Daniel Zielinski, PhD, M.ASCE
Principal Engineer / Scientist, Great Lakes Fishery Commission
dzielinski@glfc.org
http://www.glfc.org/fishpass.php

What is the connectivity conundrum?

Barrier removal and traditional fishways are recognizable solutions for reversing river fragmentation, but restoring connectivity can have consequences for both desirable and undesirable species

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*

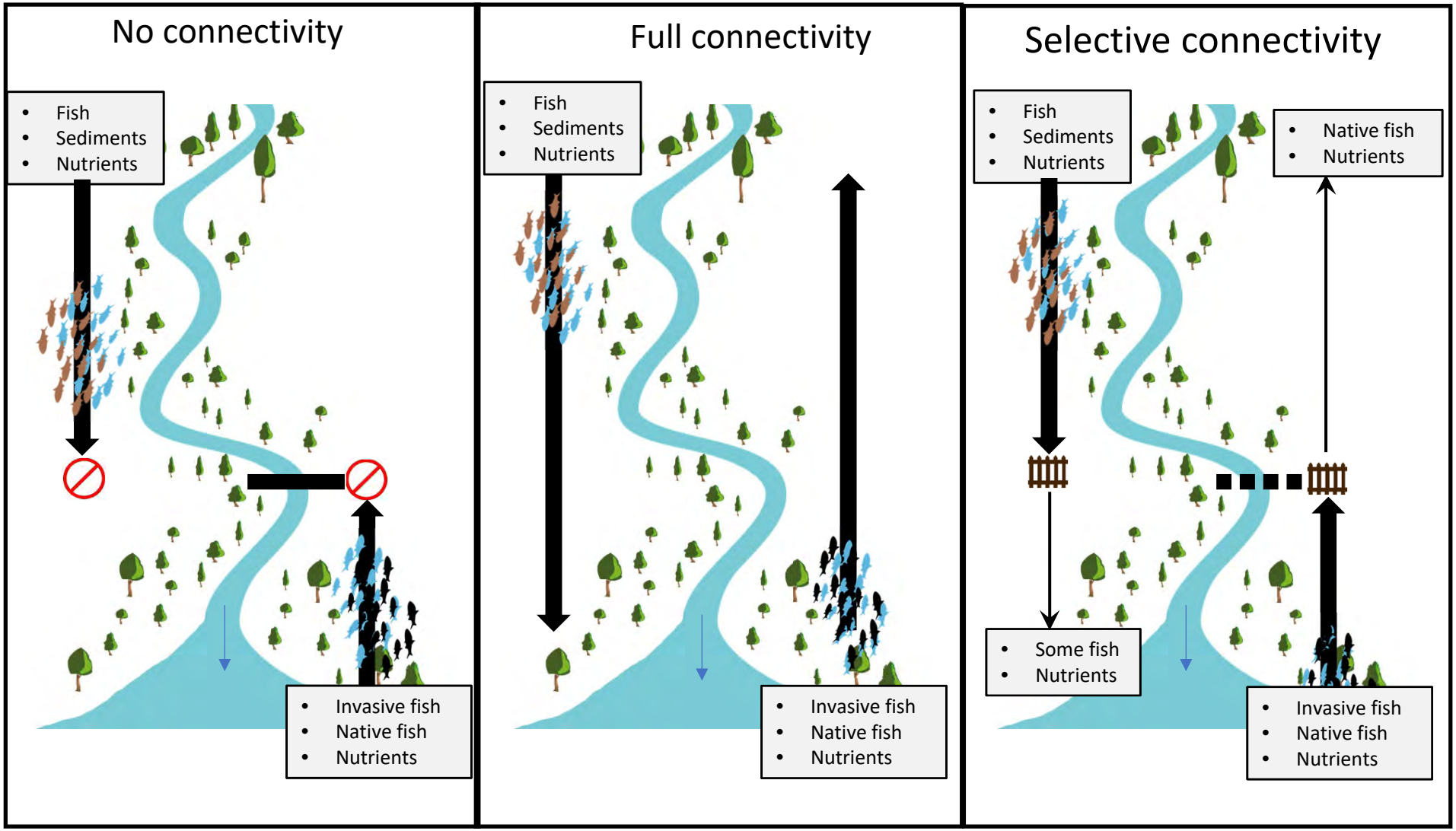
Sea Lamprey Biology

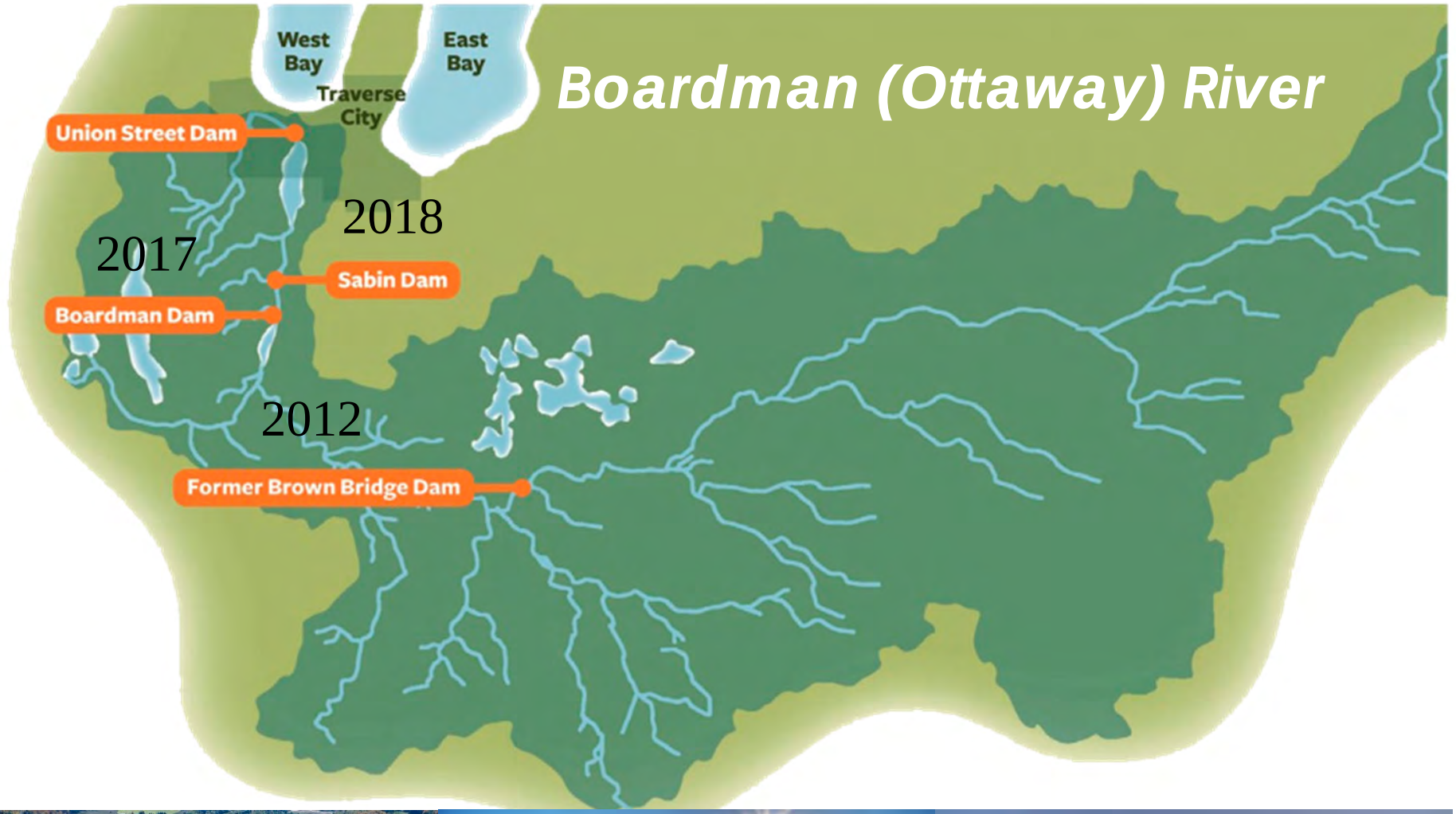
- Attach to prey fish and feed on blood and other bodily fluids
- A single sea lamprey is capable of killing 40 pounds of fish
- Migrates up rivers and streams to spawn and females can lay ~100,000 eggs

Sea Lamprey Control

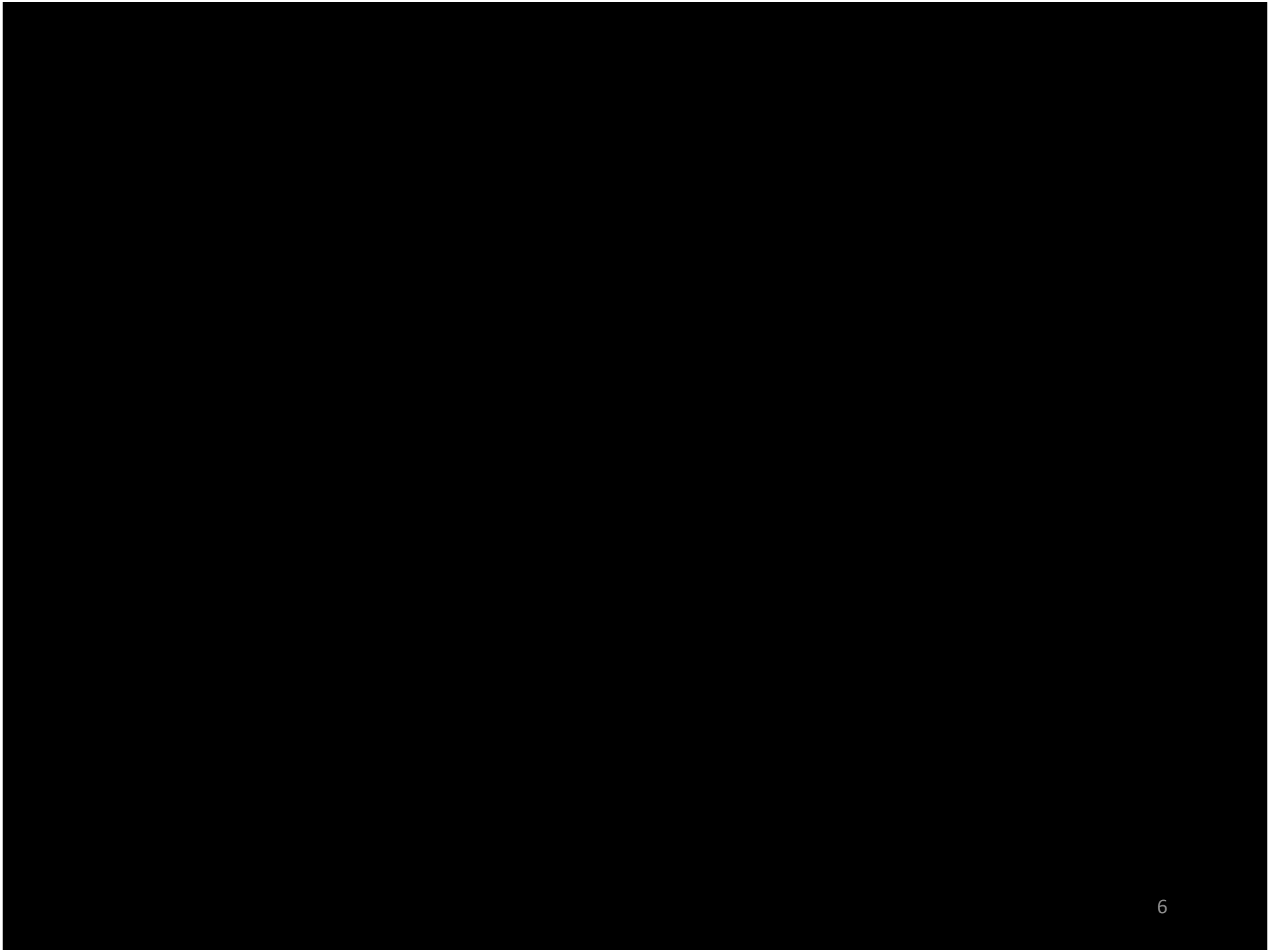
- Barriers used to deny access to spawning grounds and lampricide used to kill larvae
- Efforts have reduced population by over 90% of historic peak

