First characterization of the trophic structure and biodiversity of esker lakes

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Collaborators

- Jennifer Lento, UNB, Canada.
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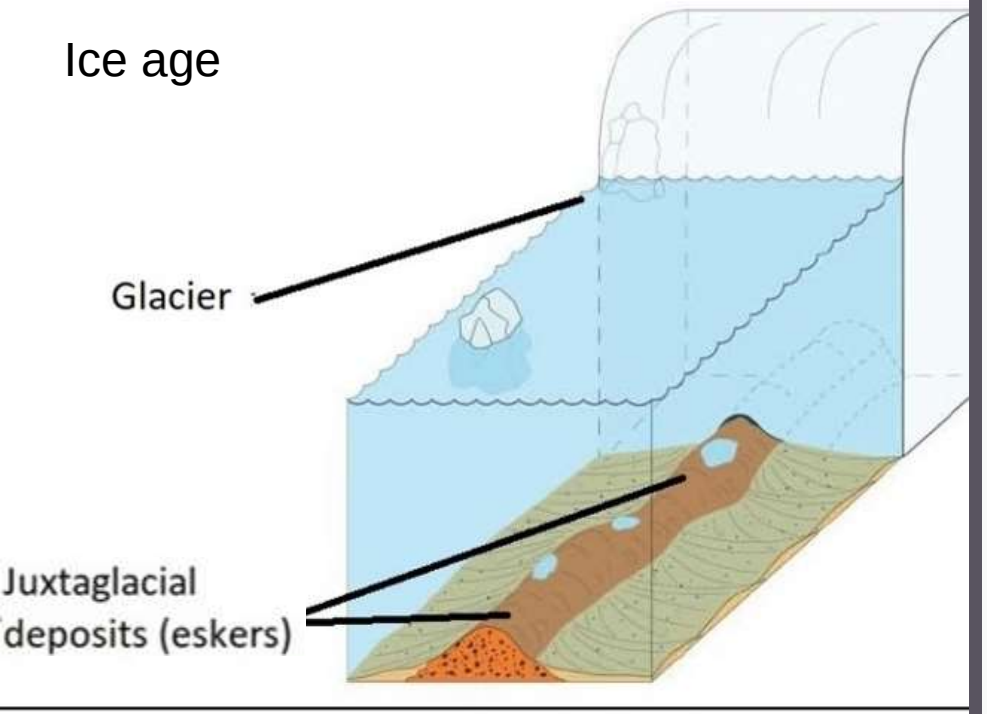
Thickness: up to two kilometers

- A Canadian Museum of Nature

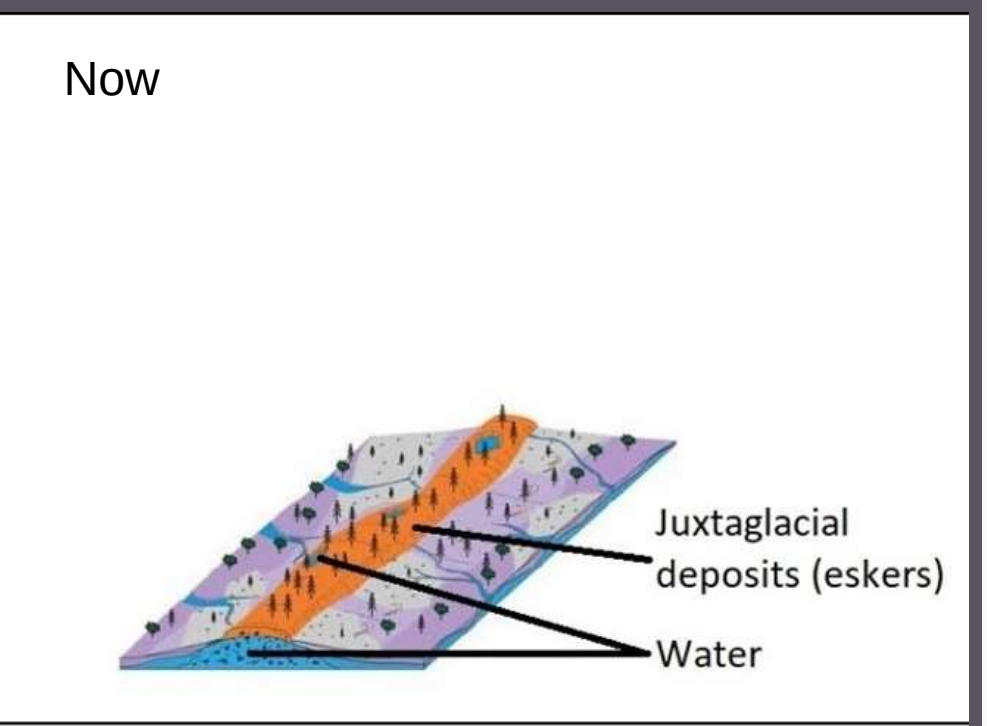
Imagine our world like this

97% of Canada

Ice age



Now



Esker formation

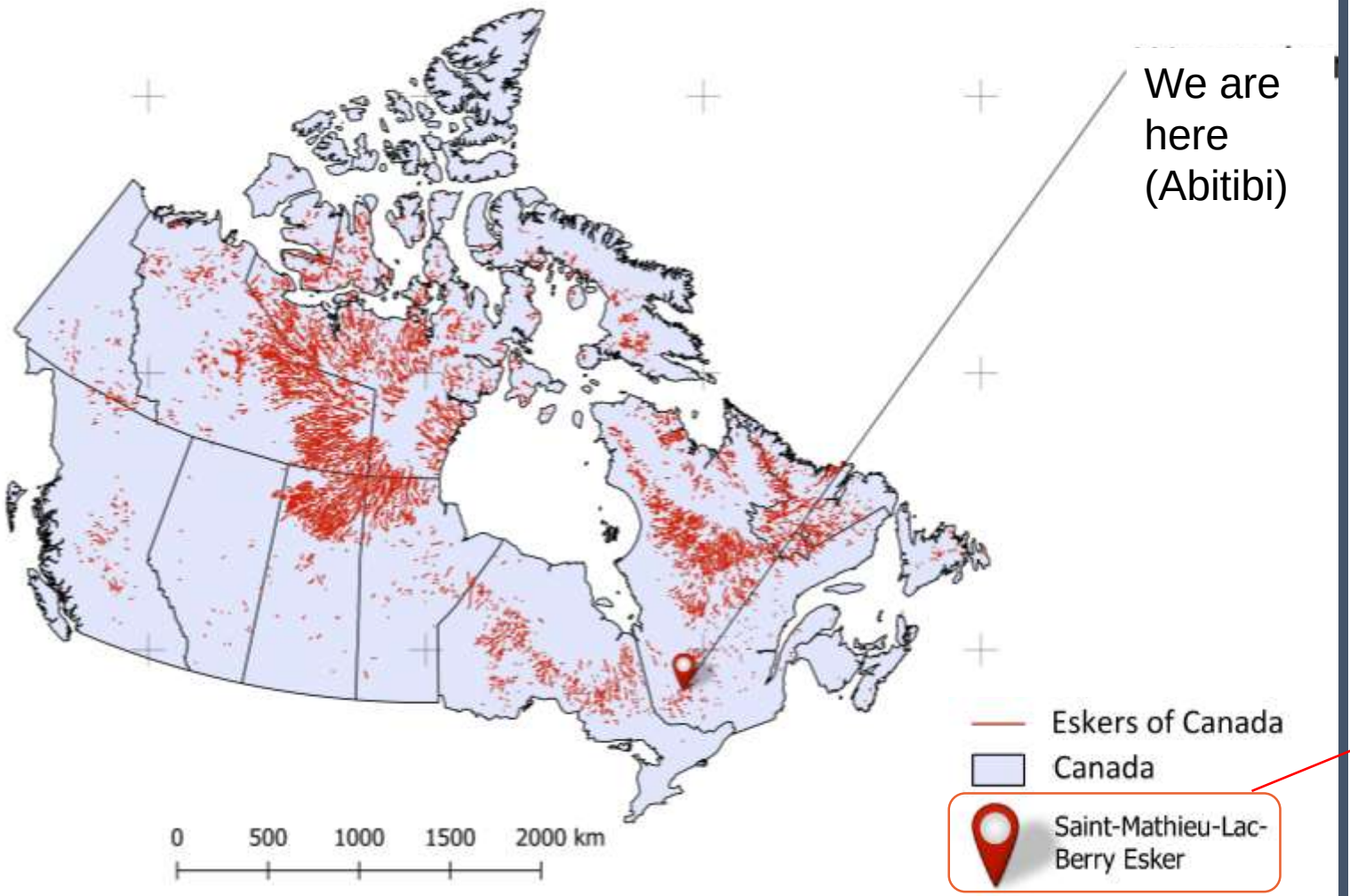
Complex geological formation formed by glaciers

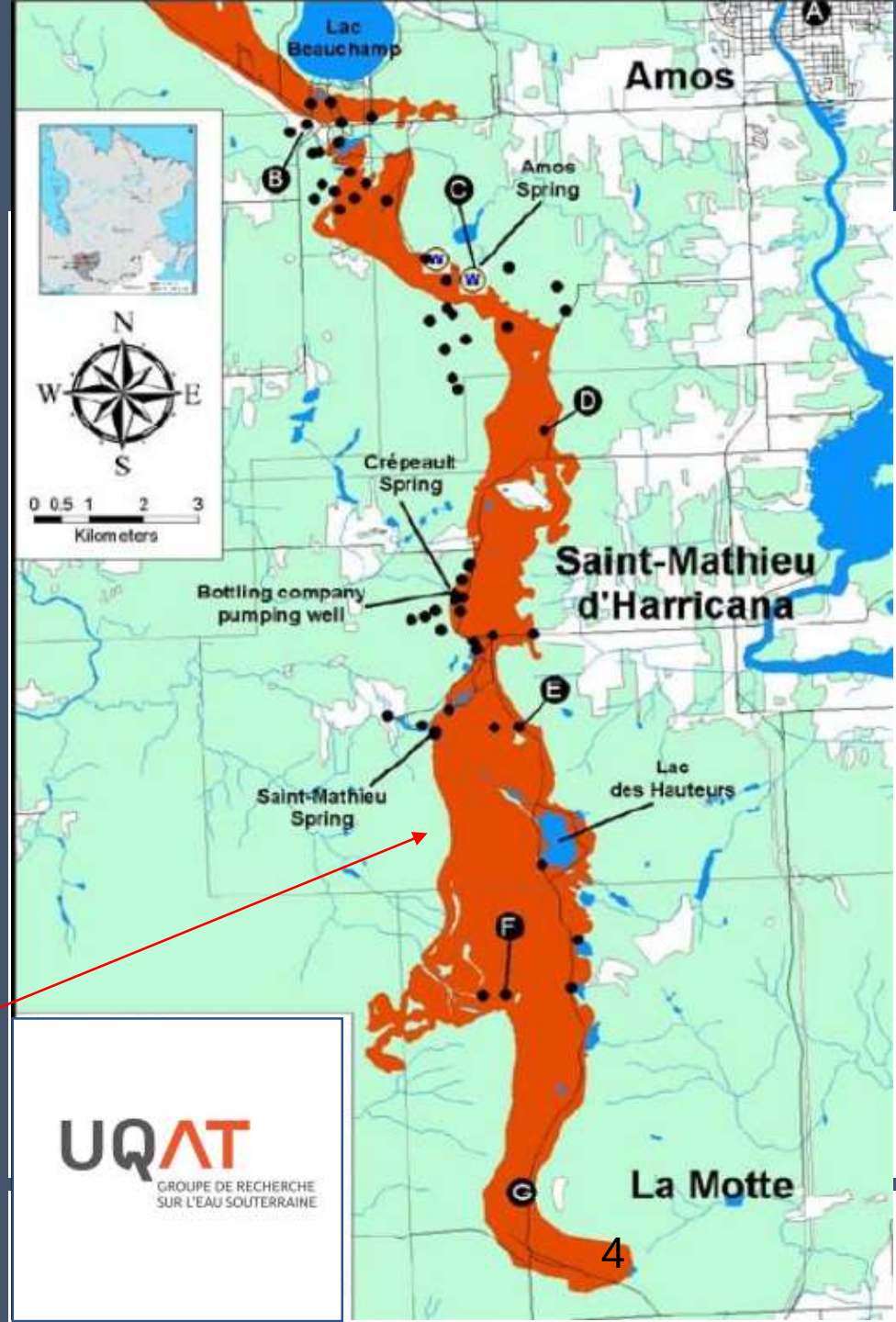
Made of layers of sand and gravel.

