

# First characterization of the trophic structure and biodiversity of esker lakes

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**Thickness: up to two kilometers**

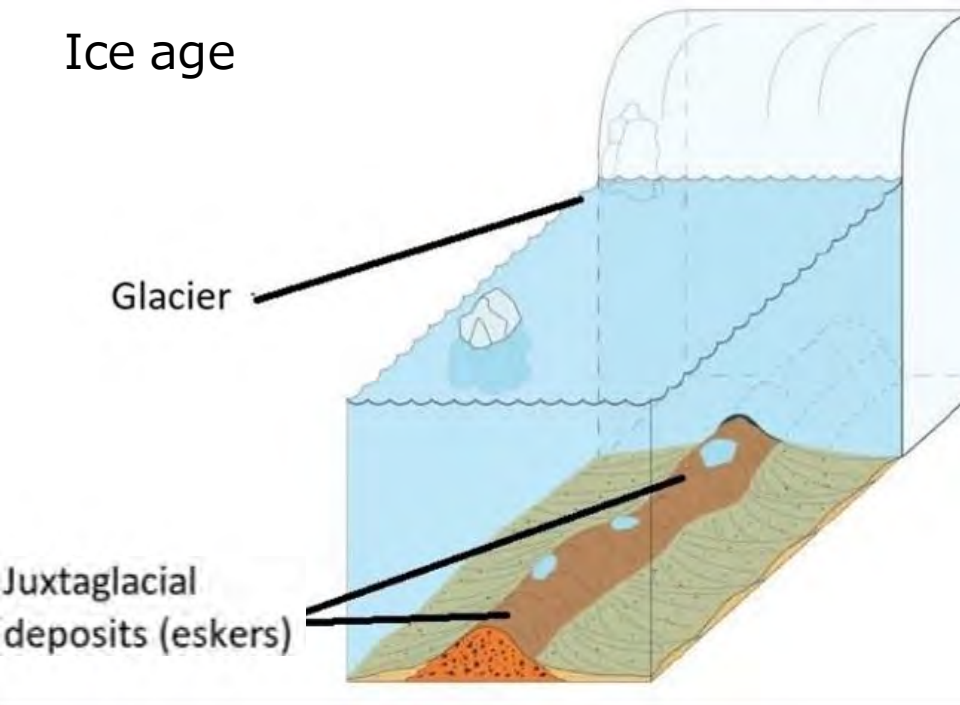
- A Canadian Museum of Nature



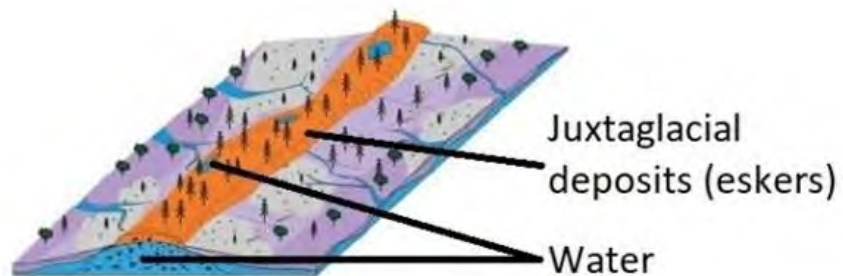
**Imagine our world like this**

**97% of Canada**

Ice age



Now



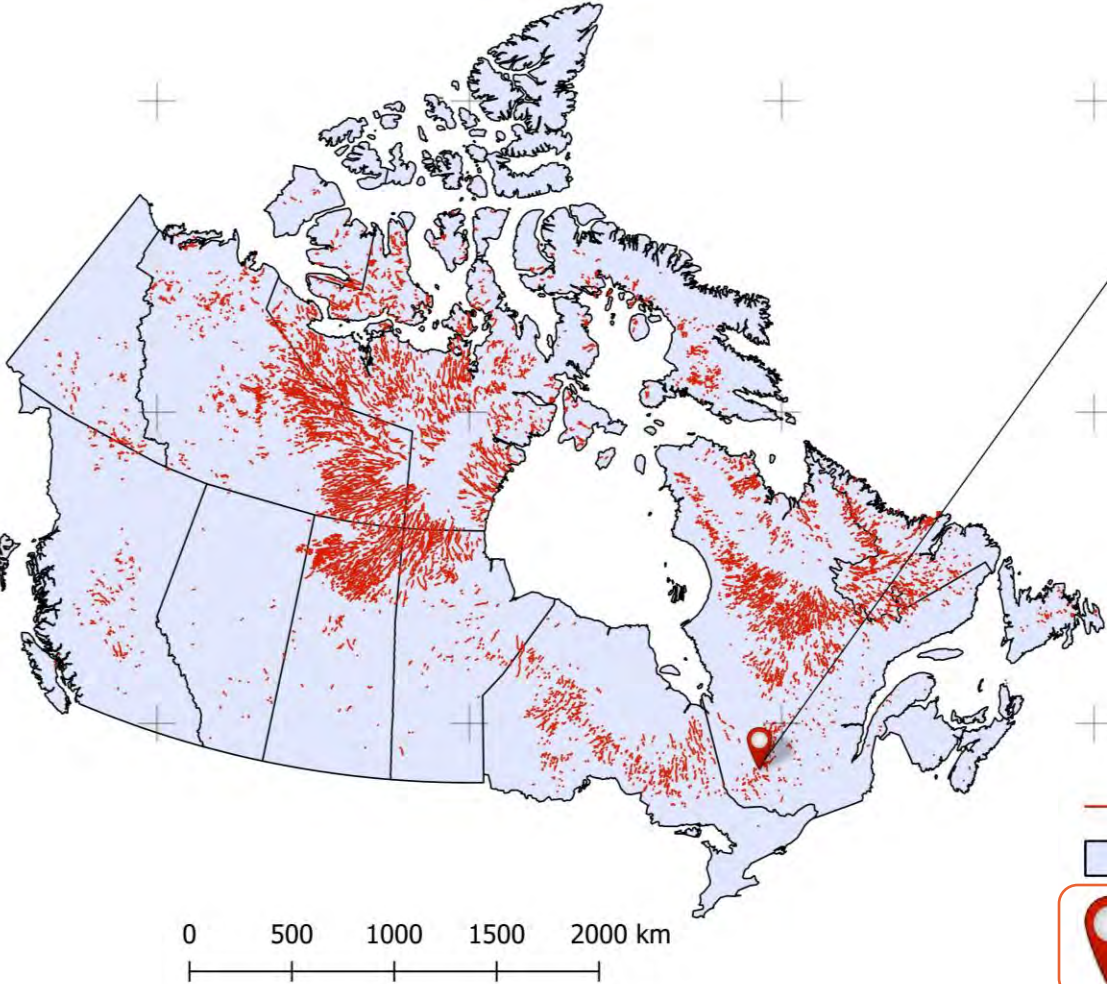
# Esker formation

Complex geological formation formed by glaciers

Made of layers of sand and gravel.

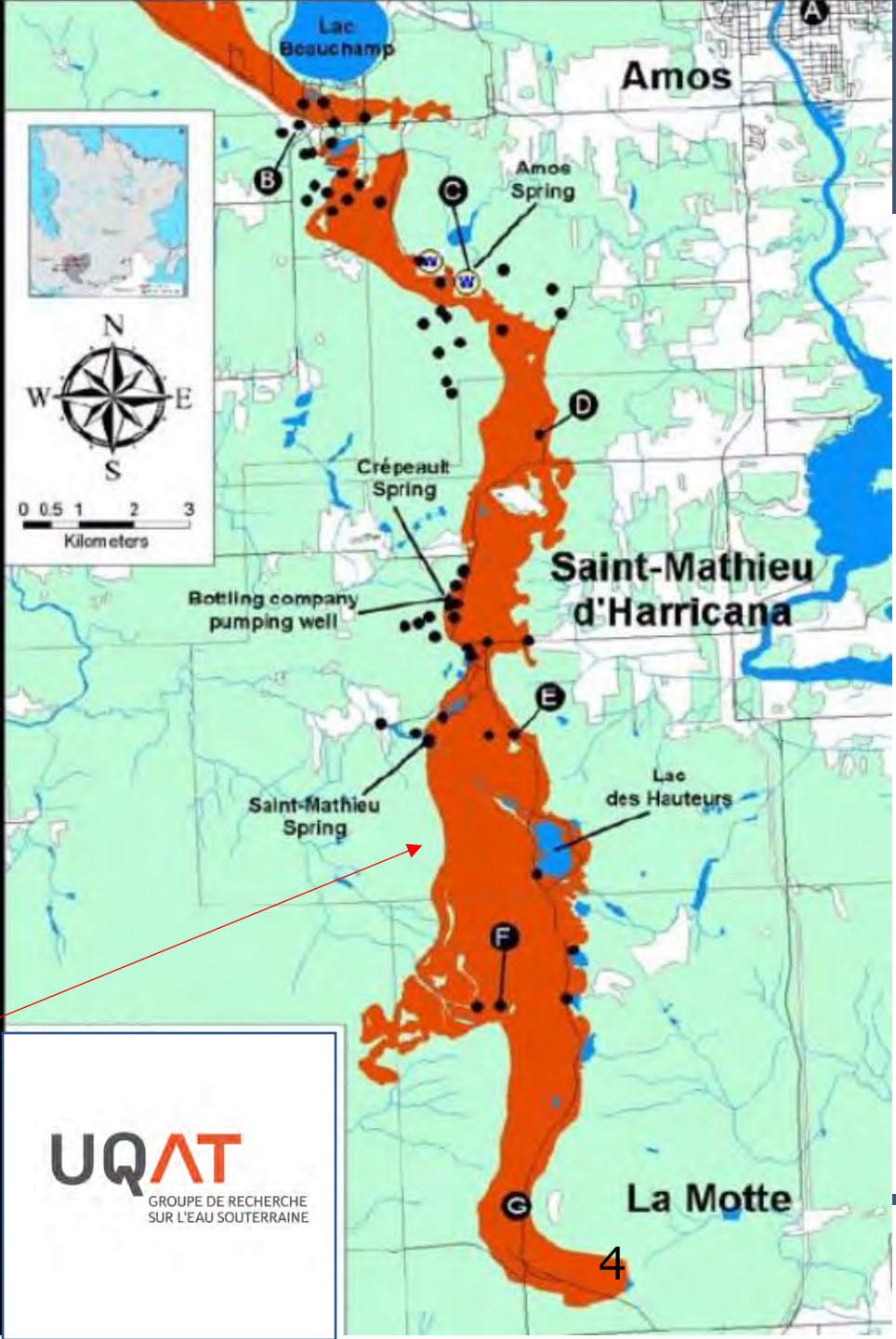
Distributed over all northern countries

# Eskers of Canada



We are here (Abitibi)

