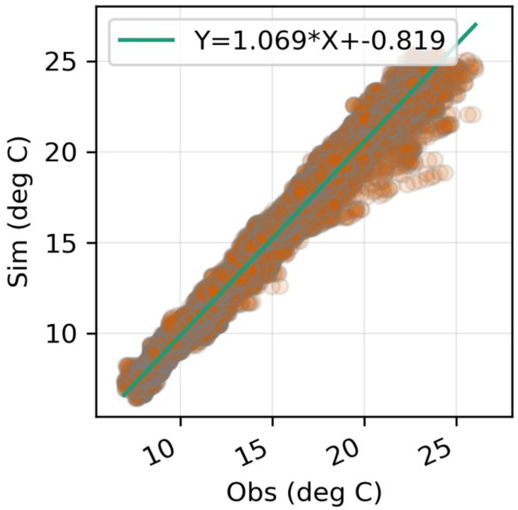
RMSE = 0.6

Quantifying Habitat Suitability

SCHISM Model Predictions

-Grizzly Bay





Observed

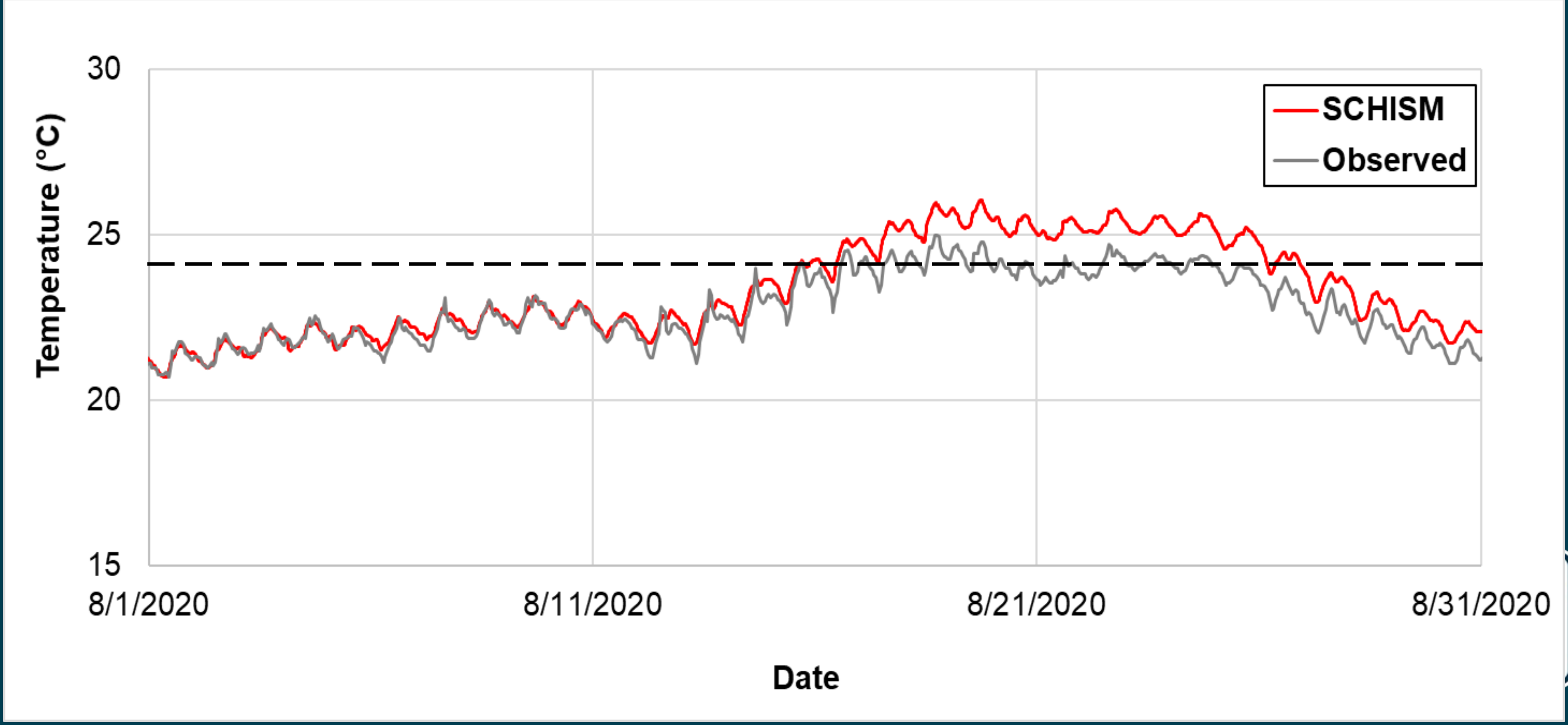
SCHISM

NSE = 0.97
Bias = 0.36
RMSE = 0.7

