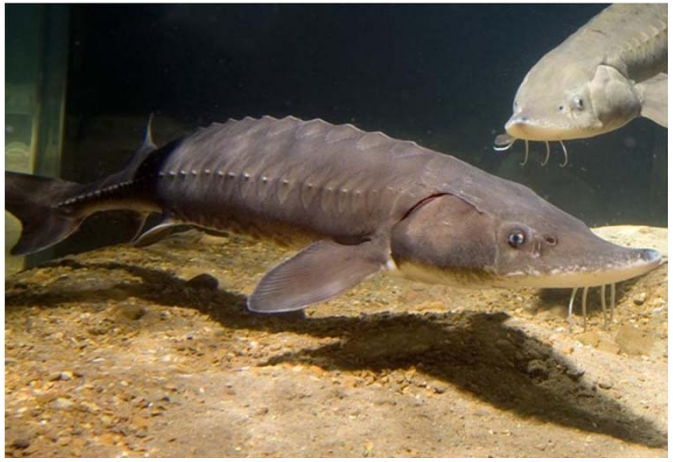
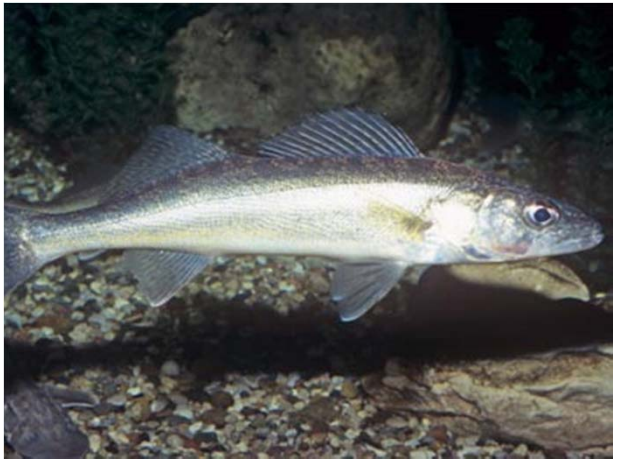
An ecological framework for fish habitat restoration in the Huron-Erie Corridor





Darryl W. Hondorp, Bruce A. Manny, David Bennion, & Edward F. Roseman

March 16, 2011

Questions & scenarios

- How does the bathymetric distribution of spawning habitat affect spawner abundance & species composition and egg deposition & survival?
- How should experimental reefs be sited longitudinally? How does reef placement impact connectivity with downstream nursery habitat?
- Is rock-cobble spawning substrate limiting?
- What inshore structure(s) maximize larval retention and nursery habitat quality in rivers/lakes?
- What role does Lake St. Clair play in fish early life history dynamics and fish population structure?
- Do populations of lake- and river-spawners fluctuate asynchronously?

HURON-ERIE CORRIDOR INITIATIVE

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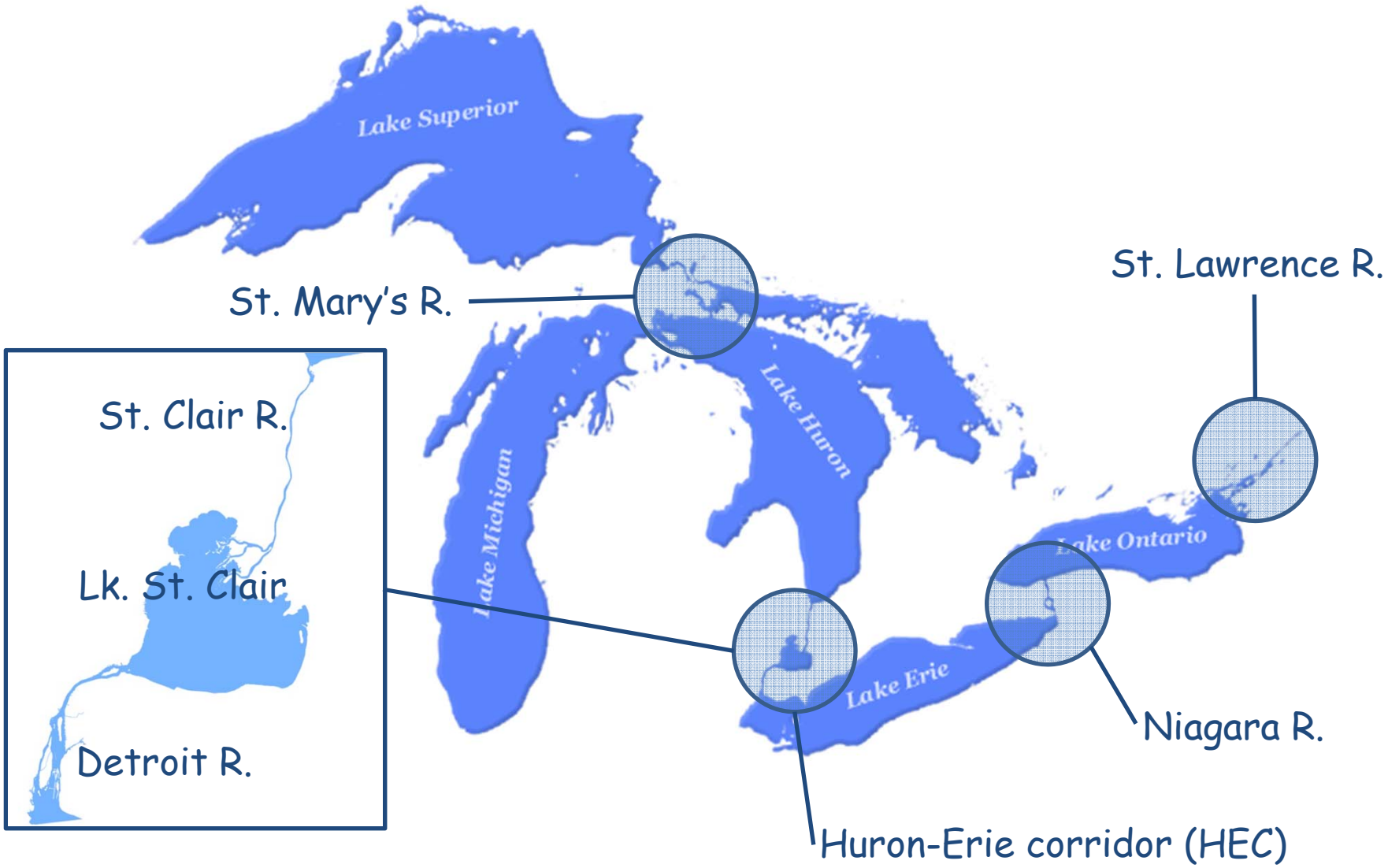
USGS science for a changing world

The Great Lakes connecting channels



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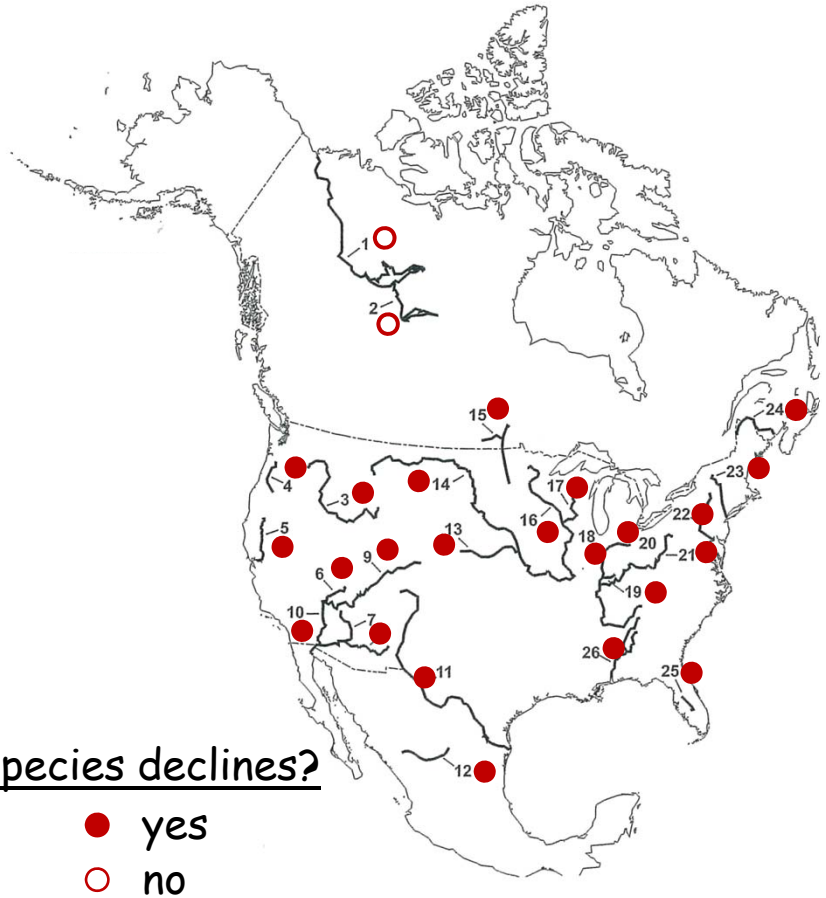
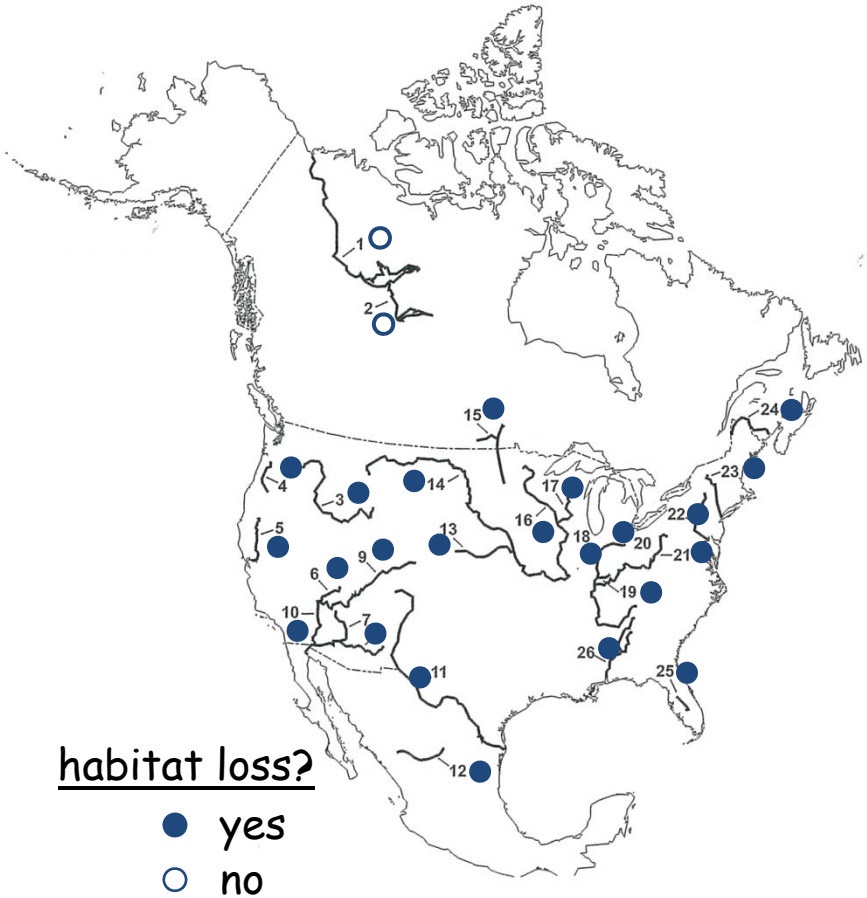
habitat restoration is necessary for conservation

Rinne et al. (2005) large river fish community survey



species declines?

- yes
- no



habitat loss?

- yes
- no

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HURON-ERIE CORRIDOR INITIATIVE

Overall objective

To develop the "...high-priority research needed to understand and remediate the impacts of habitat loss and degradation as well as invasive species on fishery resources in the HEC."

-Manny et al. (2004)

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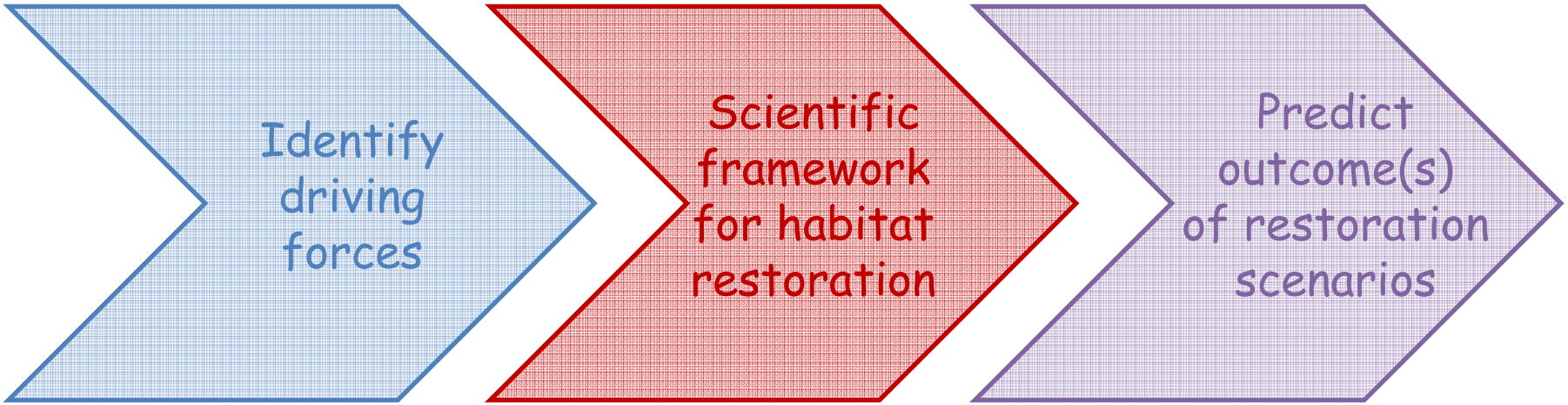
HURON-ERIE CORRIDOR INITIATIVE

Developing the science of fish habitat restoration



USGS science for a changing world

Driving forces

- Glaciation

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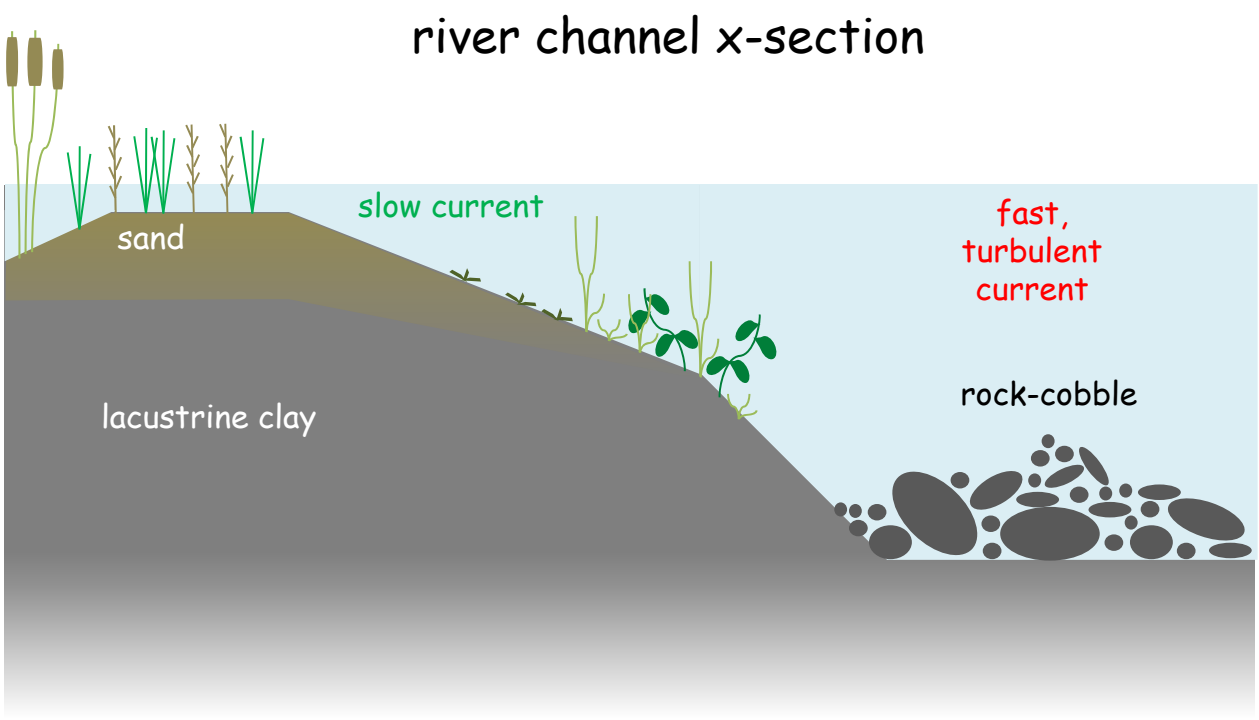
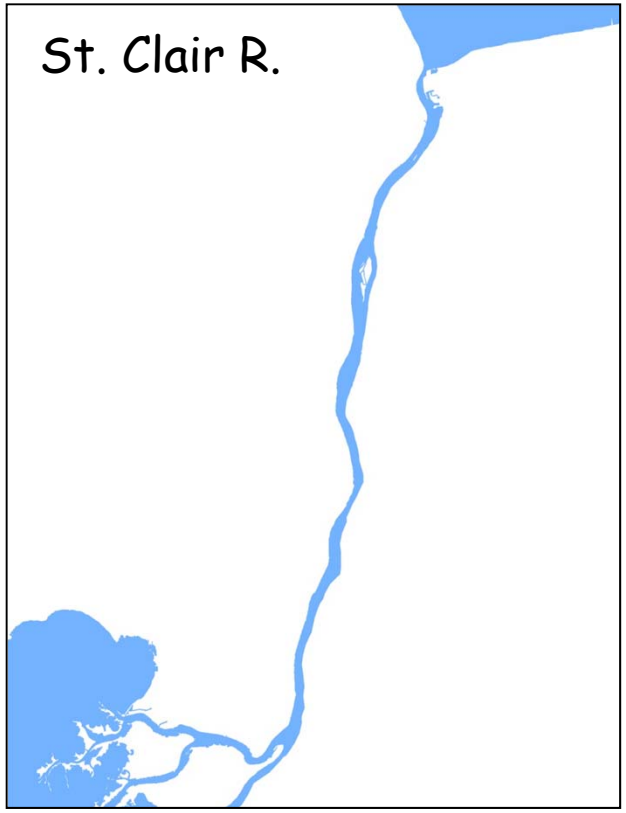
Channel hydrogeomorphology: historical





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Driving forces

- Glaciation
- Flood/drought?