- Eskers of Canada
- Canada
- 📍 Saint-Mathieu-Lac-Berry Esker



Distribution of Eskers from Canada And Study Area Location (Saint-Mathieu-Lac-Berry Esker.) Adapted from Storrar, Stokes and Evans, (2013) .



Esker  
Lakes

# Lakes on esker

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Esker lakes are connected with groundwater system

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Not connected with the river or other wetlands

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which creates a closed basin wetland

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This relationship affect water temperature, quality and nutrient



Jack Pine (*Pinus banksiana*)



# Services from esker ecosystem

**Sand and gravel**



**Best quality freshwater**



**Myco-tourism**



**Archaeological sites**



**Recreational sites**



**Jack Pine timber**



# Threats to esker ecosystem



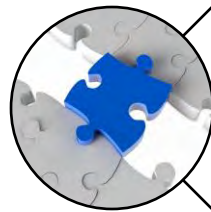
Over Extraction of sand, gravel



Forest Harvesting



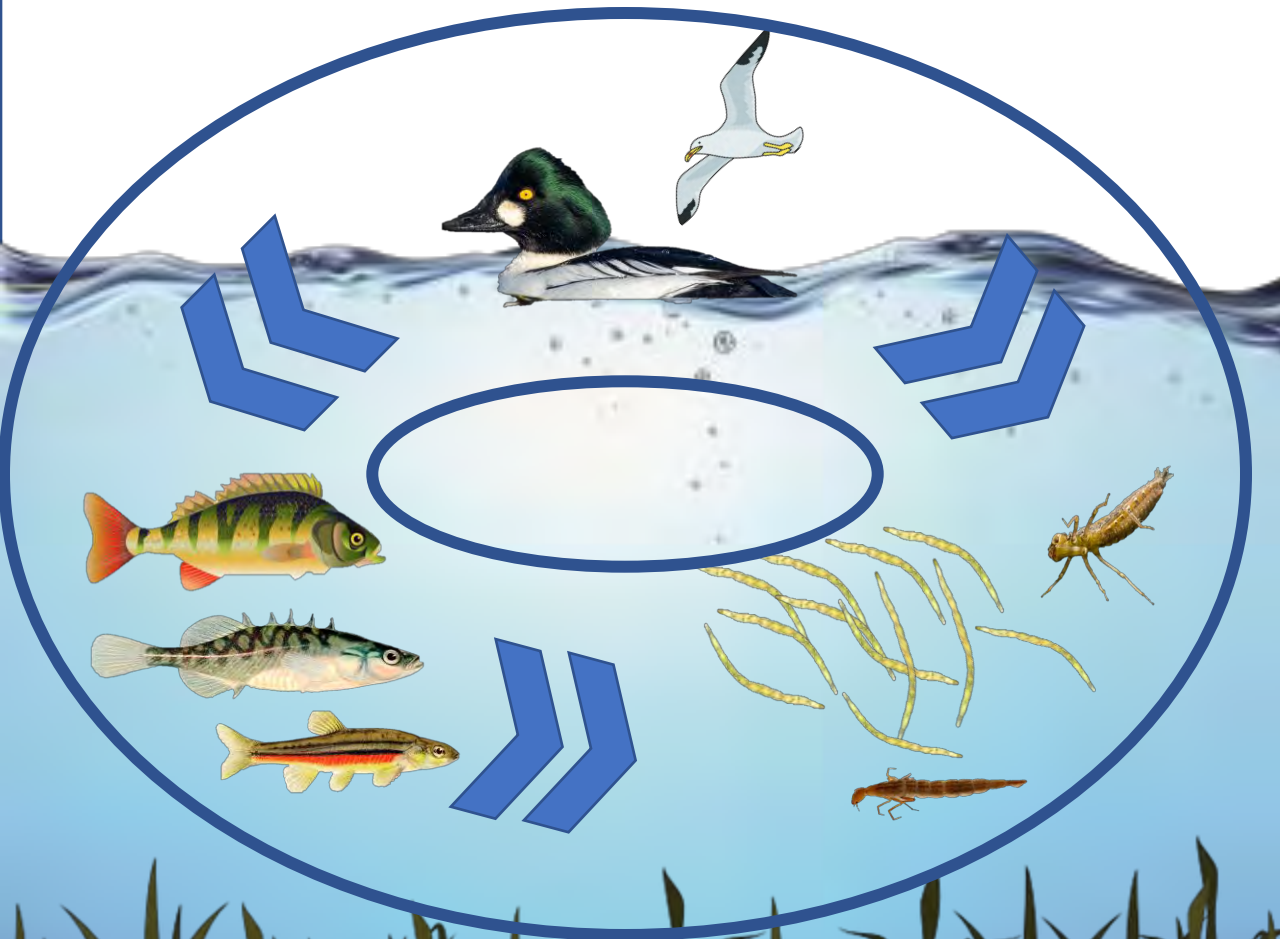
Anthropogenic disturbances (Such as camping, species introduction)



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





# Objectives

## General

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

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.

