FISH PASS
GIIGOOK MAH-JOWAG

A vision for selective fish passage and invasive species management in the Great Lakes

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Great Lakes RESTORATION
USGS science for a changing world
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CITY of TRAVERSE CITY
DEPARTMENT OF NATURAL RESOURCES DNR MICHIGAN
GRAND TRAVERSE BAND OF OTTAWA/CHIPPEWAS NATURAL RESOURCES
Great Lakes Fishery Trust
U.S. FISH & WILDLIFE SERVICE
Sea Grant Michigan
GREAT LAKES FISHERY COMMISSION PROTECTING OUR FISHERY

Connectivity conundrum?

Sea lamprey

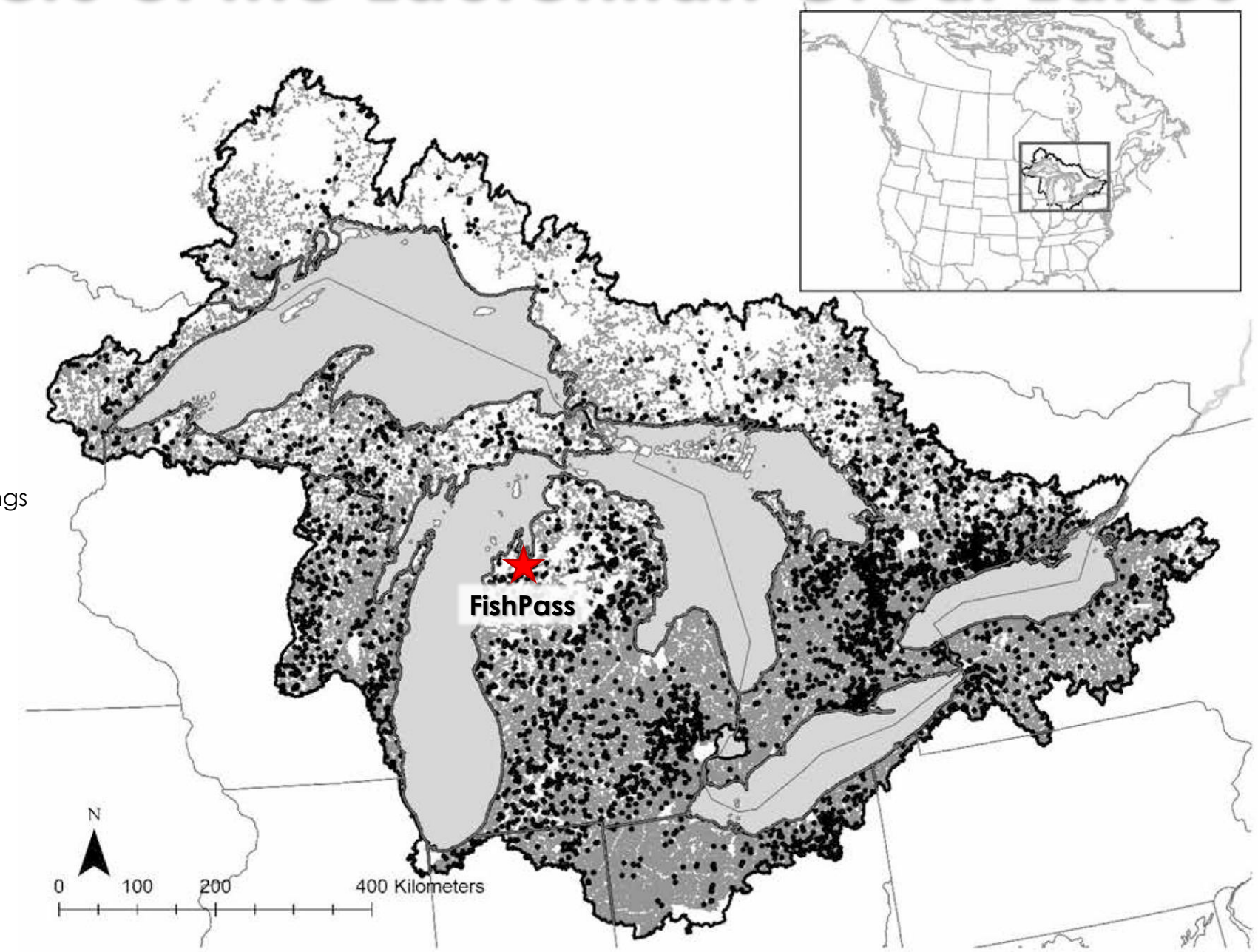
Lake sturgeon

Longnose suckers

A Global problem:

- Tension between improving passage for desirable species while decreasing or eliminating passage by invasive or undesirable species.

Barriers of the Laurentian Great Lakes



- Dams
- Road crossings

Moody et al. 2017. Fisheries. 42(1):57-65.

GLFC & Sea Lamprey Control

*GLFC is a 1955 treaty organization between Canada and the United States (www.glfc.int) charged with **sea lamprey control** and maintaining **healthy sustainable fisheries** in the Great Lakes*

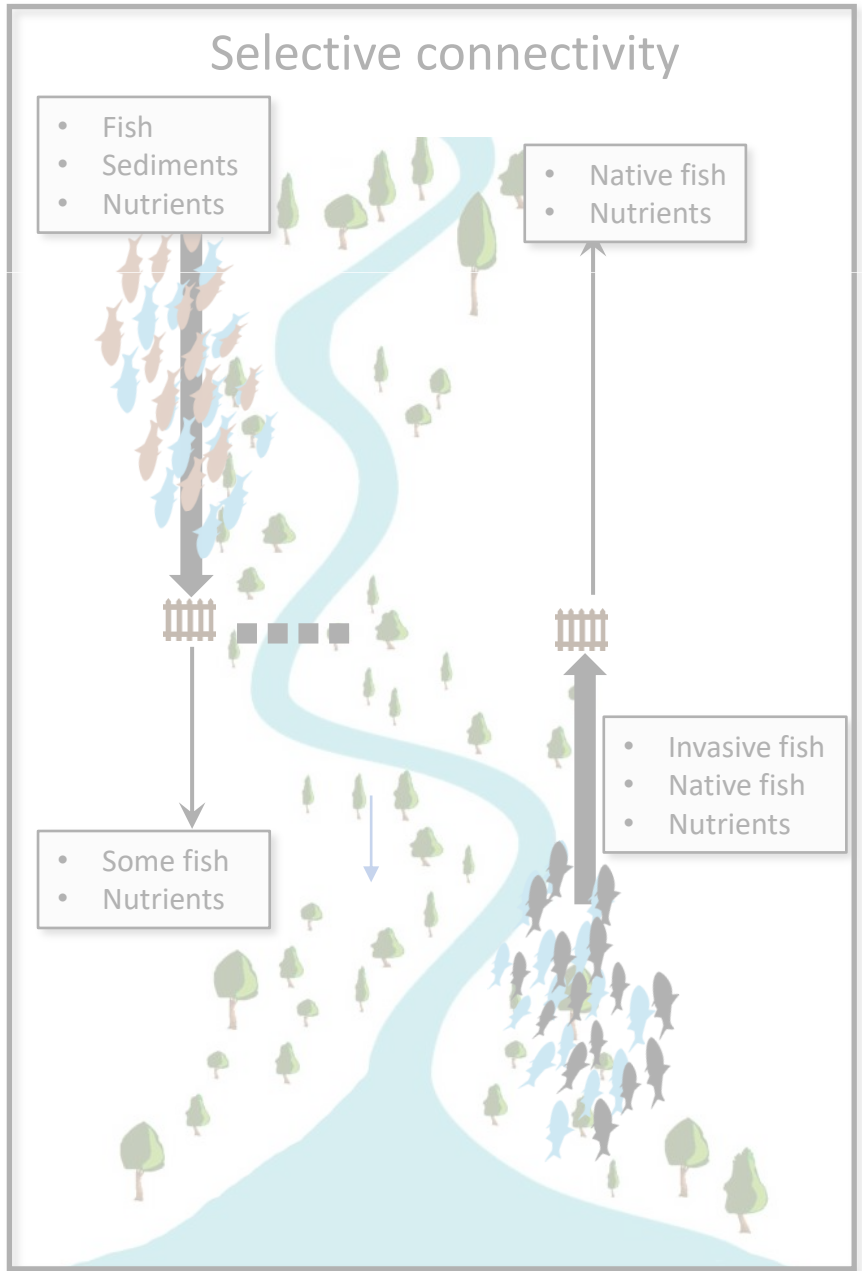
Sea Lamprey Biology

- Attach to prey fish and feed on blood and other bodily fluids
- A single sea lamprey is capable of killing 40 pounds of fish
- Migrates up rivers and streams to spawn and females can lay ~100,000 eggs