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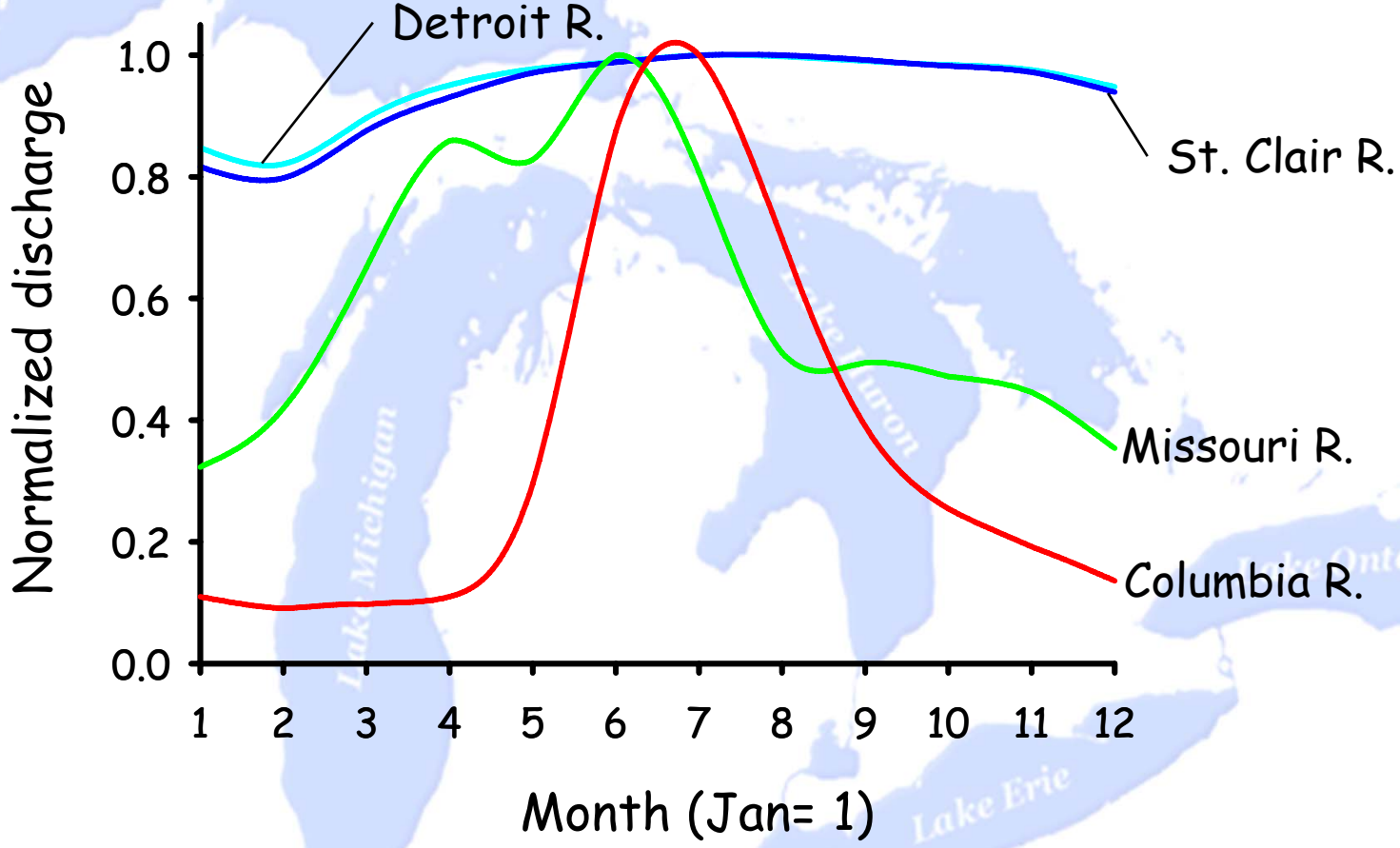
Flow regime of the connecting channels



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Driving forces

- Glaciation
- Flood/drought?
- water level

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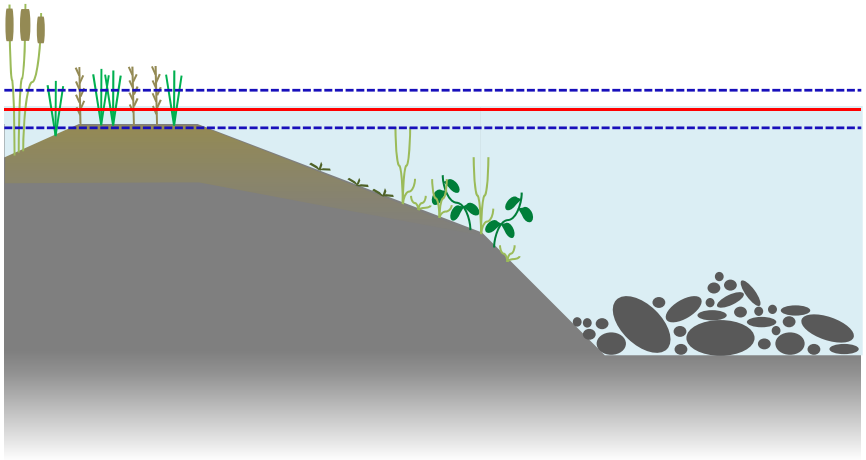
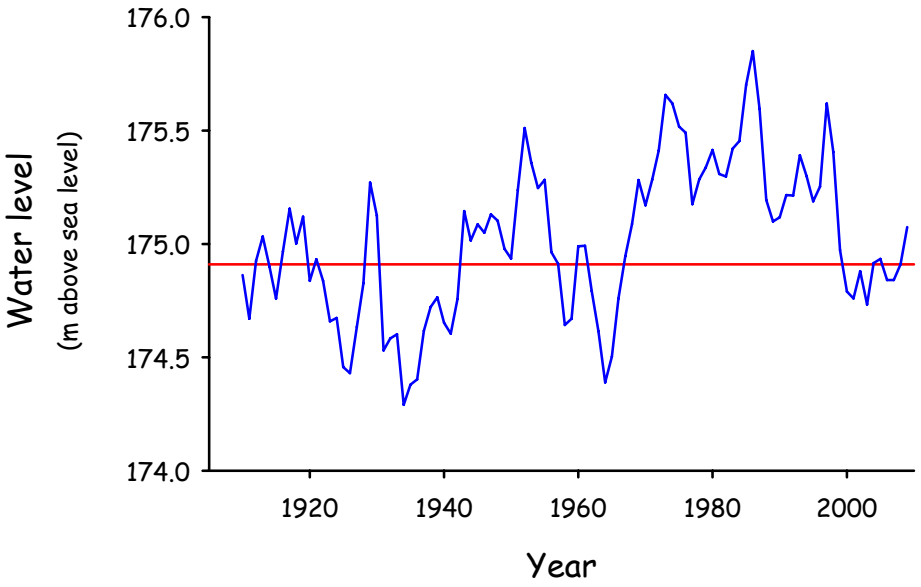
Water level fluctuations

River channel x-section (historical)



water levels in the HEC



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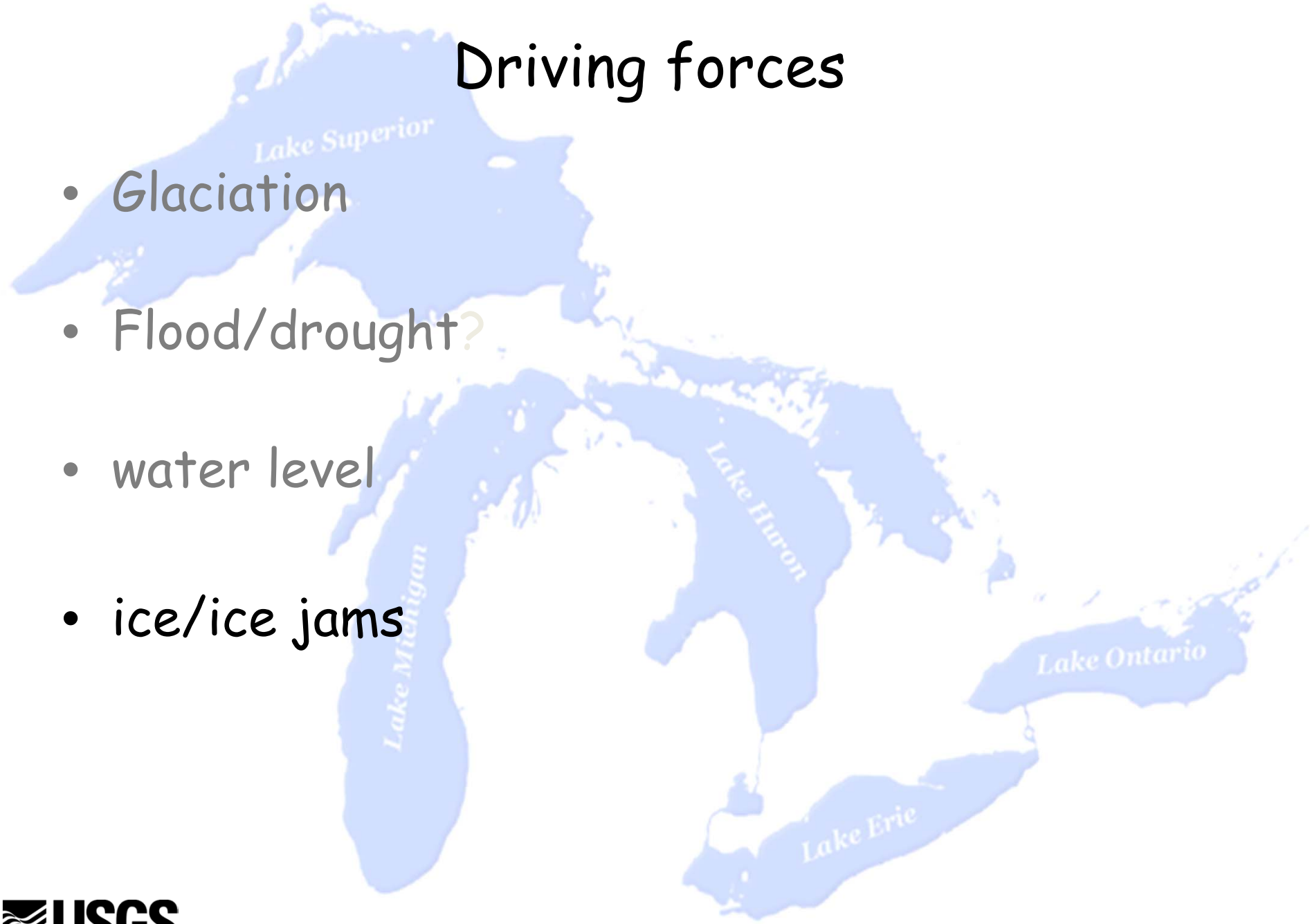
Driving forces

- Glaciation
- Flood/drought?
- water level
- ice/ice jams



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Ice

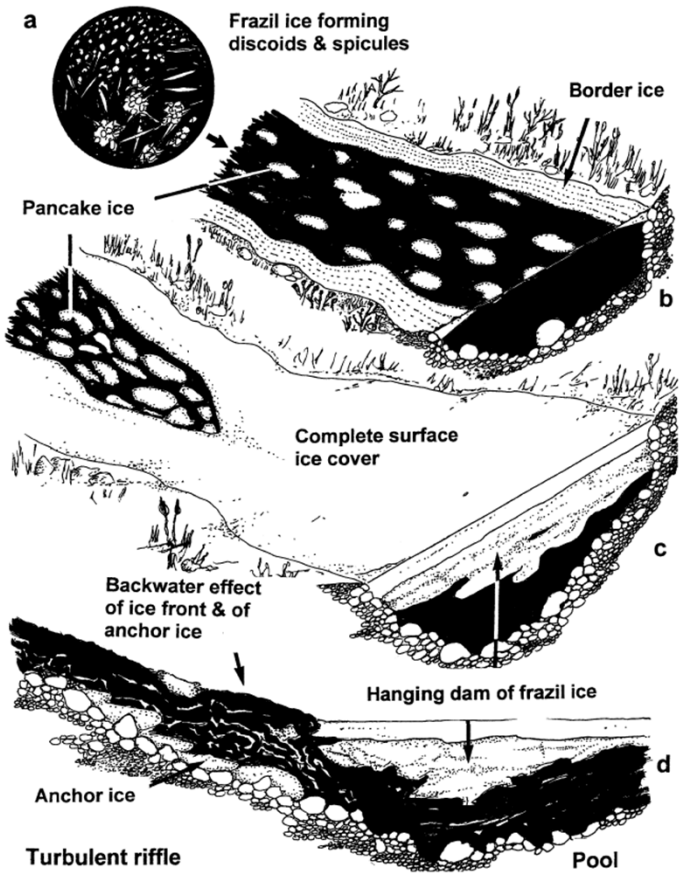

Figure 5 of Power (2002)

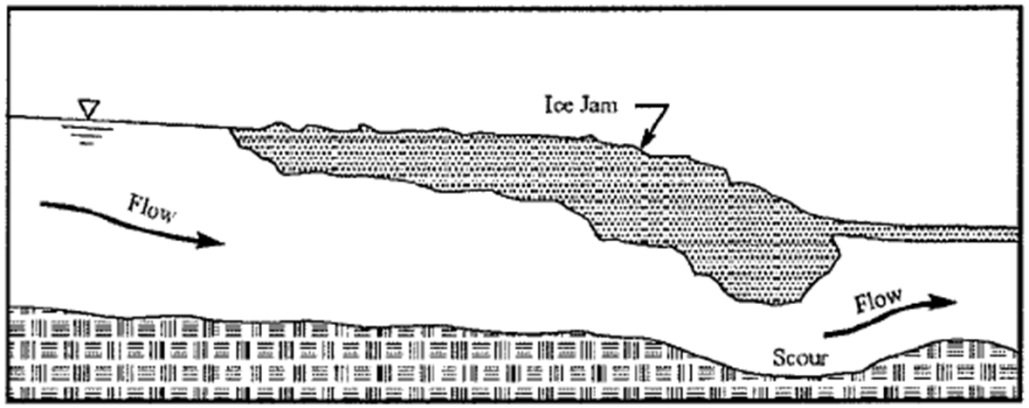

Figure 33 of Liu & Parker (2009)

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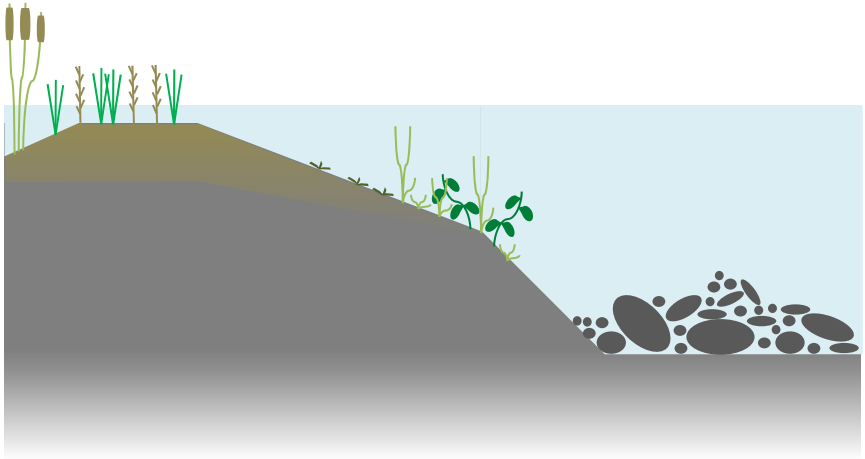
Ice