## Specific

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



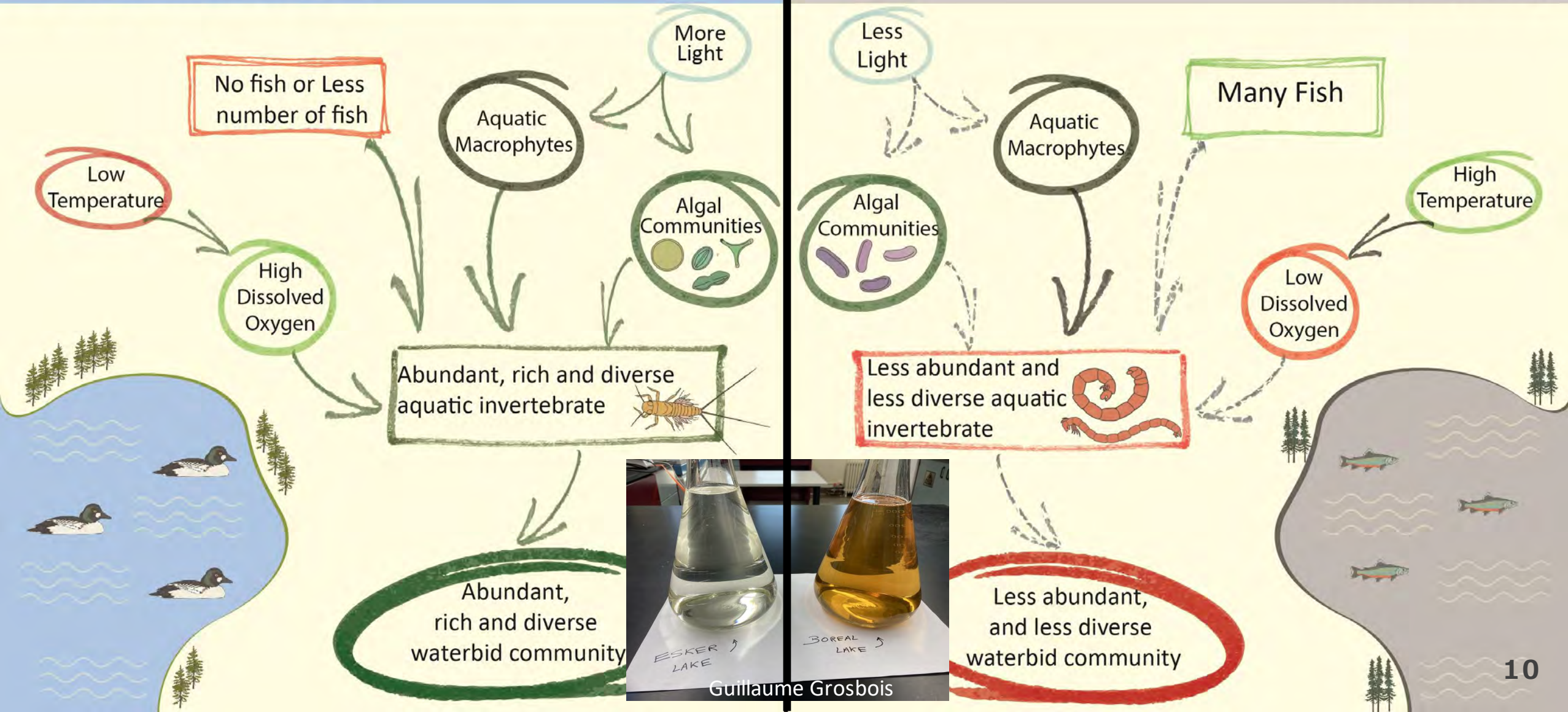
Bonaparte's gull

# Conceptual framework

Idea: M. Montoro Girona and G. Grosbois

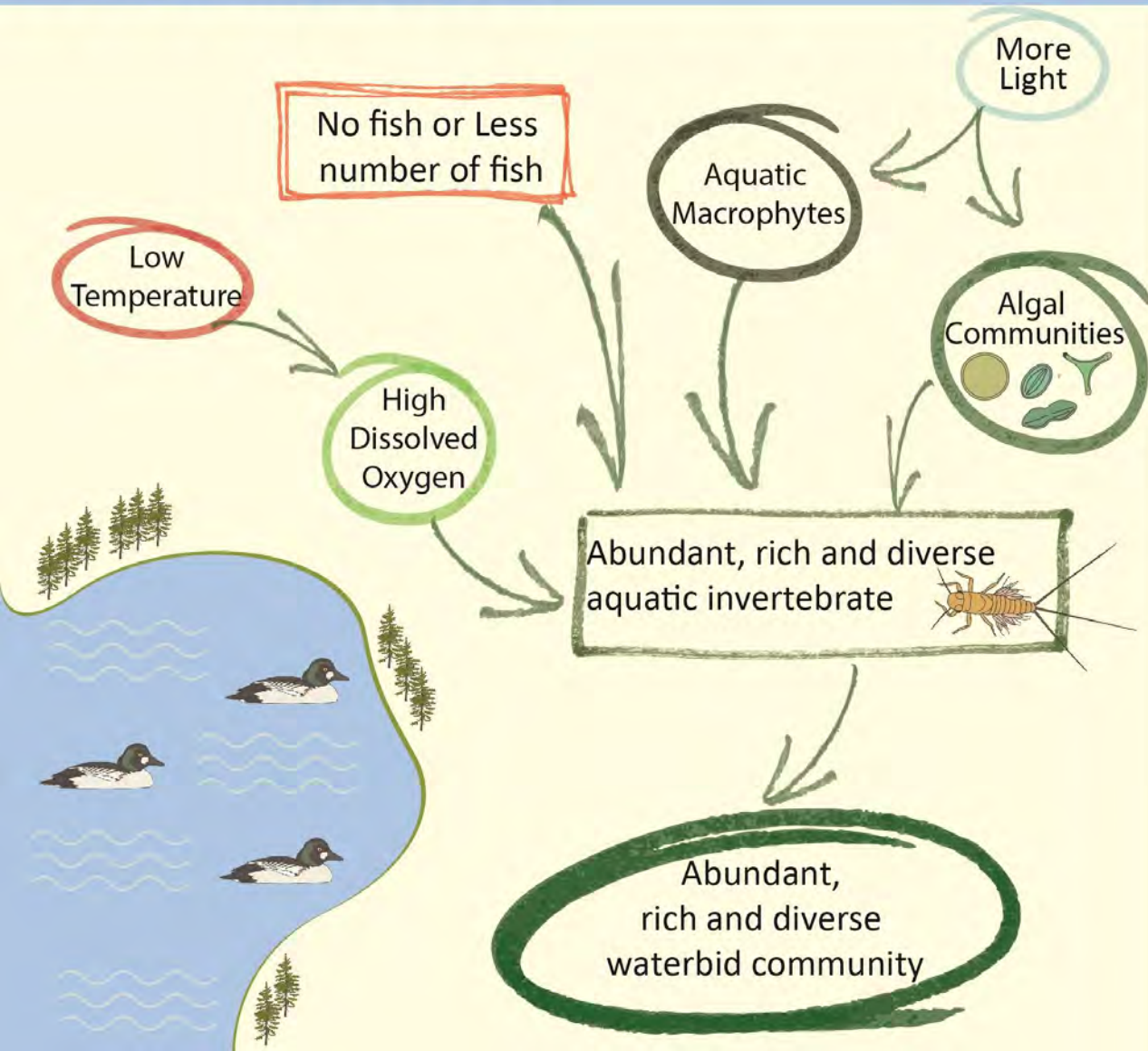
## Kettle lake on Esker

## Lake on Clay



# Conceptual framework

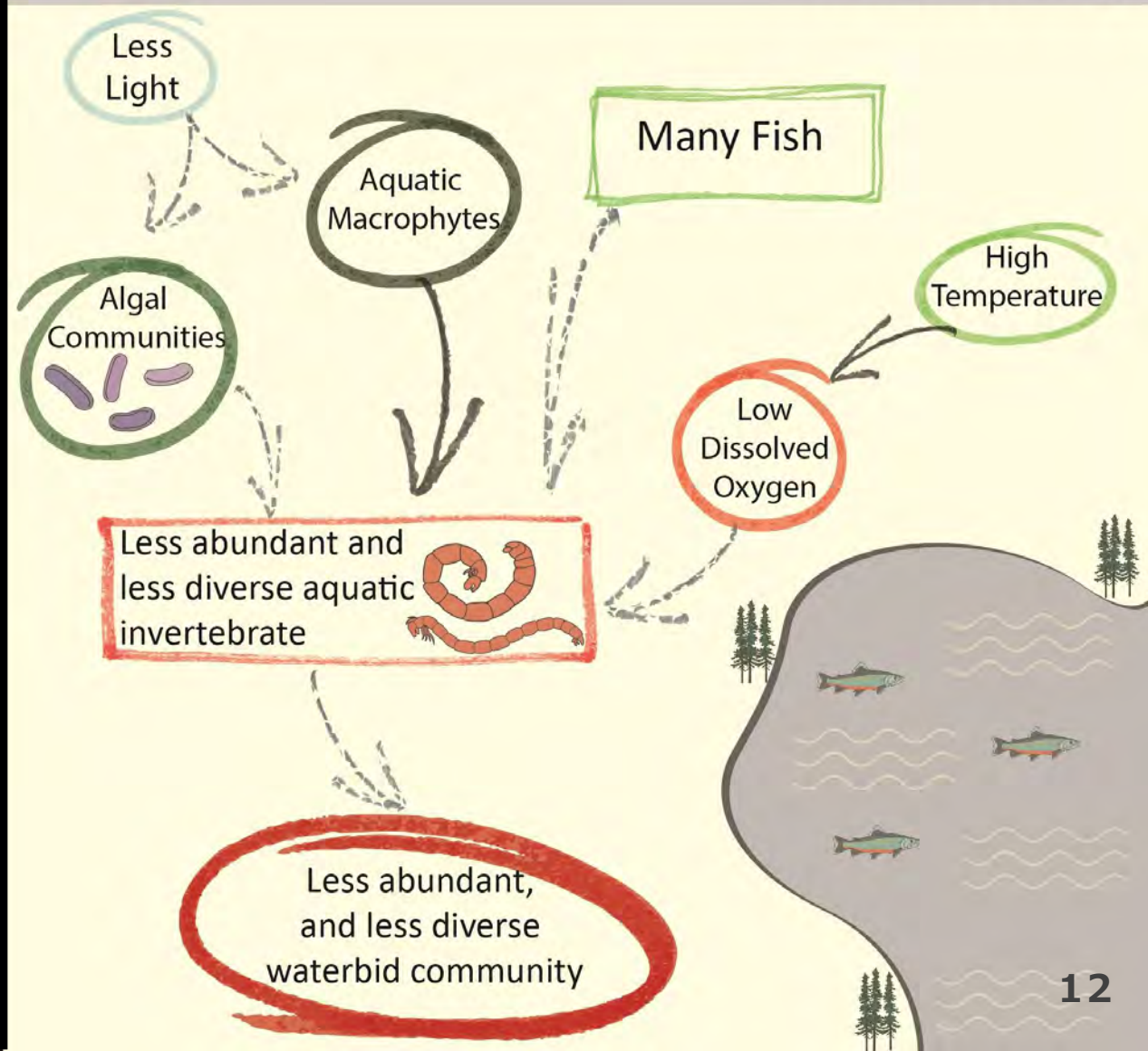
## Kettle lake on Esker



# Conceptual framework



## Lake on Clay



# Hypothesis

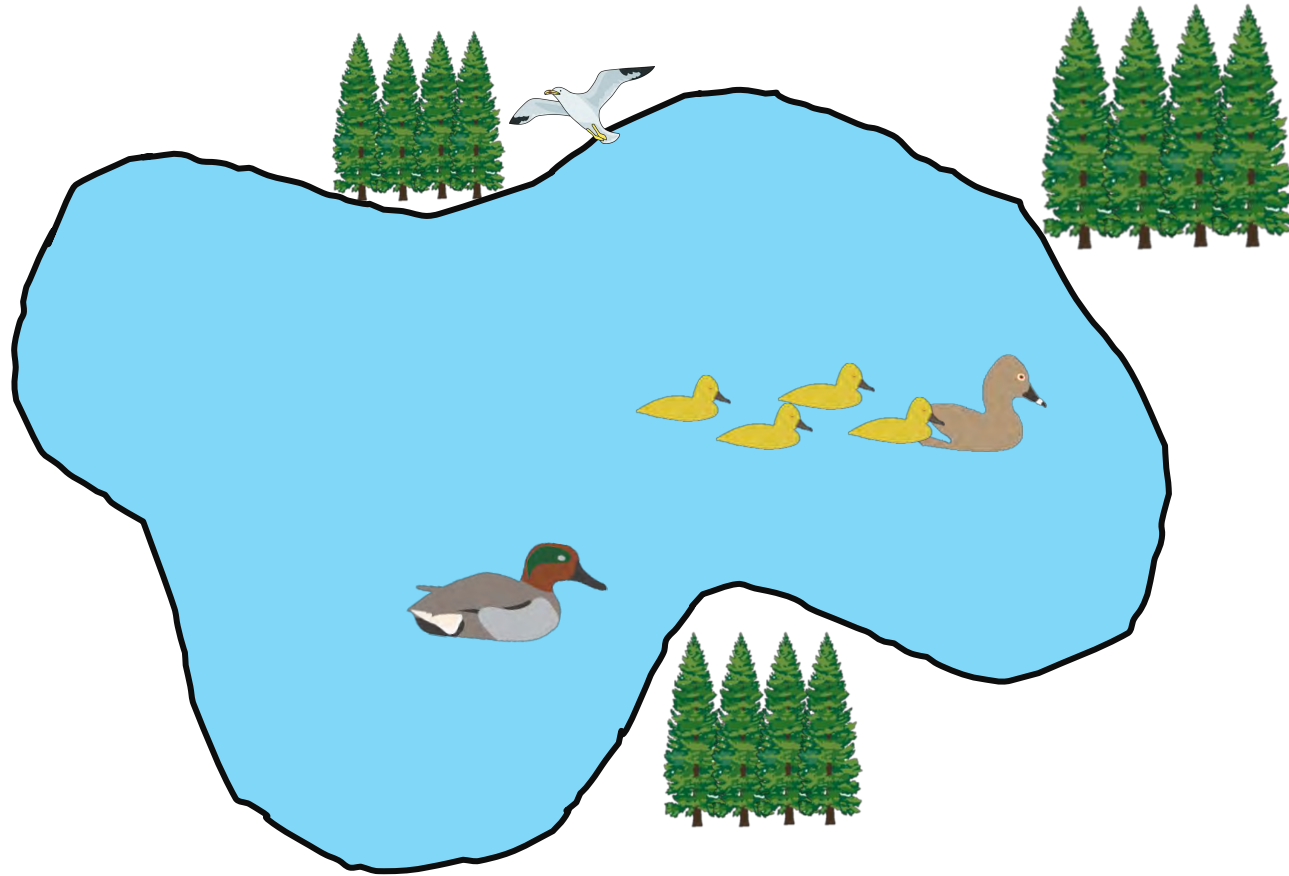
