Big fish and more of them:

Salmonid habitat availability, quality, and use across multiple scales within the Upper Henry's Fork

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Henry's Fork Watershed Council Annual Conference, St. Anthony, ID

13 December 2022

1: Henry's Fork Foundation, 2: Utah State University Dept. of Watershed Sciences, 3: U.S. Geological Survey Cooperative Fish and Wildlife Research Unit, 4: Utah State University Ecology Center, 5: Royal Ontario Museum

THE VOICE OF THE RIVER

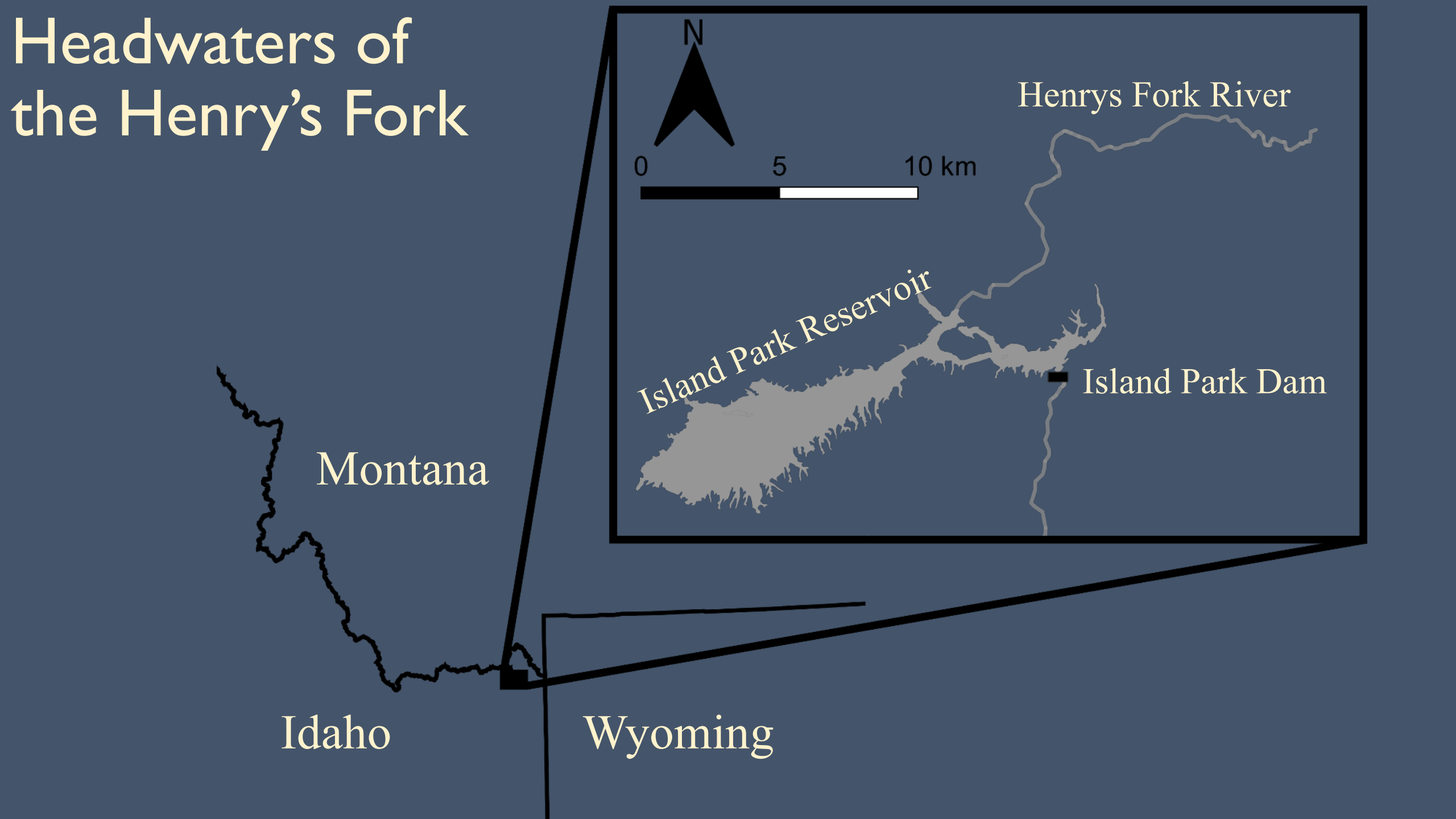
SINCE 1984

HENRY'S FORK FOUNDATION

Outline

- Background: Fish habitat in the Headwaters of the Henrys Fork
- What we did and what we found
- Conclusions, lessons learned, and conservation action

Headwaters of the Henry's Fork

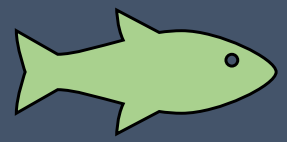


Sportfish community

Headwaters of the Henry's Fork

- Part of a…
  - World-famous fishery
  - $30 million economy

Fish Habitat in the Henry's Fork

- Fish habitat 
  - Refugia
  - Complimentary mosaic
  - Reproduction
  - Movement

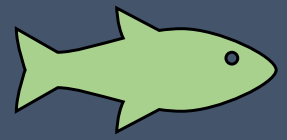
Reproduction

Refugia from harsh conditions(i.e. extreme temperature or flows) with unfavorable growth conditions

Mosaic of feeding habitats with favorable growth conditions

Adapted from Fausch et al. 2002

Fish Habitat in the Henry's Fork

- Fish habitat 
  - Refugia
  - Complimentary mosaic
  - Reproduction
  - Movement
- The "three-legged chair"
  - Changes to one affect all
  - Human pressures reduce resiliency

Reproduction

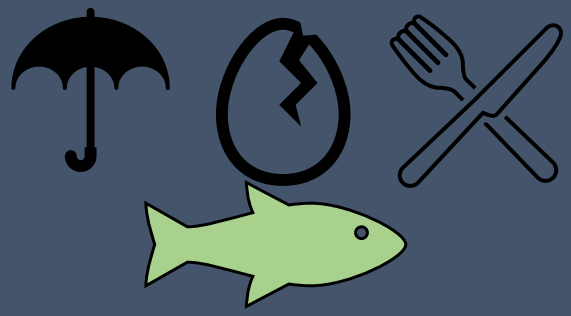
Refugia from harsh conditions(i.e. extreme temperature or flows) with unfavorable growth conditions

Mosaic of feeding habitats with favorable growth conditions

Adapted from Fausch et al. 2002

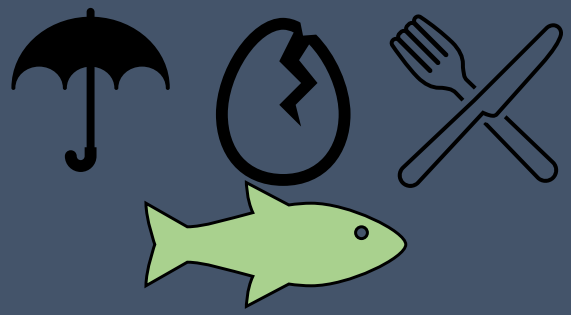
Issues in the Henry's Fork Headwaters:

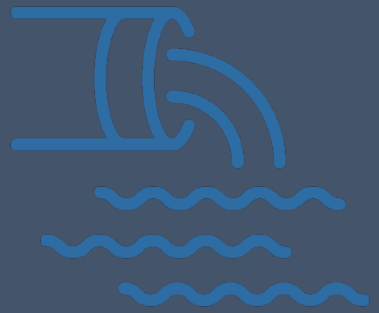
- Not the best fishery within the watershed

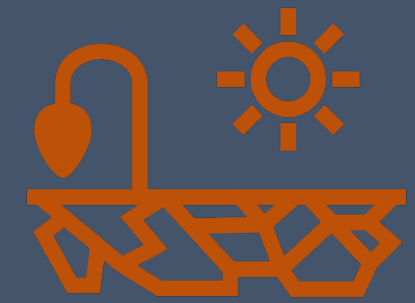


Issues in the Henry's Fork Headwaters:

- Not the best fishery within the watershed
- Threats
  - Nutrient pollution
  - Drought

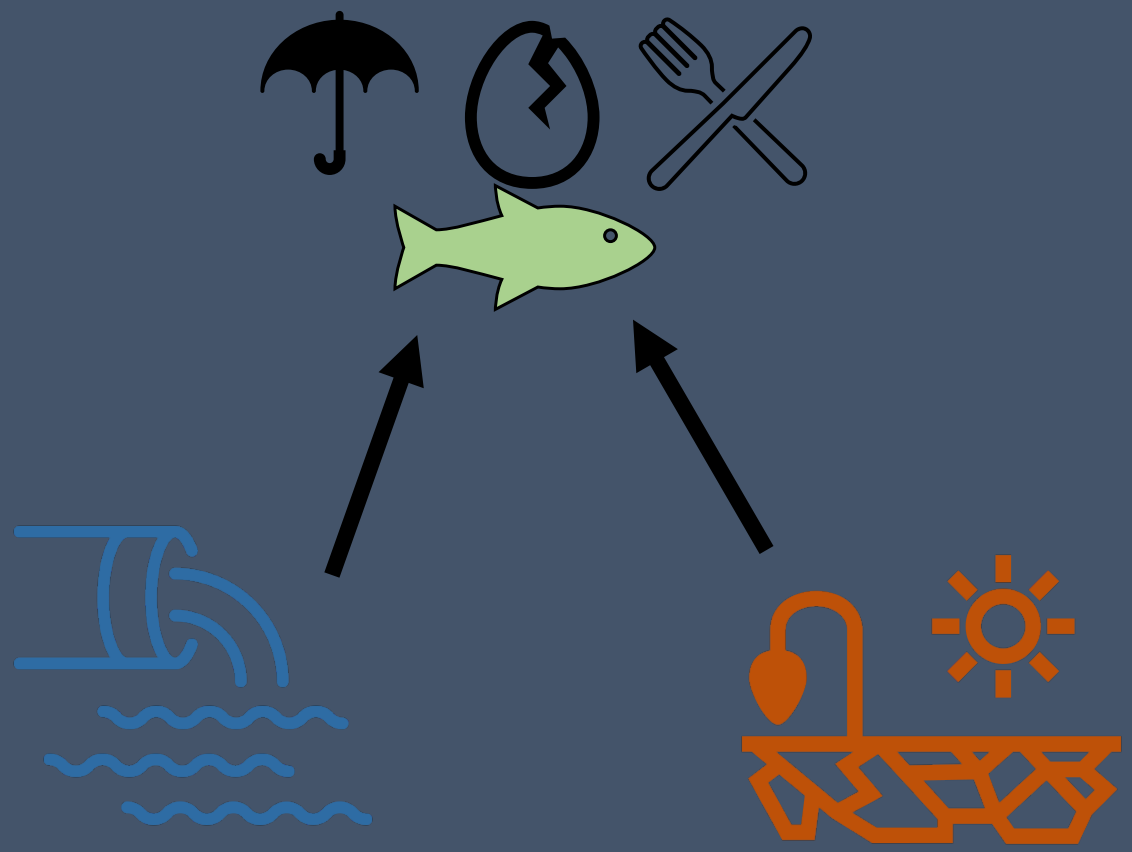






Study Questions:

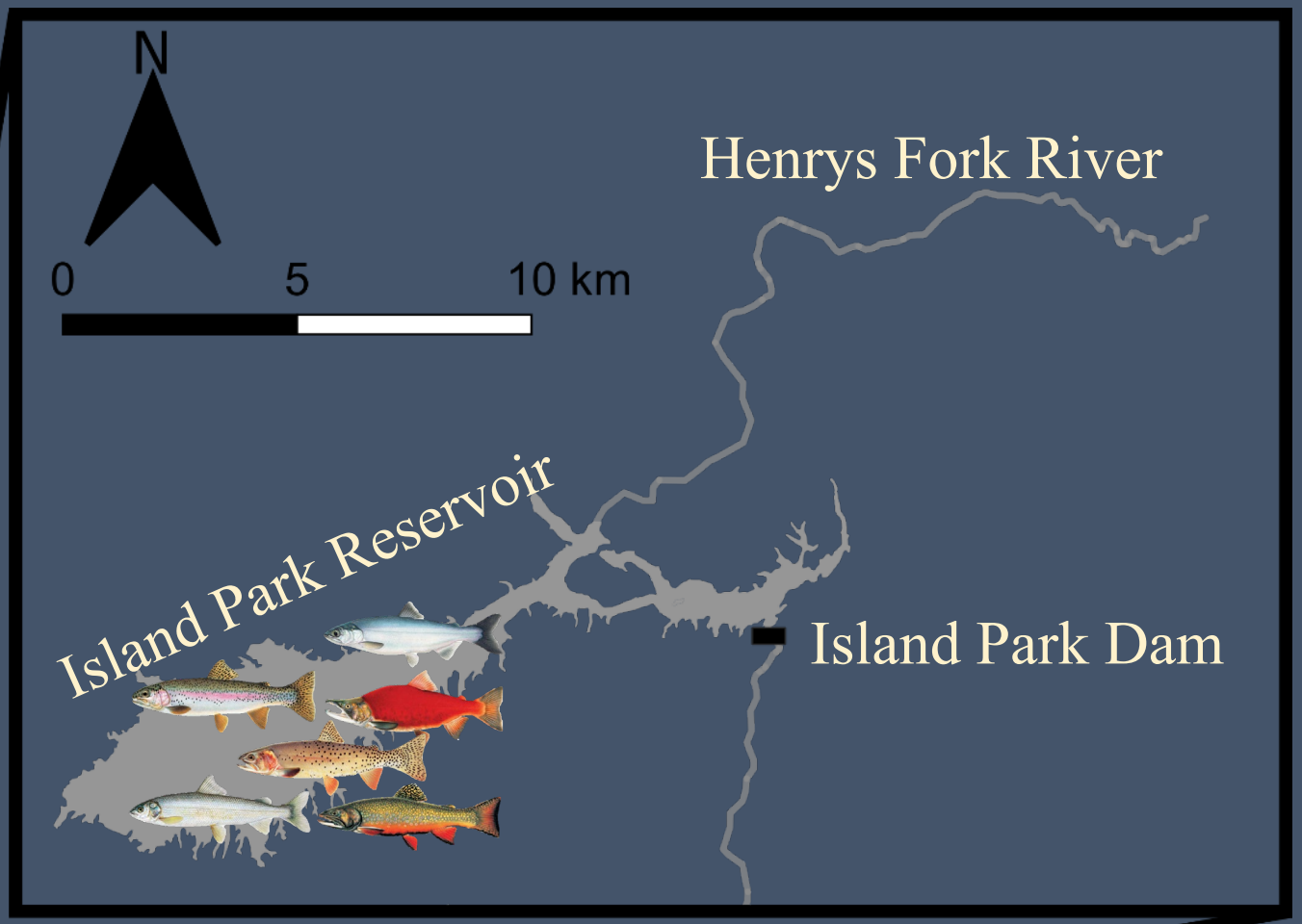
- What limits fish habitat and abundance in the Henry's Fork Headwaters?
- How might nutrient pollution and drought affect fish habitat and abundance in the Henry's Fork Headwaters?



Part 1:
The role of Island Park Reservoir as fish habitat

Headwaters of the Henry's Fork

- Island Park Reservoir
- Migratory fish



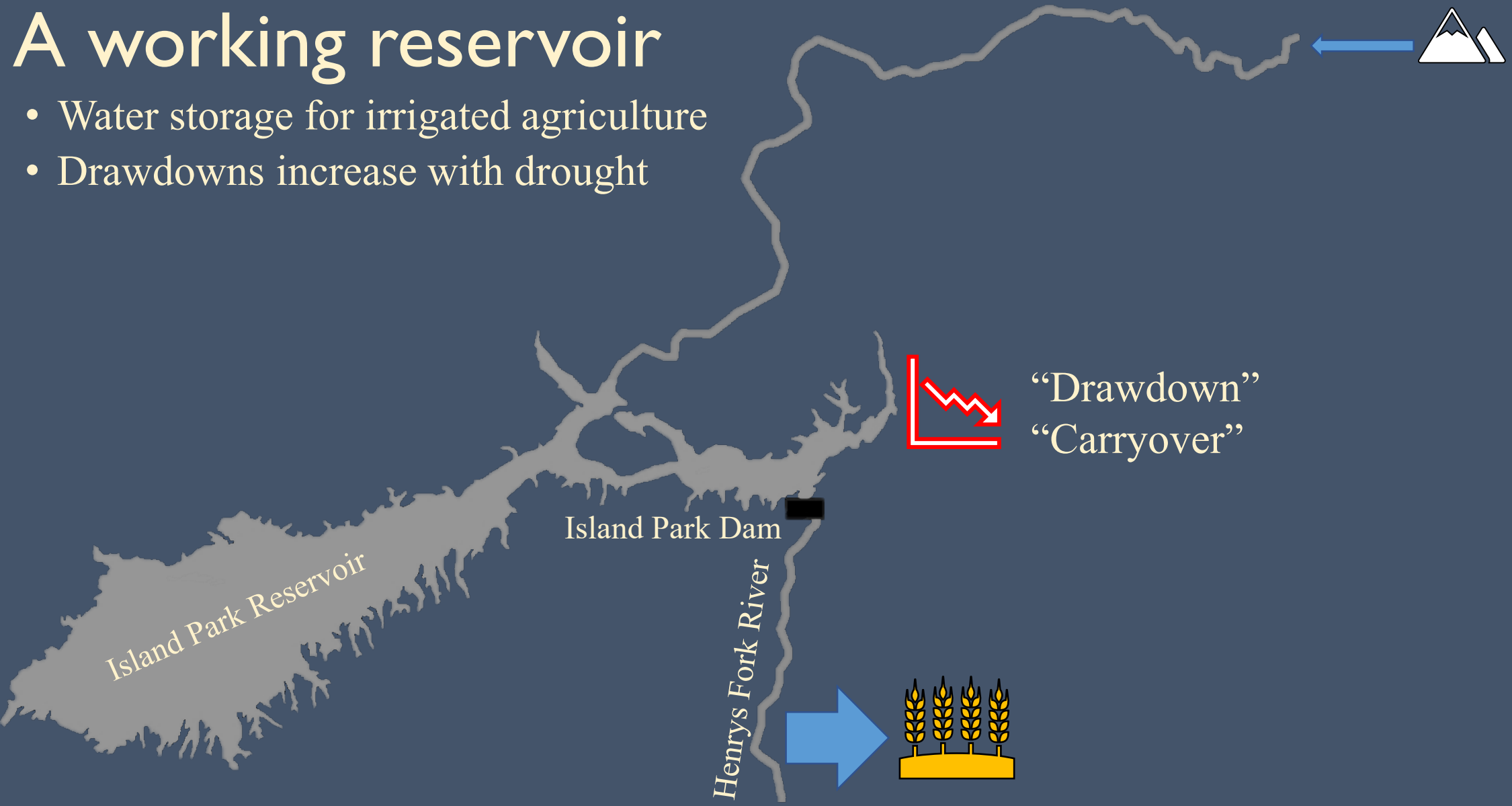
Montana

Idaho

Wyoming

A working reservoir

- Water storage for irrigated agriculture
- Drawdowns increase with drought



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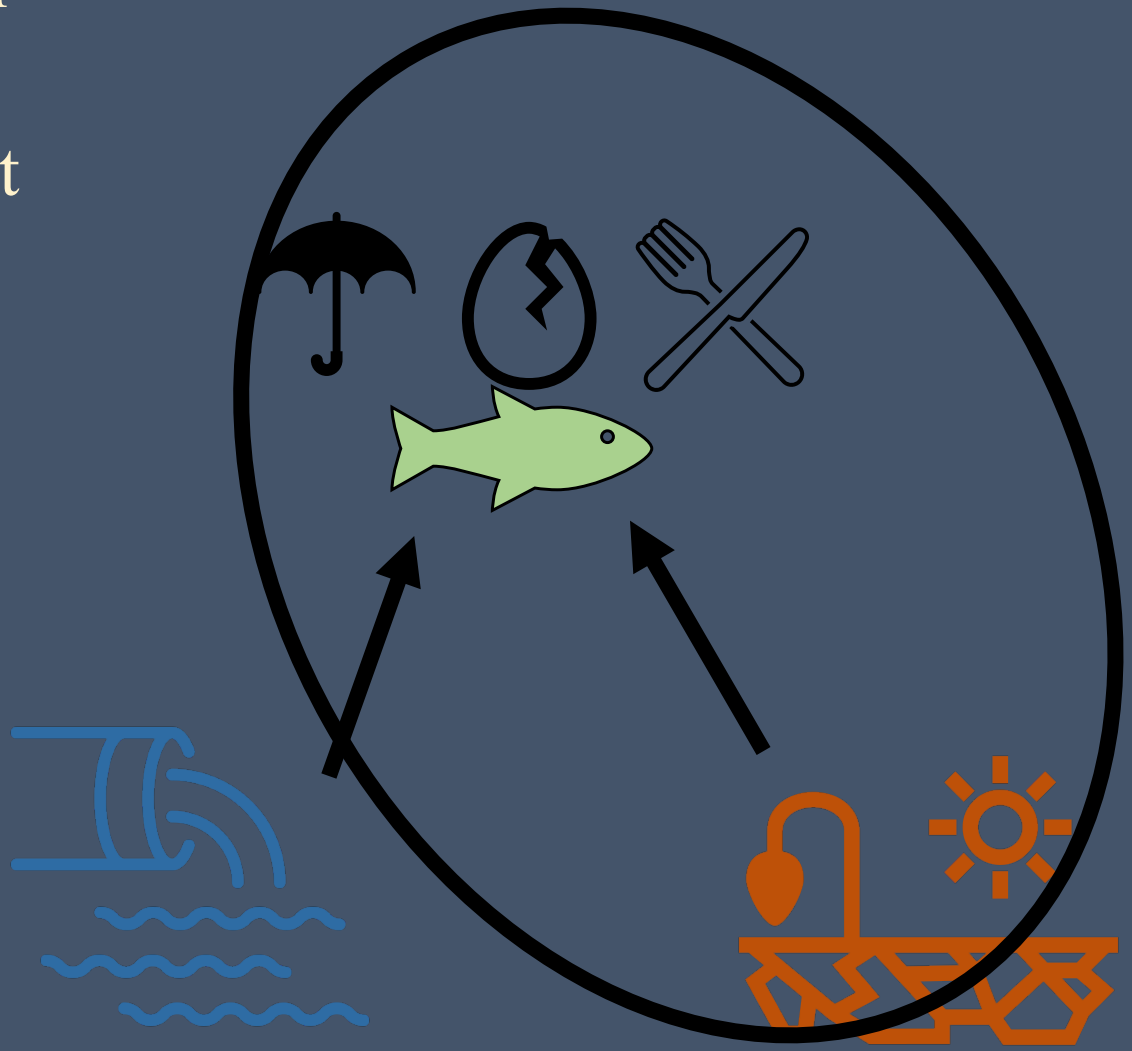