Sea Lamprey Control

- Barriers used to deny access to spawning grounds and lampricide used to kill larvae
- Efforts have reduced population by over 90% of historic peak

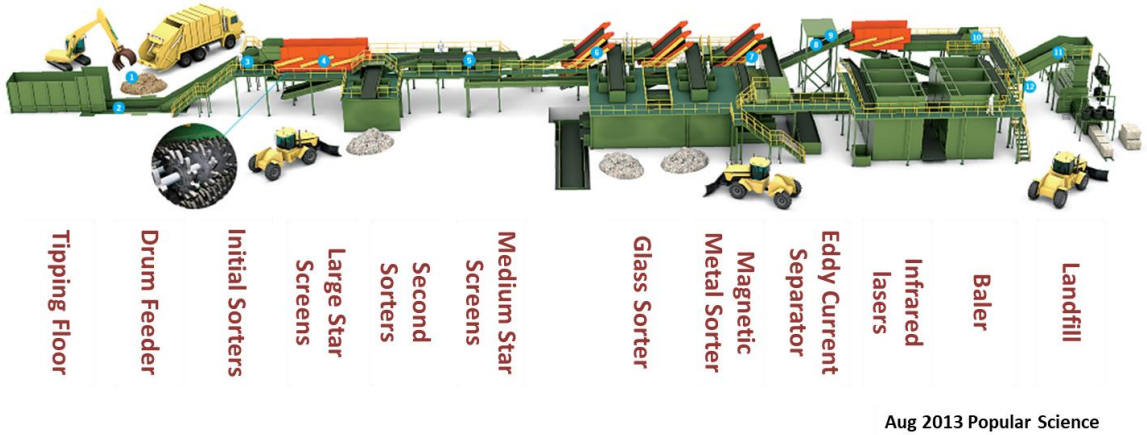
Solutions to the connectivity conundrum



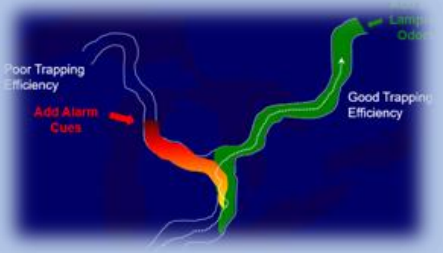
Passing desirable taxa while restricting the dispersal of undesirable taxa would solve many aspects of the connectivity conundrum

Selective passage = How to sort an assortment of things?

- Evolution of single-stream-recycling can **inform approaches** and **expectations** for selective fish passage
- Emphasize **automation** and **attribute-driven sorting**



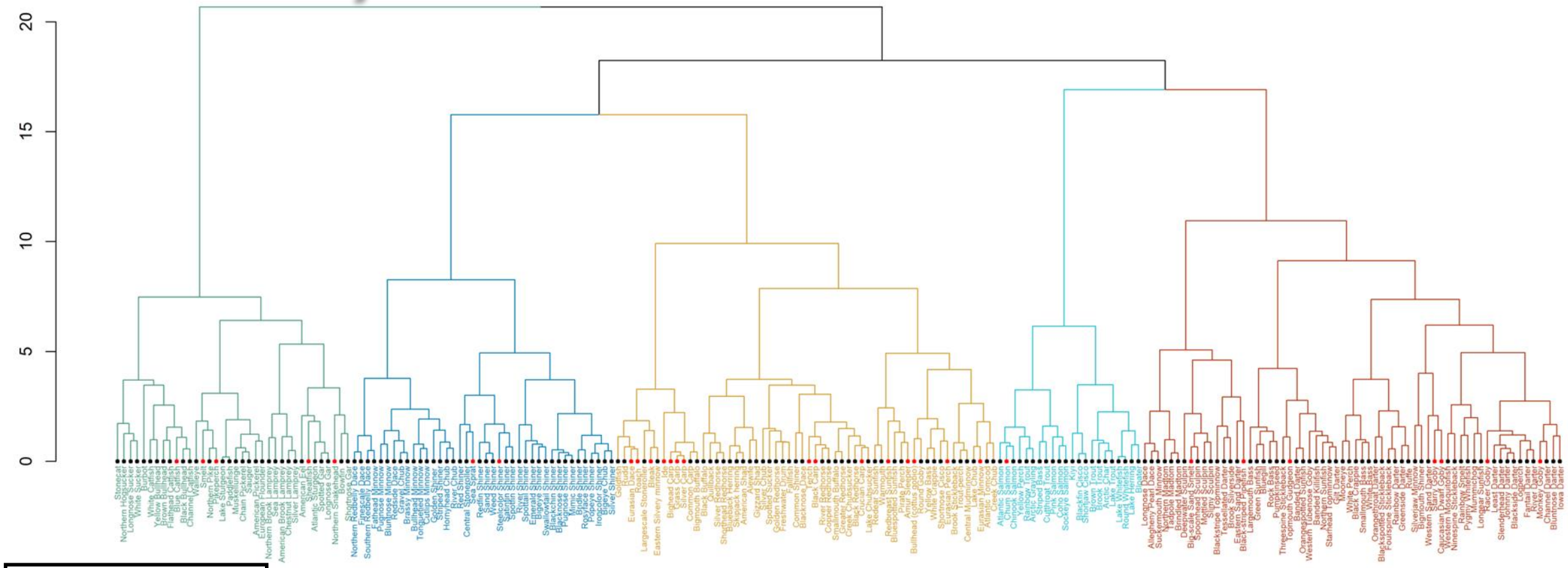
Biology Driven Engineering

PHENOLOGY	MORPHOLOGY	BEHAVIOUR	PHYSIOLOGY
Run Timing; Species	Size, Shape	Guidance, Deterrence, Attraction	Hydraulic Challenges; Leaping ability
			
			
			

Where do we start…attributes?

- Number of migratory species in the Great Lakes is vast
  - 220 species
- Sortable attributes are numerous
  - 21 sortable attributes have been identified and tabulated
- Historically, single-factor designs have been largely ineffective for non-salmonids
- Differentiation/grouping based on attributes rather than species is one way forward

Guild Analysis



Cluster 1
N=36

Migratory
High trophic level
High max length
Cool water (spring)
Small eyes
Electroreceptors
Non-schooling

Cluster 2
N=40

Undetermined migratory status
Low trophic level
Small max length
Warm water (spring/summer)
Large eyes
Schooling
Hearing specialization

Cluster 3
N=58

Migratory
Medium trophic level
Medium max length
Cool water (spring)
Schooling & non-schooling
Hearing specialization

Cluster 4
N=22

Migratory & non-migratory
High trophic level
High max length
Cool water (fall)
Schooling & non-schooling

Cluster 5
N=64

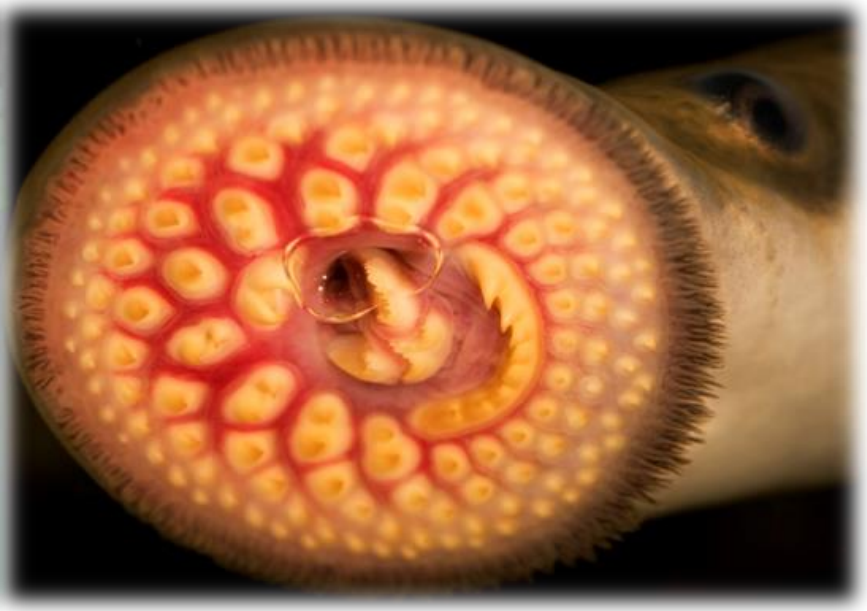
Migratory & non-migratory
Medium trophic level
Small max length
Cool water (spring)
High/large pectoral fins
Schooling & non-schooling