River channel x-section (historical)



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Driving forces

- Glaciation
- Flood/drought?
- water level
- ice/ice jams
- sand accretion/erosion

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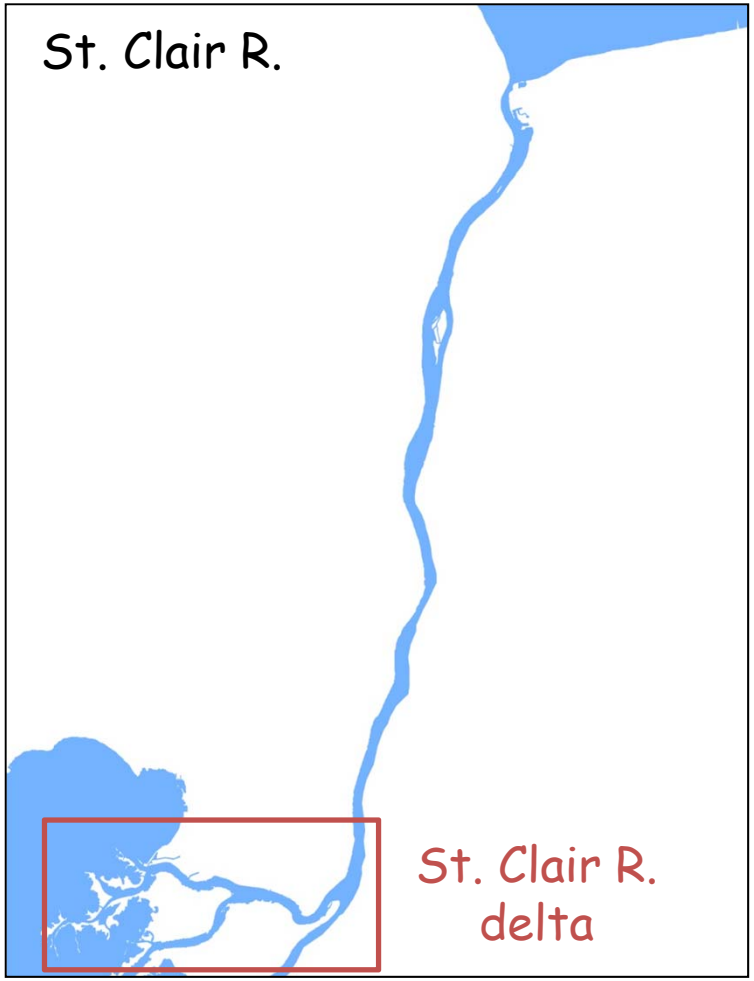
Sand accretion/erosion

http://lancastria.net/blog/wp-content/uploads/2008/07/lake_huron_2.jpg



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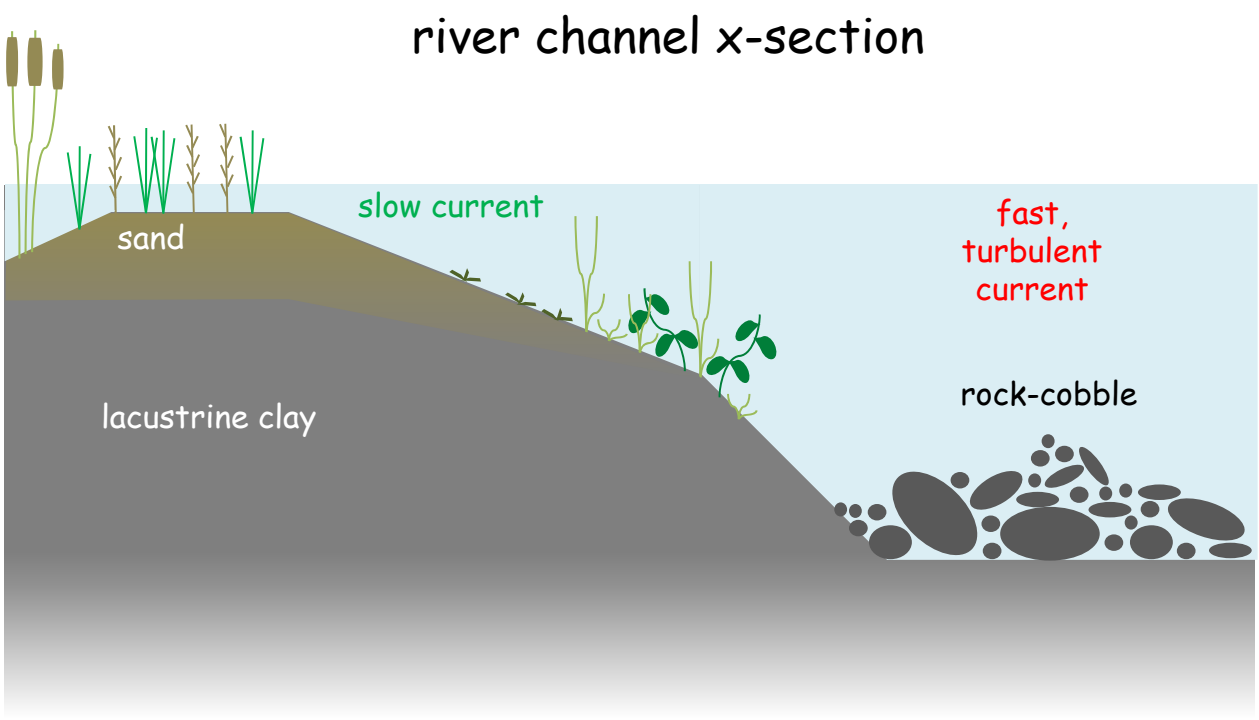
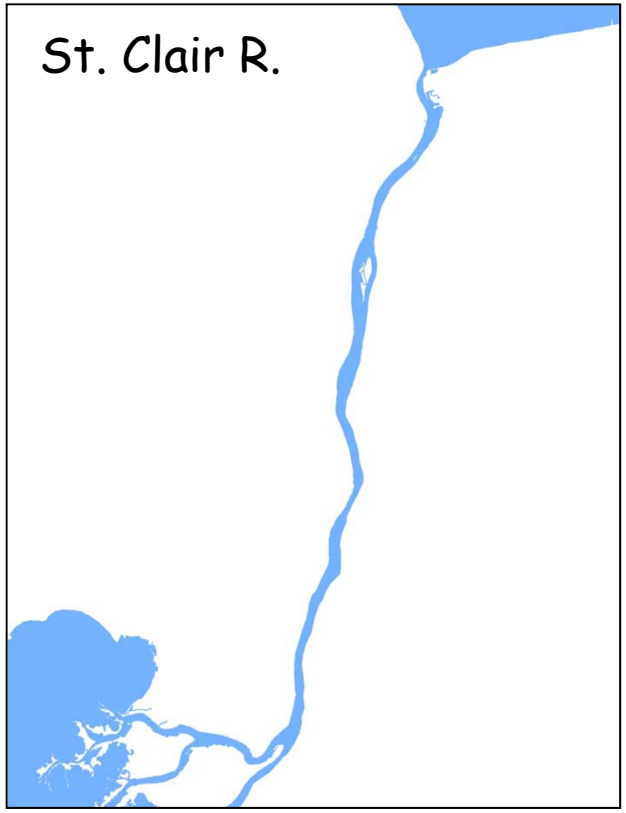
science for a changing world

Channel hydrogeomorphology: historical





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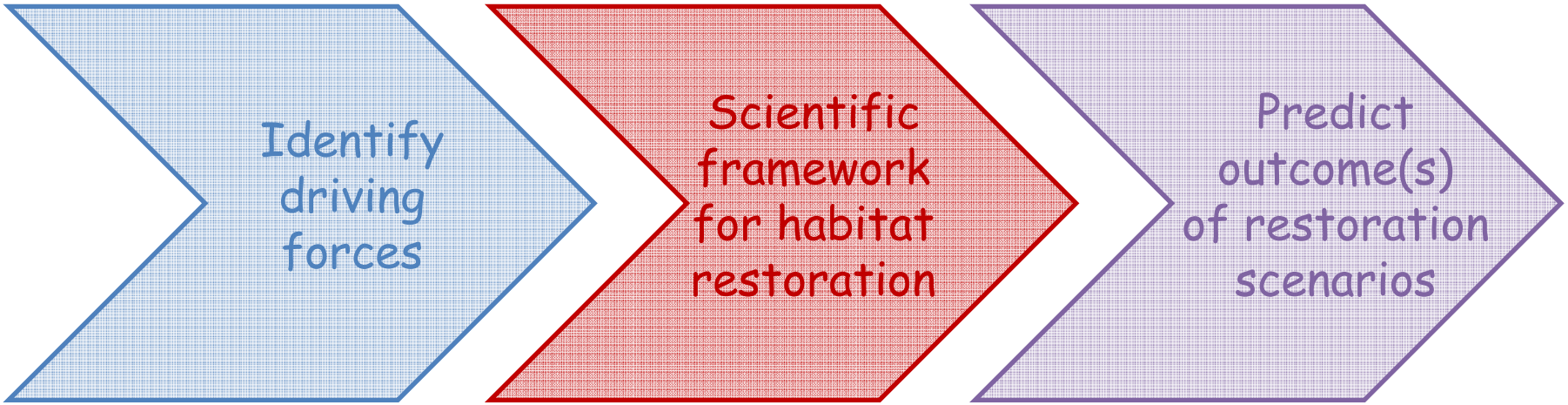
HURON-ERIE CORRIDOR INITIATIVE

Developing the science of fish habitat restoration



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Focal species: examples

lake whitefish (*Coregonus clupeaformis*)

lake sturgeon (*Acipenser fulvescens*)

cisco (*C. artedii*)

walleye (*Sander vitreus*)

coldwater — coolwater

fall-winter spawners

spring spawners

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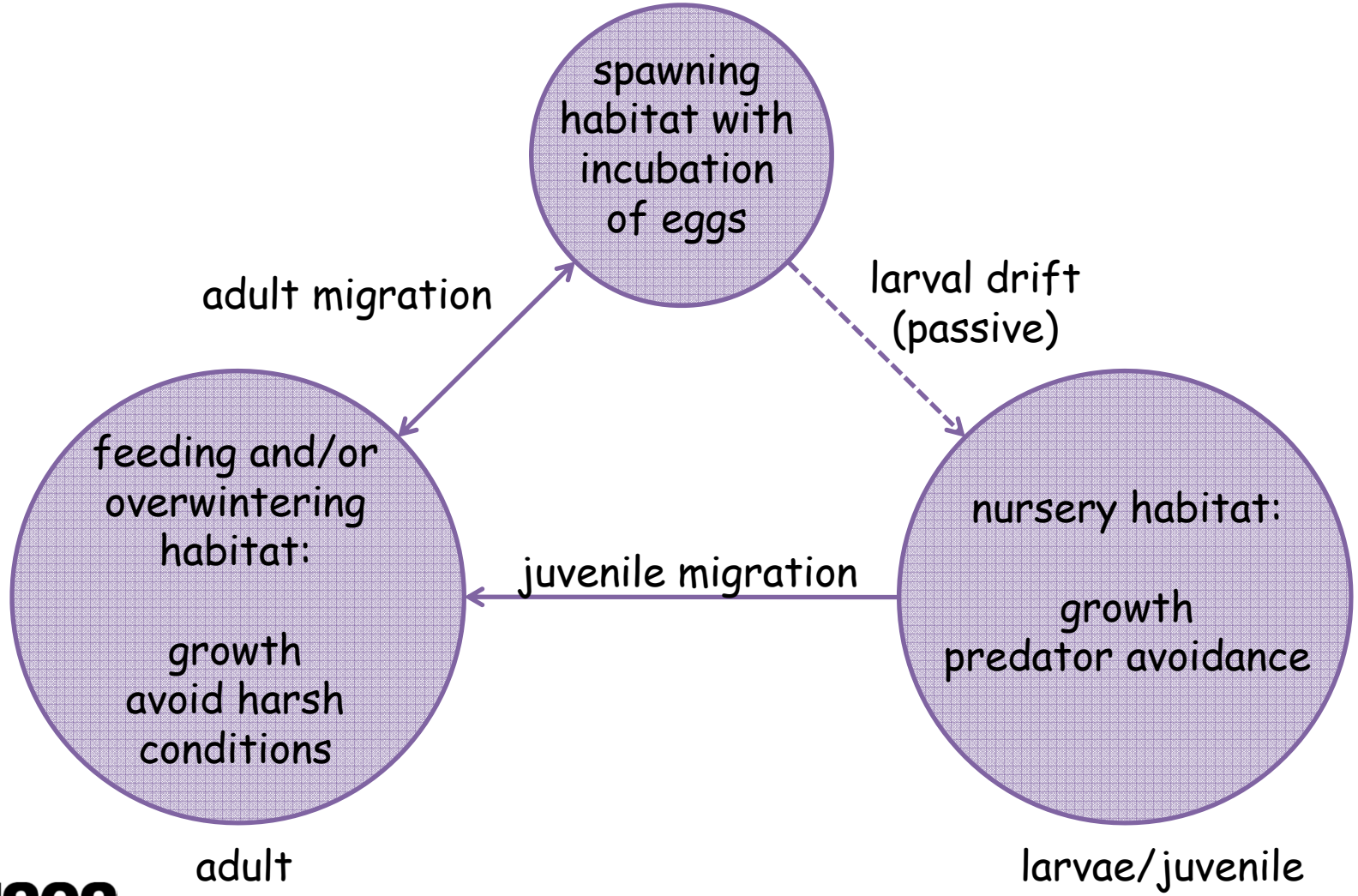
Life history-habitat model



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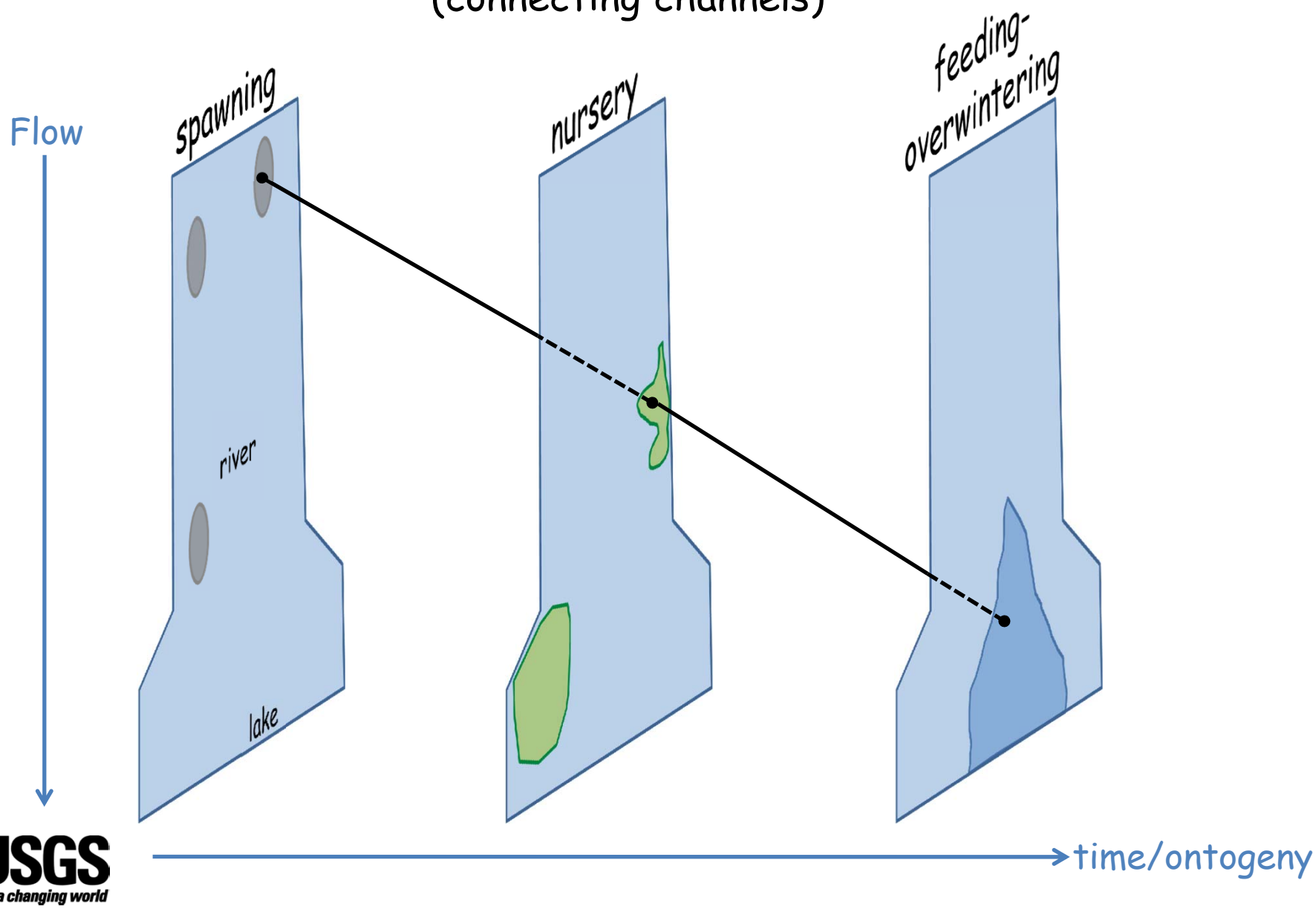
Life history-habitat model

(connecting channels)



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Framework: principles

- quality of spawning habitat is a function of the diversity & distribution of local spawning sites

- larval retention is bound to inshore/riverbed structure and form and their intersection with river/lake hydrodynamics

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Framework: principles (cont'd)

- microhabitat gradients are required to cover the changing habitat needs of larval-juvenile fish over ontogeny

- population and community diversity is a function of macro-scale habitat complexity & connectivity (e.g., main river channels, river islands, river mouths/inlets, etc.)

