



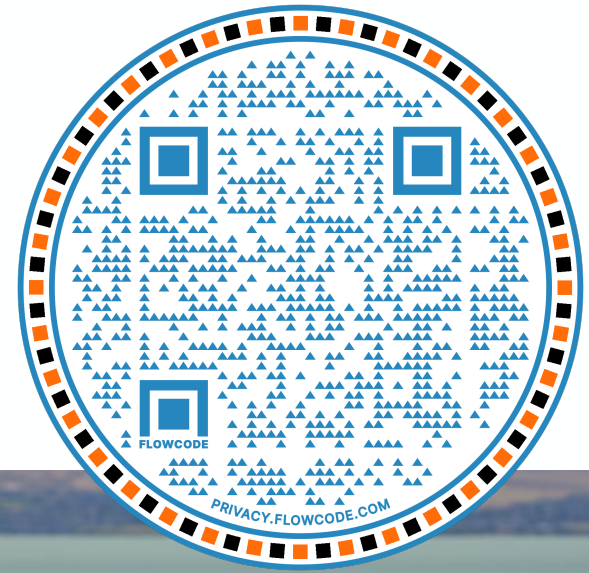
Institute of Outdoor Recreation & Tourism
UtahStateUniversity.

Translating Chlorophyll-a Monitoring Into Angler Trips and Welfare

A Threshold-Based Decision Support Workflow
for HAB Management in Recreational Fisheries

2026 Utah AFS Annual Meeting
Salt Lake City, Utah
March 3, 2026

Jordan W. Smith (jordan.smith@usu.edu) &
Chase C. Lamborn, Utah State University



Human Dimensions of Harmful Algal Blooms

The Salt Lake Tribune

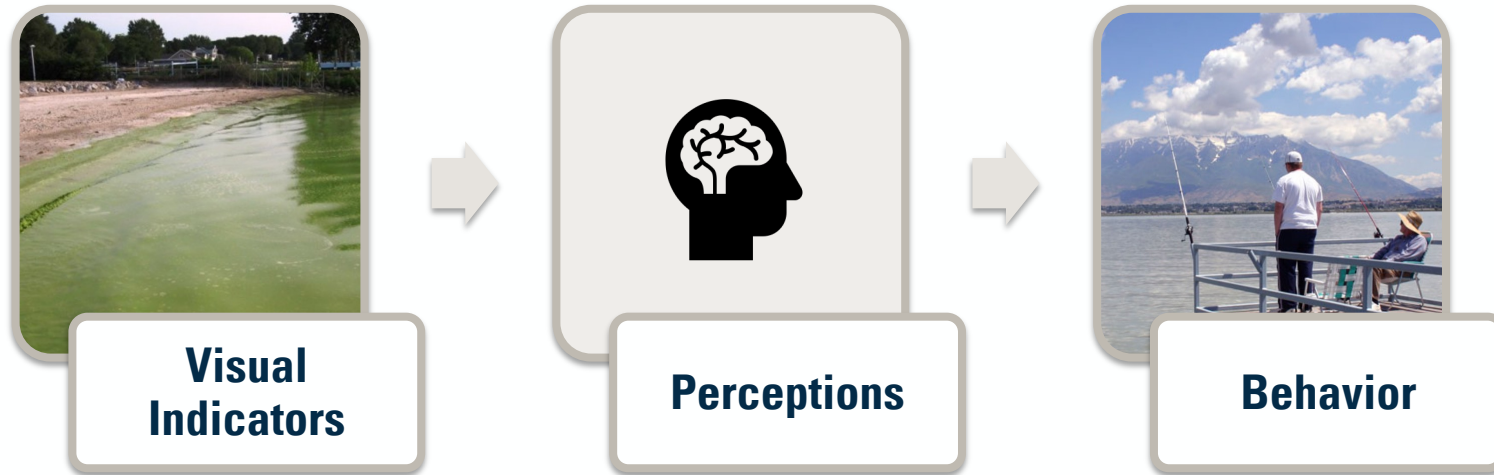
Stay out of Utah Lake, state officials warn, because of harmful algal blooms

Officials are urging swimmers and paddlers — human or pets — to avoid contact with the water.