FishPass Mission

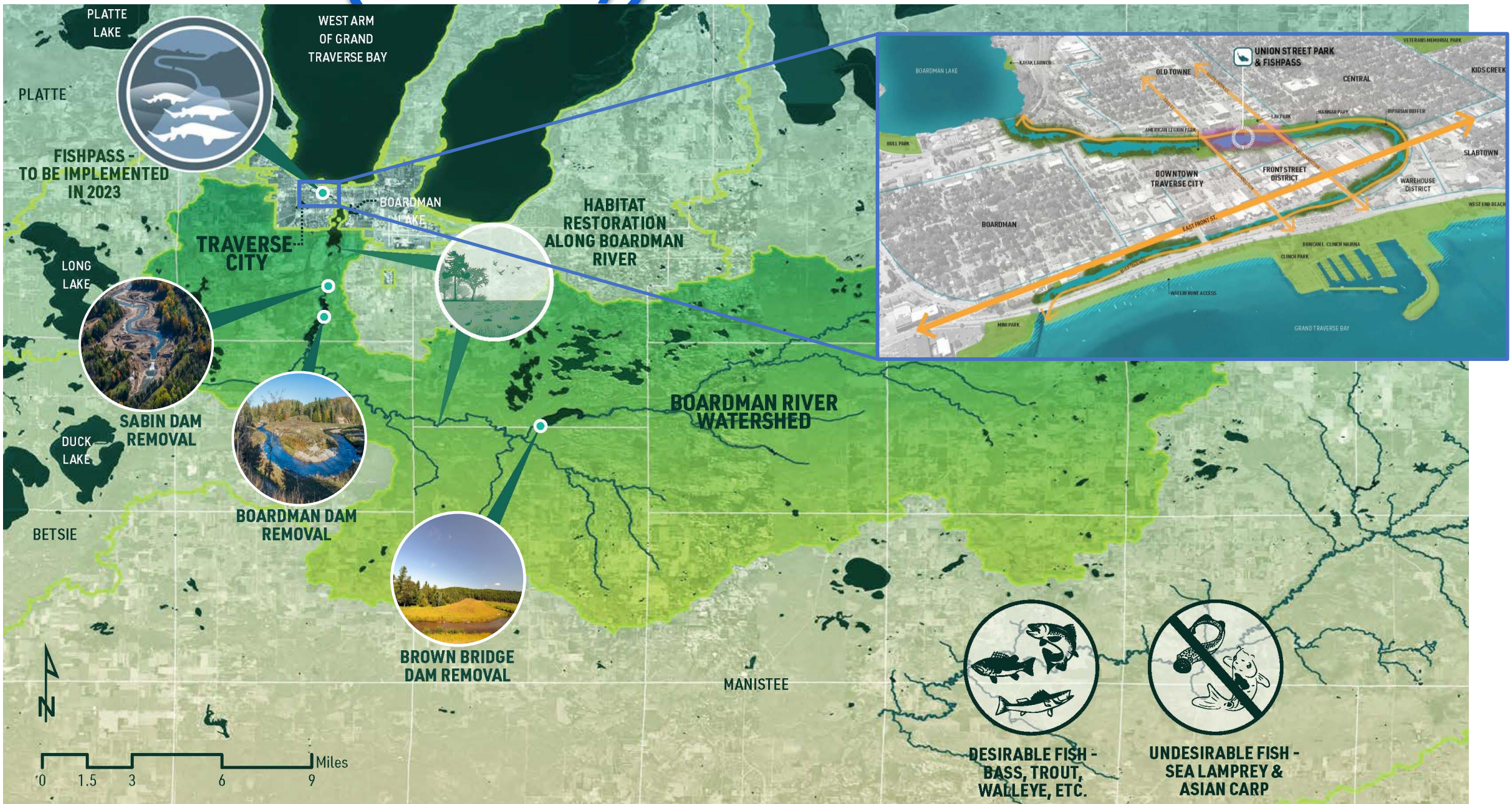
To provide up- and down-stream passage of desirable fishes while simultaneously blocking and/or removing undesirable fishes.

1) *develop and implement selective bi-directional fish guidance, sorting, and passage techniques and technologies;*
2) *determine protocols for implementing selective passage solutions within the Boardman River and throughout the Great Lakes Basin; and*
3) *set solutions in a global context so the approach can be exported.*





Boardman (Ottaway) River



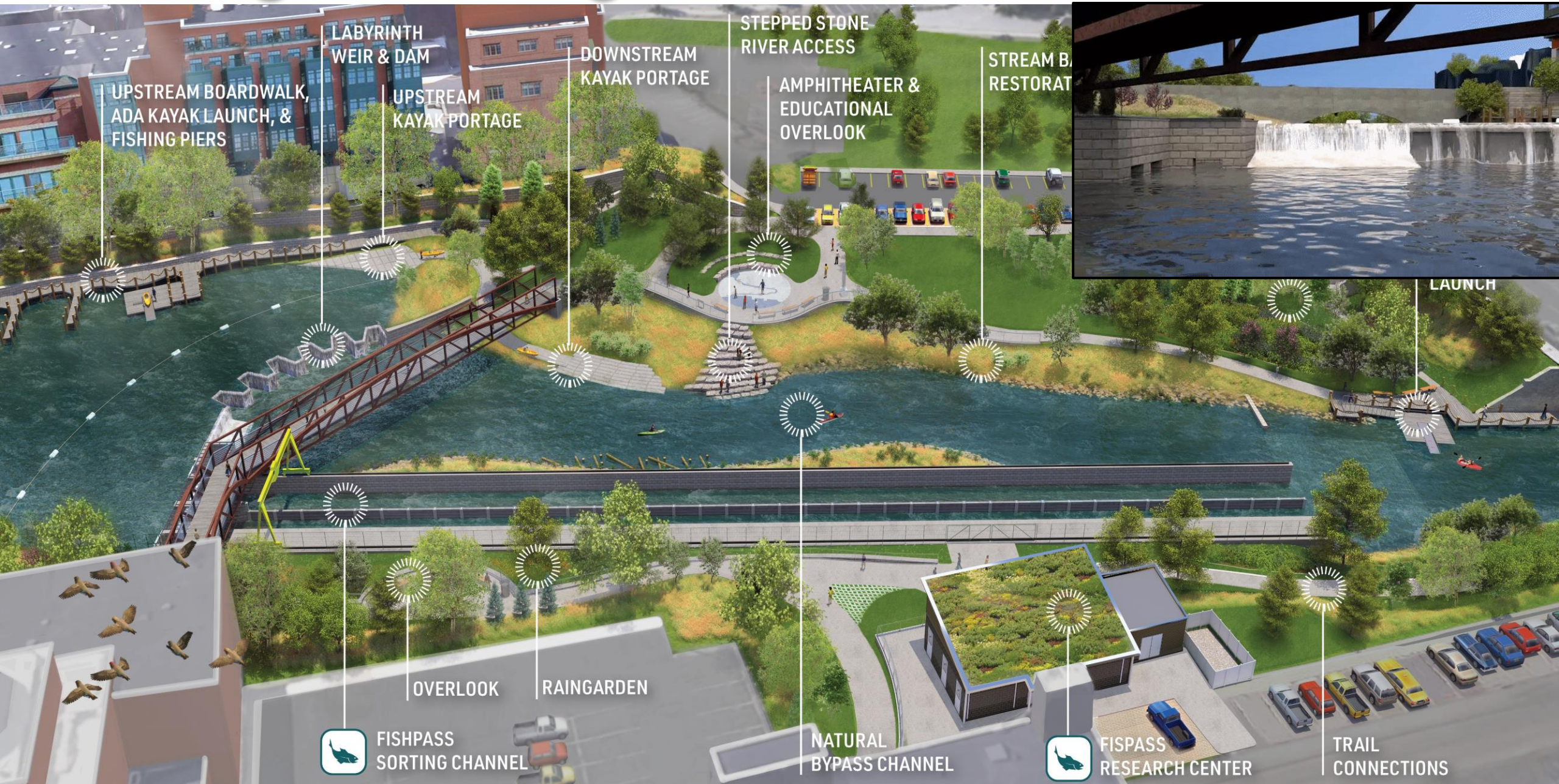
FishPass

Existing Conditions

Proposed Conditions

1. **Replace** the Union Street Dam with an improved barrier with selective fish passage capabilities
2. **Optimize** various sorting technologies below a barrier
3. **Develop** into a living laboratory
4. **Convert** to a permanent selective fishway