Solutions to the connectivity conundrum





Boardman (Ottaway) River



FishPass

Existing Conditions

Proposed Conditions

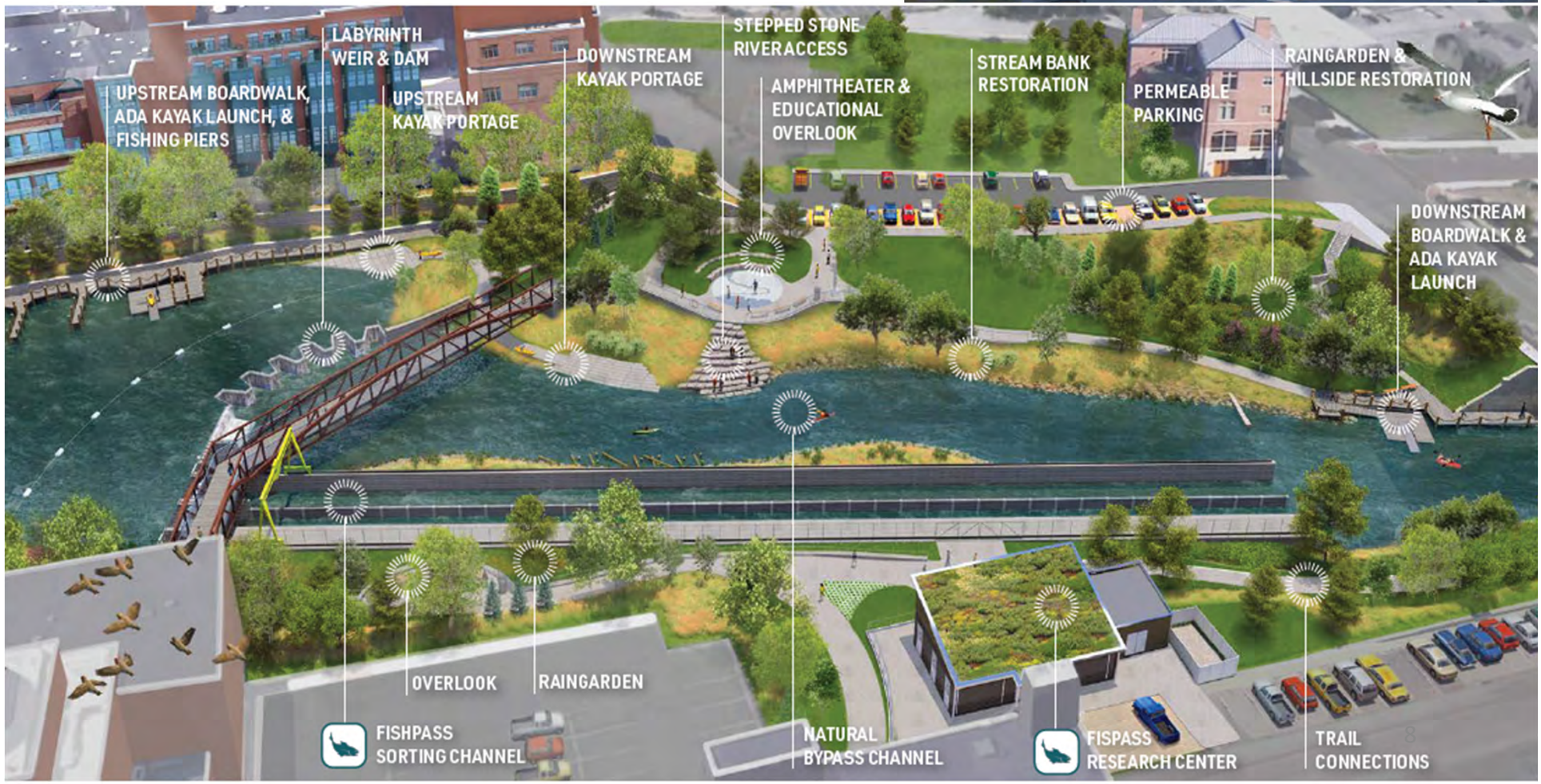
1. Replace the Union Street Dam with an improved barrier with selective fish passage capabilities

2. Optimize various sorting technologies below a barrier

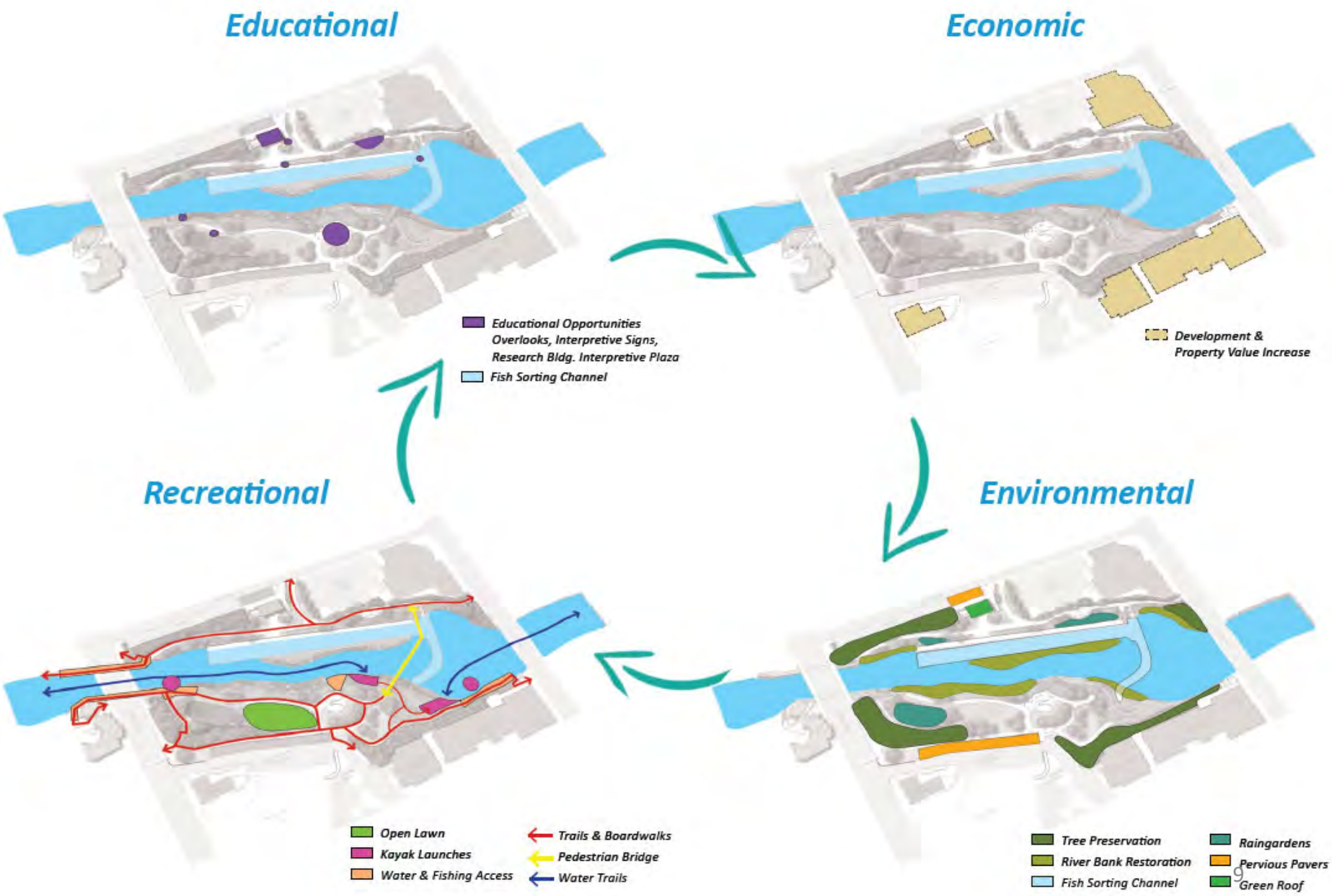
3. Develop into a living laboratory

4. Convert to a permanent selective fishway

Planning and Design



Project Benefits



Outreach and Community Engagement

- Open house to seek community input on infrastructure, green space, and educational spaces
- Engaged Boardman River angling community to understand all concerns and issues regarding Boardman River fisheries
- Over 150 meetings with stakeholders and local government since 2016