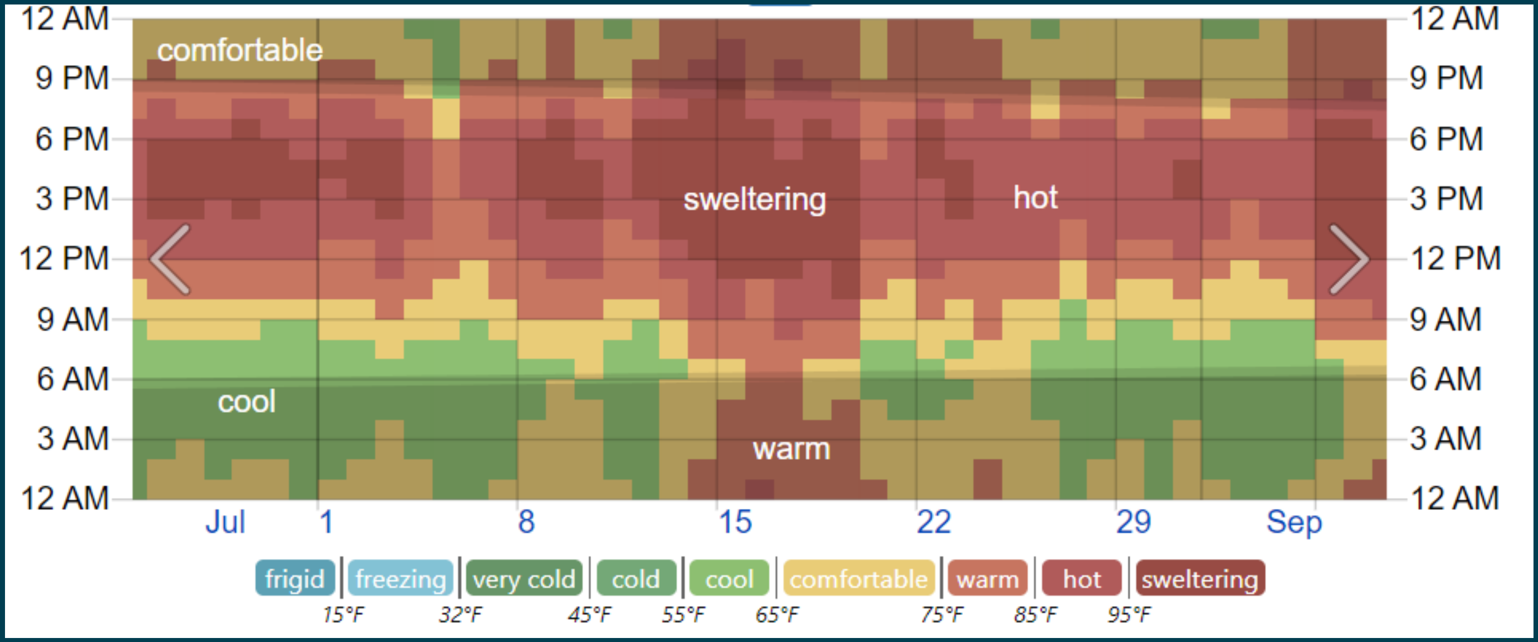
Quantifying Habitat Suitability

Challenges

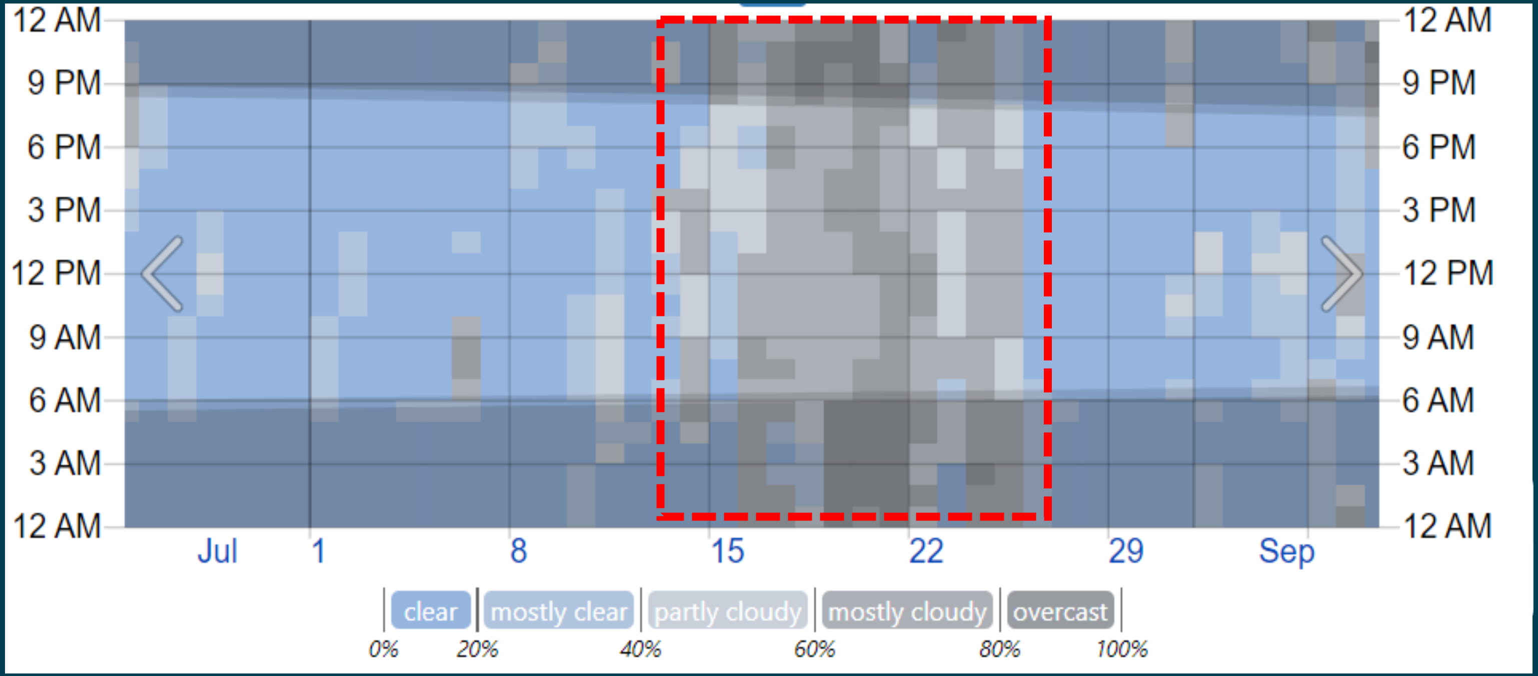
- Time series in Aug 2020
- Just so happens…
- **Also, 23.5ºC vs 24ºC vs 24.5ºC ??**



