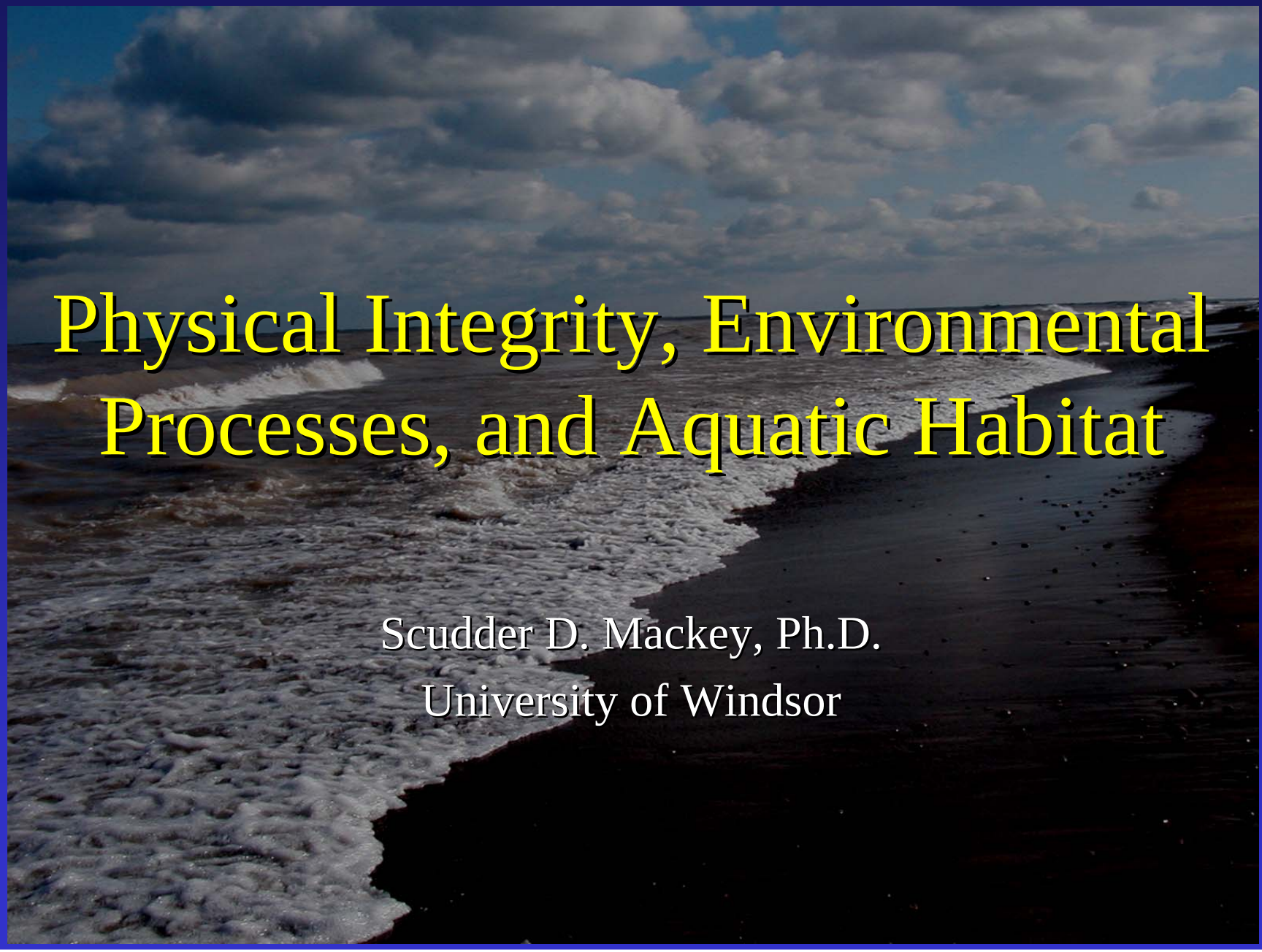


Physical Integrity, Environmental Processes, and Aquatic Habitat

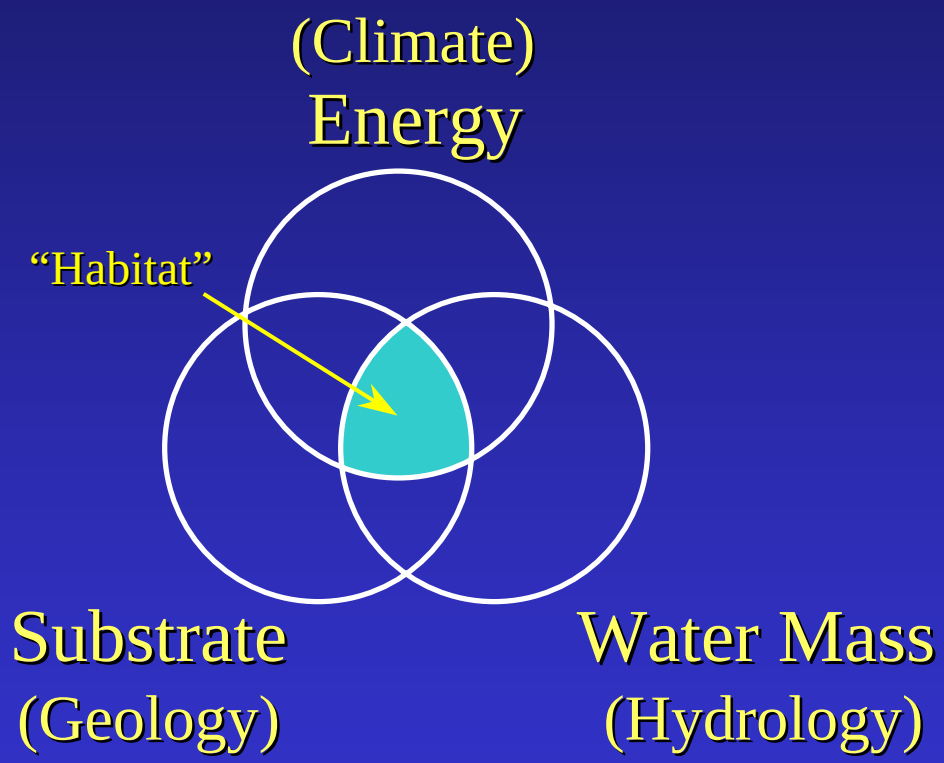
Scudder D. Mackey, Ph.D.
University of Windsor

Aquatic Habitat

- Combination of a range of physical characteristics and energy conditions that can be delineated geographically that meet the needs of a specific species and/or biological community

- Created and maintained and physical processes acting along hydrogeomorphic pathways that convey energy, water, and materials to, and through, the lakes