Distributed over all northern countries

Adapted from Nadeau et al. (2011)

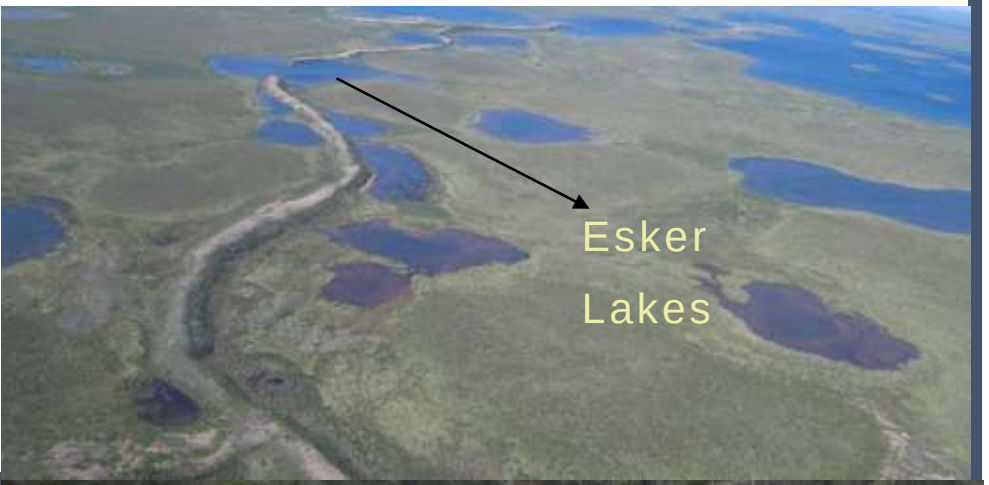
Eskers of Canada





Distribution of Eskers from Canada And Study Area Location (Saint-Mathieu-Lac-Berry Esker.)

Adapted from Storrar, Stokes and Evans, (2013) .



Lakes on esker

Esker lakes are connected with groundwater system

Not connected with the river or other wetlands

which creates a closed basin wetland

This relationship affect water temperature, quality and nutrient

Services from esker ecosystem

Sand and gravel

Best quality freshwater

Myco-tourism

Archaeological sites

Recreational sites

Jack Pine timber

Image Credits: Twitter @Danjite, TripAdvisor, My Outdoors Life, Parks Canada, © Don Johnston - www.agefotostock.com

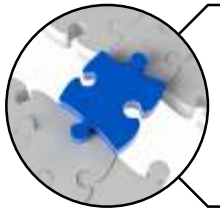
Nadeau et al. 2015, Epp 1985, Sauriol 2016, Traynor 2001

Threats to esker ecosystem

Over Extraction of sand, gravel

Forest Harvesting

Anthropogenic disturbances (Such as camping, species introduction)



Knowledge gap about biodiversity of esker

Food-web approach

Waterbird act as the top predator in esker lakes, But they are just the tip of the iceberg in esker lakes

Waterbird community

Physicochemical variables

Macrophyte cover

Anthropogenic impact

Macroinvertebrate community

Fish community

Art: Pikisuperstar

Objectives

General

To evaluate the waterbird biodiversity associated to esker lakes and identify its environmental drivers using food-web approach.

Specific

1. To assess the aquatic resources for waterbirds in lakes such as the type of habitats, the quality and quantity of macrophytes, fish and macroinvertebrate communities.

2. To assess the species richness, evenness and diversity of waterbirds and record the occurrence of indicator species possibly linked to fishless lakes on eskers.