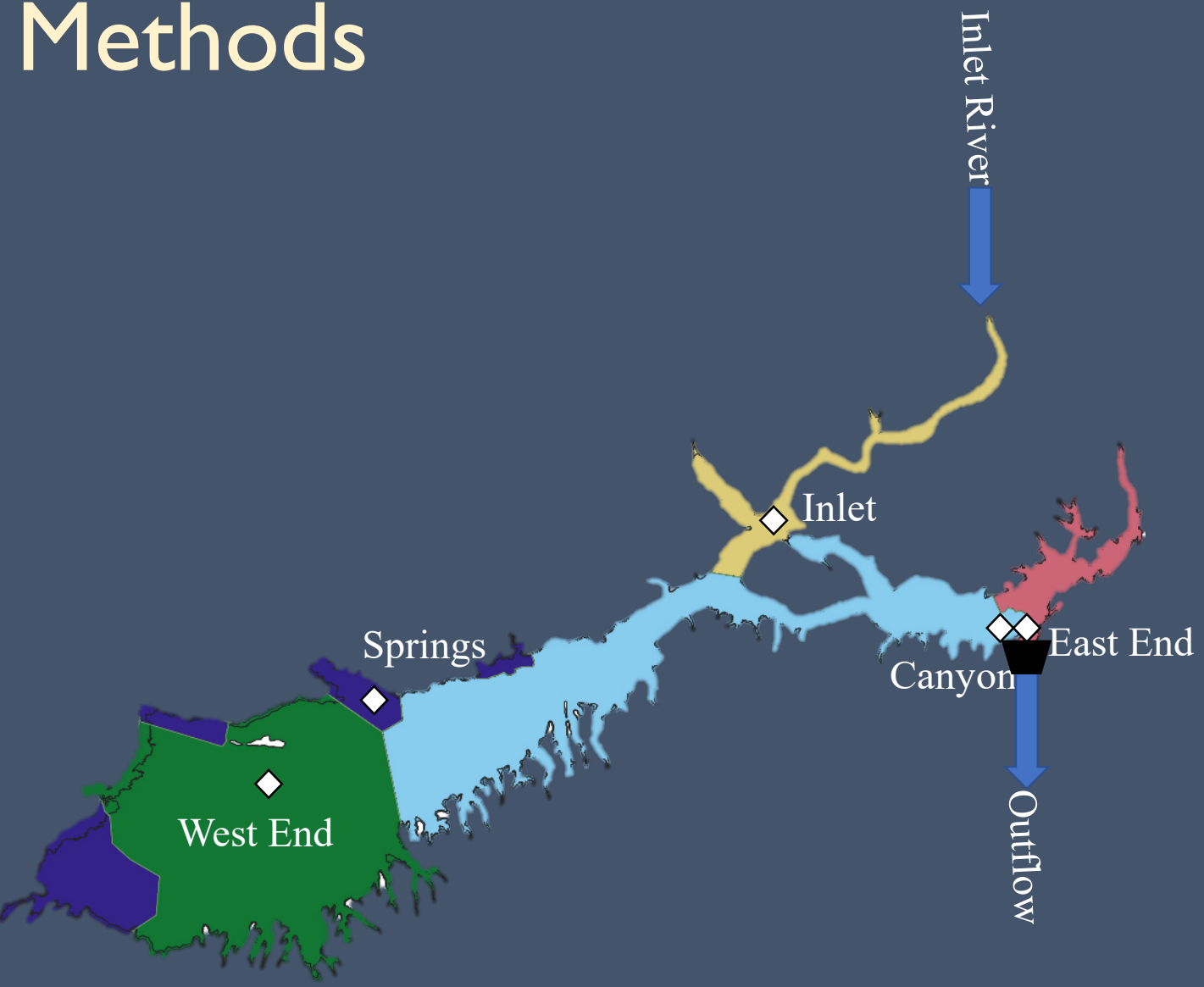
Island Park Reservoir Drawdown

Island Park Reservoir Drawdown

Hypothesis:

- Higher drawdown will negatively affect fish habitat and abundance

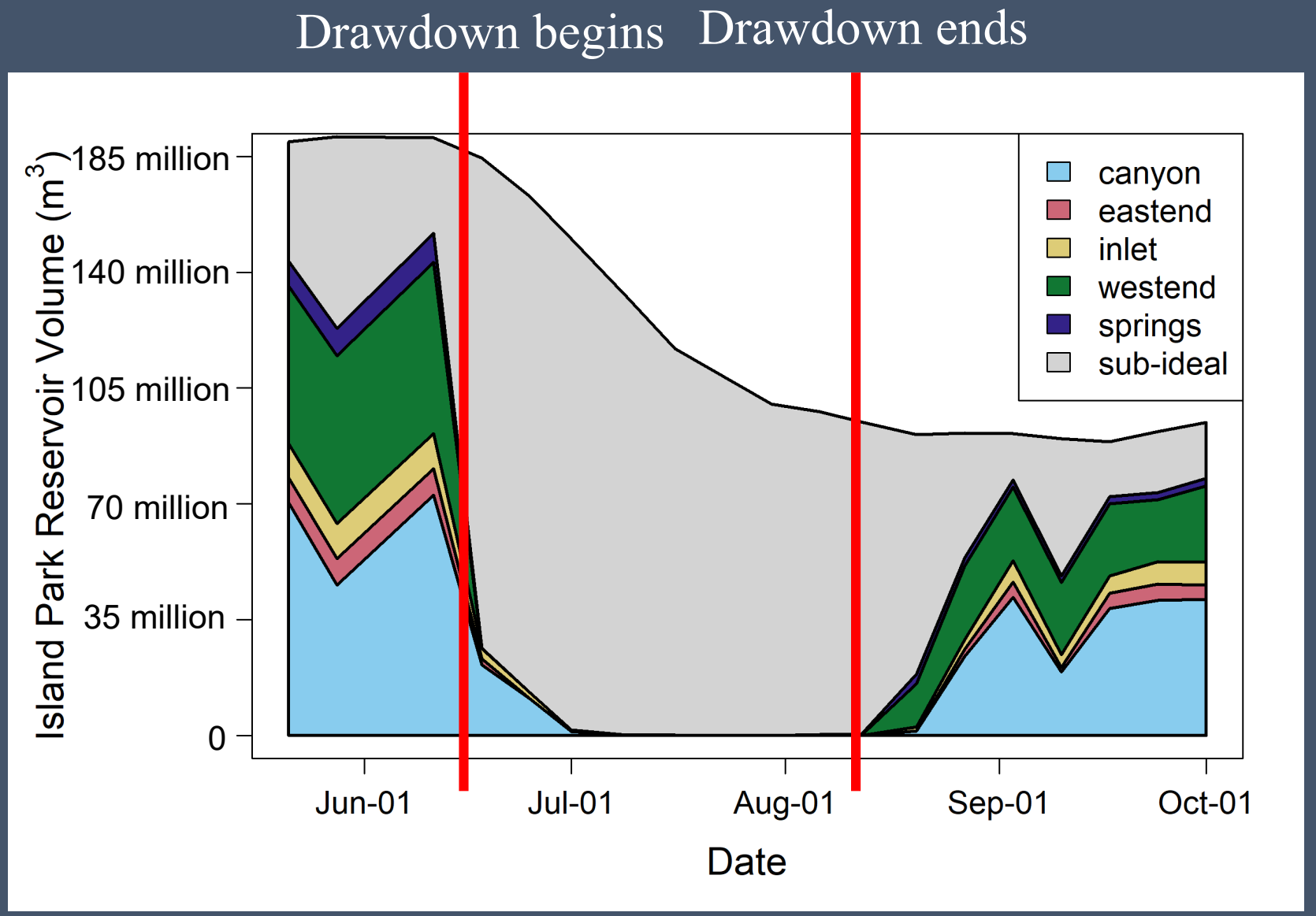
Methods



- Kokanee habitat sensitive to temperature & dissolved oxygen
  - (20 °C | 5 mg O_2/L)
- Weekly vertical profiles at five locations in Island Park Reservoir
  - Capture heterogeneity
  - 2021 drought year: 58% drawdown
- Translate vertical profiles into habitable volume at each location

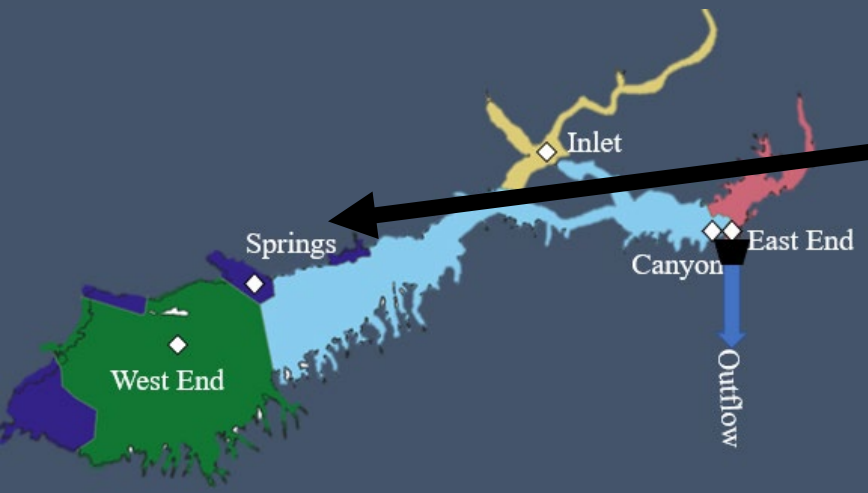
Results

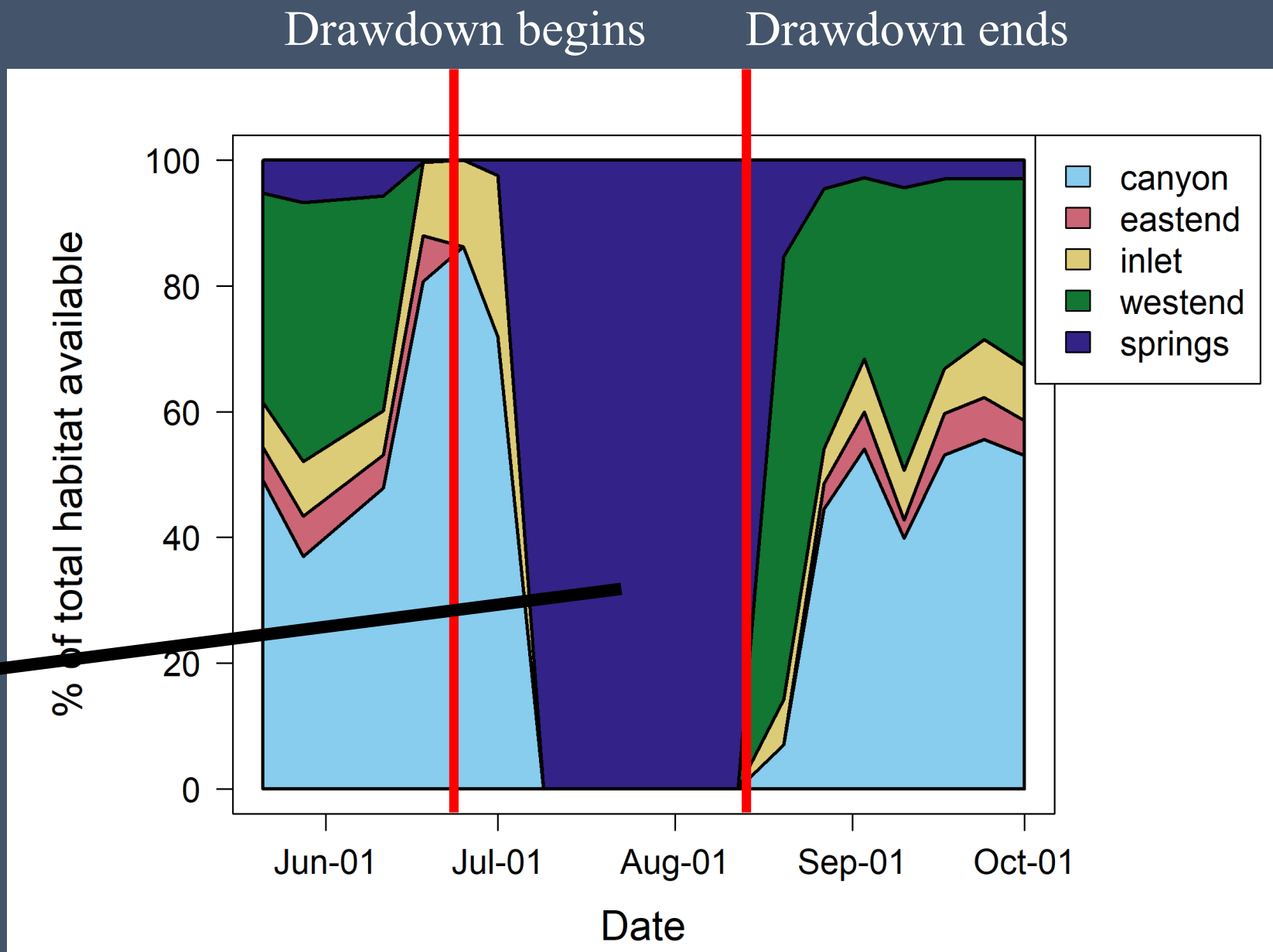
- Takeaways
  - Drawdown destroys kokanee habitat



Results

- Takeaways
  - Drawdown destroys kokanee habitat
  - Cool inflow critical for maintaining habitat





Does drawdown affect kokanee abundance?

https://www.ecomagazine.com/news/fisheries-aquaculture/salmon-carcasses-promote-tree-growth-in-Alaska, *Credit: Dennis Wise/University of Washington.*

- Kokanee salmon spawning run size

Does drawdown affect kokanee abundance?

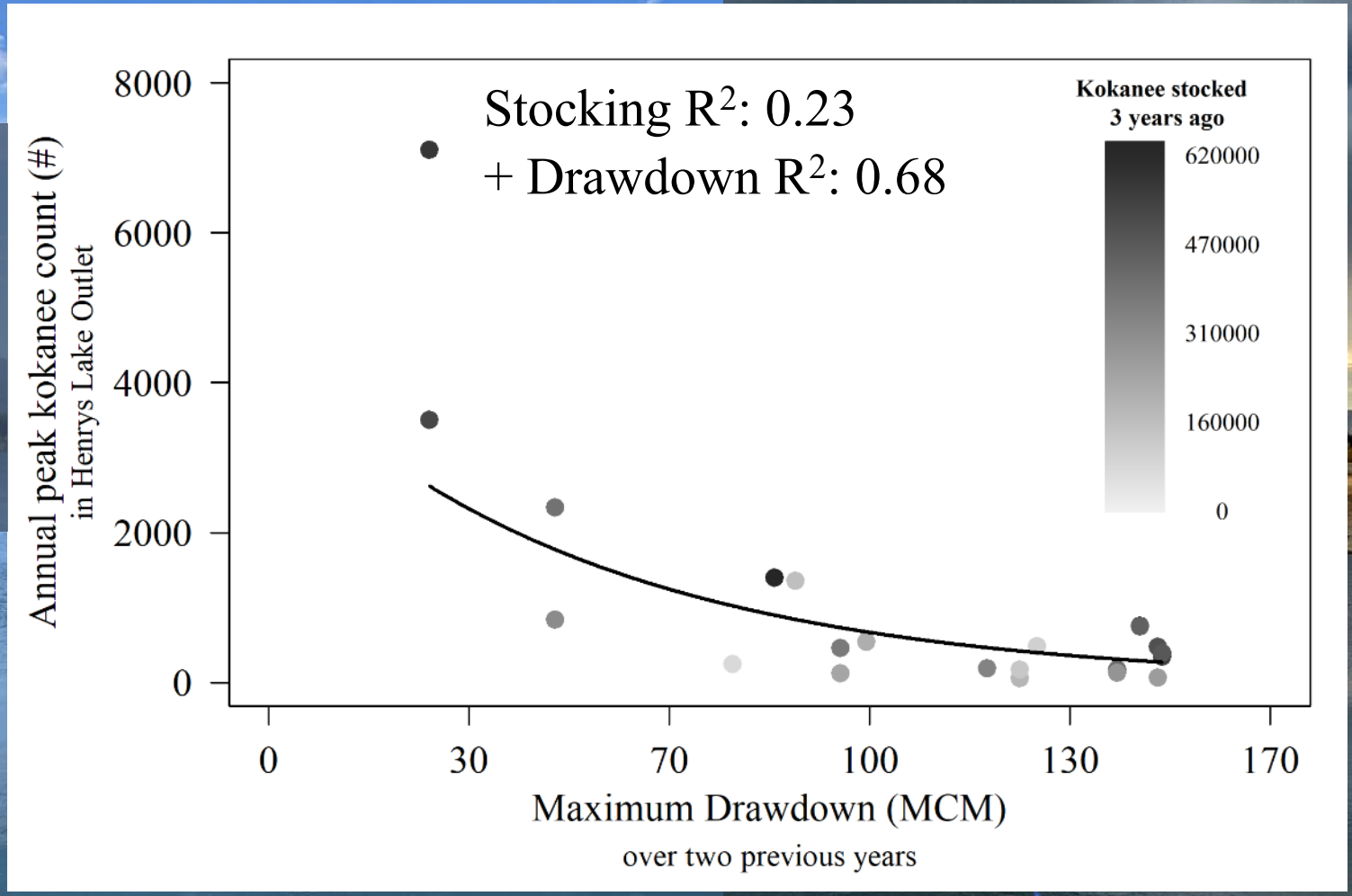
https://www.ecomagazine.com/news/fisheries-aquaculture/salmon-carcasses-promote-tree-growth-in-Alaska, *Credit: Dennis Wise/University of Washington.*

- Kokanee salmon spawning run size
  - Drawdown
  - Stocking
  - Tributary inflow
  - Air temperature

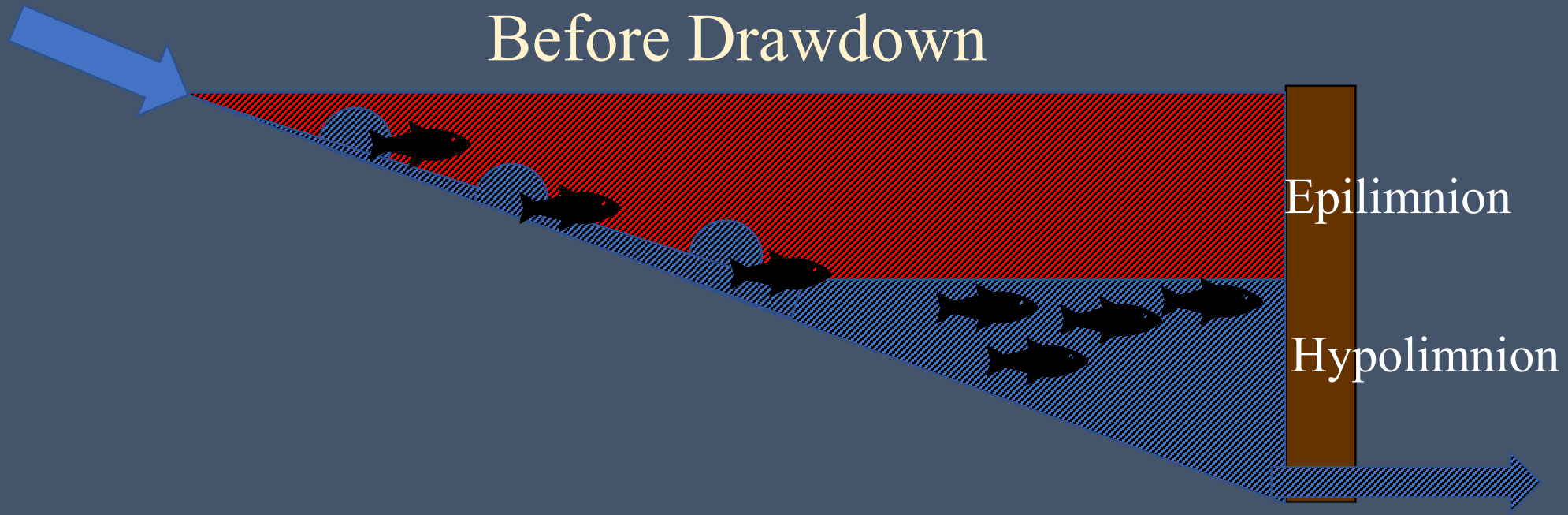
Island Park Reservoir Drawdown

Takeaway:

- Drawdown reduces kokanee abundance



What's the mechanism?