Temperature



Cloud Cover



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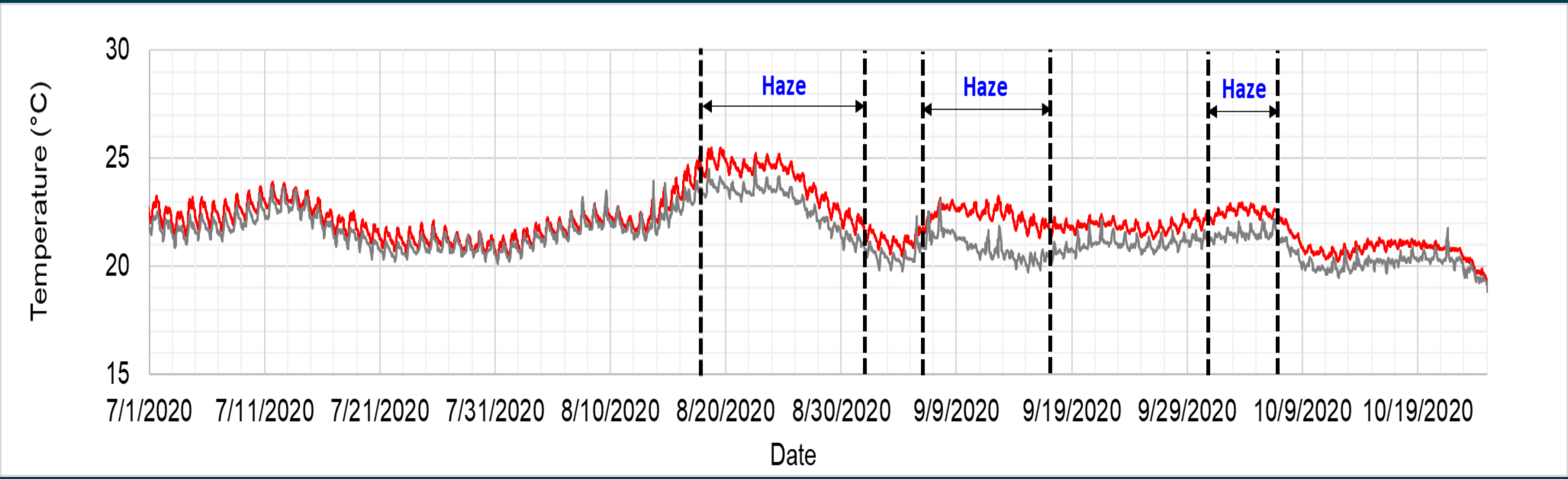
Cloud Cover at Antioch



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Quantifying Habitat Suitability

How to address these issues?

- Depends
    - Hindcasts vs Forecasts

Quantifying Habitat Suitability

How to address these issues?

Hindcast

- Correction over space and time
  - Simple constant shift in predictions across region using average bias
  - Shift in predictions using a correction surface
  - Newtonian relaxation of predictions at known locations towards observed values

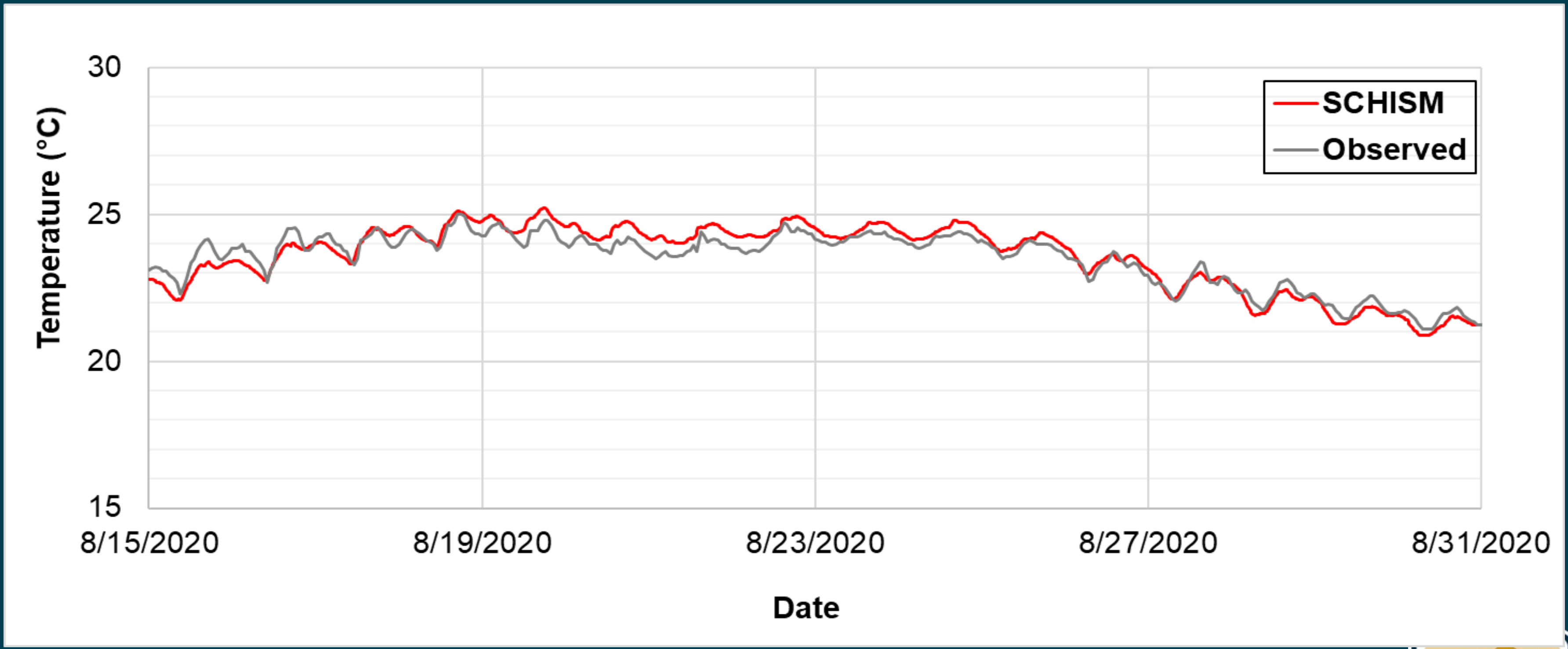
- Identifying cause and refining model inputs
  - e.g. reducing incoming radiation in this example

