Wake surfing and water quality on Island Park Reservoir

Henry's Fork Watershed Council

10/10/2023

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Outline

- Understanding Island Park Reservoir (IPR) and its importance
  - How does Island Park Reservoir work?
  - Why does Island Park Reservoir’s water quality matter?

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  - How does Island Park Reservoir work?
  - Why does Island Park Reservoir's water quality matter?
- How to improve water quality on Island Park Reservoir
- How might wakesurfing affect Island Park Reservoir?
  - What our data tells us
  - Lessons from other waterbodies

Understanding Island Park Reservoir

- Island Park Reservoir is two lakes in one

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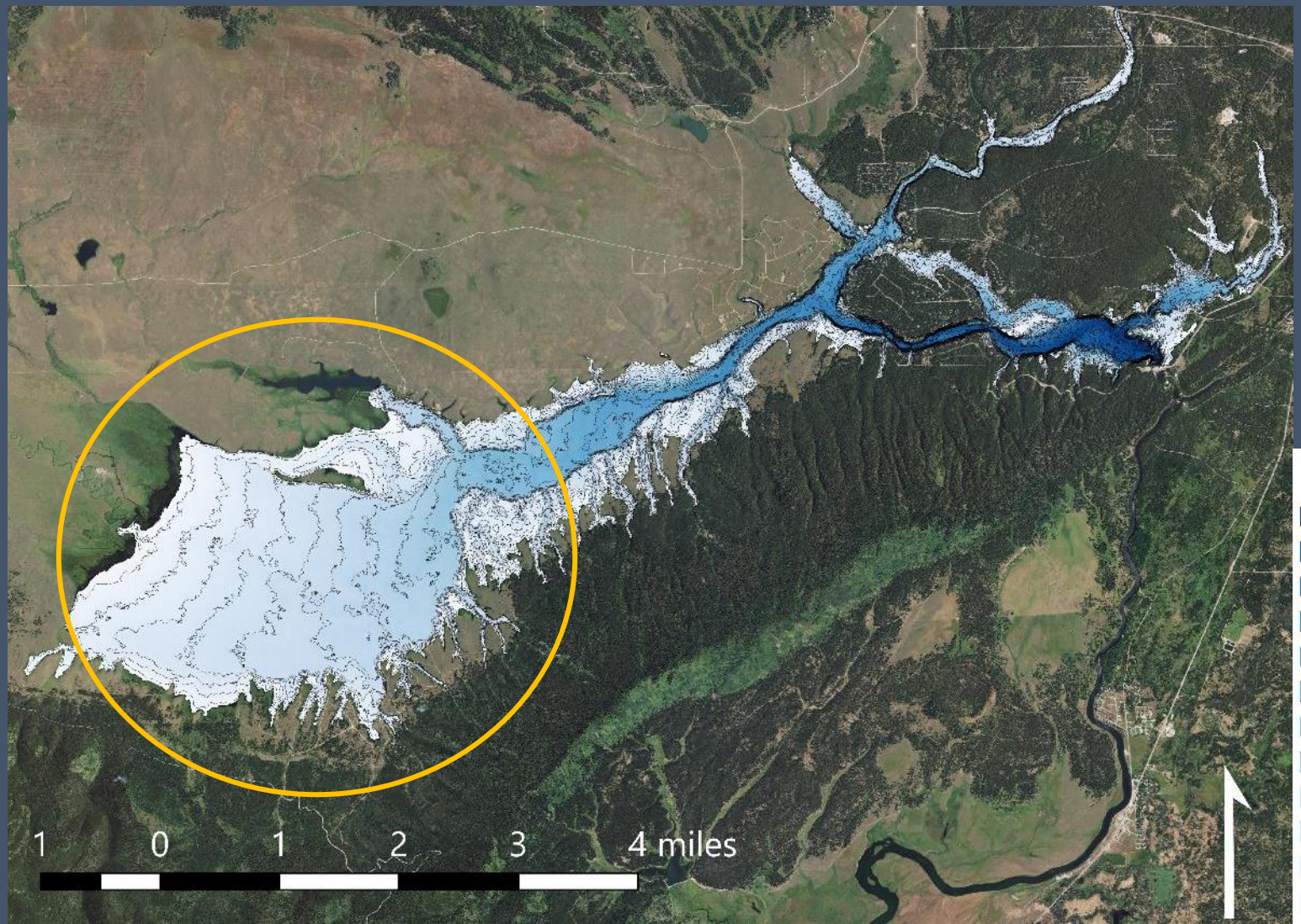
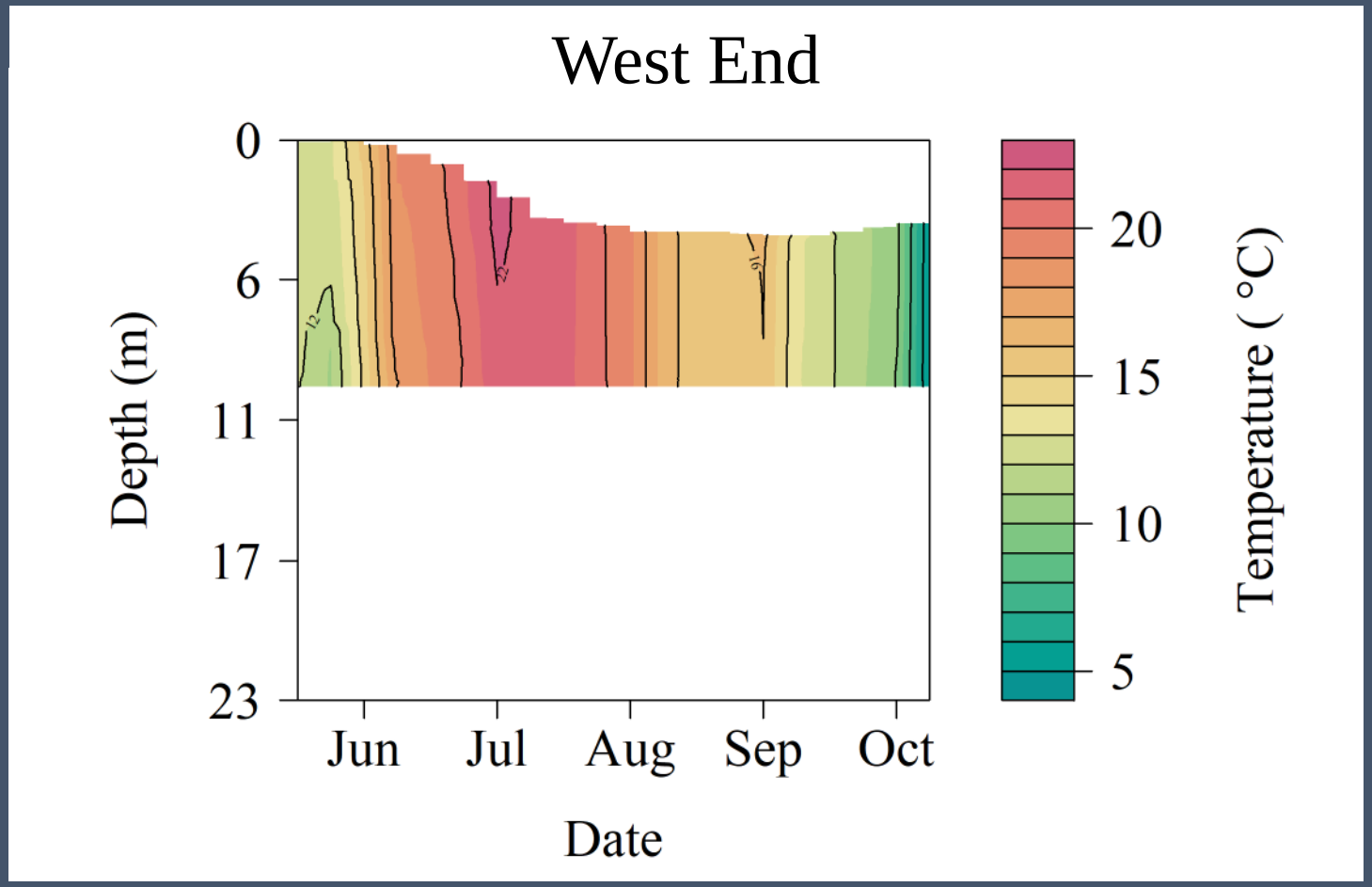
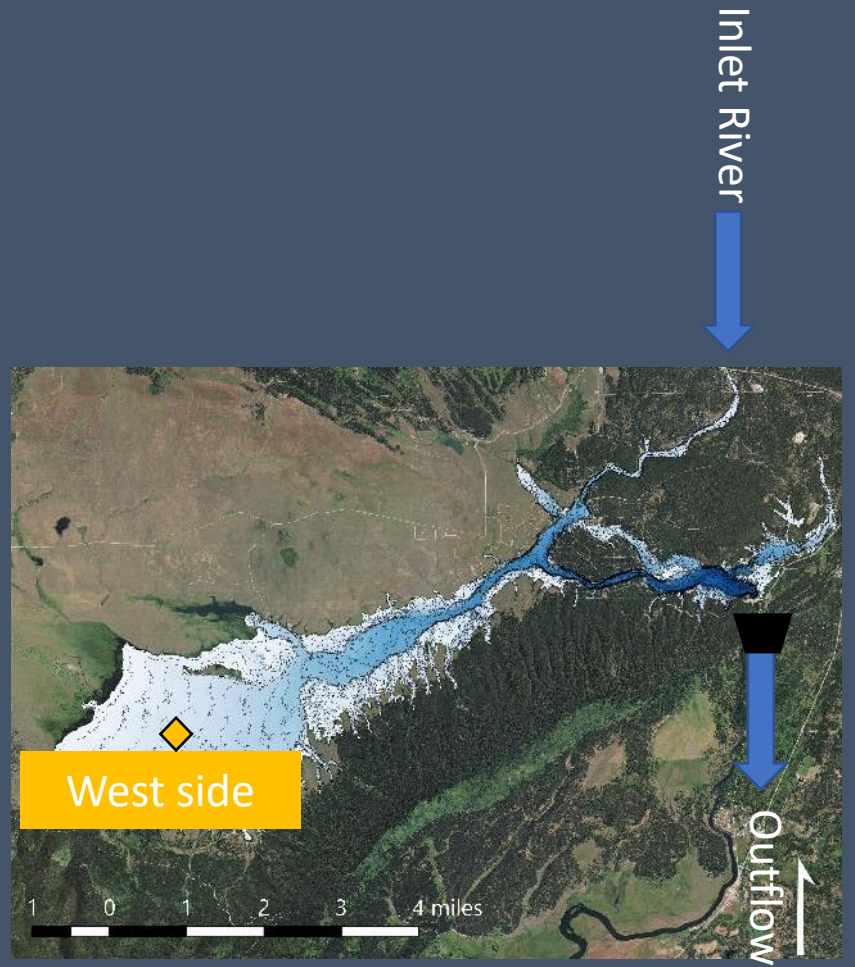