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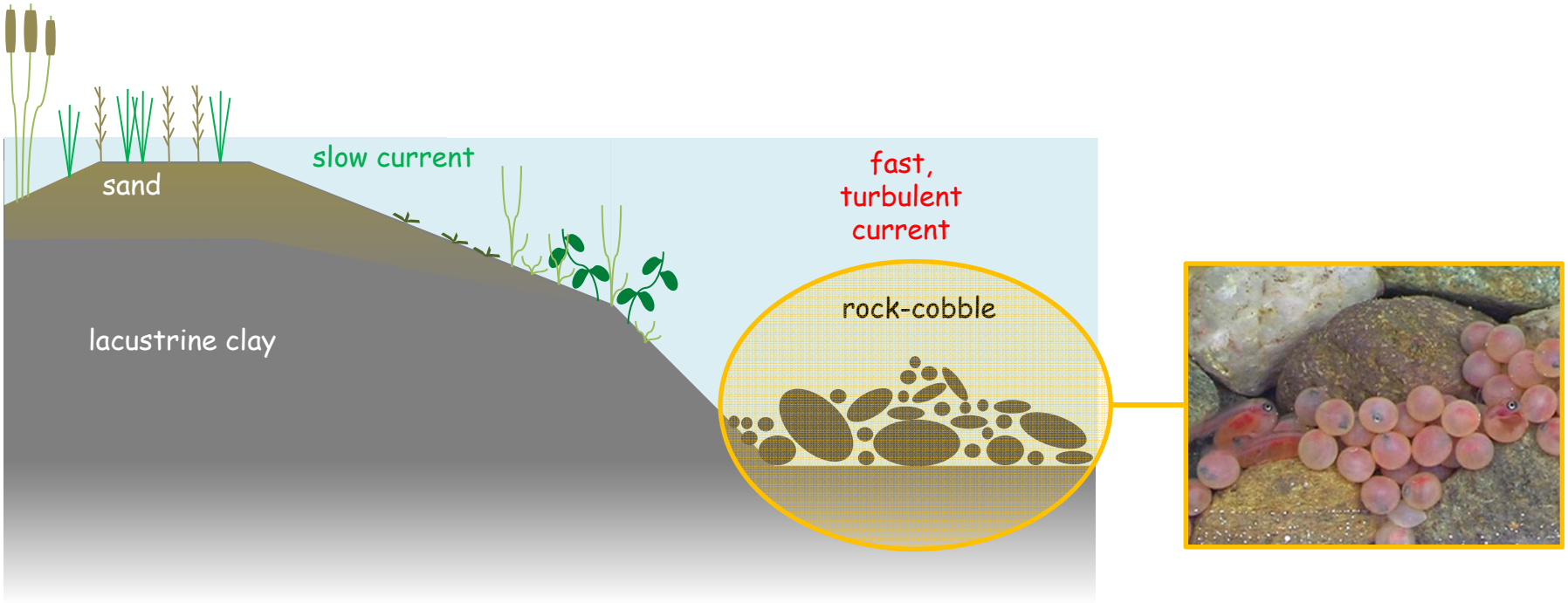
Channel hydrogeomorphology: historical



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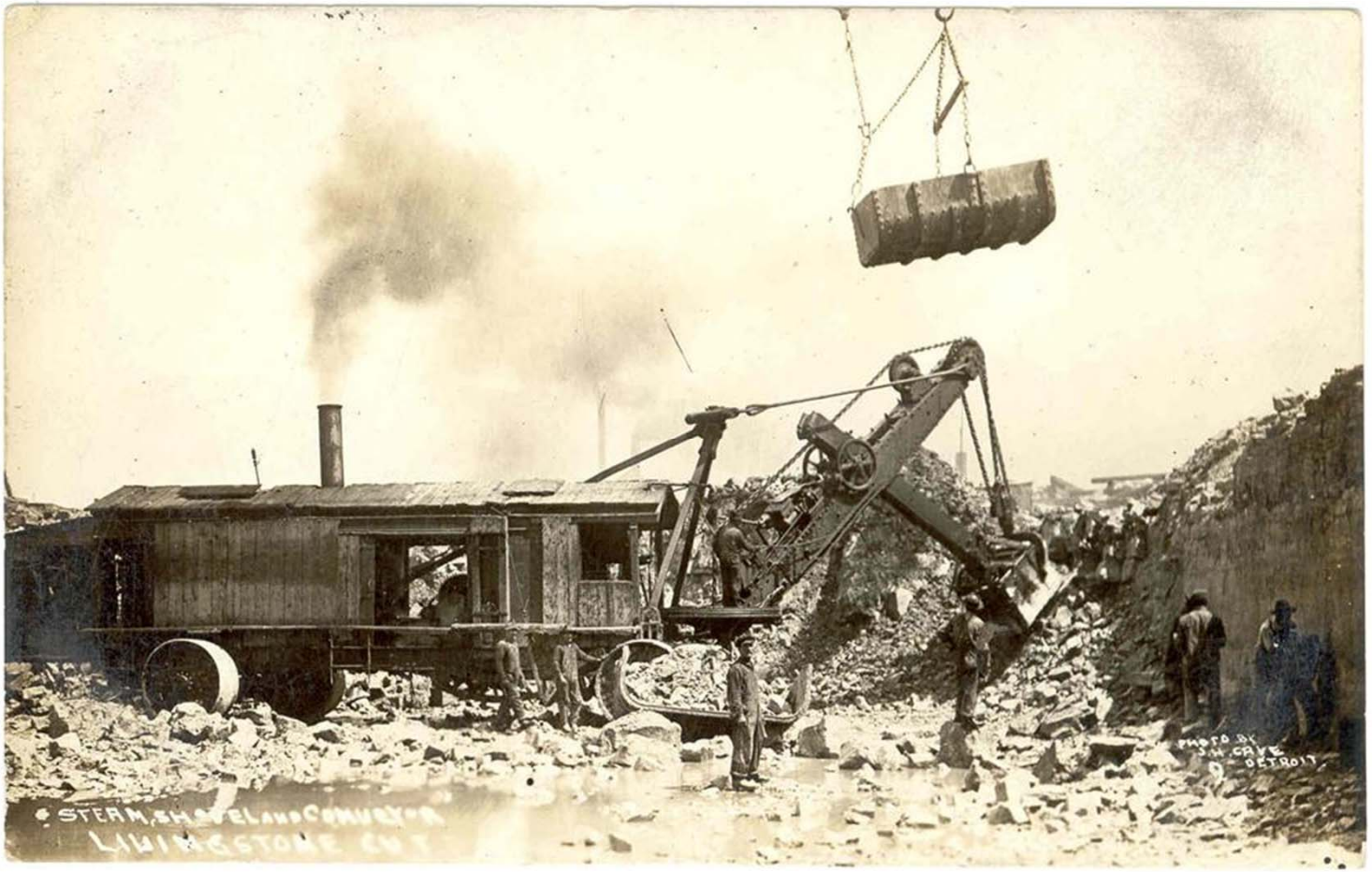
Historical spawning habitat(s)



Limekiln Crossing: lower Detroit River.

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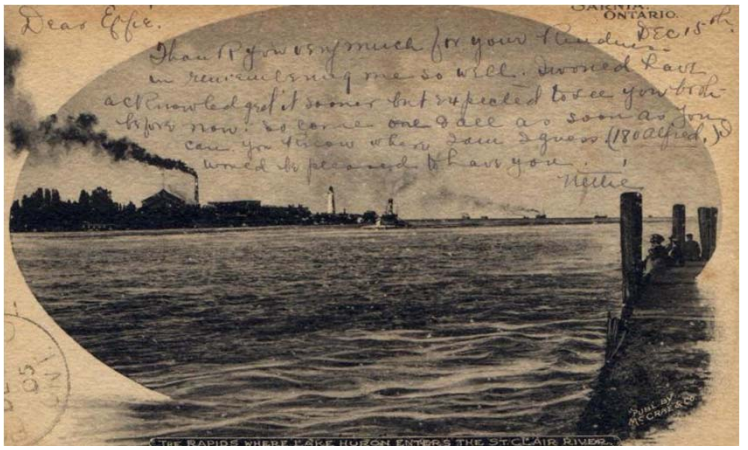
Historical spawning habitat(s)

Dipnet fishing in the St. Mary's Rapids



Port Huron "rapids"

eddy in St. Mary's Rapids

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Known lake sturgeon spawning sites (2001)

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Manny & Kennedy (2002)

Shoreline morphology

Upper Detroit River, U.S. Shoreline (north of Belle Isle)

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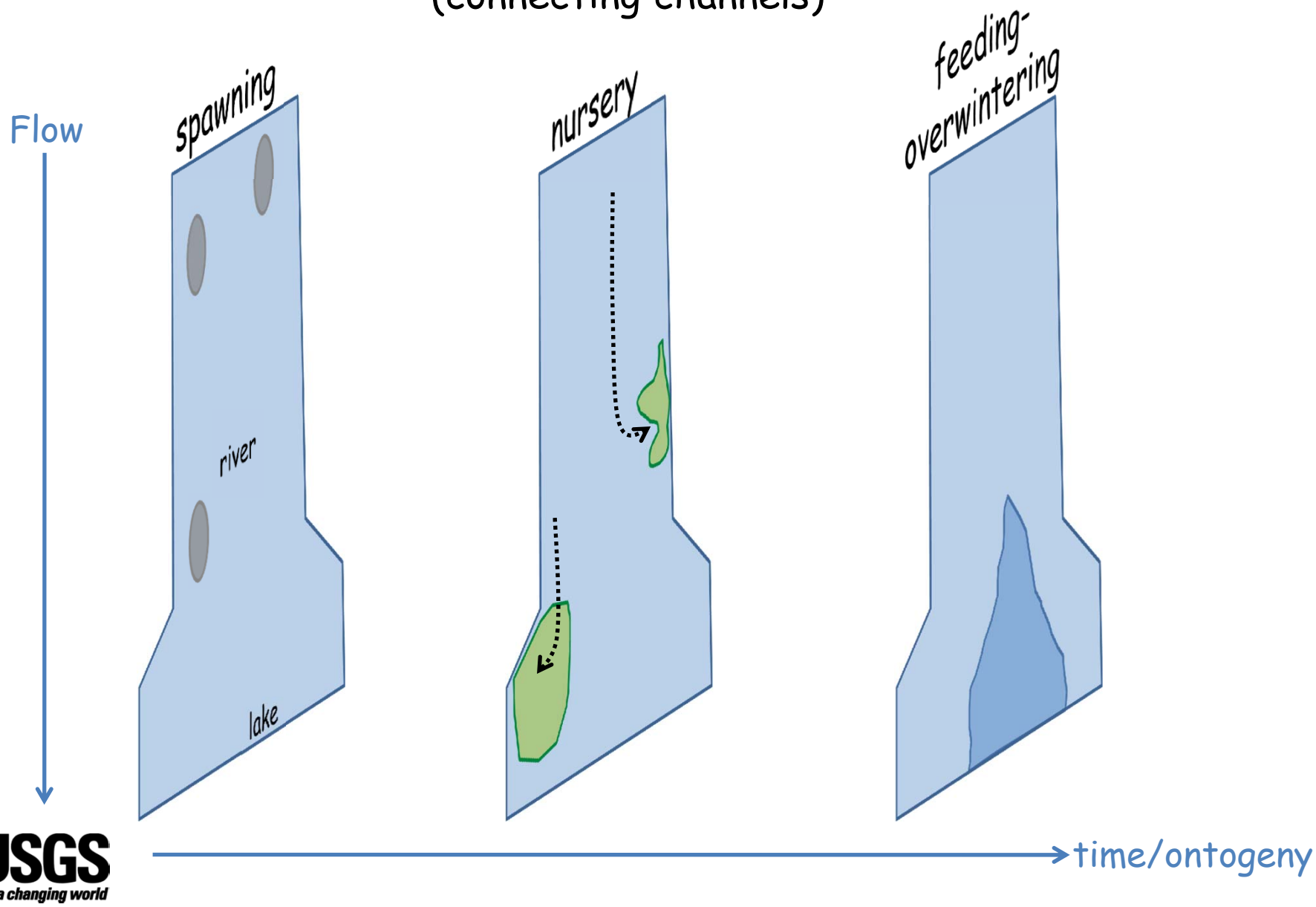
image courtesy of David Bennion

Life history-habitat model

(connecting channels)



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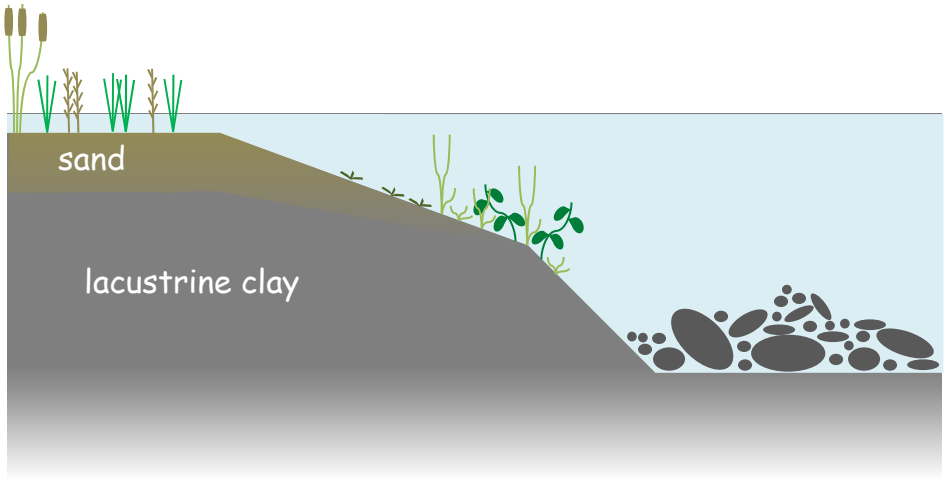
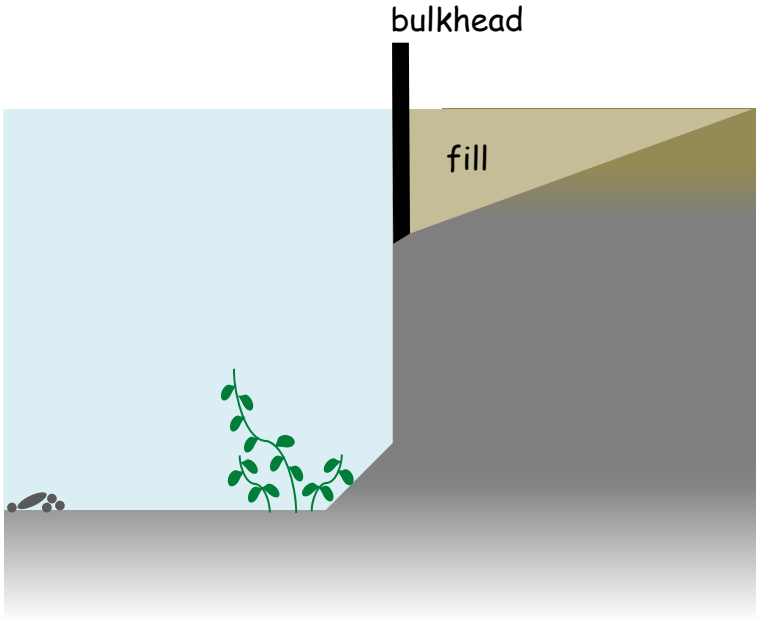
Channel morphology

River channel x-section (historical)



River channel x-section (present)