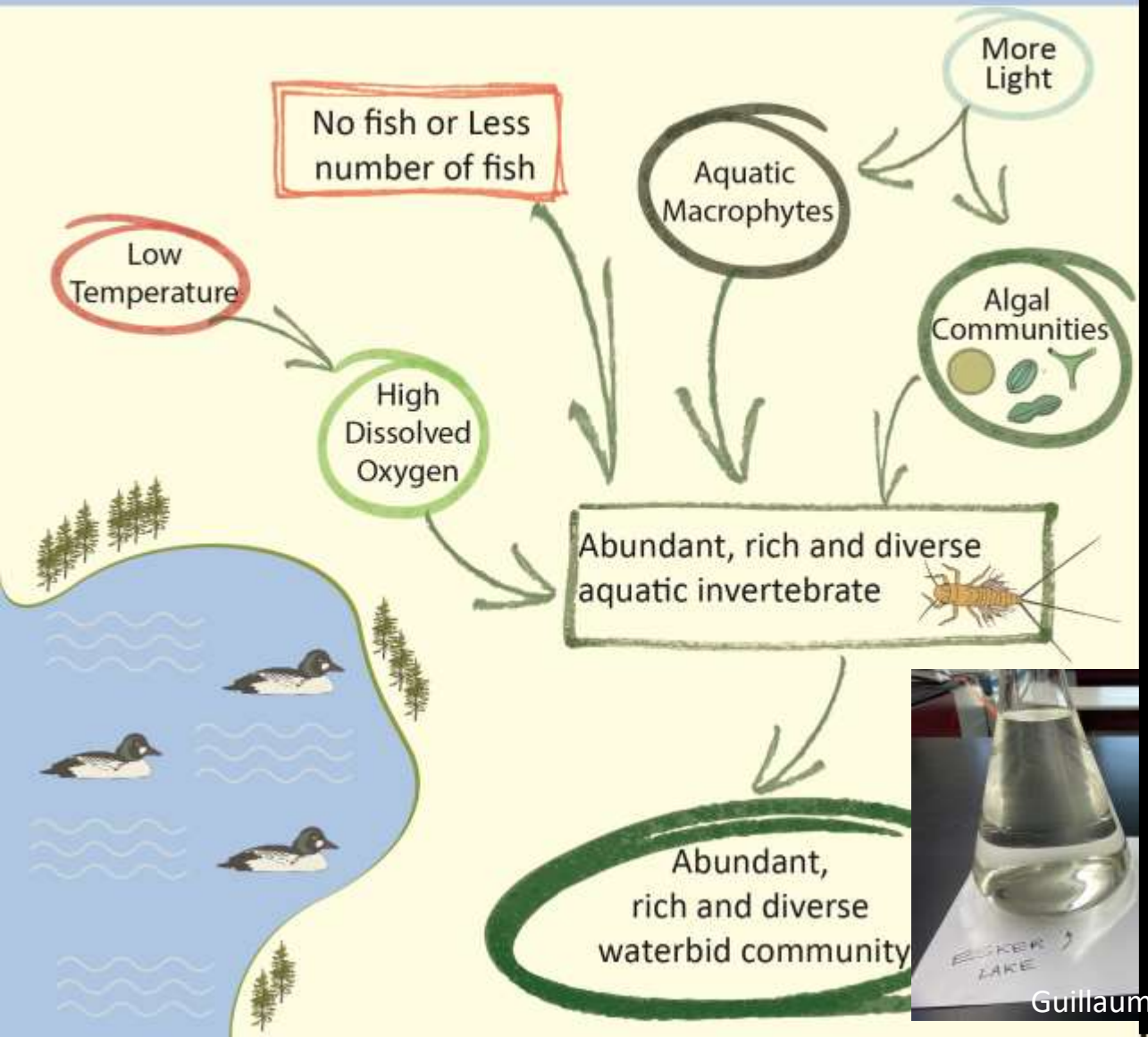
Common goldeneye

Bonaparte's gull

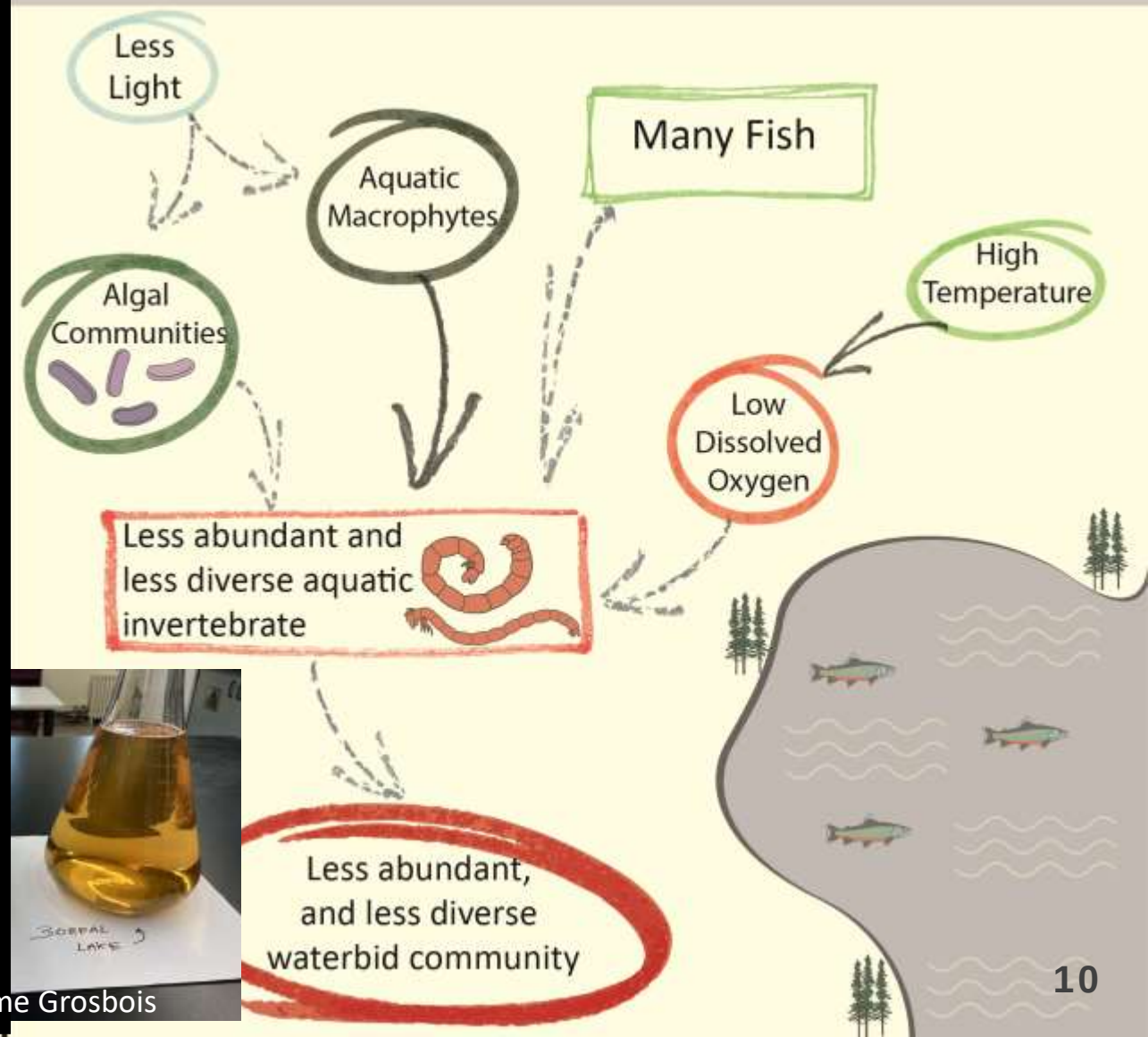
Conceptual framework

Idea: M. Montoro Girona and G. Grosbois

Kettle lake on Esker

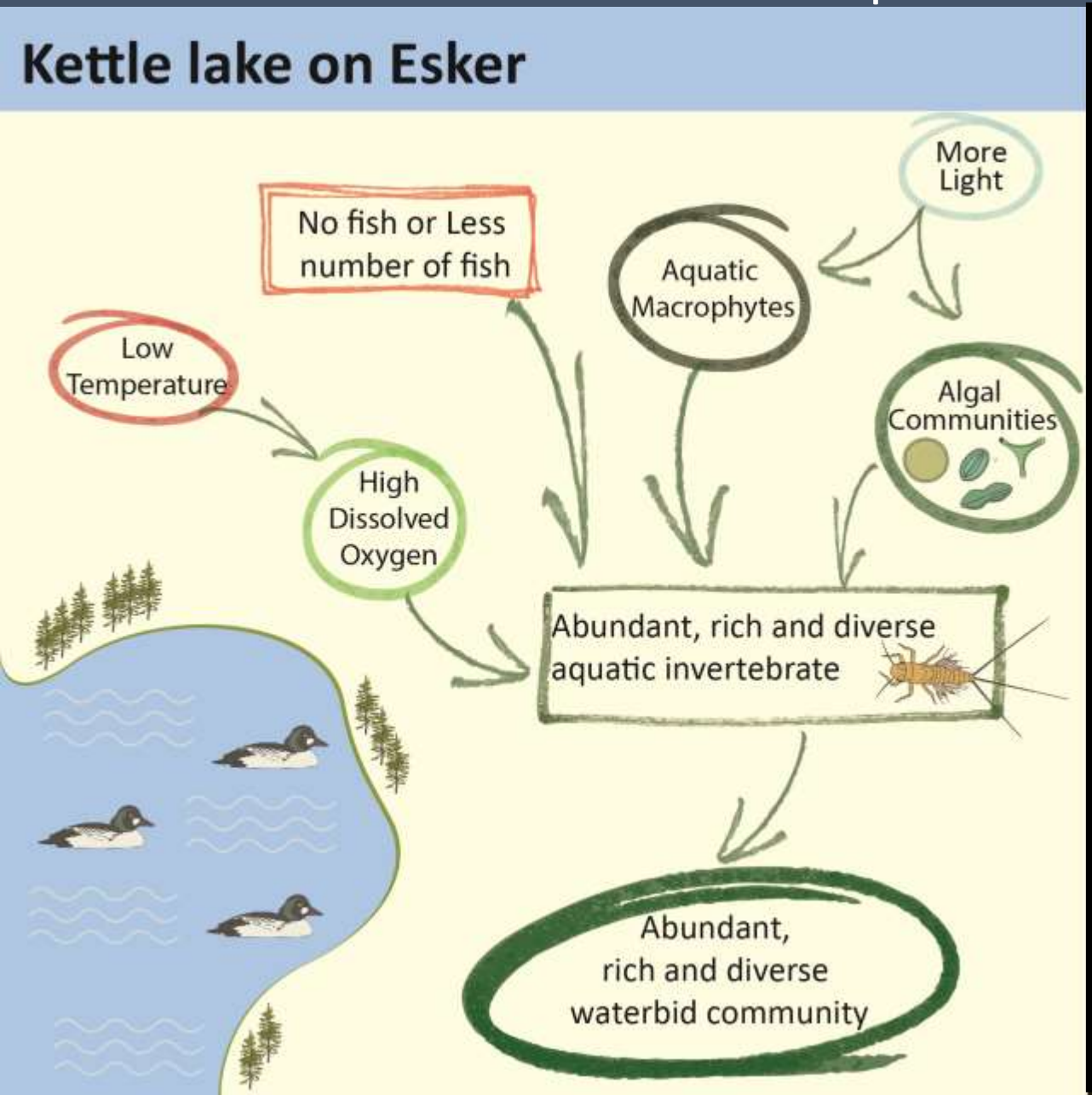


Lake on Clay

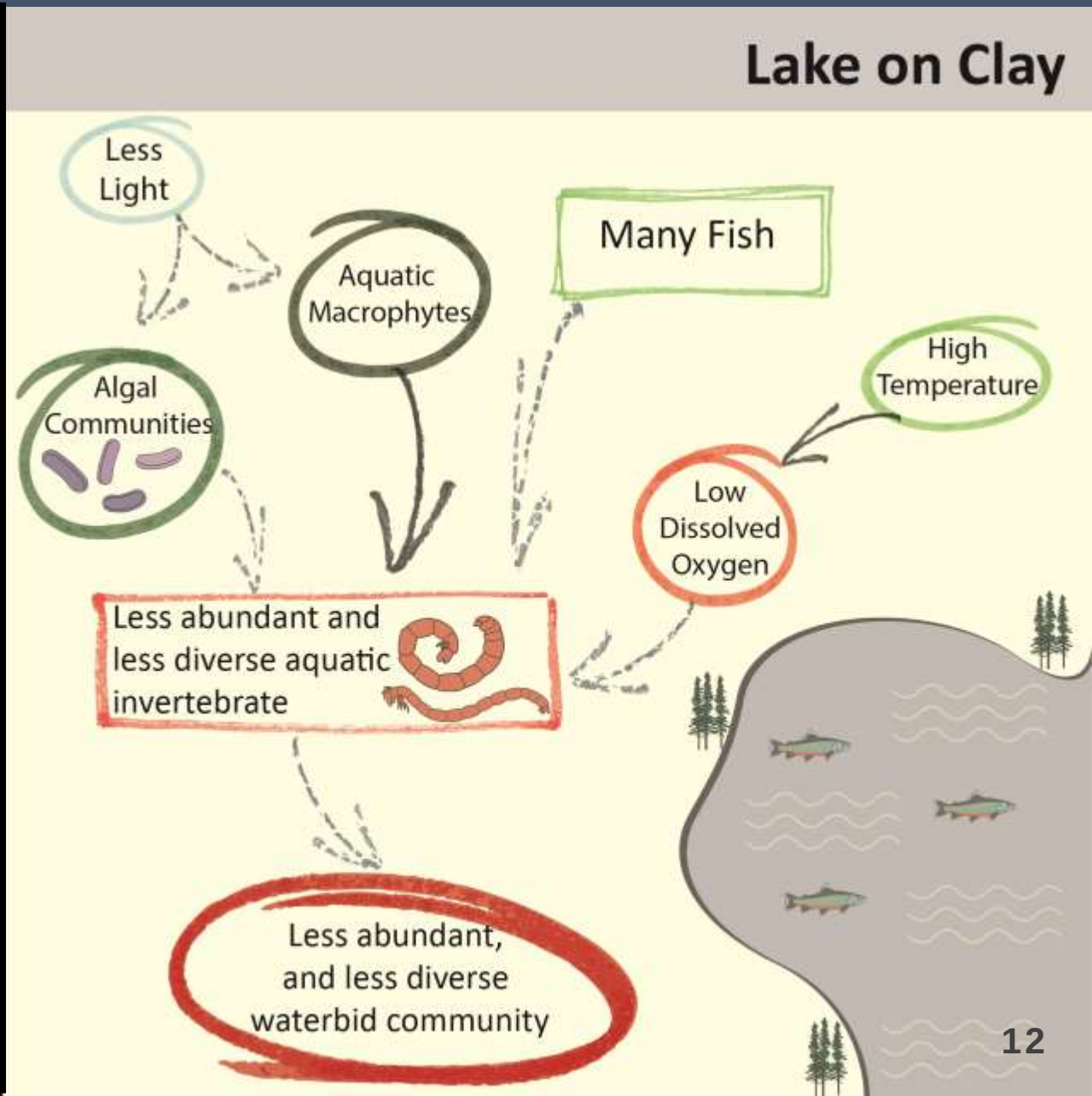


Guillaume Grosbois

Conceptual framework



Conceptual framework



Hypothesis

