Explication of Arctic Great Lake Fish Community Diversity and Vulnerability under Local and Global Cumulative Impacts

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BIG LAKES Small World 2018

- Global climate change

Fishery – Great Slave Lake

Interior Plains
– dense boreal forest
– variable flow regime

Main Basin

Close for Lake Trout trophy fishery since 1974

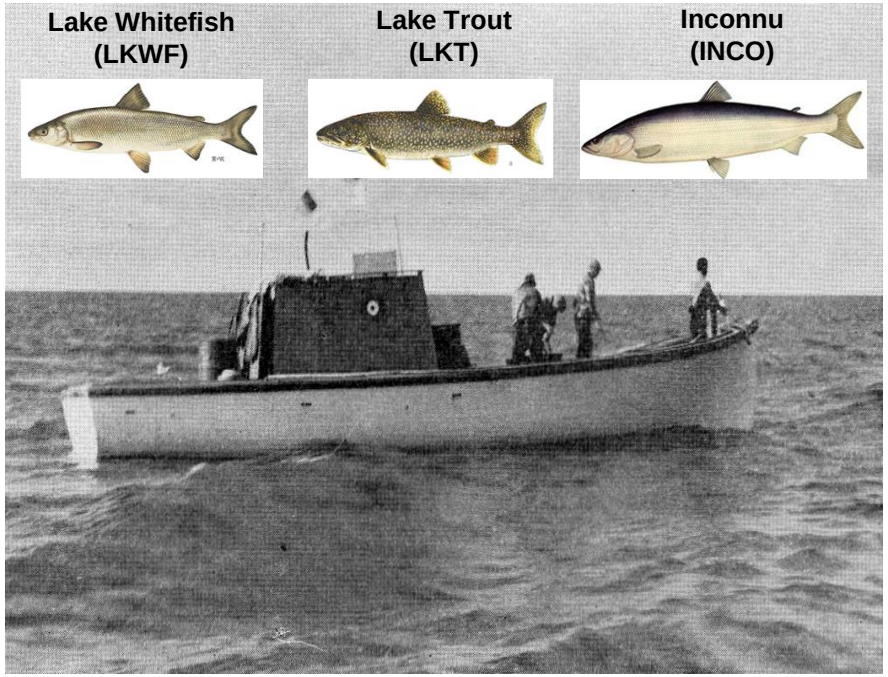
East Arm

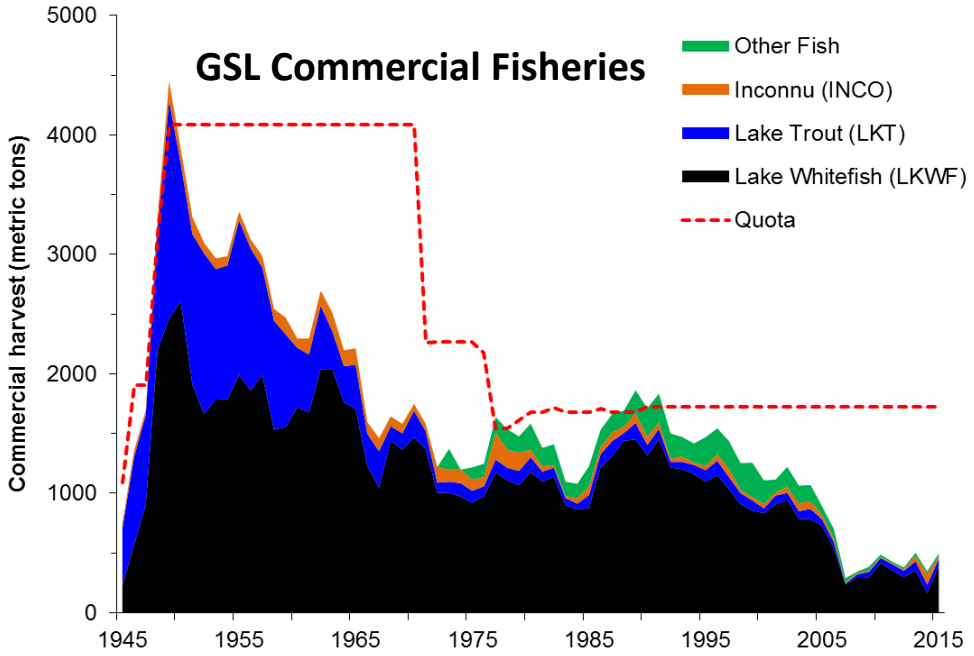
Precambrian Shield
– stunted taiga forest
– stable flow regime

Commercial fishery commenced in 1945

Traditional domestic fisheries (subsistence) in nearshore

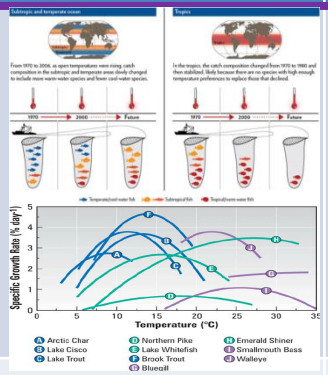
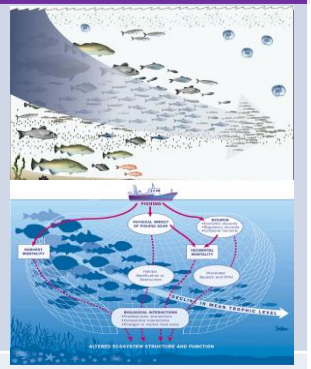
Fisheries	Fishers
Commercial	• Fishing licence entities
Subsistence	• Treaty rights entities
Recreation	• Fishing licence entities • Treaty rights entities





Product	Species	Year	Harvest (kg)
Whole fish	Whitefish	1949-50	$2.60X10^6$
	Trout	1949-50	$1.82X10^6$
	Inconnu	1977	$0.23X10^6$
Caviar	Whitefish	2013	800
	Trout	2013	1,810
	Ciscoes, Pike, Walleye and others	2013	<100

Gap Analysis

Human activities	Oil and sands	Mining and resource	Hydropower dam	Climate change	Fisheries harvest
Pros & Cons					
Symptom	• Tumor • Deformities • Infection • Mutated • Disease	• Reservoir • Toxic effluents • Passage • Chronic	• Water regulation • Passage block • Entrainment • Impingement	• Species replacement • Range shift • Foodweb • Productivity	• Size selection • Block of trophic paths • Fishing down food web
Mortality	↑	↑	↑	↑	↑
Deformity	↑	↑	Damage	NA	NA
Habitat	↓	↓	Modified	Expansion	↓
Viability	Yes	NA	Yes	NA	NA
Vulnerability	NA	NA	NA	NA	NA