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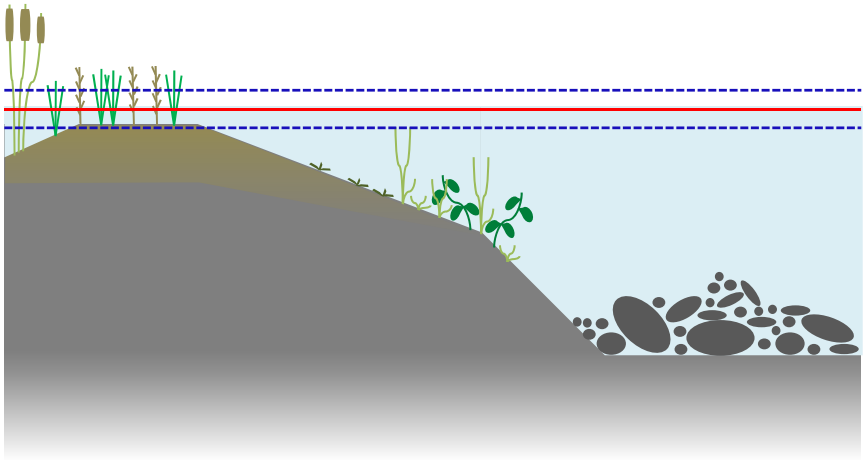
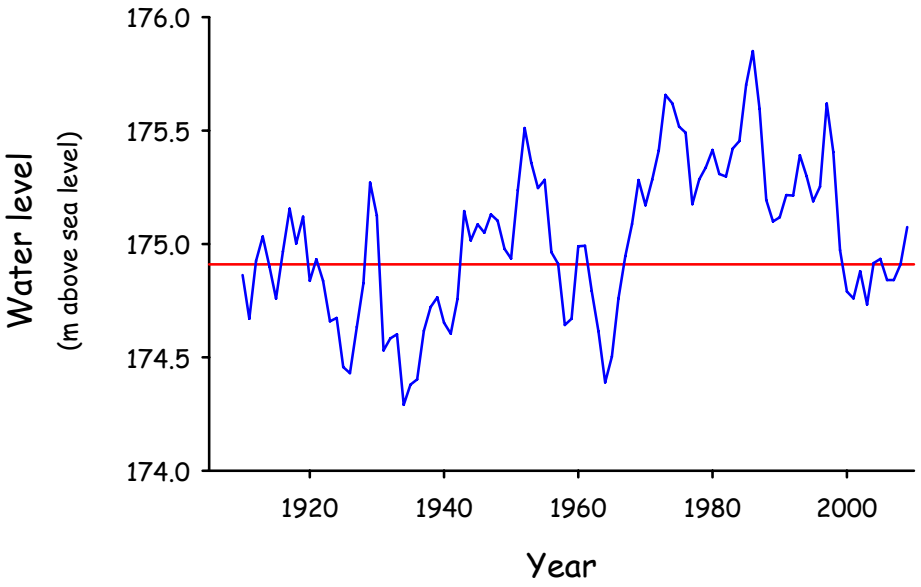
Water level fluctuations

River channel x-section (historical)



water levels in the HEC



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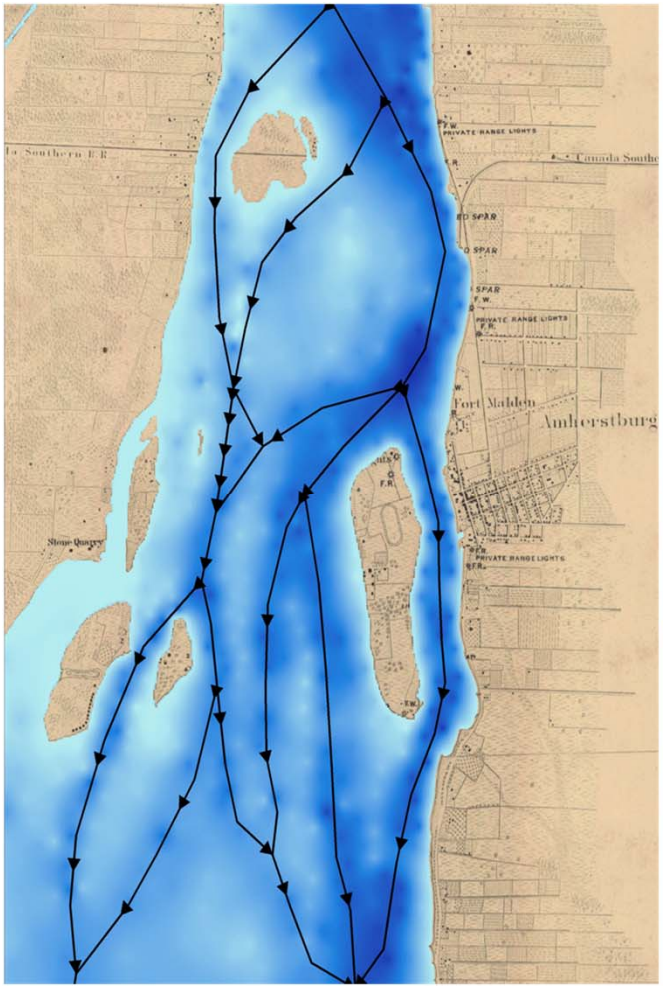
Altered flow pathways

Channel morphology: lower Detroit River (Courtesy D. Bennion)

historical



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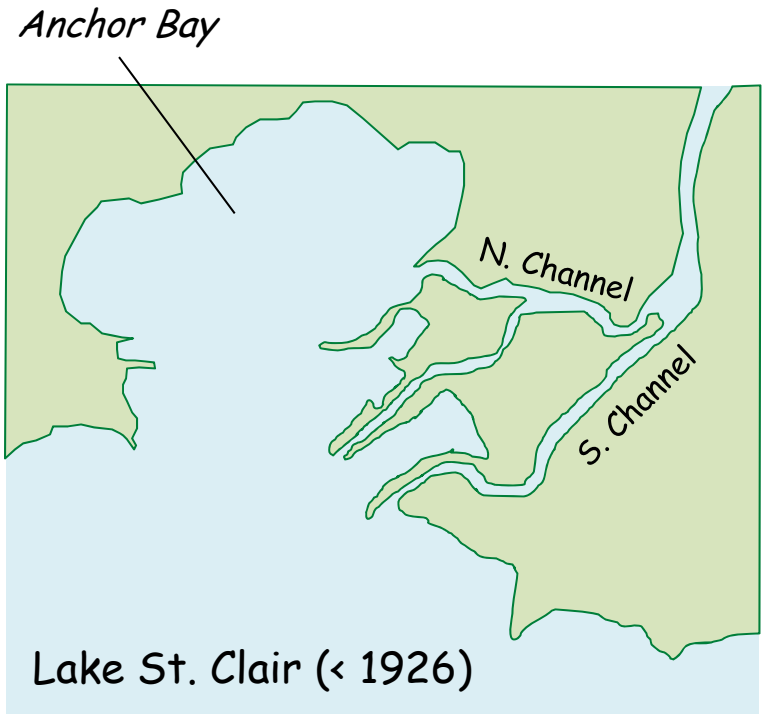
Altered flow pathways

Construction of the St. Clair cut-off and Lake St. Clair shipping channel



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Altered flow pathways

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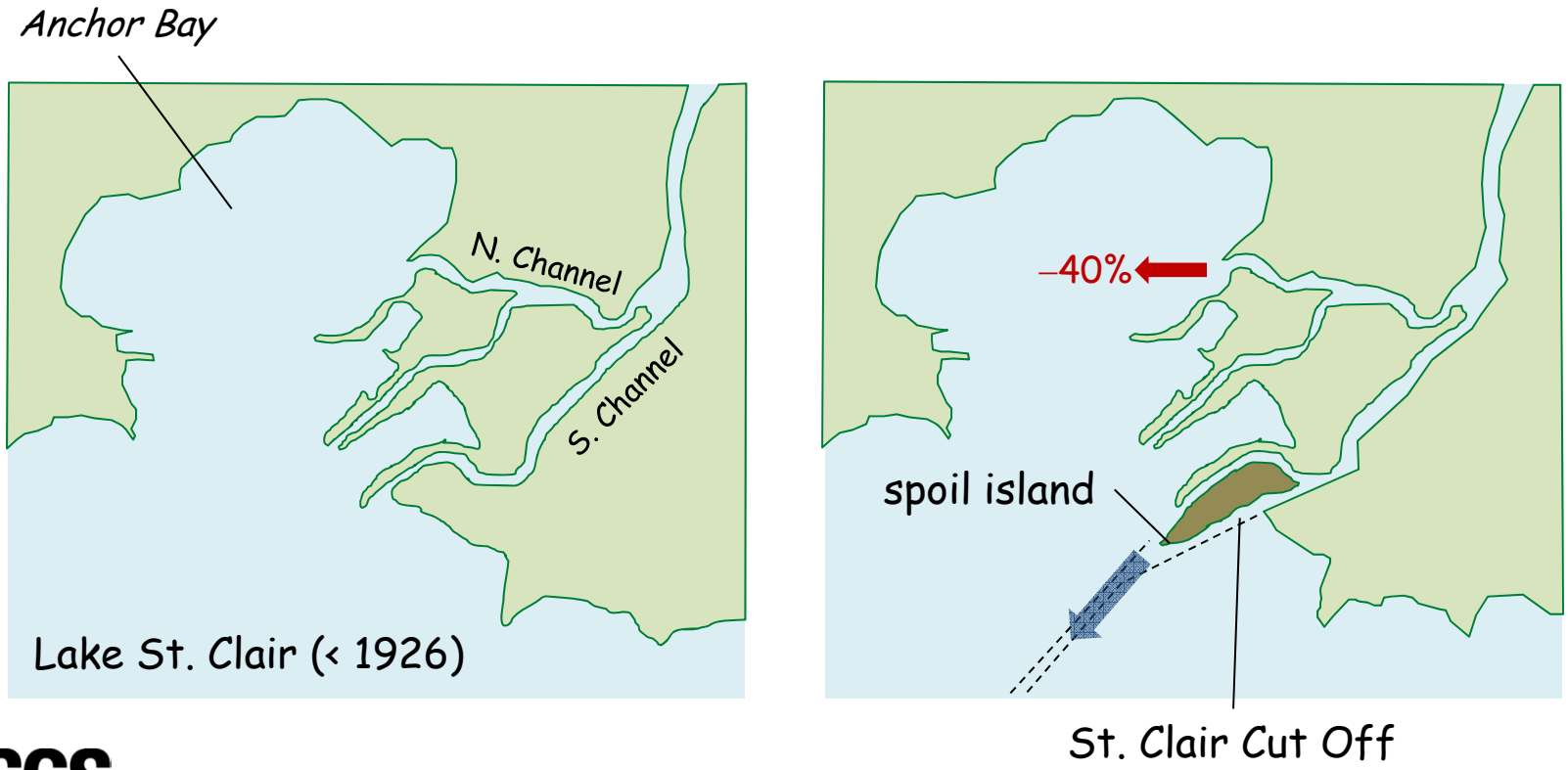

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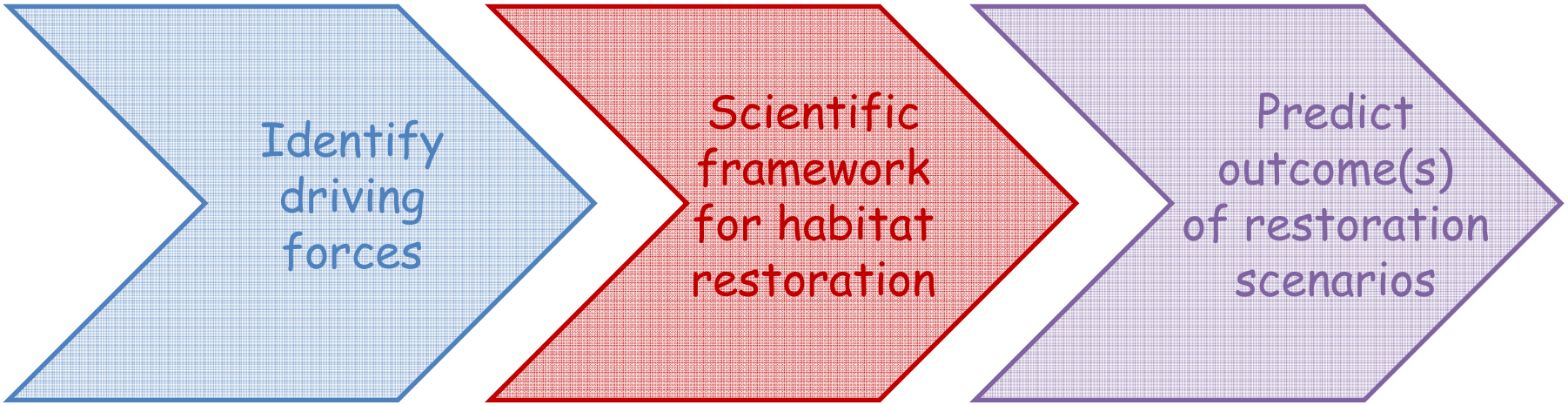
HURON-ERIE CORRIDOR INITIATIVE

Developing the science of fish habitat restoration



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HURON-ERIE CORRIDOR INITIATIVE

Questions & scenarios

- what is the effect of bathymetric distribution of spawning habitat on spawner abundance & species composition and egg deposition & survival?

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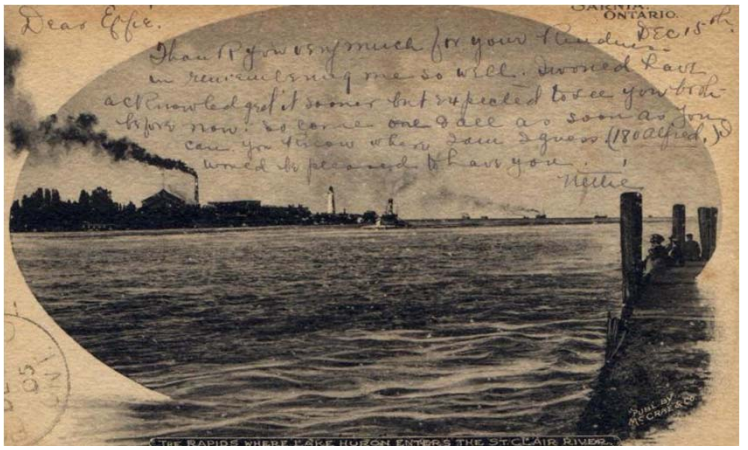
Historical spawning habitat(s)

Dipnet fishing in the St. Mary's Rapids



Port Huron "rapids"

eddy in St. Mary's Rapids

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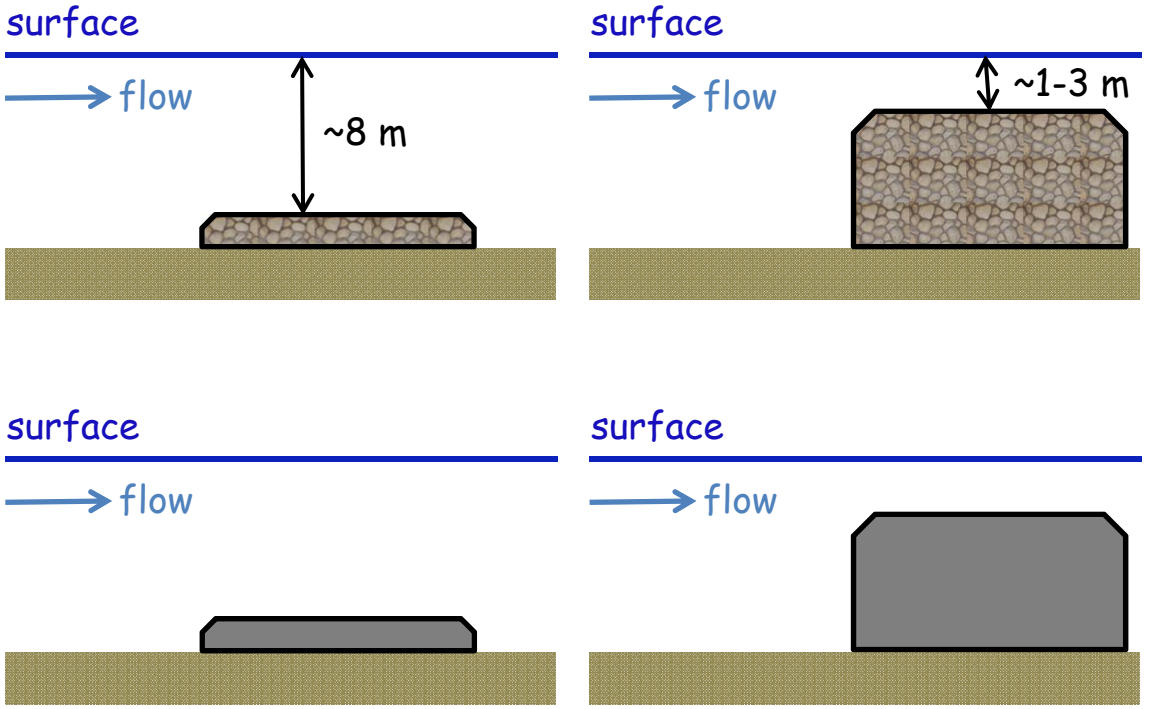
Experimental design



experimental ("impact") treatments
material = rock/cobble

controls
material = clay/fill

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HURON-ERIE CORRIDOR INITIATIVE

Questions & scenarios

- How does the bathymetric distribution of spawning habitat affect spawner abundance & species composition and egg deposition & survival?

- How should experimental reefs be sited longitudinally? How does reef placement impact connectivity with downstream nursery habitat?