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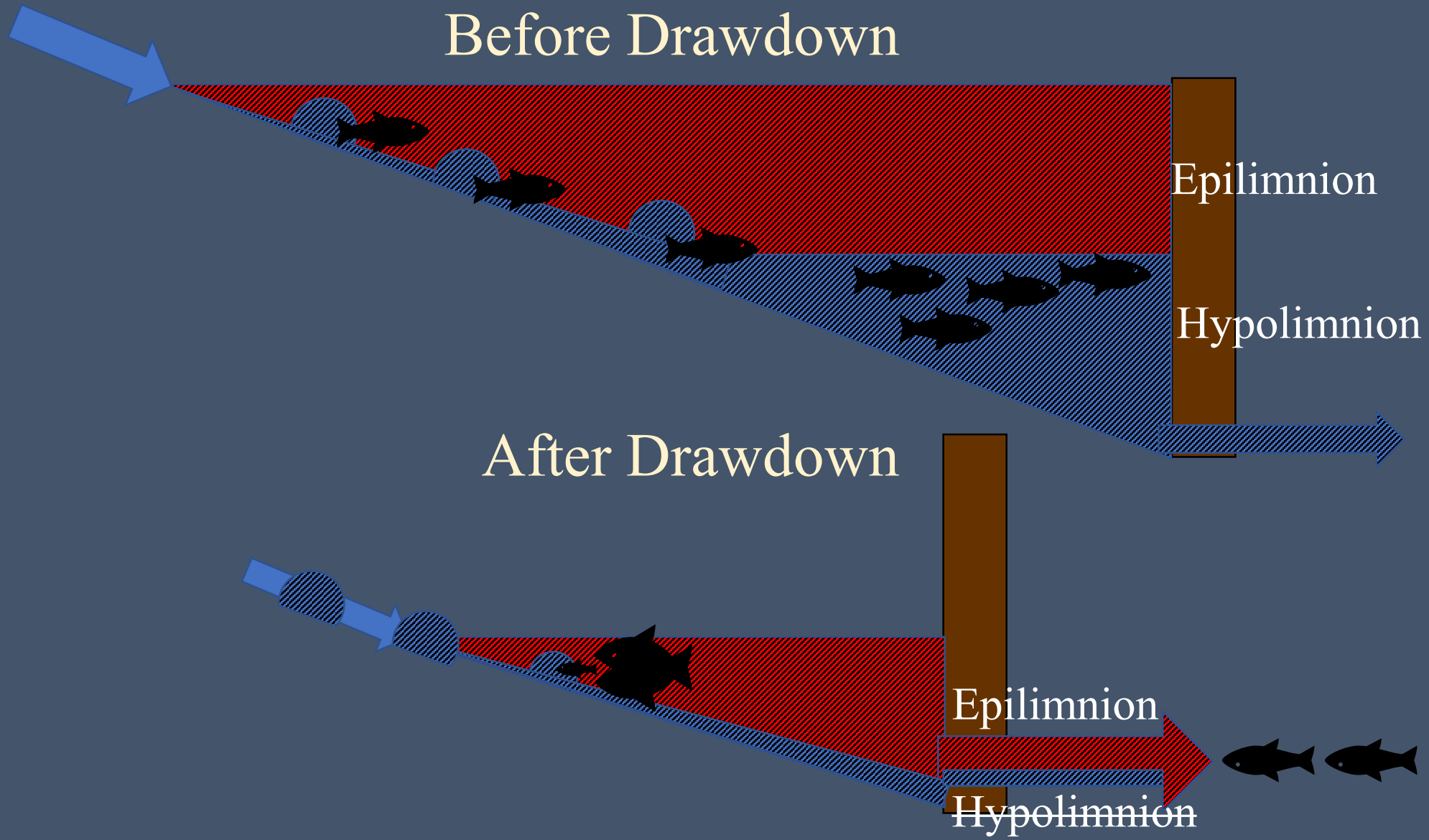
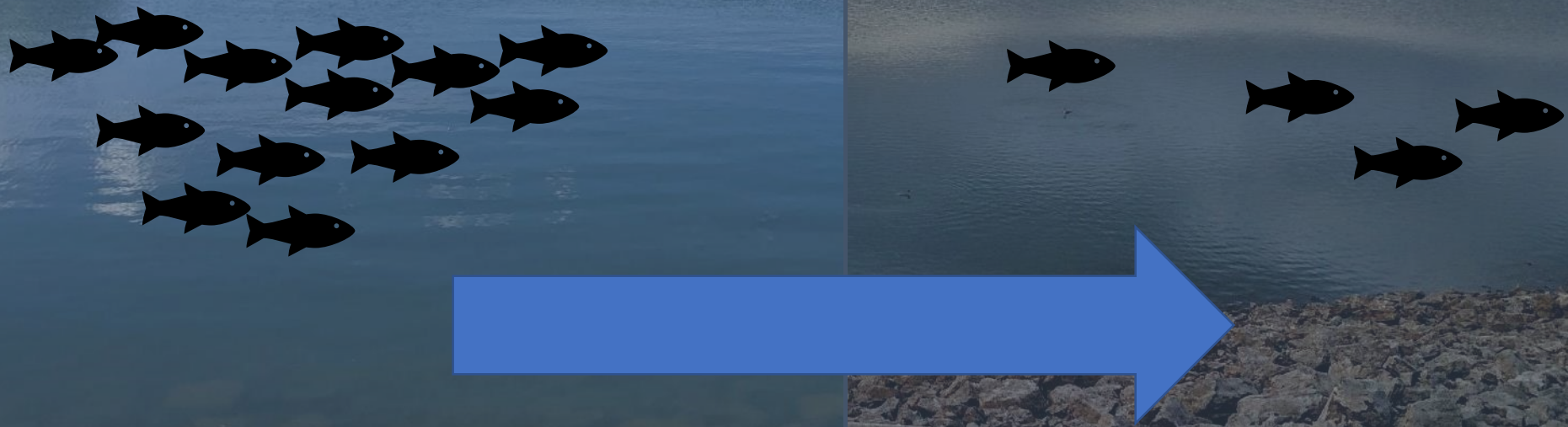


Island Park Reservoir Drawdown

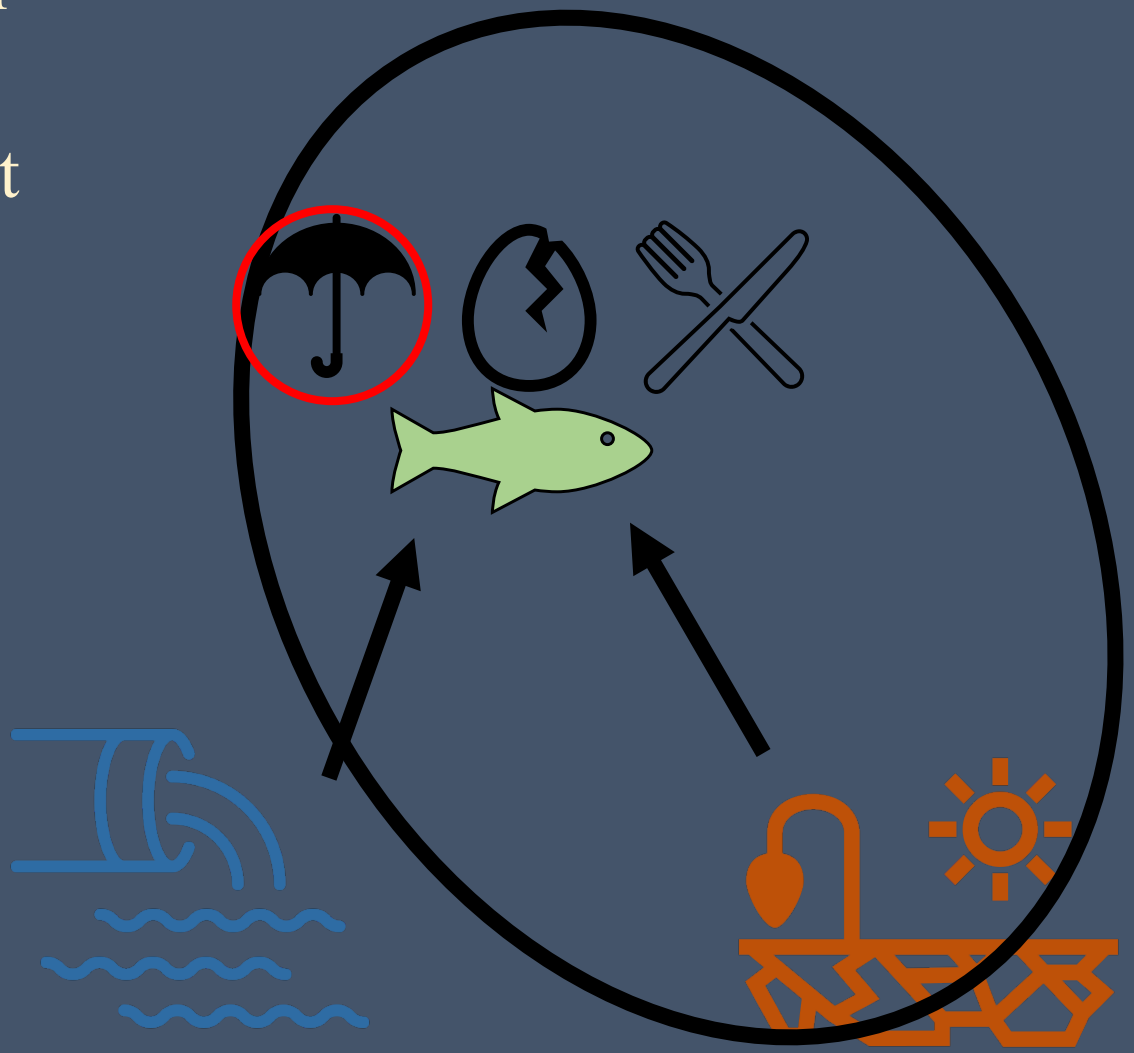
Hypothesis: **CONFIRMED**

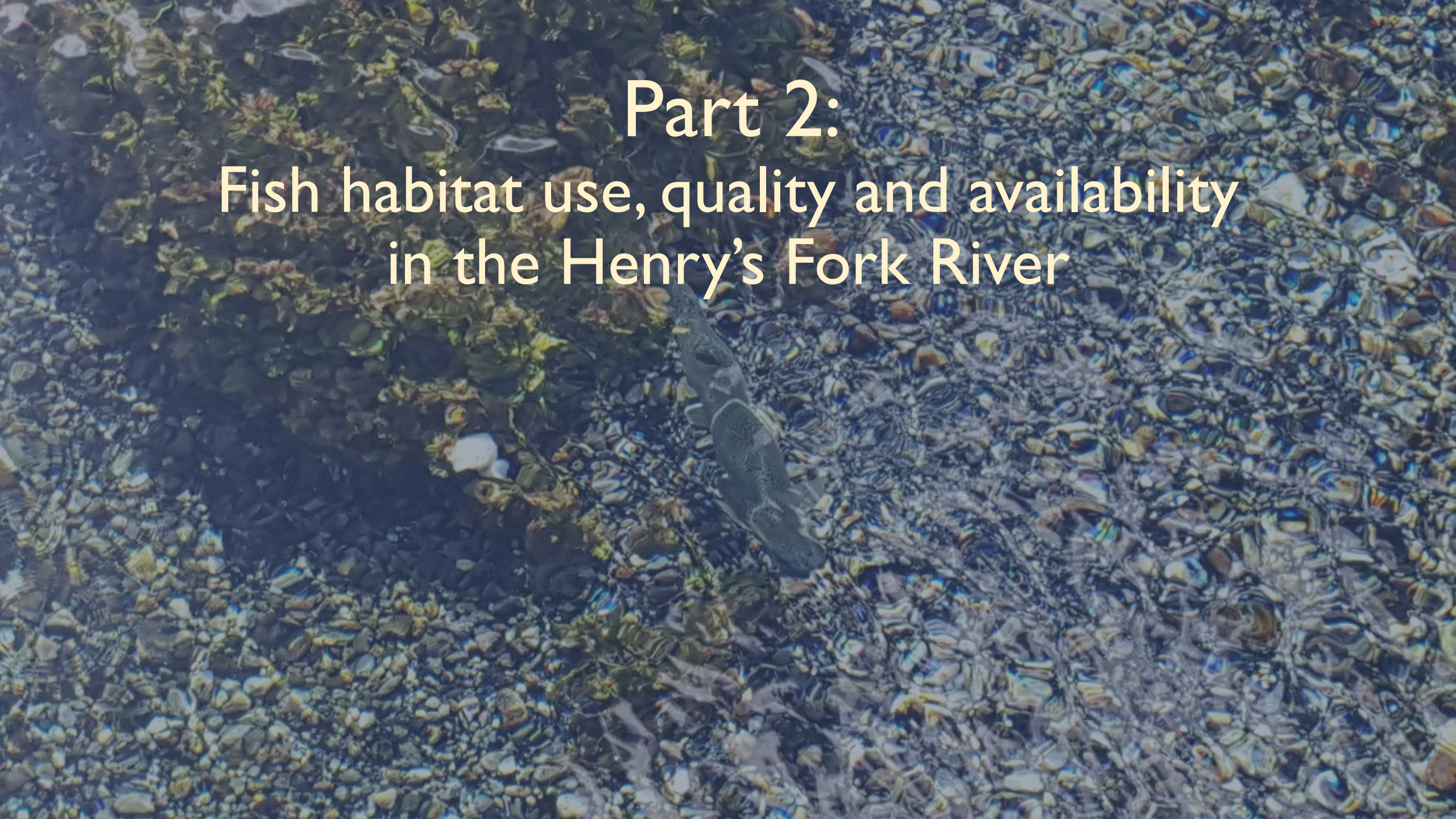
- Higher drawdown negatively affects subadult kokanee salmon habitat and abundance



Study Questions:

- What limits fish habitat and abundance in the Henry's Fork Headwaters?
- How might nutrient pollution and drought affect fish habitat and abundance in the Henry's Fork Headwaters?
- Answers:
  - Drawdown destroys kokanee habitat
  - Cool inflow critical for maintaining habitat
  - Drawdown reduces kokanee abundance

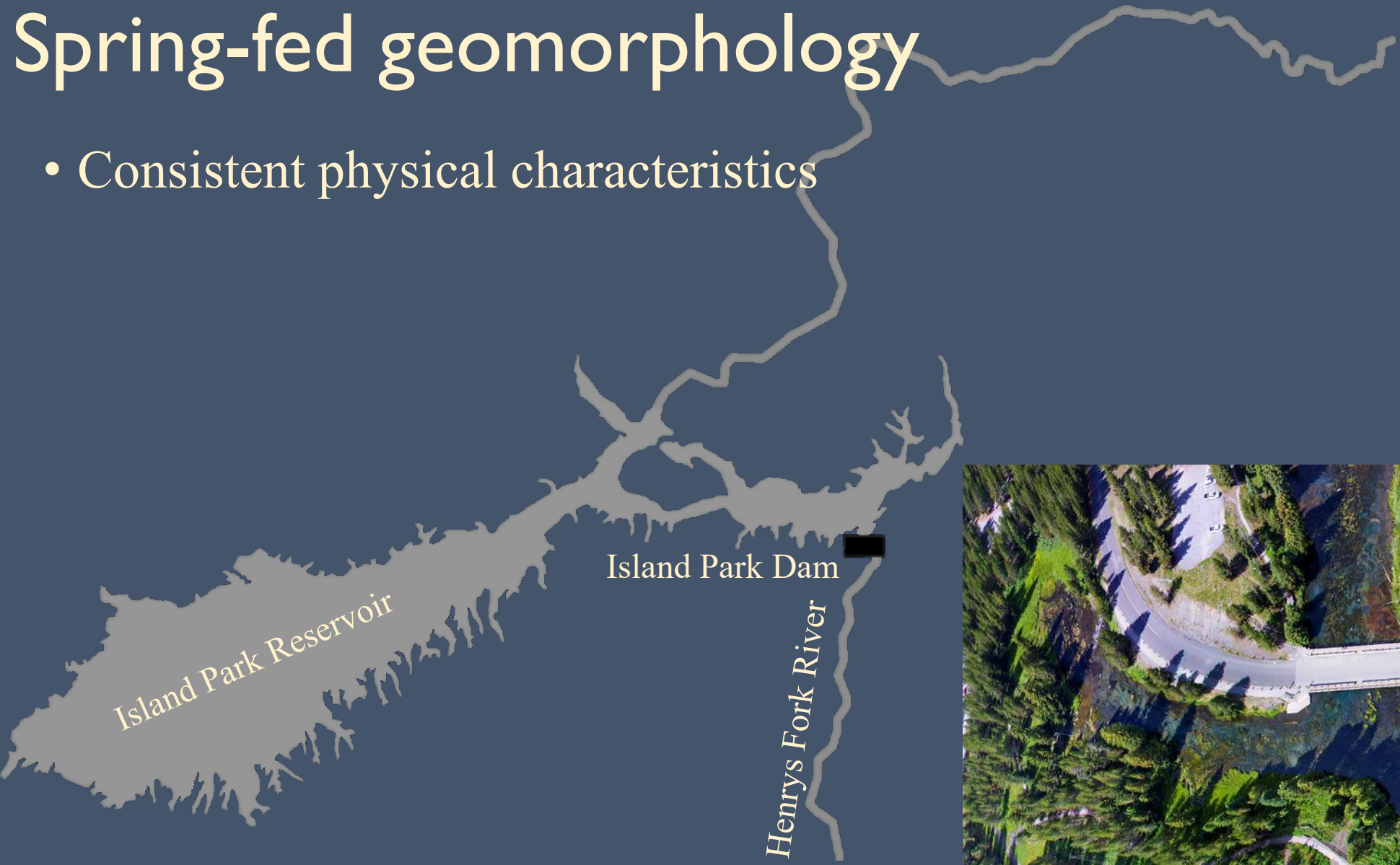




Part 2:
Fish habitat use, quality and availability in the Henry's Fork River

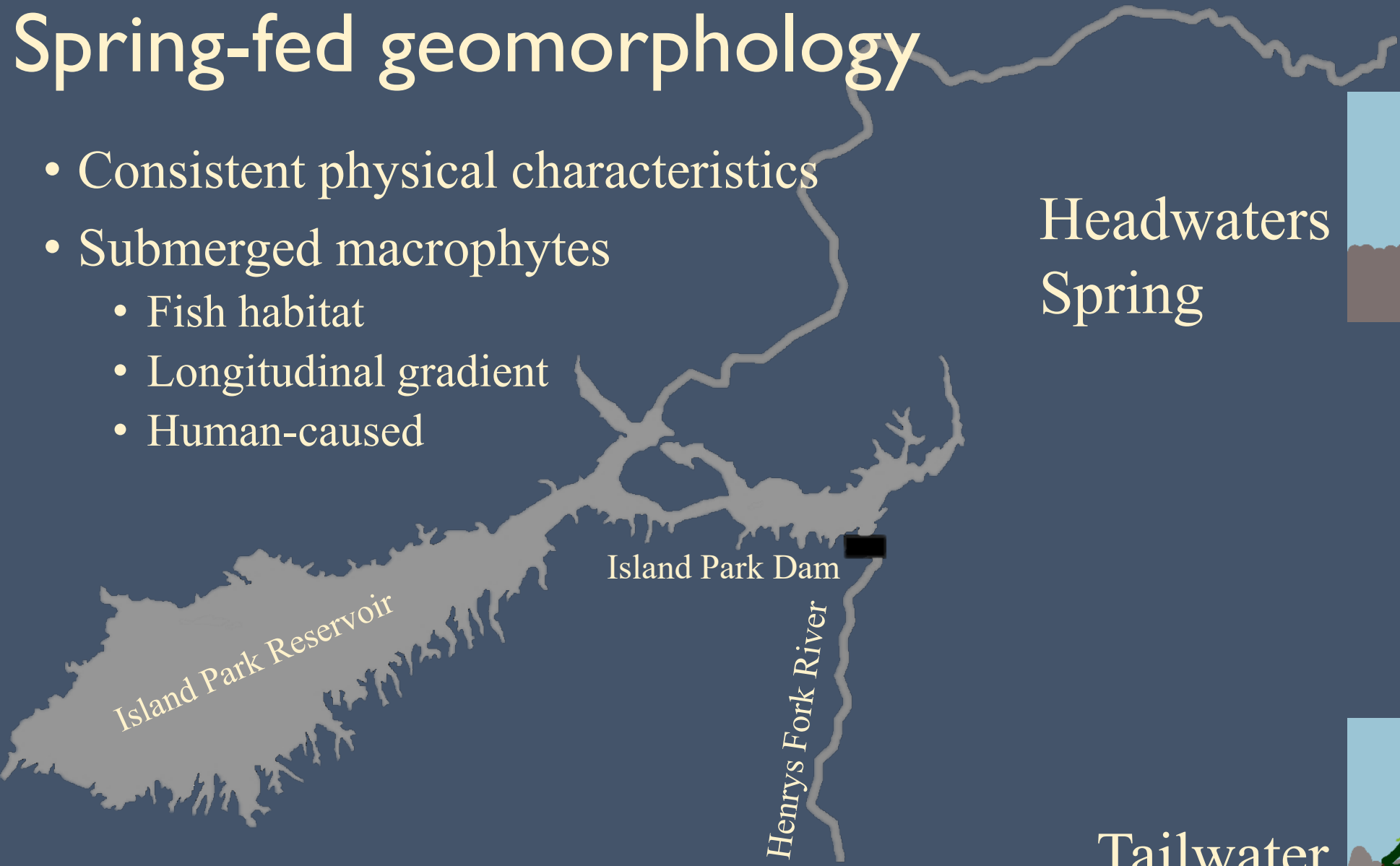
Spring-fed geomorphology

- Consistent physical characteristics



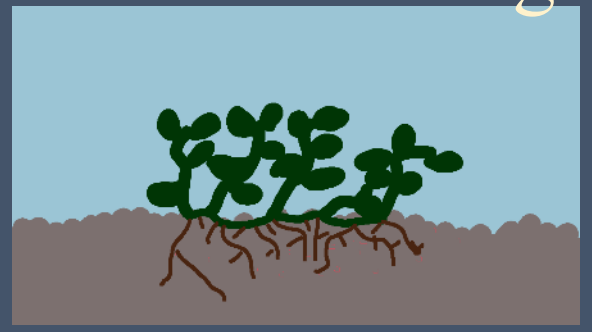
Spring-fed geomorphology

- Consistent physical characteristics
- Submerged macrophytes
  - Fish habitat
  - Longitudinal gradient
  - Human-caused