- Using a not-so-hard classification approach
  - Fuzzy classification??

Quantifying Habitat Suitability

How to address these issues?

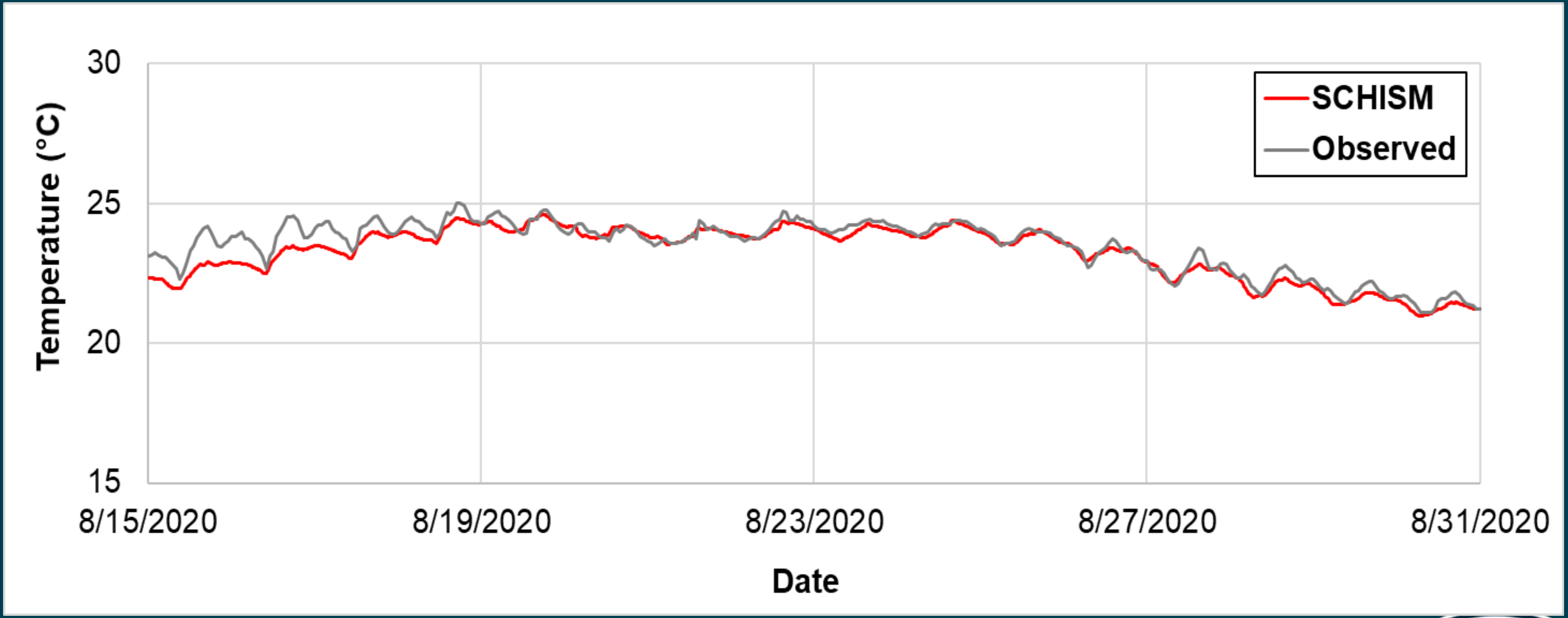
Constant Shift



Quantifying Habitat Suitability

How to address these issues?

Identifying cause and refining model inputs – reducing incoming radiation



Quantifying Habitat Suitability

How to address these issues?

- Remedies will work well for historical runs
- What to do for scenarios with no observations/ forecasting cases??

Quantifying Habitat Suitability

How to address these issues?

- What to do for simulating cases with no observations??
  - Impossible to predict conditions accurately
  - Understanding relative influence of parameters is key
    - Could potentially base HSI on past observed values where necessary
    - Assumption that temperature and turbidity not significantly affected by ops

Quantifying Habitat Suitability

How to address these issues?