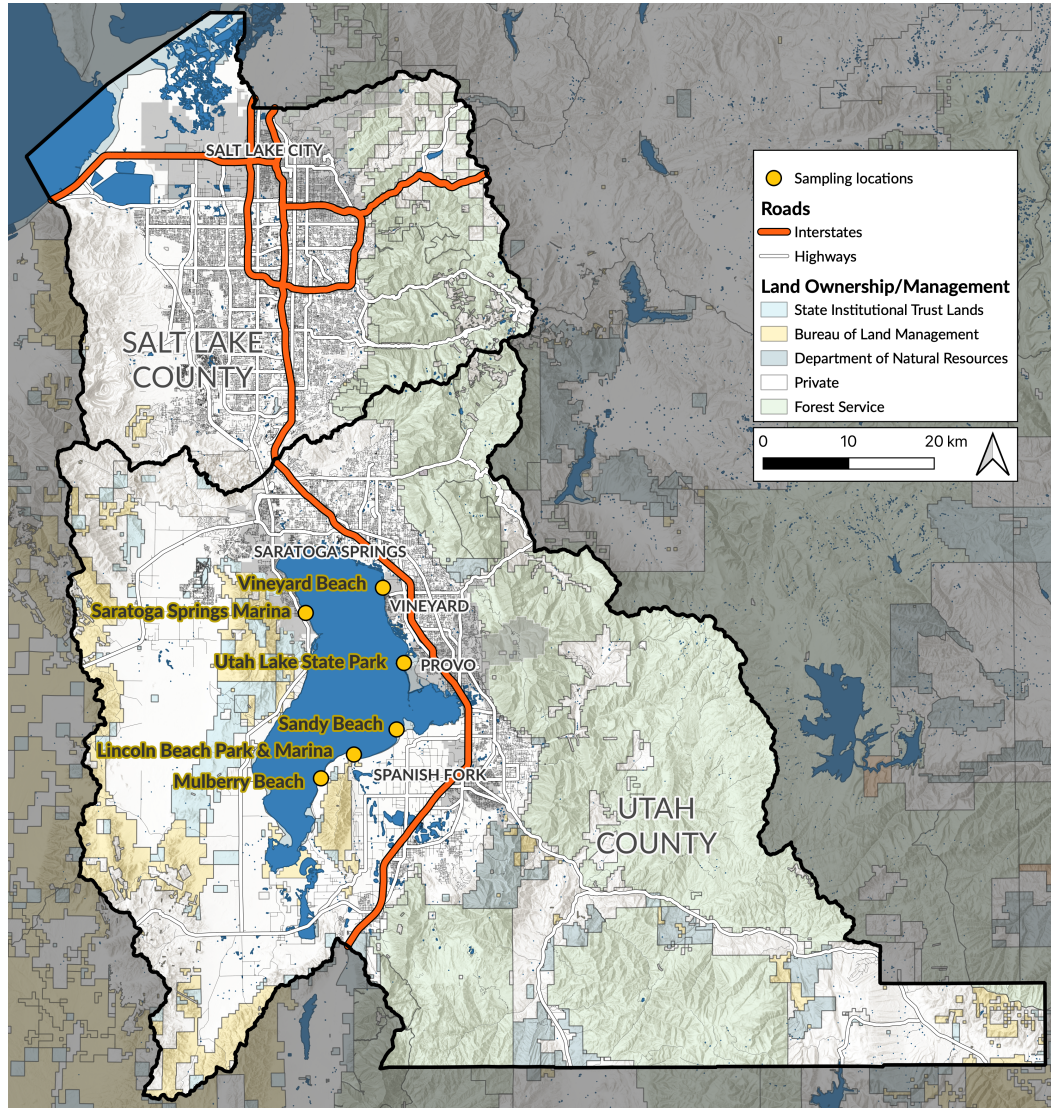
- HABs are increasing globally due to climate and nutrient enrichment
- Public relies on visual cues to assess water quality
- Anglers face exposure risks through contact and fish consumption

Research Objectives



- Examine angler sensitivity to visual water quality indicators
- Focus on chl-a
- Explore how experience and investment affect perception, behavior, and welfare

Utah Lake: An Optically Complex Ecosystem



- Shallow, wind-mixed, eutrophic lake
- Persistent turbidity complicates visual assessment
- Frequent HAB events, ongoing public health advisories



Visual Assessment Approach



TSS: 23
TVS: 10
TVS:TSS: 43
TOC: 8.0
DOC: 7.7
Turbidity: 29.4
Secchi: 0.3
Bicarbonate: 234
Chl-a: 55.2