Headwaters
Spring

Low coverage

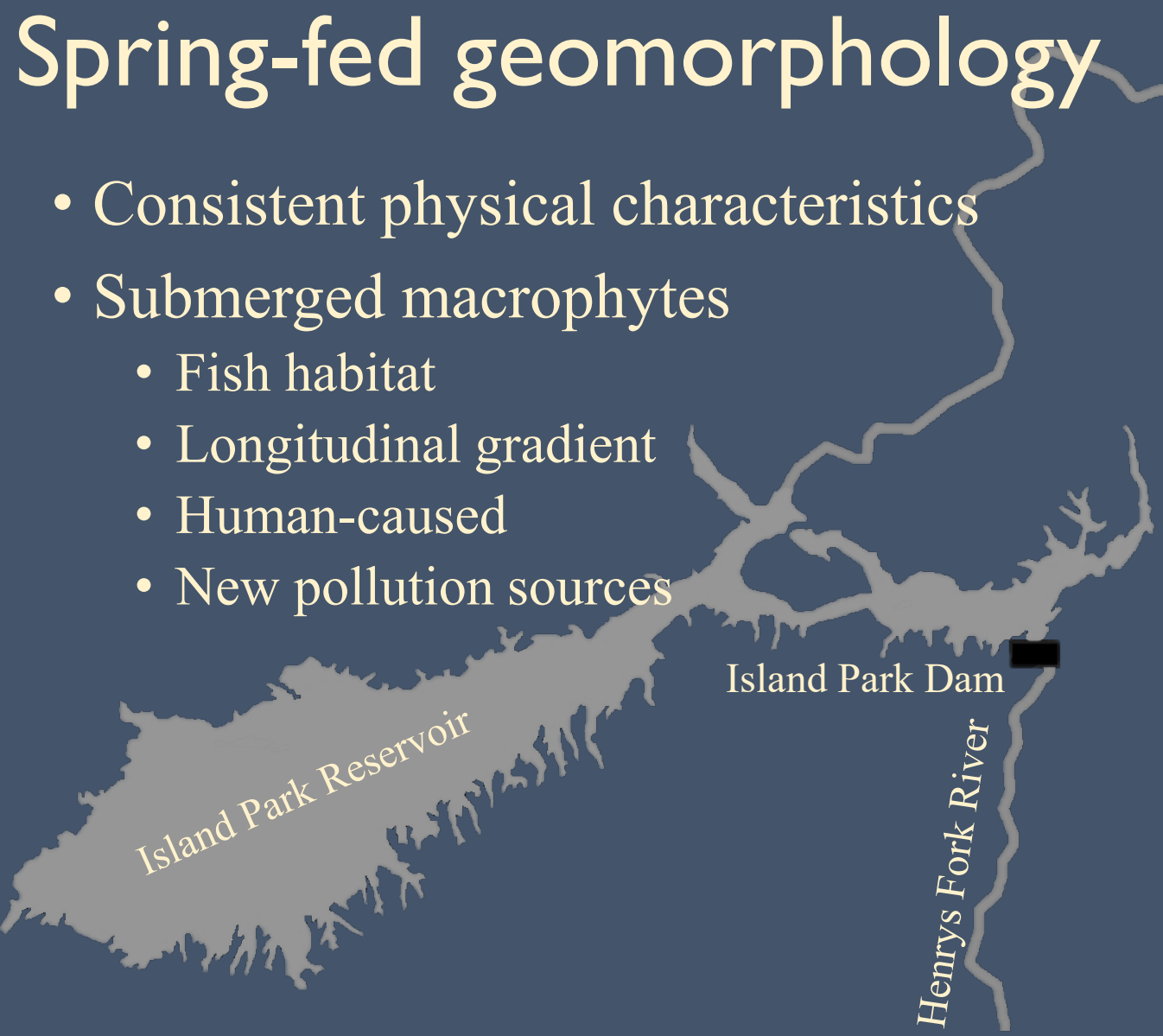


High coverage

Tailwater
Fall

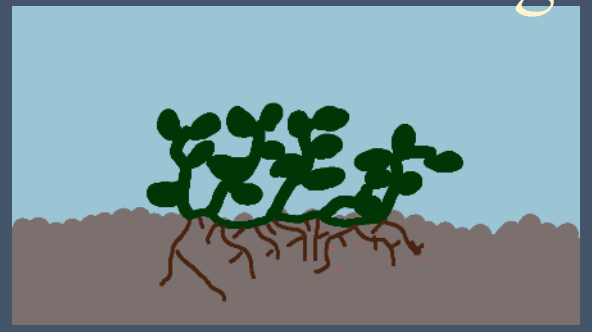
Spring-fed geomorphology

- Consistent physical characteristics
- Submerged macrophytes
  - Fish habitat
  - Longitudinal gradient
  - Human-caused
  - New pollution sources



Low coverage

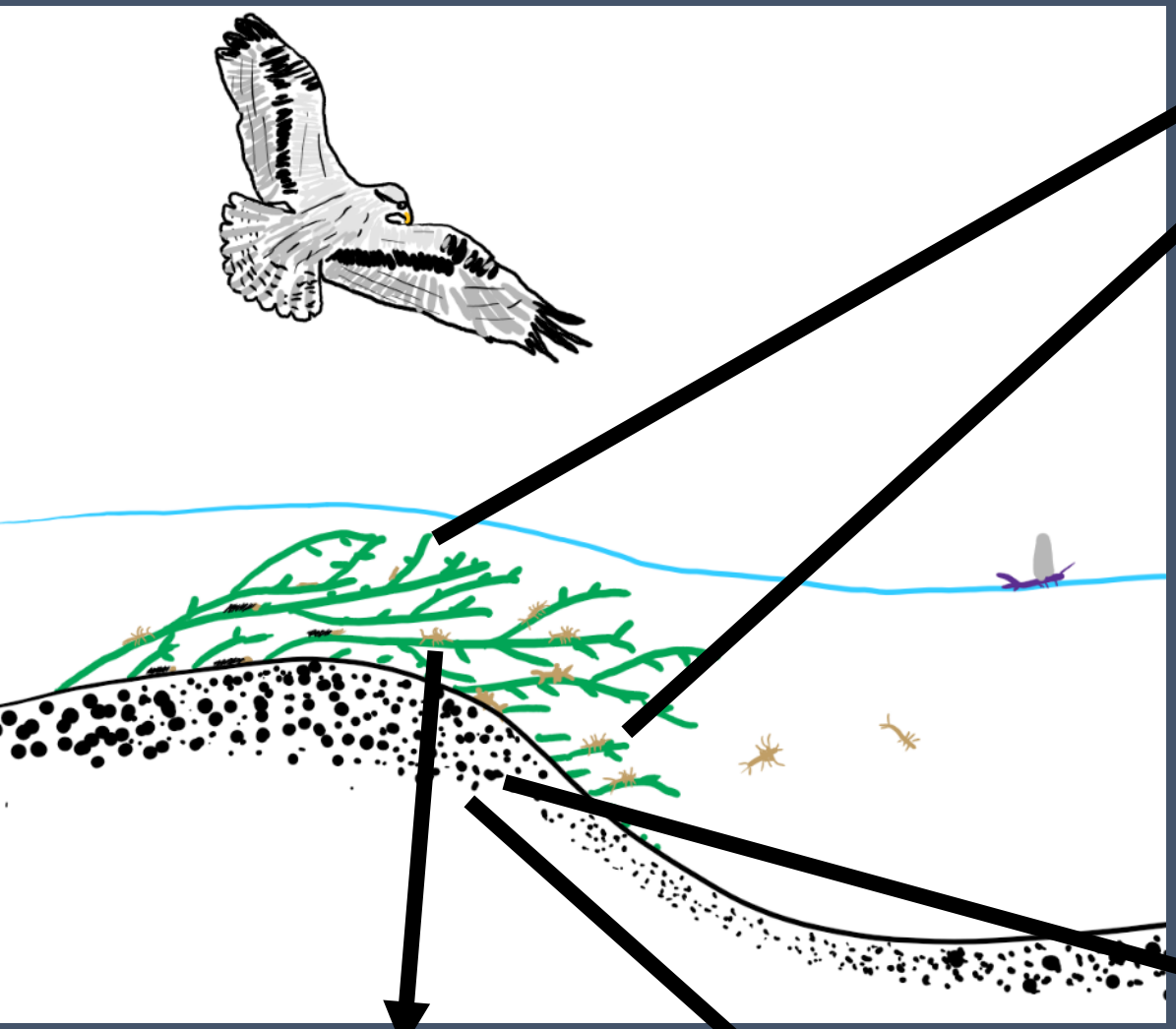
Headwaters Spring



High coverage

Tailwater Fall

Uncertainty: Macrophytes and fish



Increase water level

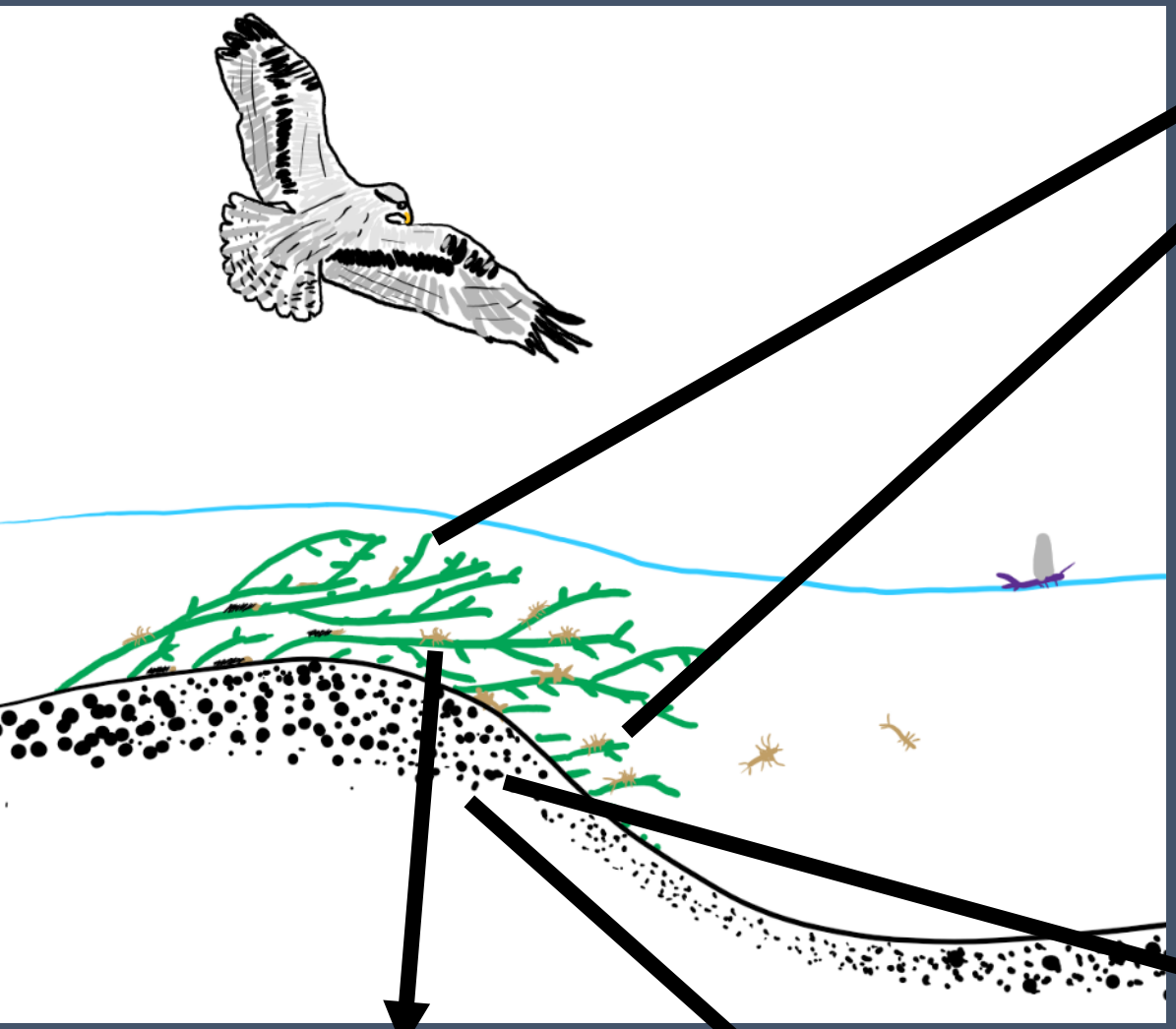
Slower velocities

Trap sediment

Refuge for macroinvertebrates

Nutrient and organic matter processing

Uncertainty: Macrophytes and fish



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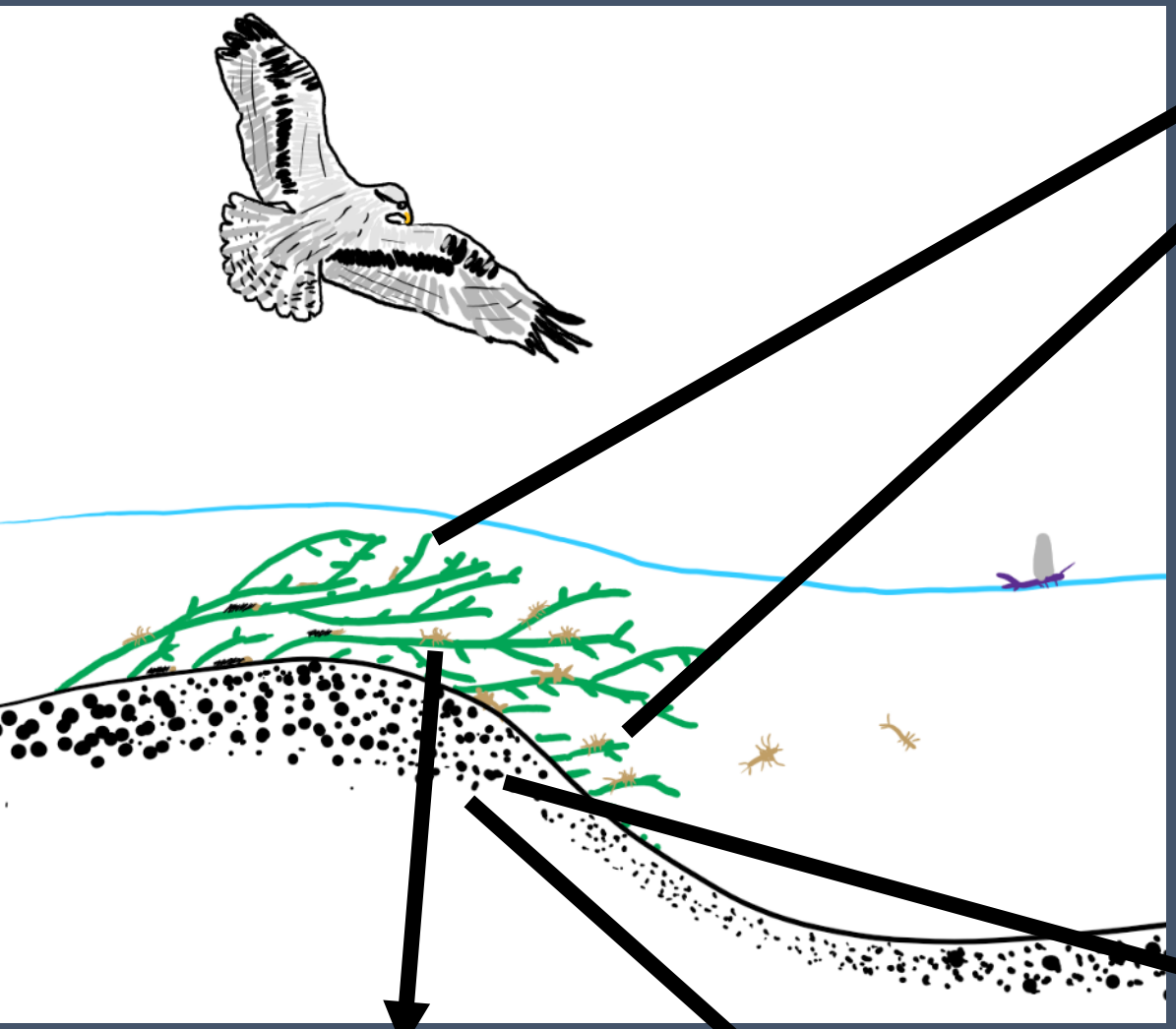

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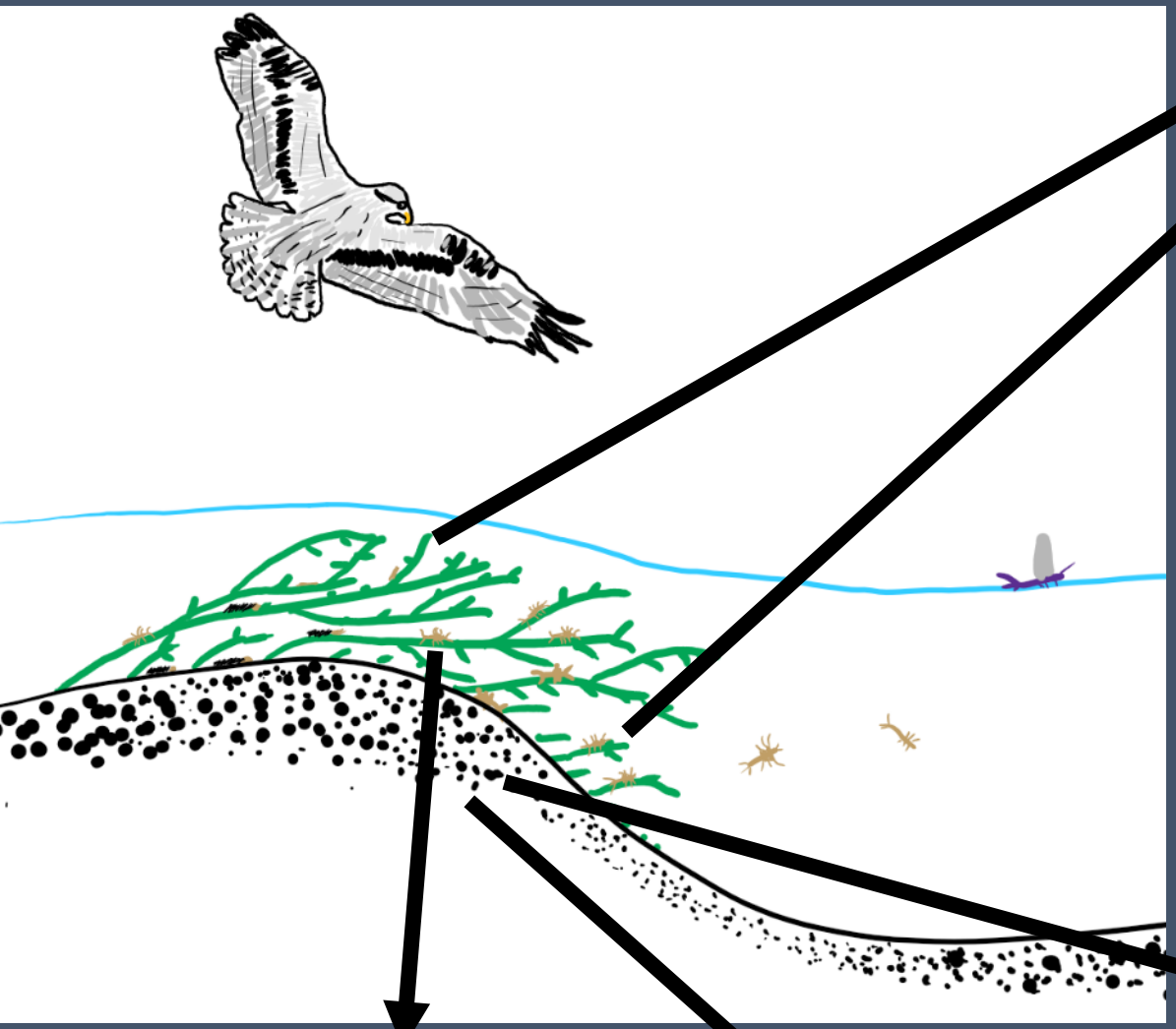