- Forecasting example
  - Current speed and salinity from SCHISM Model
  - Quantiles of past temperature and turbidity interpolated to model grid used
    - Suitability assigned based on quantiles,
      - e.g.: Example on next slide

Sample Suitability Index, S_i, Estimation

- Based on Bever et al. (2016)

$S_i = 0.67S + 0.33V$, turbidity > 12 NTU
$S_i = (0.67S + 0.33V) \times 0.42$, turbidity < 12 NTU

where S is based on the fraction of time salinity < 6 PSU (computed with SCHISM)
V is based on the maximum current speed (computed with SCHISM)

- We weighted equations based on turbidity quantiles

For example, if the 75% quantile was 12 NTU, the suitability index was calculated as:

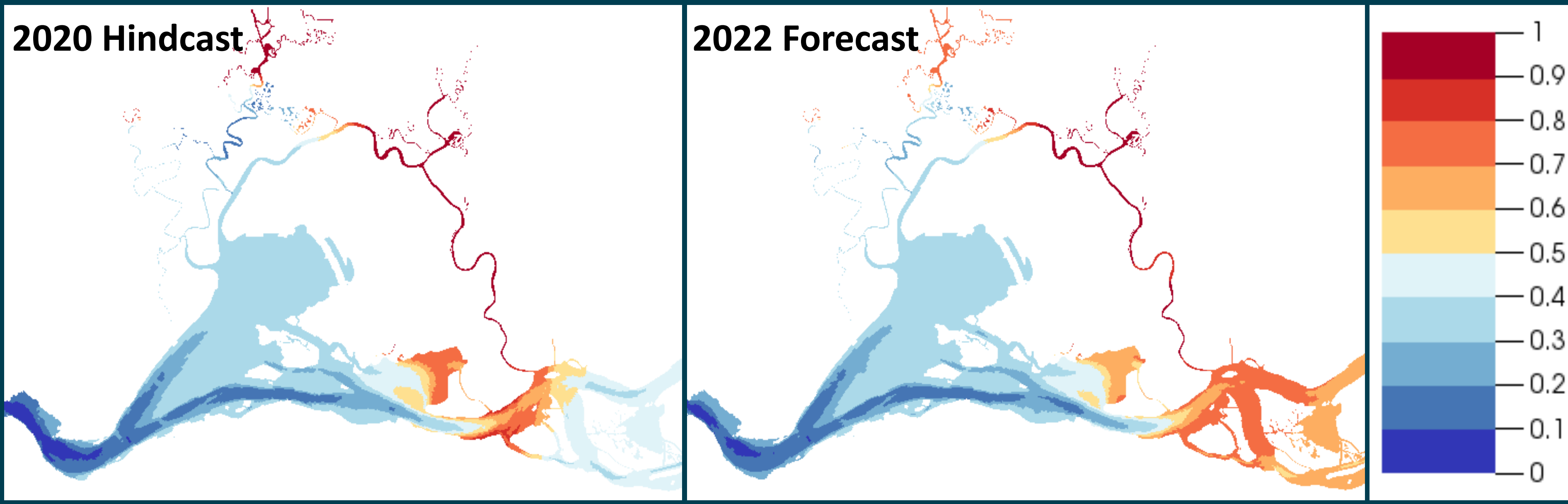
$$S_i = 0.75 \times [\ (0.67S + 0.33V) \times 0.42\ ] + 0.25 \times [0.67S + 0.33V]$$

- We then adjusted S_i with factors based on temperature quantiles

$S_{i\_final} = 1.00 \times S_i$, if 75% quantile < 24°C
$S_{i\_final} = 0.75 \times S_i$, if 50% quantile < 24°C ≤ 75% quantile

Quantifying Habitat Suitability

Evaluation of approach



Quantifying Habitat Suitability

Comments

- It can be a challenge to paint an accurate picture of habitat suitability without ACCURATE predictions when hard thresholds are used

- Softer classification/threshold approach is likely to provide more robust estimates of suitable habitat

Questions?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Quantifying Habitat Suitability

Issues with hard thresholds

- Physical

- Suitable Salinity???

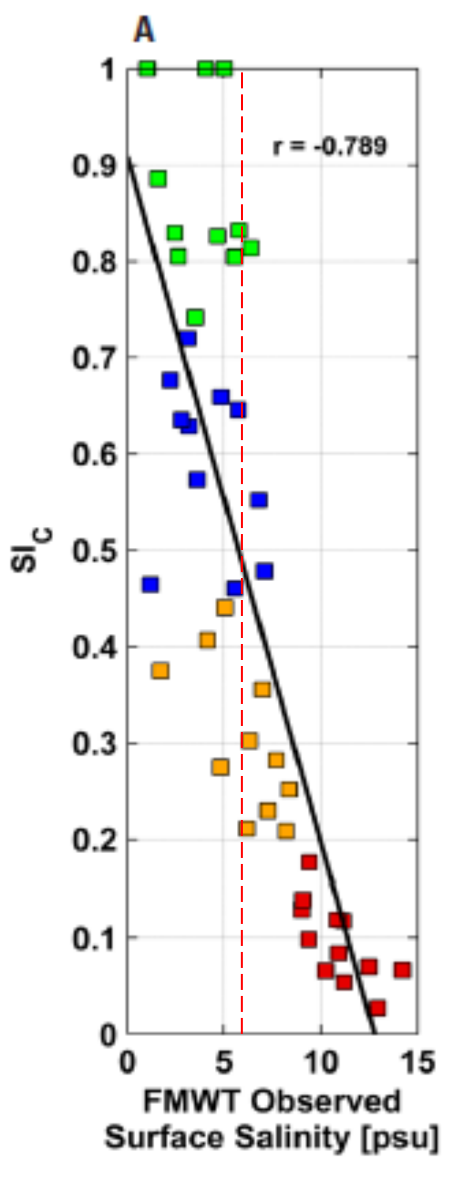
❖ 5.95 PSU vs 6.0 PSU vs 6.05 PSU ????