West side: shallow, wide, polymictic, warm, turbid

Understanding Island Park Reservoir

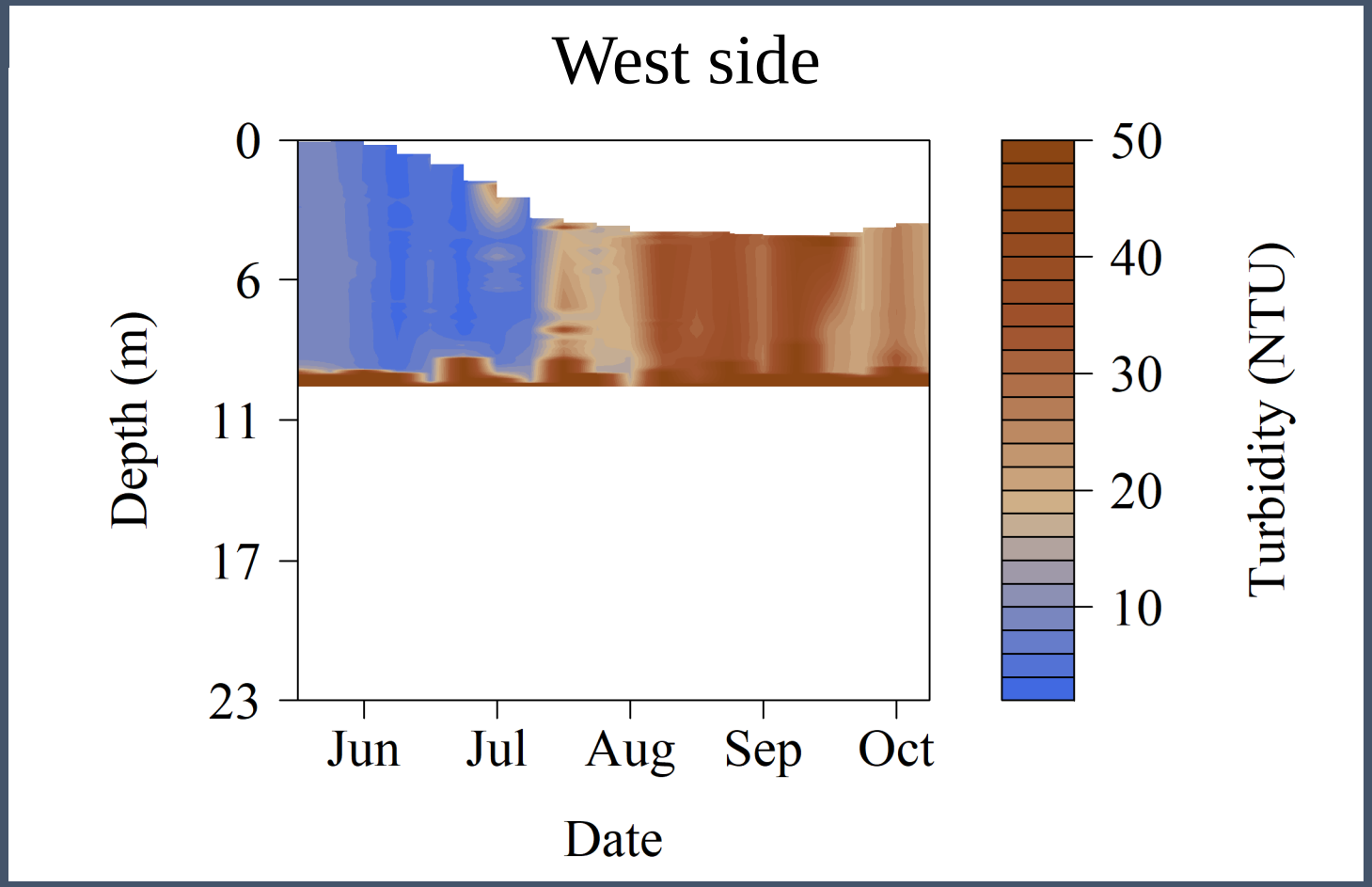
- Wind, waves prevent stratification

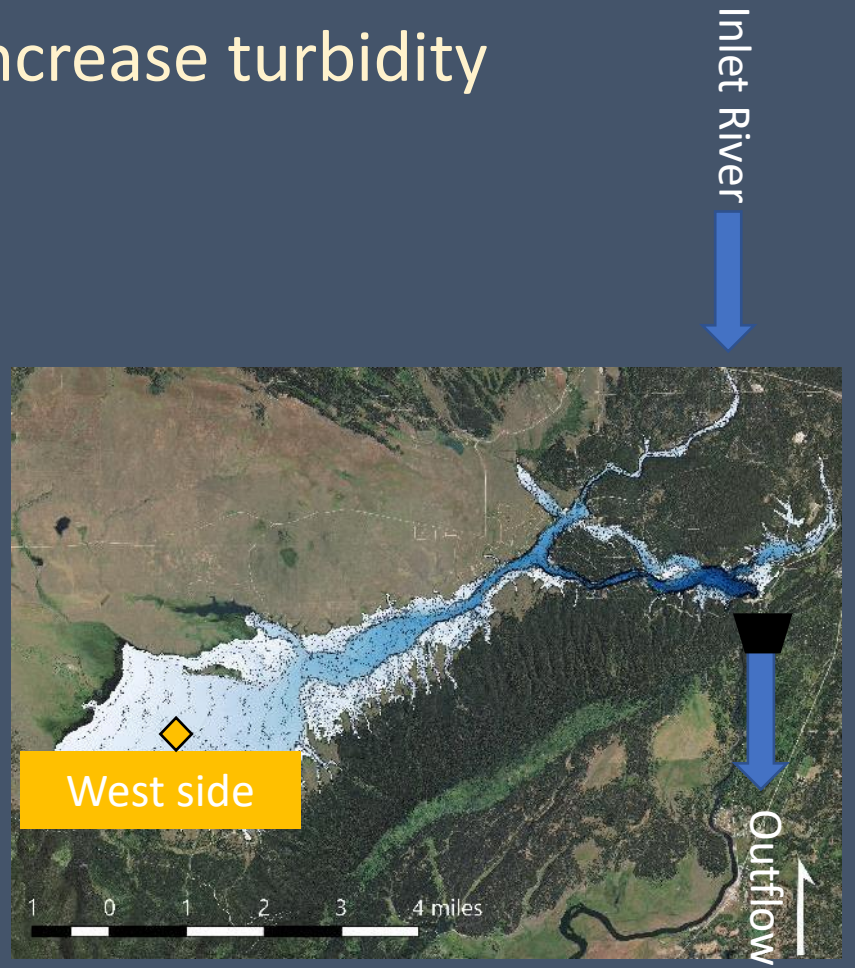




Understanding Island Park Reservoir

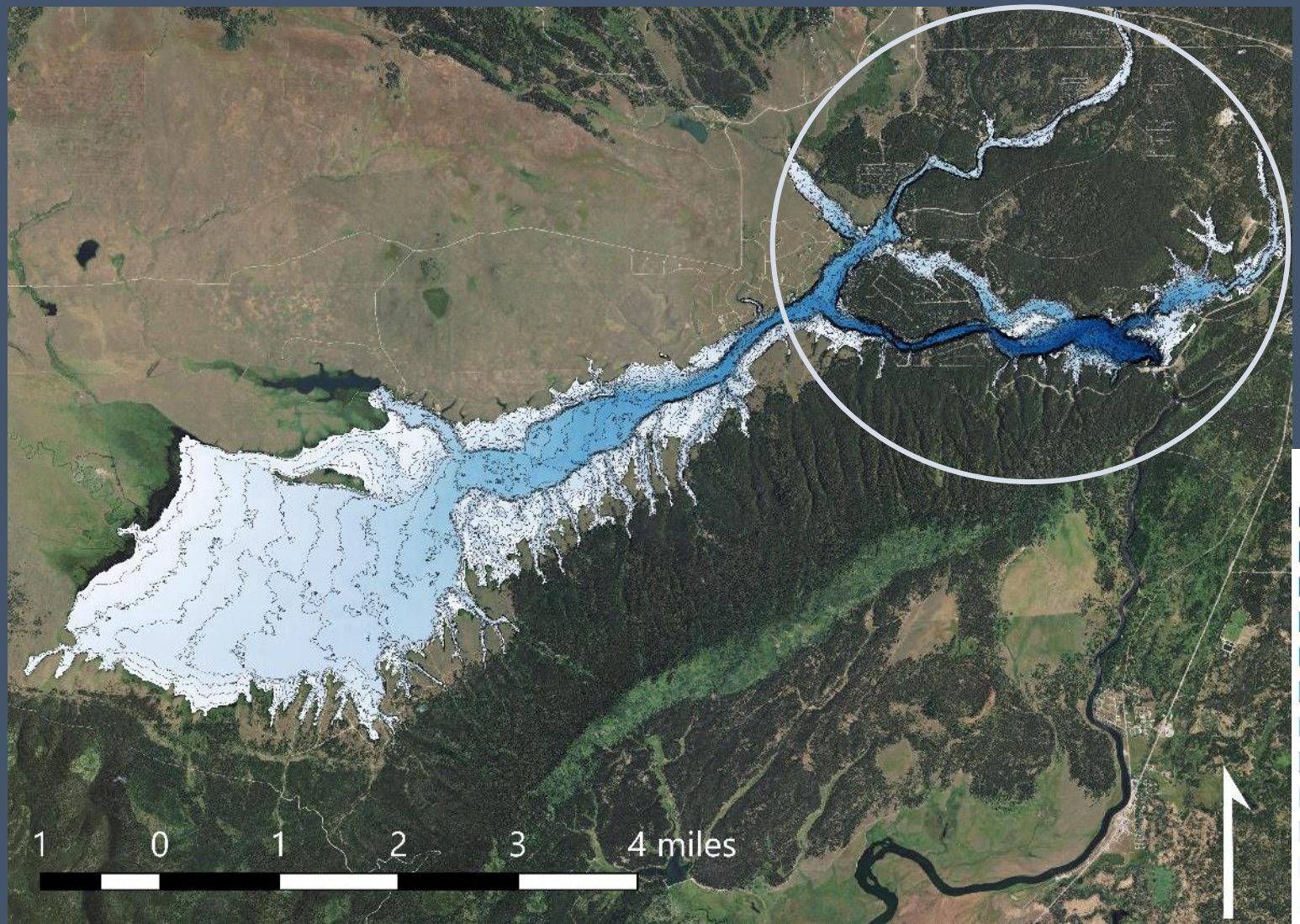
- Wind, waves, algal blooms hurt water quality, increase turbidity