Partnerships and Project Guidance

FishPass: An improved barrier

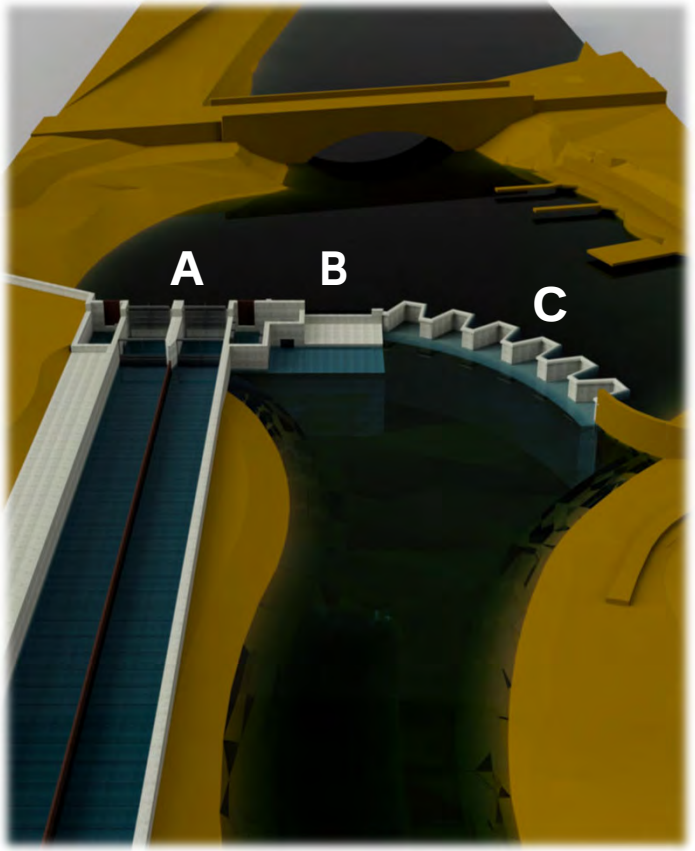
Each potential movement pathway is designed to block uncontrolled passage

Potential pathways include:

A) Fish-sorting channel
B) Low-flow weir
C) Arc-labyrinth weir

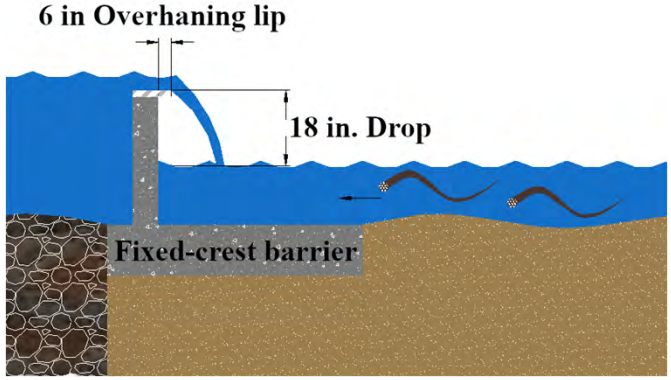
Focusing on sea lamprey and steelhead passage, a detailed analysis was conducted to:

- 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

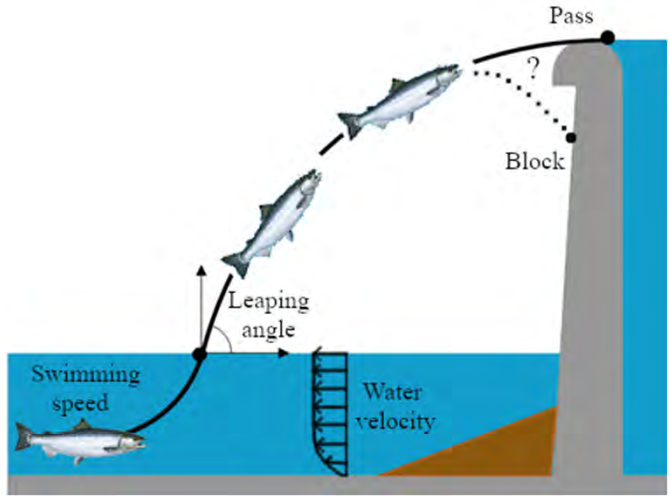


Passage risk assessment

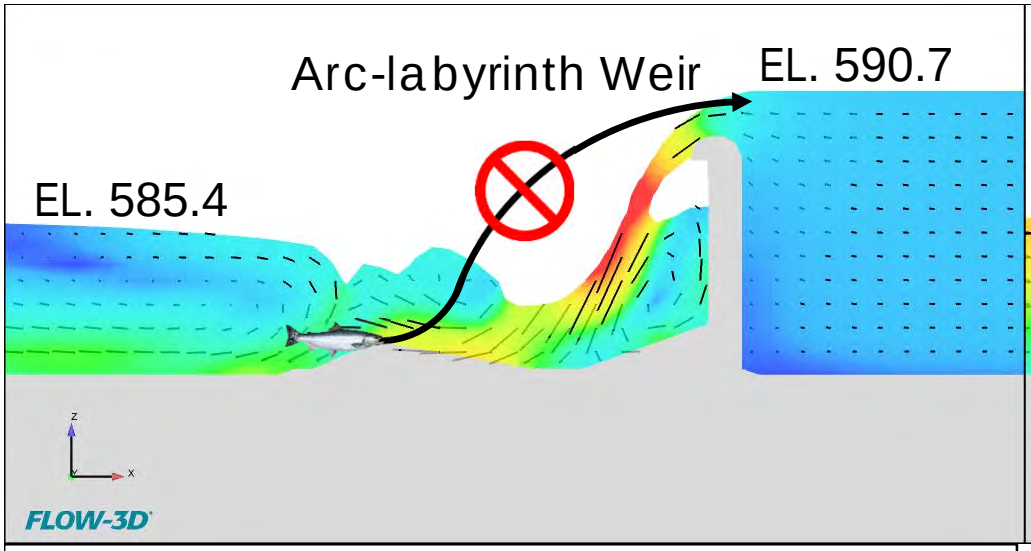
- Sea lamprey passage analysis is based on vertical differential between crest and tailwater
  - HEC-RAS and CFD models used to calculate water levels

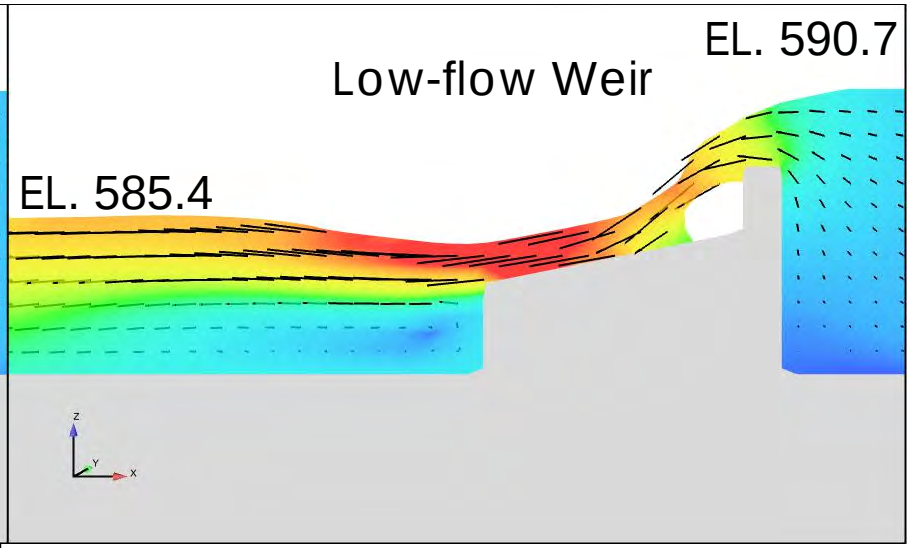


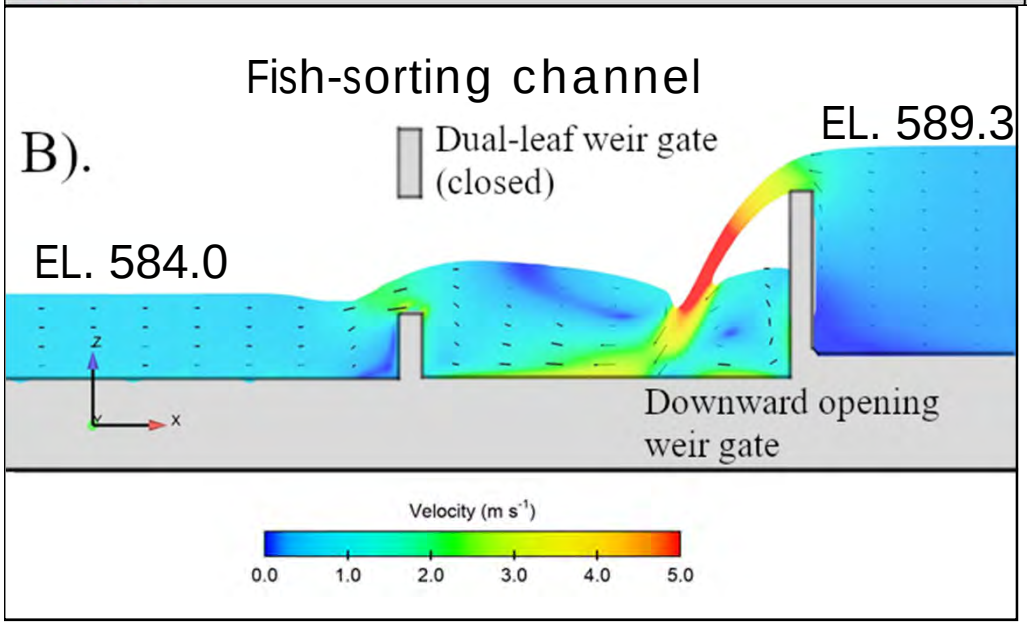
- Steelhead passage analysis based on projectile motion and tested (Powers and Osborn, 1985; Morán-López and Uceda-Tolosa, 2020)
  - Hydraulic models used to calculate velocity and depth at origin of leaping attempt