The abundance and diversity of macroinvertebrate will be higher in esker lakes compared to the lakes on clay because of a higher availability of resources and reduced fish predation.

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



U.S. Department of the Interior

# Method



# Experimental design

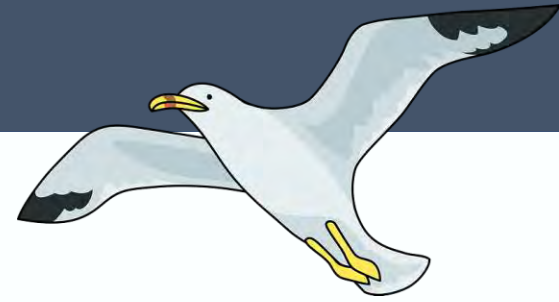
80 Lakes

Size of the lake

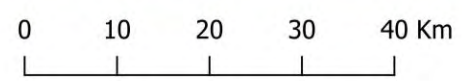
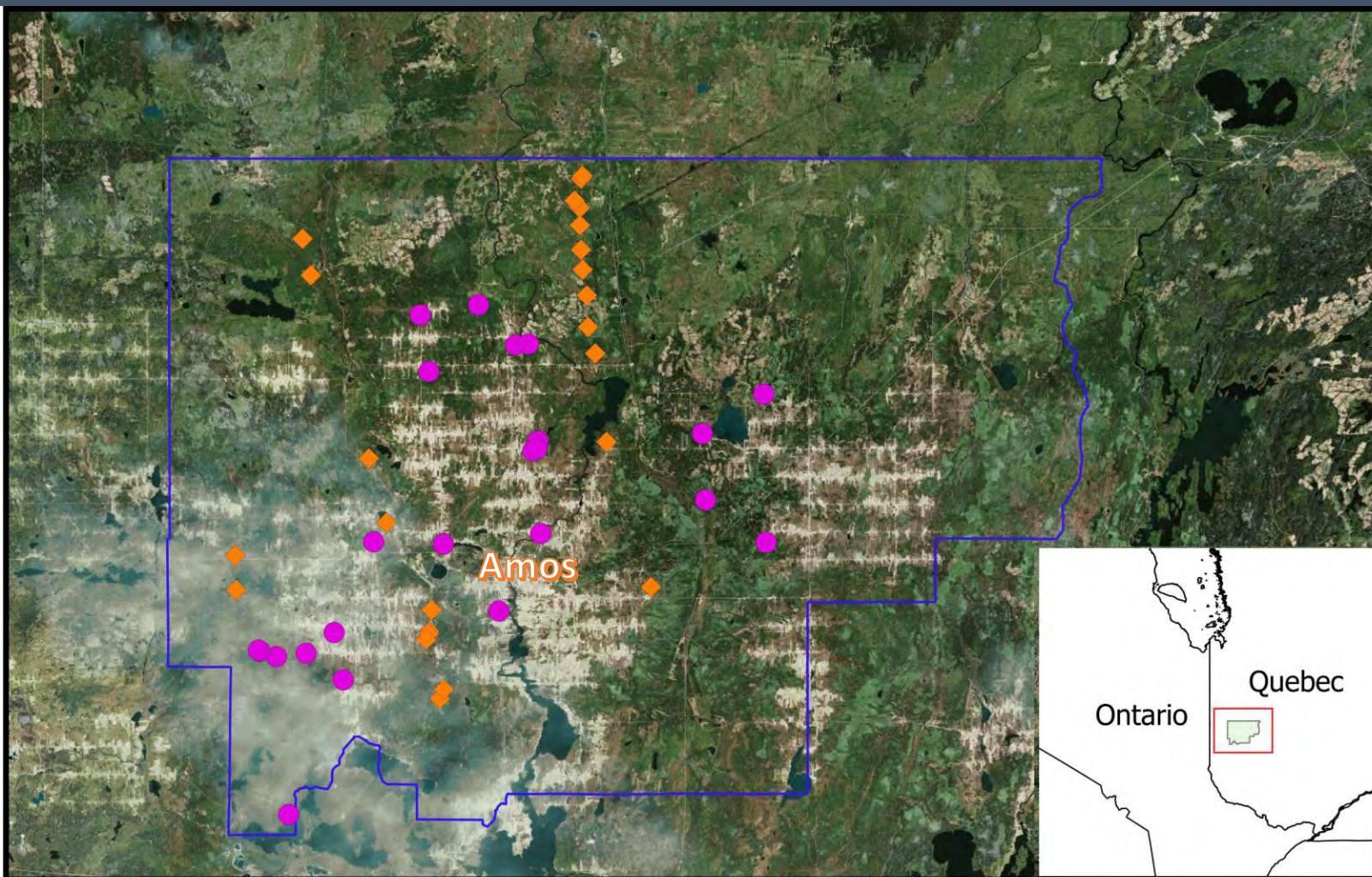
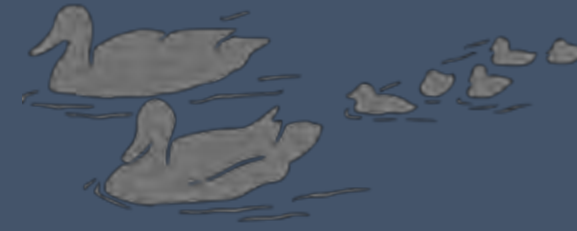
Location of the lake