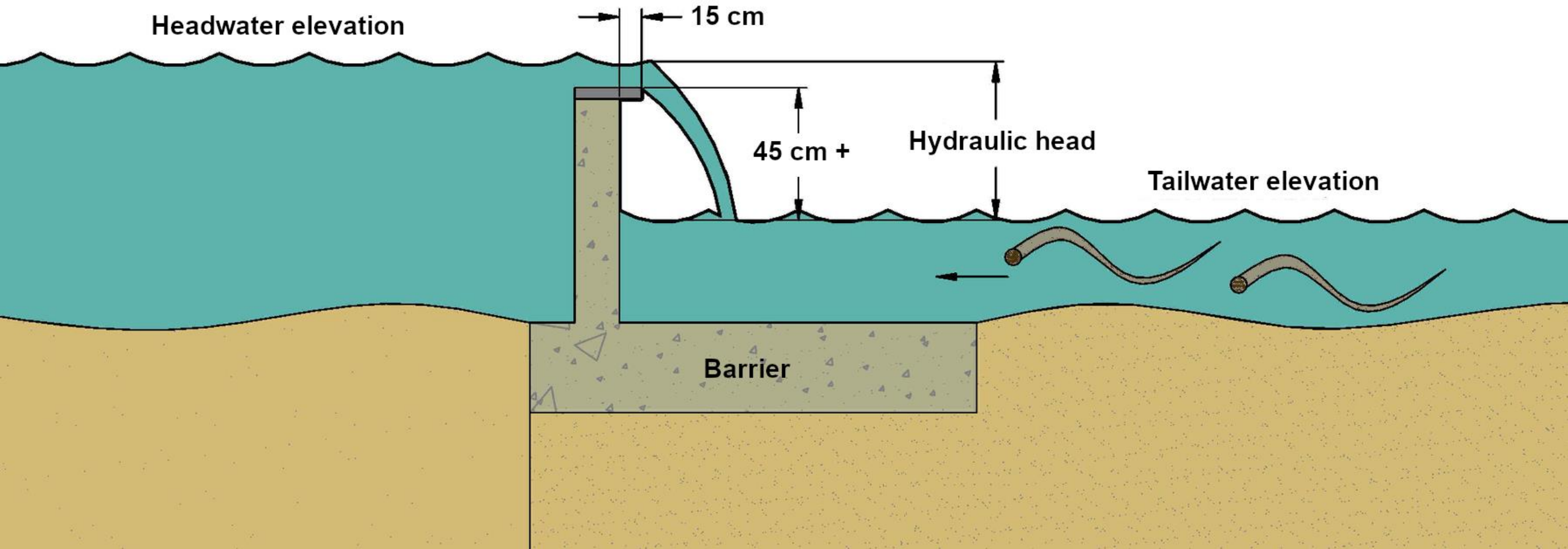
Planning and design



FishPass: An improved barrier

Sea lamprey and salmonid passage analysis was used to:

- Define operational constraints for fish-sorting channel gates
- Estimate relative risk of uncontrolled passage based on historic flows
- Establish hydraulic thresholds to trigger additional monitoring



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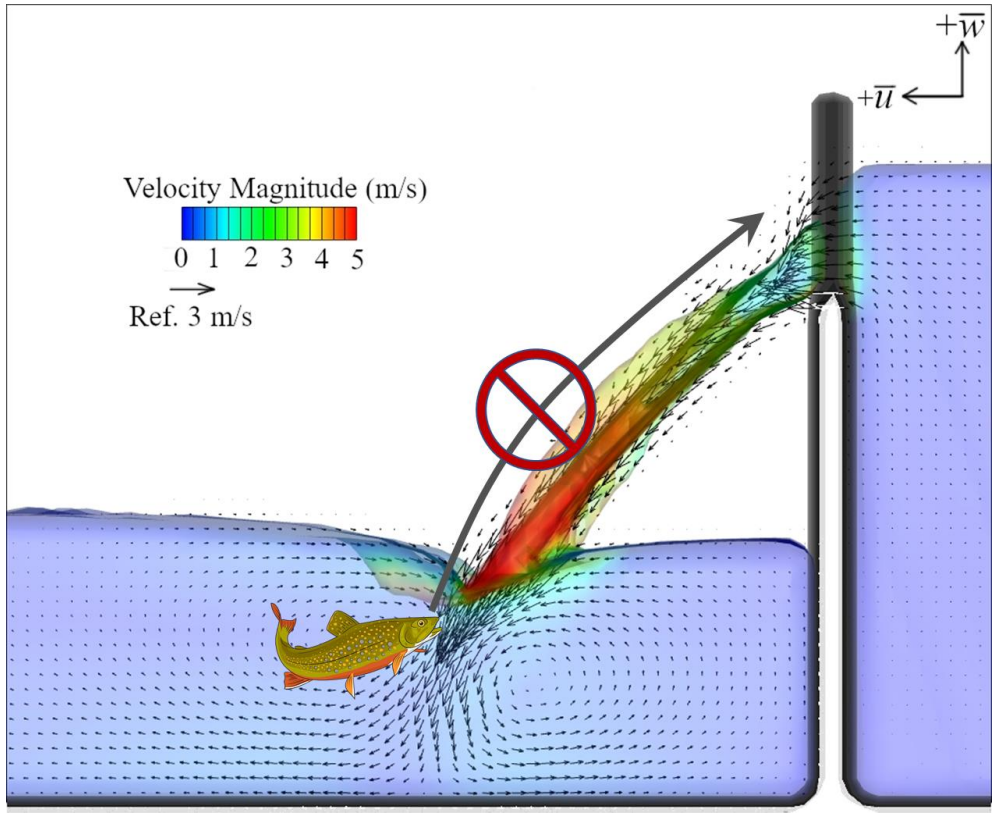