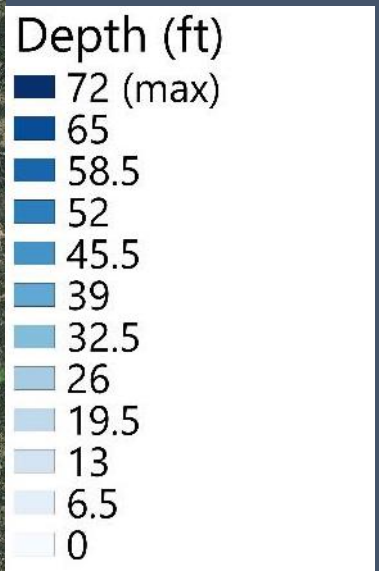


Understanding Island Park Reservoir

- Island Park Reservoir is two lakes in one

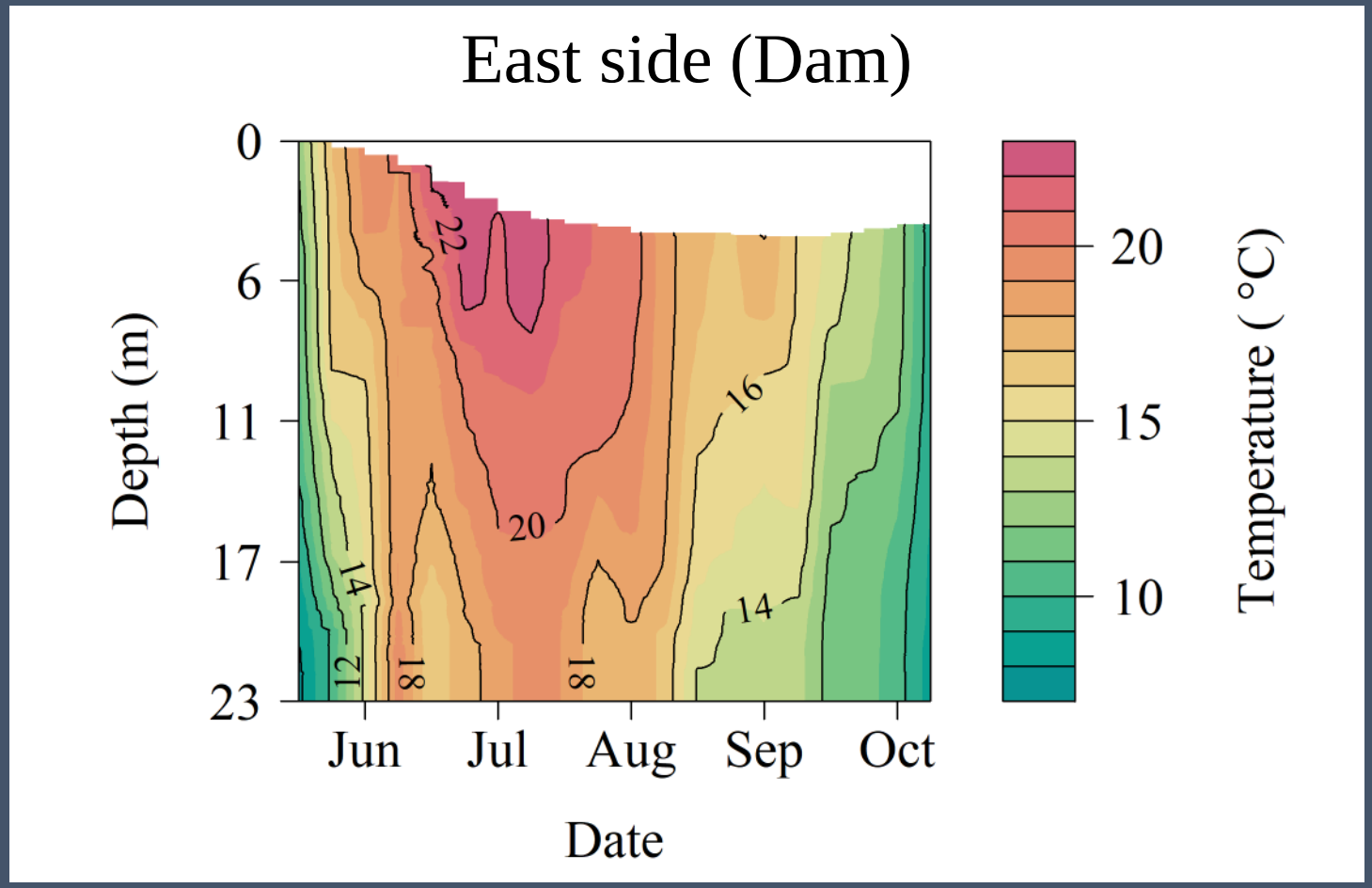


East side: deep, narrow, dimictic



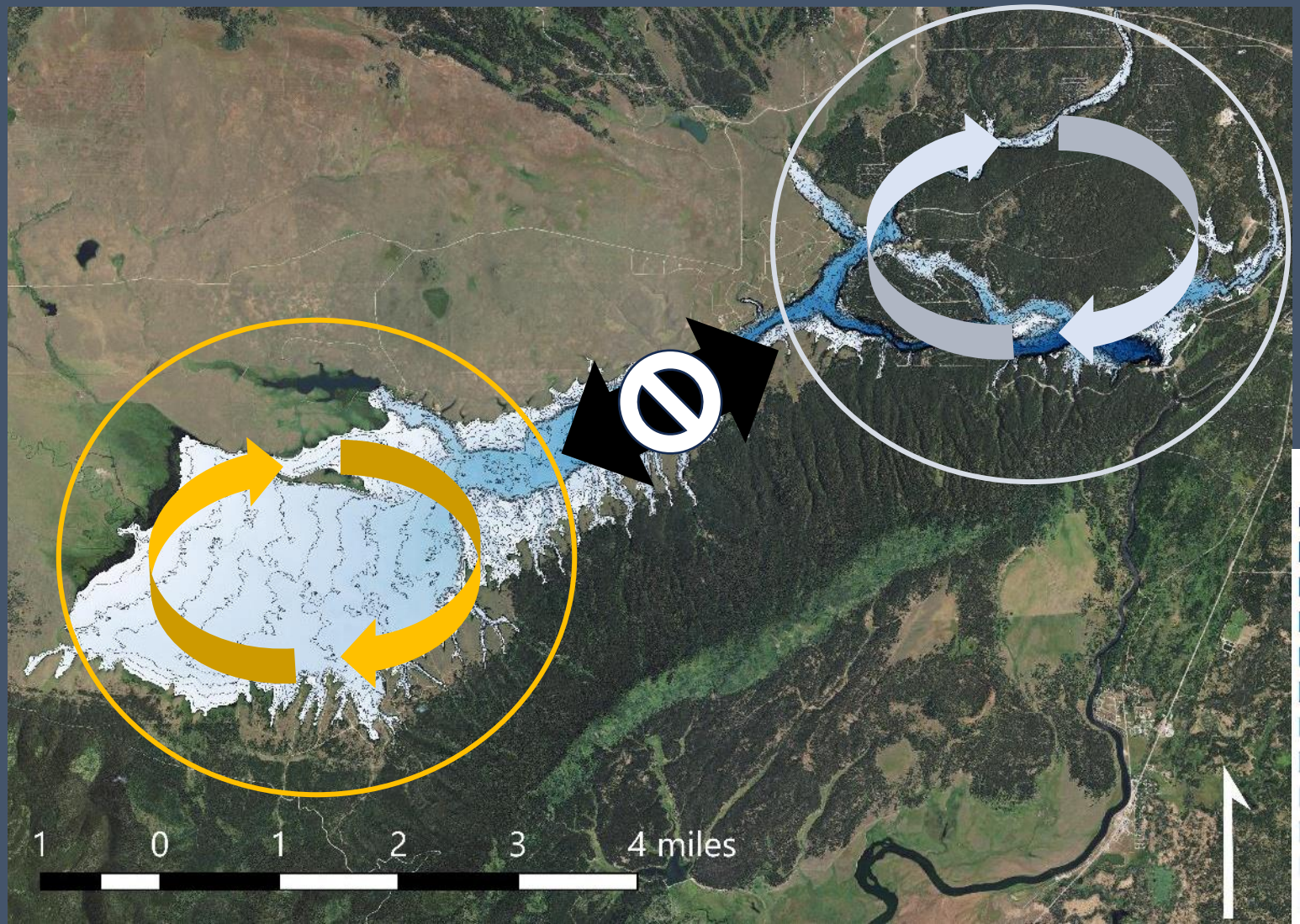
Predicting sediment spikes

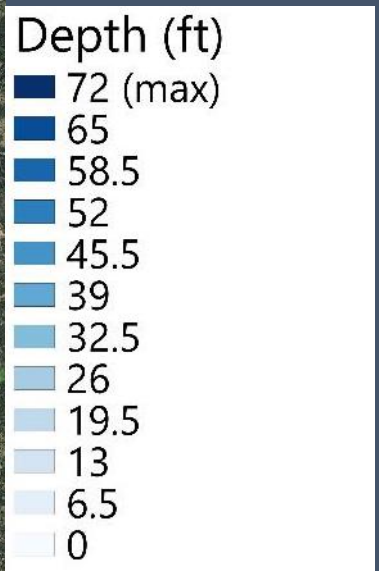
- Reservoir data from 2021



Understanding Island Park Reservoir

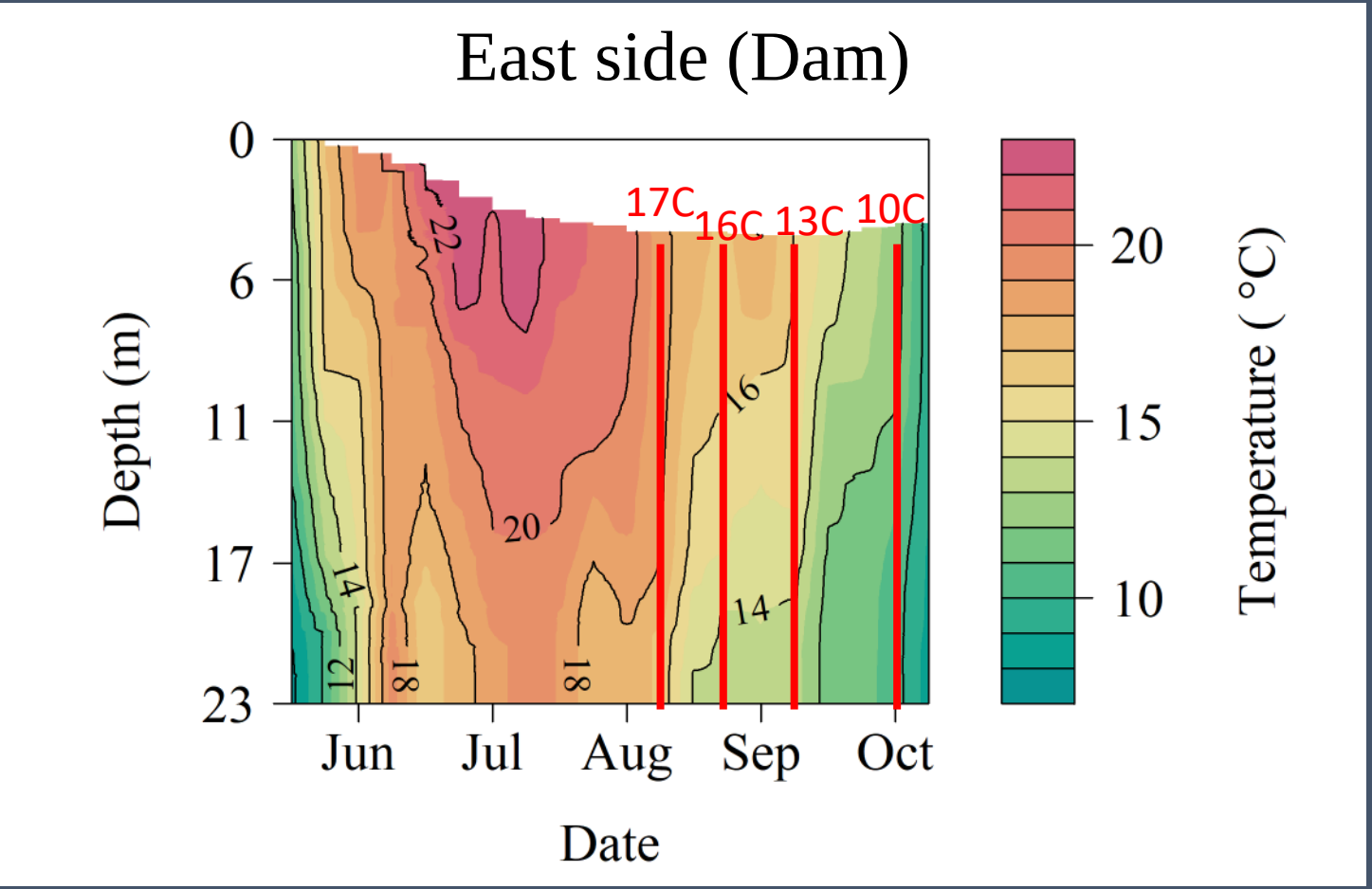
- Island Park Reservoir adds a wrinkle: two lakes in one





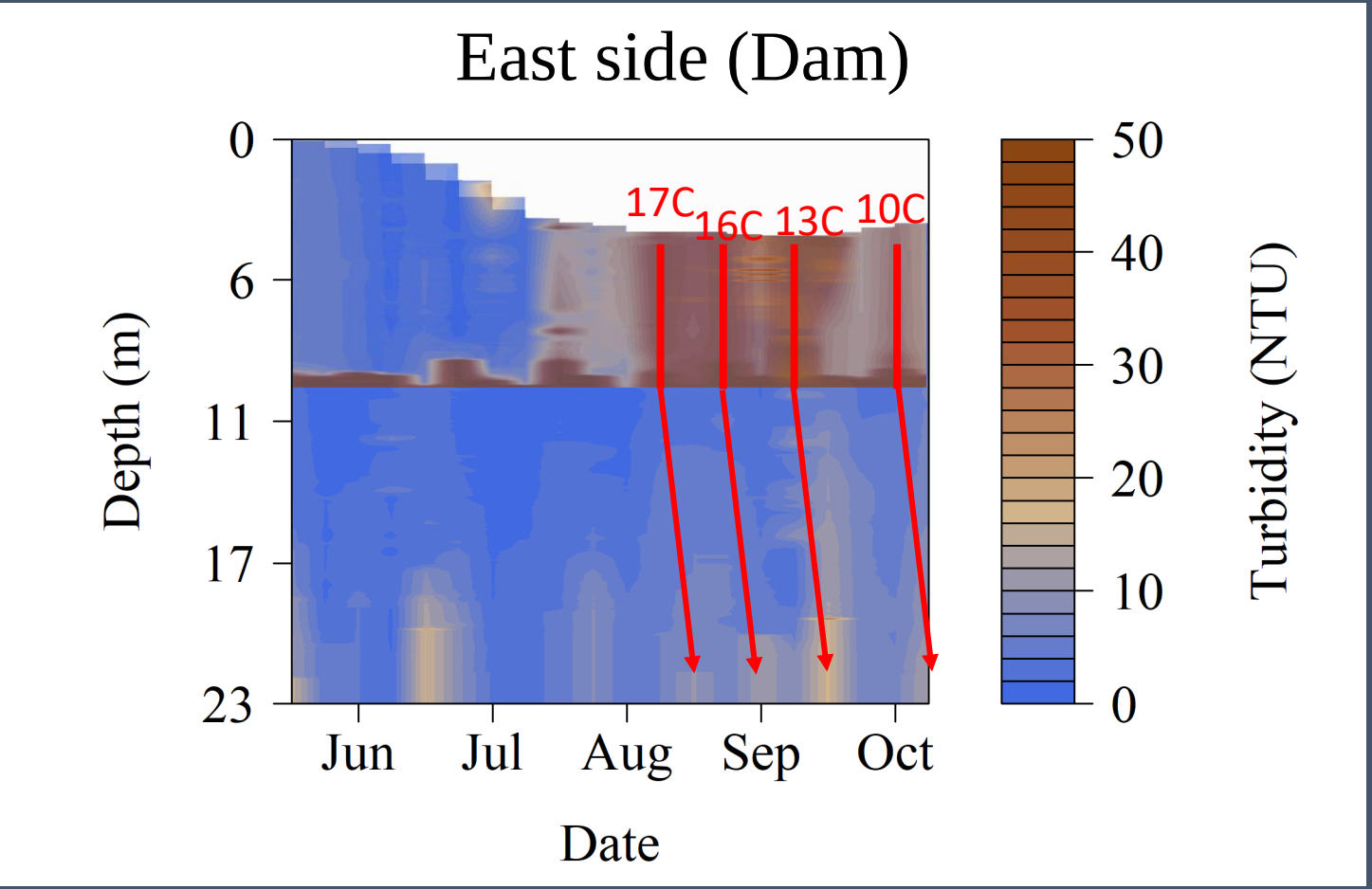
Temperature/density differences (usually) prevent mixing

Understanding Island Park Reservoir



- What happens when densities equalize?