Questions and Objectives

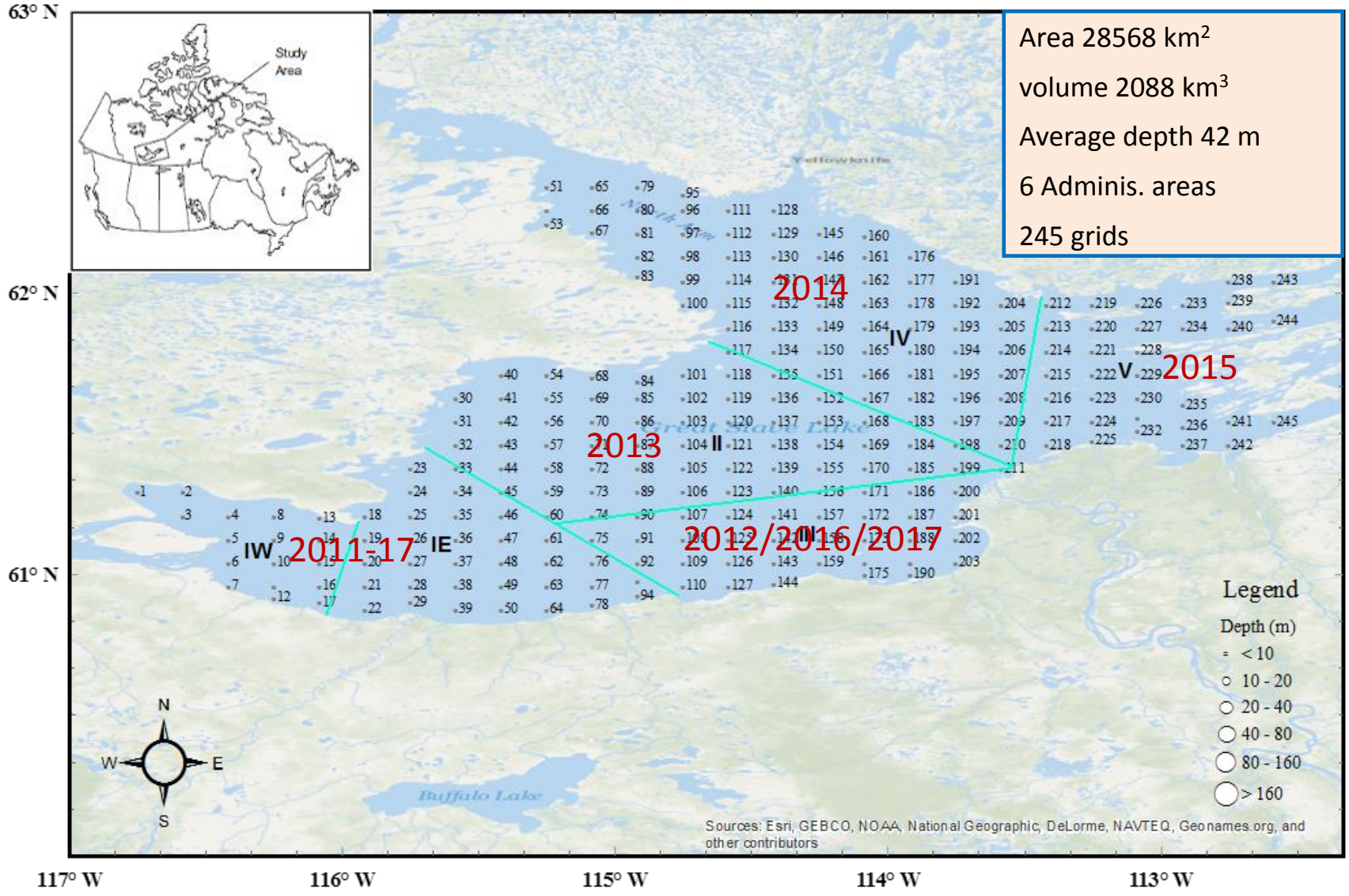
Questions

- ✓ What are fish community diversity
- ✓ What are the environmental association?
- ✓ What is vulnerability in context of fish community?

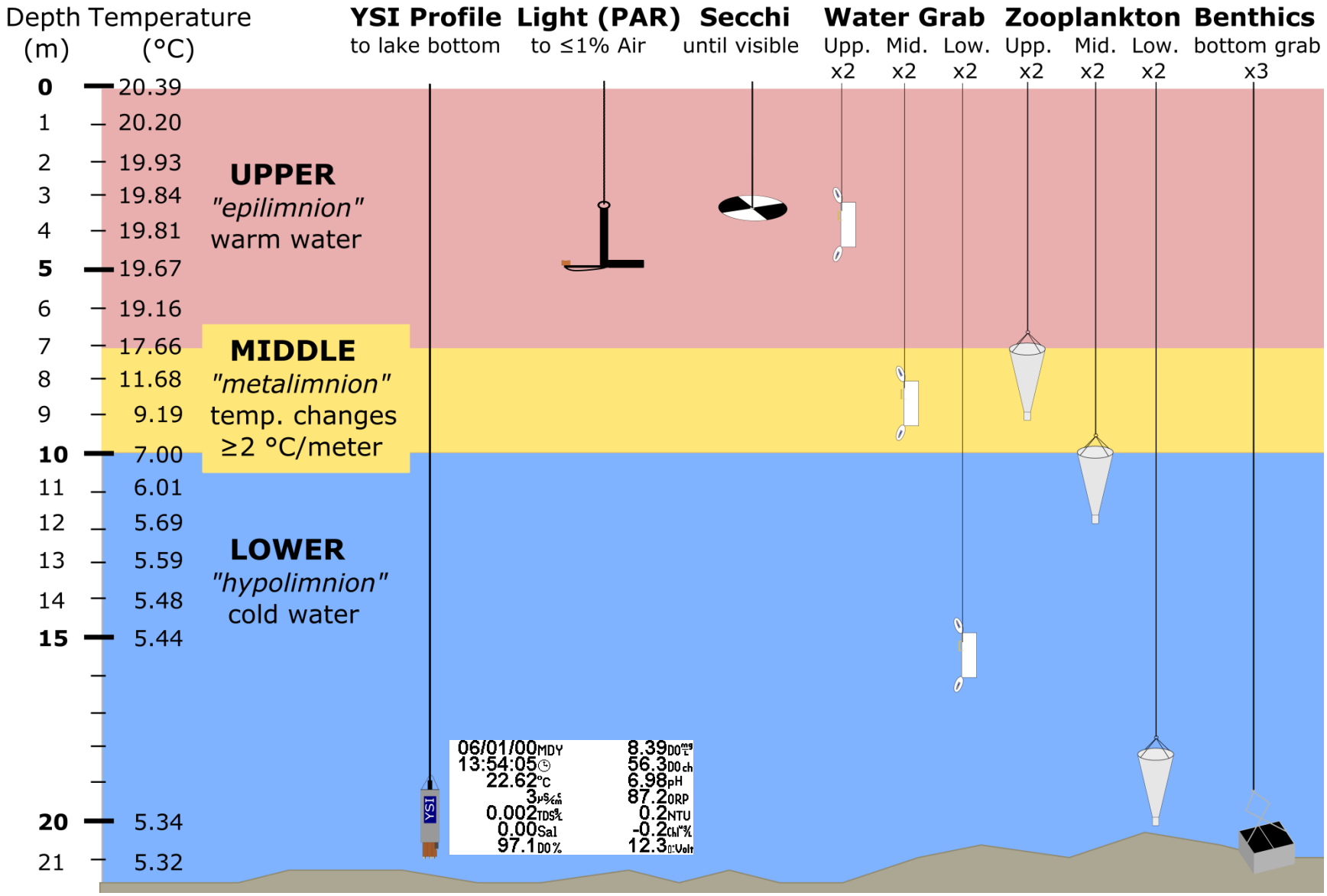
Objectives

- ✓ ***Baseline***—requirements of habitat, forage and biodiversity
- ✓ ***Indicators***—resilience and tipping points
- ✓ ***Correlation***—response to natural and anthropogenic impacts