Abiotic (Physical) Characteristics

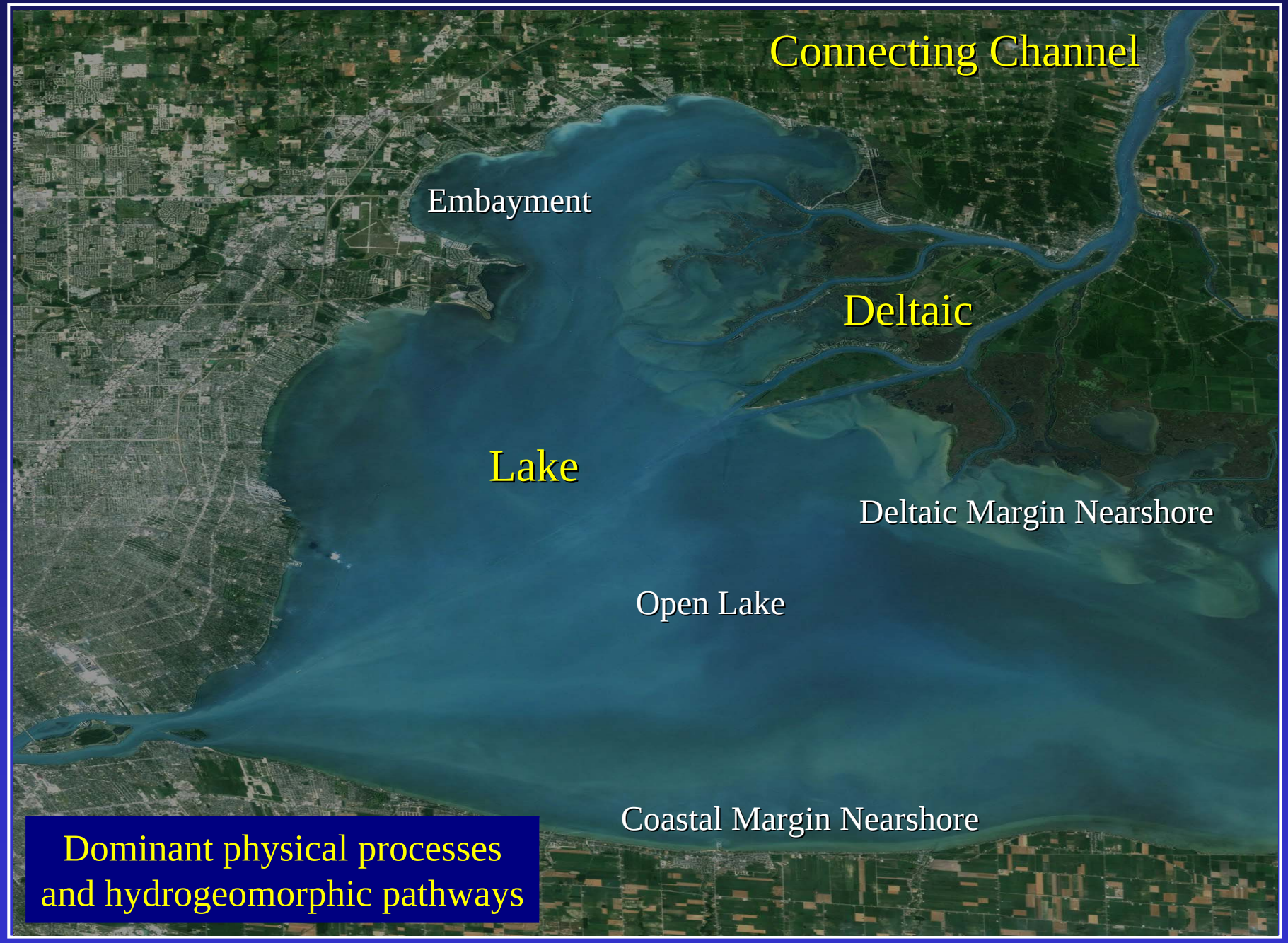


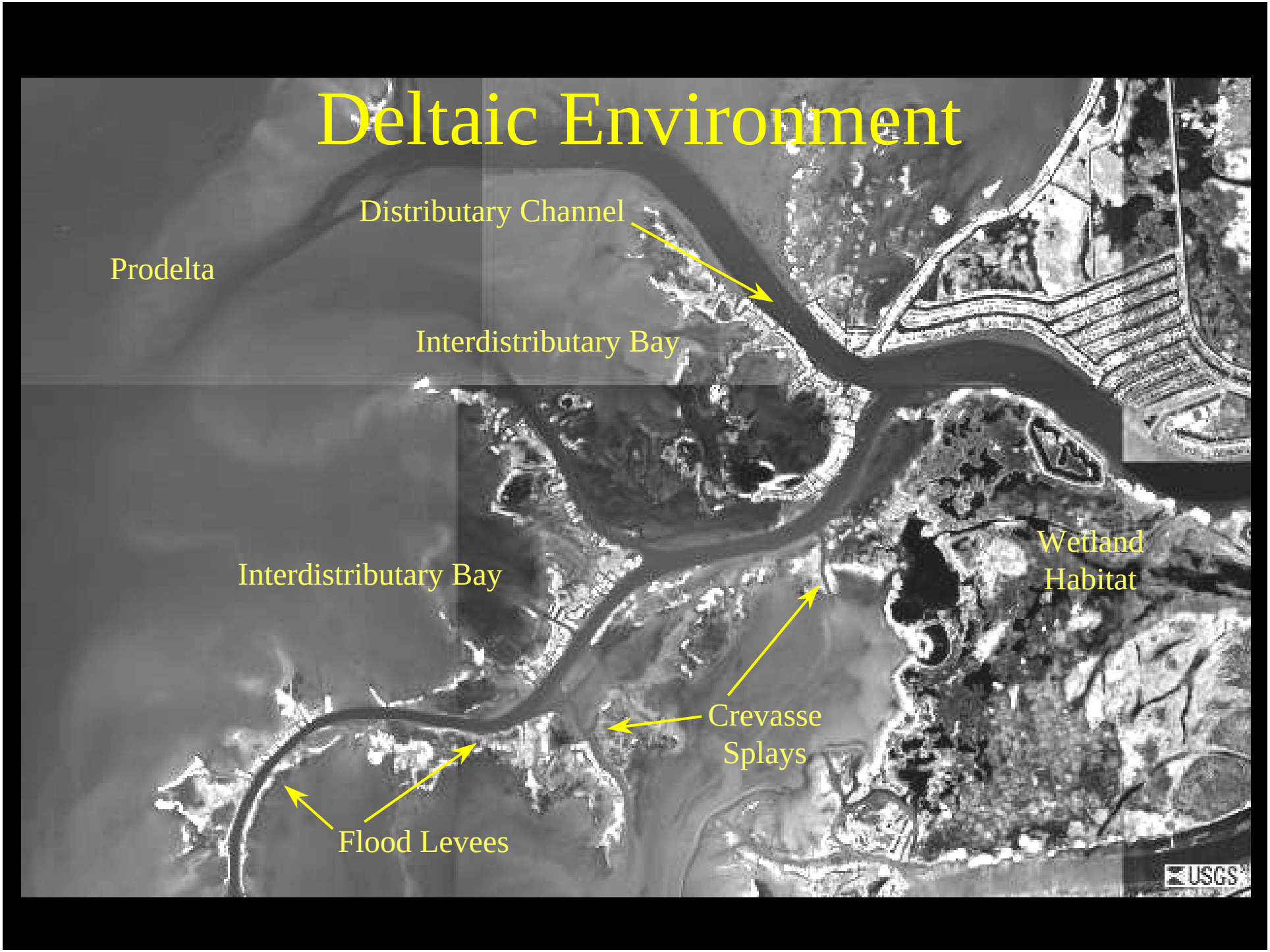
- Energy – oscillatory and unidirectional flows, shear stress, turbulence.
- Substrate – bedrock, composition, texture, hardness, stability, porosity, permeability, roughness.
- Water Mass – depth, temperature, turbidity, nutrients, contaminants, and dissolved oxygen.
- Habitat – when physical characteristics meet the needs of a specific species or biological community