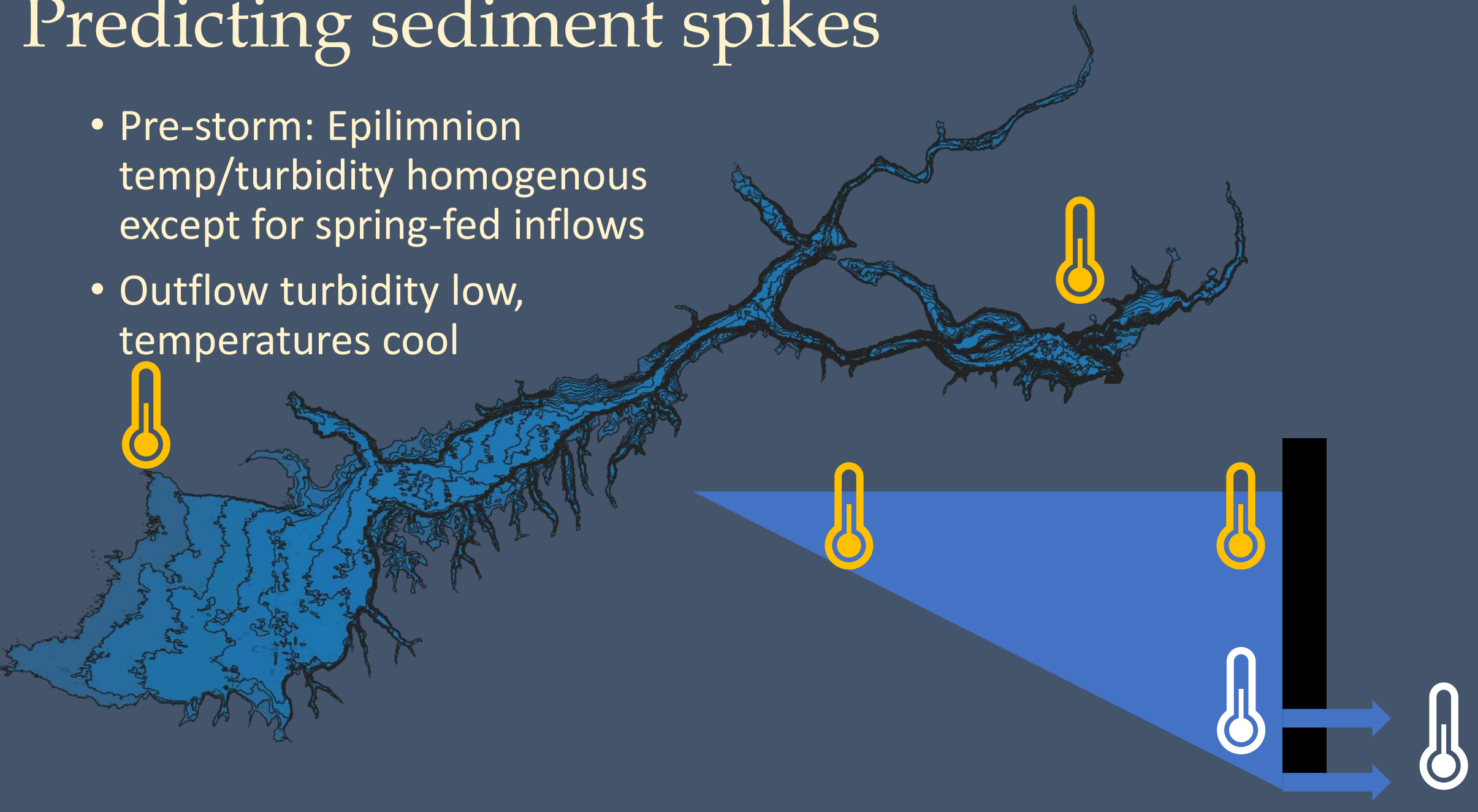
Predicting sediment spikes



- Sediment plumes that move along bottom to dam
- More intense with bigger temperature difference between E and W sides
- Arrival at dam delayed a few days

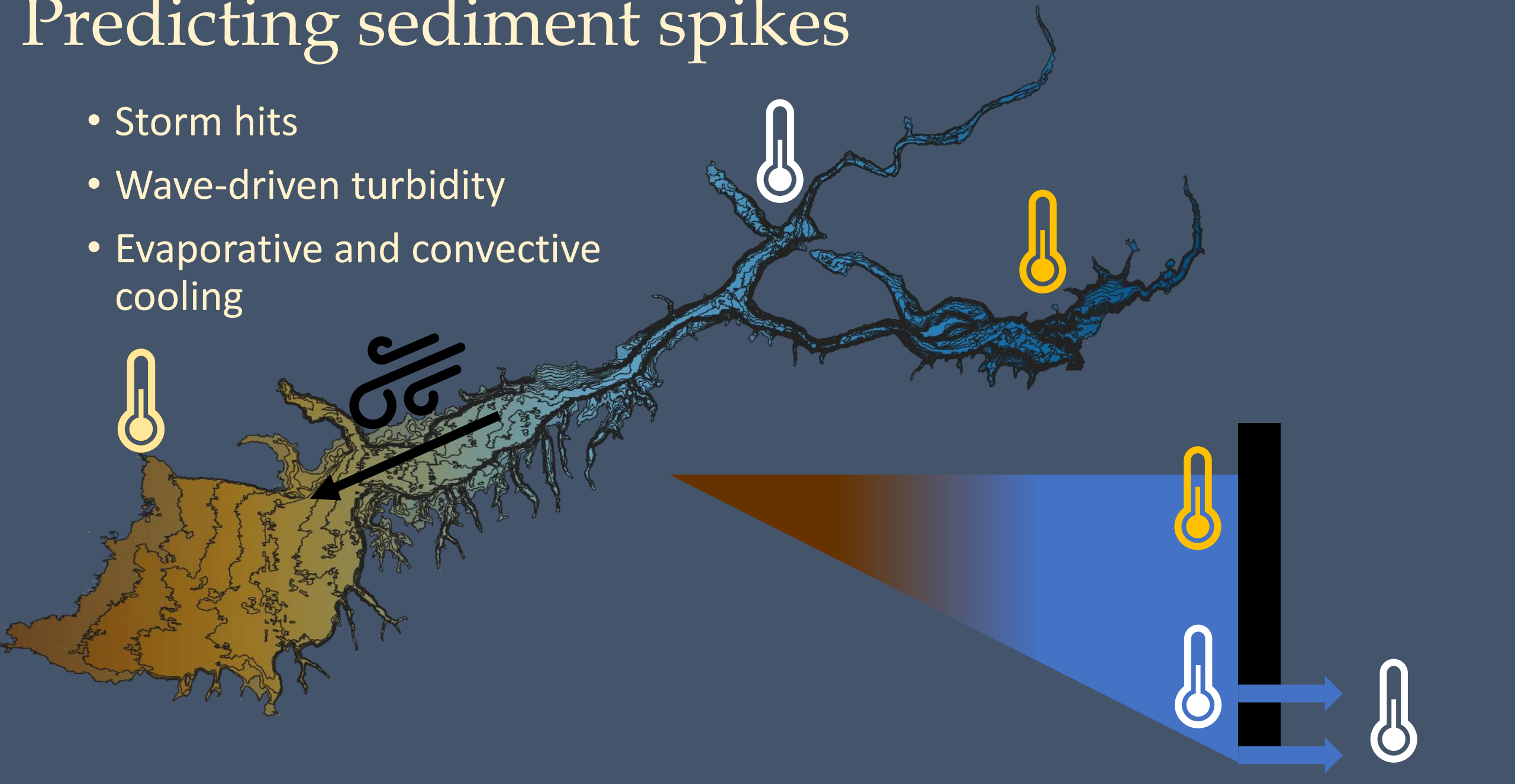
Predicting sediment spikes

- Pre-storm: Epilimnion temp/turbidity homogenous except for spring-fed inflows
- Outflow turbidity low, temperatures cool