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Minor tributaries of the St. Clair system

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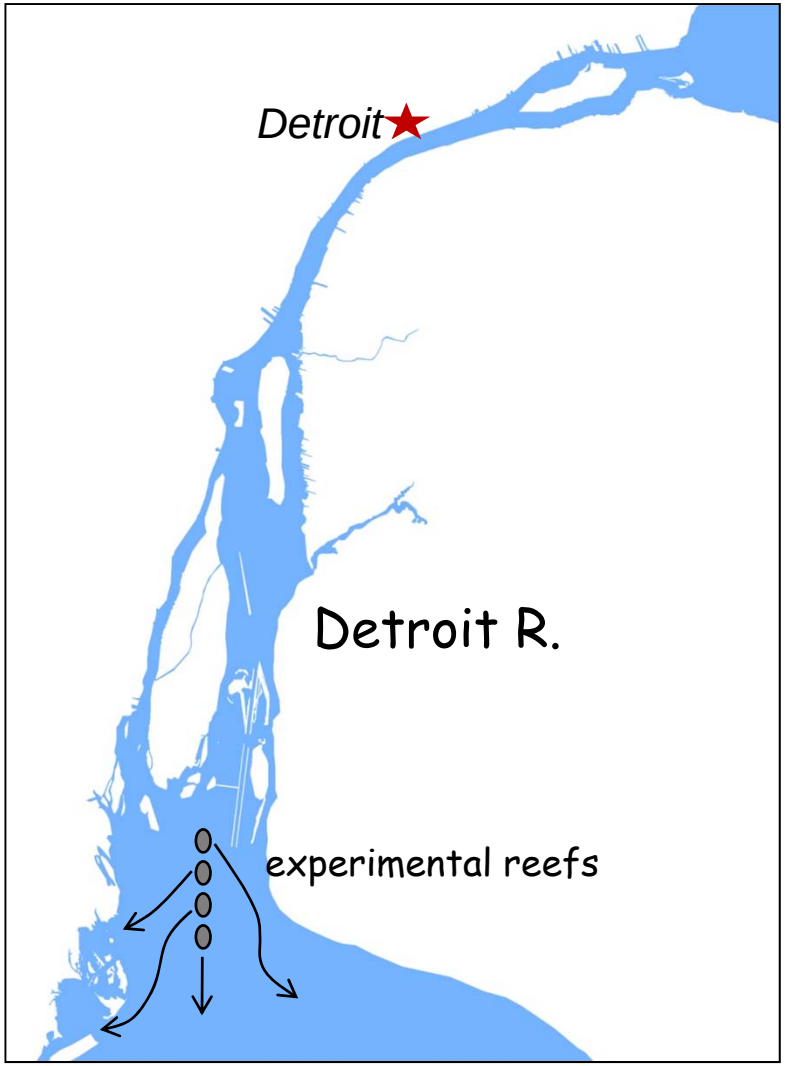
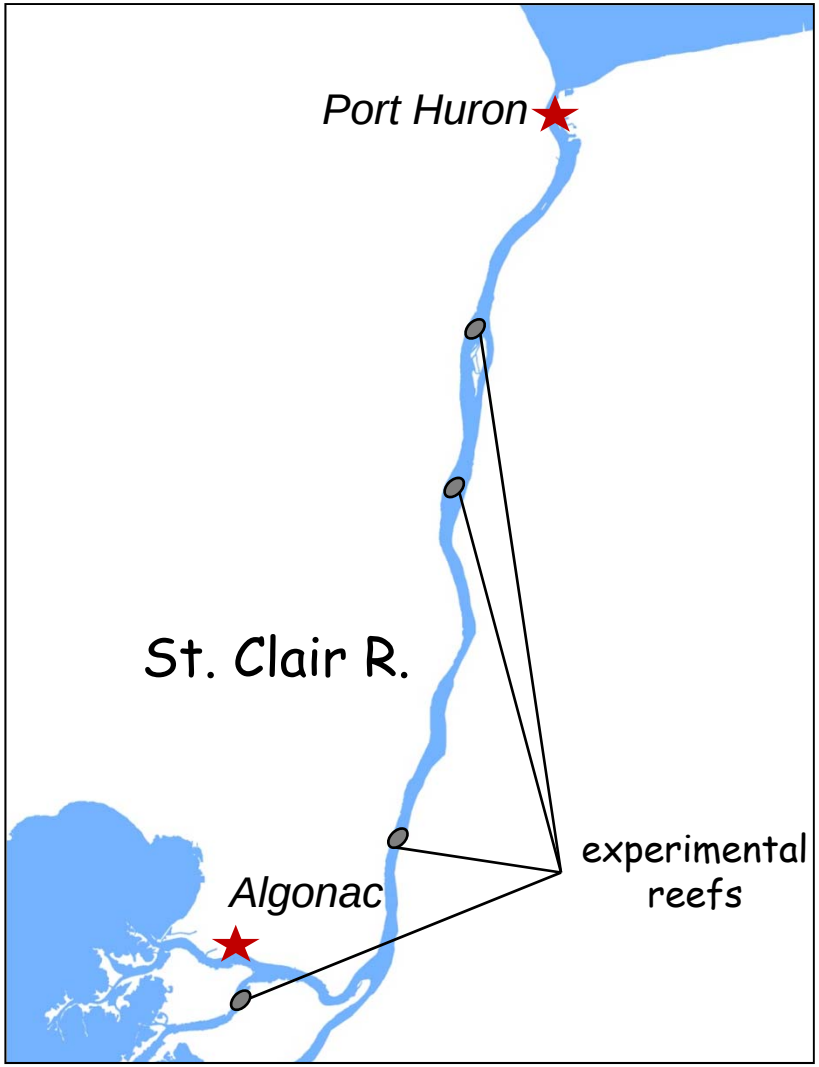
reef placement





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HURON-ERIE CORRIDOR INITIATIVE

Questions & scenarios

- How does the bathymetric distribution of spawning habitat affect spawner abundance & species composition and egg deposition & survival?
- How should experimental reefs be sited longitudinally? How does reef placement impact connectivity with downstream nursery habitat?
- Is rock-cobble spawning substrate limiting?

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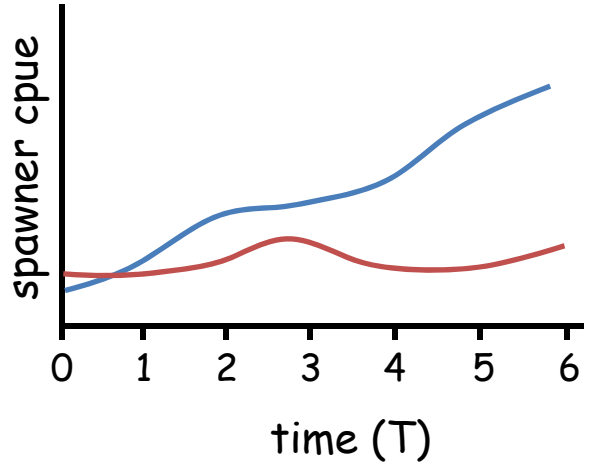
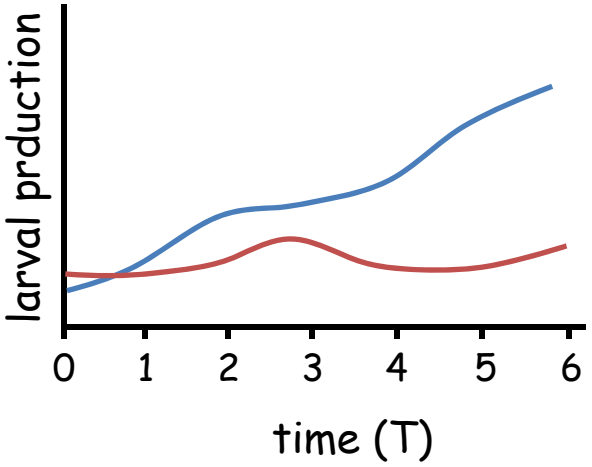
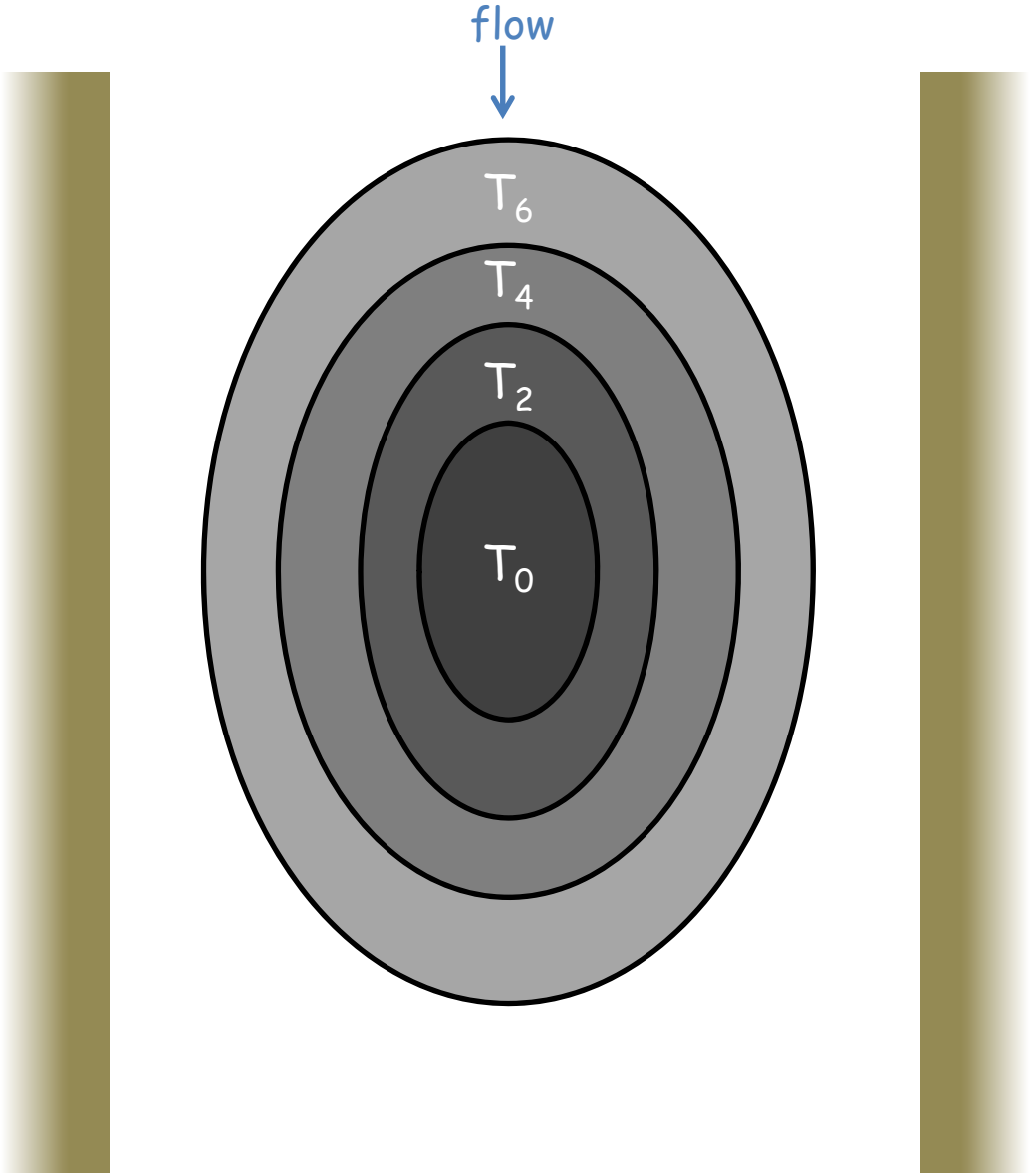
"how much rock is enough?"







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HURON-ERIE CORRIDOR INITIATIVE

Questions & scenarios

- What inshore structure(s) maximize larval retention and nursery habitat quality in rivers/lakes?

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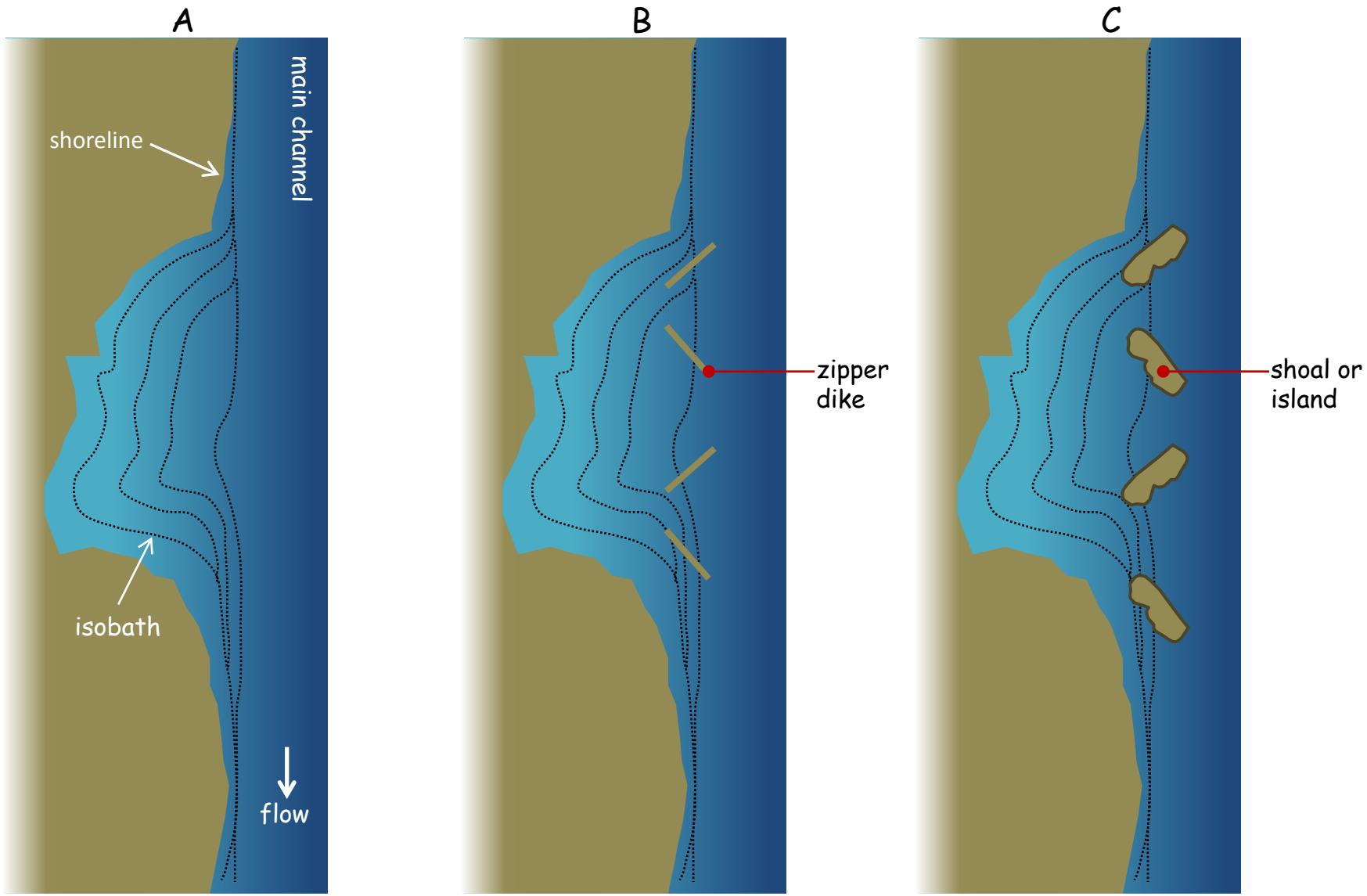

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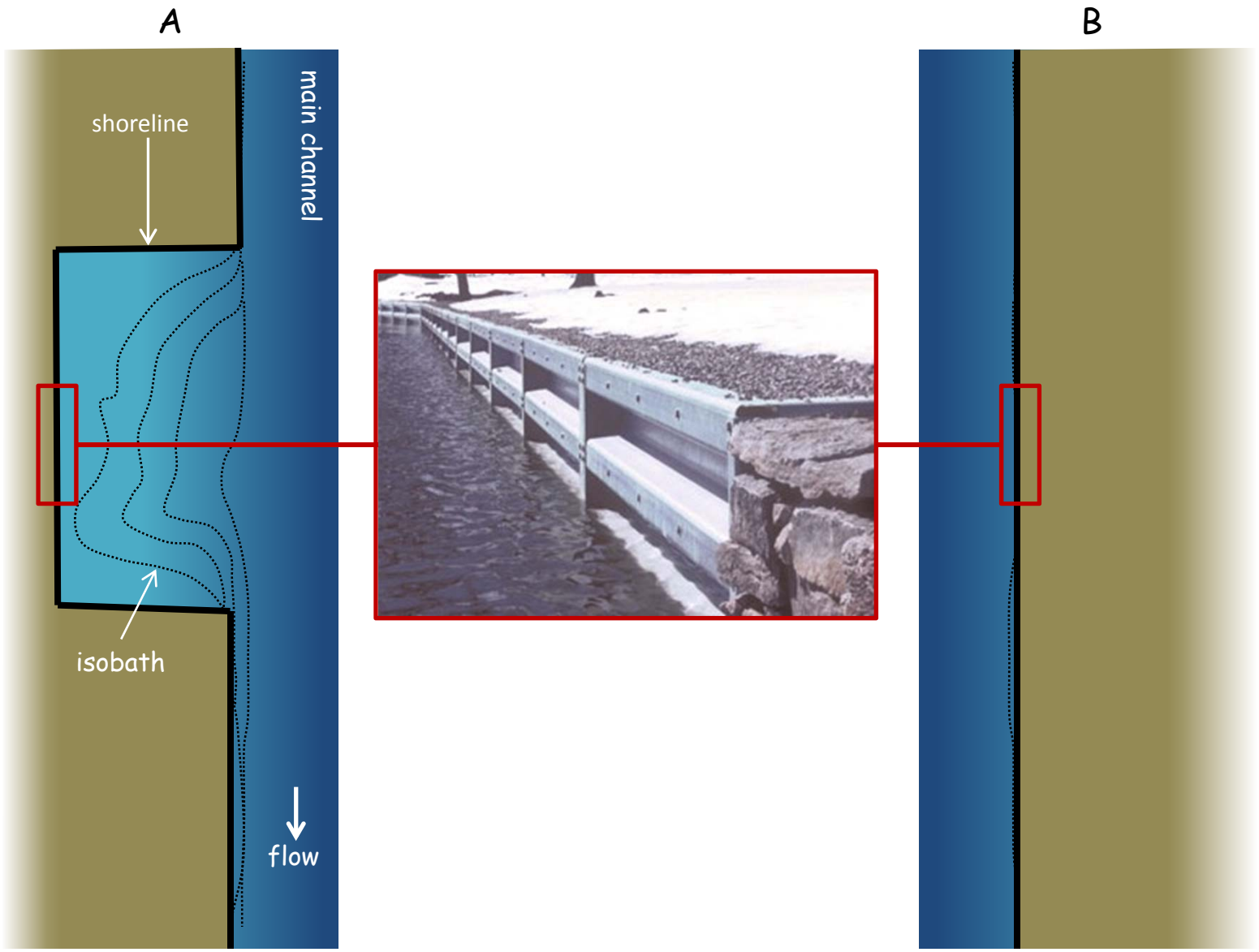

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HURON-ERIE CORRIDOR INITIATIVE

Questions & scenarios

- What inshore structure(s) maximize larval retention and nursery habitat quality in rivers/lakes?