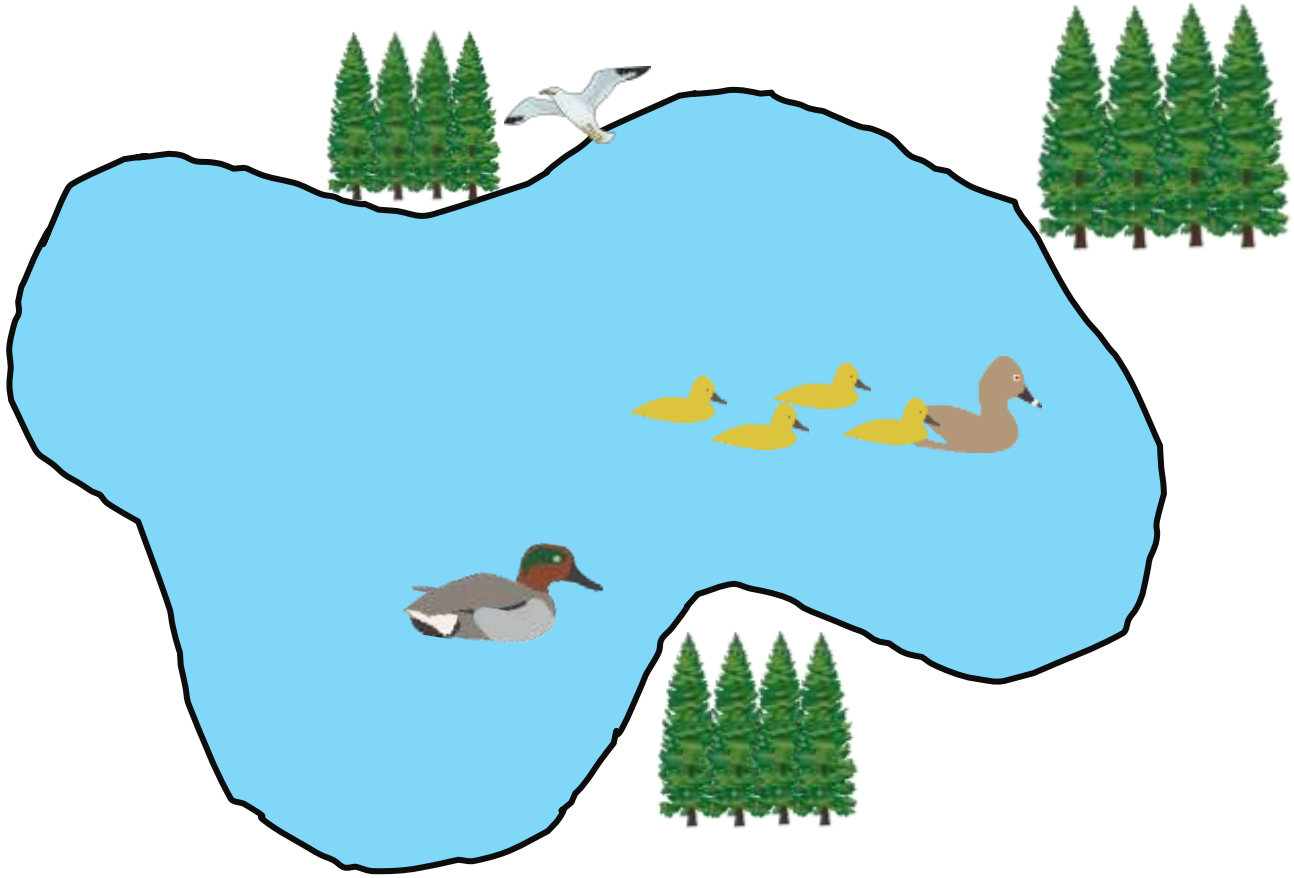
The abundance and diversity of macroinvertebrate will be higher in esker lakes compared to the lakes on clay because of a higher availability of resources and reduced fish predation.

The richness, diversity and abundance of waterbirds will be higher in kettle lakes on esker compared to the lakes on clay because of more availability of their food resources in the kettle lakes