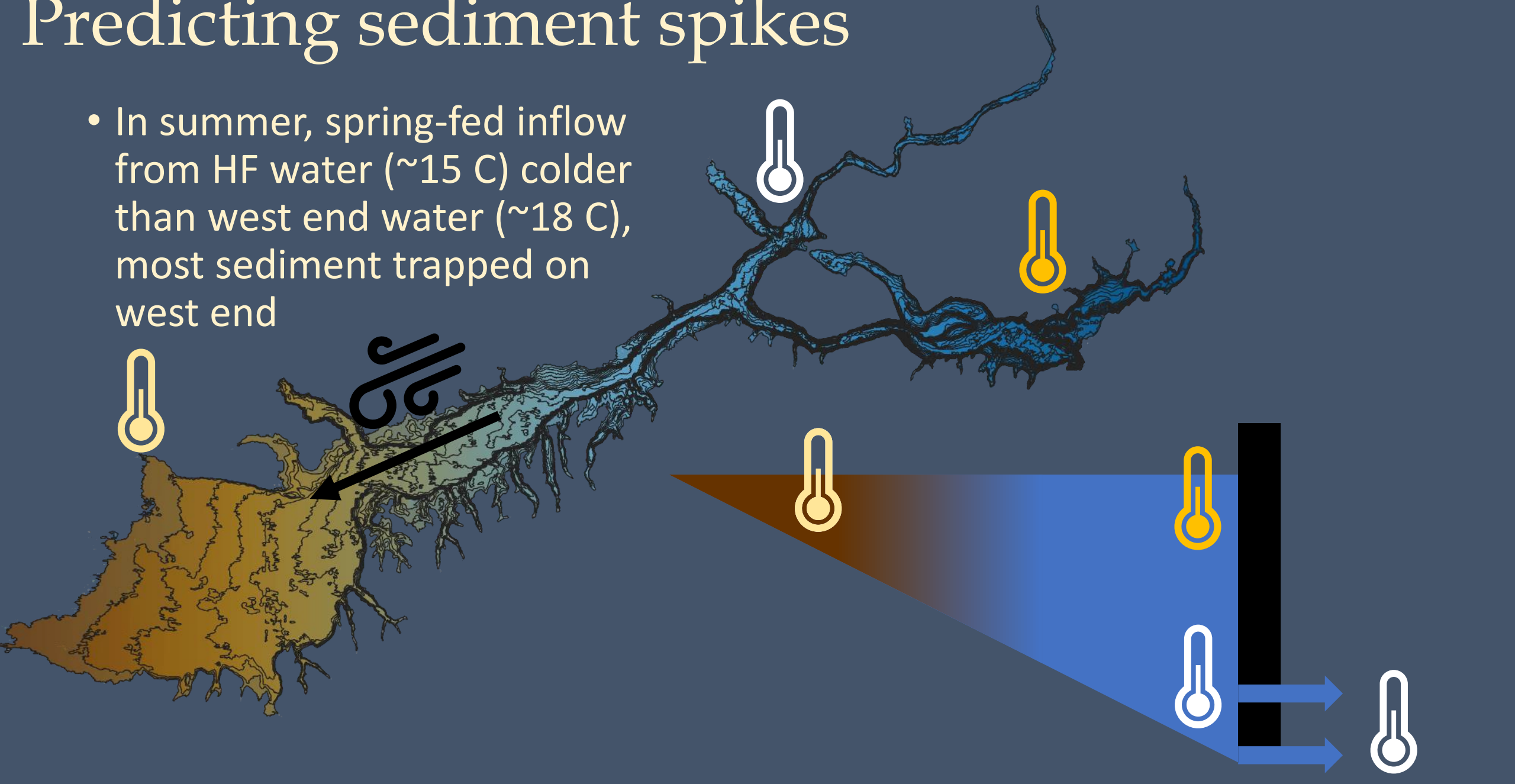
Predicting sediment spikes

- Storm hits
- Wave-driven turbidity
- Evaporative and convective cooling



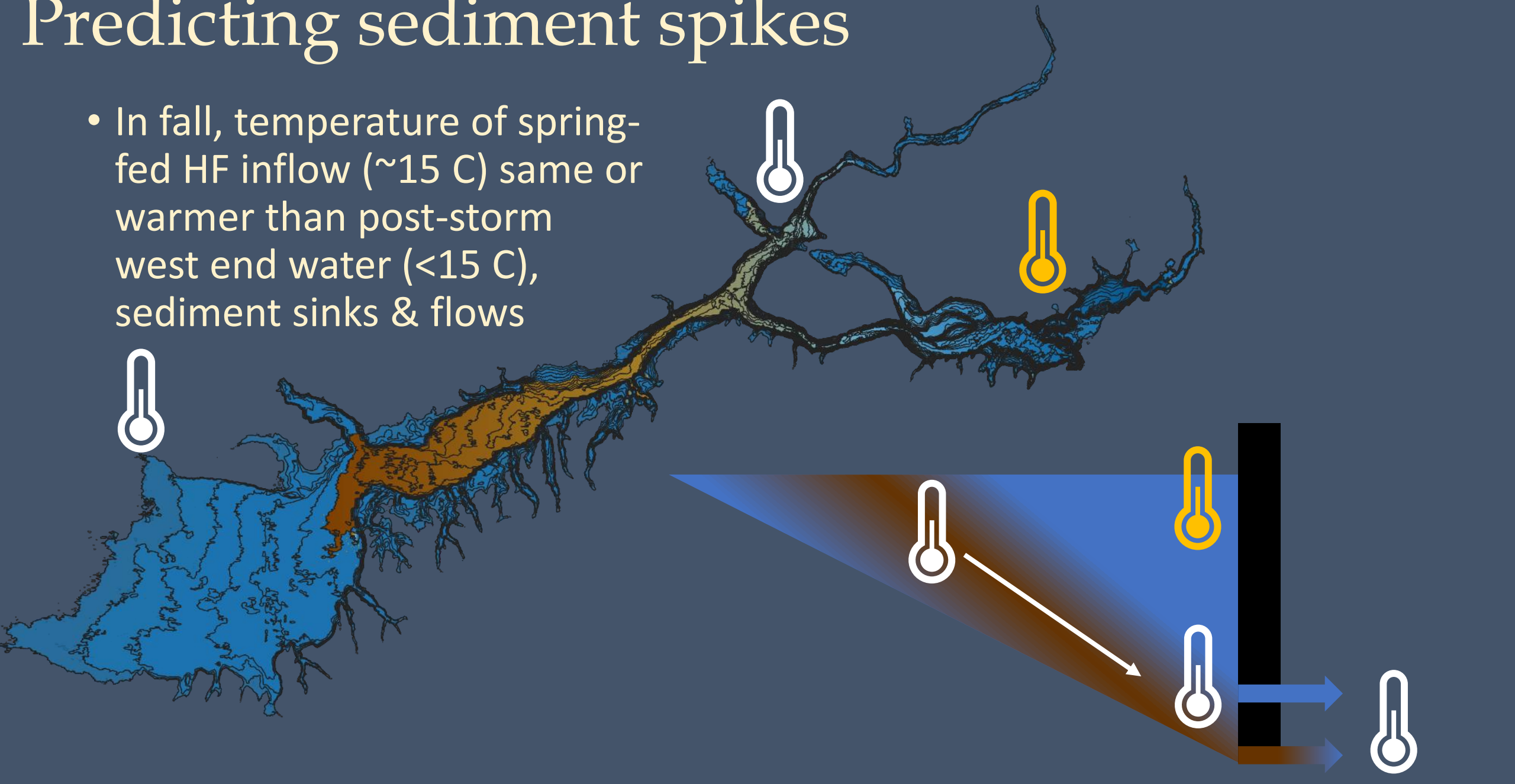
Predicting sediment spikes

- In summer, spring-fed inflow from HF water (~15 C) colder than west end water (~18 C), most sediment trapped on west end



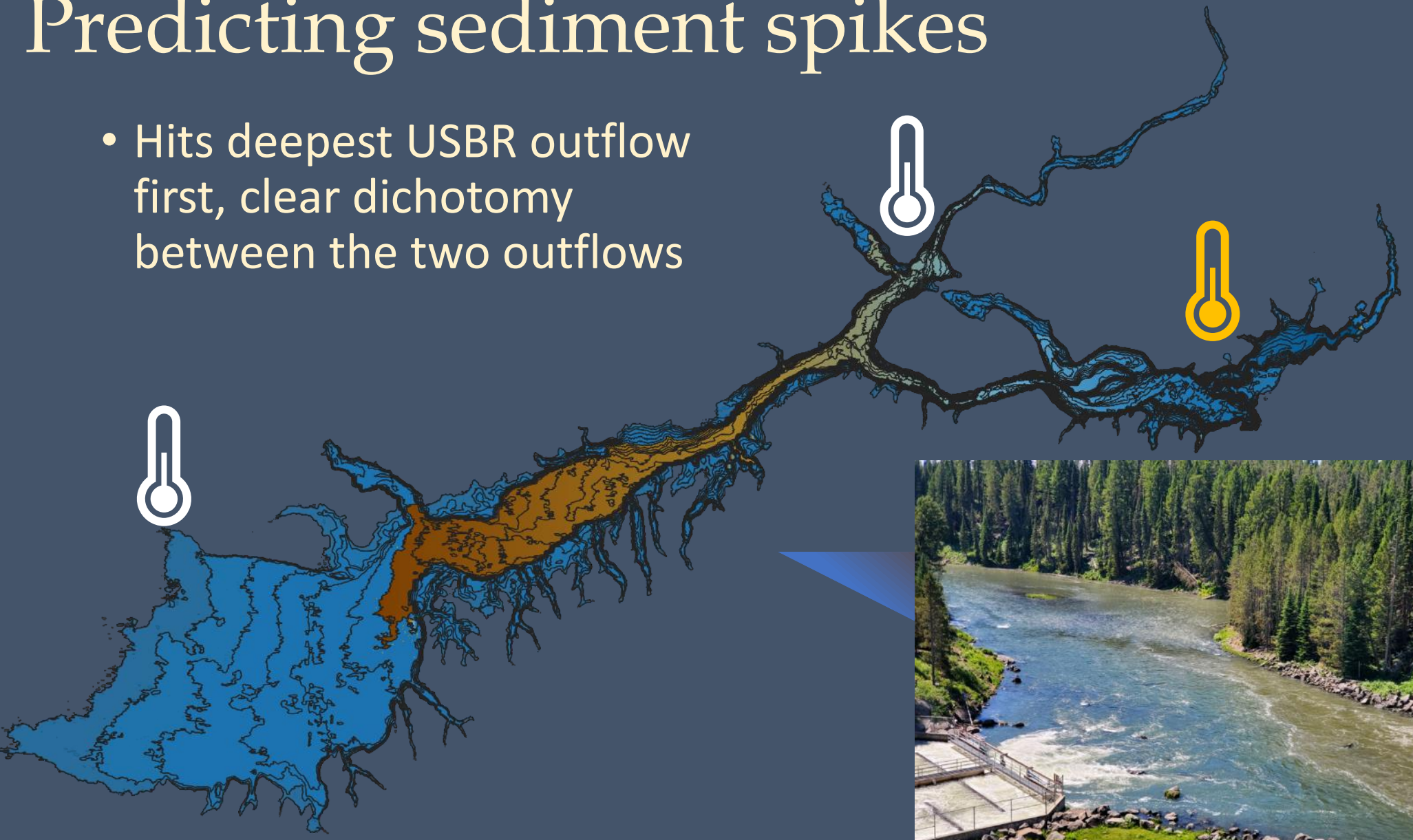
Predicting sediment spikes

- In fall, temperature of spring-fed HF inflow (~15 C) same or warmer than post-storm west end water (<15 C), sediment sinks & flows