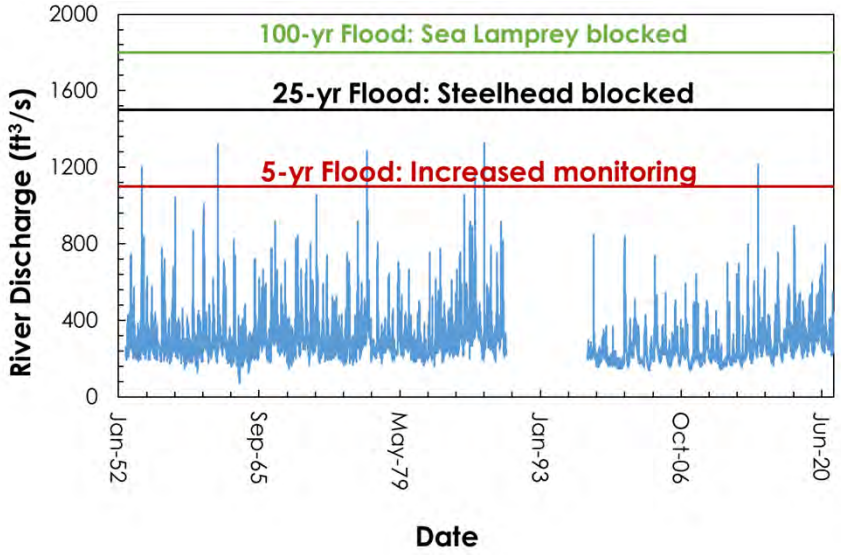


Fish Passage/Lamprey Exclusion Evaluation

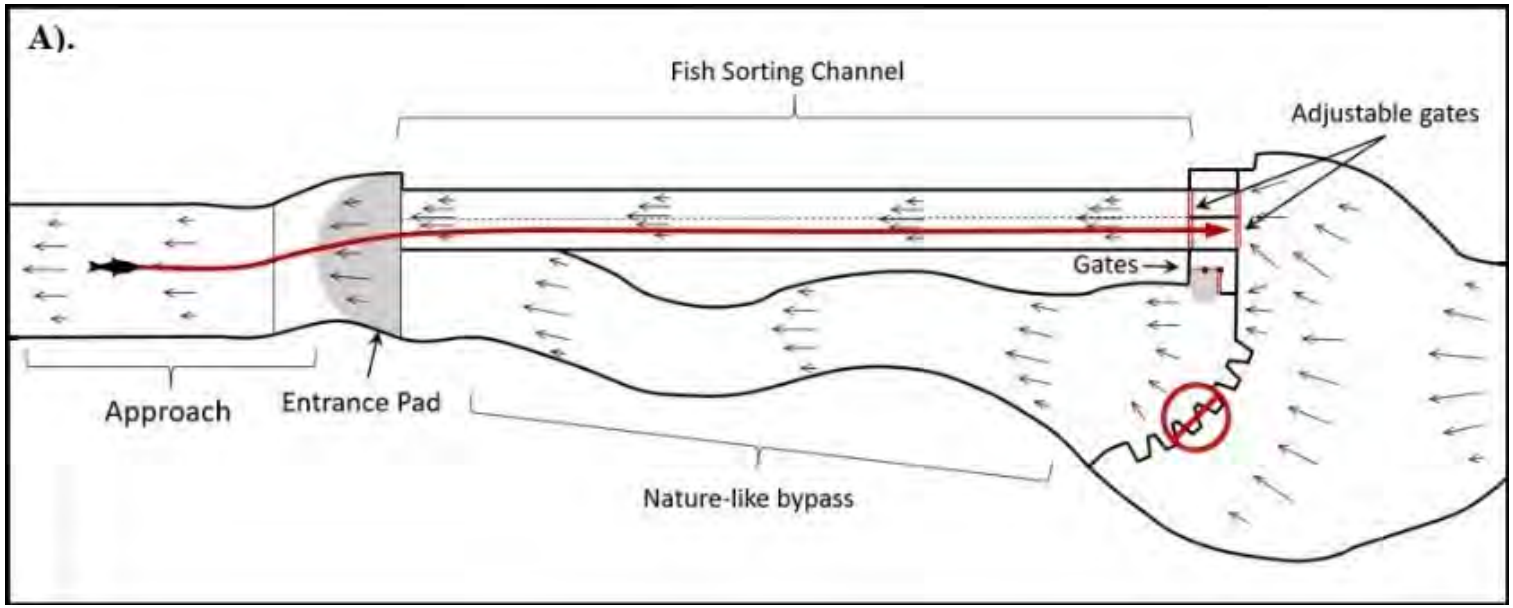


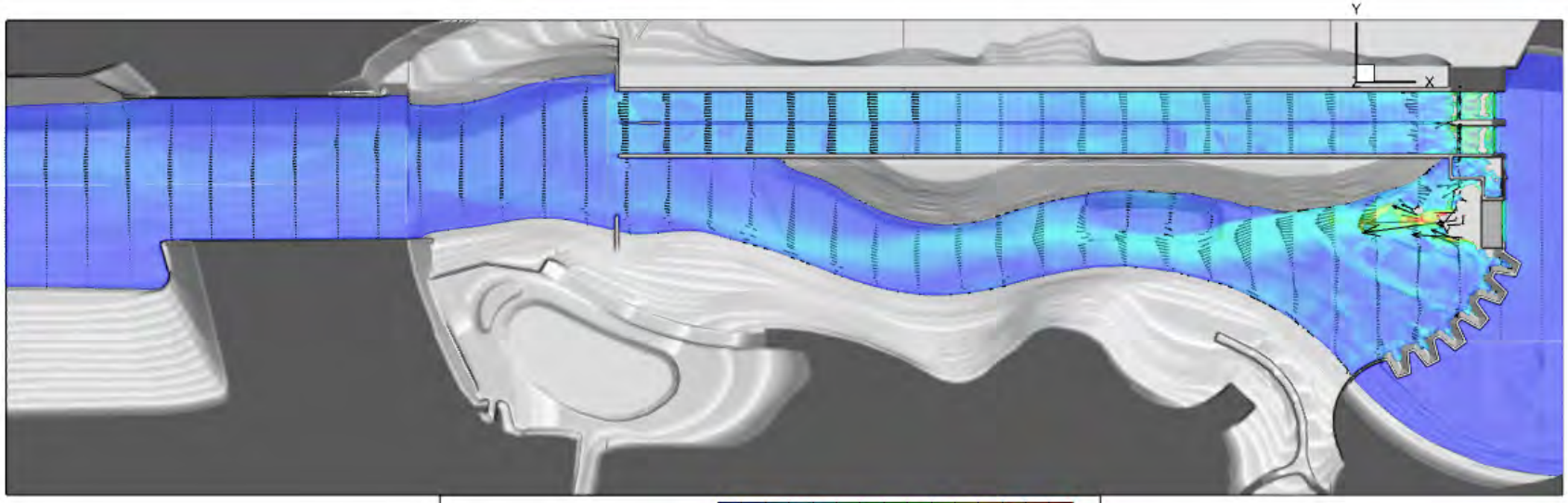




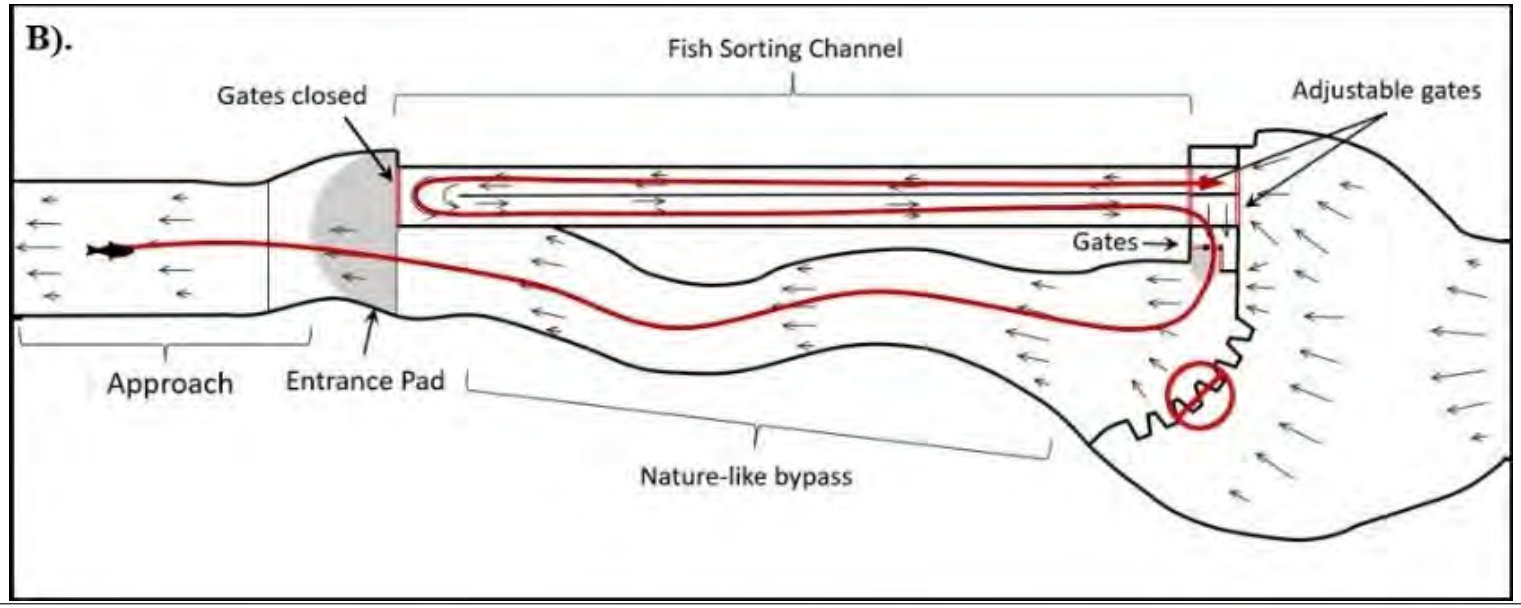


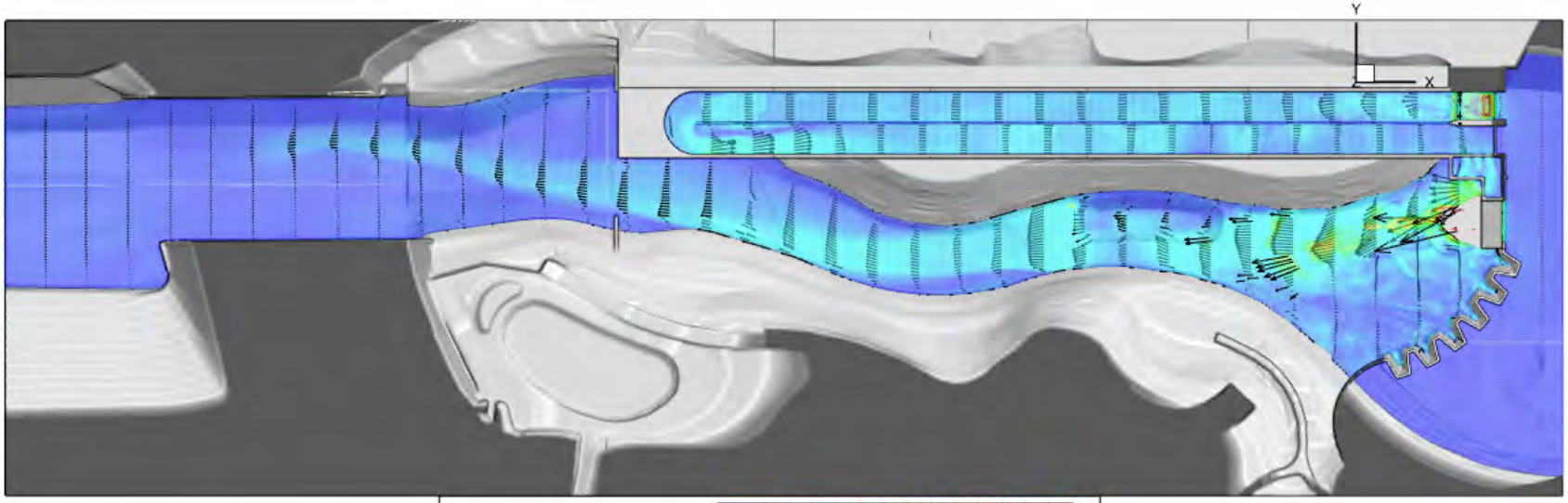
FishPass operations





FishPass operations





Single-stream recycling as an integrated model for fish passage

Recycling

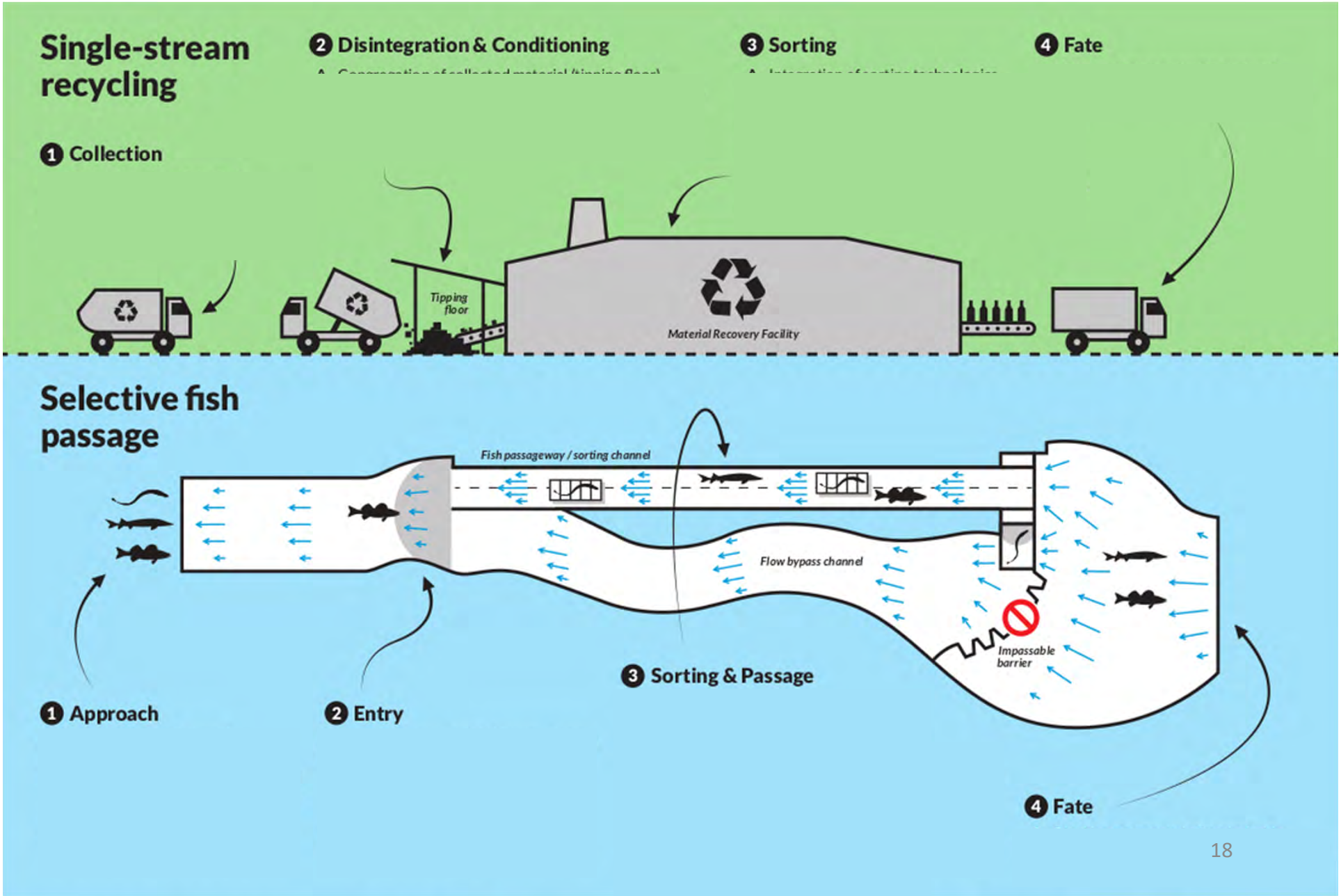
A. Response to environmental awareness and government policy.