Quantifying Habitat Suitability

Issues with hard thresholds

- Physical
  - Suitable Salinity???

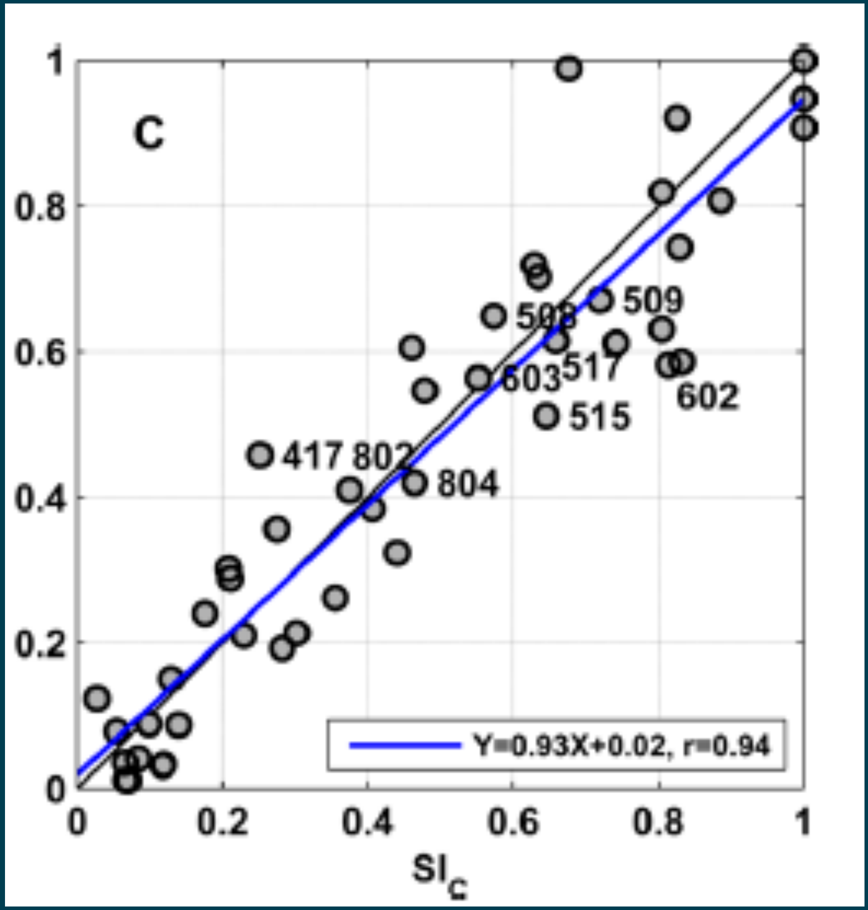
$$SI_c = \frac{\text{Normalized Percent Catch} + \text{Normalized Total Catch}}{2}$$



Quantifying Habitat Suitability

Issues with hard thresholds

- Physical
  - Suitable Salinity???



Quantifying Habitat Suitability

Evaluation of approach (Bever et al)