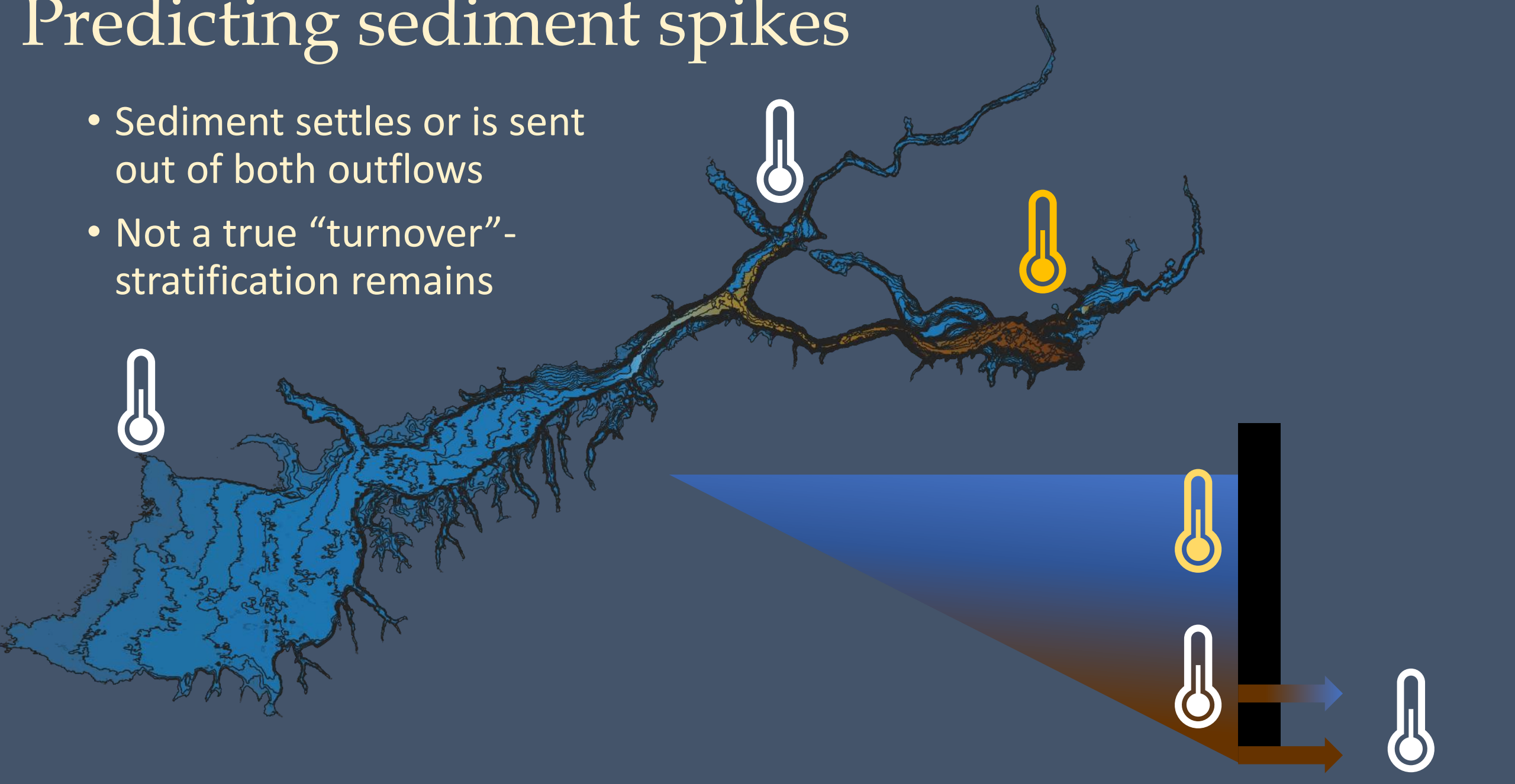
Predicting sediment spikes

- Hits deepest USBR outflow first, clear dichotomy between the two outflows



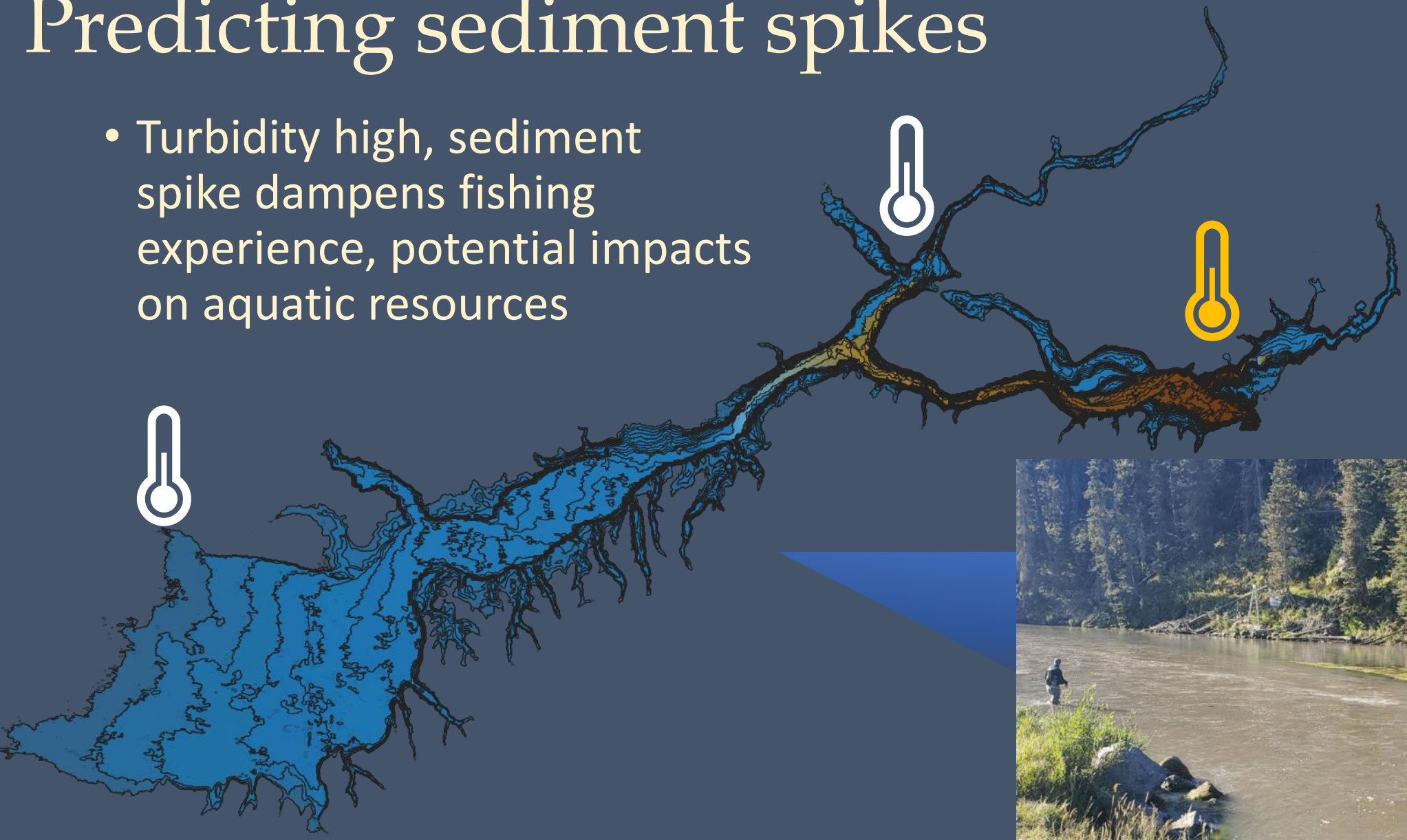
Predicting sediment spikes

- Sediment settles or is sent out of both outflows
- Not a true “turnover”- stratification remains

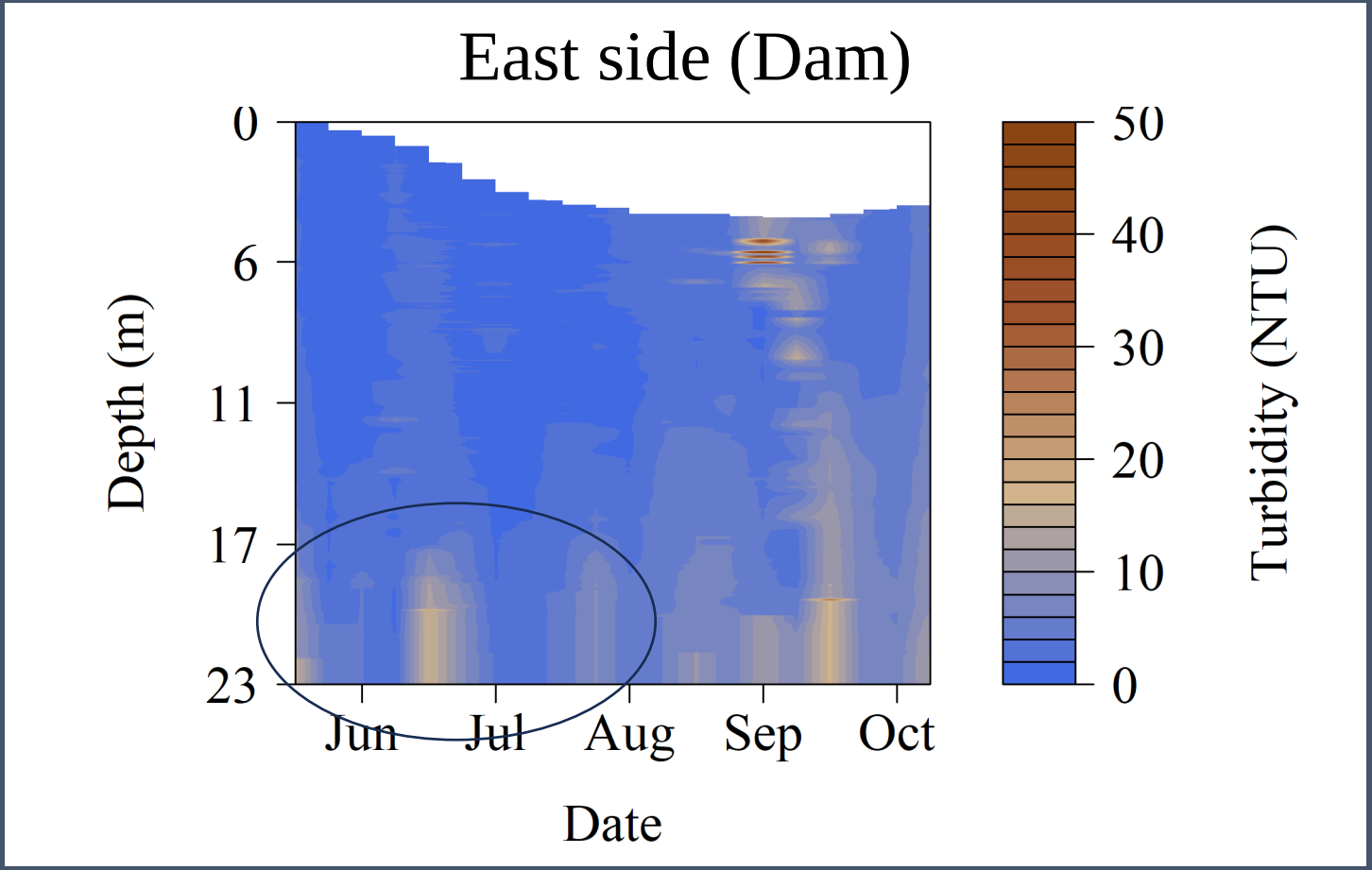


Predicting sediment spikes

- Turbidity high, sediment spike dampens fishing experience, potential impacts on aquatic resources

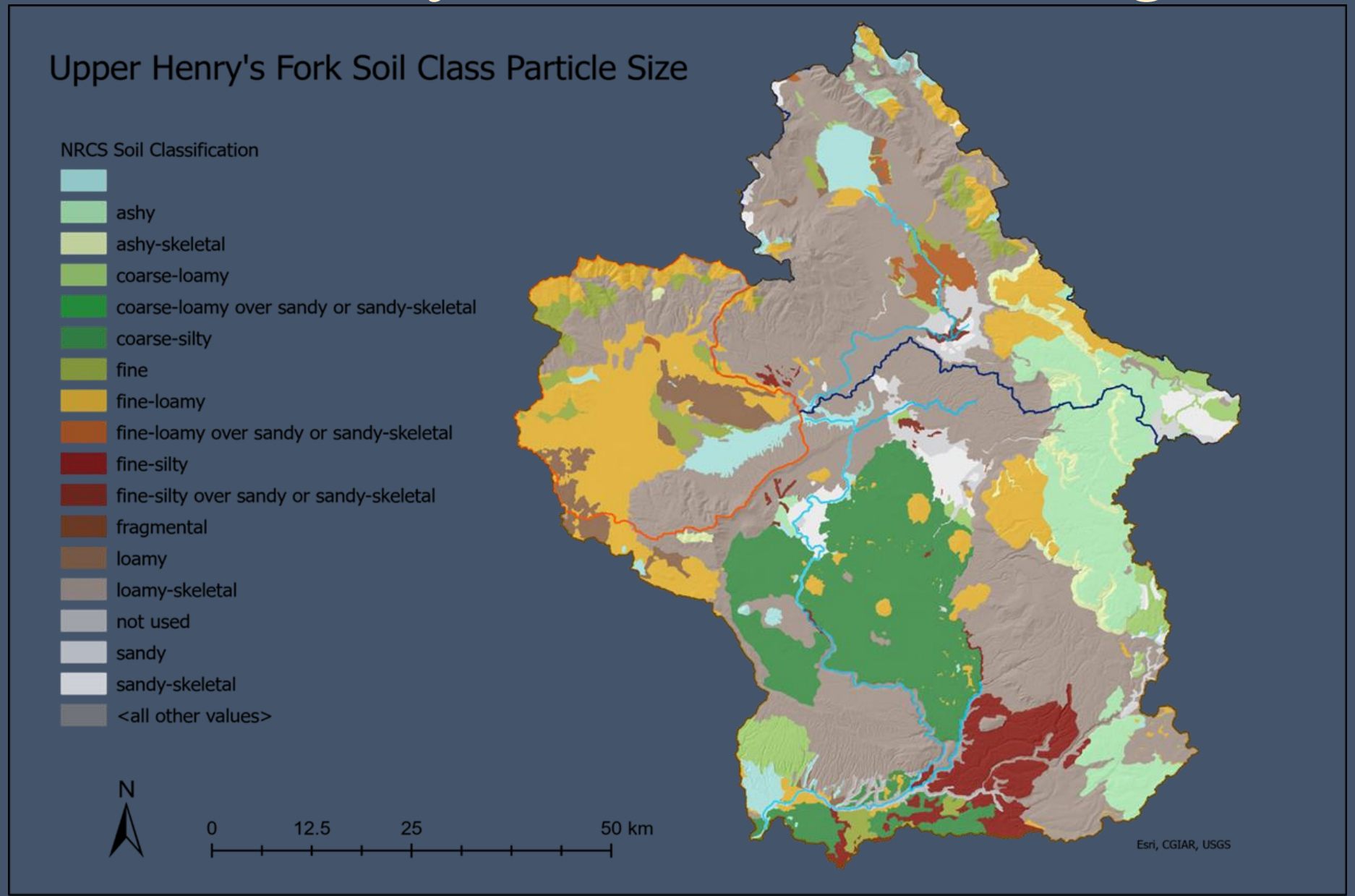


Predicting turbidity spikes



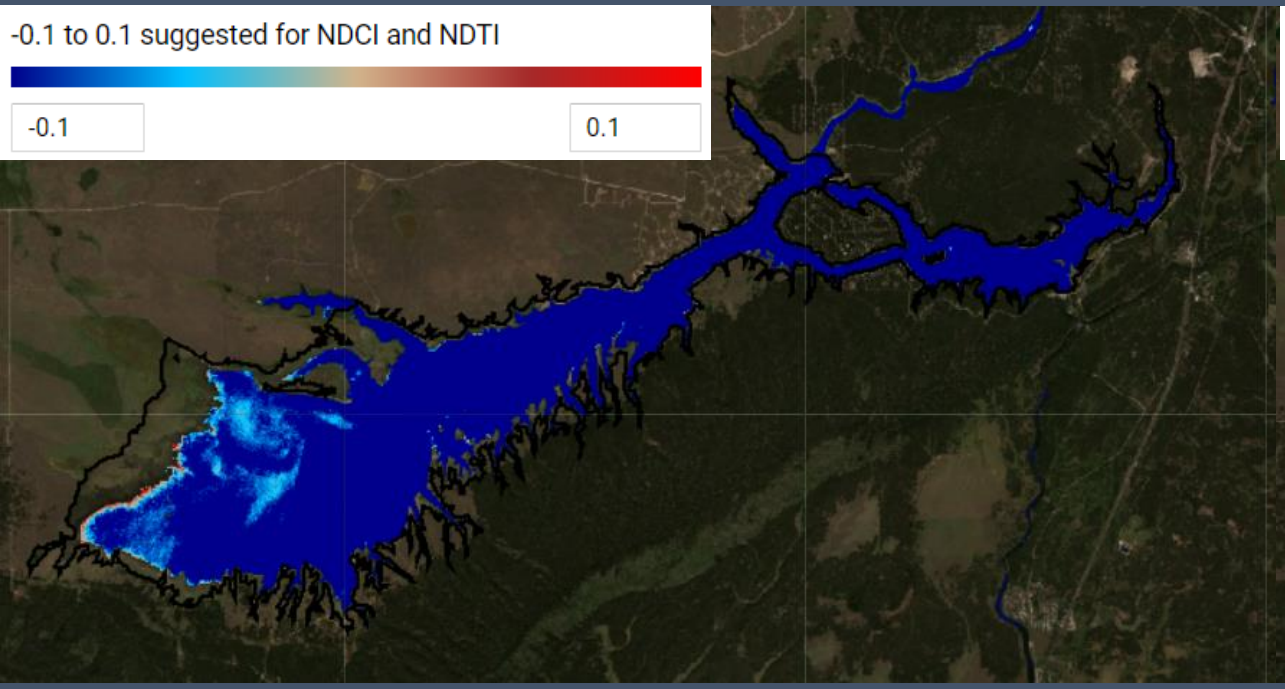
- Weather alone does not always explain elevated turbidity