ÉMILIE DESJARDINS

U.S. Department of the Interior

Method



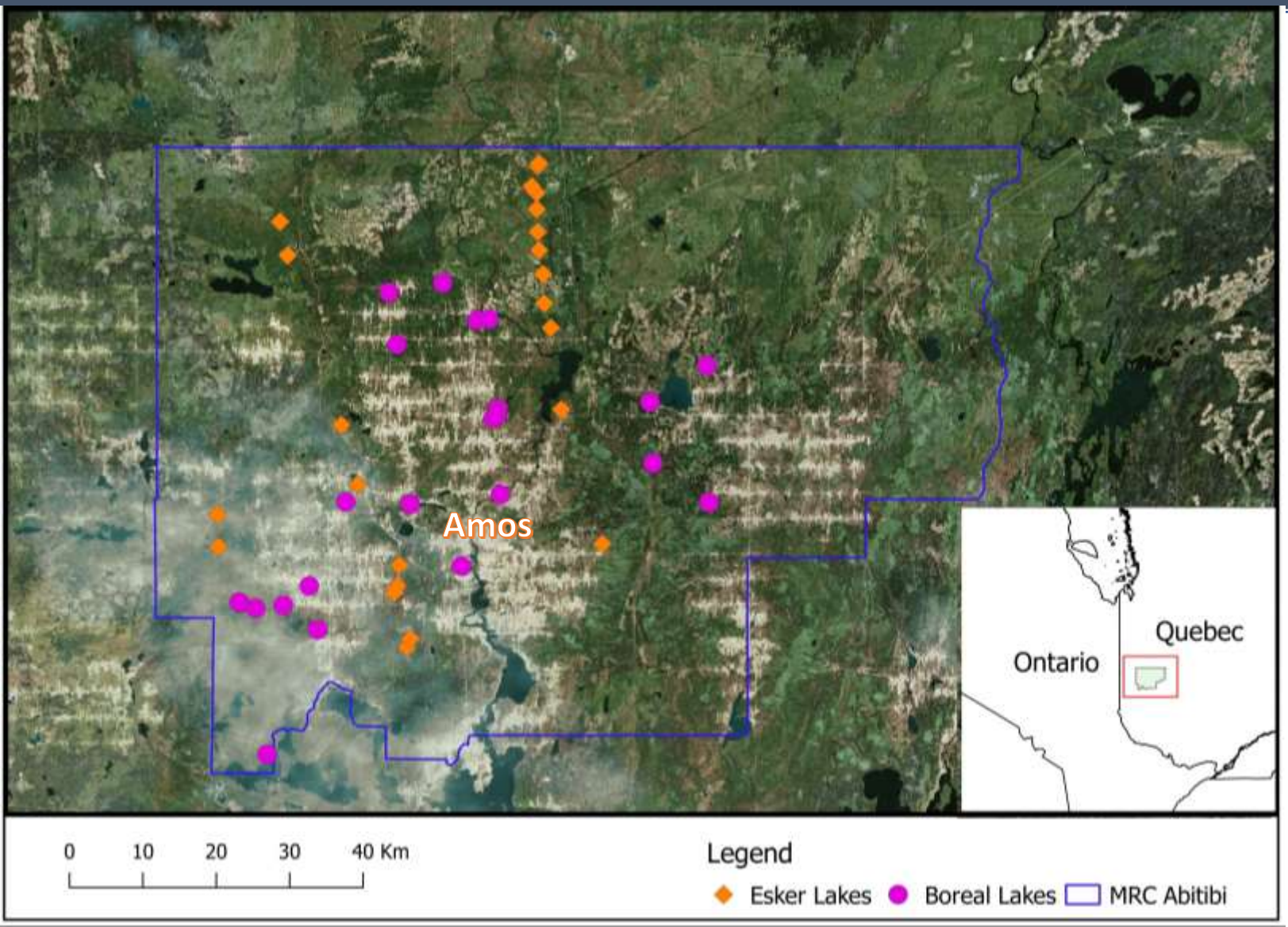
Experimental design

80 Lakes

- Size of the lake
- Location of the lake
- Logistics

50 Lakes

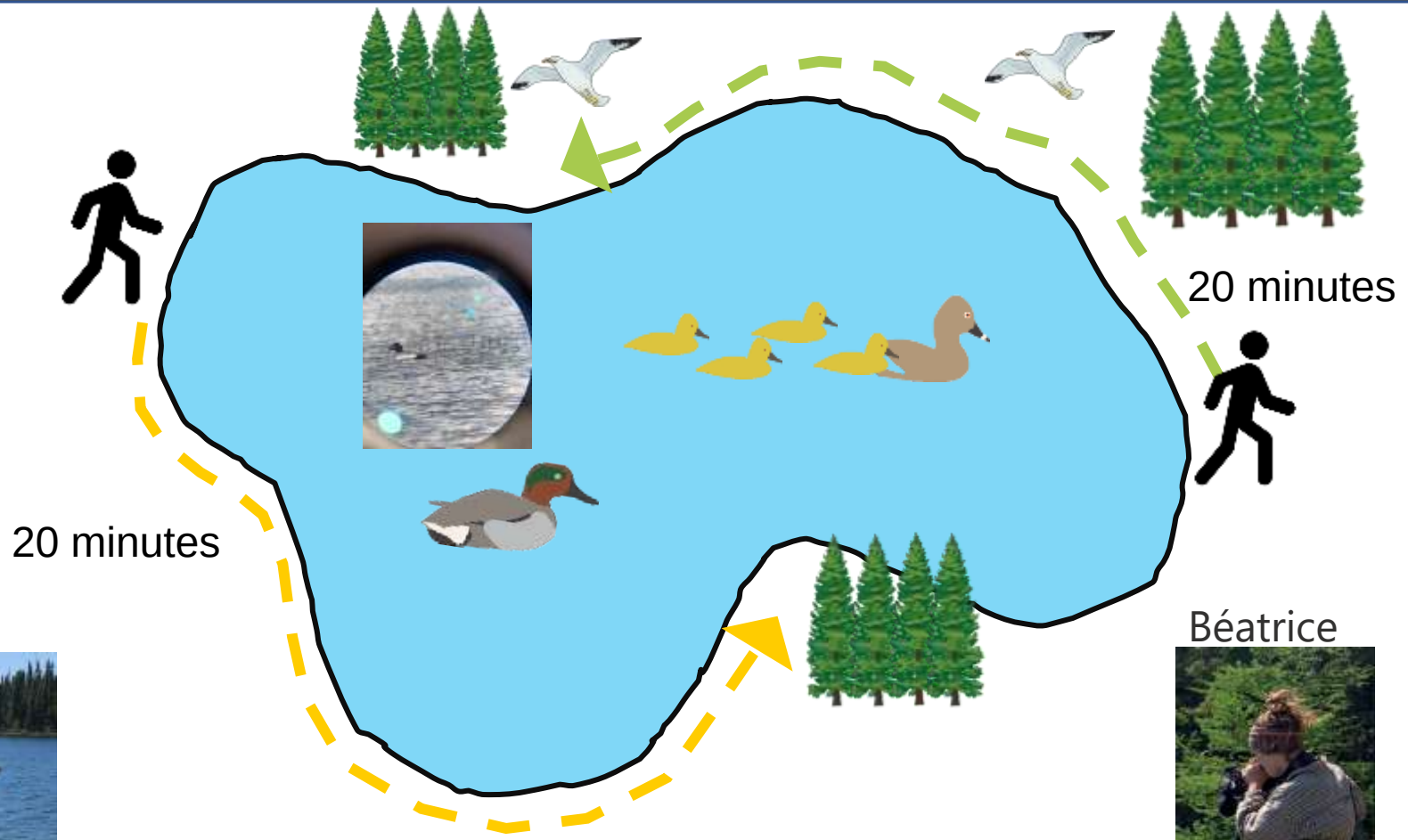
Study area



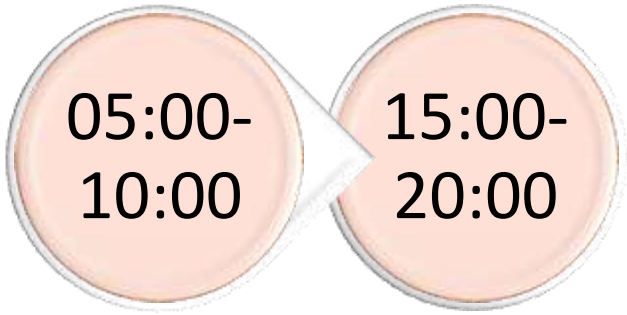
25 Esker lakes

25 Boreal lakes on clay belt

Waterbird survey



Survey Time



2 visit per lake

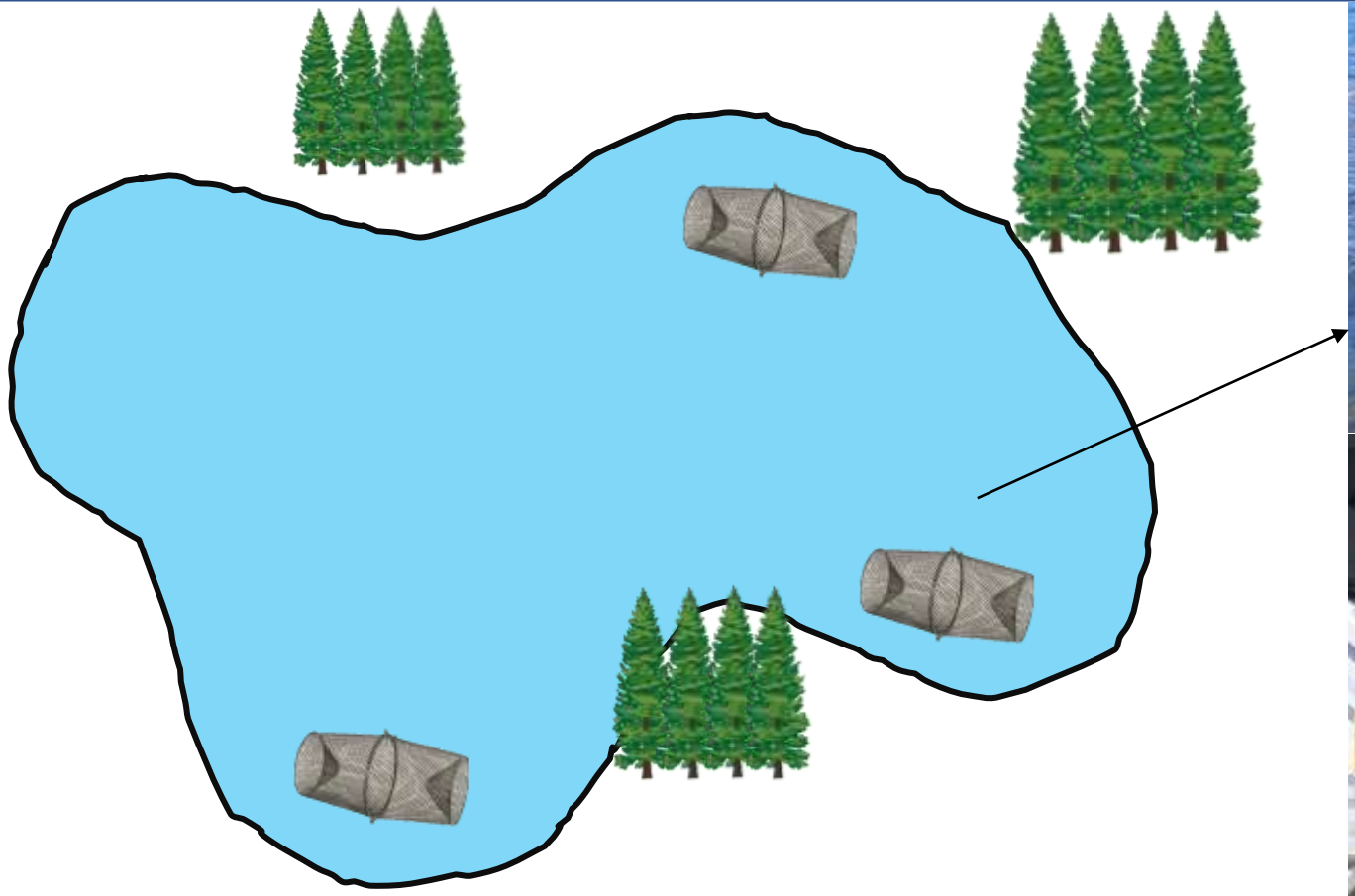
Waterbird Survey Method

- Point count
- Flush count

Hugo

Béatrice

Fish survey



3 minnow traps/lake
24 hours

Identified 6,406 fish

1. Total length
2. Body weight
3. Species
4. Abundance

Macroinvertebrate

Collection from the Lake

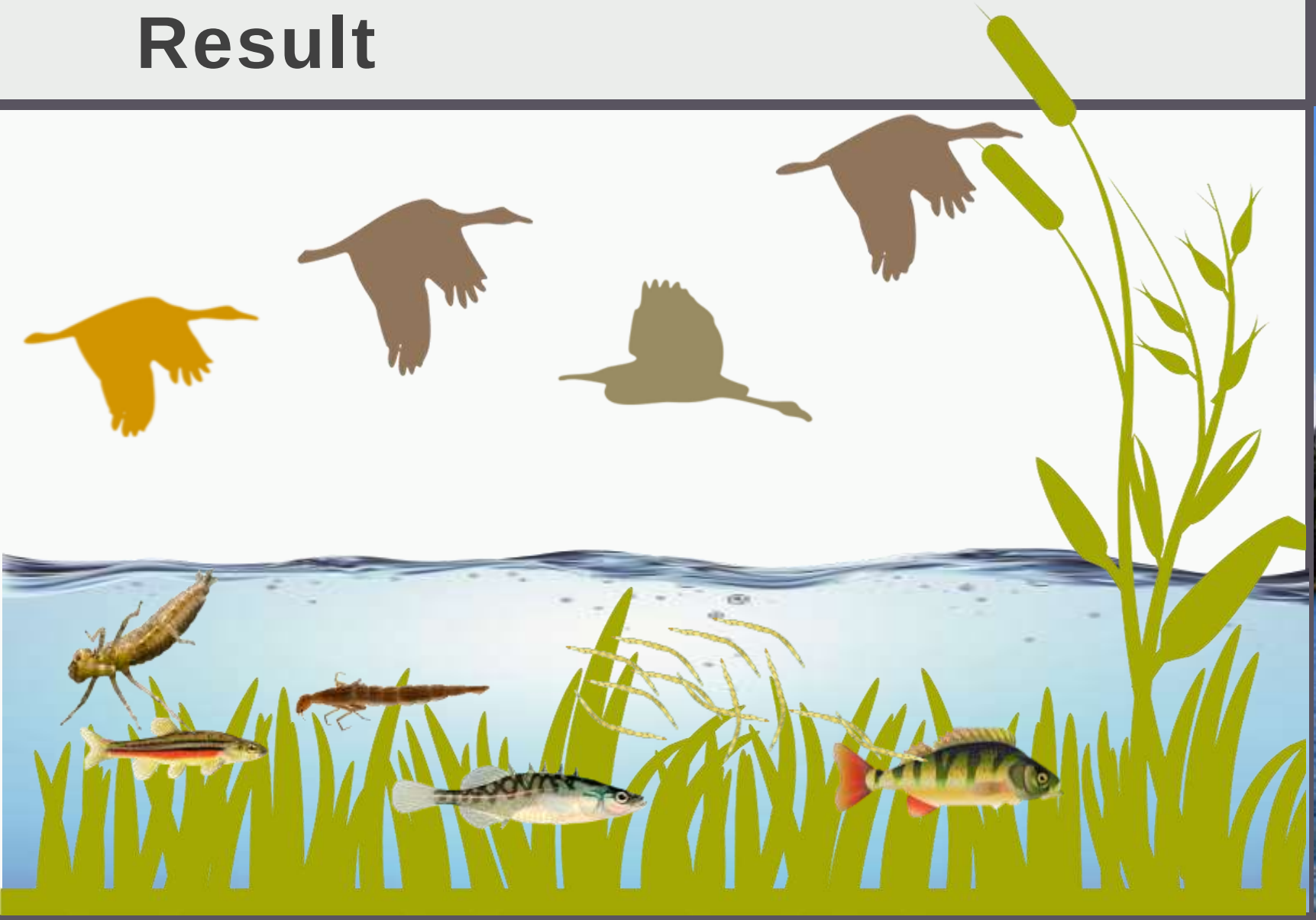
Extracting each macroinvertebrate

600 hours in the binocular to identify 19,947 macro-invertebrates

D-frame net (350 µm mesh, surface area = 0.0604 m2)

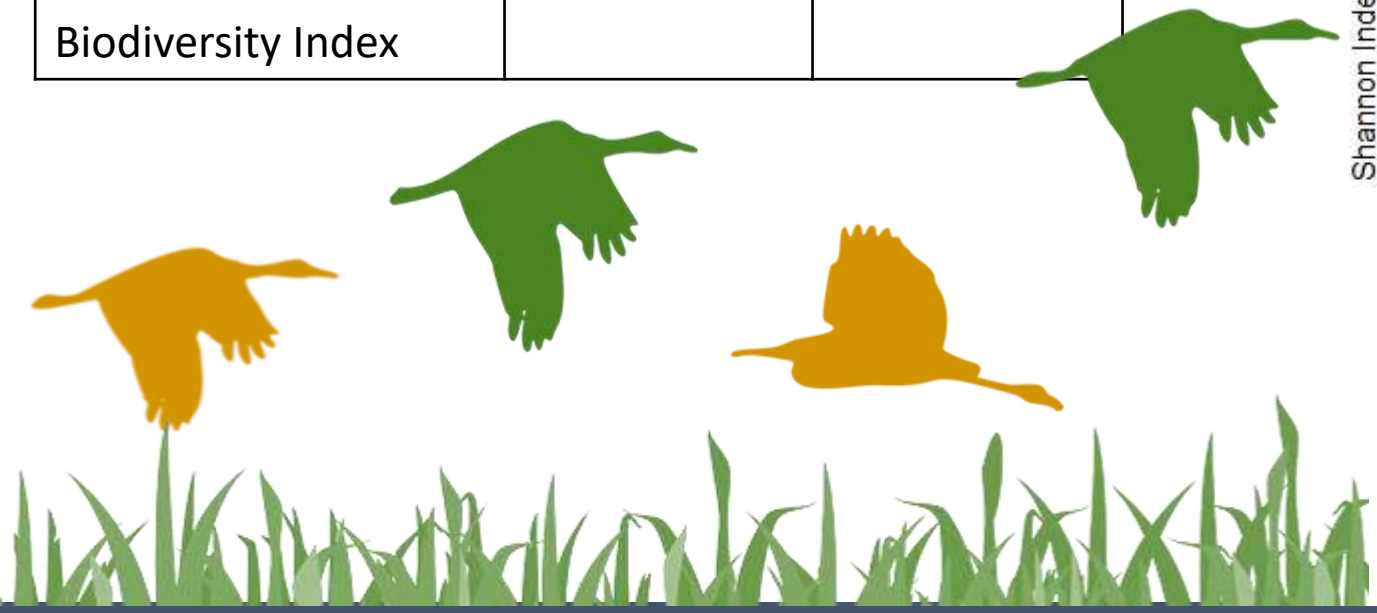
Diptera Larvae (Chironomidae and Ceratopogonidae)