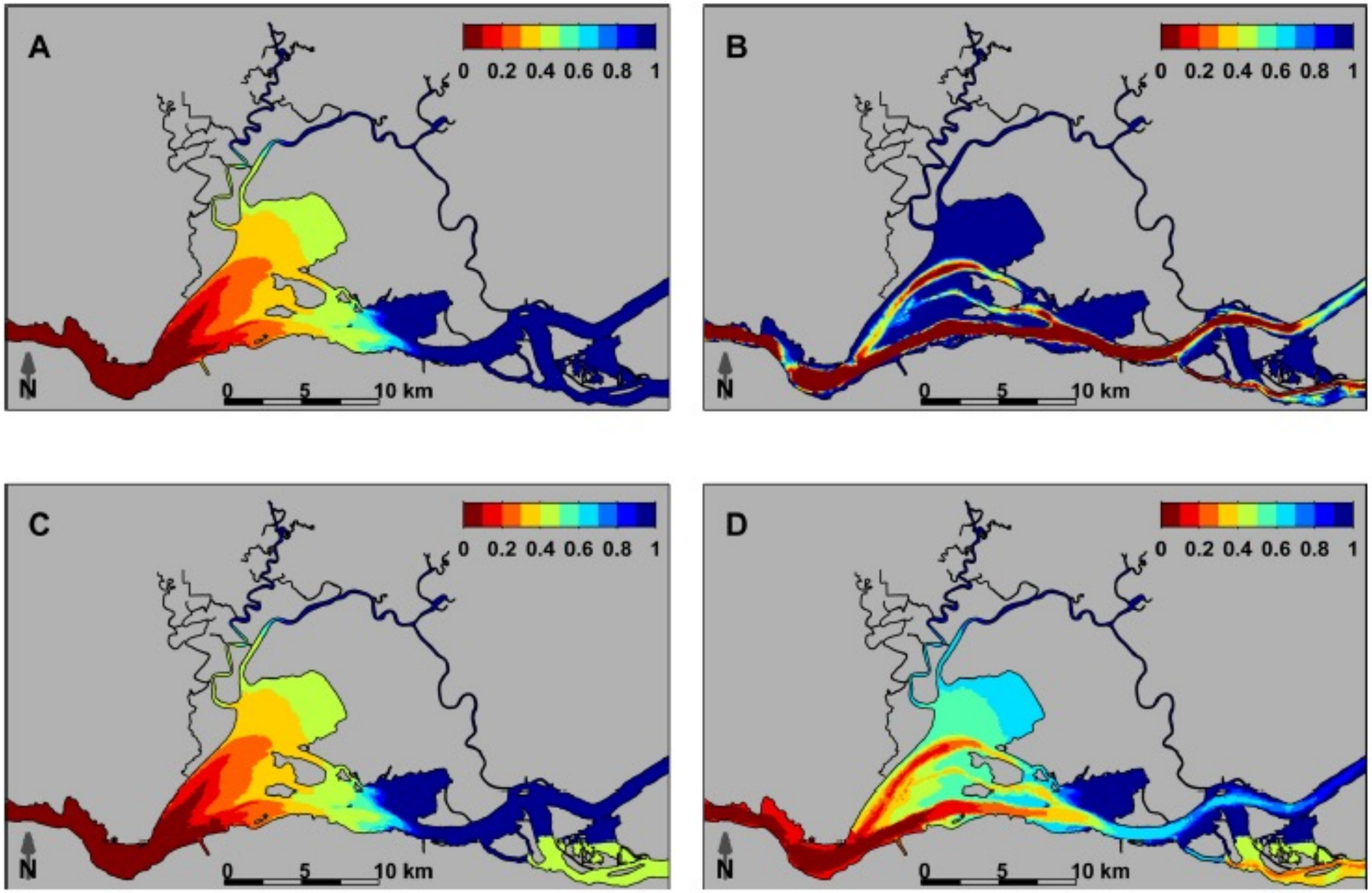
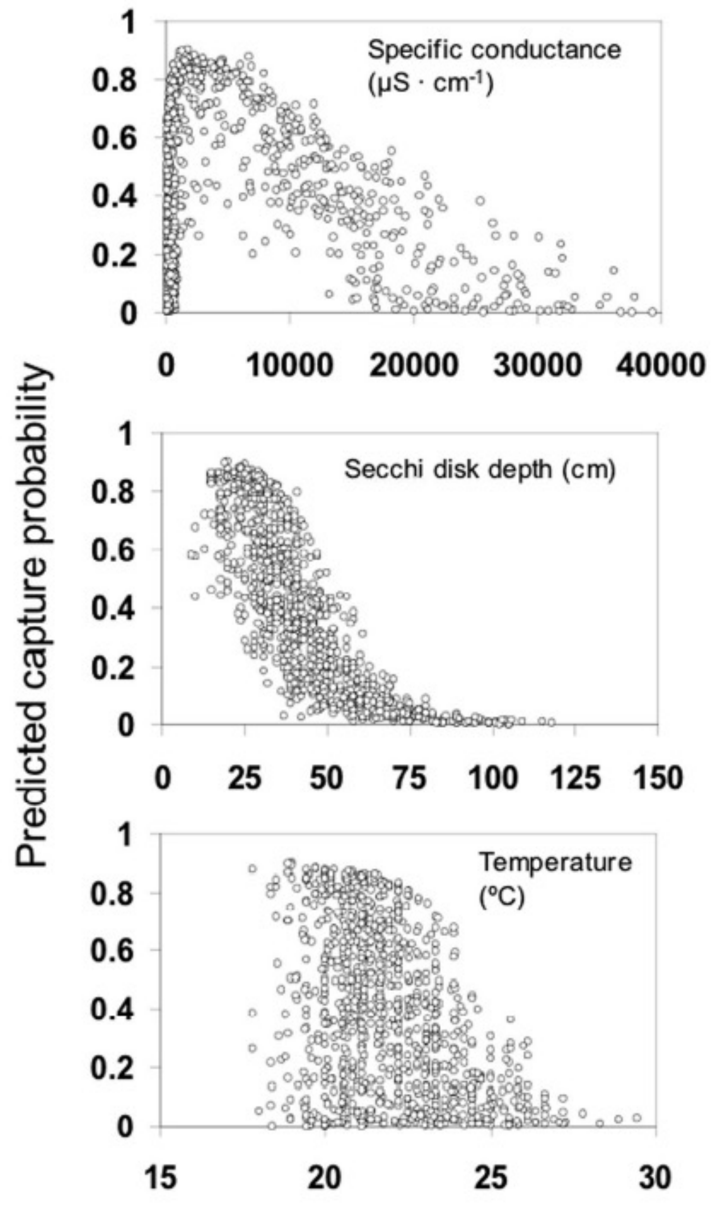