Logistics

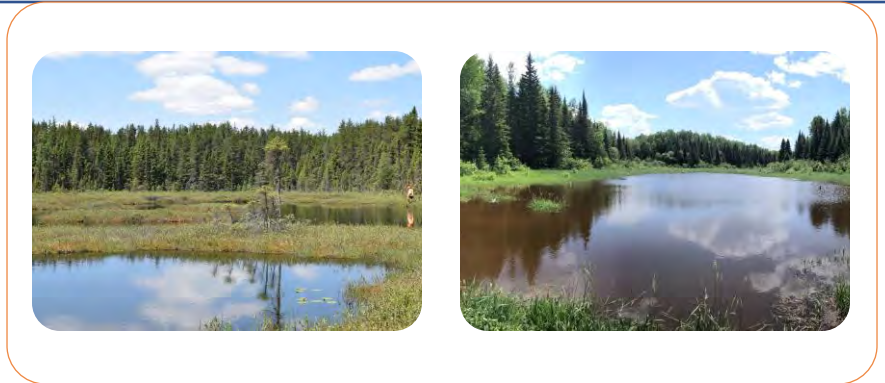
50 Lakes



# Study area



Legend  
◆ Esker Lakes   ● Boreal Lakes   □ MRC Abitibi

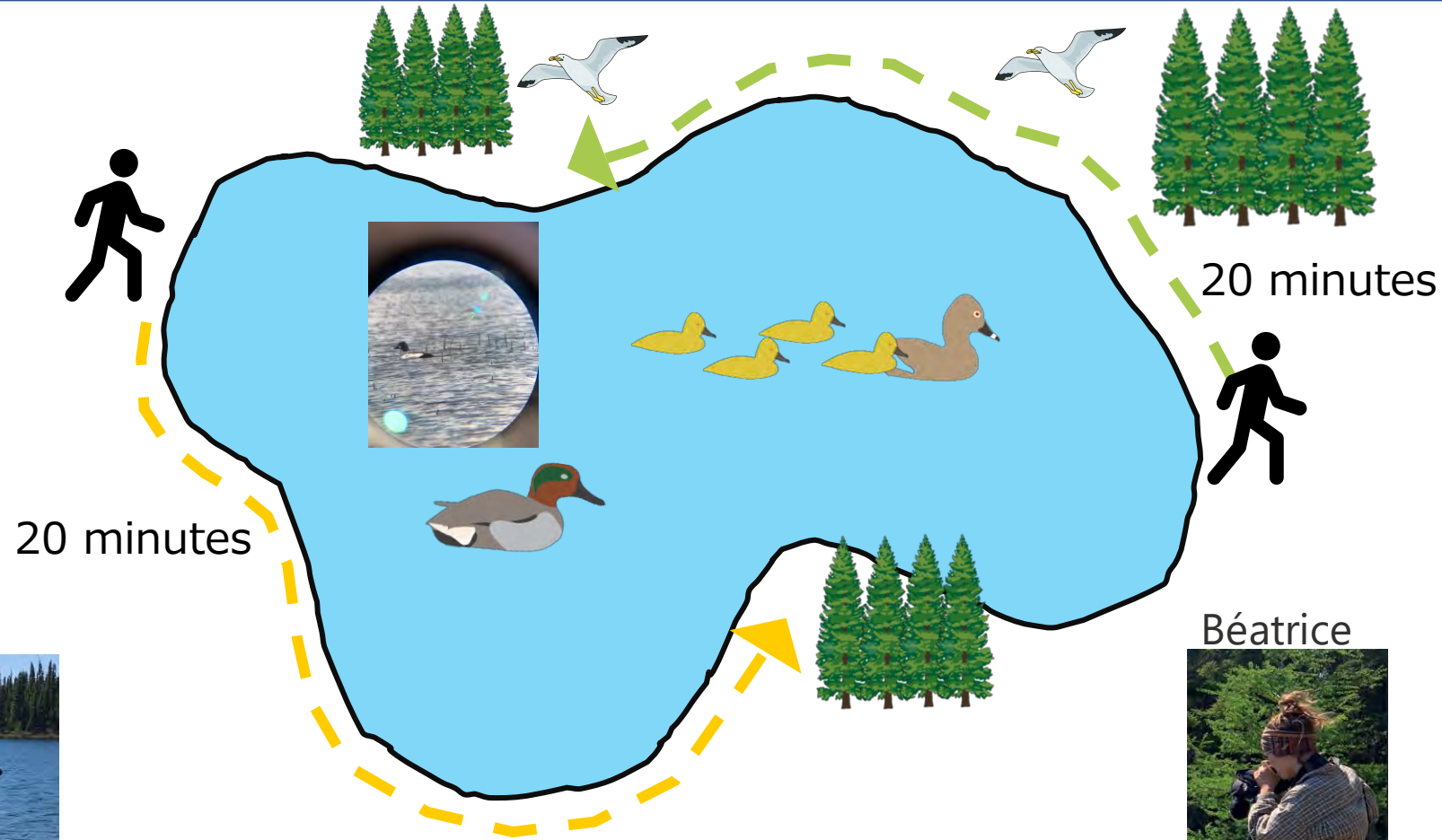


25 Esker lakes

25 Boreal lakes on clay belt



# Waterbird survey



## Survey Time

05:00-  
10:00

Morning

15:00-  
20:00

Afternoon

2 visit per lake

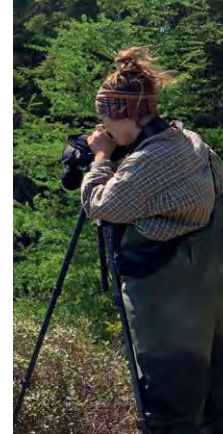
## Waterbird Survey Method

- Point count
- Flush count

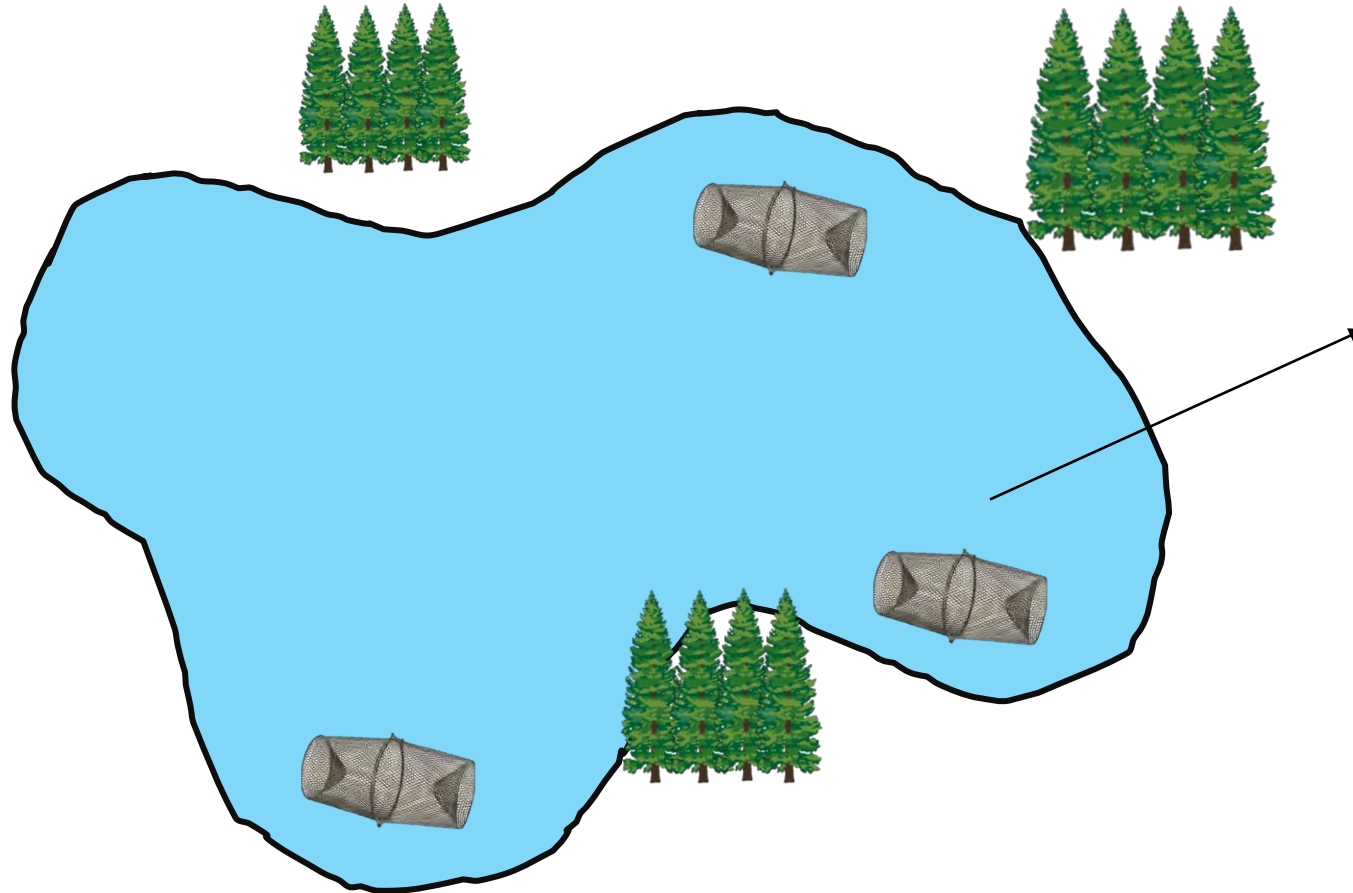
Hugo



Béatrice



# Fish survey



3 minnow traps/lake  