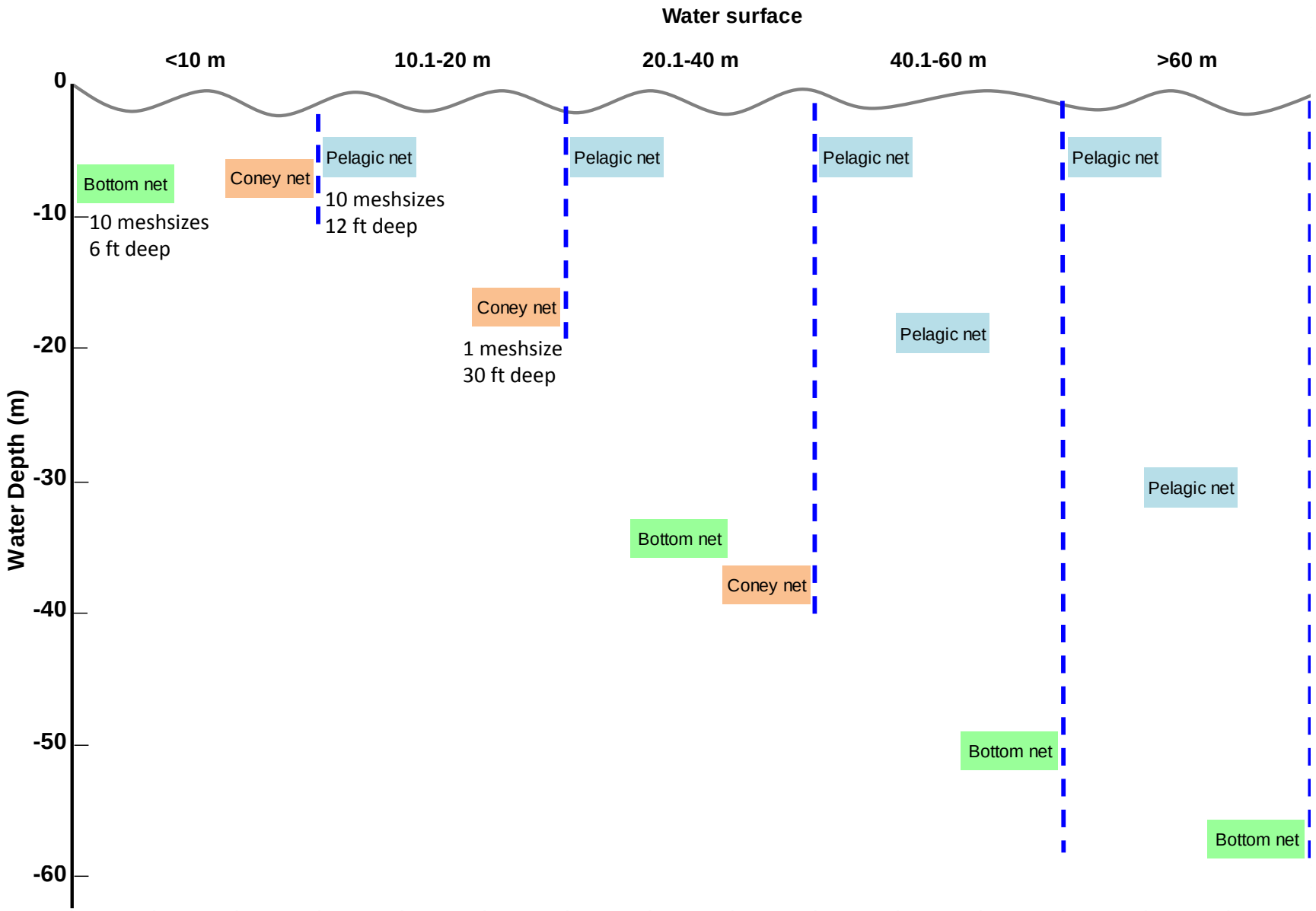
Survey Design

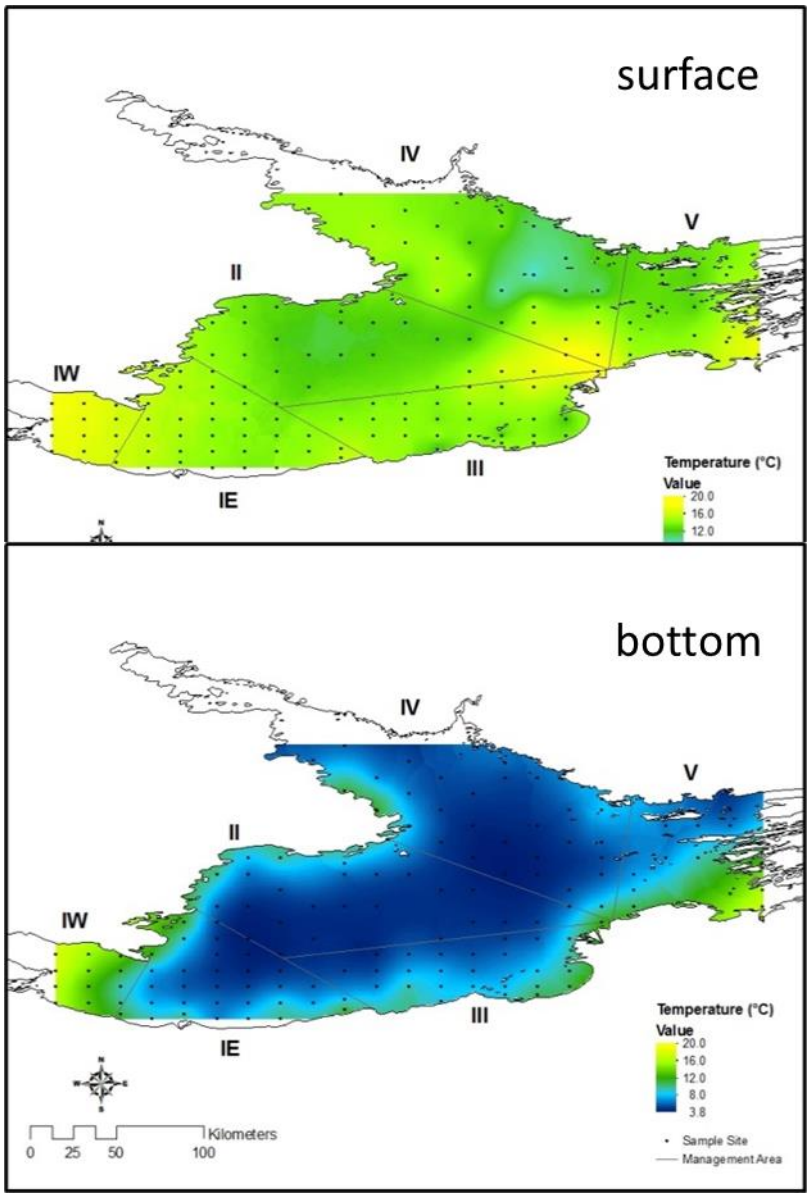