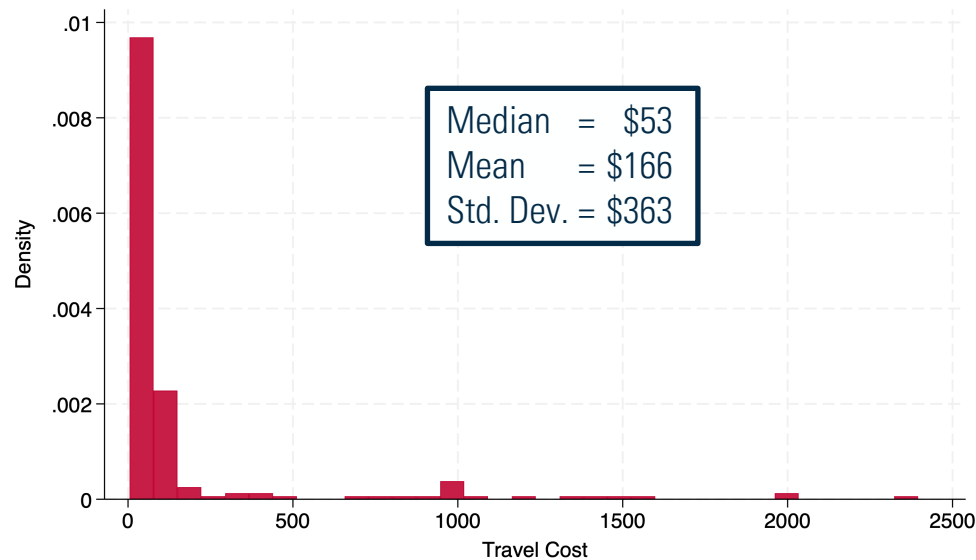
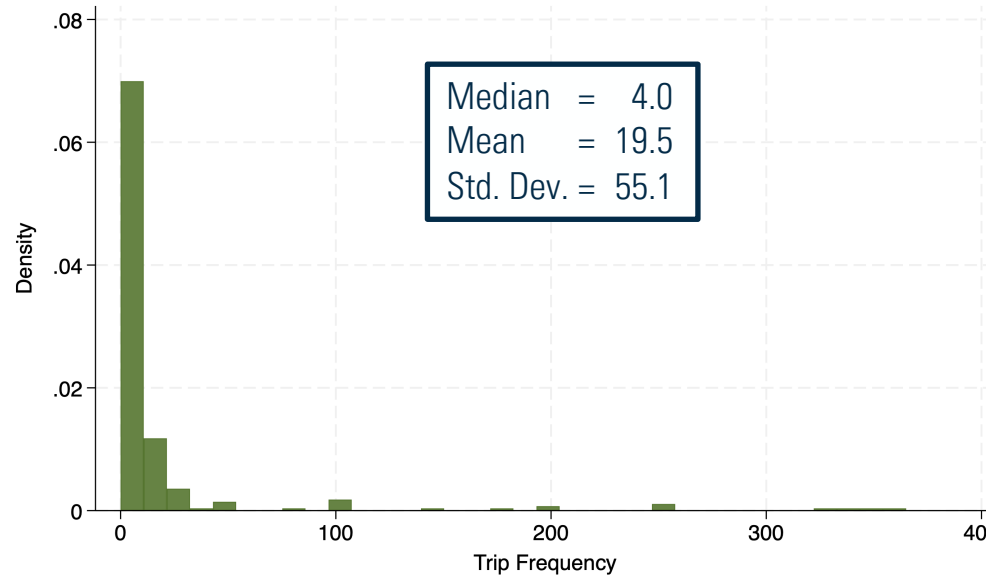


TSS: 63
TVS: 15
TVS:TSS: 24
TOC: 8.3
DOC: 8.0
Turbidity: 45.9
Secchi: n/a
Bicarbonate: 236
Chl-a: 57.2

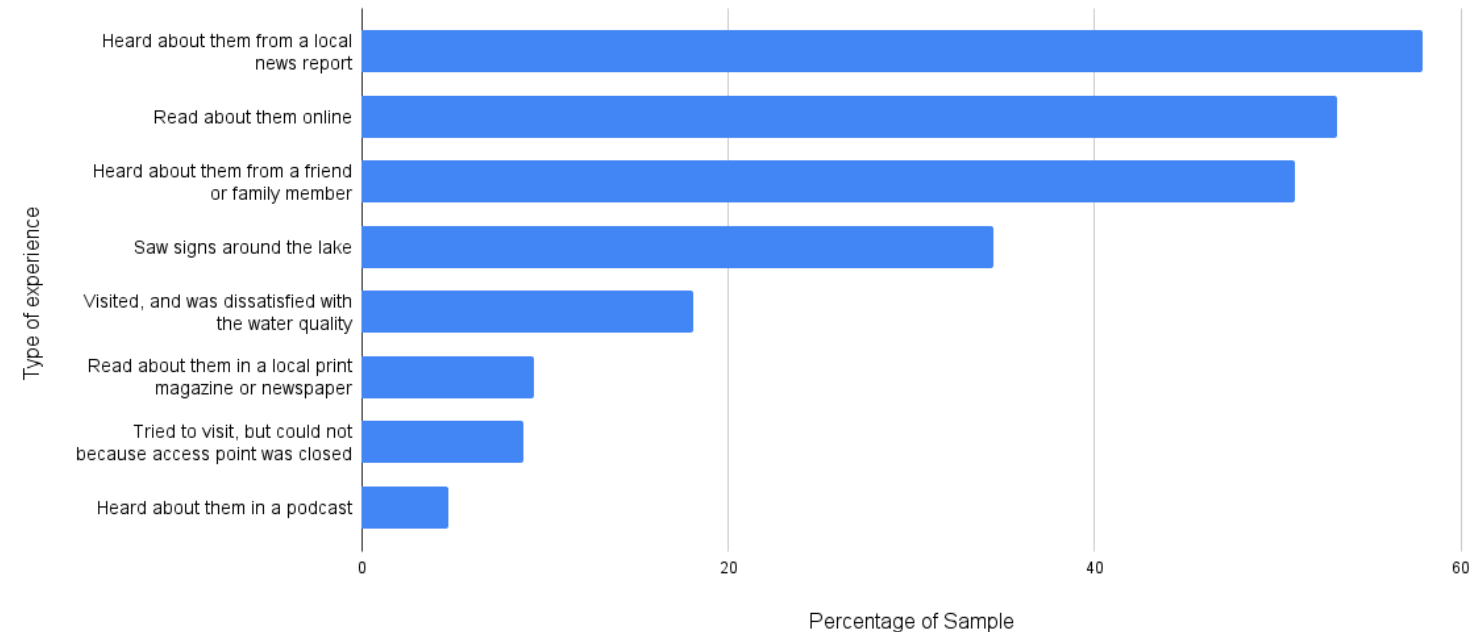
- Photo-based intercept survey (n = 174 anglers)
- Linked to in situ chl-a data
- Ratings for fishing desirability