B. Early drawbacks due to high cost and co-mingling of non-recyclables.
C. Move to single-stream driven by sophisticated technology, greater capacity, and desire to collect more diverse materials.

Selective Fish Passage

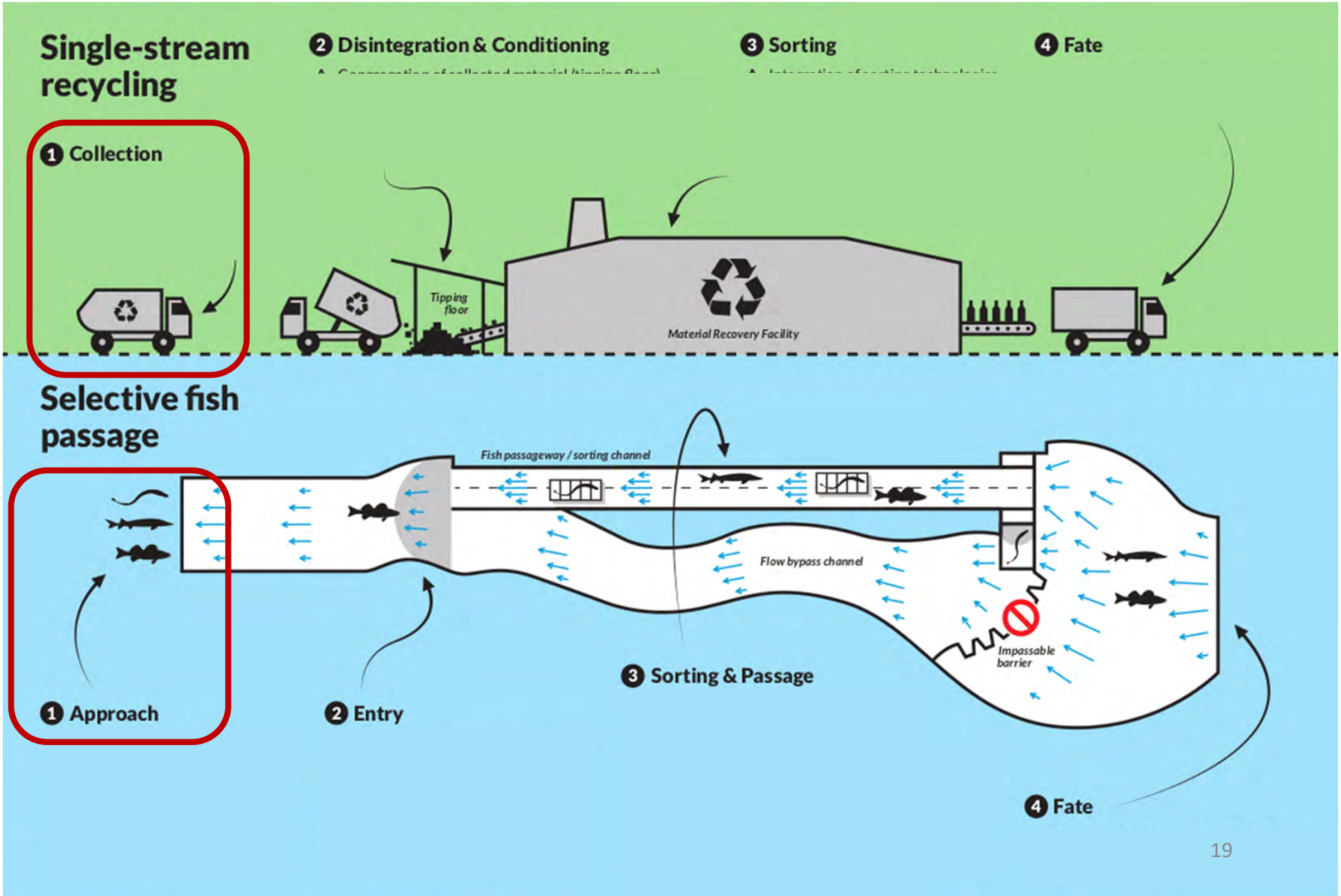
A. Response to connectivity conundrum.
B. Early drawbacks of effort required for manual trap-and-sort.
C. Required for expansion of fisheries management beyond commercially important species.