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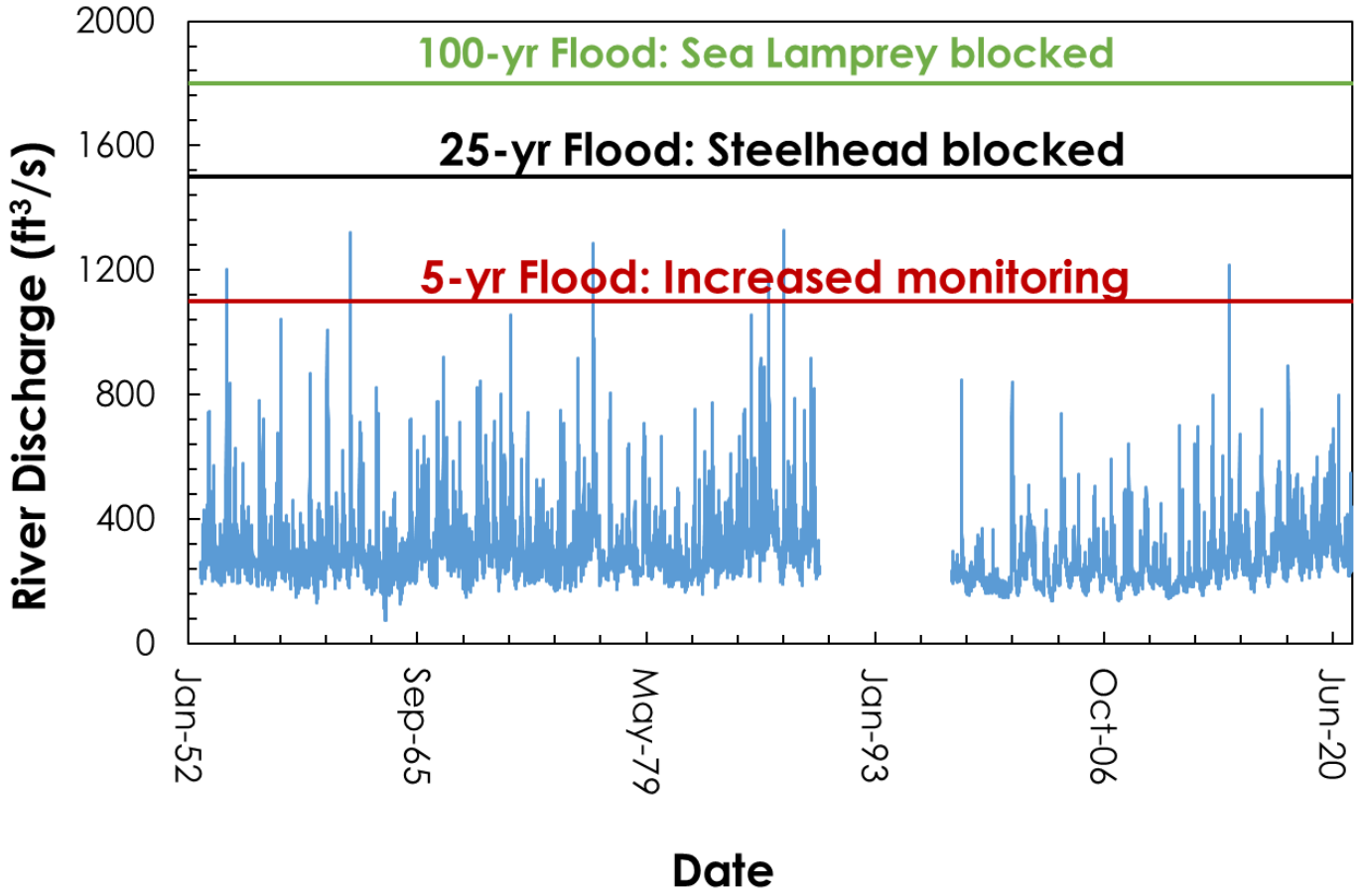
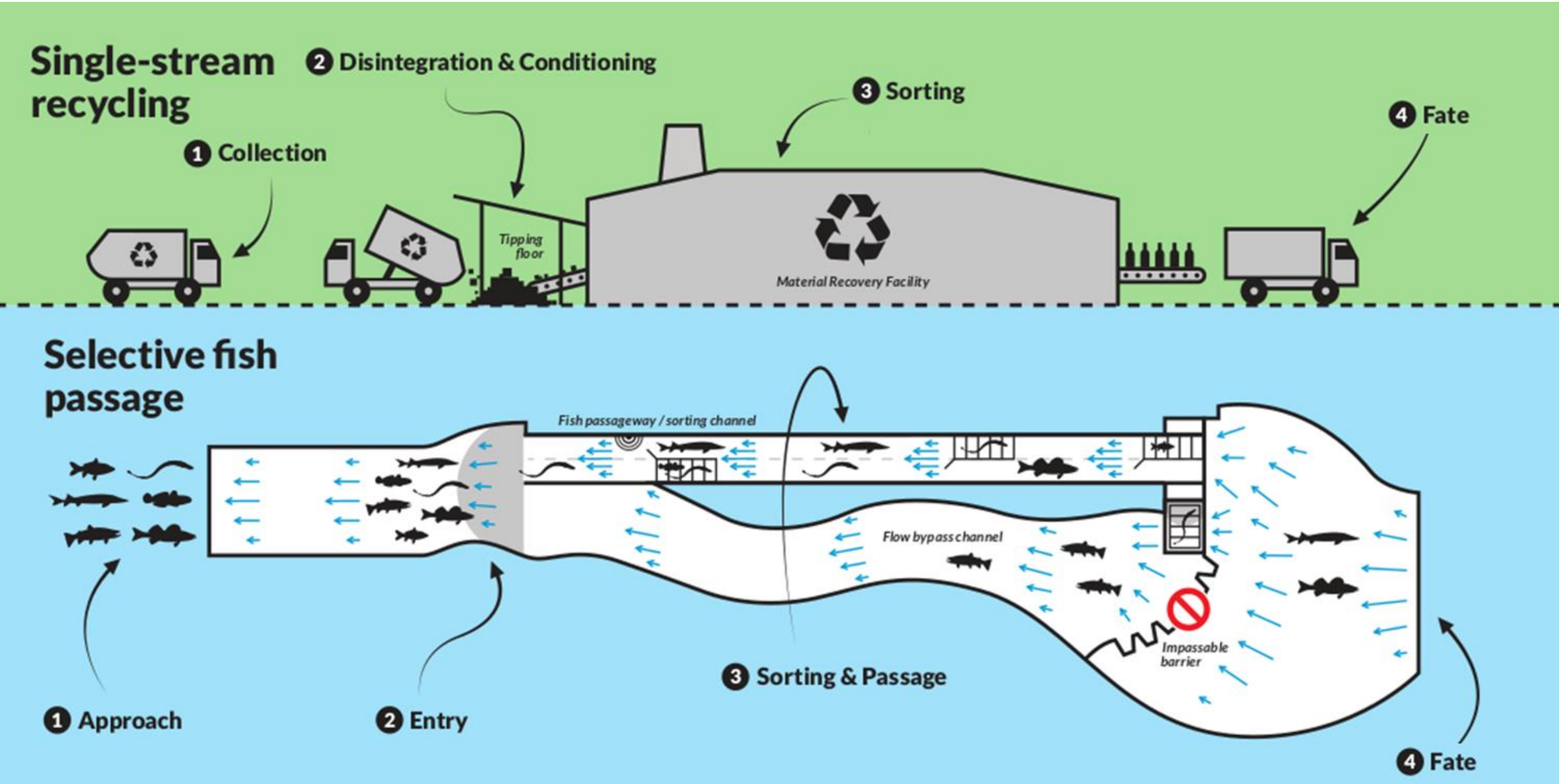


Parallel mechanics of fish passage and recycling



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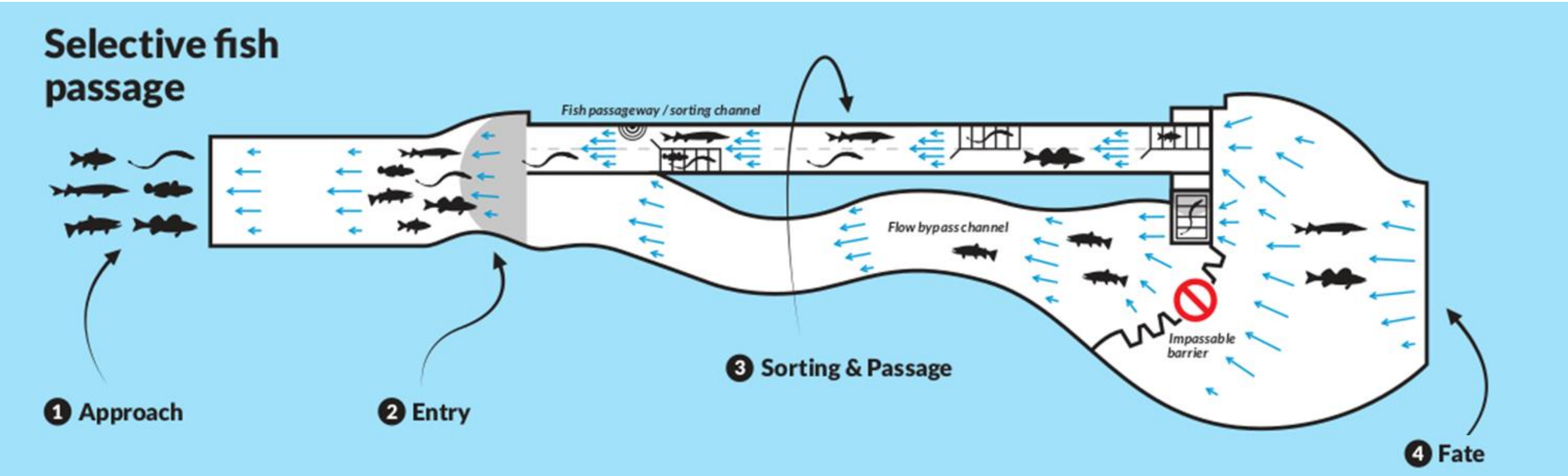
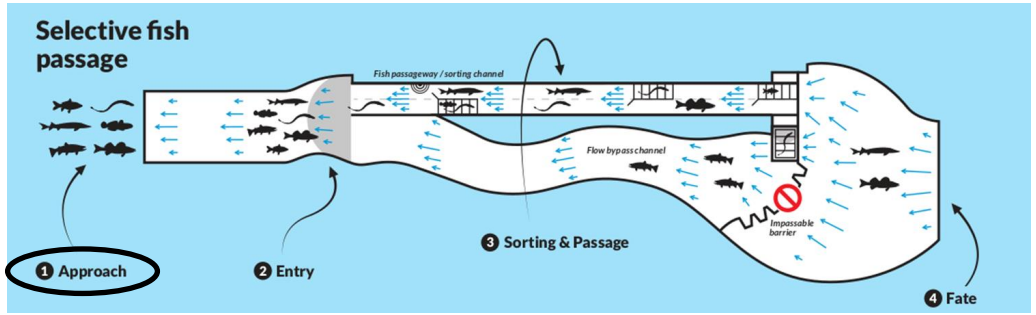