Angler Experience & Investment

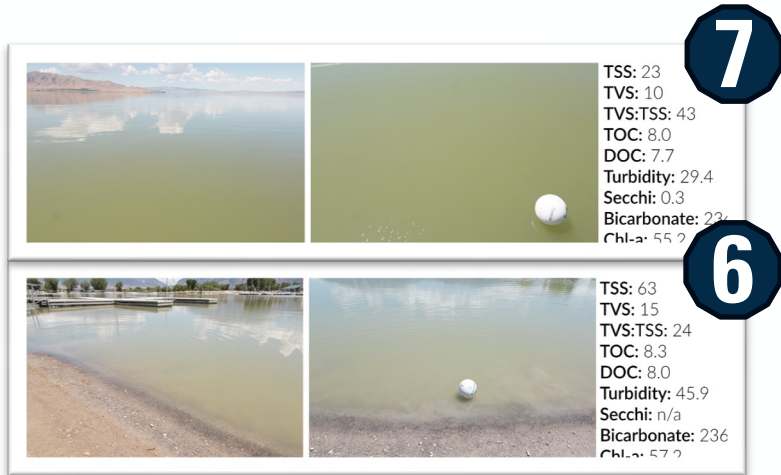
- Trip frequency: habituation and tolerance
- Travel cost: proxy for recreational investment
- Awareness of past water quality issues



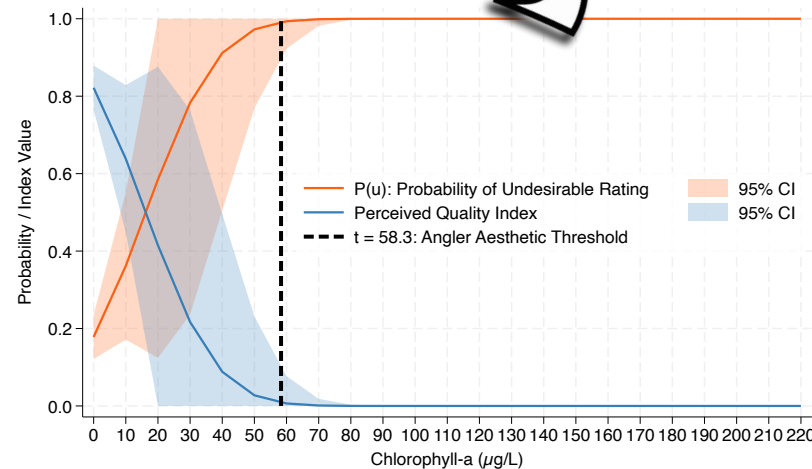
Previous Experience with Water Quality Issues at Utah Lake