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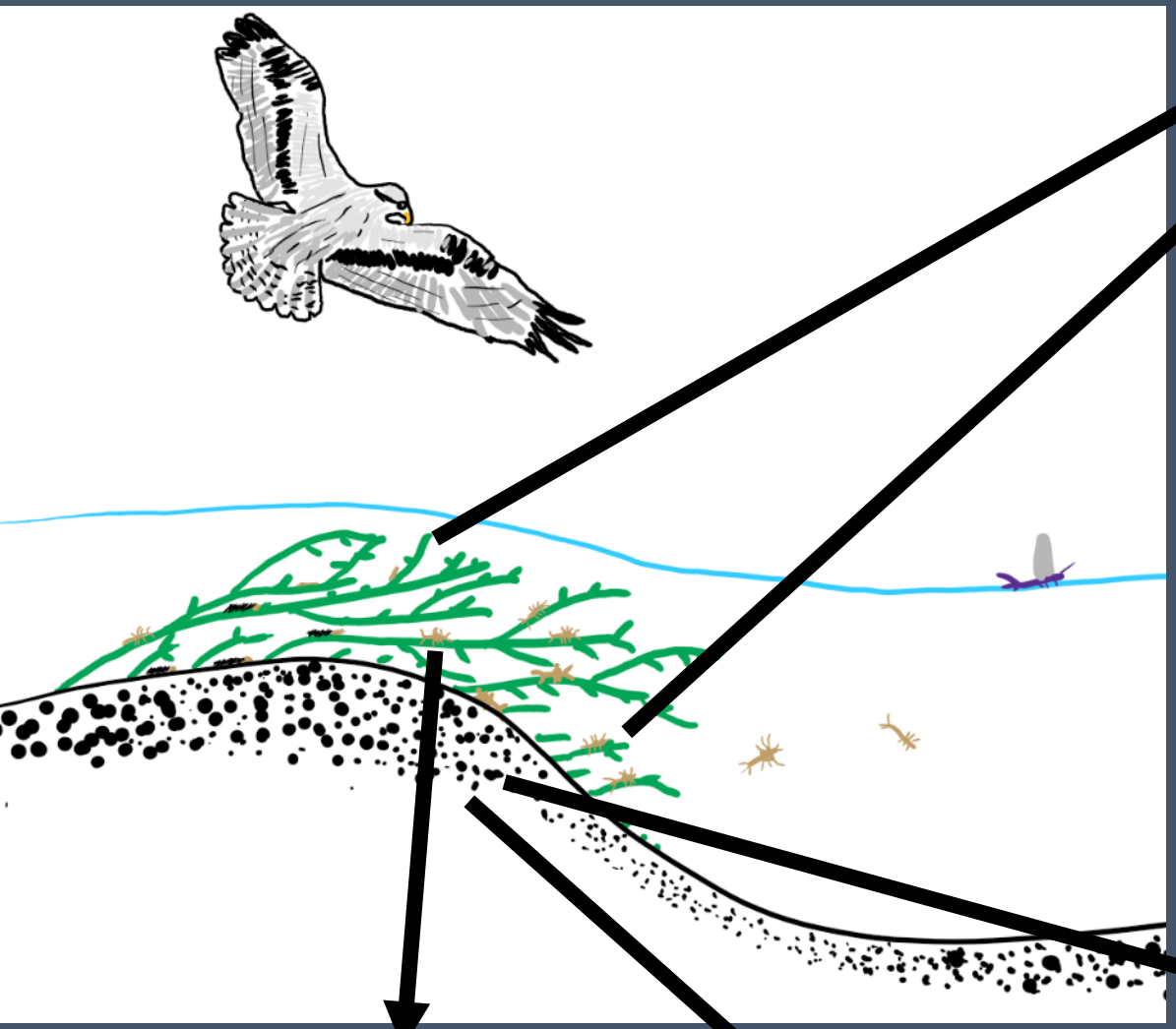

Increase water level

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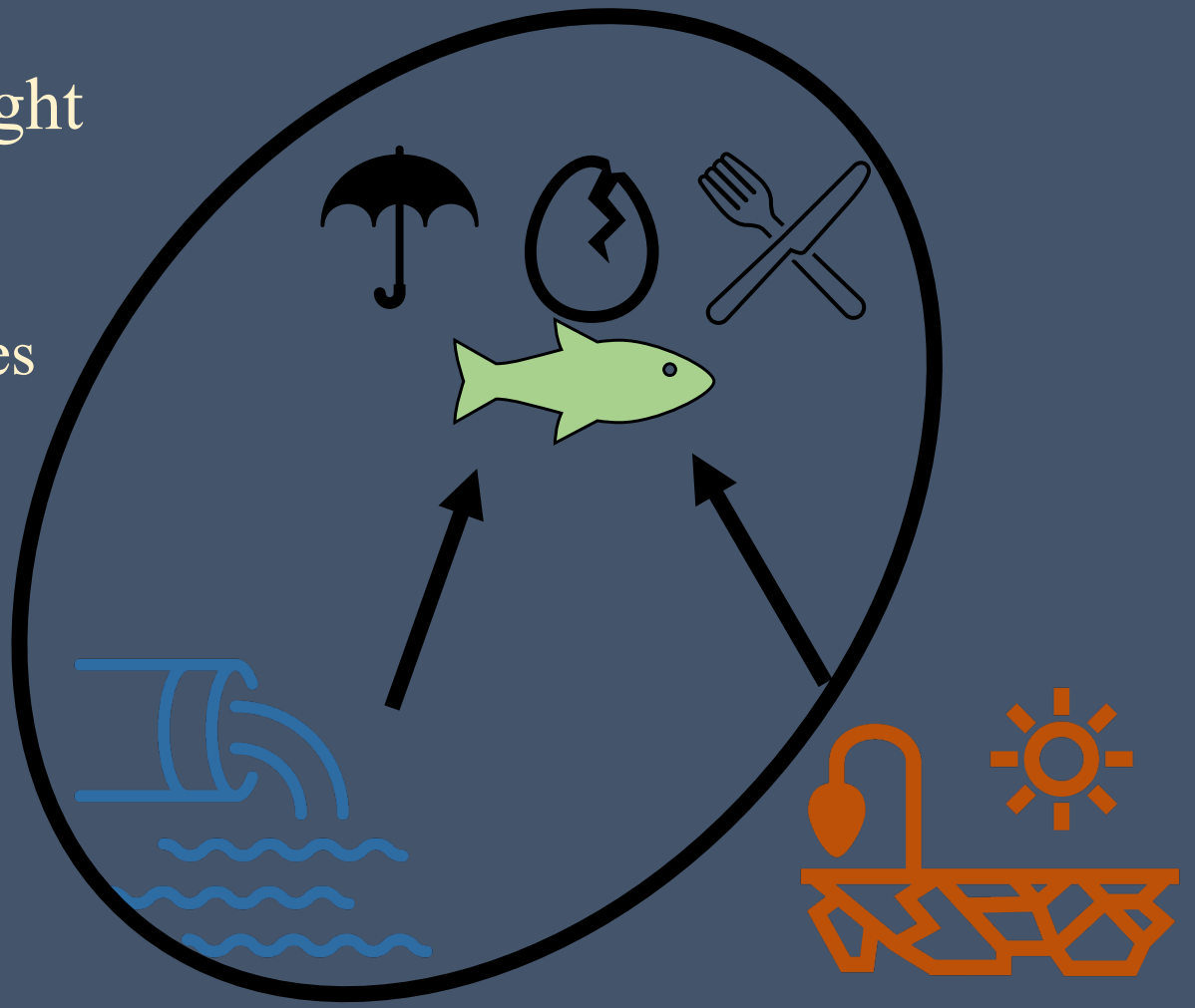
Refuge for macroinvertebrates

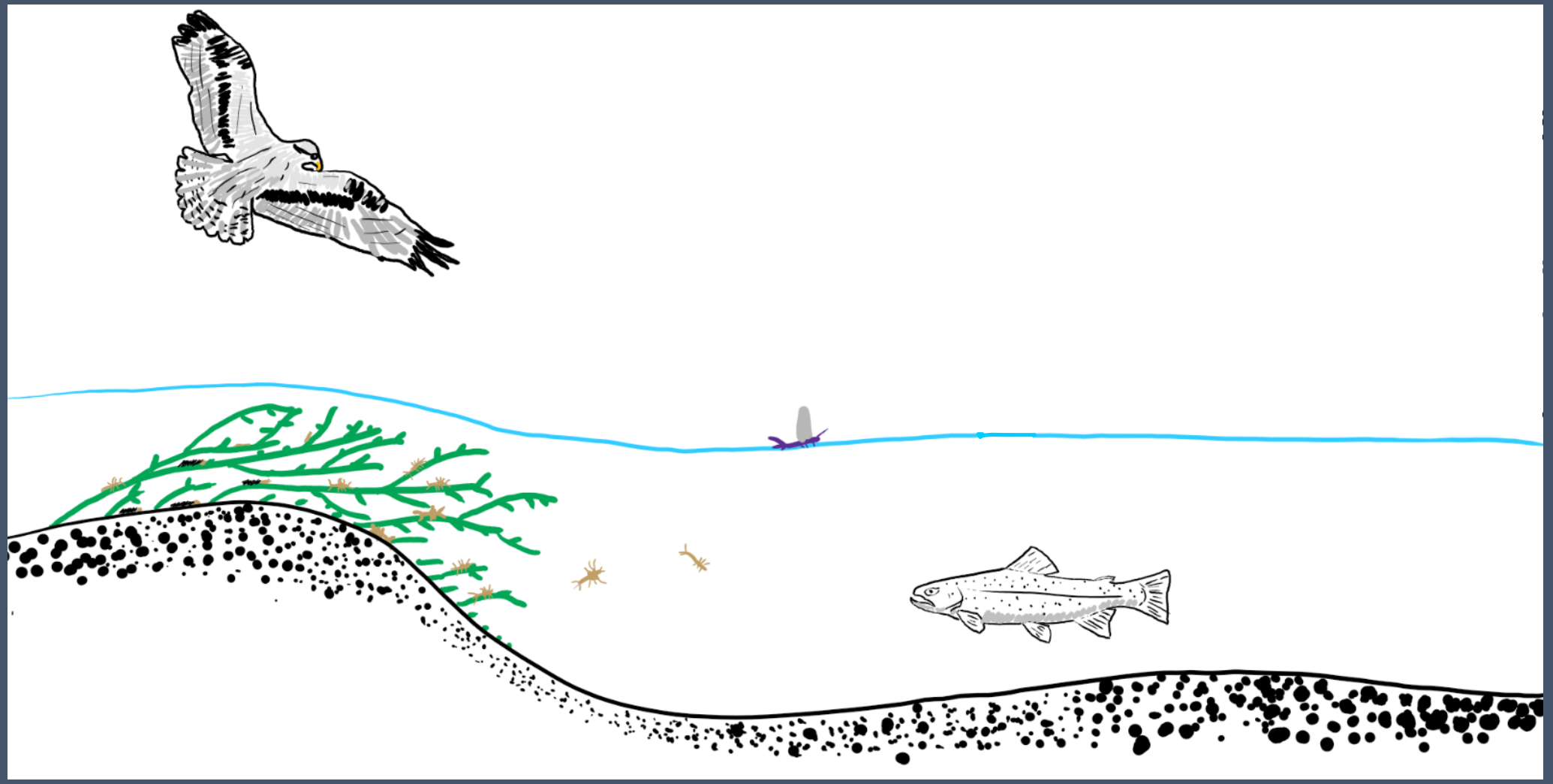
Nutrient and organic matter processing

Study Questions:

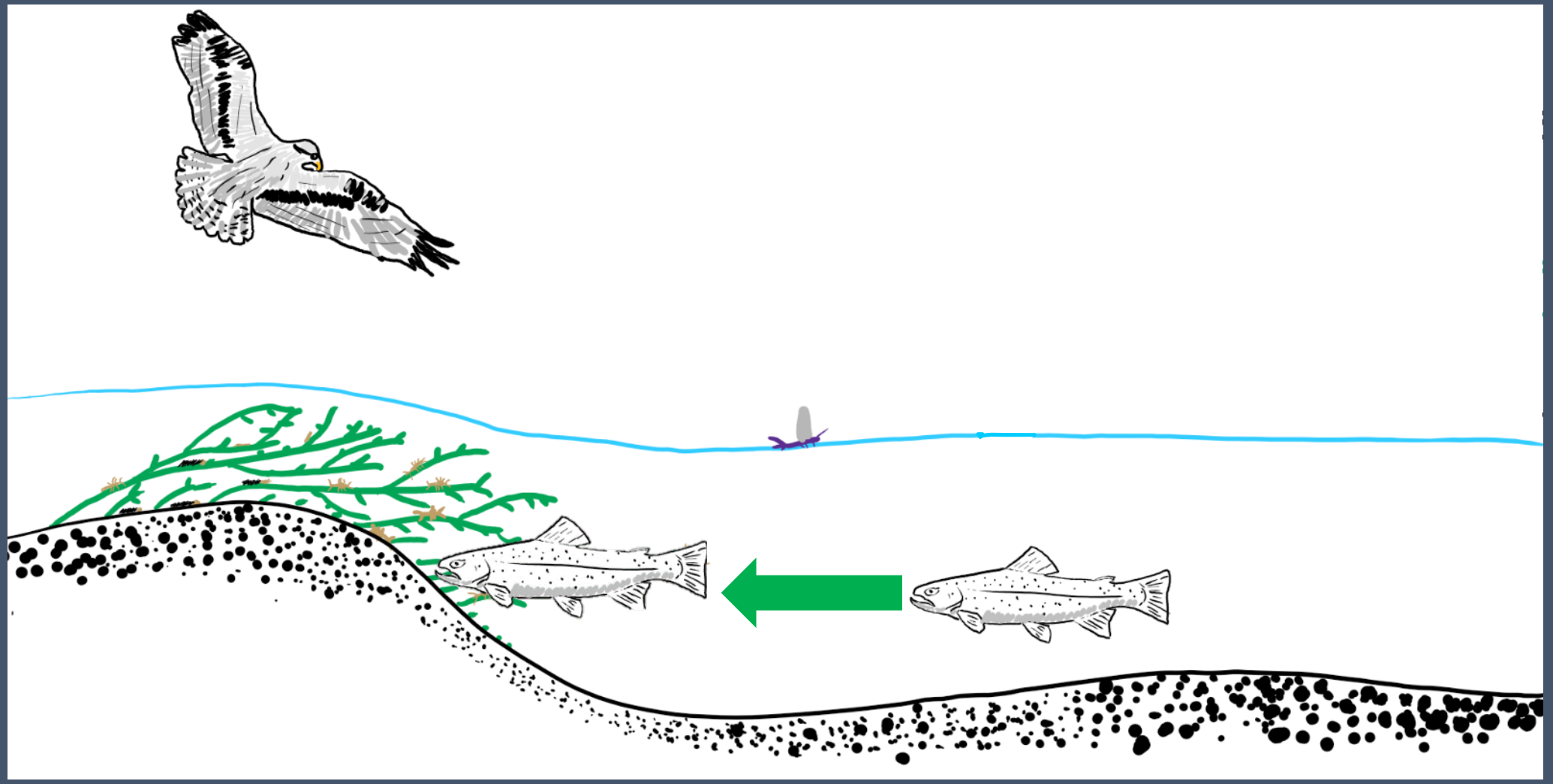
- What limits fish habitat and abundance in the Henry's Fork Headwaters?
- How might nutrient pollution and drought affect fish habitat and abundance in the Henry's Fork Headwaters?
  - Could increases in submerged macrophytes threaten the fishery?
  - What is the net effect of submerged macrophytes on fish habitat?



Hypothesis



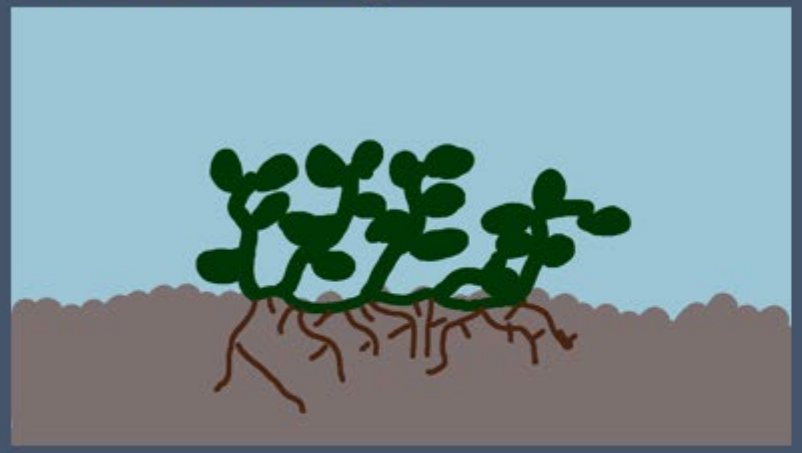
Hypothesis



Methods: trout habitat

- Snorkel surveys: individual trout habitat preferences

Low coverage



Headwaters
Spring

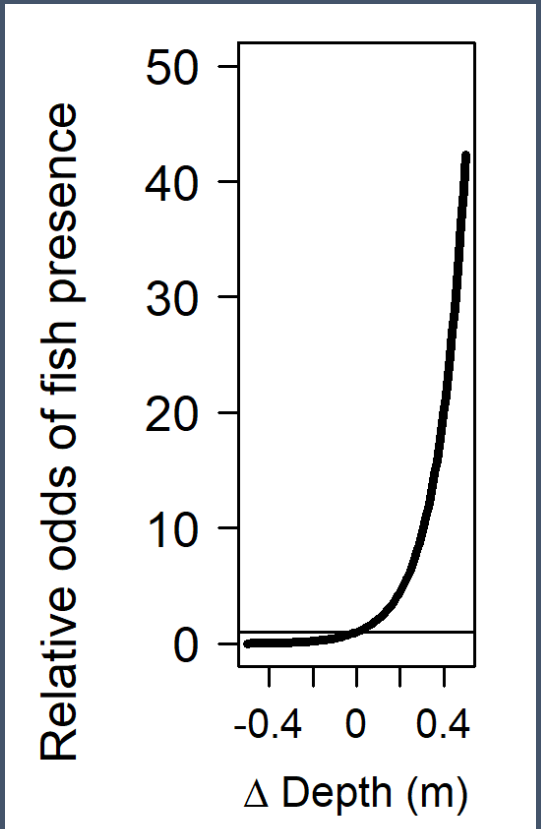
High coverage

Tailwater
Fall

Methods: trout habitat

- Snorkel surveys: individual trout habitat preferences
- Identified focal points, measured
  - Depth
  - Macrophtye coverage & height
  - Velocity
  - Substrate size
  - Invertebrate drift
  - Temperature
  - Dissolved oxygen

Results – individual-scale



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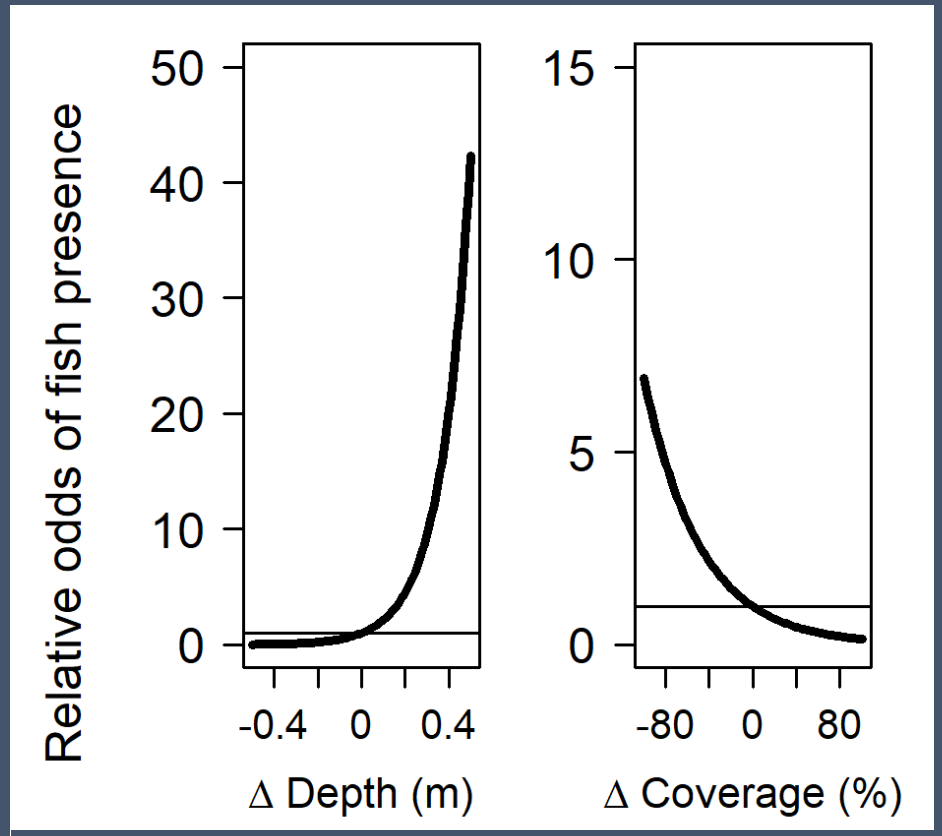