24 hours

Identified 6,406 fish

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

Patrice

# Macroinvertebrate

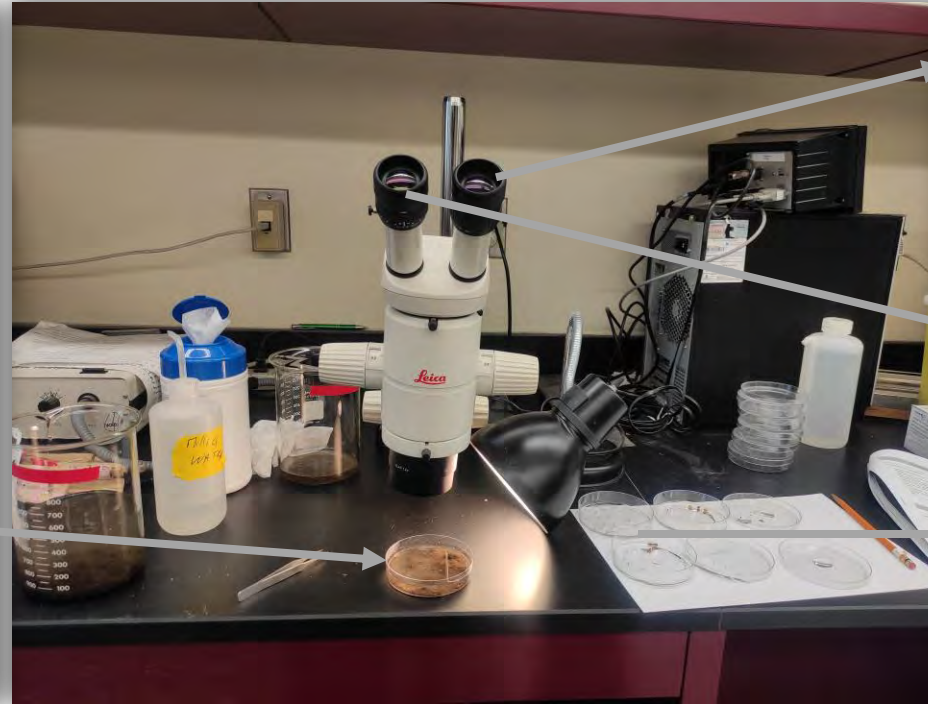
## Collection from the Lake



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

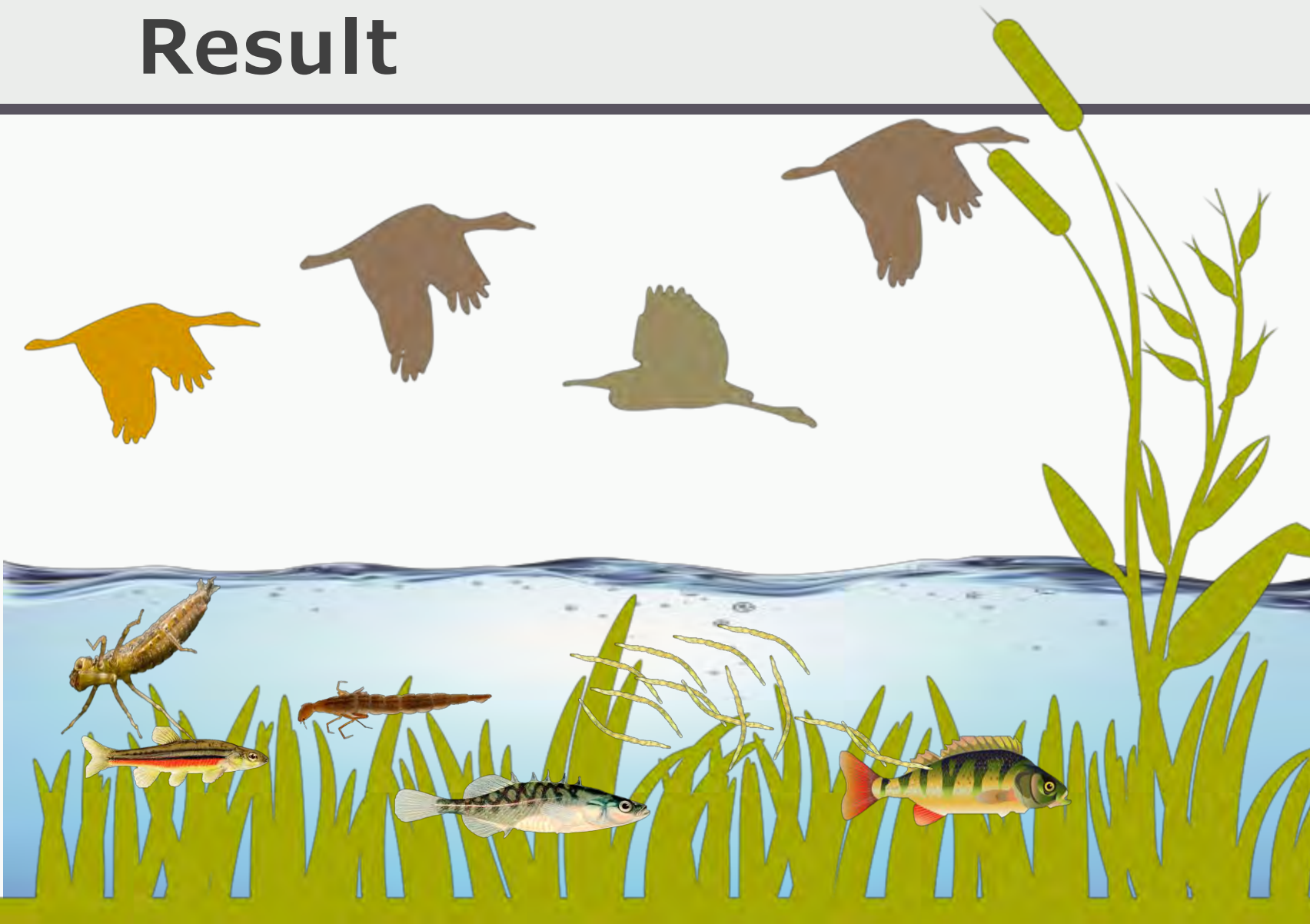
D-frame net (350  $\mu\text{m}$  mesh, surface area = 0.0604  $\text{m}^2$  )

## Extracting each macroinvertebrate



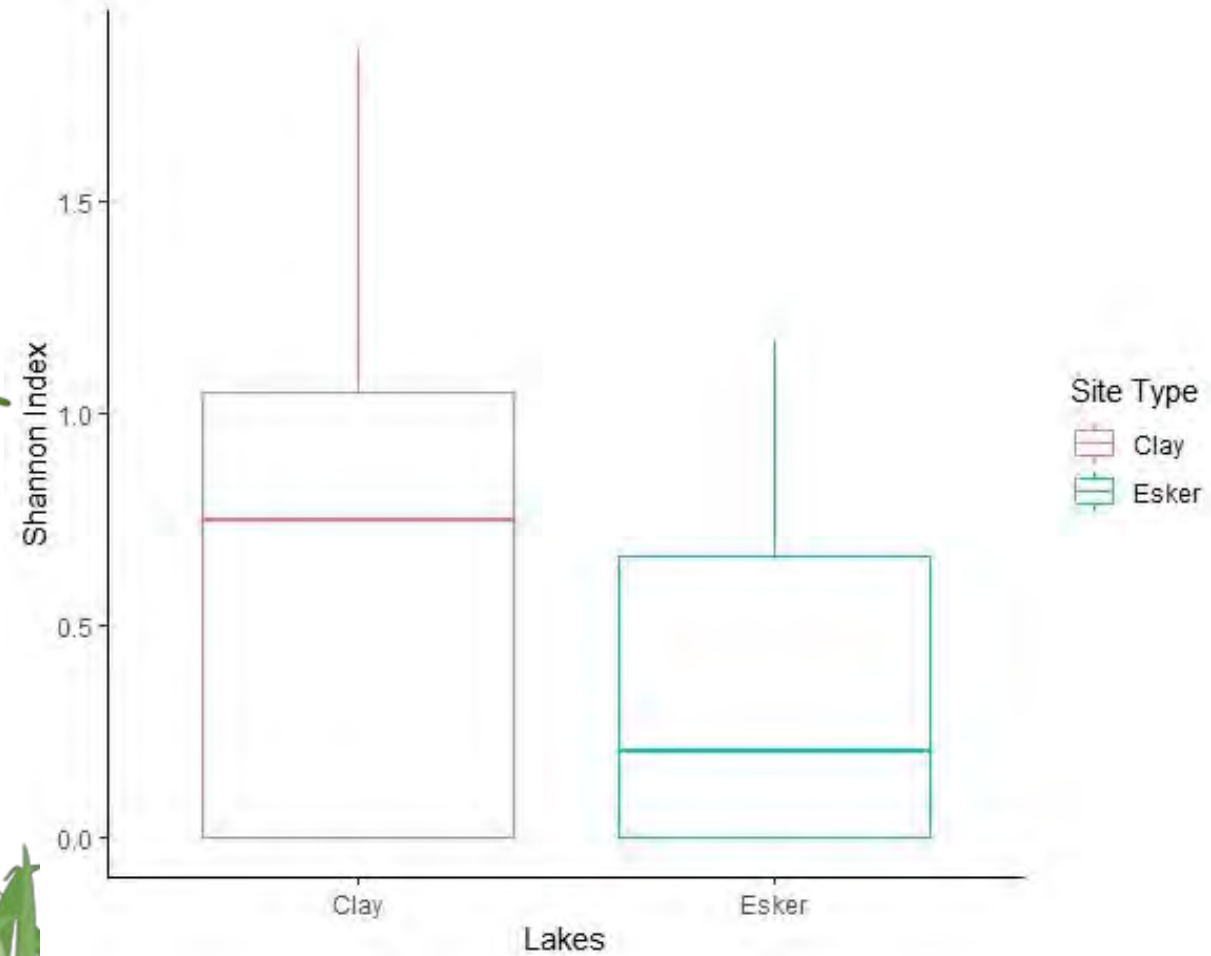
Diptera Larvae (Chironomidae and Ceratopogonidae)