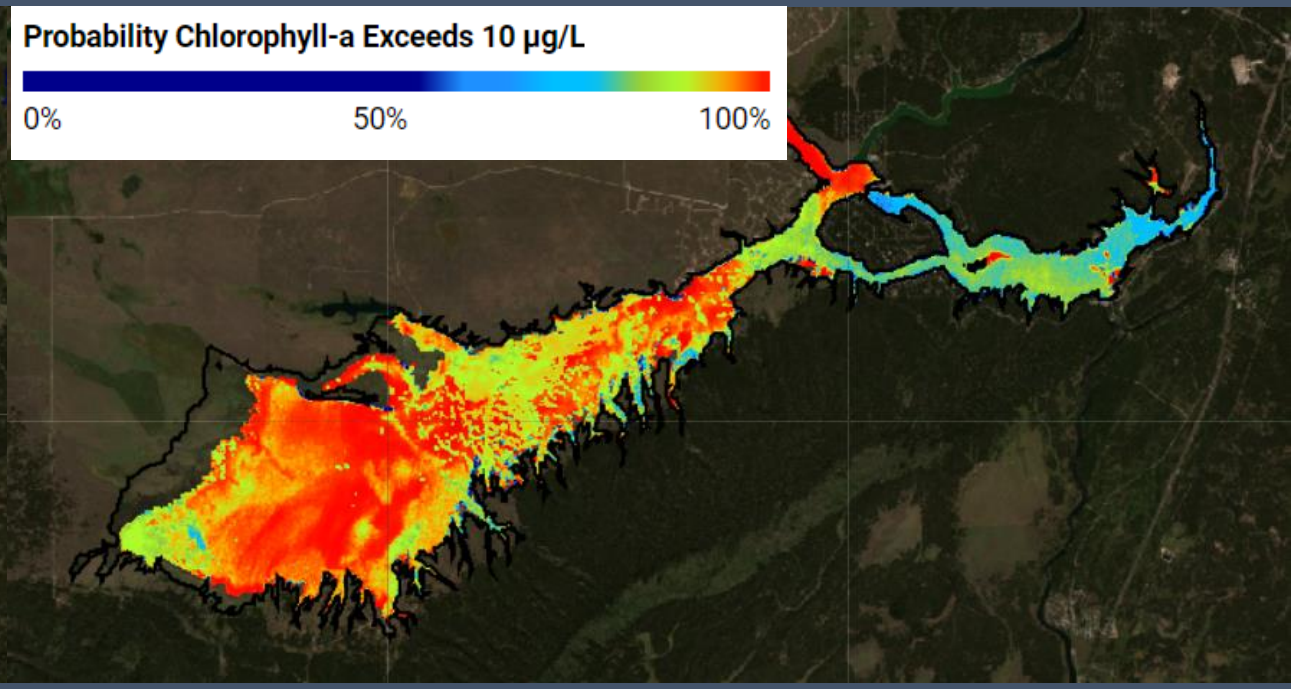
Where is turbidity/sediment coming from?



Where is turbidity/sediment coming from?

- West side of IPR inundated 10-20 feet (!) of fine or unconsolidated sediments
- High productivity and algal blooms





Takeaways: How to improve water quality in IPR & downstream

1. Stop density currents before they start: reduce turbidity on the west end of Island Park Reservoir
2. Prevent the passage of density currents through Island Park Dam

- “D.I.R.T.T.” plan, or “Developing Infrastructure to Reduce Temperature and Turbidity”.

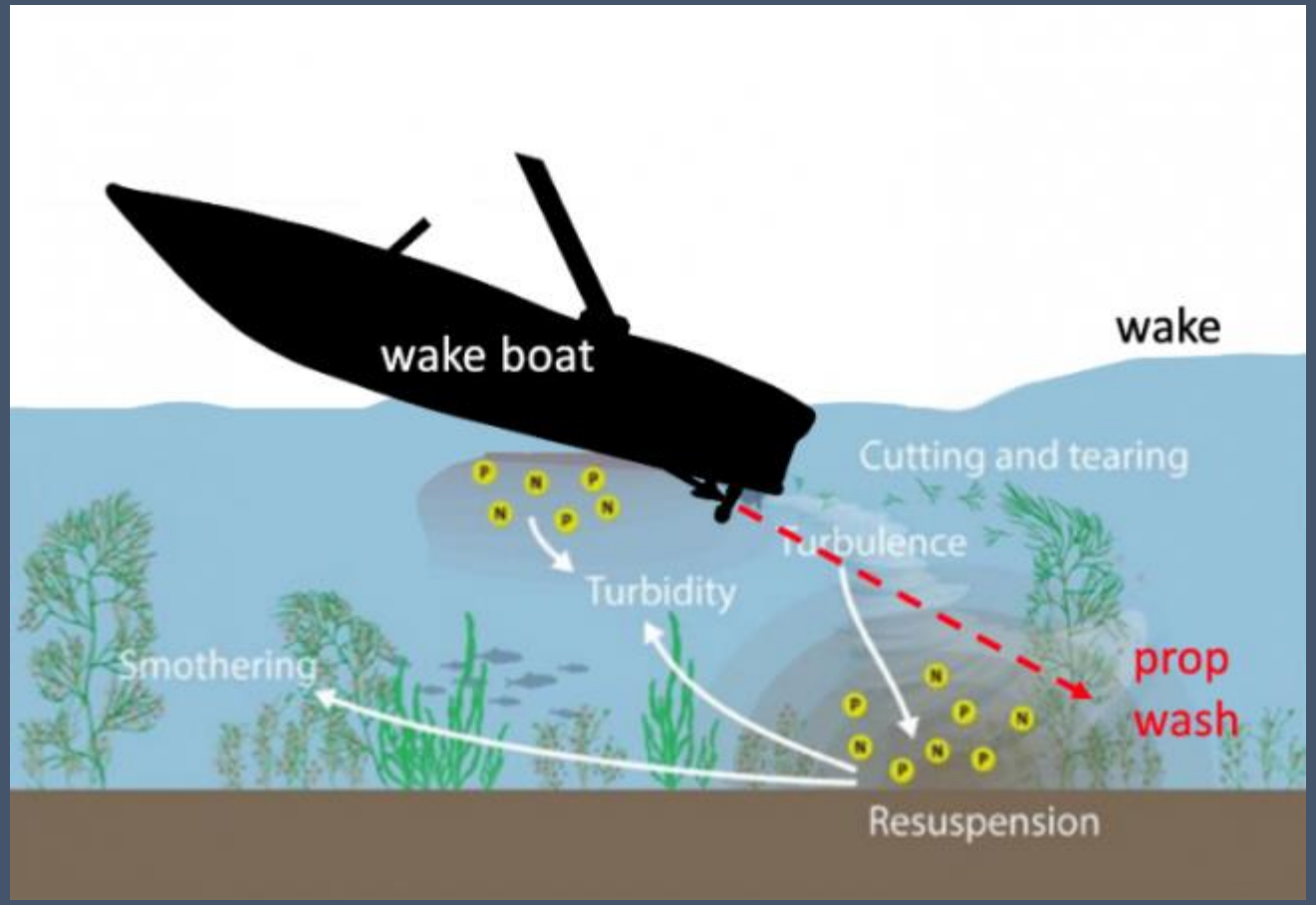
Takeaways: How to improve water quality in IPR & downstream

1. Stop density currents before they start: reduce turbidity on the west end of Island Park Reservoir
   - Sediment & shoreline stabilization
   - Reduce eutrophication & algal blooms
2. Prevent the passage of density currents through Island Park Dam
   - Dam-side physical infrastructure like variable-level outflow gates

- “D.I.R.T.T.” plan, or “Developing Infrastructure to Reduce Temperature and Turbidity”.

Wake surfing effect on turbidity

- Wake surfing boats designed to create large wakes for the purpose of wake surfing.
- Ballast tanks and mechanical systems designed to enhance the size of the boat's wake
- Both wakes and prop wash cause clear ecological damage (Mosisch & Arthington 1998; Daeger et al. 2022)



Wake surfing effect on turbidity: direct

- Direct: suspension of bottom sediments and shoreline erosion
- Power boating industry research & state of Indiana: within 200 feet of shore or over water less than 10 feet deep (Fay et al. 2022; Daeger et al. 2022)
- State of Michigan & Laval University in Quebec: 500 feet of shore or over water less than 15 feet (Raymond and Galvez 2015; Francis et al. 2022)
- Research in Vermont, Wisconsin, and Maine extend the depth of potential impact to 20 feet (Griggs 2021; Johnson 2022).
- Payette Lake in Idaho, sediment resuspension was observed under wakesurfing boats in depths to 33 feet (Ray 2020).

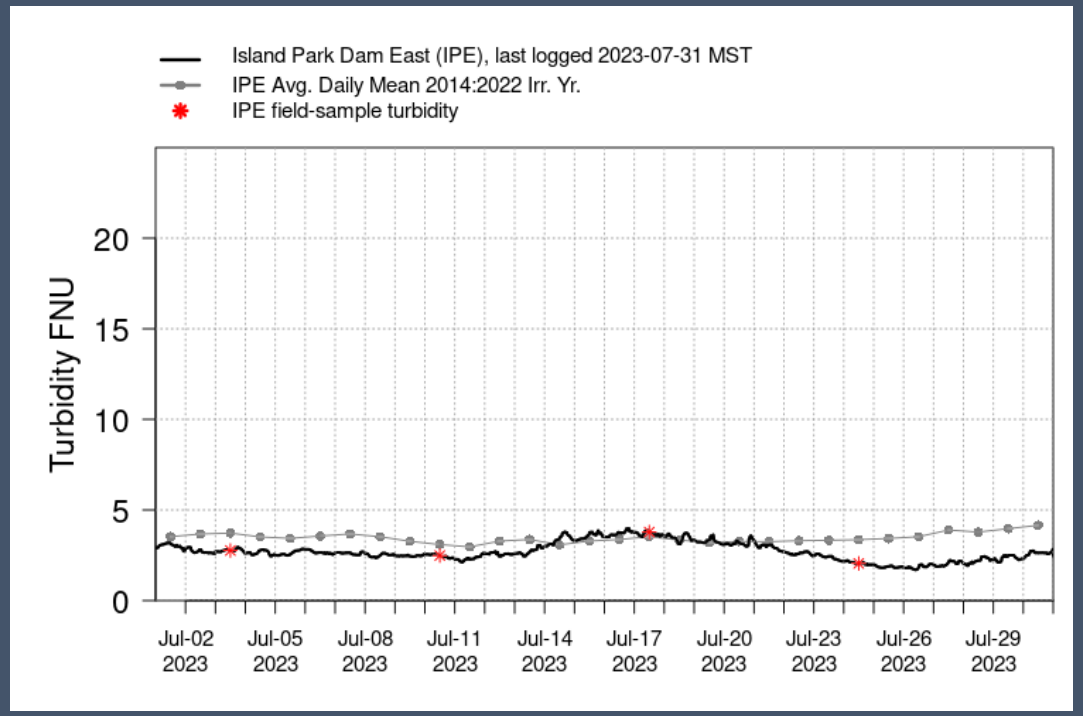
Wake surfing effect on turbidity: direct