- What role does Lake St. Clair play in fish early life history dynamics and fish population structure?

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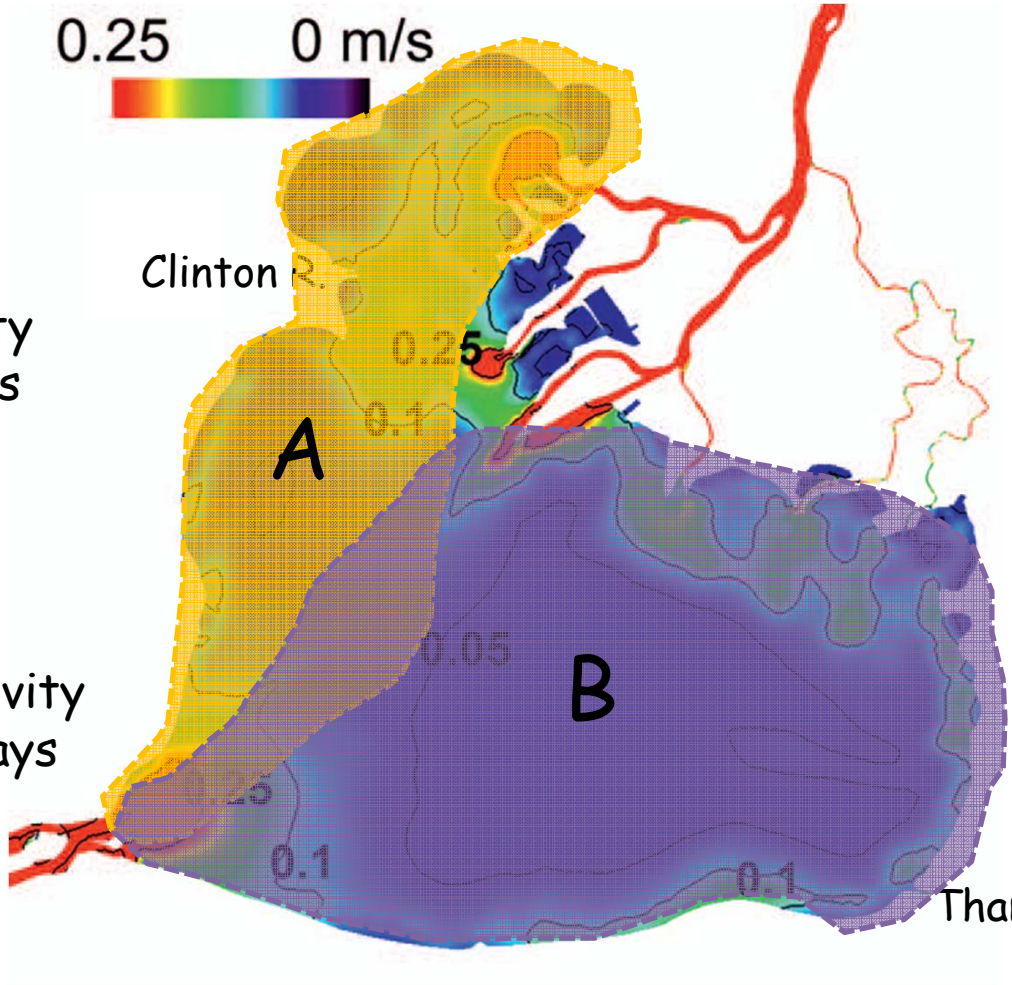
Water masses: Lake St. Clair

A: Lake-Huron/St. Clair R.

- higher current velocity
- cooler, lower productivity
- residence time ~4.5 days

B: South Channel/cut-off

- Thames R. influenced
- stagnant
- warmer, higher productivity
- residence time ~8-30 days



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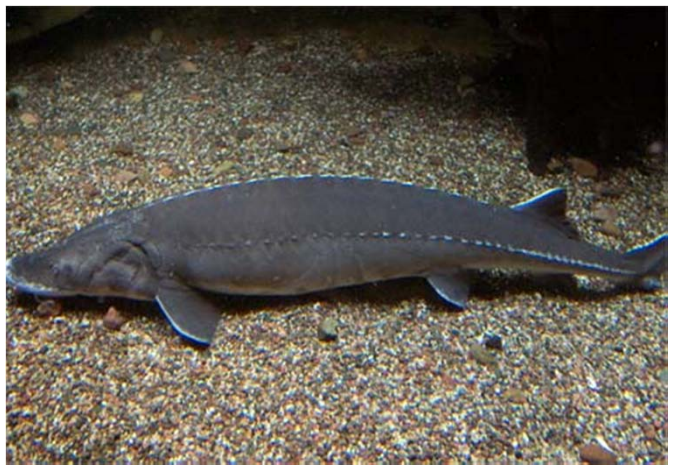
Lake sturgeon metapopulation structure in a complex, river-lake ecosystem



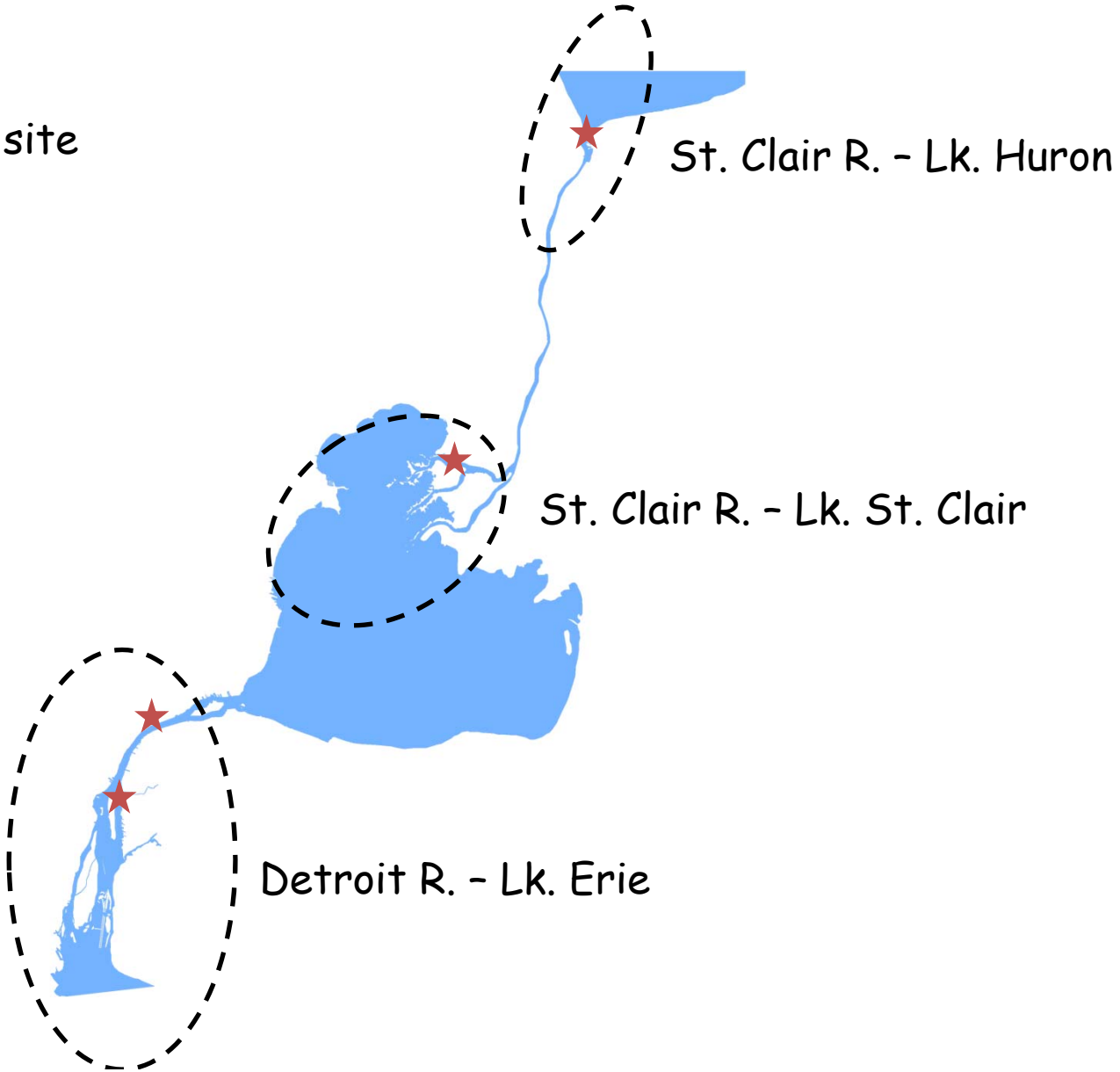


Charles C. Krueger (GLFC), Darryl W. Hondorp (USGS), James C. Boase (USFWS), Edward F. Roseman (USGS), et al.

February 8-9, 2011

Hypothesis: 3 local populations?

★ known spawning site



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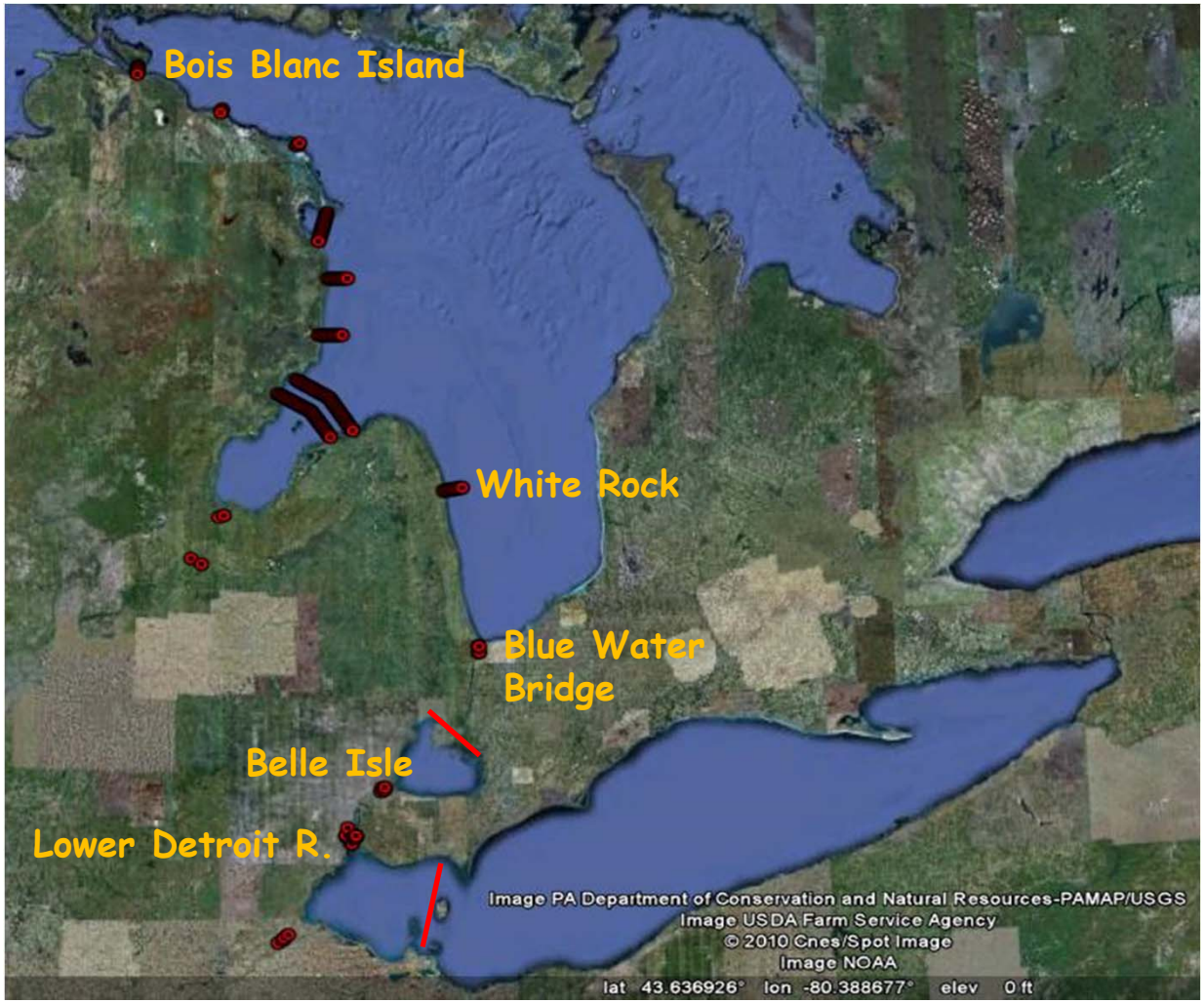
Acoustic receiver array design



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HURON-ERIE CORRIDOR INITIATIVE

Questions & scenarios

- What inshore structure(s) maximize larval retention and nursery habitat quality in rivers/lakes?
- What role does Lake St. Clair play in fish early life history dynamics and fish population structure?
- Do populations of lake- and river-spawners fluctuate asynchronously?