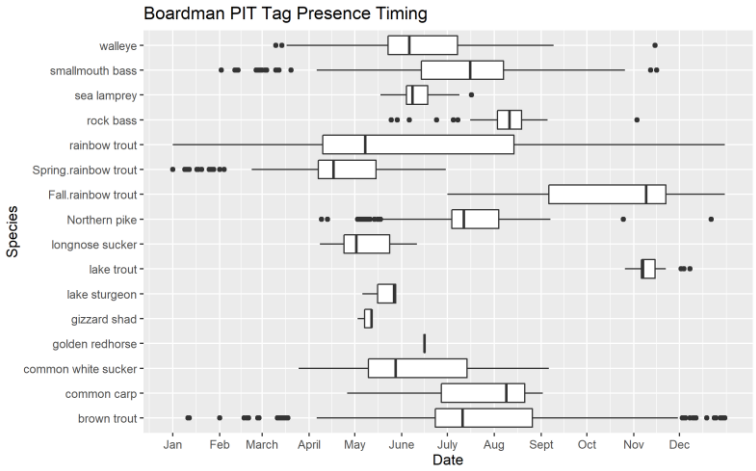
Attribute based selective passage at FishPass



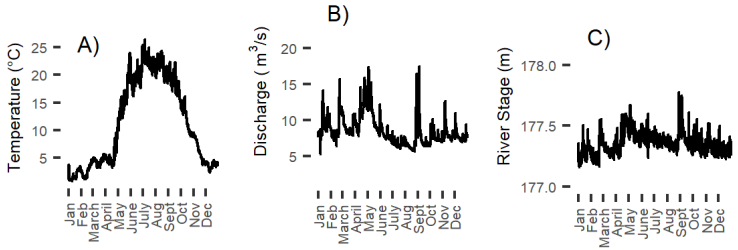
Stage: Approach

Attribute: Phenology, Behavior

Monitoring:



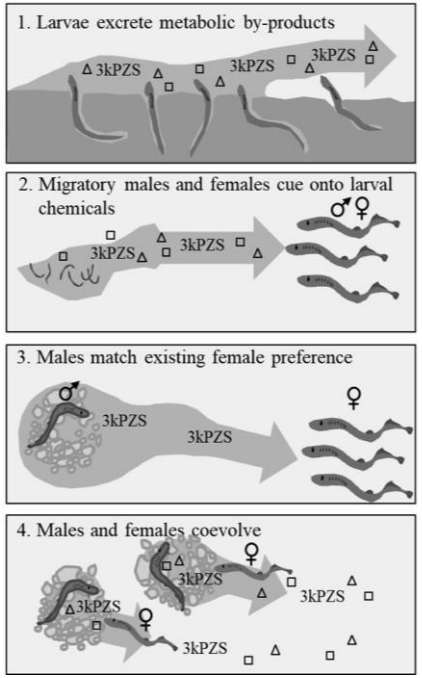
Telemetry:
I.D. migration timing of fish assemblage

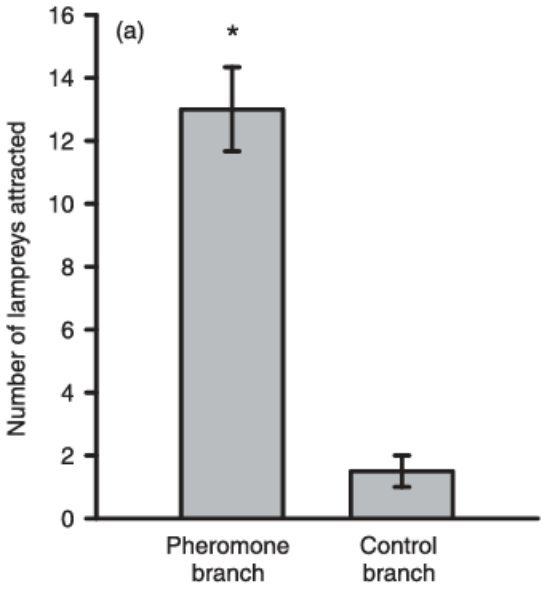


Enviro. sensing:
Quantify cues of movement timing

Sorting:

Pheromones:
Chemical cues used to attract sea lamprey





Fisette et al. 2021. J Great Lakes Res 47:S660-S672.
Wagner et al. 2006. J. Fish. Aquat. Sci. 63(3):475-479.

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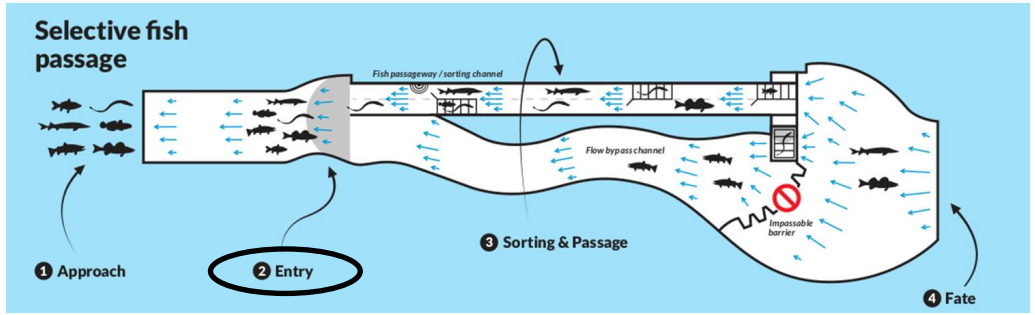
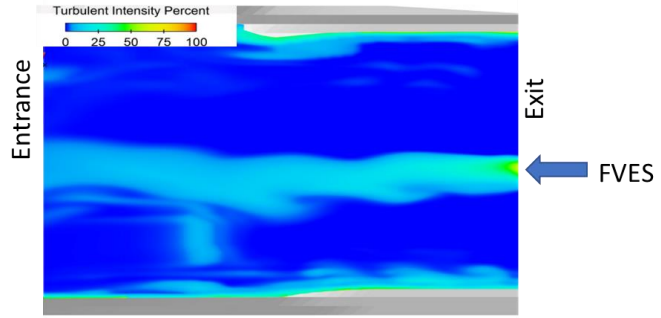
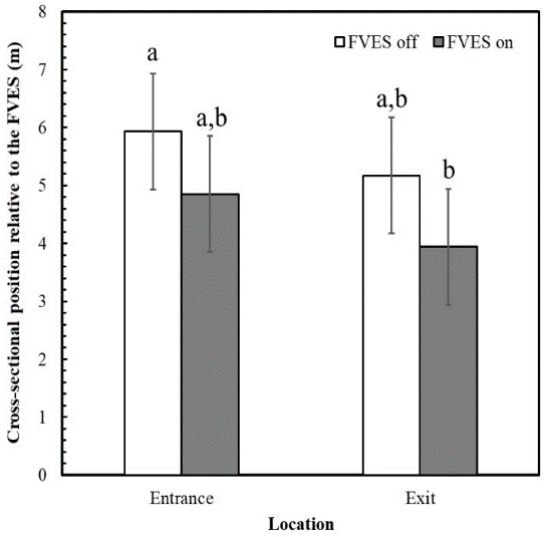


Stage: Entry

Attribute: Phenology, Behavior, Morphology, Physiology

Sorting:

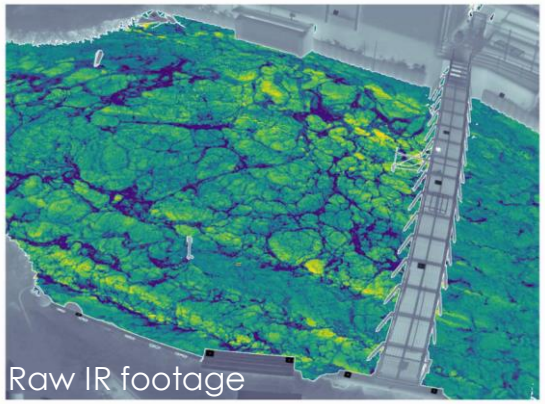


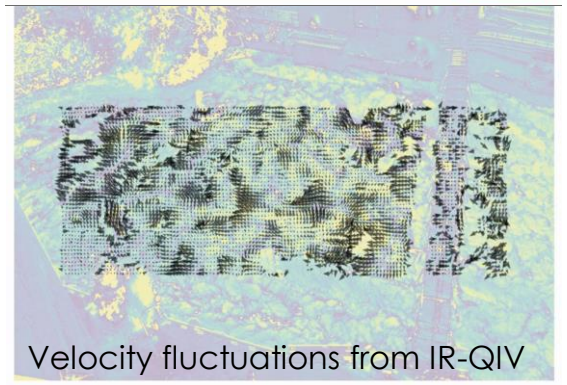


Turbulence:
Flow Velocity Enhancement System (FVES) creates a turbulent plume that attracts fish

Zielinski et al. *2020. J. Ecohydraulics 6:82-90.*

Monitoring:



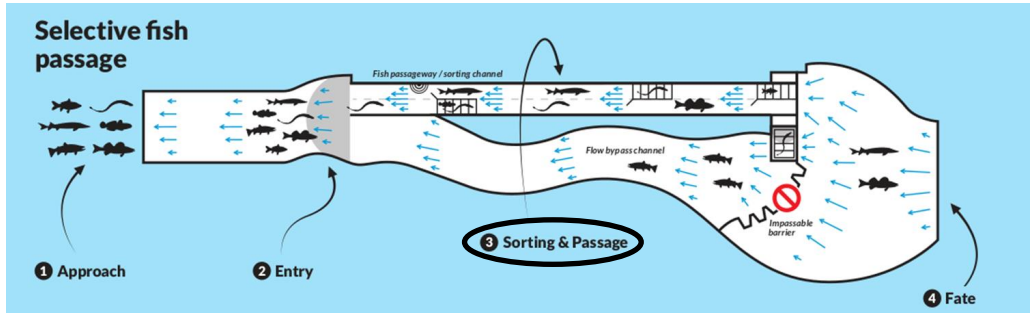


S. Schwitzer (Cornell)

IR-QIV:

- Near-real time sampling of water surface velocities
- Use in conjunction with baffles or other modifications to direct fish movement in real time

Attribute based selective passage at FishPass



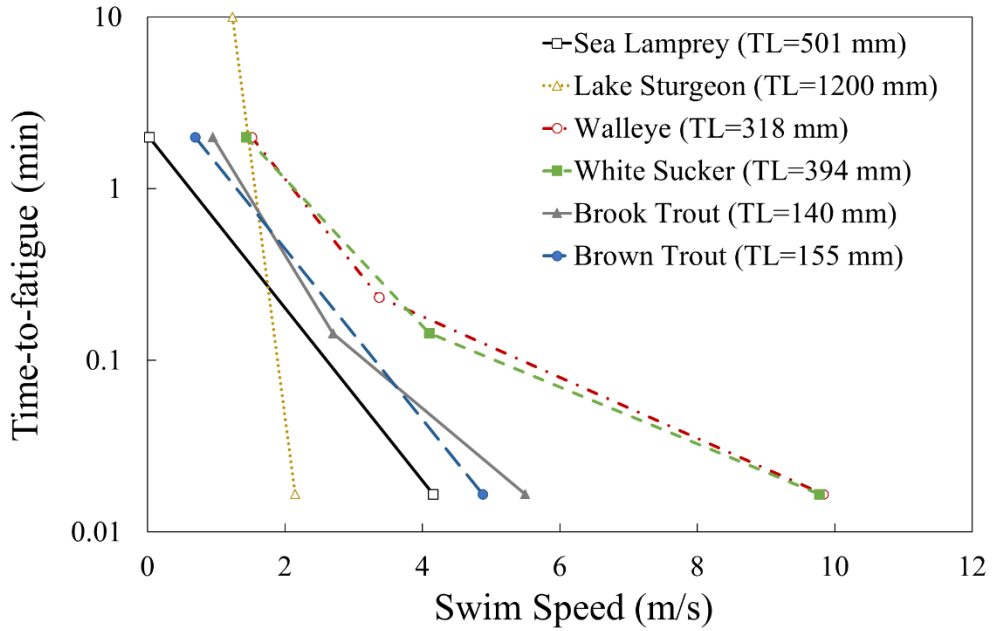
Stage: Sorting & Passage

Attribute: Phenology, Behavior, Morphology, Physiology

Sorting:

Velocity barrier:

Exploit sea lamprey attachment and swimming performance relative to desirable species



Size:

Sea lamprey have unique morphology that can be exploited by screens…

…or image recognition…

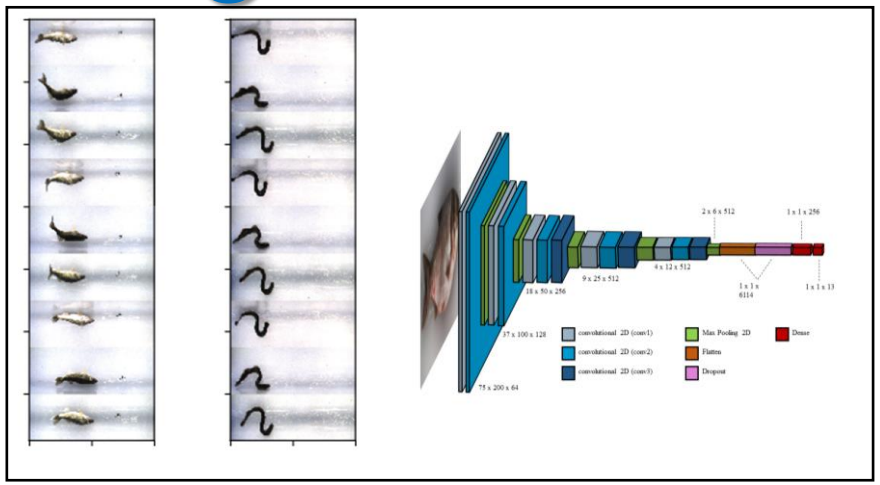
Zielinski et al. *2019*. Rev. Fish. Sci. Aqua 27(4):438-457.