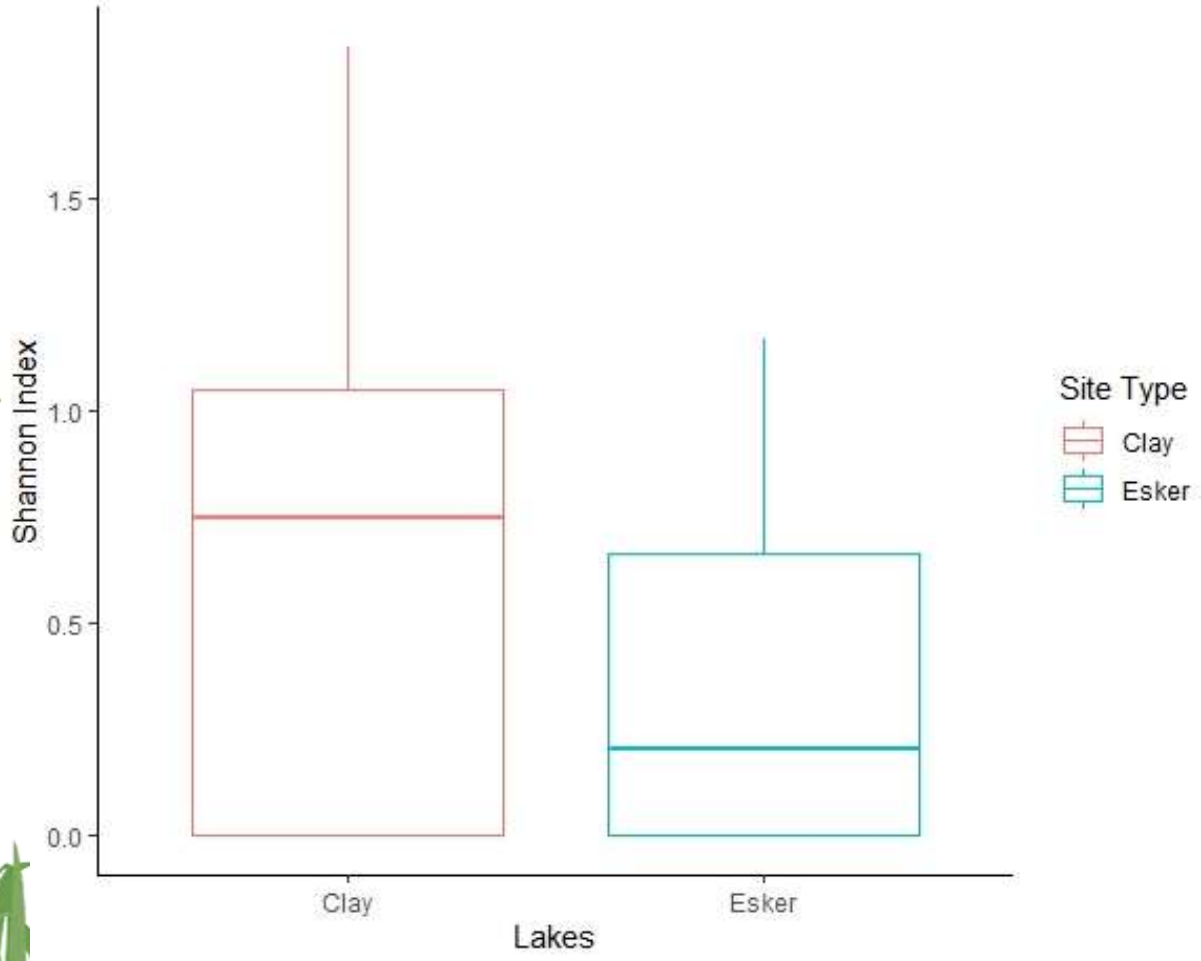
Result



Waterbird diversity

Variables	Clay	Esker
Mean Abundance	**8.96**	8.4
Total Abundance	**224**	210
Total Richness	**13**	10
Mean Shannon Biodiversity Index	**0.45**	0.31





Art Credit: Émilie Desjardins

Fish diversity

Variables	Clay	Esker
Mean Abundance	**210.4**	22.92
Total Abundance	**5833**	573
Total Richness	8	**9**
Mean Shannon Biodiversity Index	**0.76**	0.10

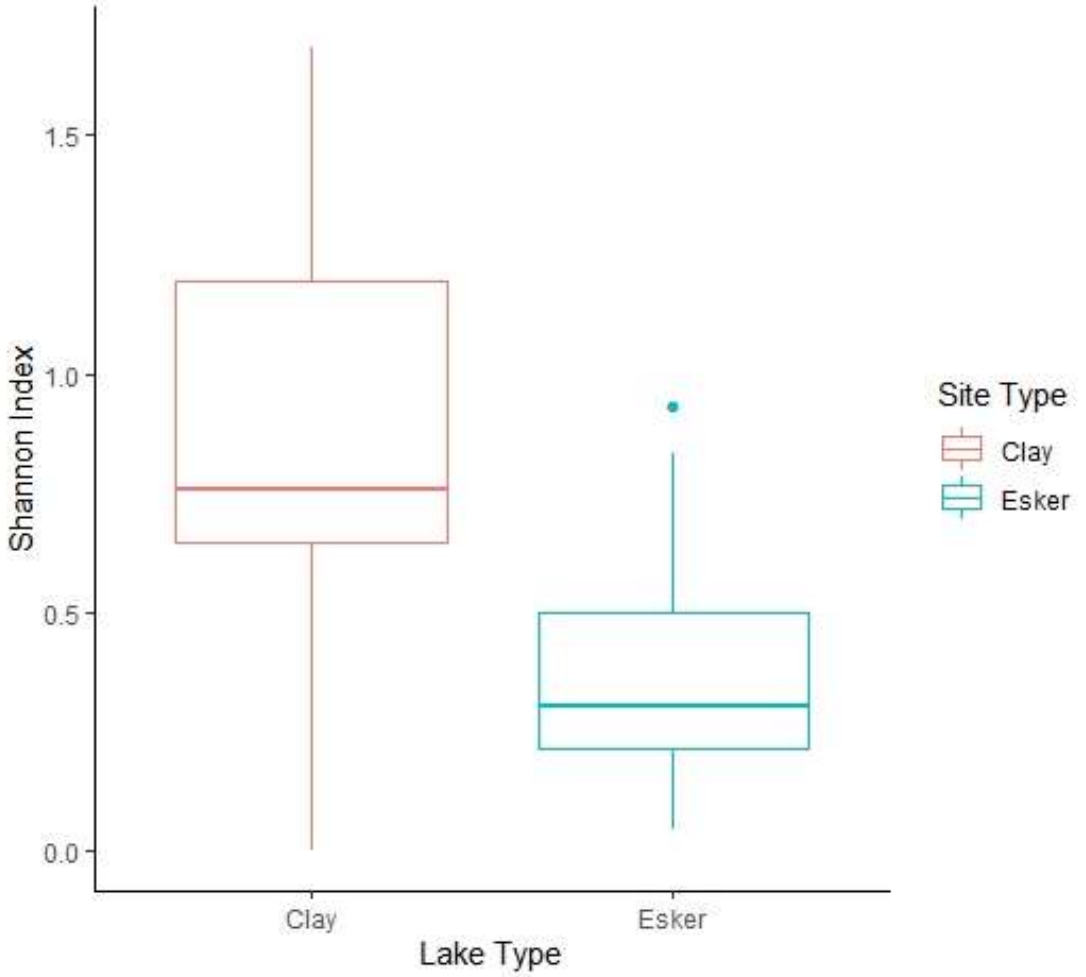


Image: iStock, Gograph, Dreamstimes, nicepng

Macroinvertebrate diversity

Variables	Clay	Esker
Mean Abundance	**164.2**	156.36
Total Abundance	**4104**	3909
Mean Richness	**10.28**	9.48
Mean Shannon Biodiversity Index	**1.29**	1.23