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Population diversity & stability in variable environments

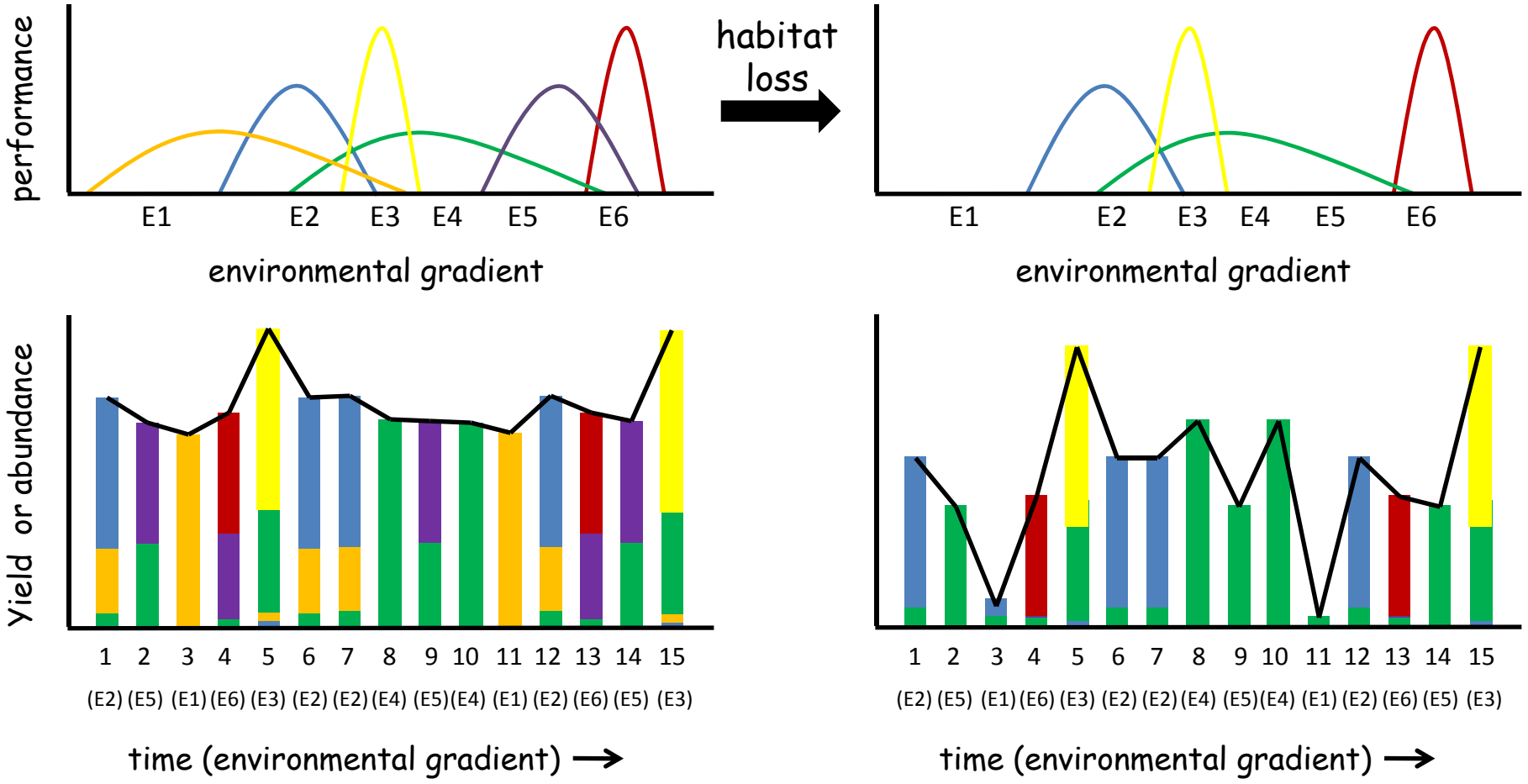

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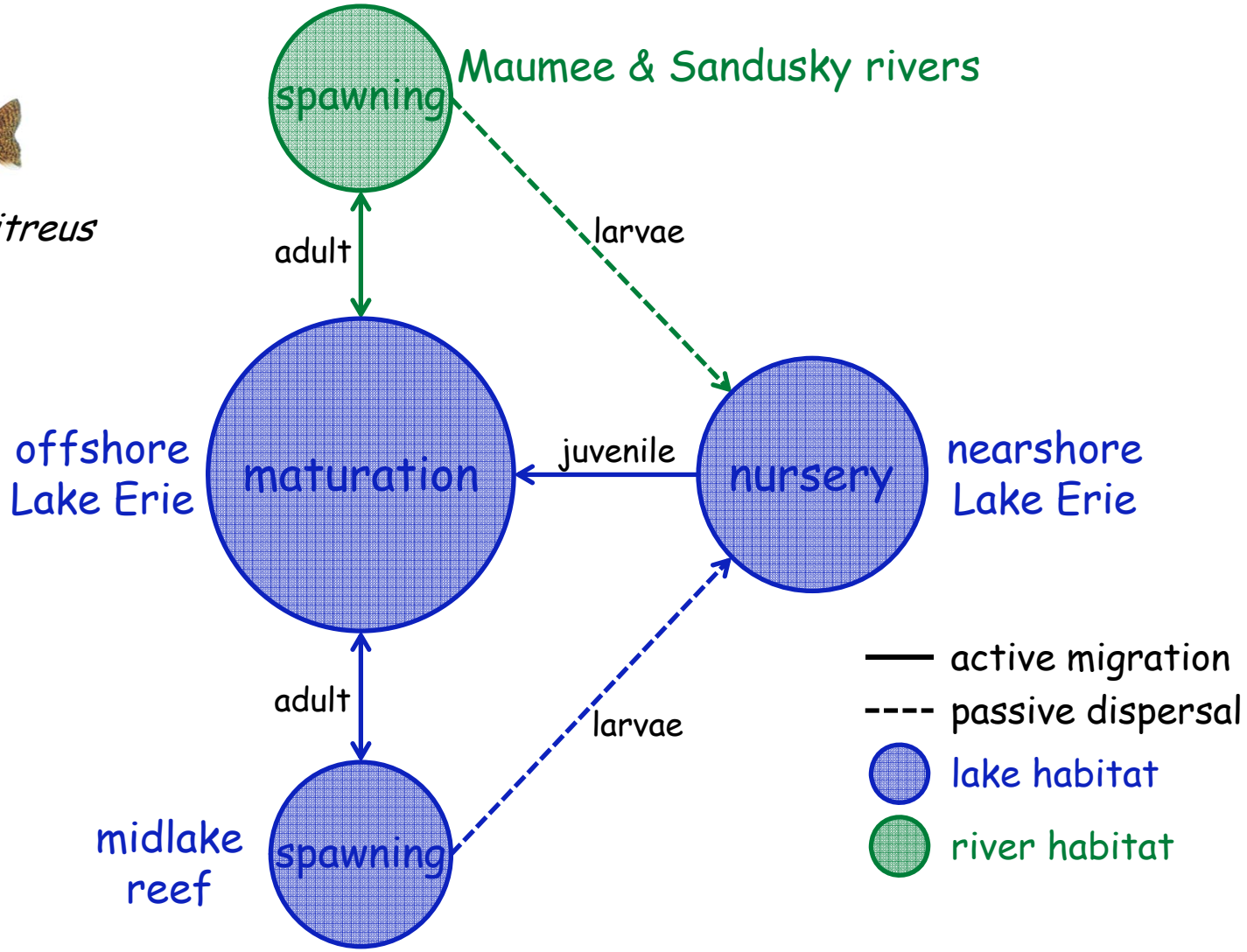
Figure 3.8 of Liss et al. (2006)

Risk spreading: a Great Lakes example

walleye *Sander vitreus*



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Risk spreading: Lake Erie walleye

walleye *Sander vitreus*

<u>spawning populations</u>

midlake reef

Maumee & Sandusky rivers

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Questions pertaining to existing projects

- Is selection of spawning substrate species specific?
- Does substrated type influence egg survival/hatching success?
- How does cross-channel placement affect spawning reef quality?

Collaborators, contributors & funding

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HURON-ERIE CORRIDOR INITIATIVE

ONTARIO MINISTRY OF NATURAL RESOURCES

Great Lakes RESTORATION

Michigan DNRE natural resources & environment

Greater Detroit American Heritage River Initiative

U.S. FISH & WILDLIFE SERVICE DEPARTMENT OF THE INTERIOR

Bathymetry: Upper St. Clair R.

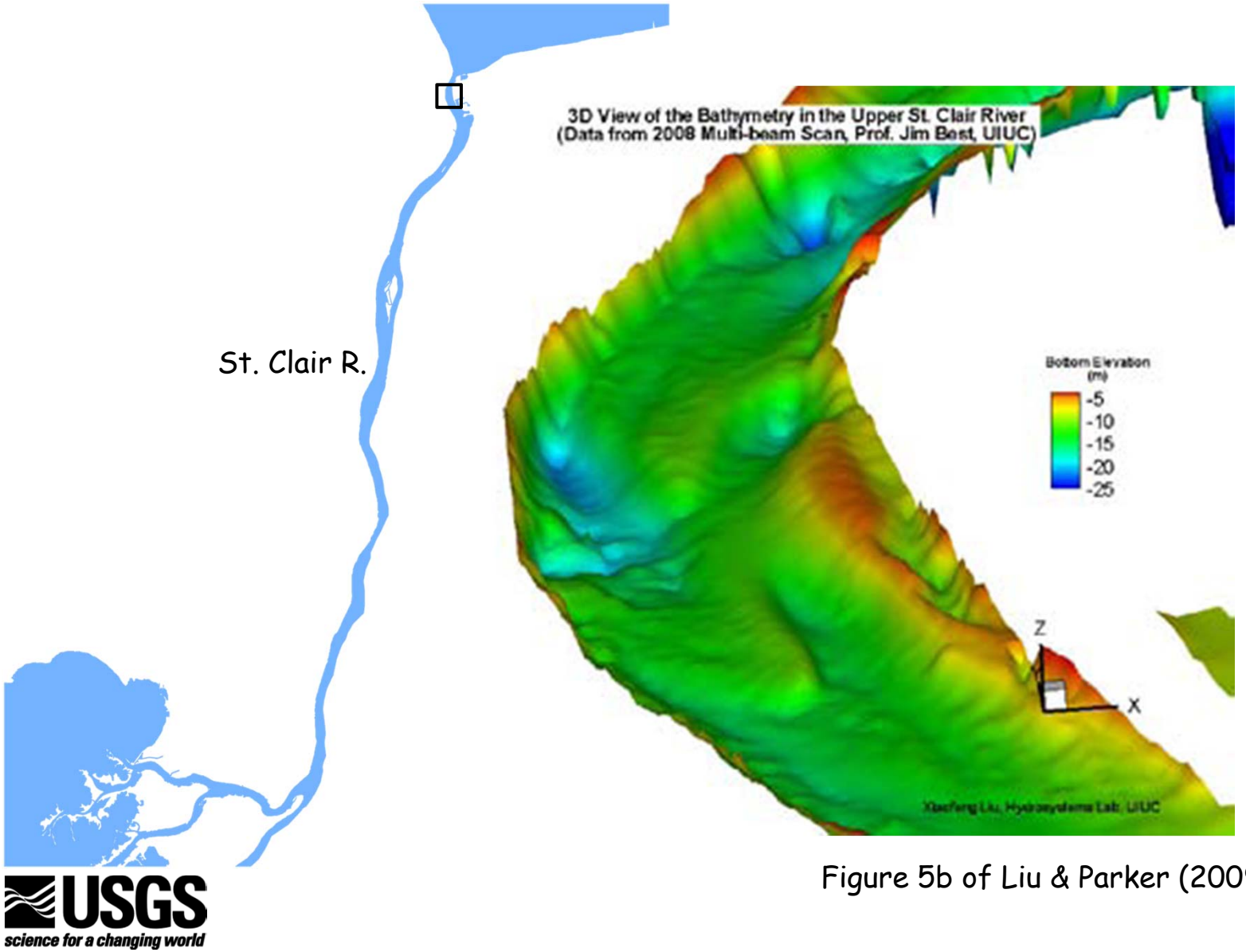

Figure 5b of Liu & Parker (2009)

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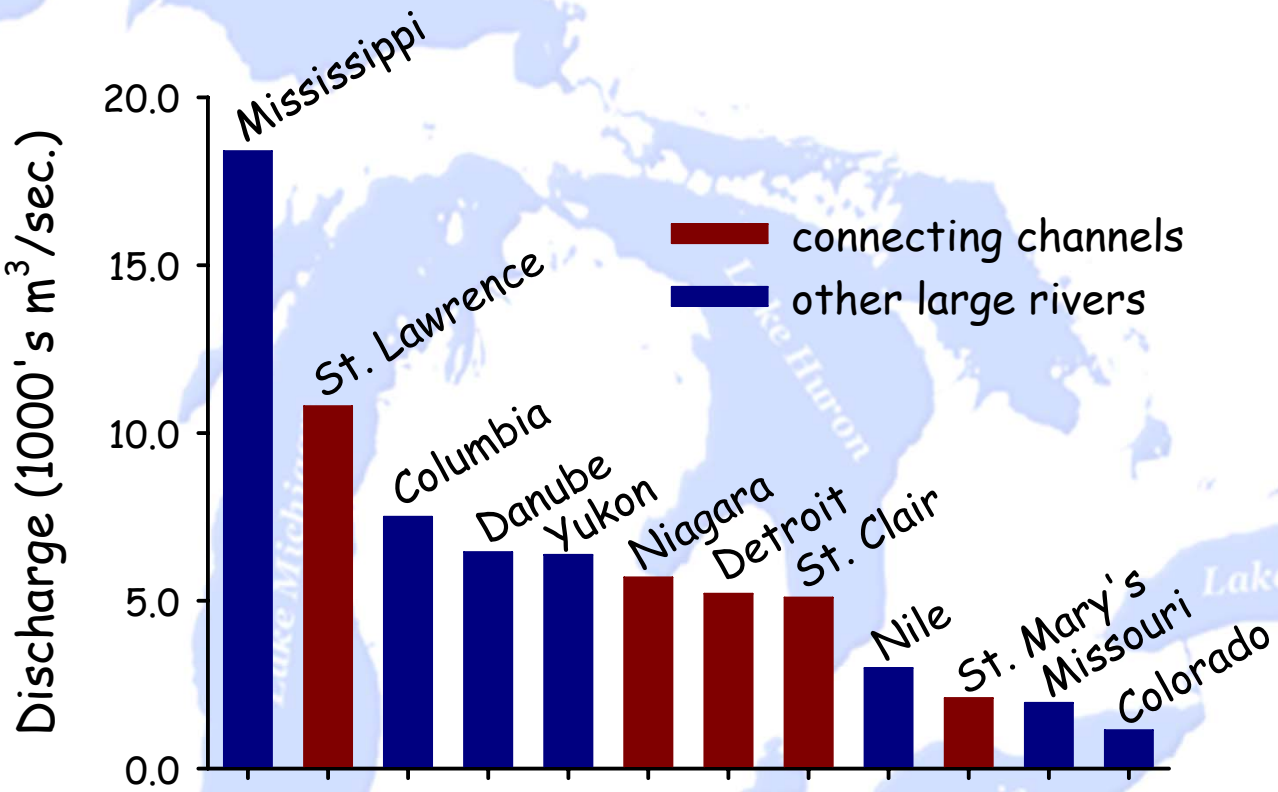
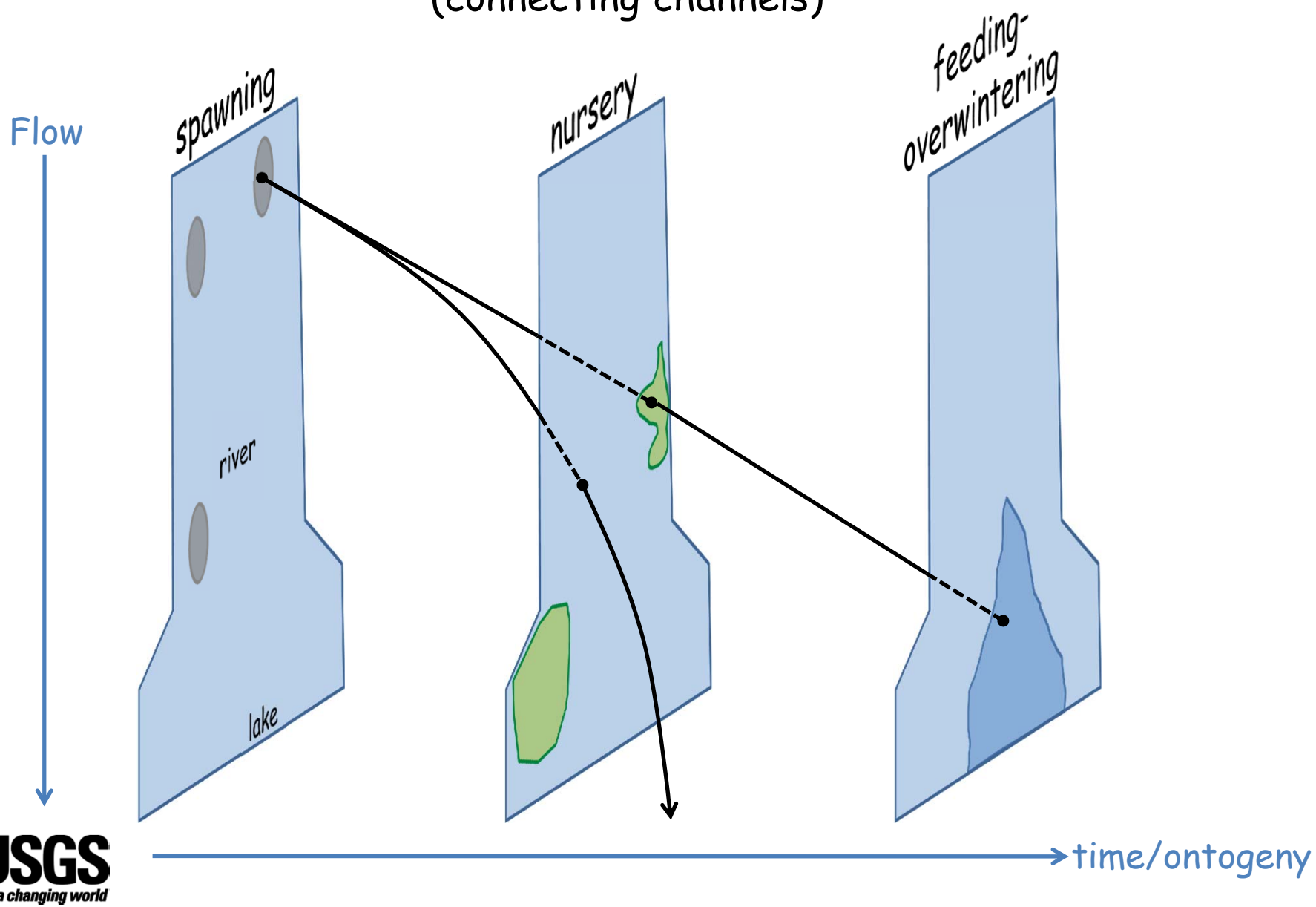
The connecting channels *are* large rivers



Life history-habitat model

(connecting channels)



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