Aug 2013 Popular Science

Single-stream recycling as an integrated model for fish passage



Single-stream recycling as an integrated model for fish passage



Step 1

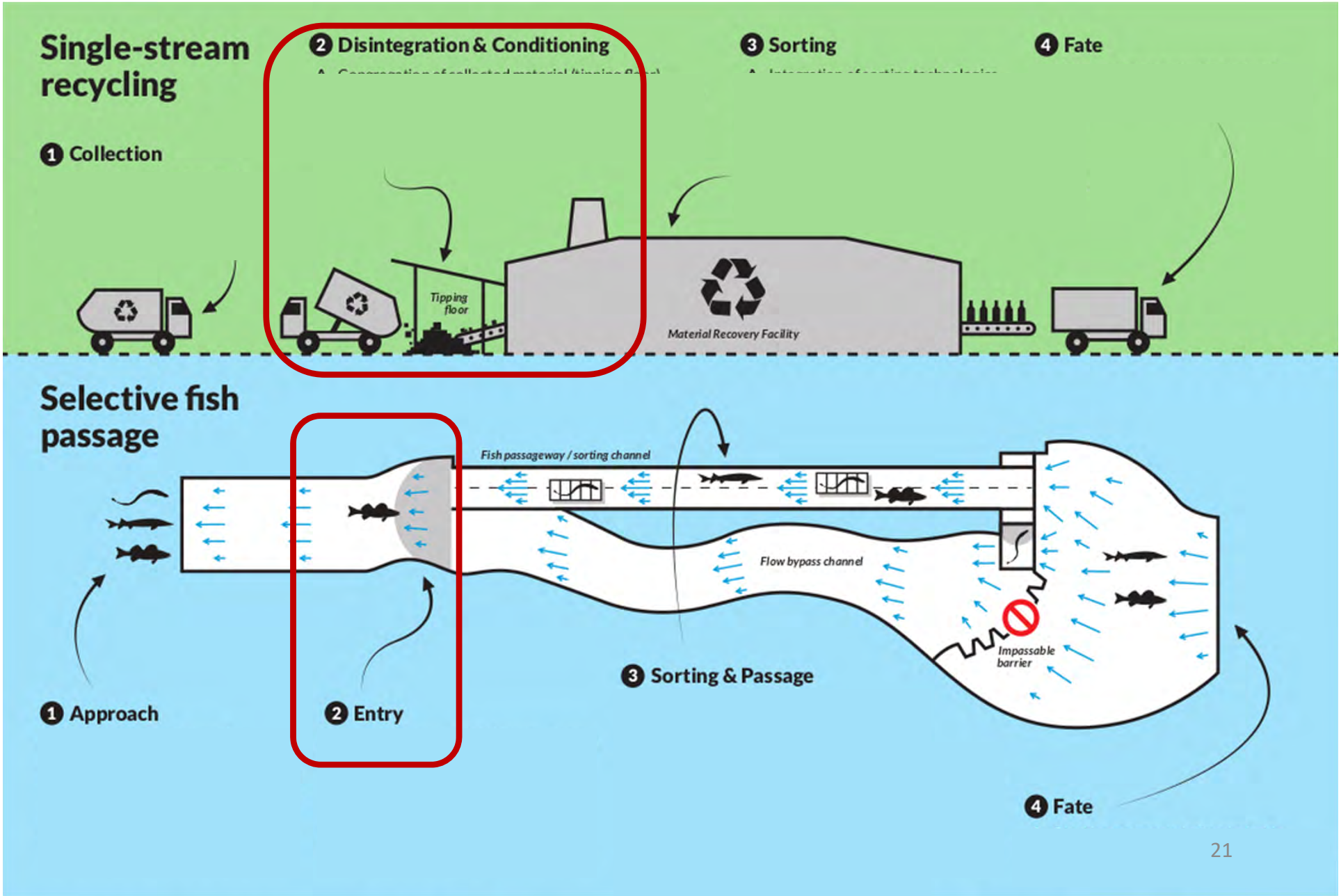
Collection

A. Manual sorting (historical)
B. Pre-sorting
C. Packer truck delivers materials

Approach

A. Manual trap-and-sort (historical)
B. Life history, phenology, behavioral self-sorting, and far-field guidance
C. Guide desirable fish to and deter undesirable fish from entrance

Single-stream recycling as an integrated model for fish passage



Step 2

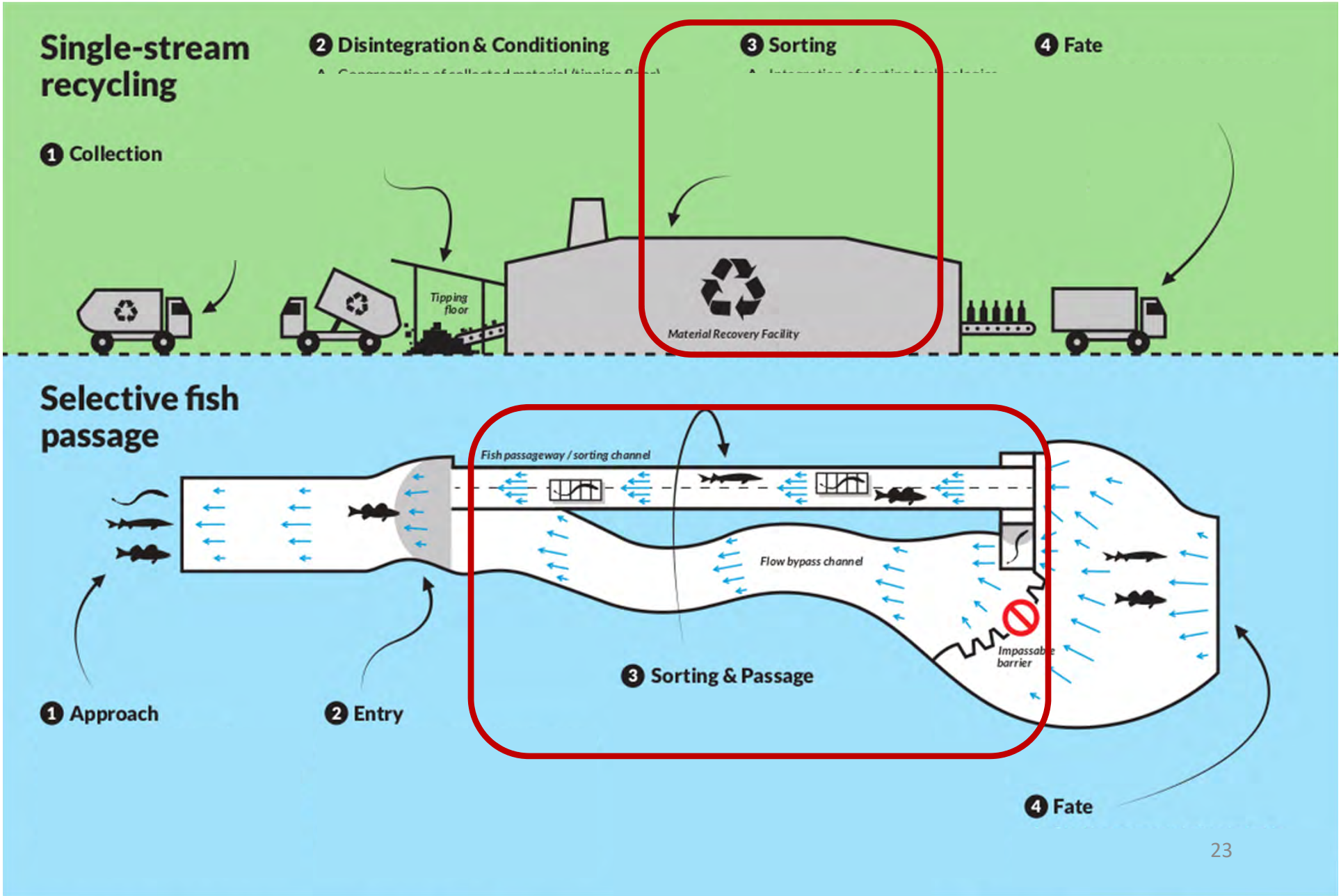
Disintegration & Conditioning

A. Congregation of collected materials
B. Removal of bulky items and break down consolidations
C. Reduce particle size for improved sorting

Entry

A. Fish congregate at fishway entrance
B. Volitional entry an opportunity for sorting; behavioral guidance on smaller spatial scale, gates or screens for metered entrance
C. Modify environmental context to enhance sorting

Single-stream recycling as an integrated model for fish passage



Step 3

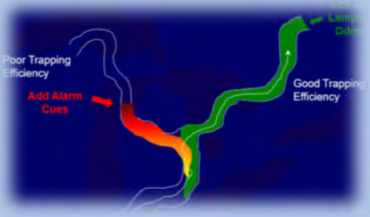
Sorting

A. Integration of sorting tech.
B. Process train
C. Redundancy in sorting
D. Flow sheets (trial and error)
E. No comingling of streams
F. Negative/positive and direct/indirect processes
G. Non-volitional movement and sorting

Sorting & Passage

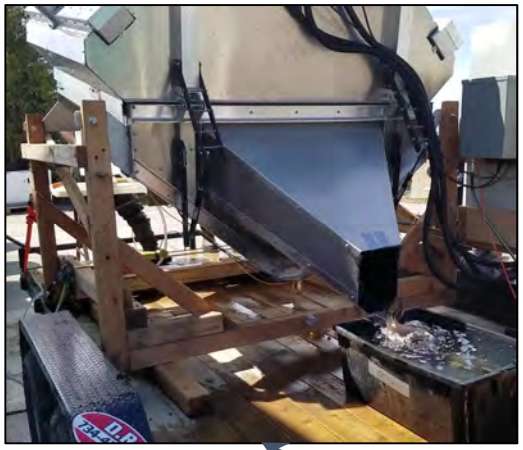
A. Integration of sorting tech.
B. Specified order of operations (currently unknown)
C. Redundancy in sorting
D. Seasonal optimization
E. Removal of undesirable species
F. Negative/positive and direct/indirect processes
G. Volitional vs. non-volitional movement and sorting

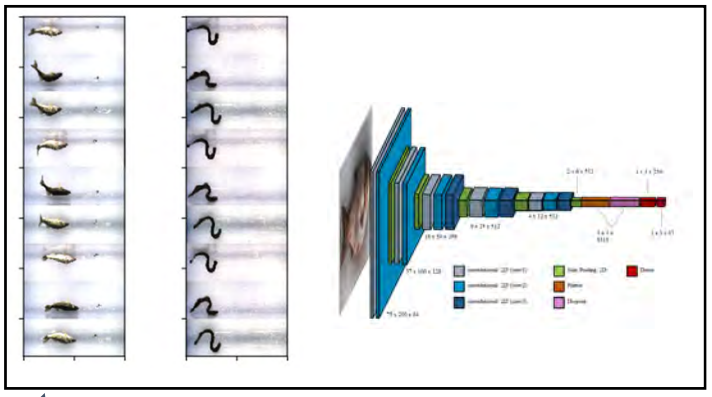
Biology Driven Engineering

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

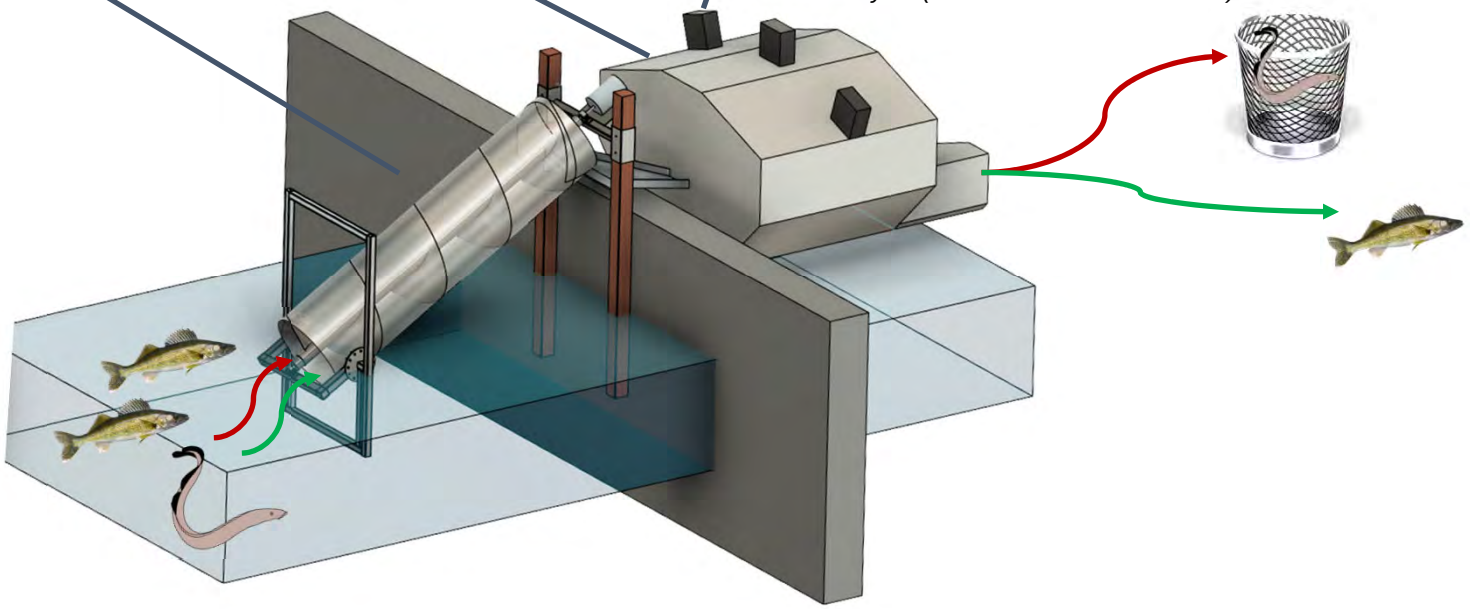
Created by Jon Lemerond

Research towards an optical sorting tool for selective fish passage (2017-Current)