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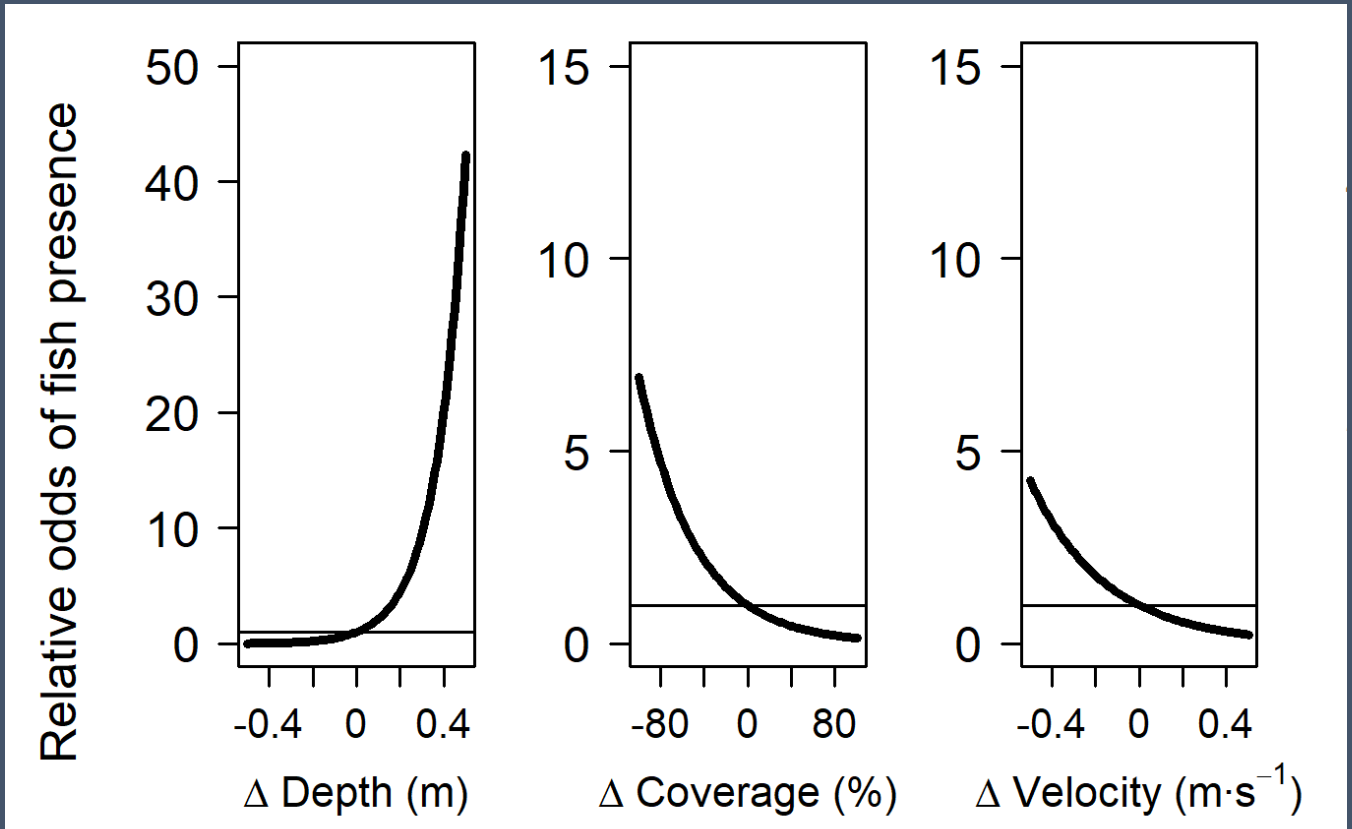

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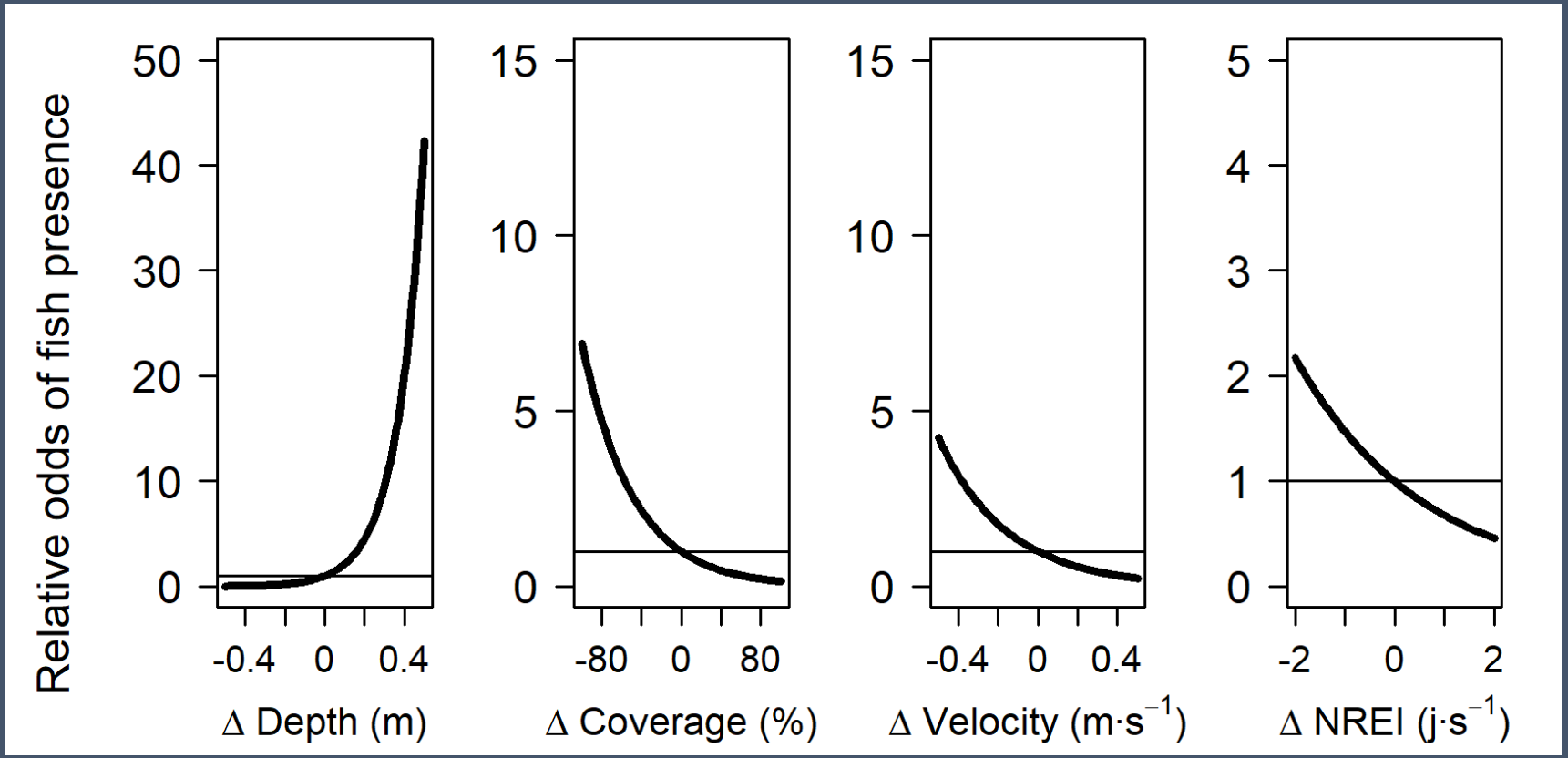

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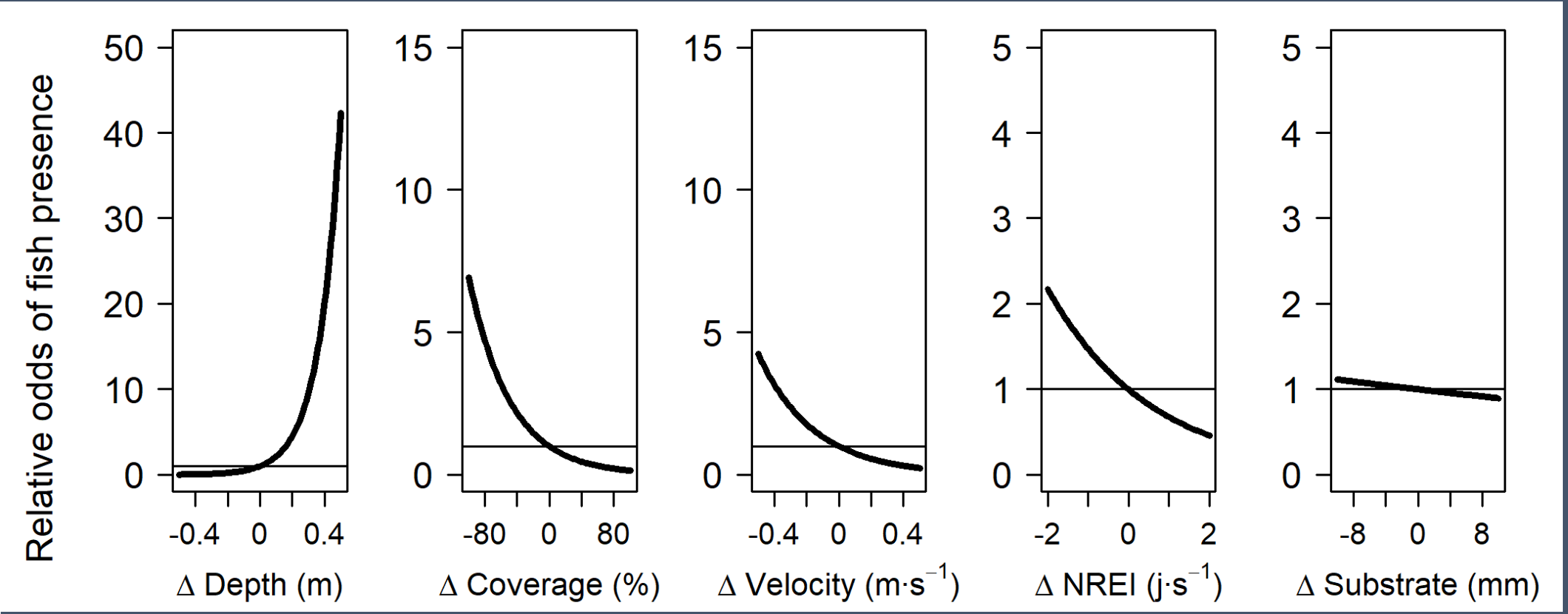
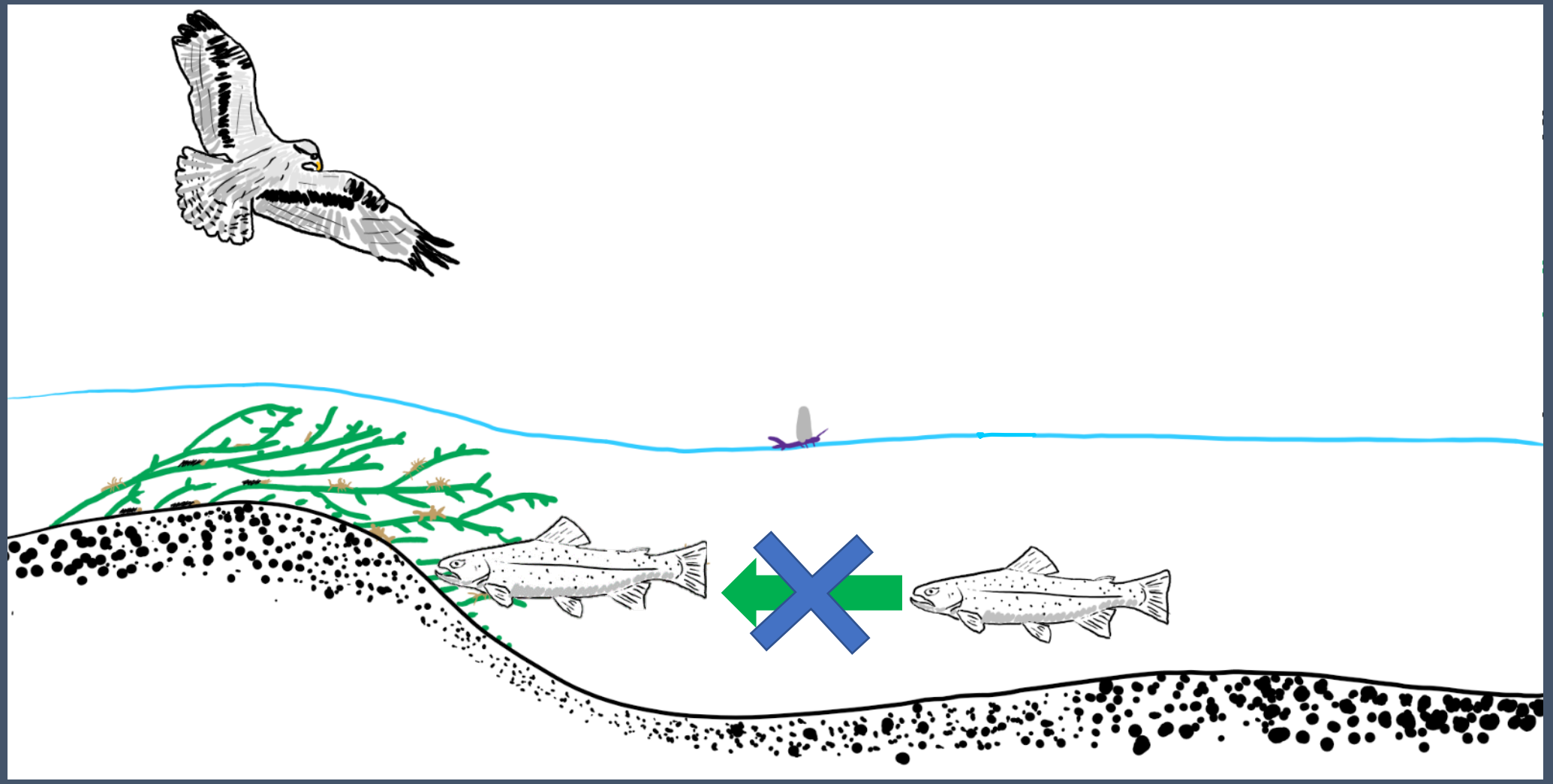
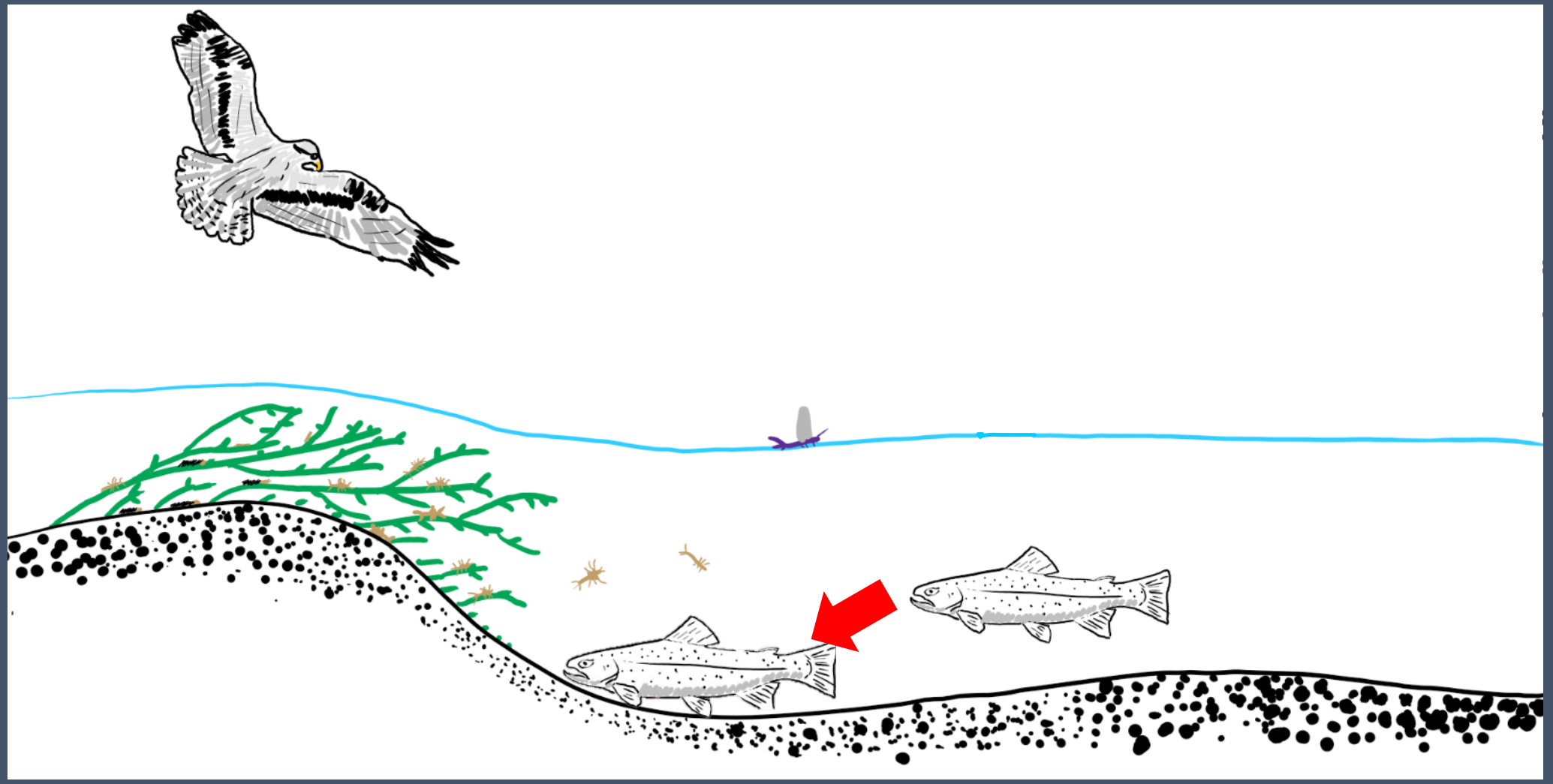


Takeaway: Fish prefer deeper, slower, macrophyte-free water, no preference for food/growth

Discussion - hypothesis

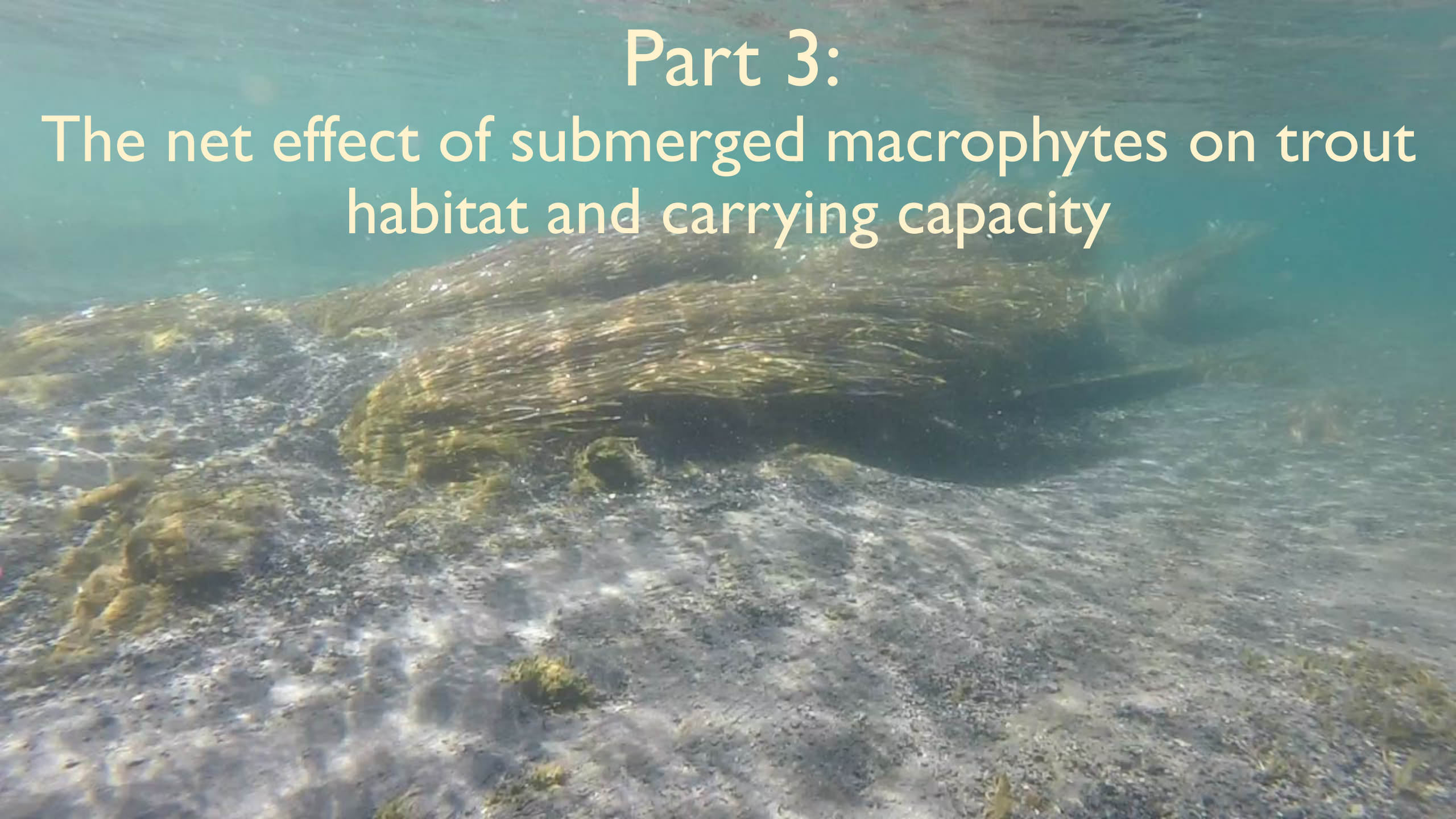


Discussion - hypothesis



Should we fight macrophyte growth?

- Macrophyte cutting?
- Pool creation?
- Fight new treated sewage outfall?