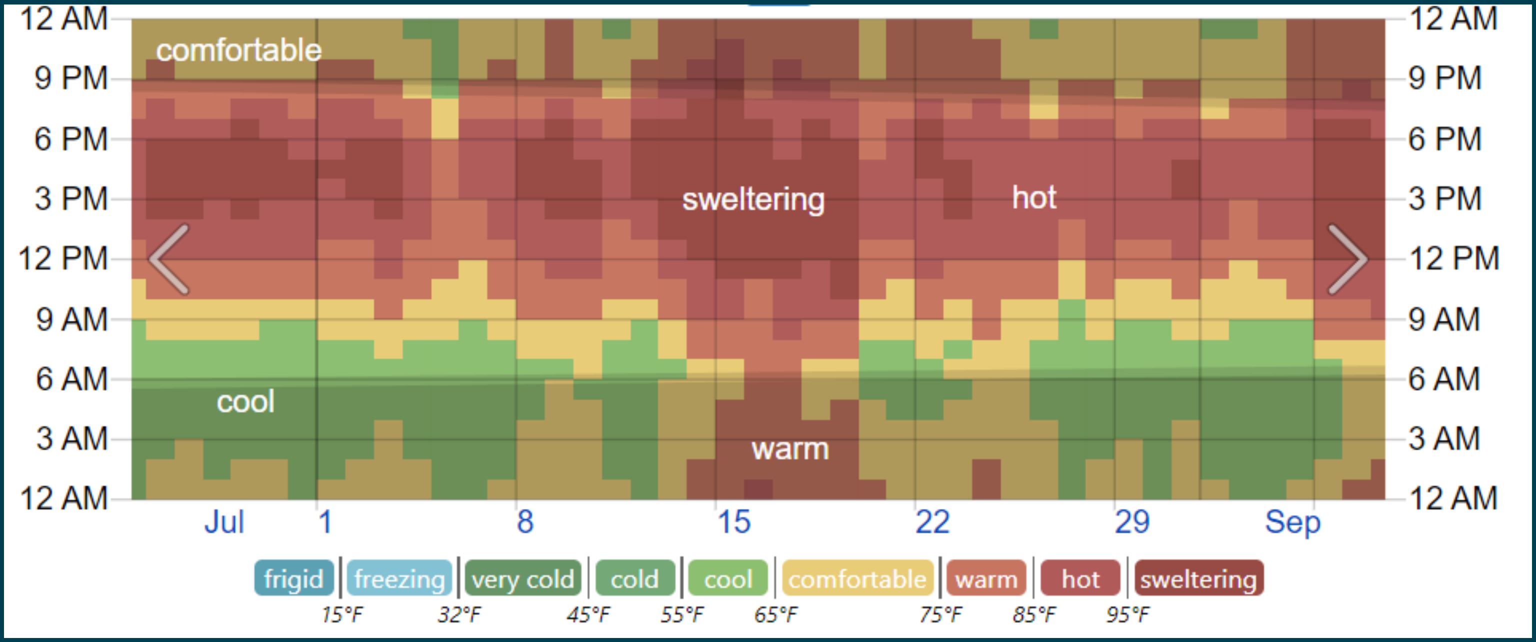
Figure 8 Two-dimensional maps of the station index (SI_H) based on (**A**) the predicted percent of time the depth-averaged salinity was less than 6 psu; (**B**) the maximum depth-averaged current speed; (**C**) percent of time the depth-averaged salinity was less than 6 psu and the Secchi depth threshold; and (**D**) the salinity and velocity metrics with the Secchi depth threshold.

Quantifying Habitat Suitability

Nobriga et al (2008)



Temperature



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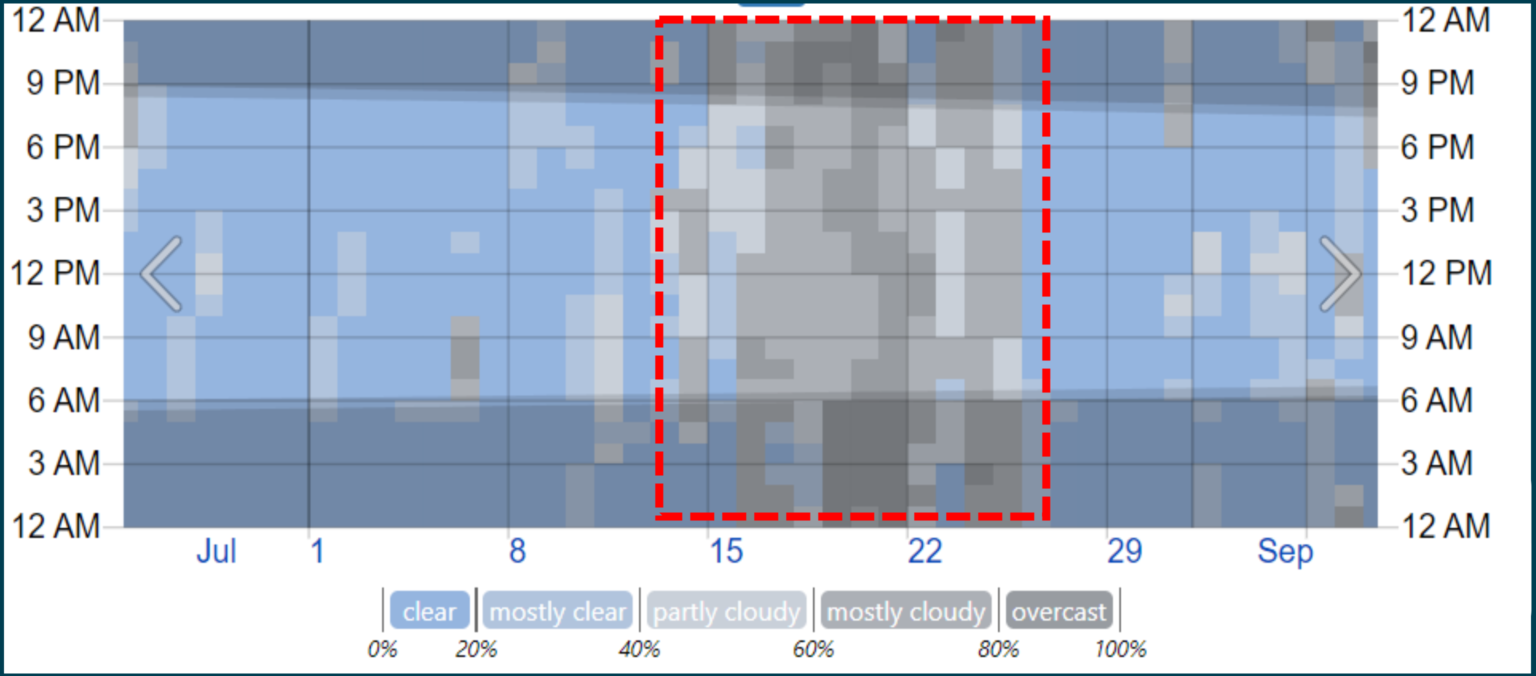

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