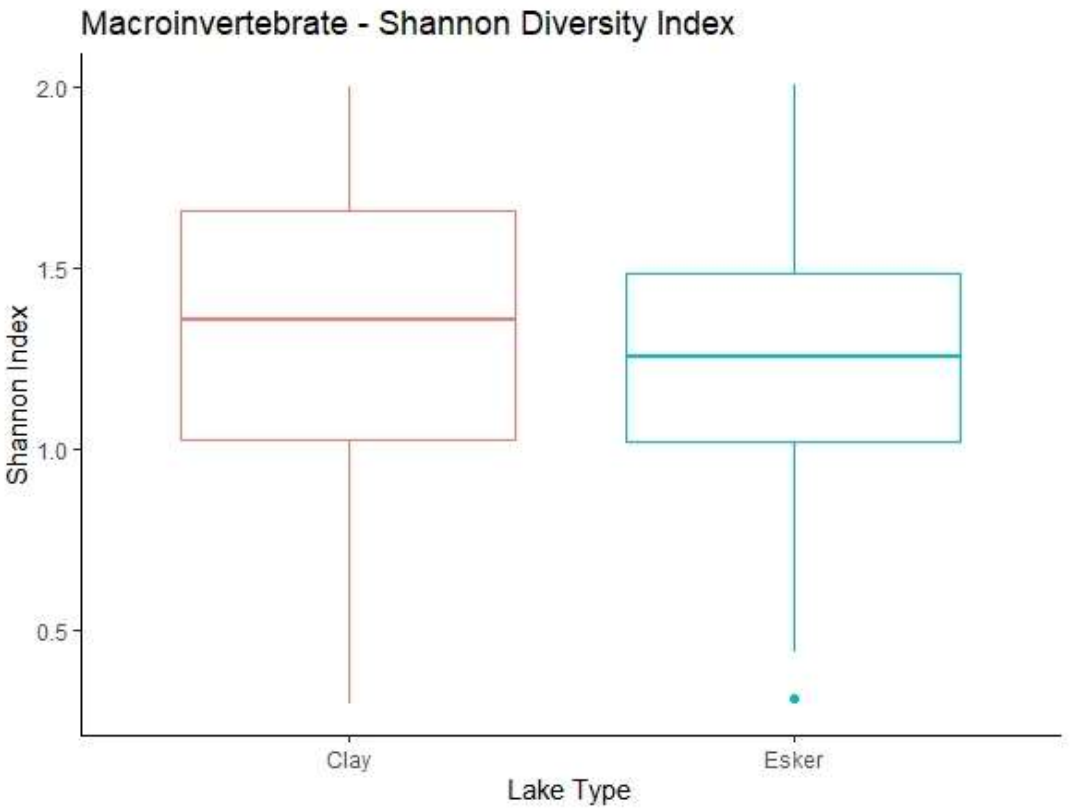
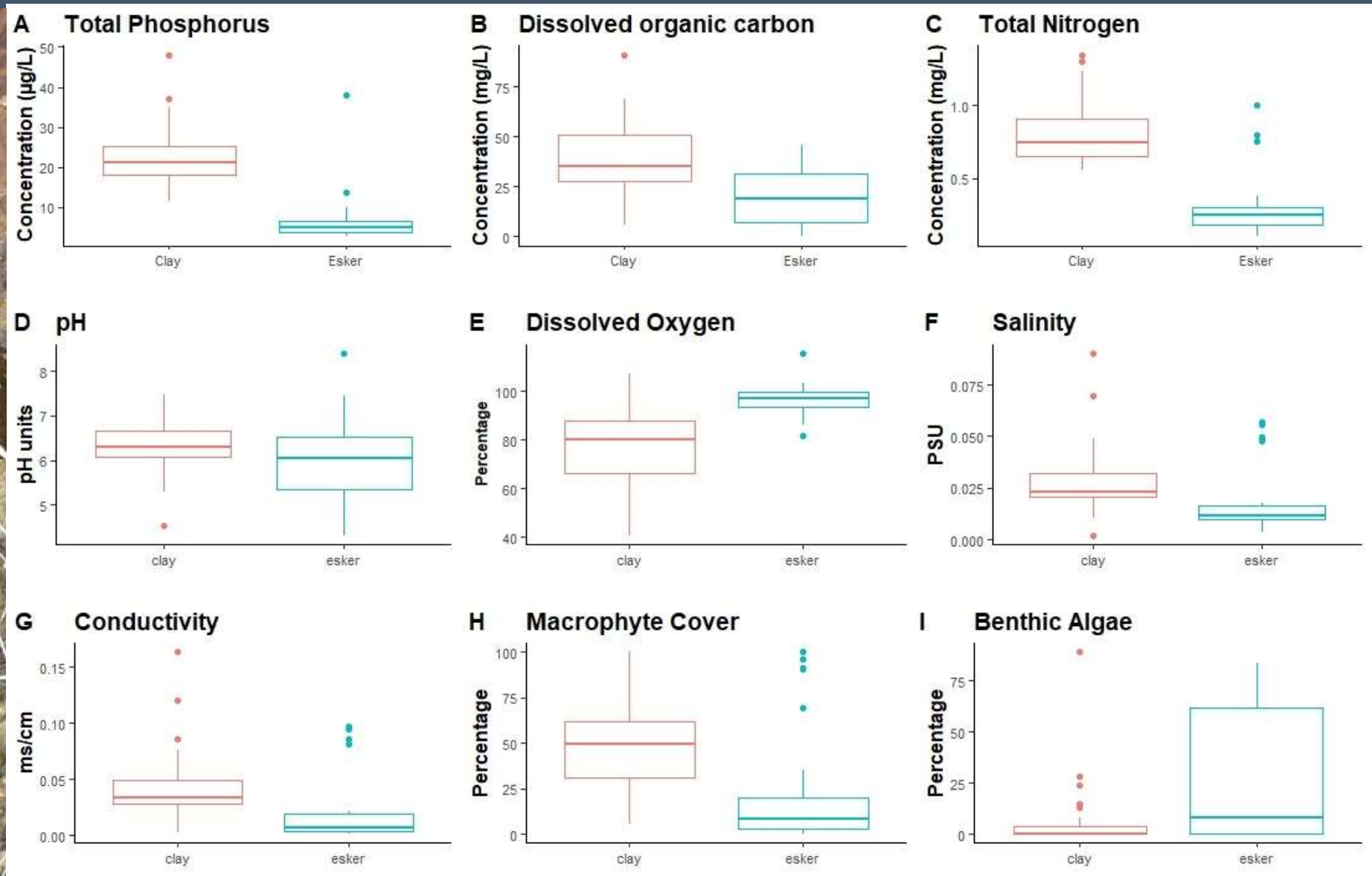


Image: NJ Watershed Monitoring Network,

Physicochemical variables



Effect of physiochemical variables on waterbird richness

Response Variable: Waterbird Richness	**Intercept -1.86**	
Fish Richness	0.008 ± 0.080	
Macroinvertebrate Richness	0.063 ± 0.041	
Total Phosphorus	0.001 ± 0.022	P < .1
Total Nitrogen	-0.112 ± 0.778	
Dissolved Organic Carbon	0.018 ± 0.007	P < .05
Lake Area	-0.182 ± 0.077	P < .05
Harvesting distance	-0.001 ± 0.001	P < .1
Dissolved Oxygen	0.003 ± 0.011	
Macrophyte	-0.002 ± 0.004	