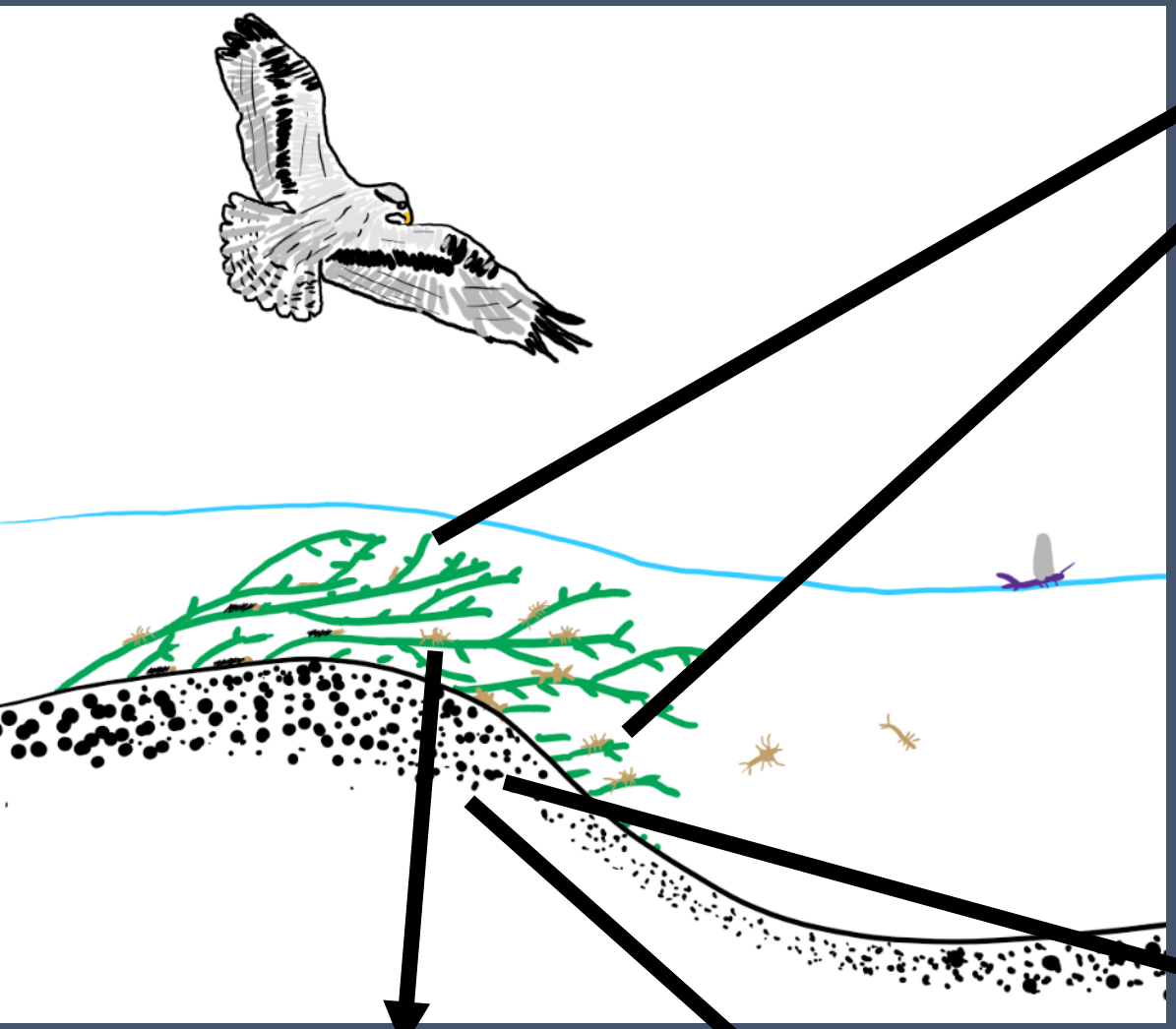


Part 3:
The net effect of submerged macrophytes on trout habitat and carrying capacity

Question: What is the net effect of submerged macrophytes on trout habitat?

- Hypotheses: Submerged macrophyte coverage creates a riverscape of complimentary habitats at the reach scale, improving net fish habitat

Submerged macrophytes at the reach scale



Increase water level

Slower velocities

Trap sediment

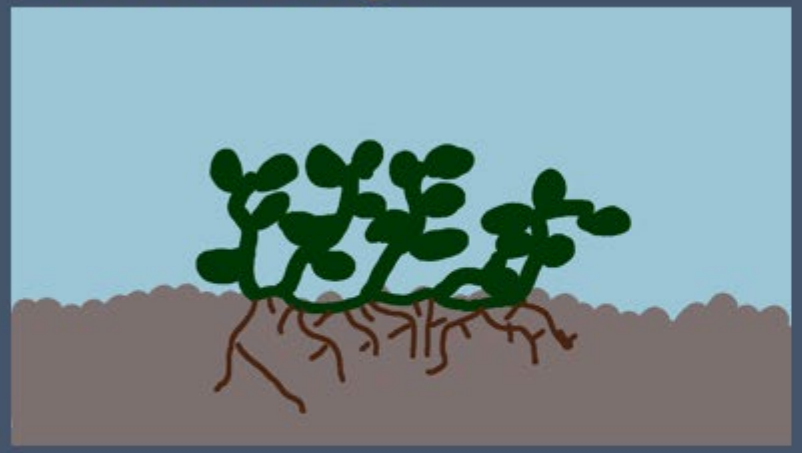
Refuge for macroinvertebrates

Nutrient and organic matter processing

Methods: identify habitat types

- Physical surveys: reach-wide effects of submerged macrophytes

Low coverage



Headwaters
Spring

High coverage

Tailwater
Fall

Methods: identify habitat types

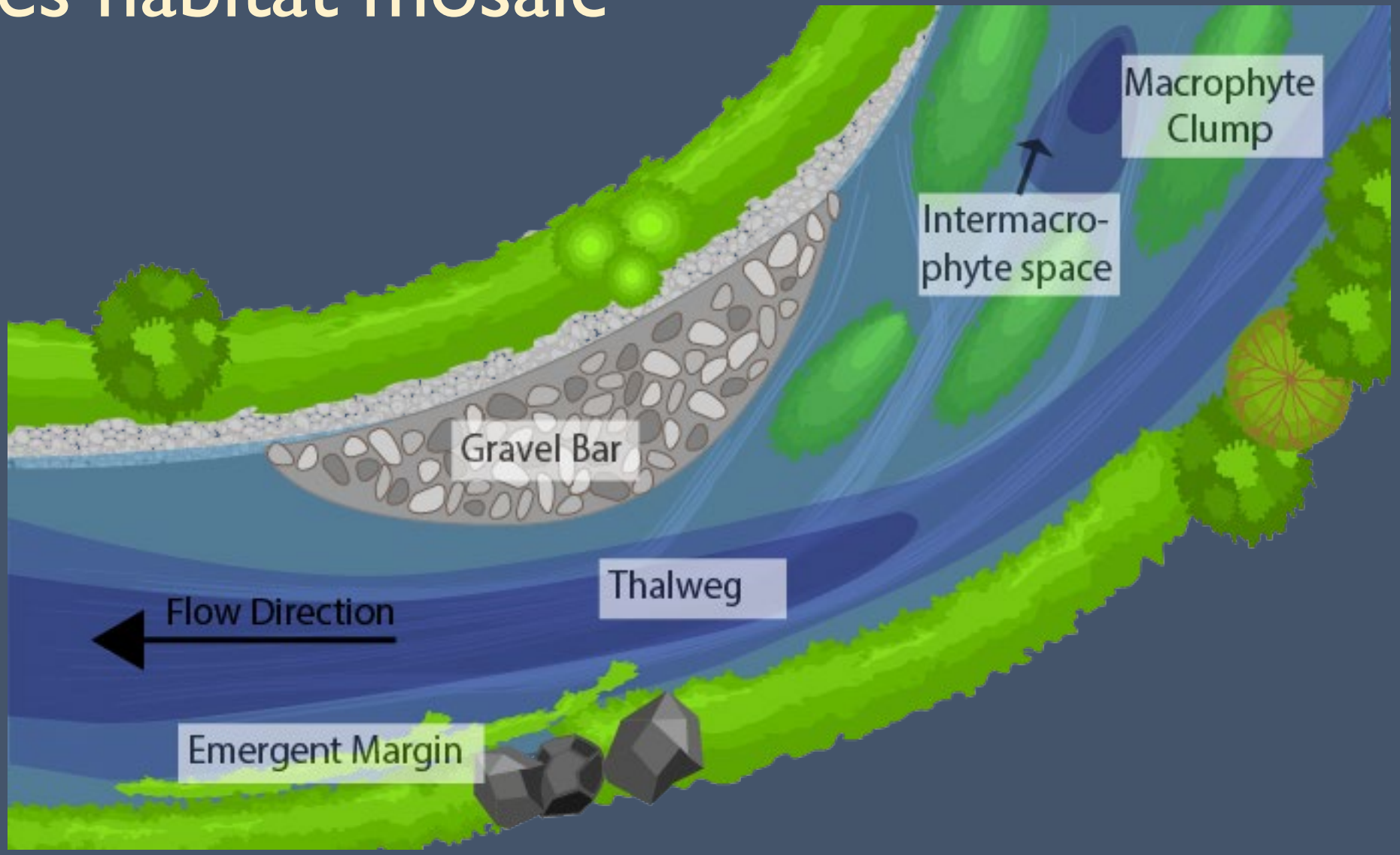
- Physical surveys: reach-wide effects of submerged macrophytes
  - Macrophyte coverage (%)
  - Macrophyte growth height (m)
  - Substrate size (mm)
  - Water velocity (m/s)
  - Water depth (m)

Methods: identify habitat types

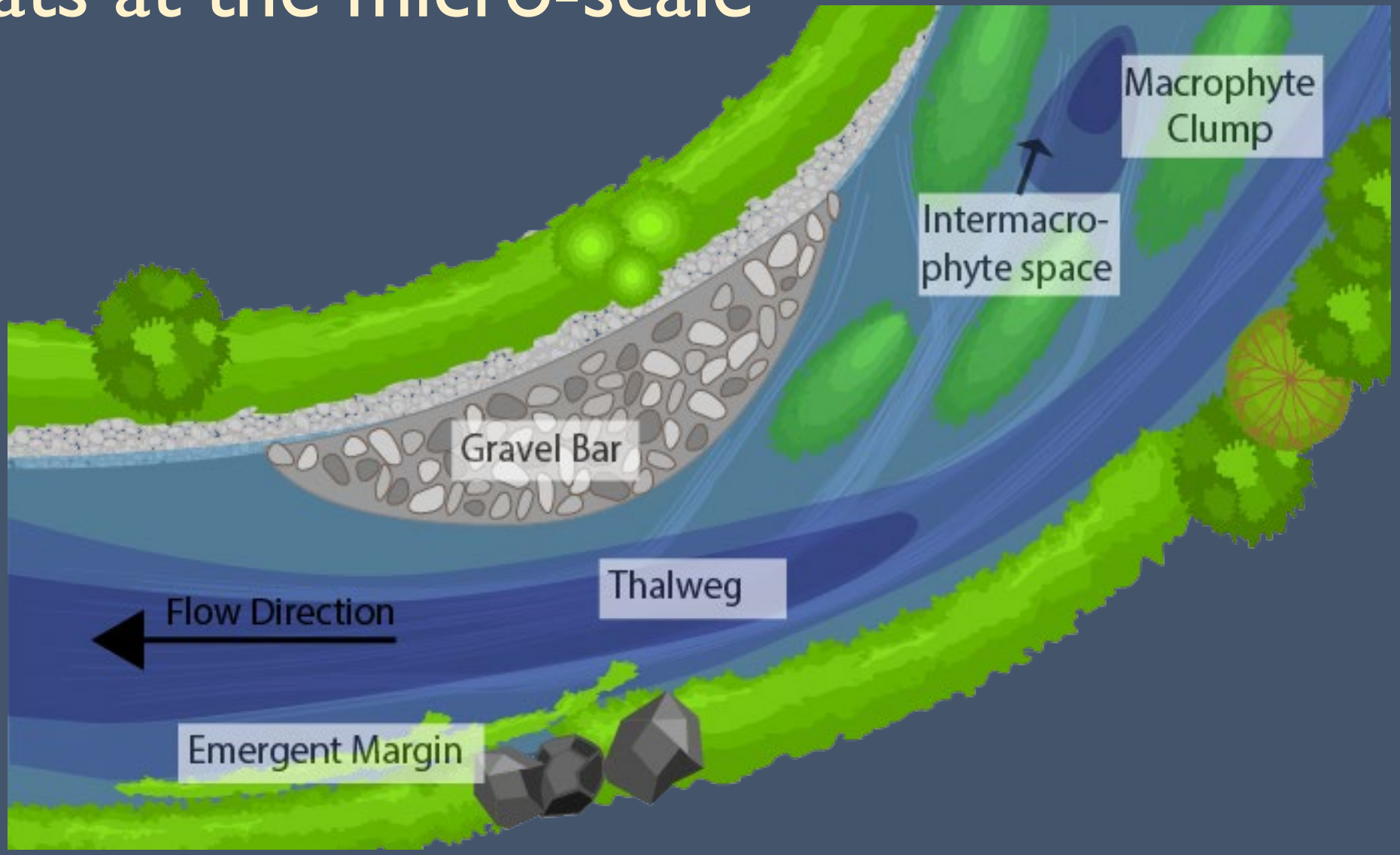
- Physical surveys: reach-wide effects of submerged macrophytes
  - Macrophyte coverage (%)
  - Macrophyte growth height (m)
  - Substrate size (mm)
  - Water velocity (m/s)
  - Water depth (m)

K-means clustering: identify habitat types

Reach-scale submerged macrophyte coverage creates habitat mosaic



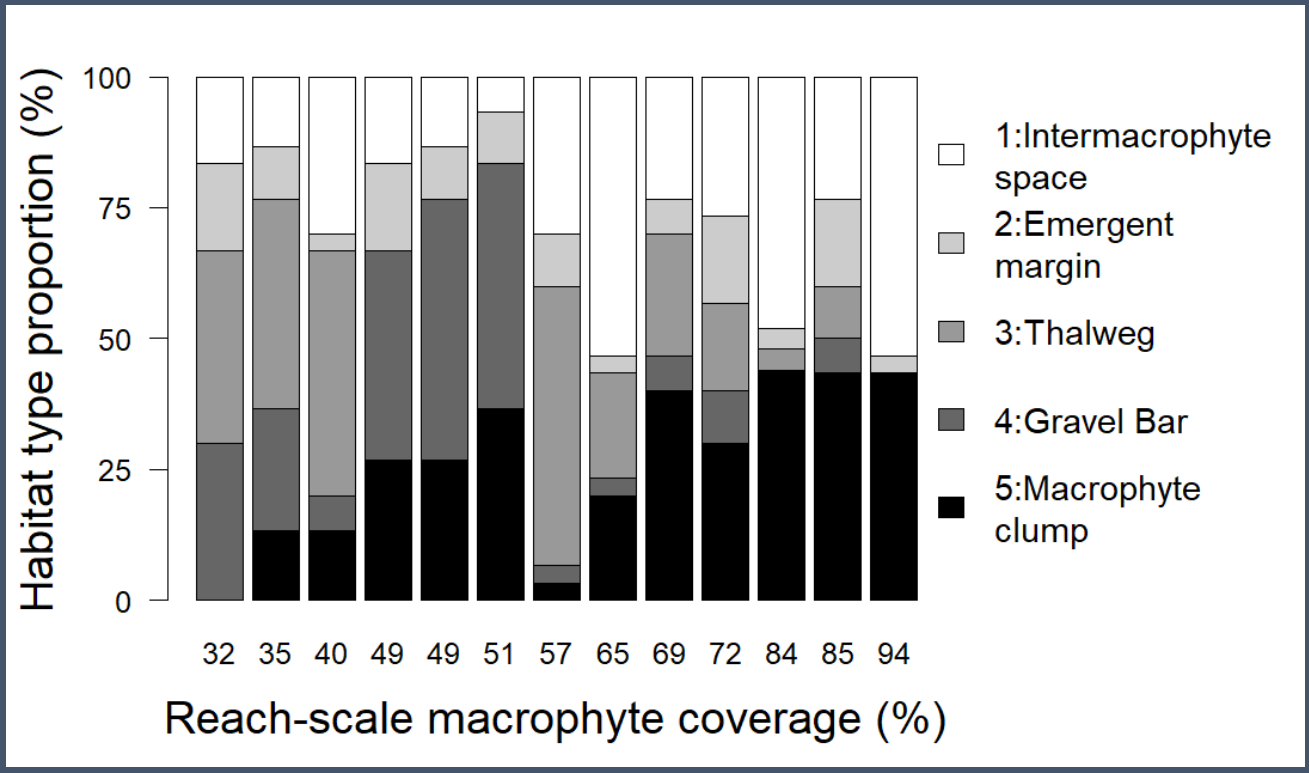
Reach-scale vegetation creates favorable habitats at the micro-scale