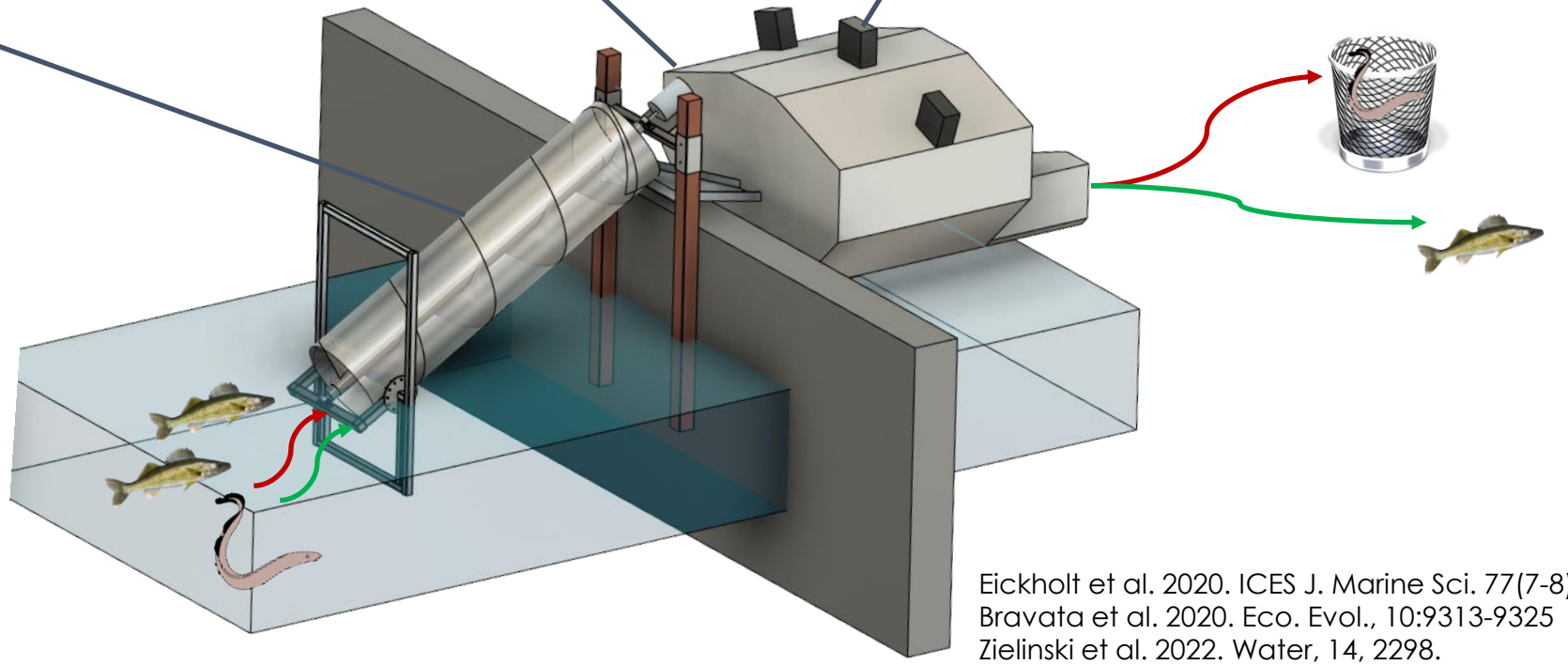
Morphological sorting – Image recognition

2021: Test of a screw-style fish lift for introducing migratory fish into a selective fish passage device.

2023-2025: Resolving uncertainty in capture and lift efficacy to further develop a novel optical sorting process.

2017-2020: Collection of fish images to be used in development of autonomous fish identification and sorting tool.





Eickholt et al. 2020. ICES J. Marine Sci. 77(7-8):2804-2813
Bravata et al. 2020. Eco. Evol., 10:9313-9325
Zielinski et al. 2022. Water, 14, 2298.

Created by Jon Lemerond

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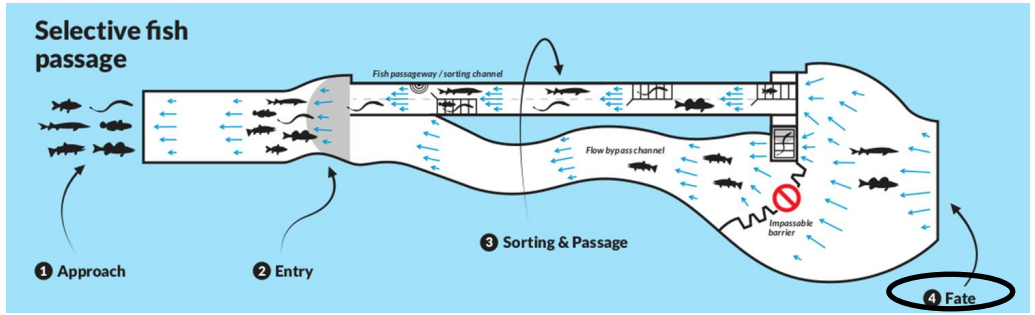


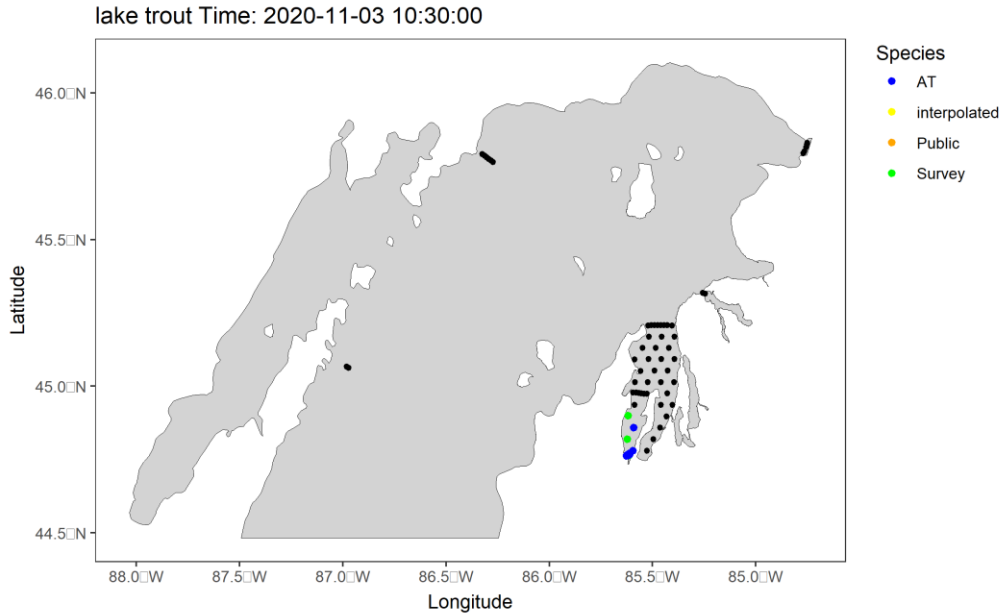
Stage: Fate

Attribute: N/A

Assessment:

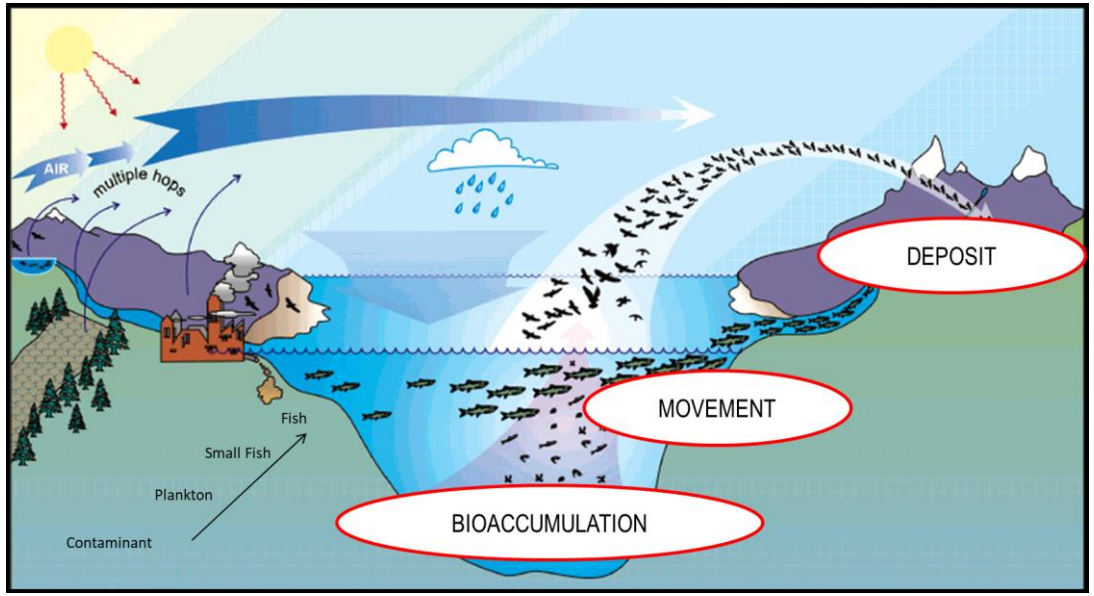
Telemetry:

I.D. where fish are coming from and where do they go in the watershed



Effects of selective connectivity:

Monitor energy, nutrients, contaminants, and gene flow before and after connectivity is restored



Project Timeline

2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025+

Commission and CLC identify Selective Bi-Directionality a High Priority

Workshop #1: Partnership & Needs

Assessment Begins

Workshop #2: Alternatives Analysis

Workshop #3: 30% Design Review

65% Engineering Design

Final Engineering Design

Construction

Research to Optimize Passage Selectivity

Contact us

- Dan Zielinski, Principal Engineer/Scientist (dzielinski@glfc.org)

http://www.glfc.org/fishpass.php

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GIIGOOK MAH-JOWAG

Existing Conditions

Proposed Conditions