Ordered Probit Panel Models

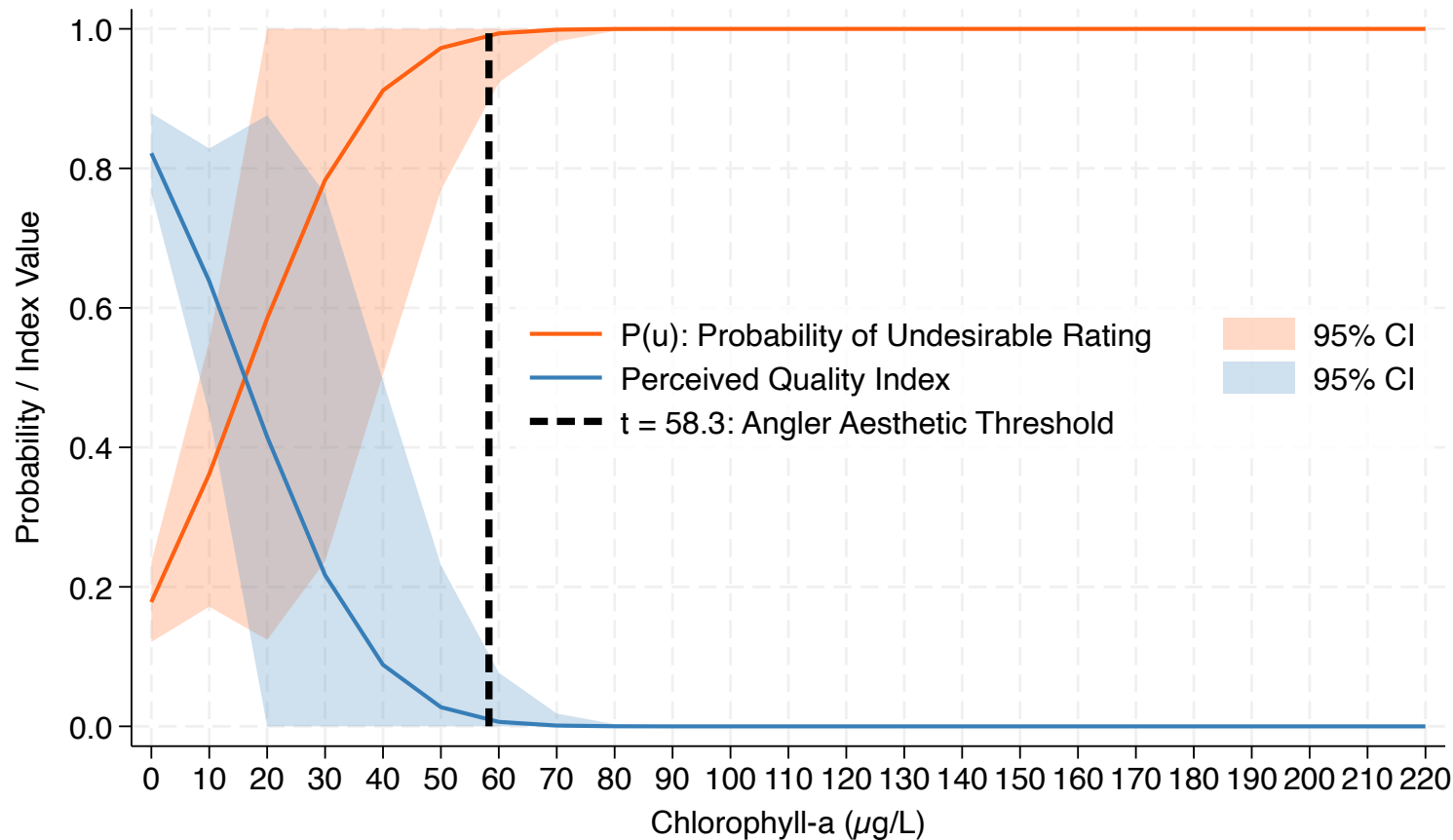


$$\Pr(y_{it} > k | \kappa, \mathbf{x}_{it}, \nu_i) = \Phi(\mathbf{x}_{it}\beta + \nu_i - \kappa_k)$$



- Repeated observations per angler
- Models for fishing and fish consumption
- Controls for demographic and site variables

Chlorophyll-a Influences Fishing Desirability

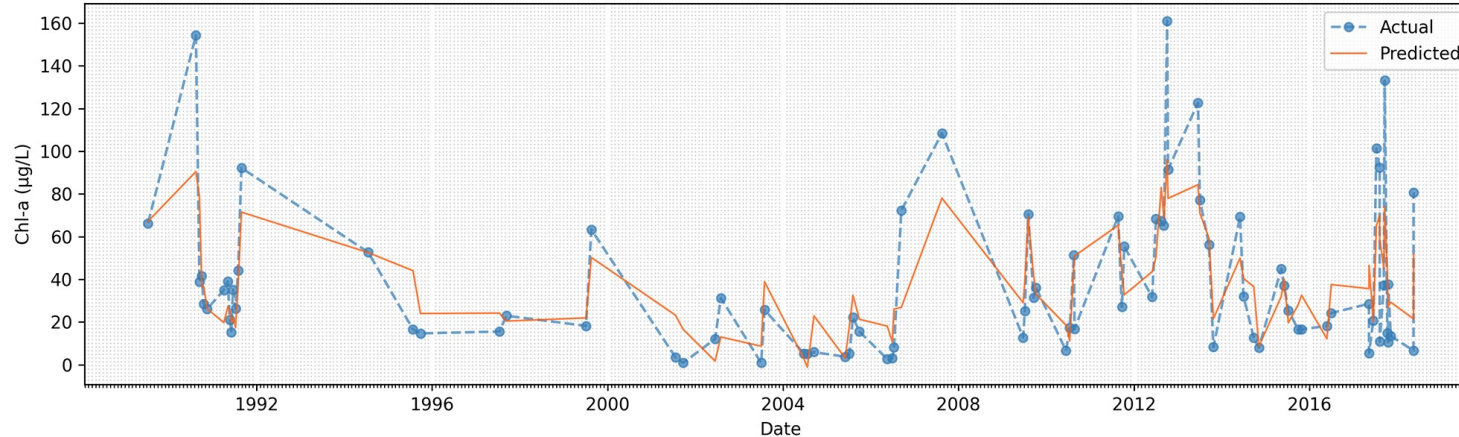


- 99% of anglers rate water quality as unacceptable for fishing above 58.3 $\mu\text{g/L}$
- Frequent users more tolerant
- Higher travel cost $\rightarrow$ lower ratings