Ecological Monitoring

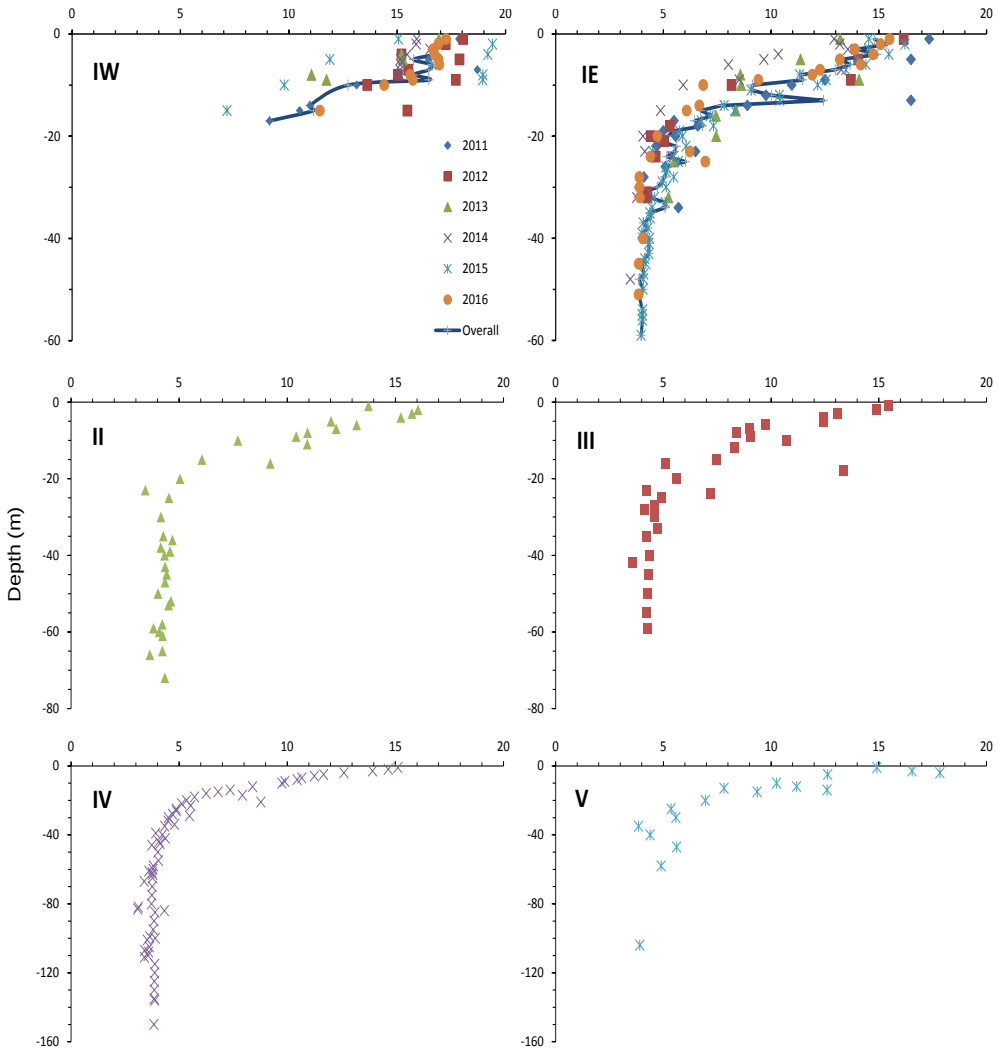


Fish and Fisheries





Water Temperature (°C)