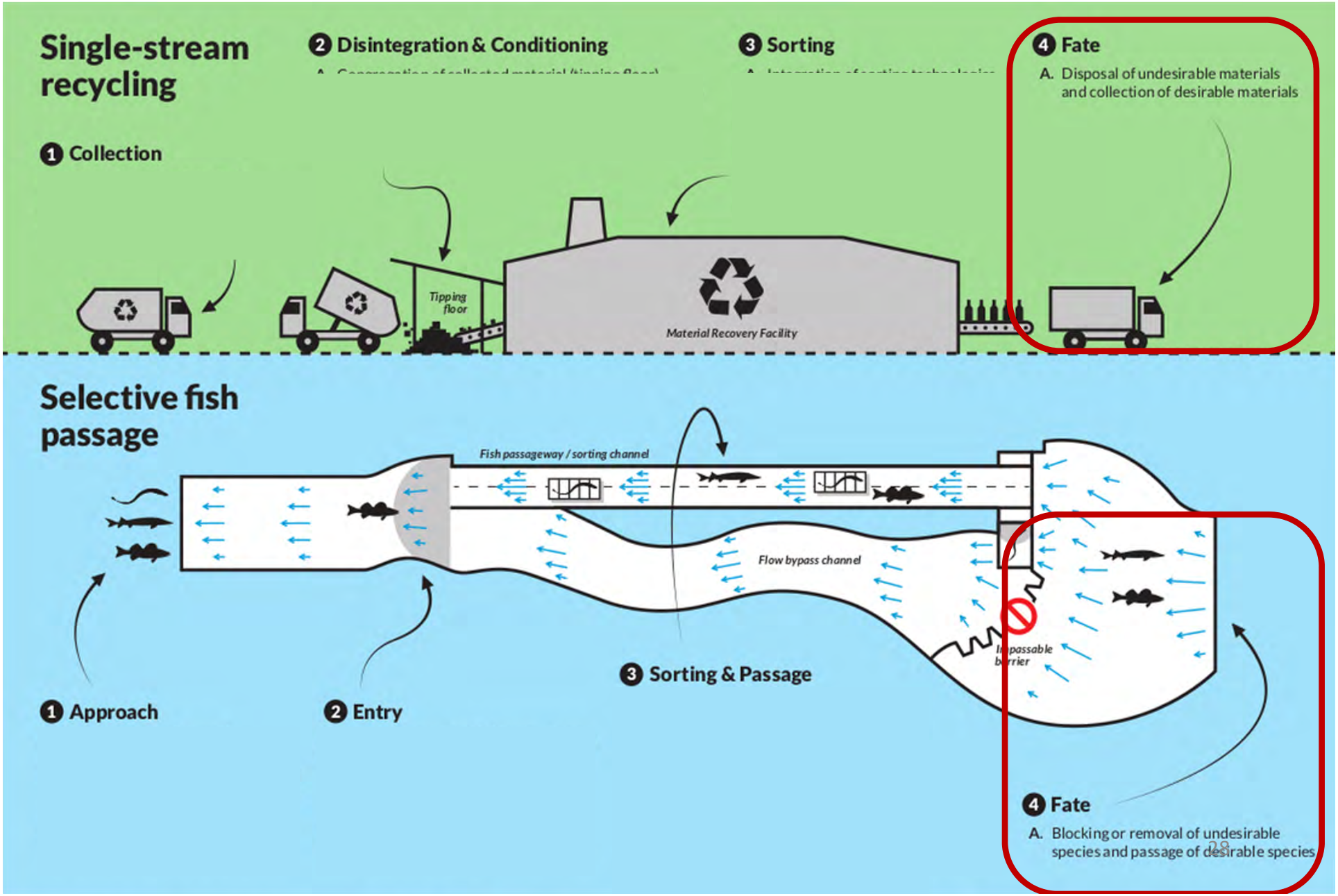
2017-2020: Collection of fish images to be used in development of autonomous fish identification and sorting tool.
S. Miehls (USGS)
J. Eickholt (CMU)
D. Zielinski (GLFC)
J. Bryan (Whooshh Innovations Inc.)



2021: Test of a screw-style fish lift for introducing migratory fish into a selective fish passage device.
S. Miehls (USGS)
S. Lewandoski (USFWS)
D. Zielinski (GLFC)

Publications: Eickholt et al. (2020) ICES J. Marine Sci., 77(7-8):2804-2813; Bravata et al. (2020) Eco. Evol., 10:9313-9325.

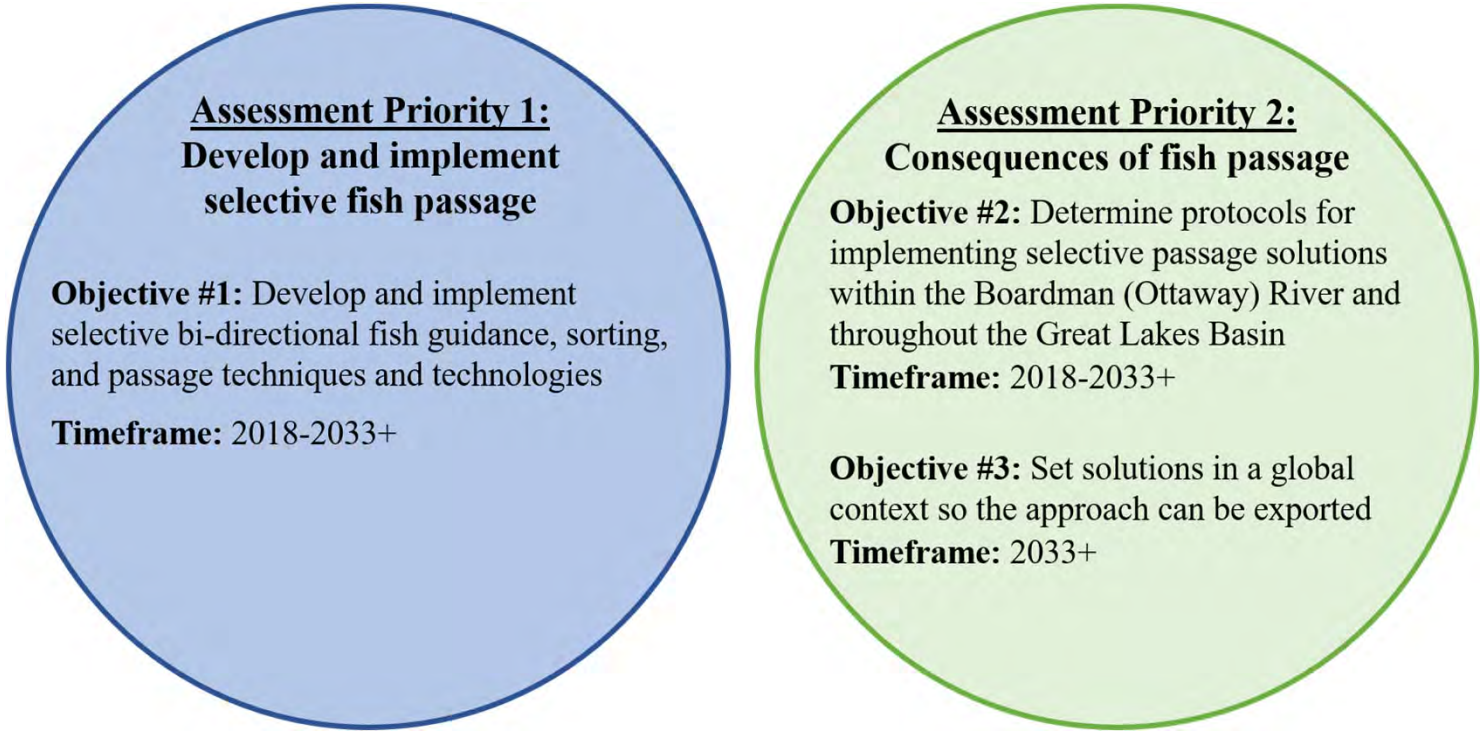
Single-stream recycling as an integrated model for fish passage



Expectations for selective connectivity and fish passage

- Success of selective connectivity for fish passage is goal dependent
- Efforts and goals must be tied to broader conservation goals.
- Must be developed within an adaptive management framework
  - Single-stream recycling was not developed overnight
  - Larger existing toolbox of single-attribute sorting tech.

Assessment Plan



- Fish movement
- Sorting efficiency
- Abiotic variables of fish passage

- Immediate monitoring
  - Extent & Fate
- Long-term monitoring
  - Community, growth, production, ecosystem and food web change, habitat, genetics, contaminates, etc.