Lake St. Clair

- Length: 41.8 km (26 mi)
- Average Depth: 3 m (10 ft)
- Volume: 4.17 km^3 (1 mi^3)
- Drainage Area: 12,616 km^2 (4,890 mi^2)
- Retention/Replacement Time: ~ 5-7 days
- Width: 38.6 km (24 mi)
- Max Depth: 6.4 m (21 ft)
- Surf. Area: 1614 km^2 (430 mi^2)
- Shoreline Length:
  - 209 km (130 mi) Mainland
  - 204 km (127 mi) Islands

Approximately 97% of water entering Lake St. Clair is from the St. Clair River


Connecting Channel
Embayment
Deltaic
Lake
Deltaic Margin Nearshore
Open Lake
Coastal Margin Nearshore
Dominant physical processes
and hydrogeomorphic pathways

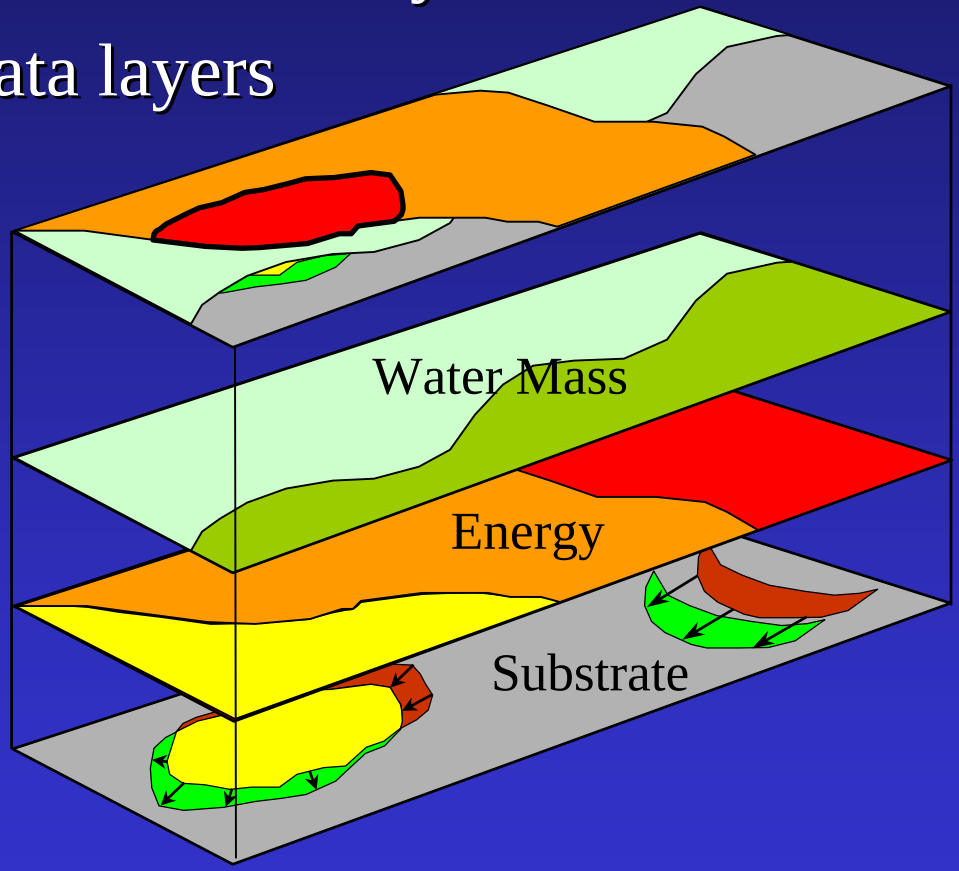

Deltaic Environment
Distributary Channel
Prodelta
Interdistributary Bay
Interdistributary Bay
Wetland
Habitat
Crevasse
Splays
Flood Levees
USGS

HEC Environmental Zones

Environmental Zone	Low Energy Area	High Energy Area
Connecting Waters and Channels	Shallow water (bank) and backwater areas, riparian wetland habitat	Deep water (thalweg) and main channel areas
Deltaic	Interdistributary bays, delta plain, deltaic wetland habitat	Distributary channels, Delta margin nearshore
Lake	Embayments, coastal wetland habitat, open lake	Coastal margin nearshore, open lake