Thermocline: 2°C/m

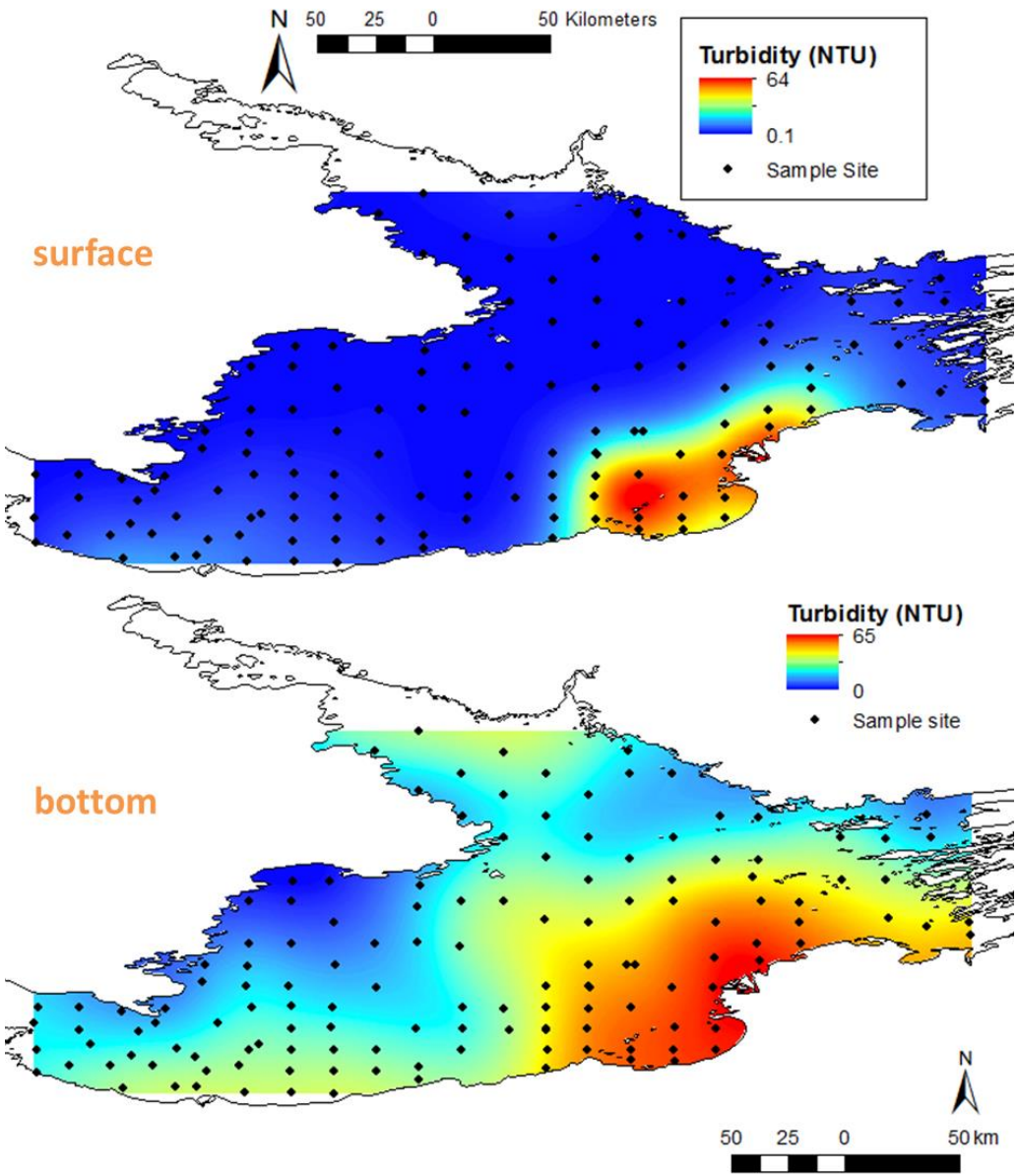
Turbidity

Surface

- Uniform
- Slave River Delta

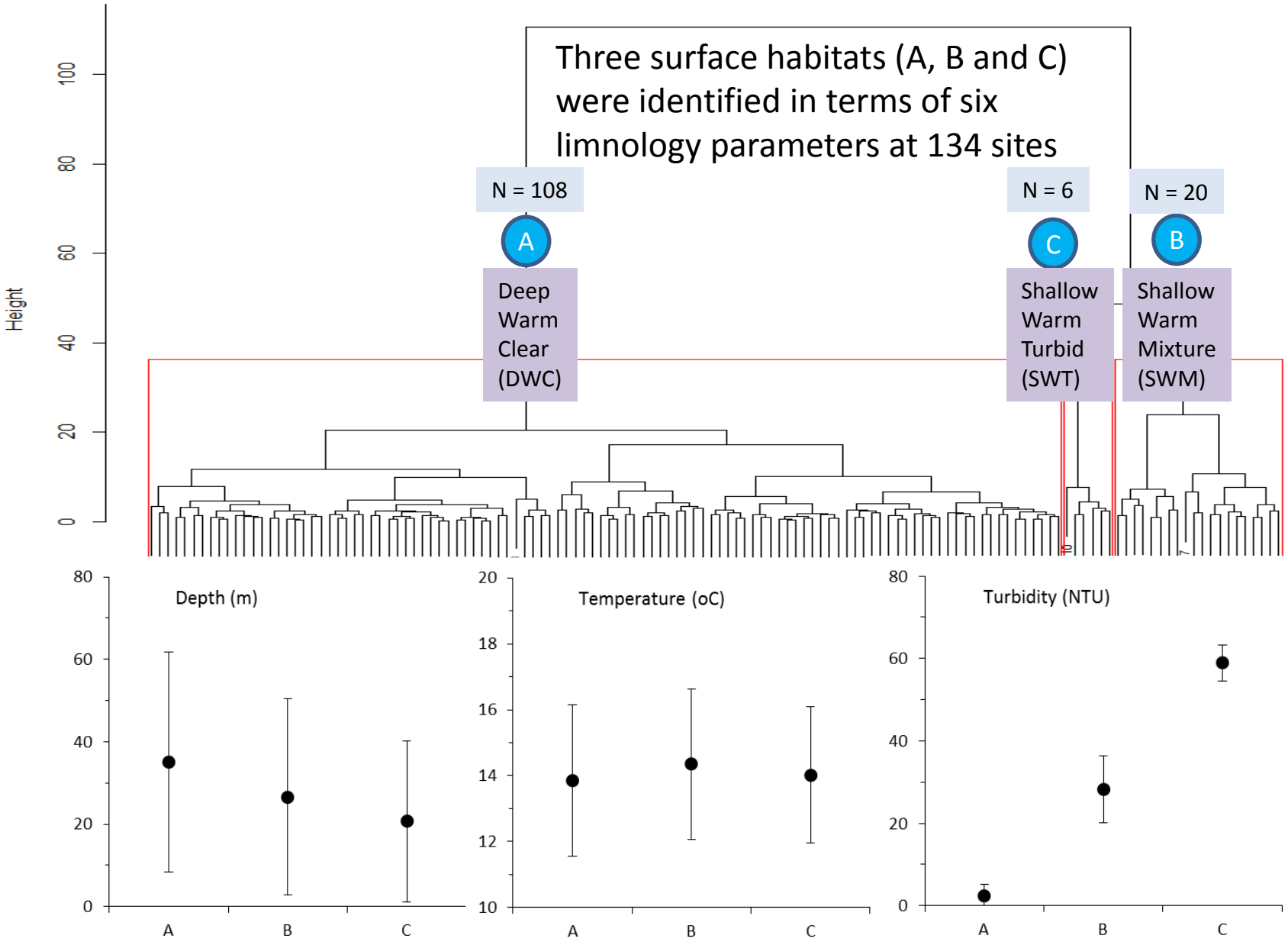
Bottom

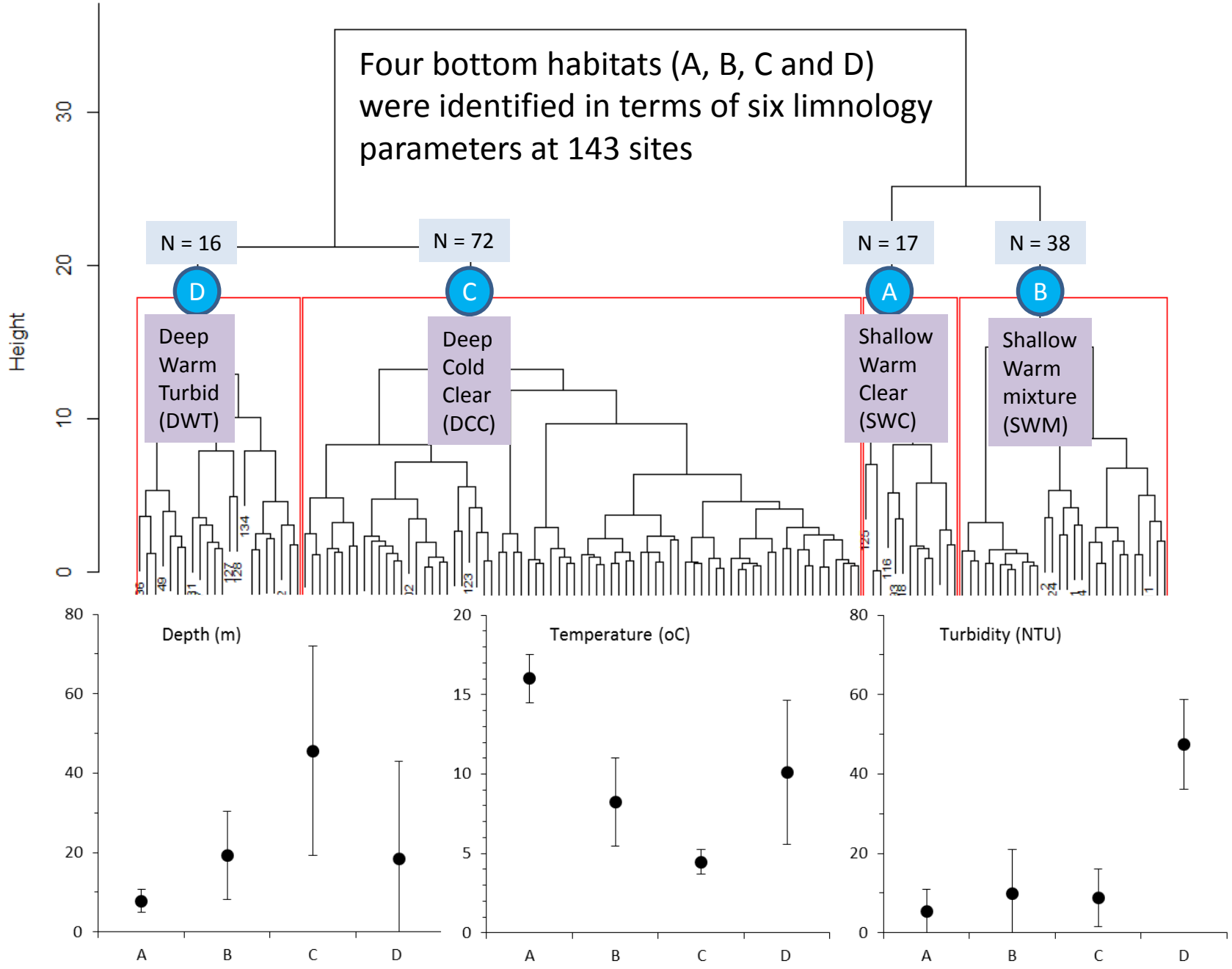
- Turbid inflow can invade into deep water, influencing geo-biological processes;
- Clear water in Moraine Bay



red = higher turbidity
blue = lower turbidity

Three surface habitats (A, B and C) were identified in terms of six limnology parameters at 134 sites



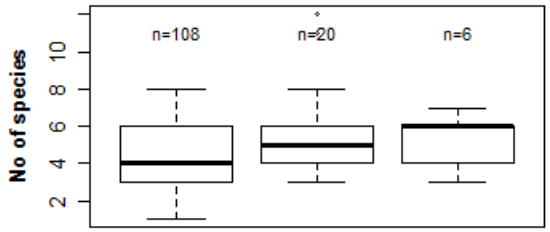

Four bottom habitats (A, B, C and D) were identified in terms of six limnology parameters at 143 sites
Height
0
10