- Images from July 4th 2023
- Hundreds of boats
- Clear turbidity plume on west end

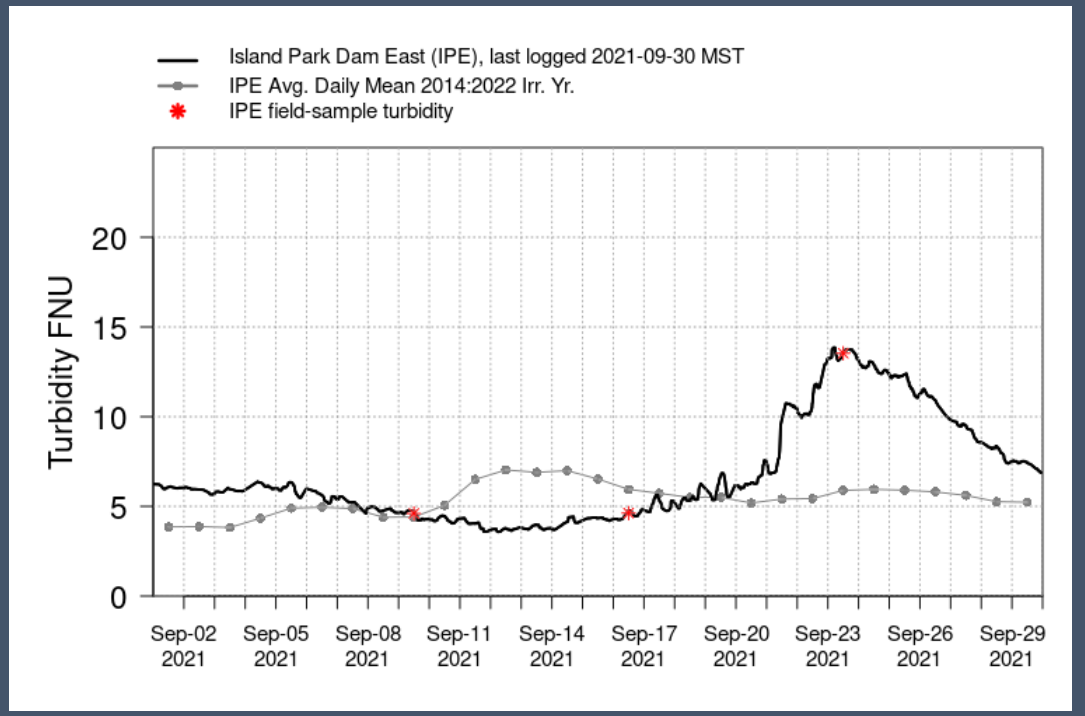
Wake surfing effect on turbidity: direct

- Minor turbidity increase downstream ~1 week after July 4th
  - Weak; not seen every year or after every big weekend
  - Contrast magnitude/duration with weather-driven density events

July 2023



September 2021

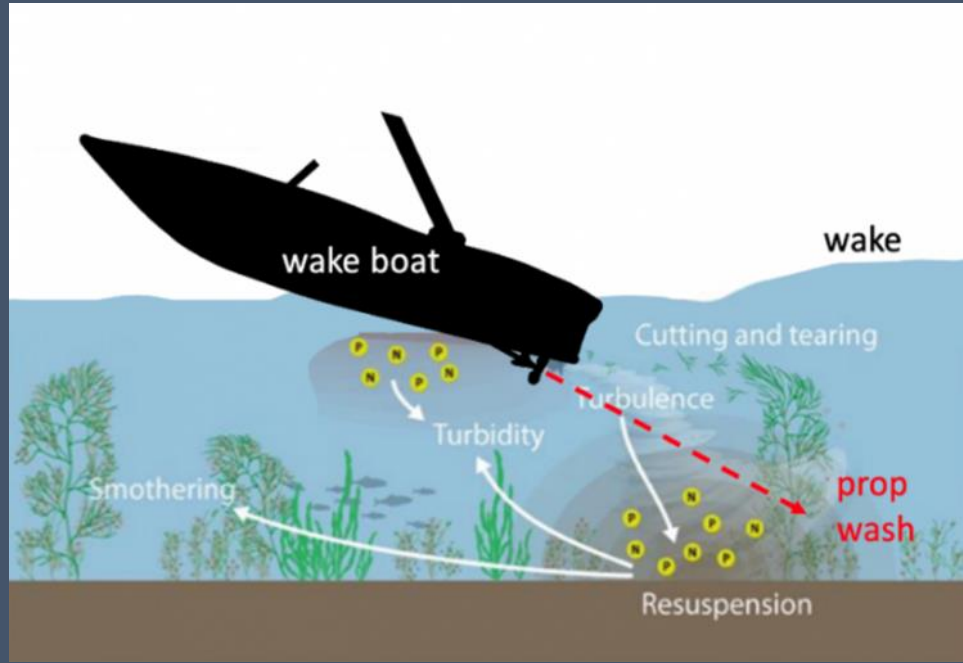


Wakesurfing effect on turbidity: indirect

- Suppression of submerged macrophyte growth (Madsen et al. 2001; Daeger et al. 2022)
  - Reduces nutrient absorption and promotes algal blooms
  - Reduces sediment stabilization through roots
  - Reduces sediment settling
- Suspension of phosphorus and nitrogen

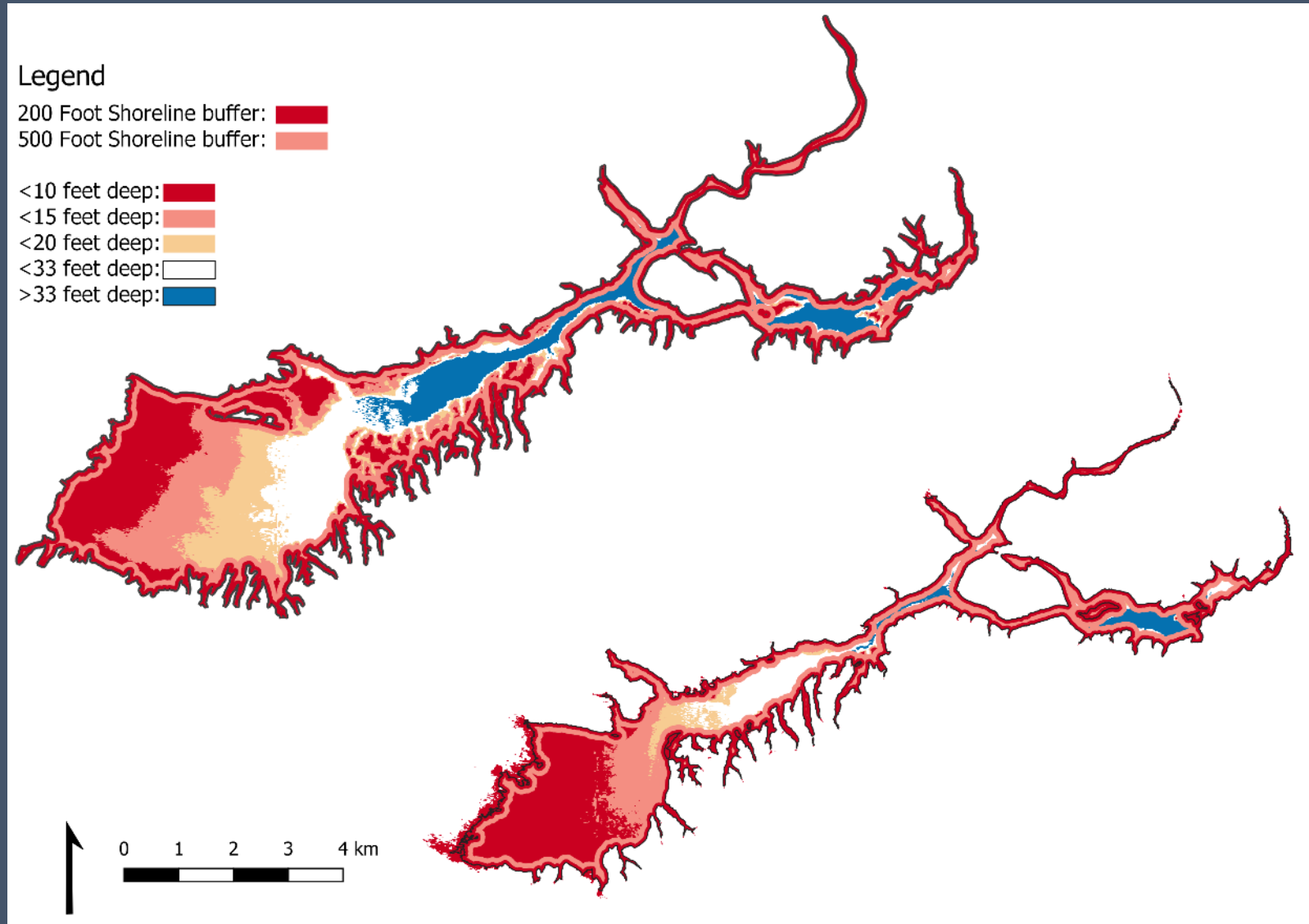
(Madsen et al. 2001; Daeger et al. 2022)

  - Increases likelihood of algal blooms
- Invasive species
  - Ballast tanks



What if we adopt recommendations from other states?

- At full pool: approximately 7.039 km 2 or 23% of total surface area wakesurf-able
- At average end-of-season pool (61,000 acre-feet, 11.6 feet low): 1.822 km 2 or 10% of total surface area wakesurf-able



What if we adopt recommendations from other states?

- Pros:
  - Reduce possibility that wakesurfing degrades of valuable downstream resources
  - May help prevent future issues such as invasive species
  - Can we walk and chew gum? May help the effectiveness of other conservation actions: aeration, chelation, water level management
- Cons:
  - Little evidence of direct effects yet
  - May shift wakesurfing to areas more prone to HABs and ecological damage
  - May distract from more effective conservation actions: aeration, chelation, water level management

Takeaways

- **Stop density currents before they start** to improve water quality in Island Park Reservoir and downstream
- **Secondary driver at most,** but evidence suggest some wakesurfing impact on IPR water quality
- **Less than half of Island Park Reservoir falls within recommended limits** for low-impact wakesurfing under ideal conditions
- **The HFF will continue monitoring and working with partners** to reduce sediment resuspension, eutrophication, and create infrastructure to prevent sediment movement through Island Park Dam.

Sources

Fay, E.M., Gunderson, A., Anderson, A. 2022. Numerical Study of the Impact of Wake Surfing on Inland Bodies of Water. Journal of Water Resource and Protection. 14:238-272

Francis, J., Nohner, J., Bauman, J., Gunderman, B. 2022. Wake boats: concerns and recommendations related to natural resource management in Michigan waters. Michigan Department of Natural Resources, Fisheries Report 37, Lansing.

Griggs, D. 2021. Consequences of slow speed power boat activities. For the Kezar Lake Watershed Association. <https://kezarwatershed.org/reports>

Johnson, D. 2022. Considerations in assessing shoreline and near shore impacts of wind-driven waves vs motorboat waves in Vermont. <bit.ly/3Q5BuhM>

Ray, A. 2020. Analyzing Threats to Water Quality from Motorized Recreation on Payette Lake, Idaho. Prepared for: Big Payette Lake Water Quality Council, Valley County Board of Commissioners, City of McCall. <bit.ly/3OiYk3Y>

Raymond, S., and Galvez, R. 2015. Impact of Lake Navigation - Sediment Suspension Study: Lake Masson and Sand Lake Cases. Laval University. 30 p.

Daeger, A., Bosch, N.S. and Johnson, R., 2022, July. IMPACTS ON NUTRIENT AND SEDIMENT RESUSPENSION BY VARIOUS WATERCRAFT ACROSS MULTIPLE SUBSTRATES, DEPTHS, AND OPERATING SPEEDS IN INDIANA'S LARGEST NATURAL LAKE. In Proceedings of the Indiana Academy of Science (Vol. 130, No. 2, pp. 112-122).

Madsen, J. D., Chambers, P. A., James, W.F., Koch, E. W. and Westlake, D. F. (2001). The interaction between water movement, sediment dynamics, and submersed macrophytes. Hydrobiologia 444, 71–84.

Mosisch, T.D. and Arthington, A.H. (1998), The impacts of power boating and water skiing on lakes and reservoirs. Lakes & Reservoirs: Research & Management, 3: 1-17. https://doi.org/10.1111/j.1440-1770.1998.tb00028.x

And many more! The literature on the effects of recreational boating on inland waterways is extensive