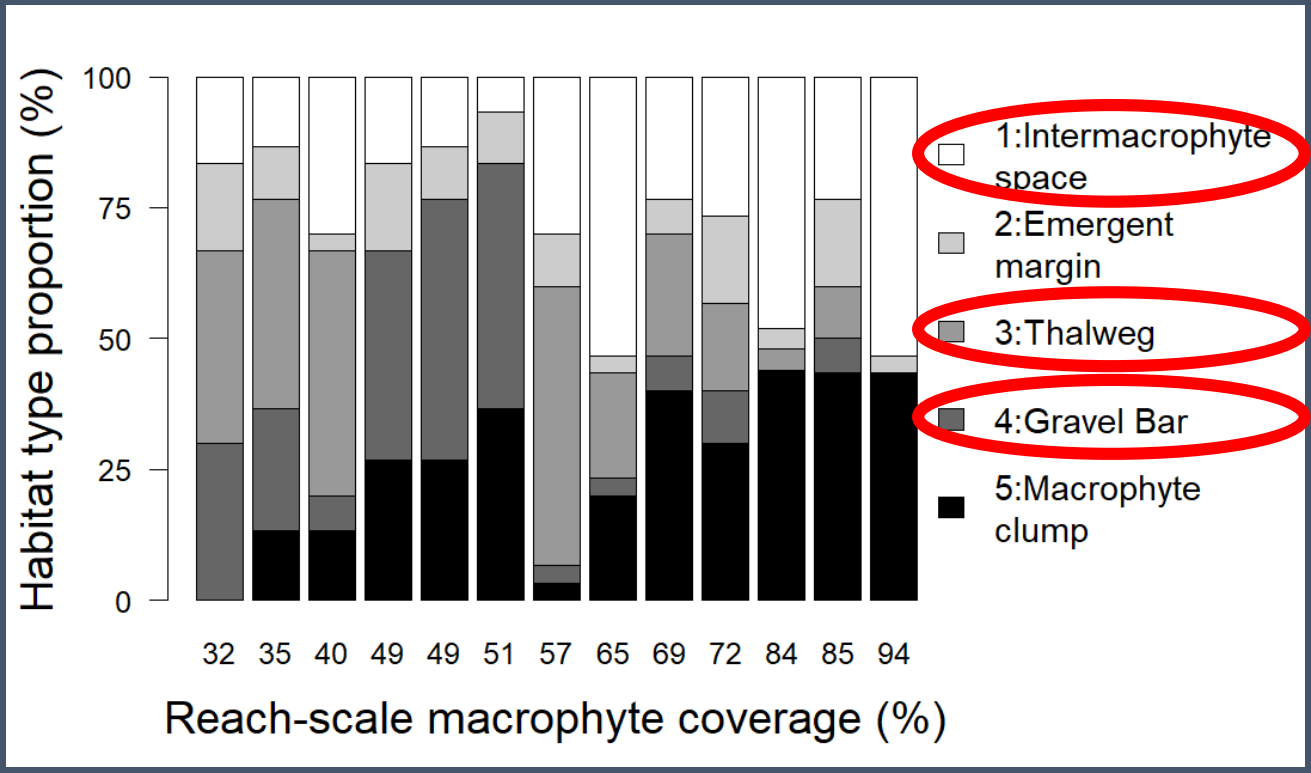
Results – Biogeomorphology

Takeaway

- Submerged macrophyte coverage governs relative abundance of habitat types



Results – Net effect

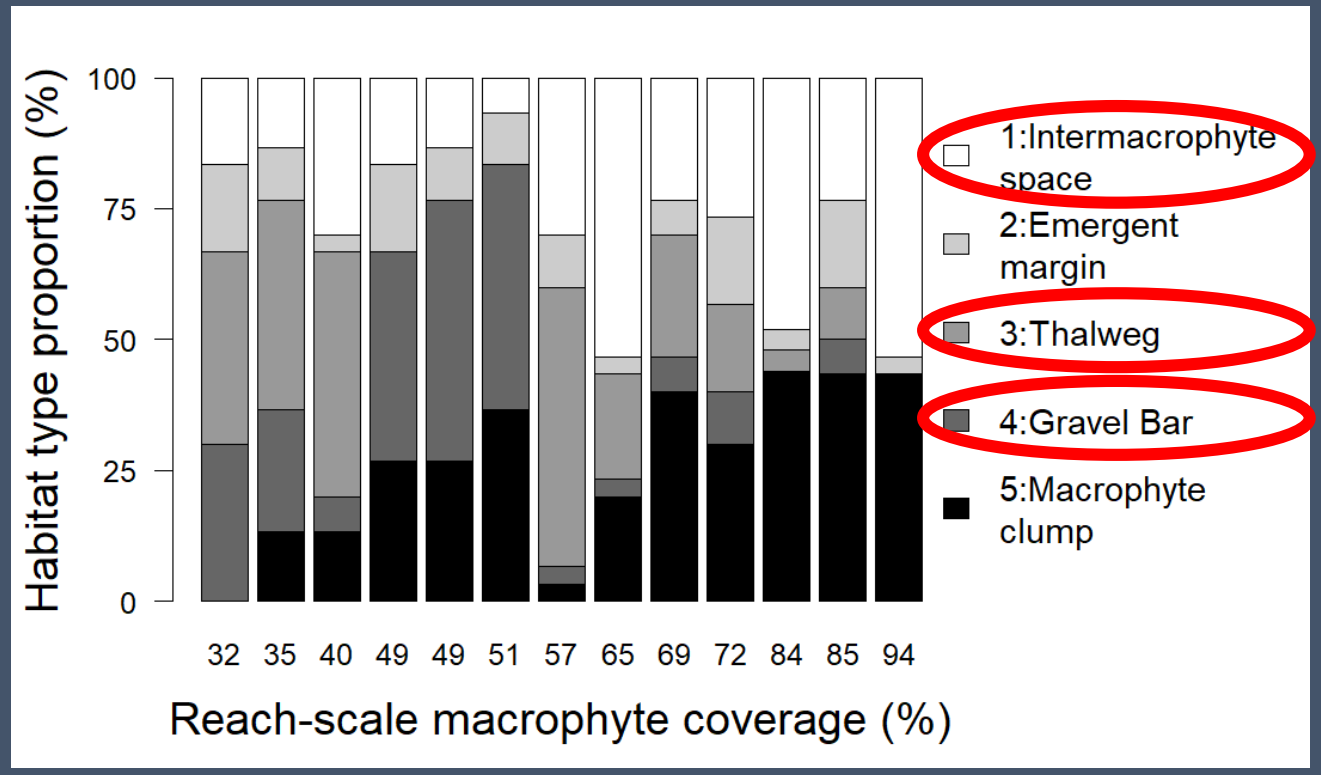


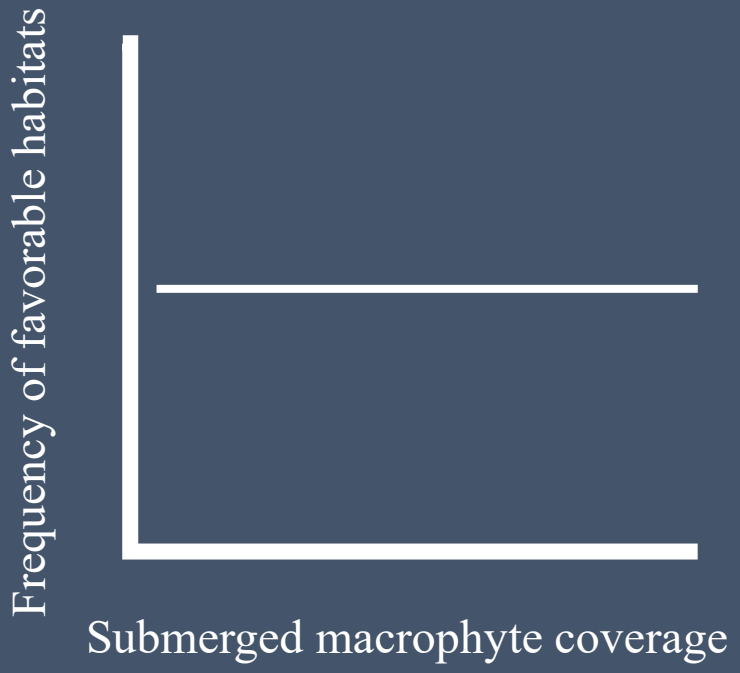
Preferred habitat types

Results – Biogeomorphology

Takeaways

- Preferred habitat frequency stable along reach-scale macrophyte gradient

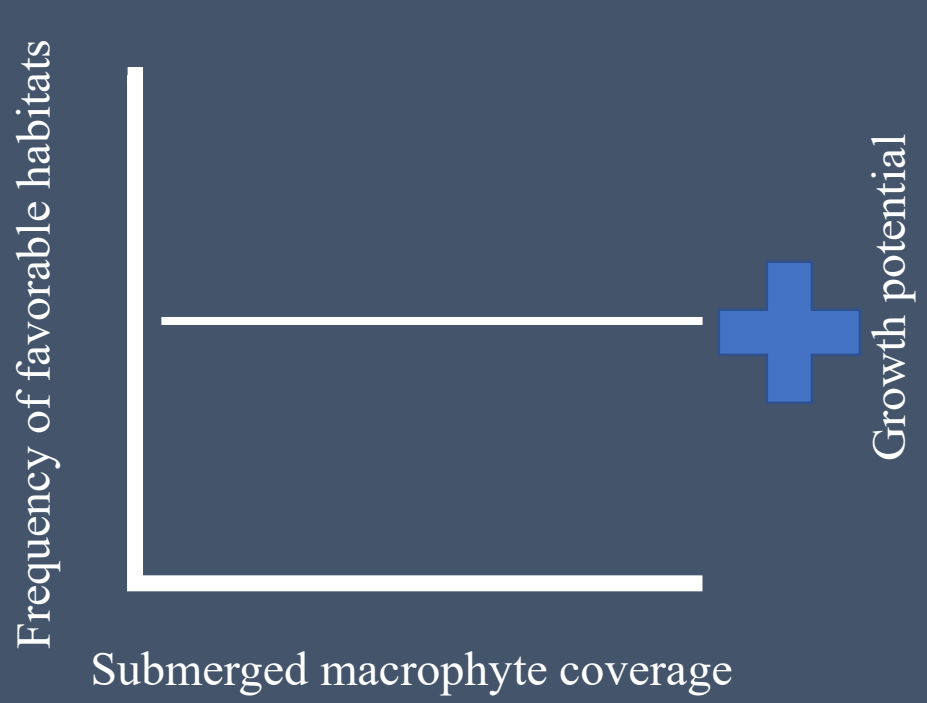


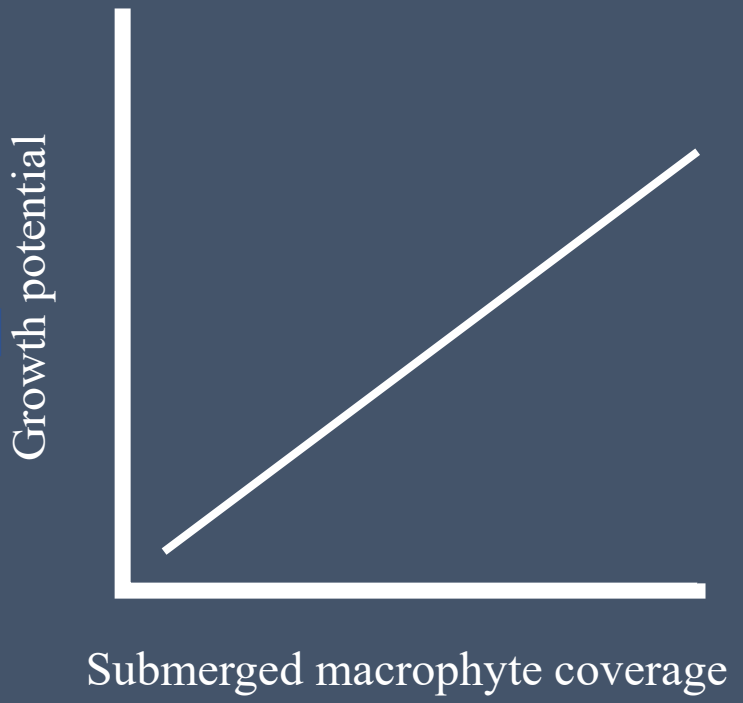


Results – Biogeomorphology

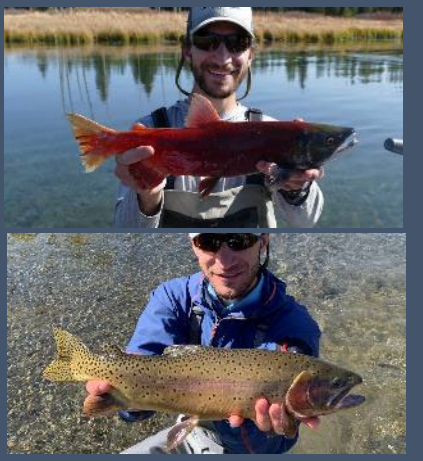
Takeaways

- Preferred habitat frequency stable along reach-scale macrophyte gradient
- Preliminary data shows submerged macrophytes also appear to increase reach-scale growth potential



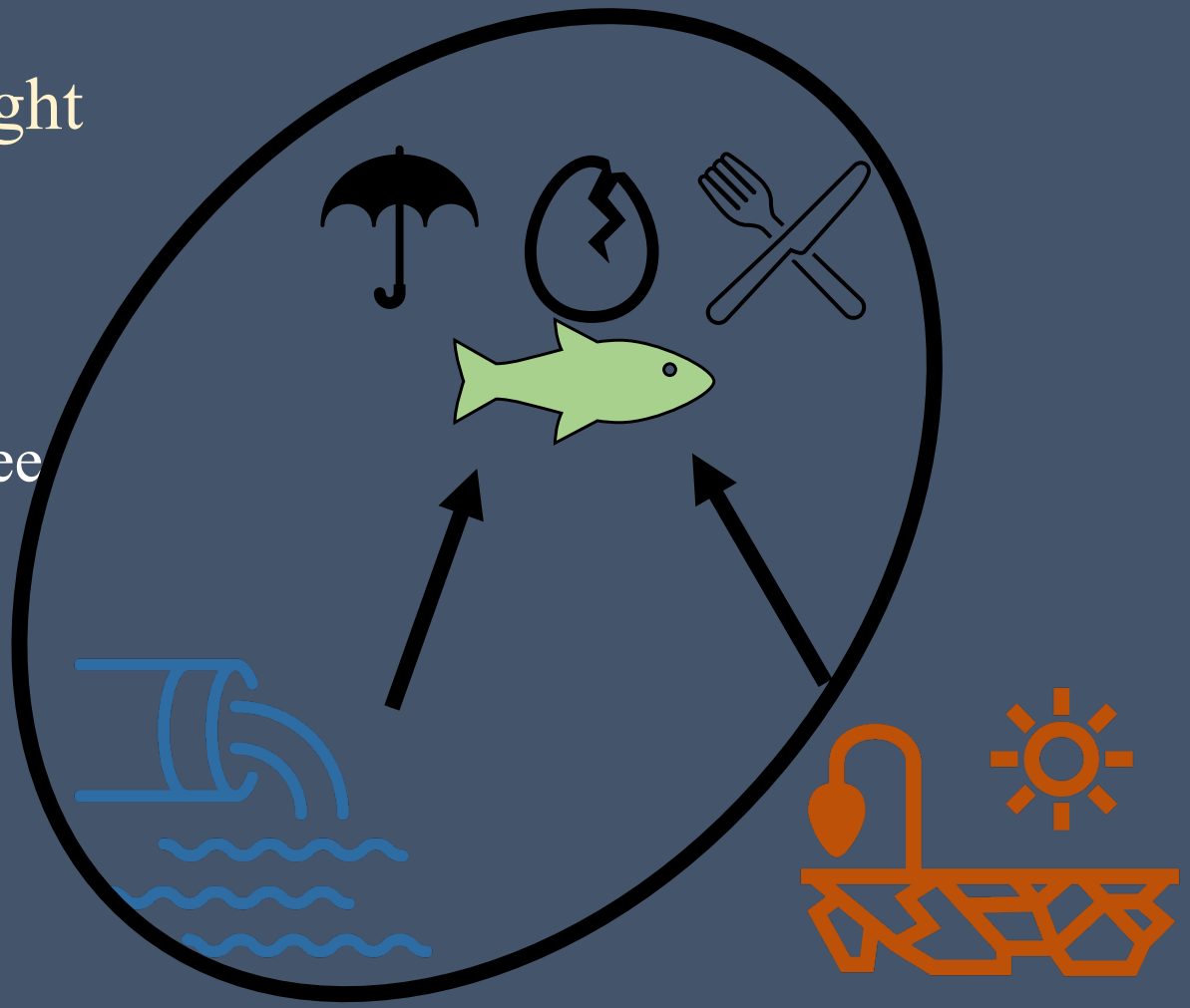


More and bigger fish



Study Questions:

- What limits fish habitat and abundance in the Henry's Fork Headwaters?
- How might nutrient pollution and drought affect fish habitat and abundance in the Henry's Fork Headwaters?
- Answers:
  - Fish prefer deeper, slower, macrophyte-free water, no preference for food/growth
  - Submerged macrophytes create habitat mosaic
  - Submerged macrophyte coverage governs reach-scale habitat frequency
  - Net effect on fish habitat likely positive



Takeaways

1. Total fish numbers are a function of Island Park Reservoir drawdown

Takeaways

2. Fish *availability* for anglers is (likely) a function of

- Fish numbers
- Fish fertility (spawning urge)
- Fish Habitat

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   - Overall productivity

Scientific Takeaways

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} Vegetation growth, Nutrient availability, Drought

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Conservation Takeaways

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Keep IPR as full as possible as long as possible

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Conservation Takeaways

Experimental stocking?
Habitat manipulation?

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Keep IPR as full as possible as long as possible

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Promote vegetation growth, productivity

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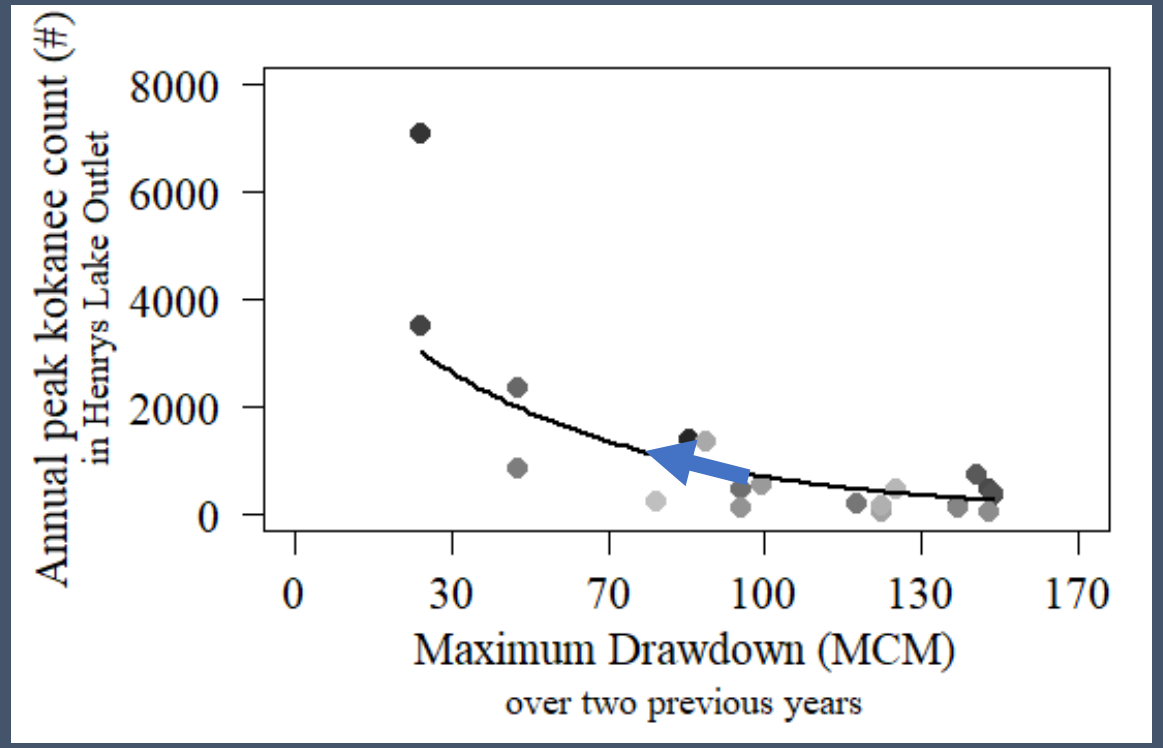
Conservation success

- **Keep IPR as full as possible as long as possible:** Precision Management & Farms and Fish programs
  - Save 20,000 acre/feet
  - Potential 50% increase in kokanee abundance (150% of expected)



Conservation success

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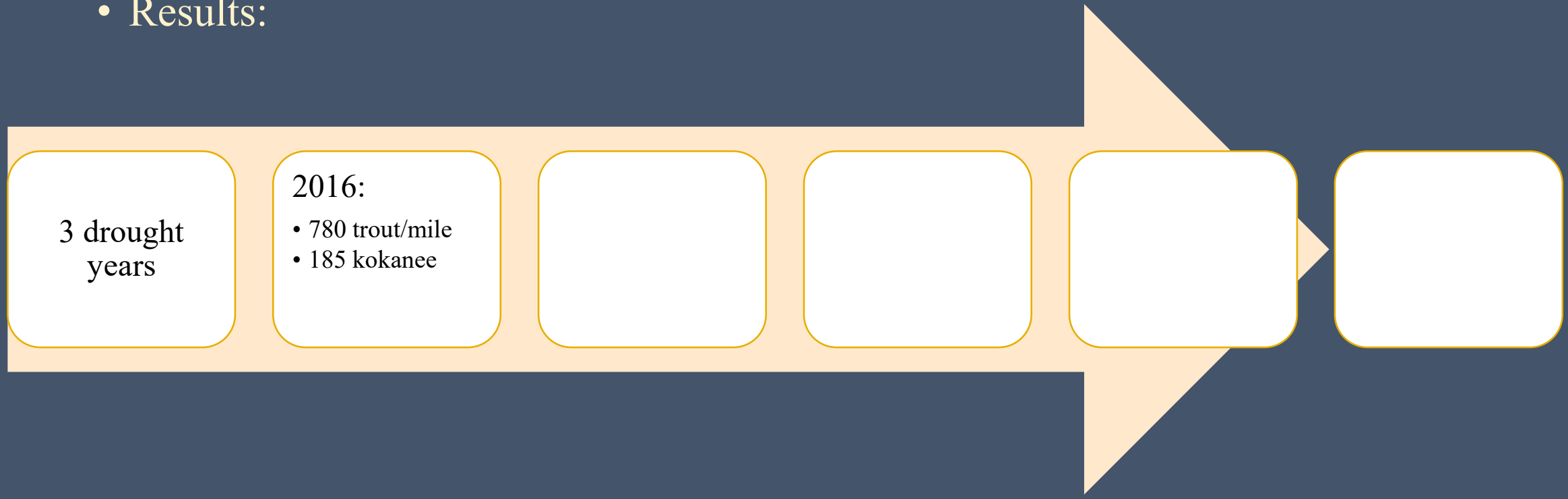
  - Results:



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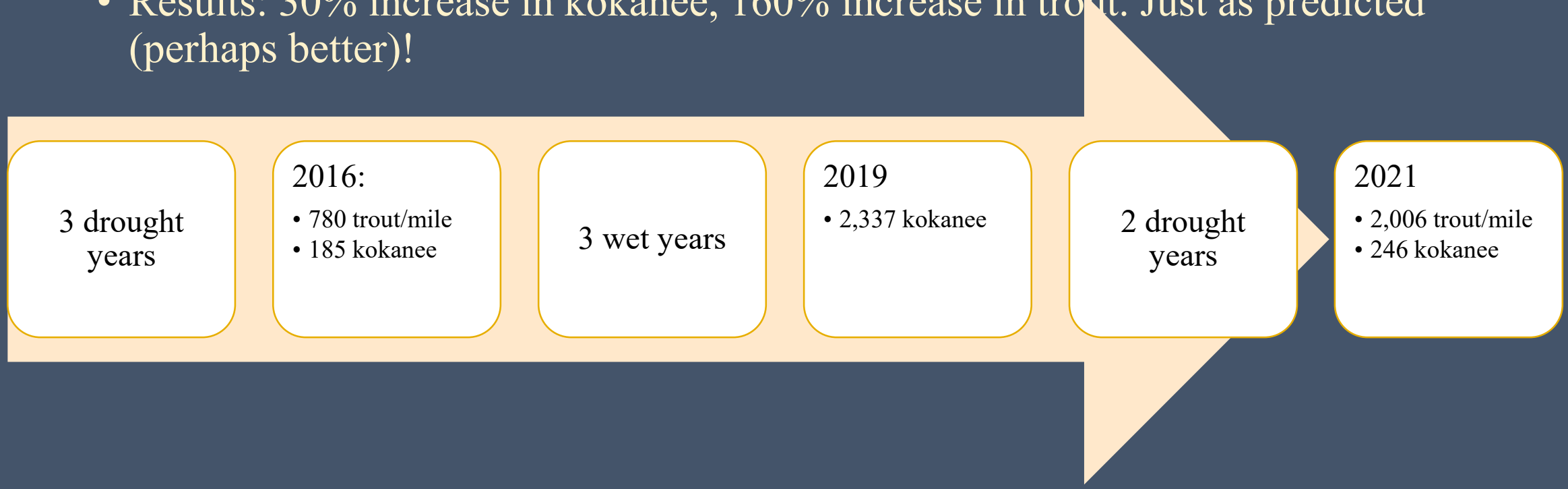
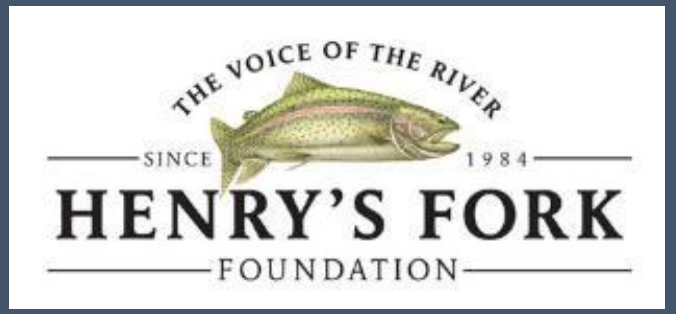
Conservation success

- **Keep IPR as full as possible as long as possible:** Precision Management & Farms and Fish programs
  - Save 20,000 acre/feet
  - Results: 30% increase in kokanee, 160% increase in trout. Just as predicted (perhaps better)!



Big fish and more of them!

Acknowledgements



Questions?