20
30
N = 16
N = 72
N = 17
N = 38
D
C
A
B
Deep Warm Turbid (DWT)
Deep Cold Clear (DCC)
Shallow Warm Clear (SWC)
Shallow Warm mixture (SWM)
Depth (m)
Temperature (oC)
Turbidity (NTU)
A
B
C
D

Fish Species Composition

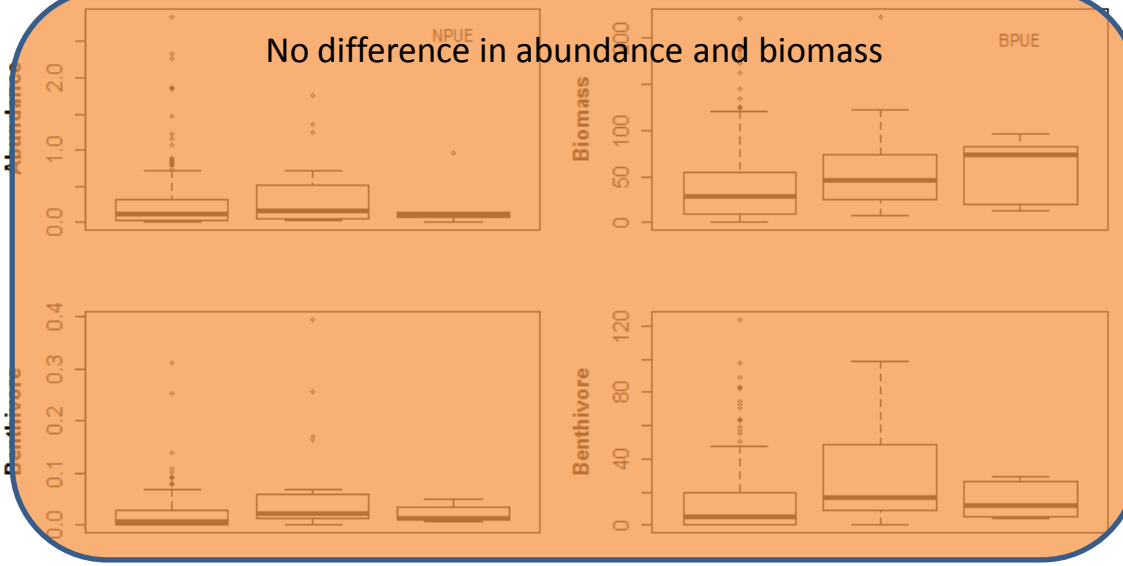
- A total of 24 fish species have been identified from the six-year experimental gillnet survey;
- Dominated by cold-water Coregonid species

Species	Top	Bottom	Overall
Lake Whitefish	25.50	51.68	37.95
Lake Herring	26.54	14.76	19.88
Least Cisco	28.13	8.53	19.44
Burbot	3.91	15.05	9.75
Longnose Sucker	5.40	3.81	4.68
Inconnu	6.23	0.39	2.56
Lake Trout	2.97	0.67	2.10