Environmental Template

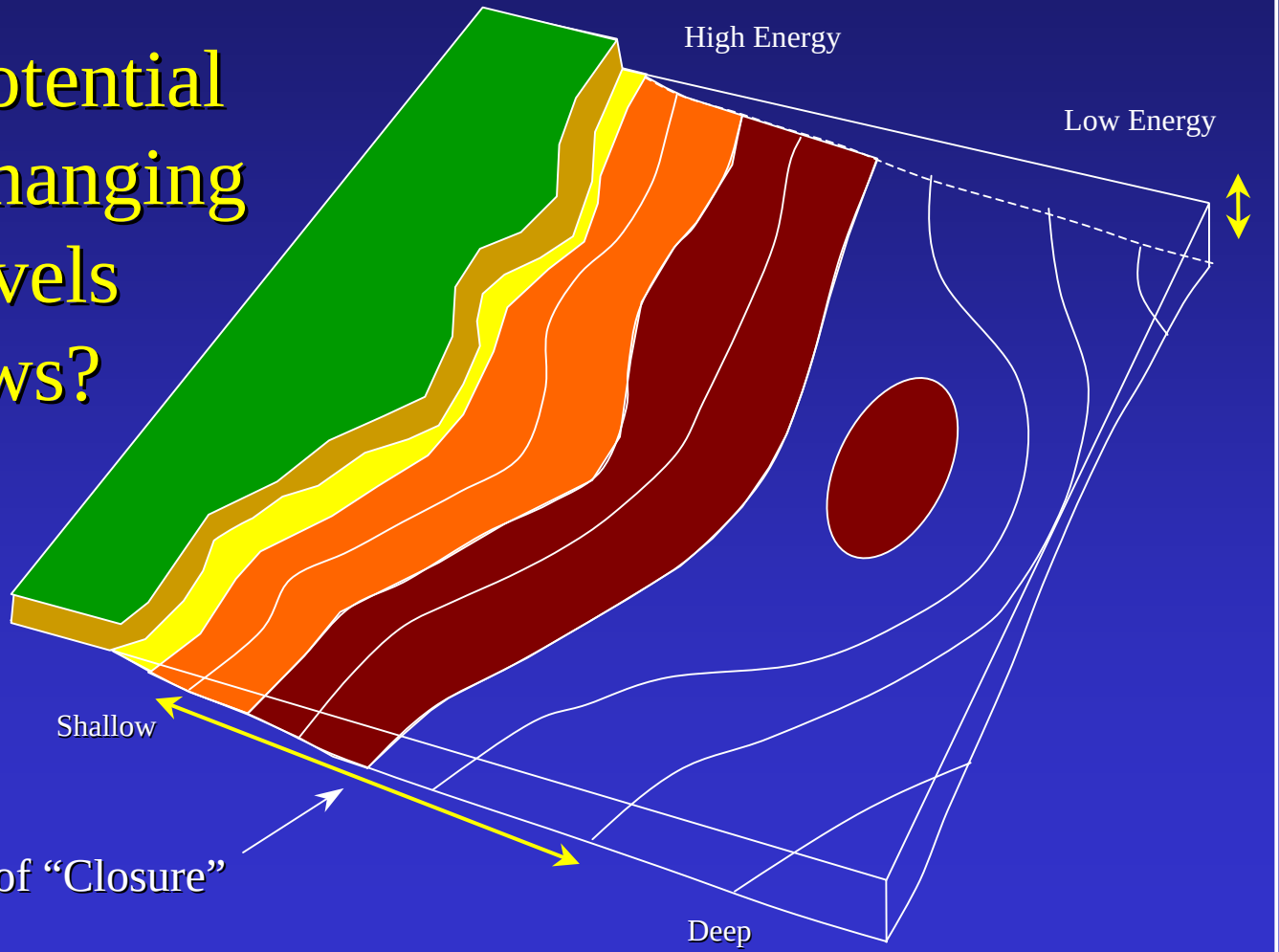
- Requires a dynamic classification system
- Multiple geospatial data layers
- 3-Dimensional



What are the characteristics (or variables) that define high-quality habitat?

Open Lake and Coastal Margin Nearshore

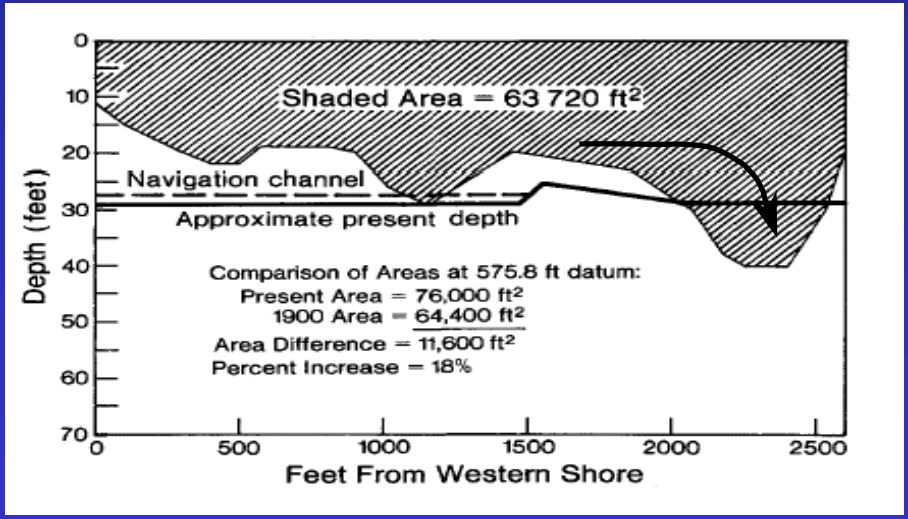
What are potential effects of changing water levels and flows?