# Result



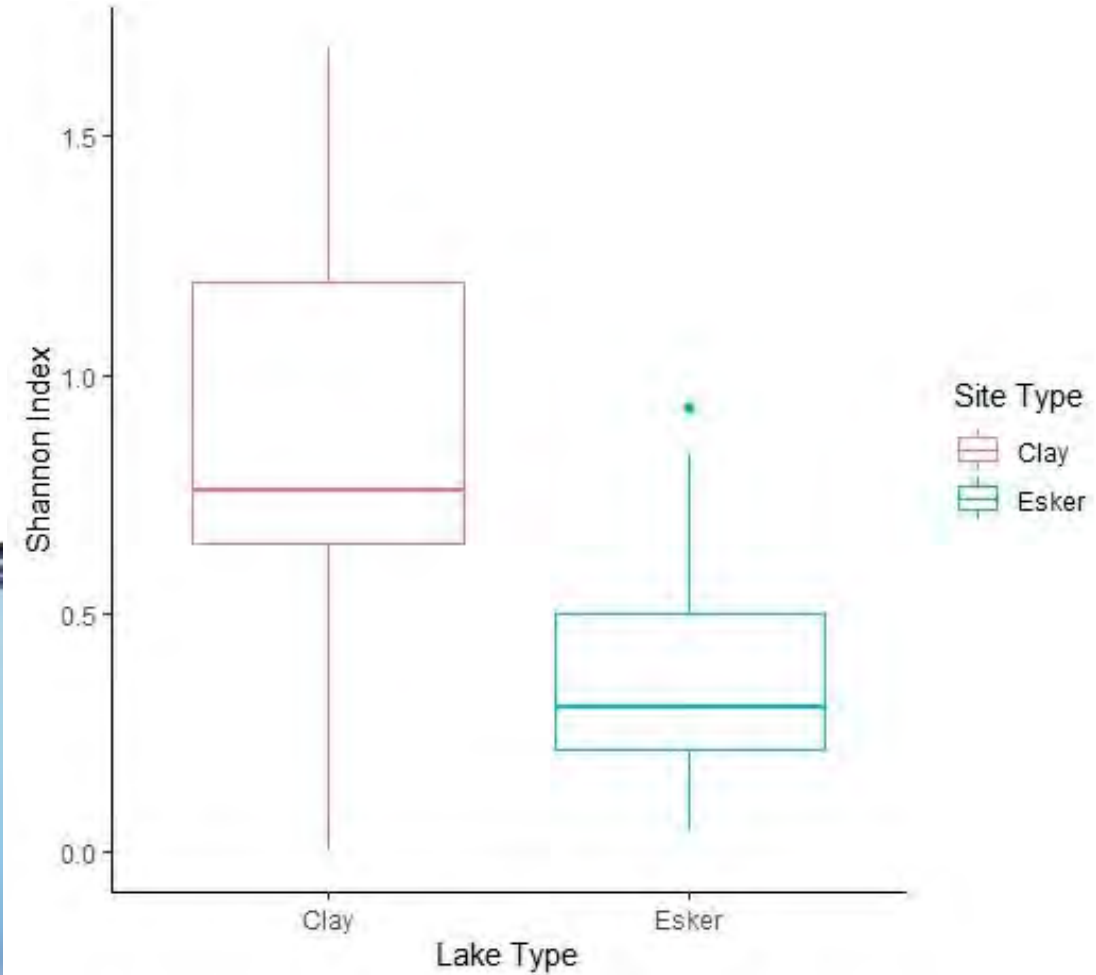
# Waterbird diversity

| Variables                       | Clay        | Esker |
|---------------------------------|-------------|-------|
| Mean Abundance                  | <b>8.96</b> | 8.4   |
| Total Abundance                 | <b>224</b>  | 210   |
| Total Richness                  | <b>13</b>   | 10    |
| Mean Shannon Biodiversity Index | <b>0.45</b> | 0.31  |



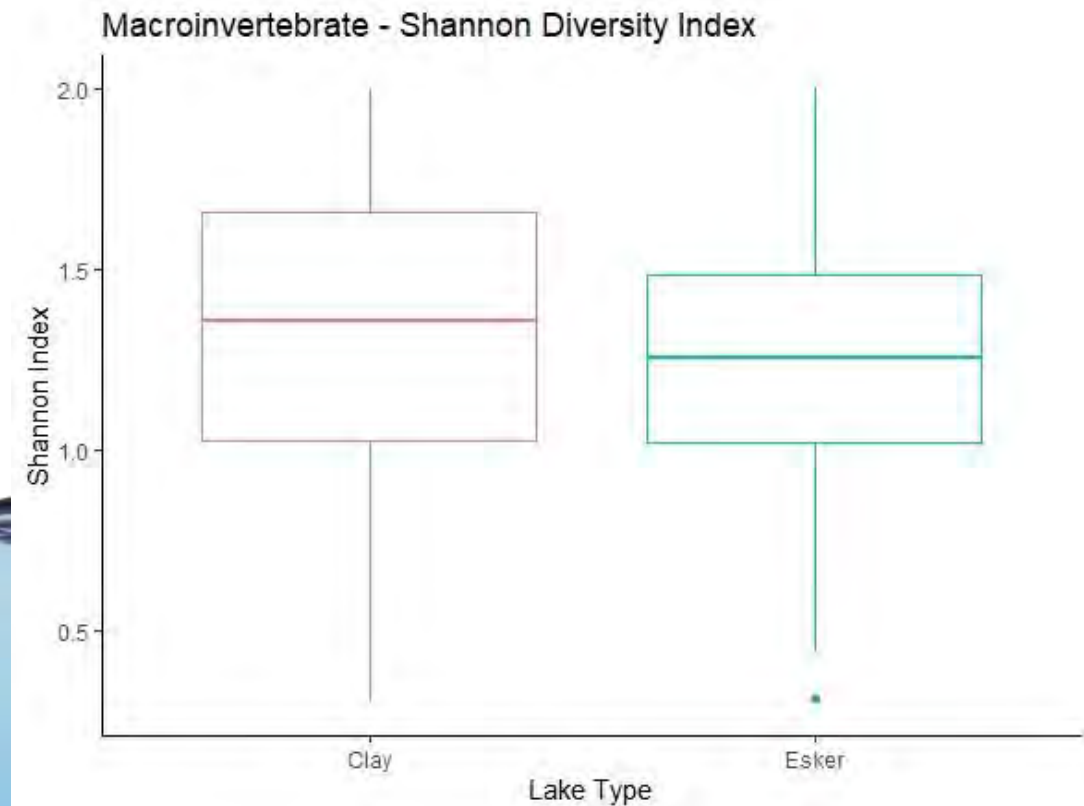
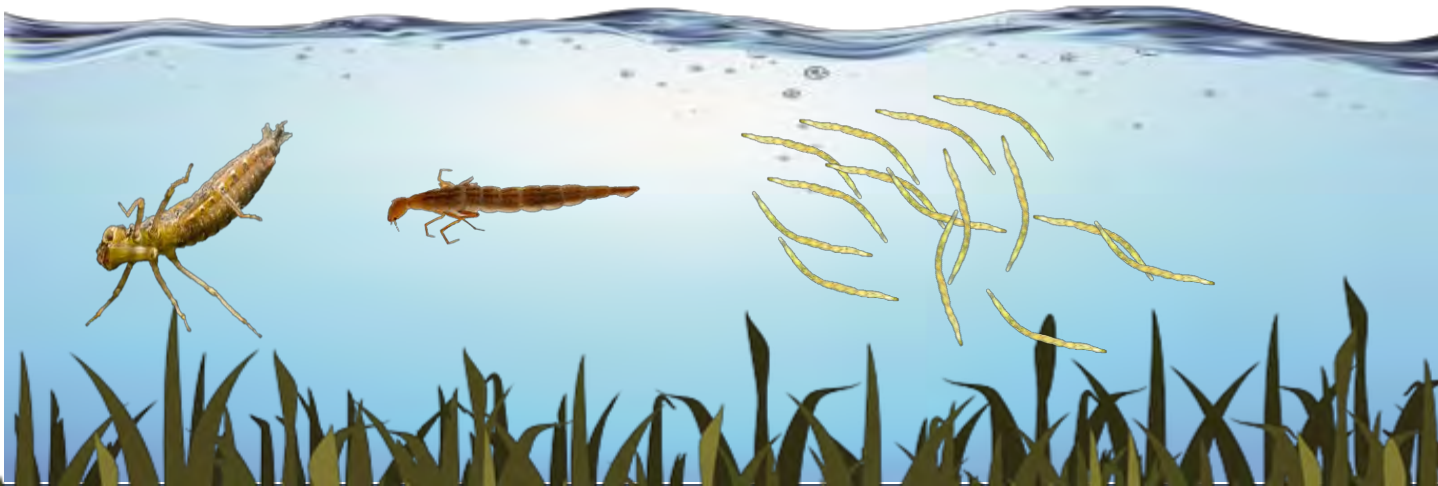
# Fish diversity

| Variables                       | Clay         | Esker    |
|---------------------------------|--------------|----------|
| Mean Abundance                  | <b>210.4</b> | 22.92    |
| Total Abundance                 | <b>5833</b>  | 573      |
| Total Richness                  | <b>8</b>     | <b>9</b> |
| Mean Shannon Biodiversity Index | <b>0.76</b>  | 0.10     |