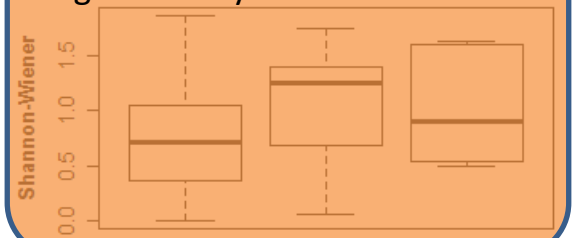
Fish Community in Upper Environment

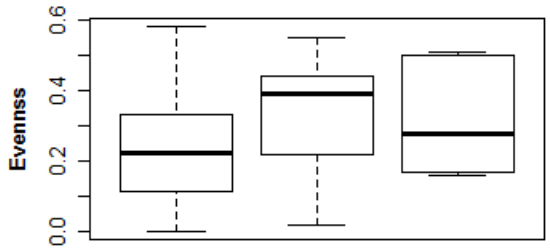


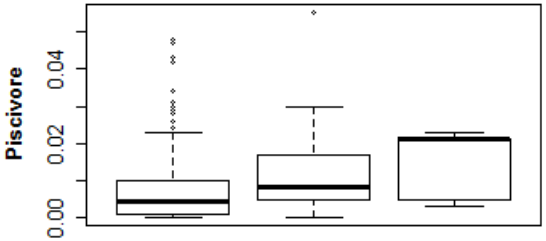
No difference in abundance and biomass

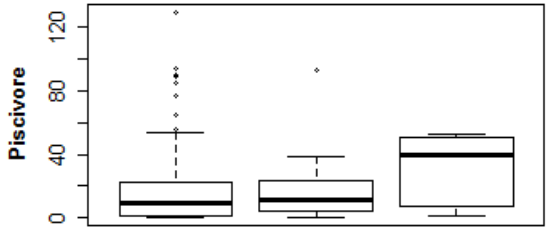


High diversity in mixture area

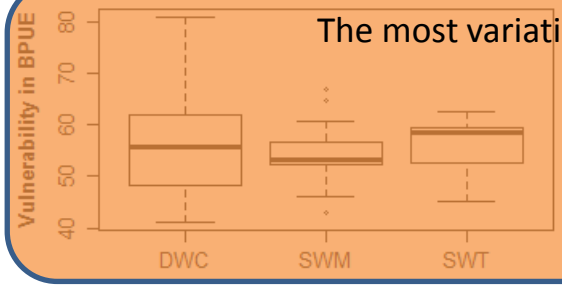


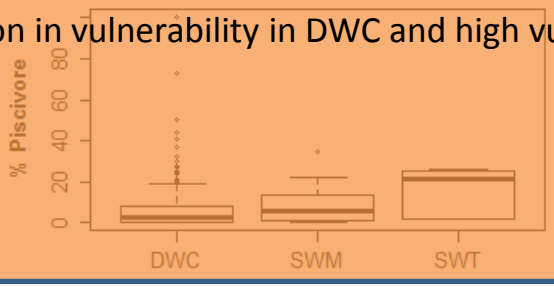


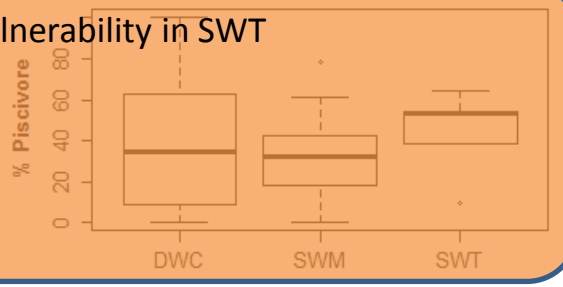




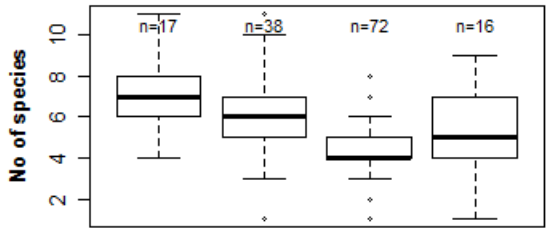
The most variation in vulnerability in DWC and high vulnerability in SWT



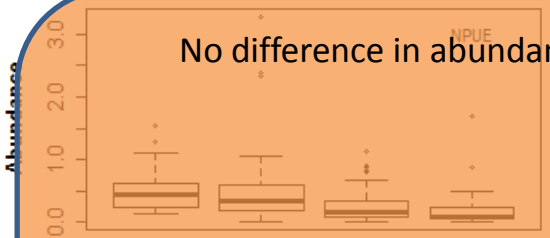


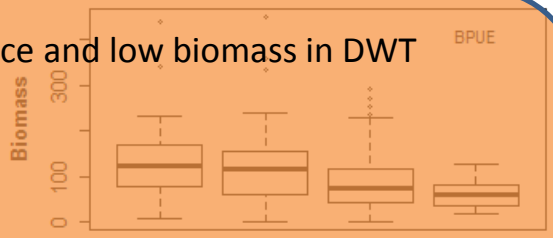


Fish Community in Bottom Environment

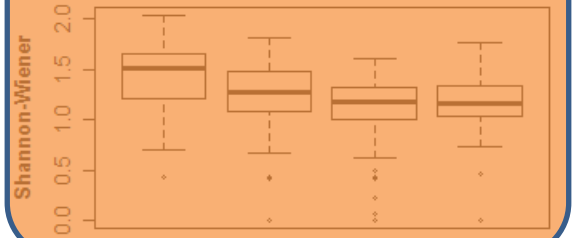


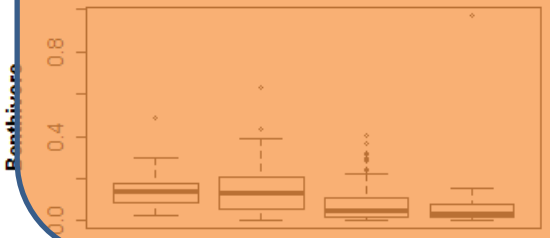
No difference in abundance and low biomass in DWT