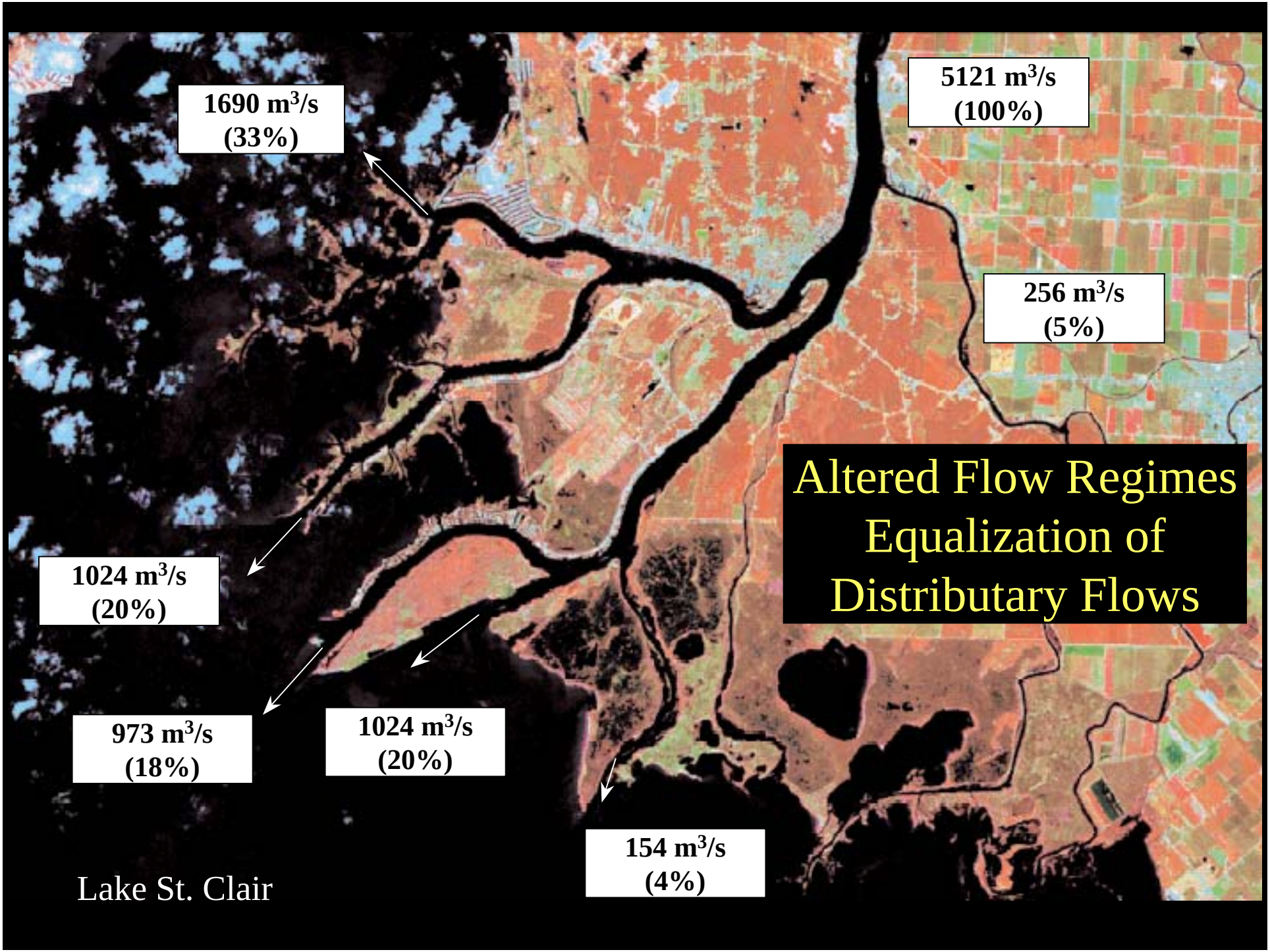
Navigation Channels

- 1933 - Depth 7.6 m (25 ft)
- 1962 - Depth 8.2 m (27 ft)
- 1963-2003 – USACE removed 1.9 million m^3 sediment from St. Clair River (maintenance dredging)

- 0.27 m (0.9 ft) permanent lowering of Lakes Michigan-Huron
- Water volume loss: 32 km^3 (7.7 mi^3)