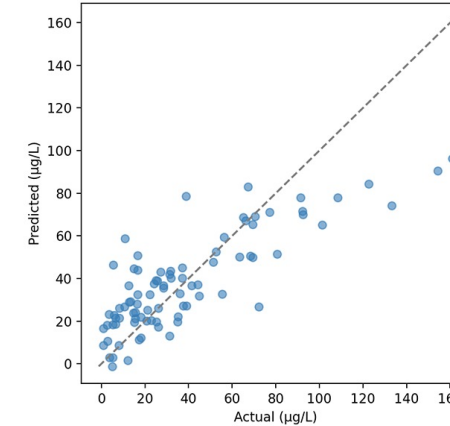
How Many Days Exceed Anglers' Perceptual Thresholds?

Histogram gradient-boosting machine learning model to predict daily chl-a from sparse sampling data

Chl-a (TRAIN) - Best Model: {'learning_rate': 0.1, 'max_iter': 100, 'max_depth': 3, 'l2_regularization': 0.0, 'min_samples_leaf': 20}



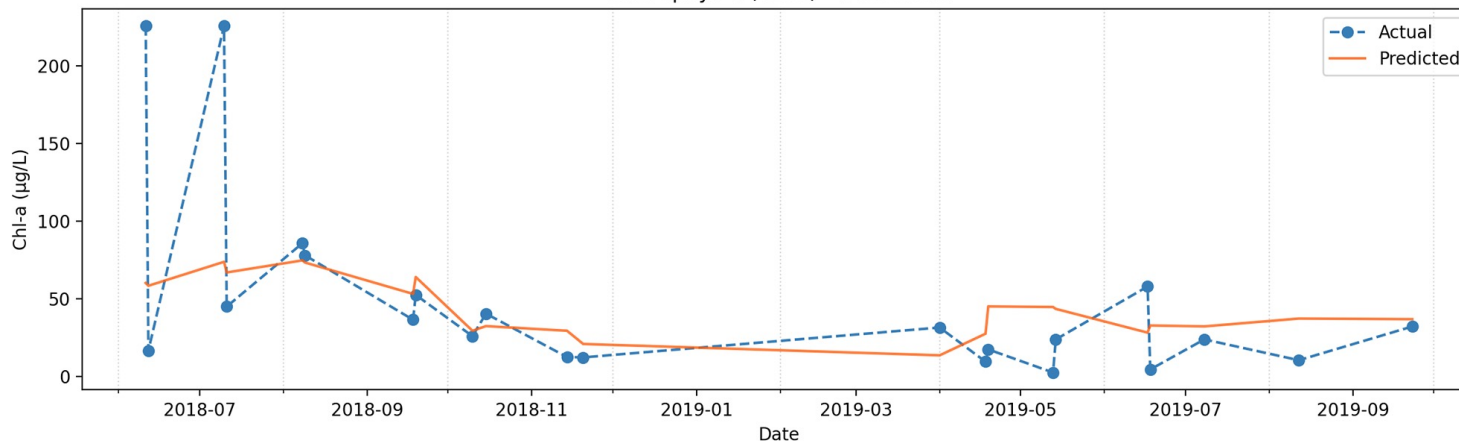
Predicted vs Actual (TRAIN)



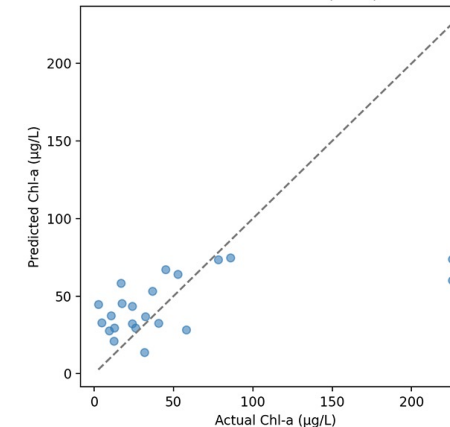
109 in-situ measurements across 30-years

Train $R^2 = 0.65$
Test $R^2 = 0.25$

Chlorophyll-a (TEST) - Best Model



Predicted vs Actual (TEST)