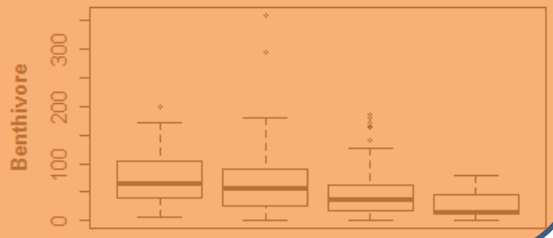


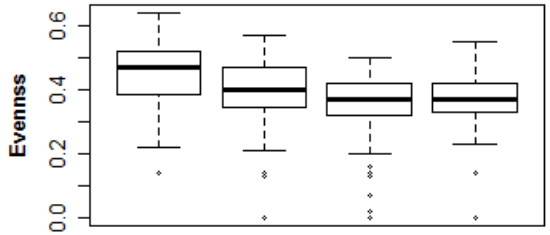


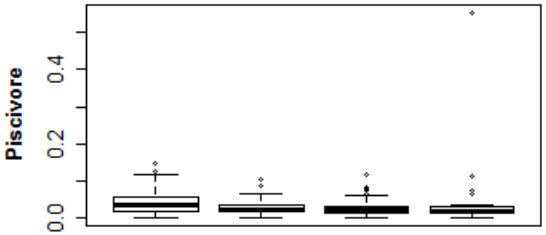
No difference in SW index

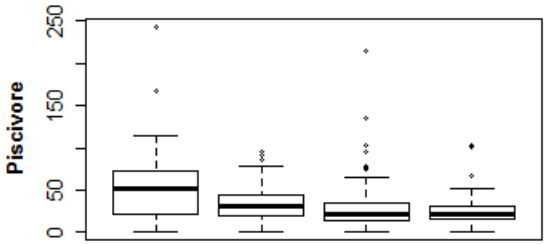




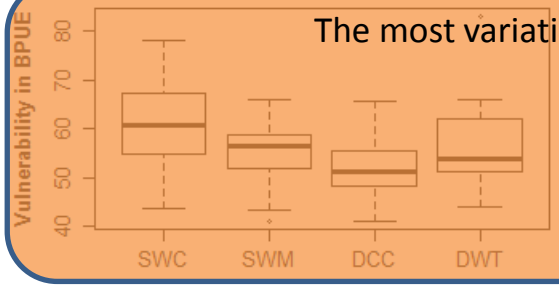


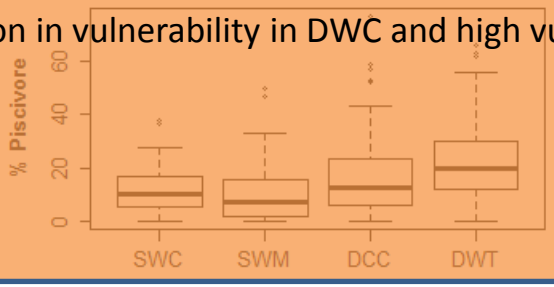


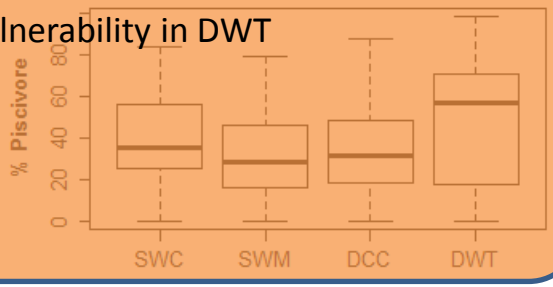




The most variation in vulnerability in DWC and high vulnerability in DWT

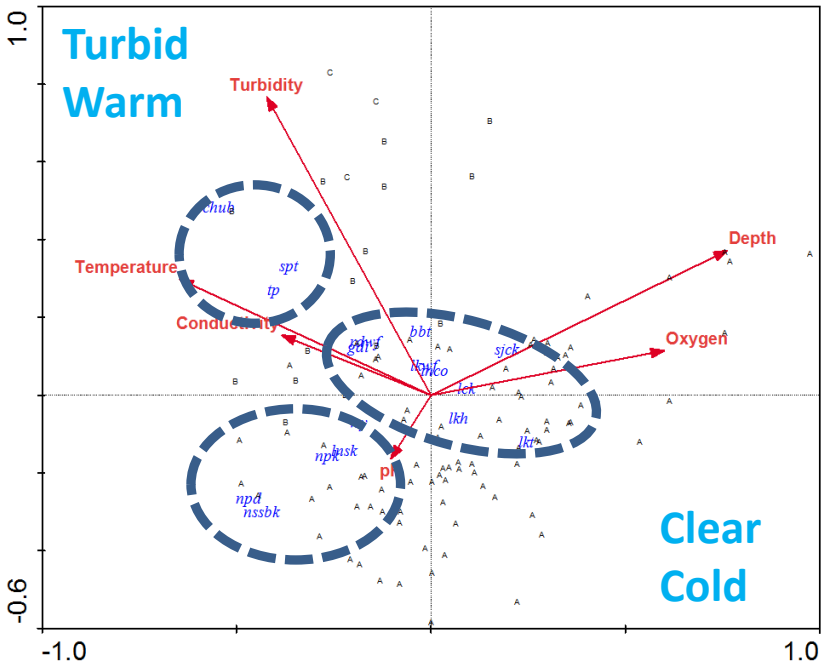


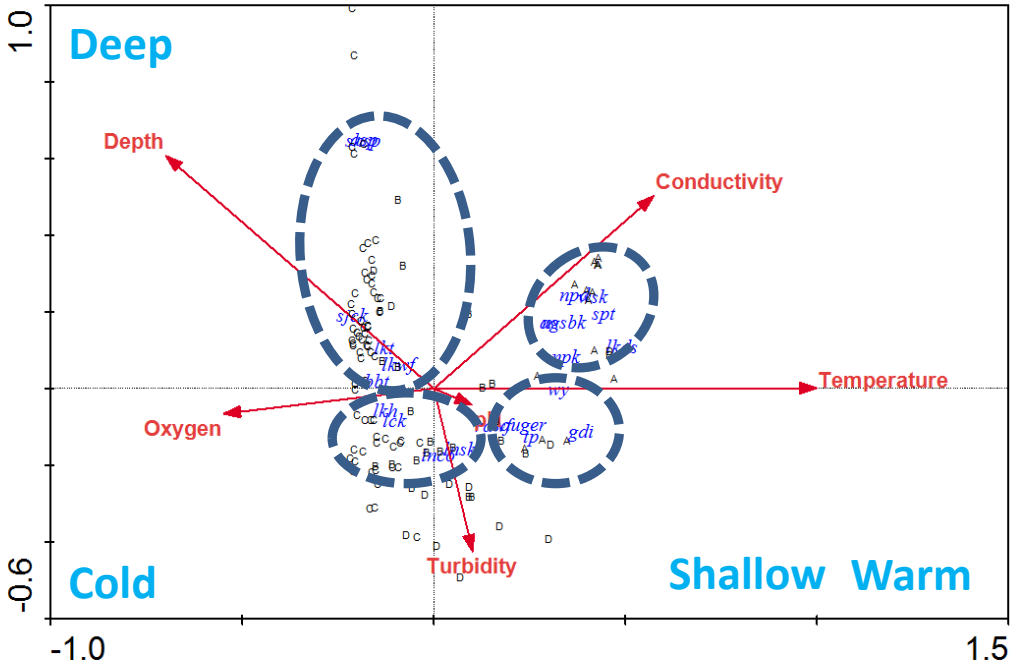




Fish Community vs Environment

Upper **Bottom**





Driving environmental factors	
Upper	Bottom
• Depth • Temperature • Turbidity	• Temperature • Depth • Turbidity

Messages from This Study

- **Limnology** in GSL is characterized by the presence of a 5-m thermocline in 10 m below the surface and localized turbid water masses in the summer time
- **Fish community** is dominated by cold-water coregonid fishes, like Lake Whitefish and Ciscoes
- Fish **vulnerability** is primarily related to the changing limnology parameters, like depth-specific temperature and turbidity, and composing fish species
- **Fish community dynamics** is an important indicator for monitoring cumulative impacts in arctic great lakes

Acknowledgements

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Thanks for your attentions!