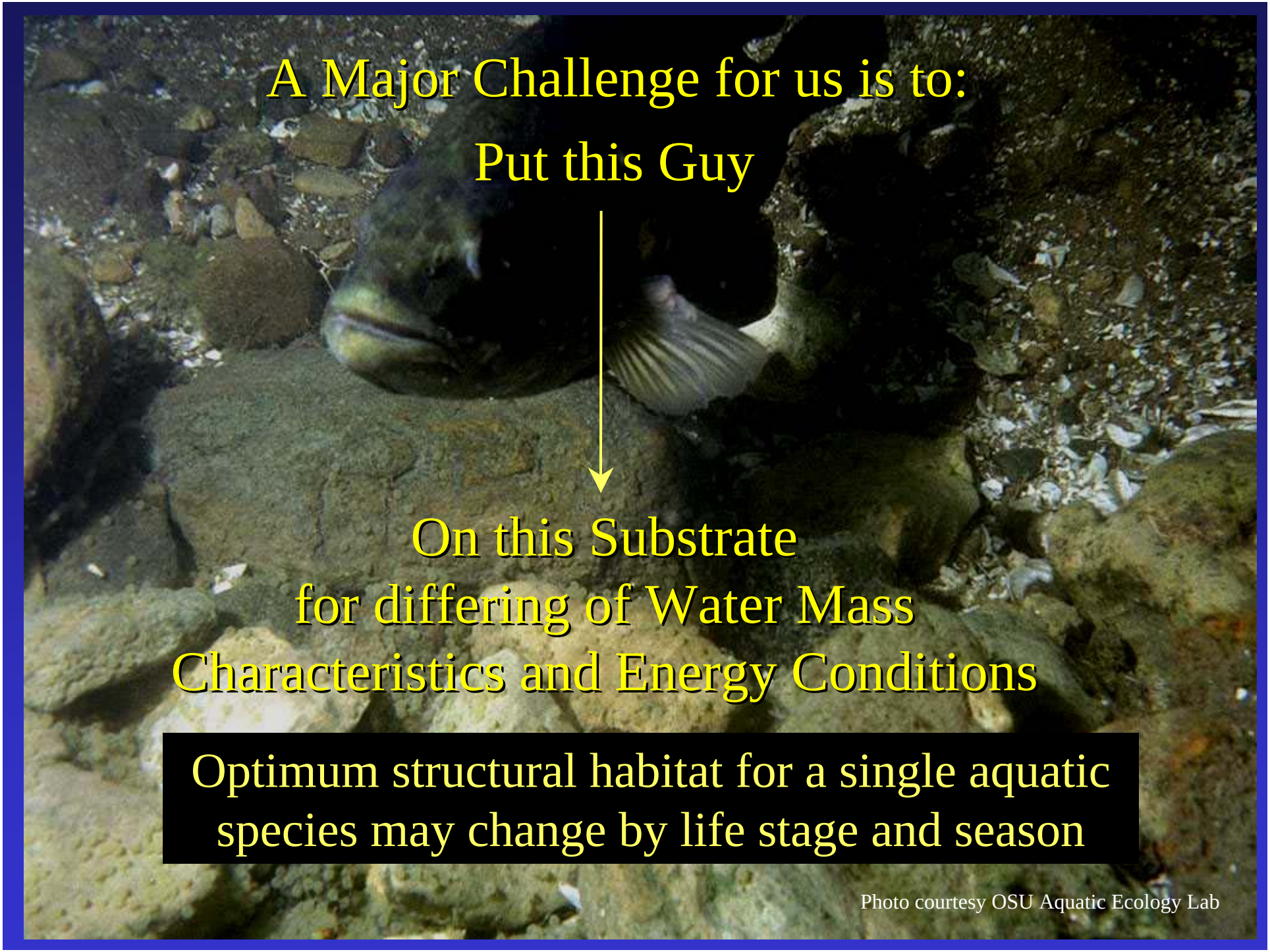


(Derecki, 1985)