Image Credit: Patrice Blaney

Indicator waterbirds – esker lakes

Common goldeneye
Garrot à œil d'or
Bucephala clangula
p = 0.049

Canada Goose
Bernache du Canada
Branta canadensis
p = 0.031

Image Credit: TheCornellLab

Indicator waterbirds – clay lakes

Ring necked duck
Fuligule à collier
Aythya collaris
p = 0.020

Hooded Merganser
Harle couronne
Lophodytes cucullatus

p = 0.021

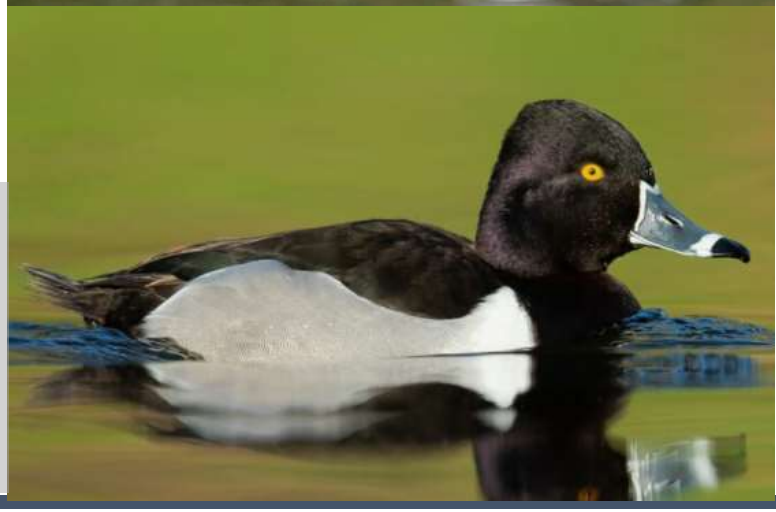


Image Credit: TheCornellLab

Indicator fish- esker lakes

Yellow perch
Perchaude
Perca flavescens
p = 0.105

Indicator fish- clay lakes

Northern redbelly dace
Chrosomus eos
p = 0.001

Northern finescale dace
Chrosomus neogaeus
P = 0.001

Fathead minnow
Pimephales promelas
p = 0.001

Indicator macroinvertebrate – esker lake

Image Credit: macroinvertebrate.org

Indicator macroinvertebrate – clay lake

Coleoptera Order

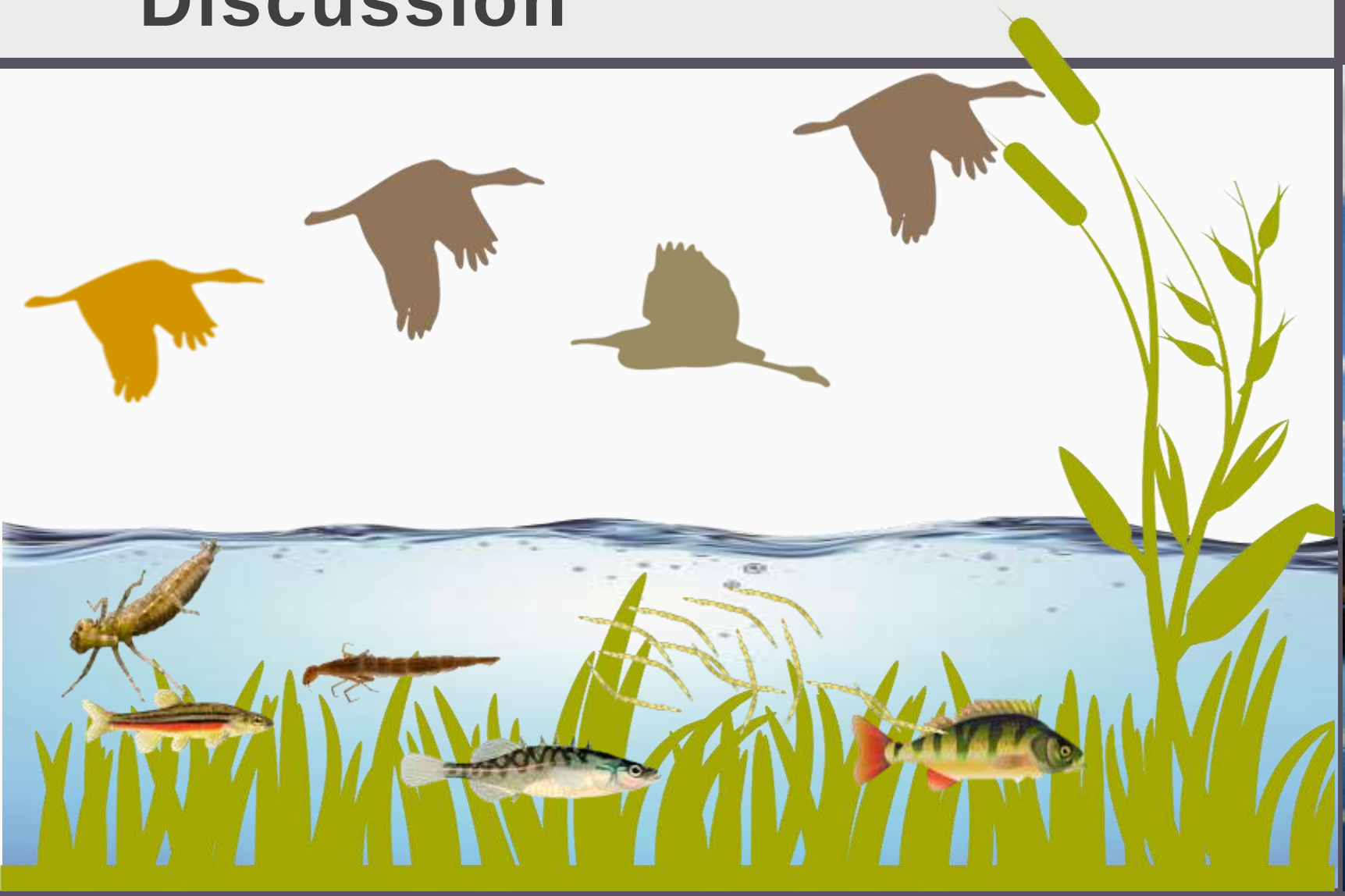
Dytiscidae
P value = 0.009

Elmidae
P value = 0.039

Belostomatidae
P value = 0.036

Image Credit: macroinvertebrate.org

Discussion

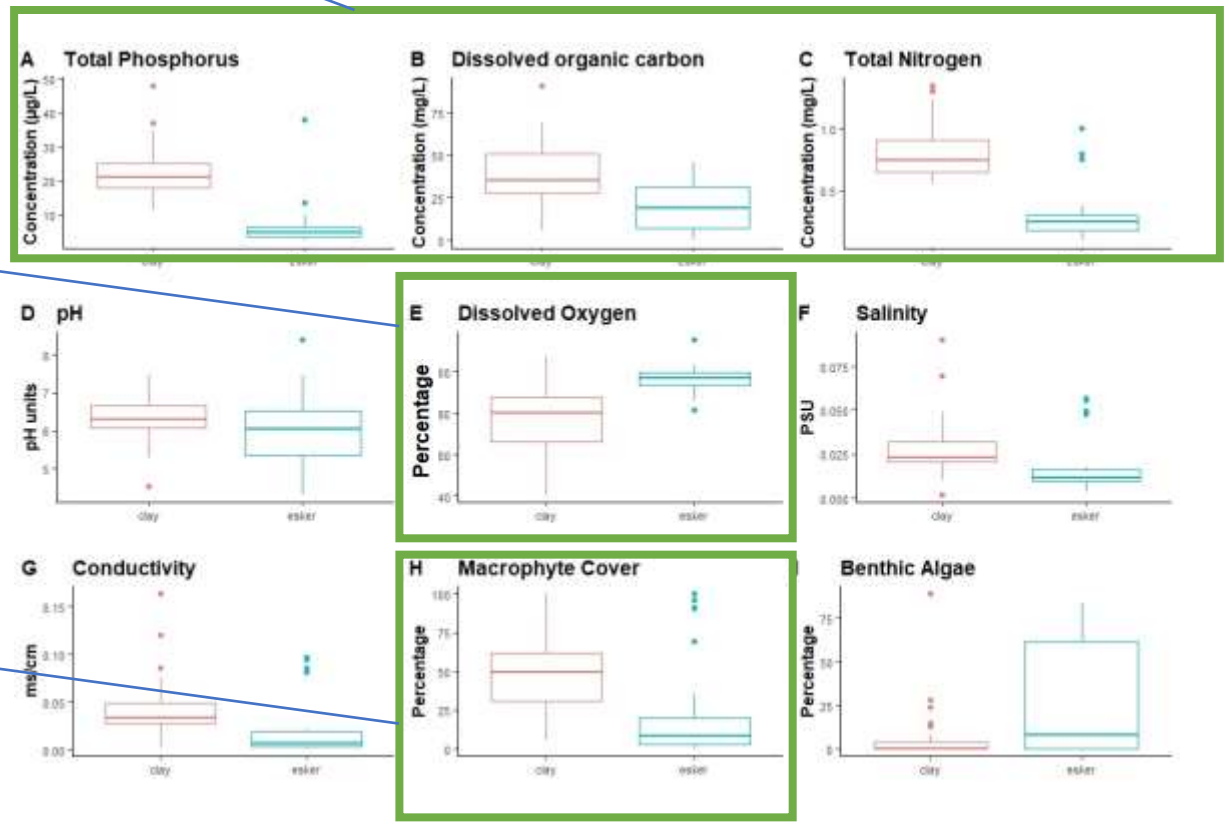


Discussion – esker vs clay lakes

Esker lakes get less nutrients input from the watershed because of their isolation

Recharge from groundwater and water temperature

Less nutrient for macrophyte to thrive



Discussion – Waterbird

- Esker lakes had lower waterbird richness and diversity,

However, few species showed strong association.

Example: Common Goldeneye

- During breading season Common Goldeneye prefer fishless

lakes (Eriksson 1979).

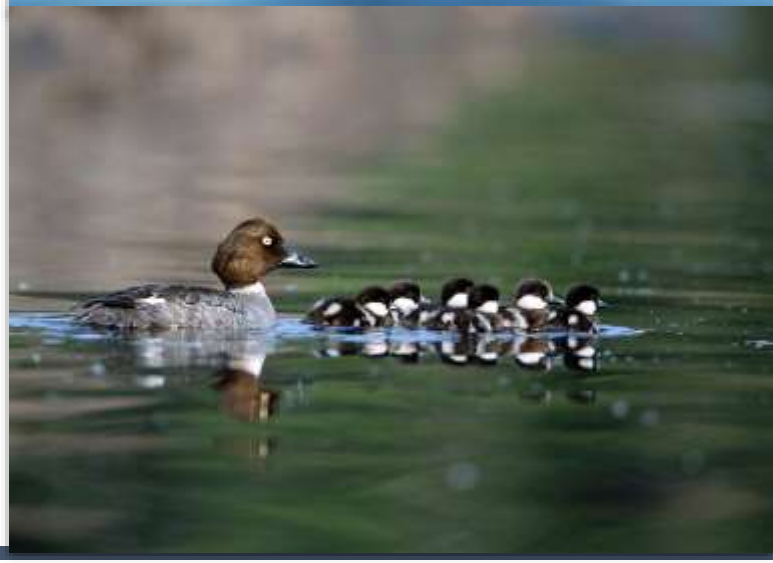
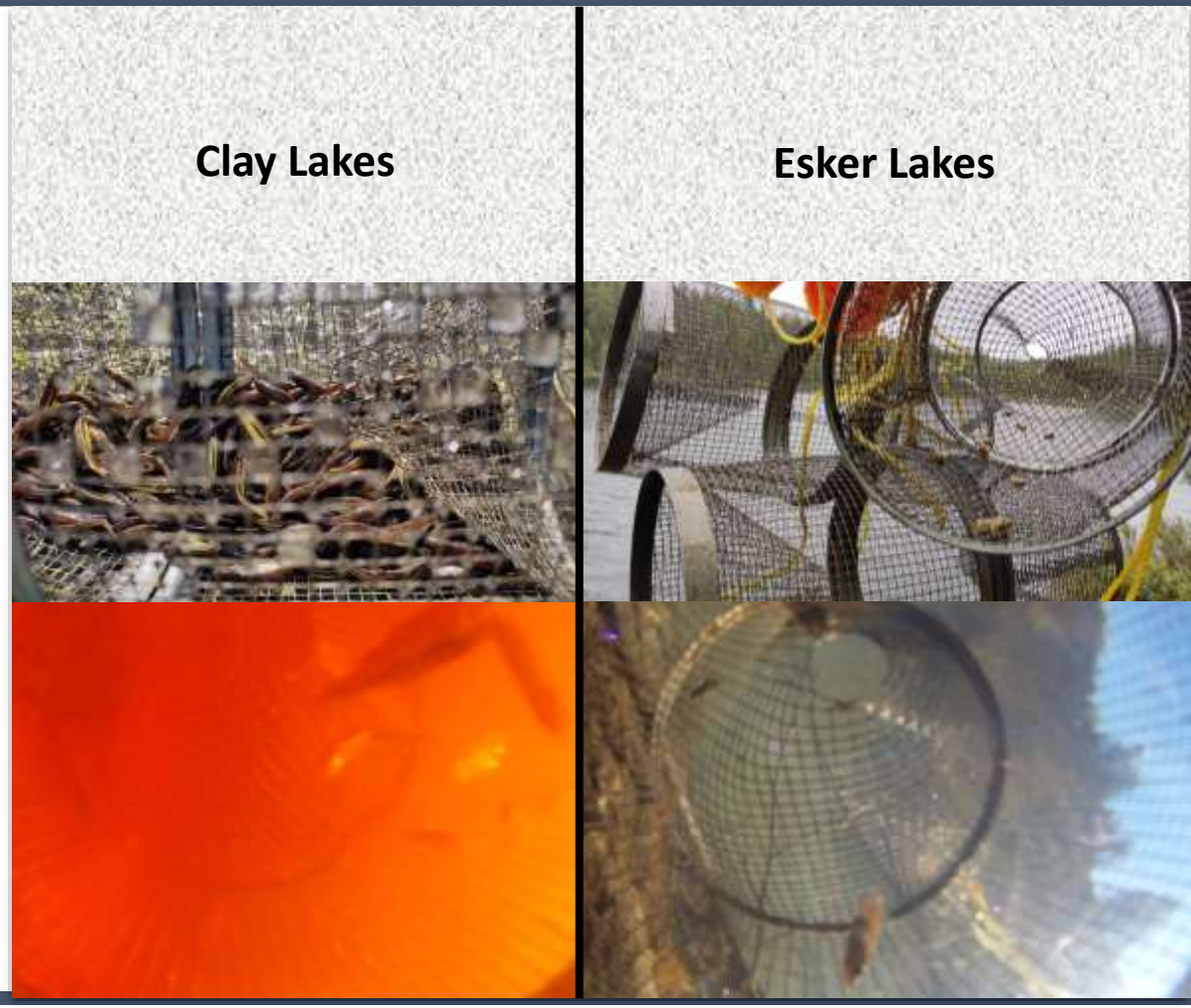


Image: eBird, Toby Skov

Discussion - Fish

- Diversity of fish in esker Lakes were significantly lower than clay lakes
- Half of the esker lakes were completely fishless
- Isolation of esker lakes and their lower nutrient content can explain this



Discussion – Macroinvertebrate

- The significance association of Stoneflies (Perlidae family) can be explained from higher dissolved oxygen in esker lakes.
- Dragonflies and damselflies (Odonata Order) act as the predator in esker lakes

Image: Hugo Morin-Brassard

Discussion – Effects on biodiversity

- Harvesting activity significantly alter the ecosystem around esker lakes
- Several other anthropogenic activity (mining, species introduction, pollution, camping) also alter esker habitat for biodiversity
- Lake area and perimeter strongly affect waterbird habitat selection

Conclusion

- The diversity of esker lakes is lower in all trophic level of the food web
- Few important communities showed strong association with esker lakes because they need this special ecosystem to survive
- Anthropogenic activity might alter this pristine esker ecosystem

Contributors

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Reference

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