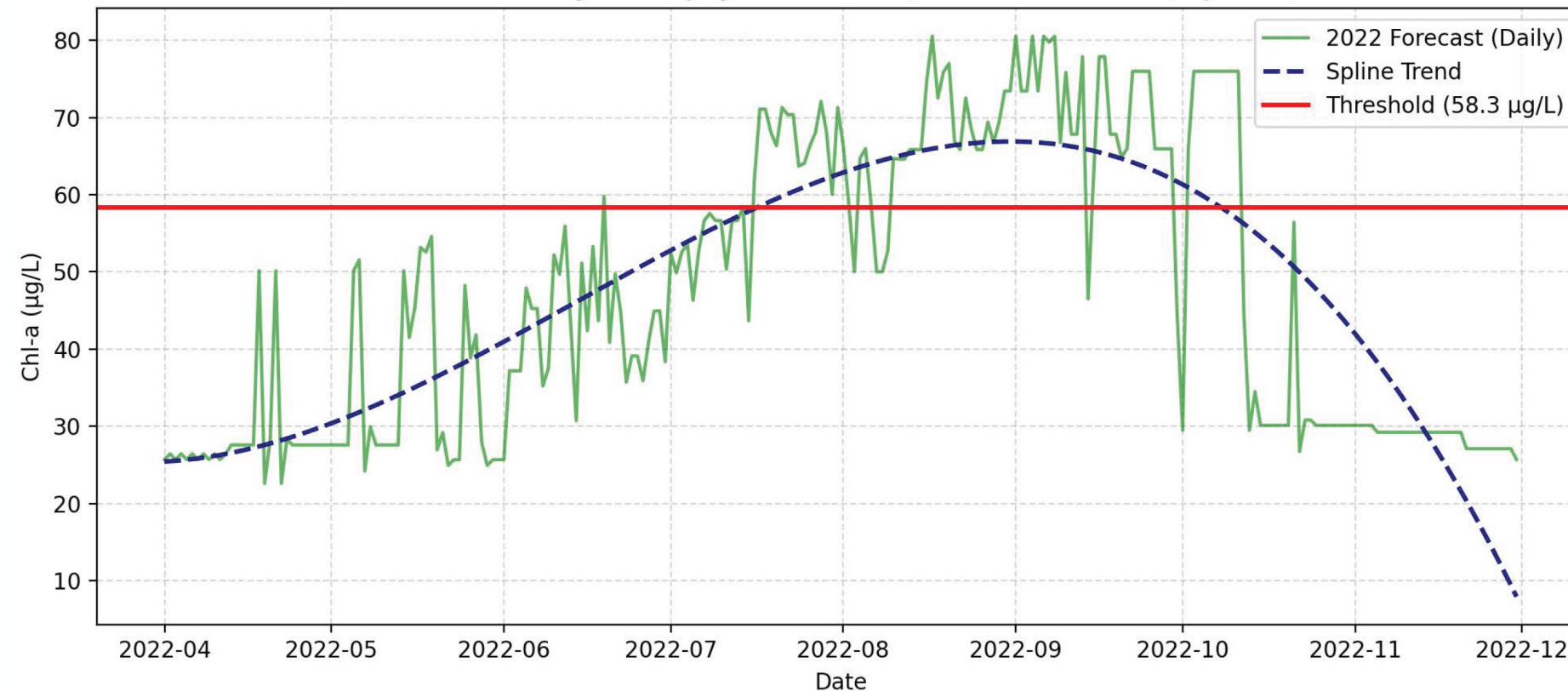
Important and positive predictors

- Days since previous measurement
- Maximum daily temperature
- Mean daily temperature

How Many Days Exceed Anglers' Perceptual Thresholds?