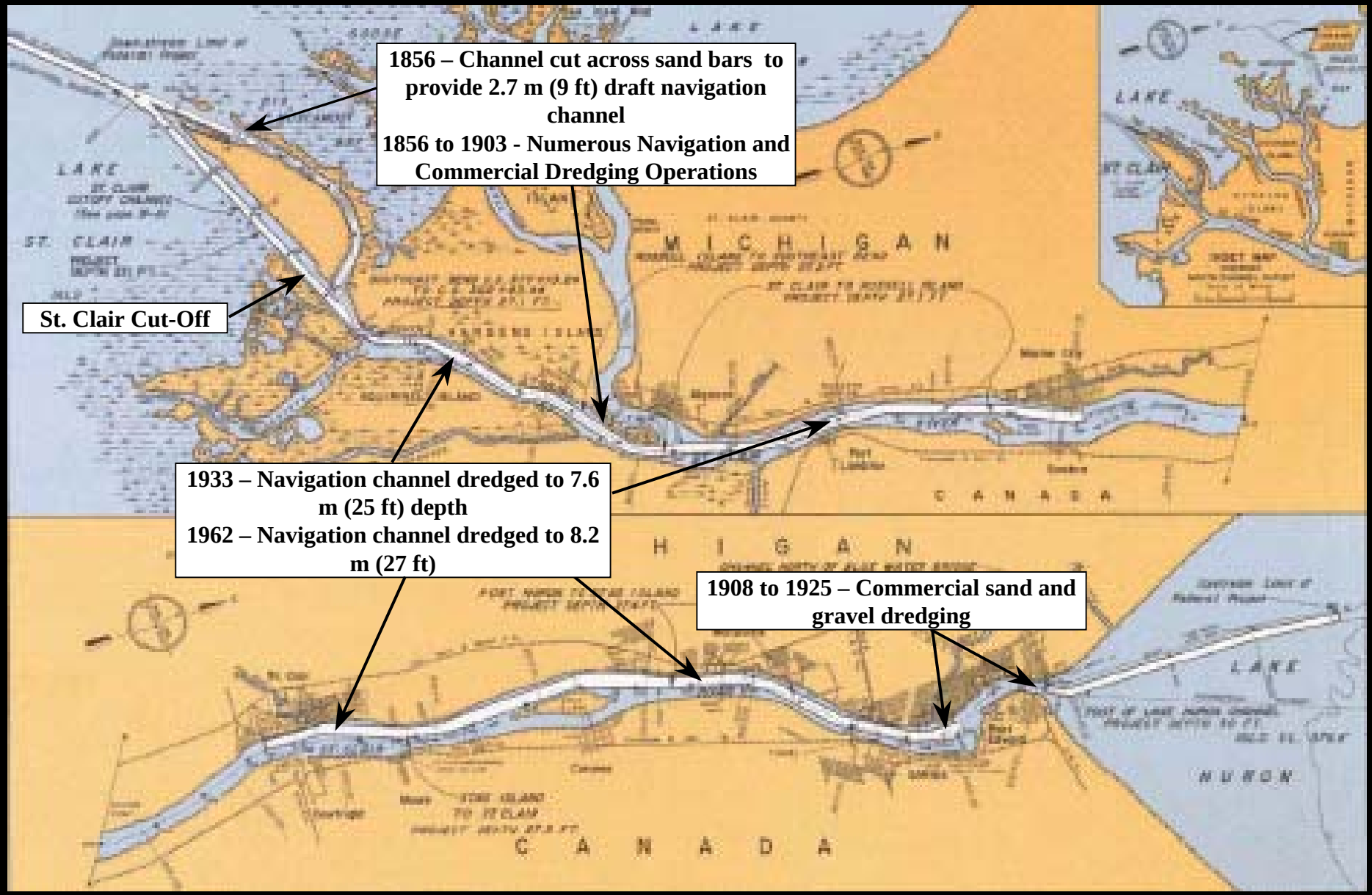

1690 m3/s
(33%)
5121 m3/s
(100%)
256 m3/s
(5%)
Altered Flow Regimes
Equalization of
Distributary Flows
1024 m3/s
(20%)
973 m3/s
(18%)
1024 m3/s
(20%)
154 m3/s
(4%)
Lake St. Clair

Summary

- The physical integrity of the HEC has been altered by changes in land cover, shoreline hardening, dredging, diking, and altered flow regimes.
- These actions have altered environmental processes, flows, and hydrogeomorphic pathways that create and maintain critical and essential environments within the HEC.
- Environmental template - What are the characteristics (or variables) that define high-quality habitat?
- What are the potential effects of changing water levels and flows?
- Are proposed HEC Environmental Zones appropriate and useful?

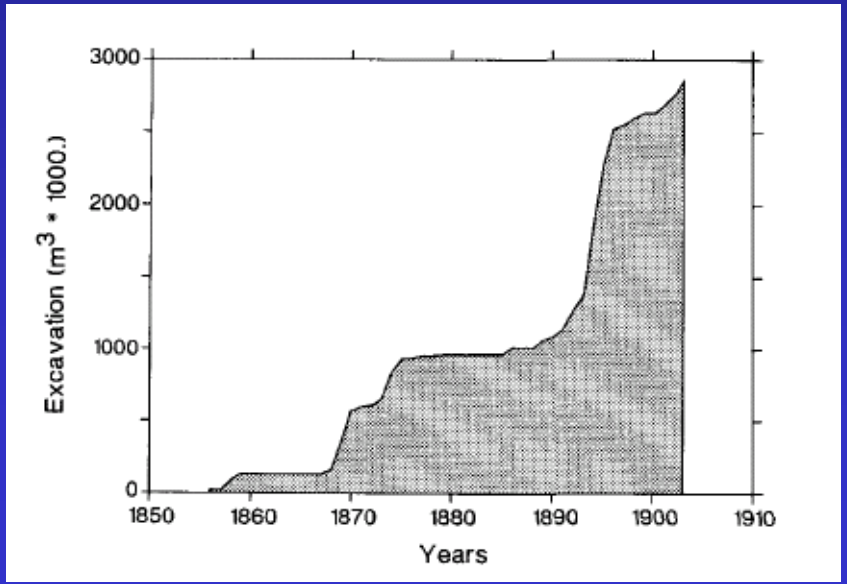

A Major Challenge for us is to:
Put this Guy
On this Substrate
for differing of Water Mass
Characteristics and Energy Conditions
Optimum structural habitat for a single aquatic species may change by life stage and season
Photo courtesy OSU Aquatic Ecology Lab

St. Clair River Dredging



St. Clair River Dredging

- Commercial Sand & Gravel Dredging
  - Pre-1900 - 2.8 million m^3
  - Continued 1908 through 1925 in the Upper St. Clair River (example: 191,000 m^3 extracted by commercial operations in 1909)



(Brunk, 1978)