Fish Movement: Boardman River

OBJECTIVES: *Baseline movement data*

1. Changes in use of space in response to selective fish passage
2. Provide a starting point for implementation

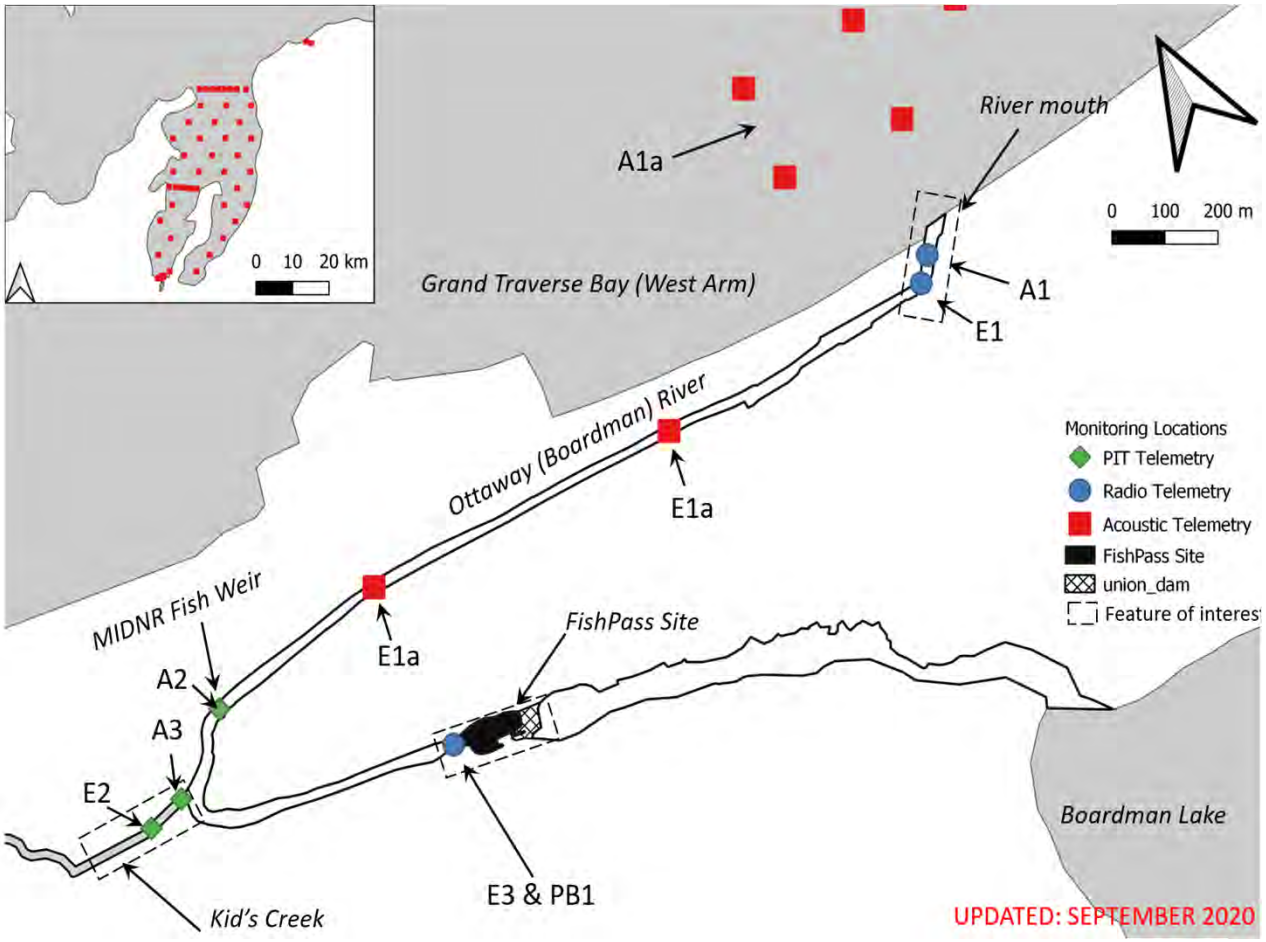
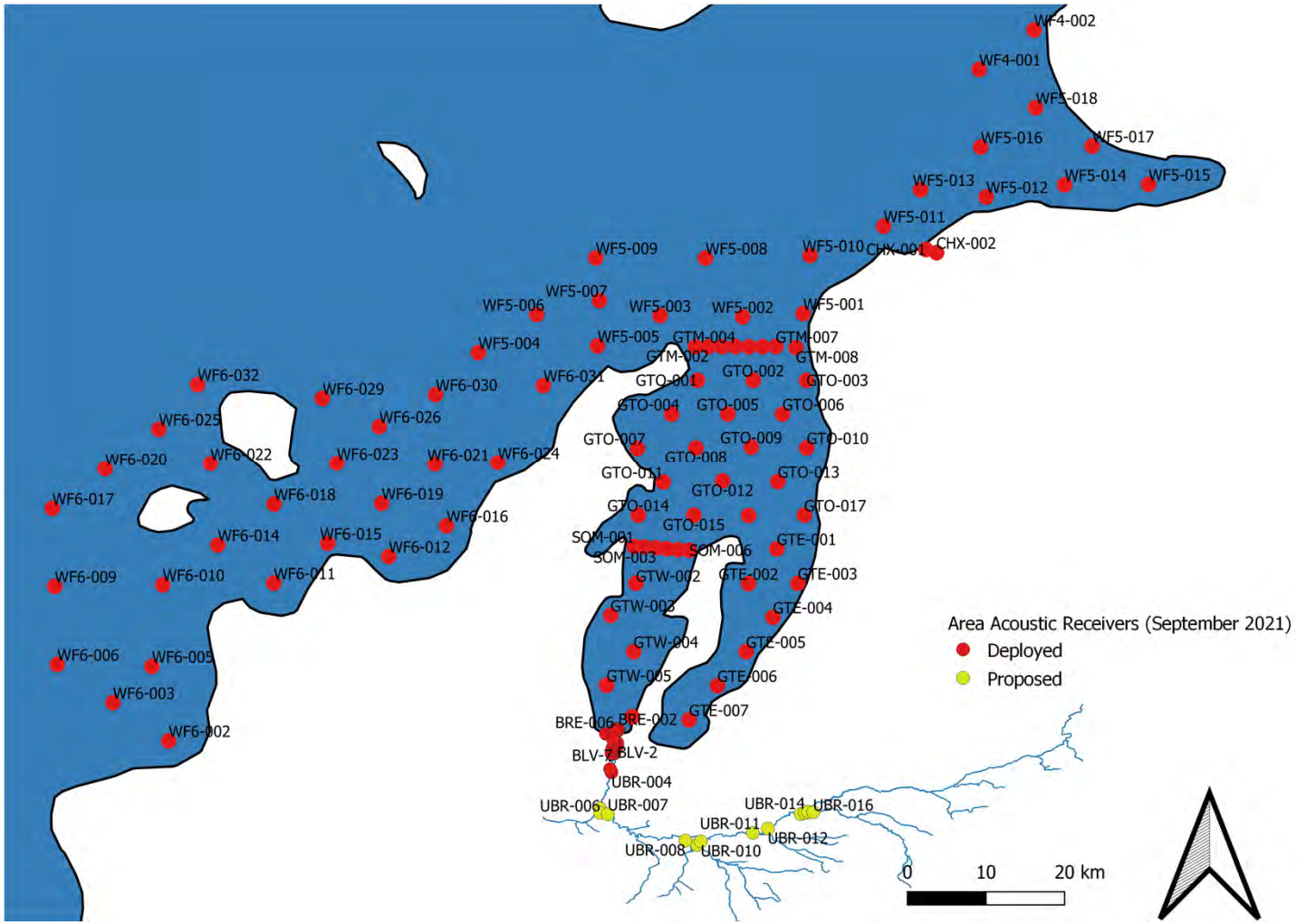


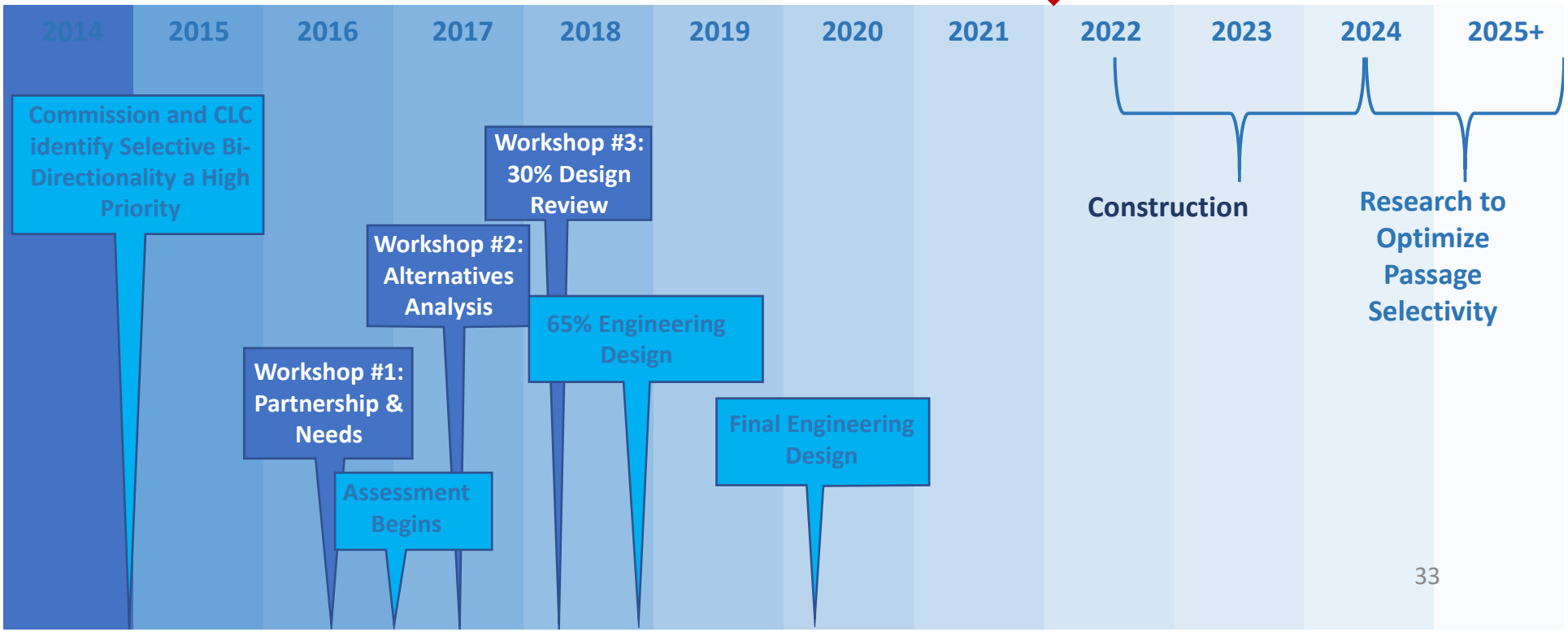
Figure 2-1. Diagram of fish movement detection array with respect to how *approach* (A), *entry* (E), and *passage/blockage* (PB) metrics are monitored in respect to features of interest (Boardman River, Kid's Creek and the FishPass Site) during the basic research phase.

Current Acoustic Array

- Project expansion of the Grand Traverse Bay Coregonid (GTCOR) work
- Proposed expansion of FishPass receivers in support of Energy and Nutrient Dynamics project (later in talk)



Project Timeline



Contact us

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

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

FISH PASS
GIIGOOK MAH-JOWAG

Existing Conditions

Proposed Conditions