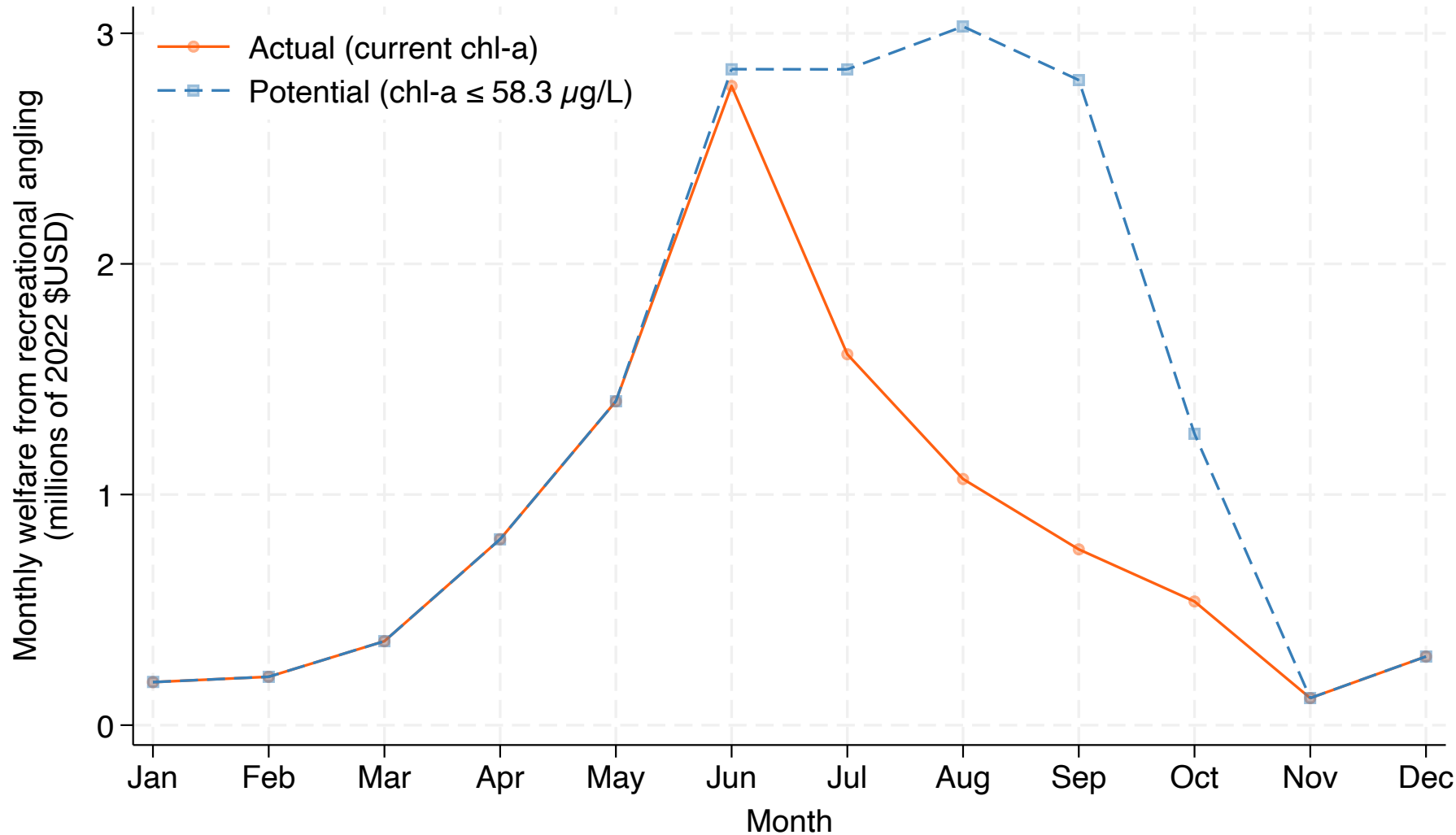
Recursive Forecast for April-November 2022

Estimated Daily Chlorophyll-a for 2022 (Recursive Forecast, Apr-Nov)



- 83 days > threshold
- 35 consecutive days during mid-summer

What's the Cost to Anglers?



- Recreational angling at Utah Lake State Park (in isolation) generated **\$10.1 M** in consumer surplus (i.e., angler benefit) in 2022.
- Chl-a concentrations above threshold “cost” anglers **\$6.0 M** in lost angling opportunities.

Improving Policy

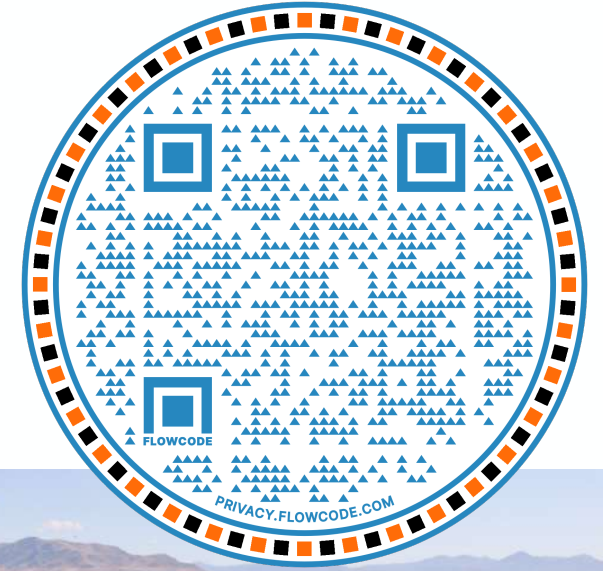


- Visual cues shape angler behavior before formal advisories
- Frequent users may have higher tolerance and/or more frequent exposure to chl-a
- Welfare-based outcome indicators can support prioritization and appraisal
 - Program costs
 - Mitigation
 - Investments in substitute alternatives



Institute of Outdoor Recreation & Tourism
UtahStateUniversity.

QUESTIONS?



Translating Chlorophyll-a Monitoring Into Angler Trips and Welfare

A Threshold-Based Decision Support Workflow
for HAB Management in Recreational Fisheries

2026 UT-AFS Annual Meeting
Salt Lake City, Utah
March 3, 2026

Jordan W. Smith (jordan.smith@usu.edu) & Chase C. Lamborn