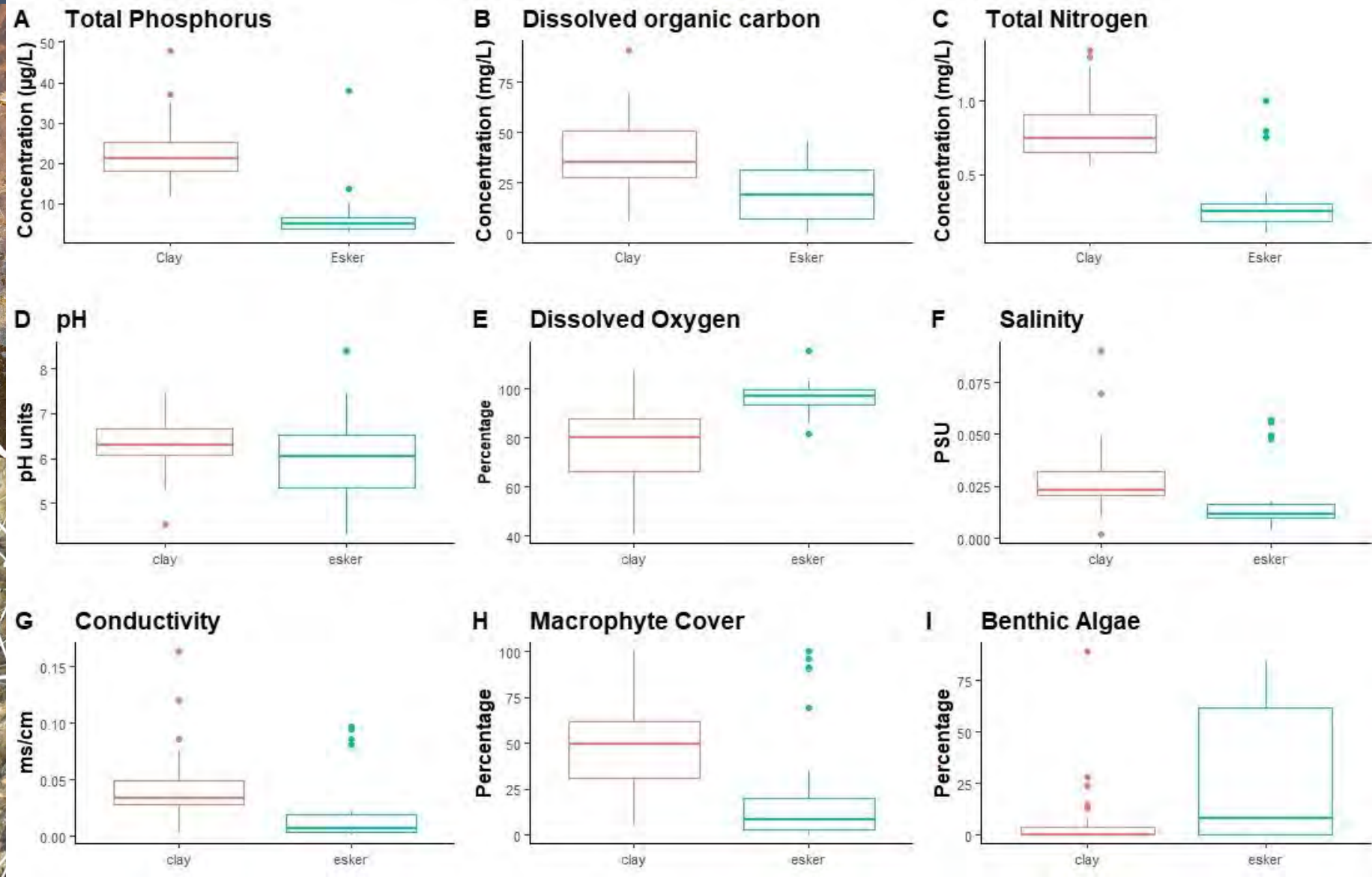


# Macroinvertebrate diversity

| Variables                       | Clay         | Esker  |
|---------------------------------|--------------|--------|
| Mean Abundance                  | <b>164.2</b> | 156.36 |
| Total Abundance                 | <b>4104</b>  | 3909   |
| Mean Richness                   | <b>10.28</b> | 9.48   |
| Mean Shannon Biodiversity Index | <b>1.29</b>  | 1.23   |



# Physicochemical variables





# Effect of physiochemical variables on waterbird richness



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

# Indicator waterbirds – esker lakes



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



Canada Goose  
Bernache du Canada  
*Branta canadensis*  
 $p = 0.031$



# Indicator waterbirds – clay lakes



Ring necked duck  
Fuligule à collier  
*Aythya collaris*  
 $p = 0.020$



Hooded Merganser  
Harle couronne  
*Lophodytes cucullatus*

$p = 0.021$



# 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



Stoneflies

Perlidae  
 $p = 0.003$



Damselflies

Calopterygidae  
 $p = 0.035$



# Indicator macroinvertebrate – clay lake



Dytiscidae  
P value = 0.009



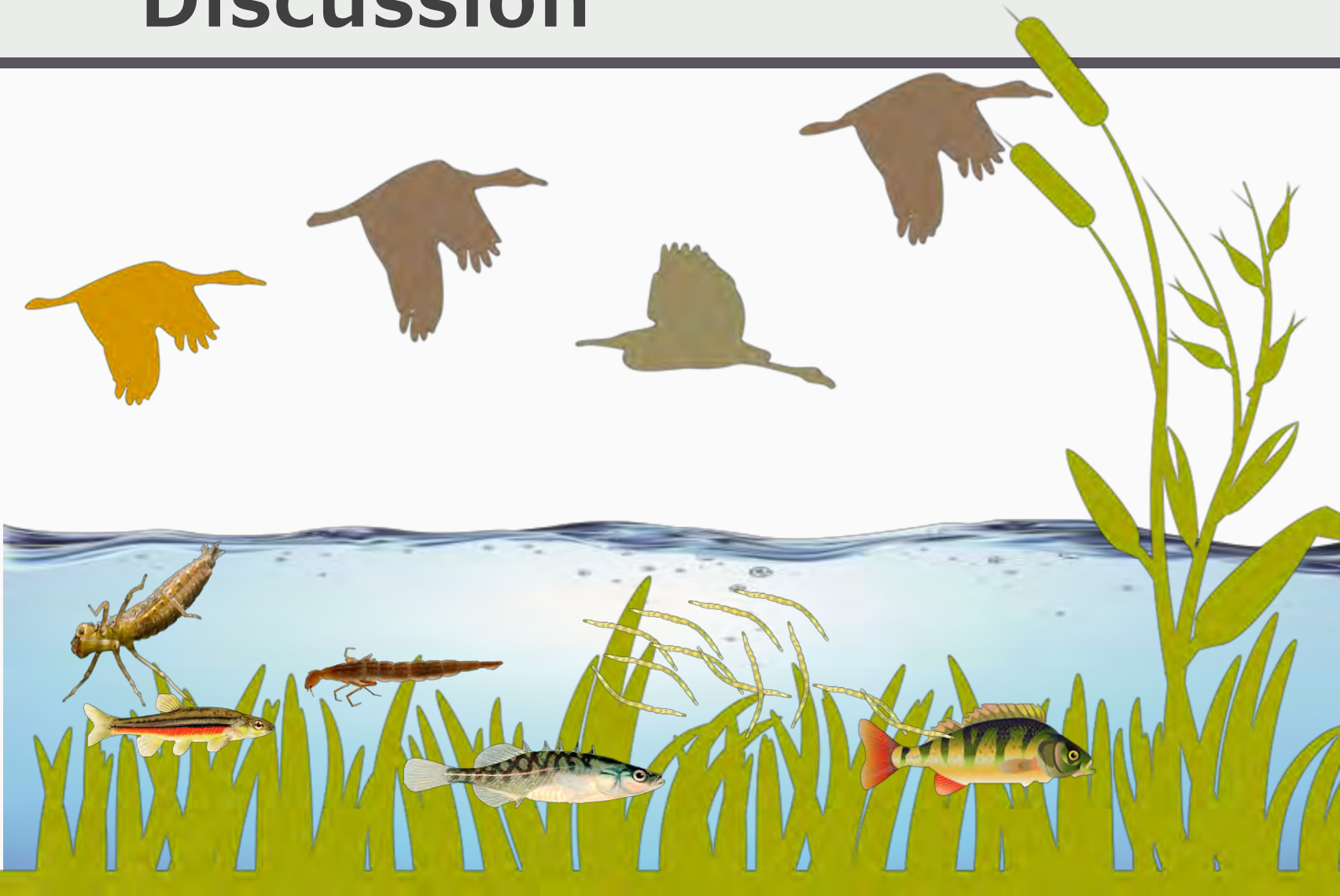
Elmidae  
P value = 0.039

Coleoptera Order



Belostomatidae  
P value = 0.036

# Discussion



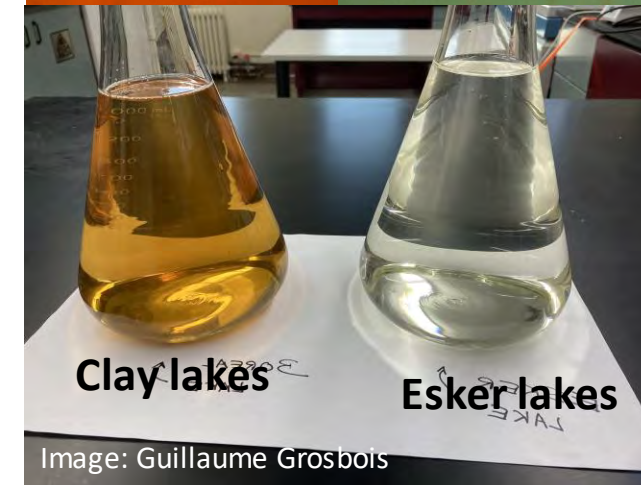
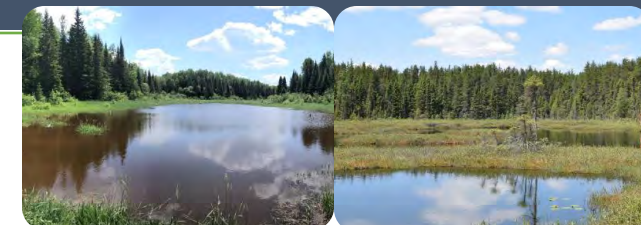
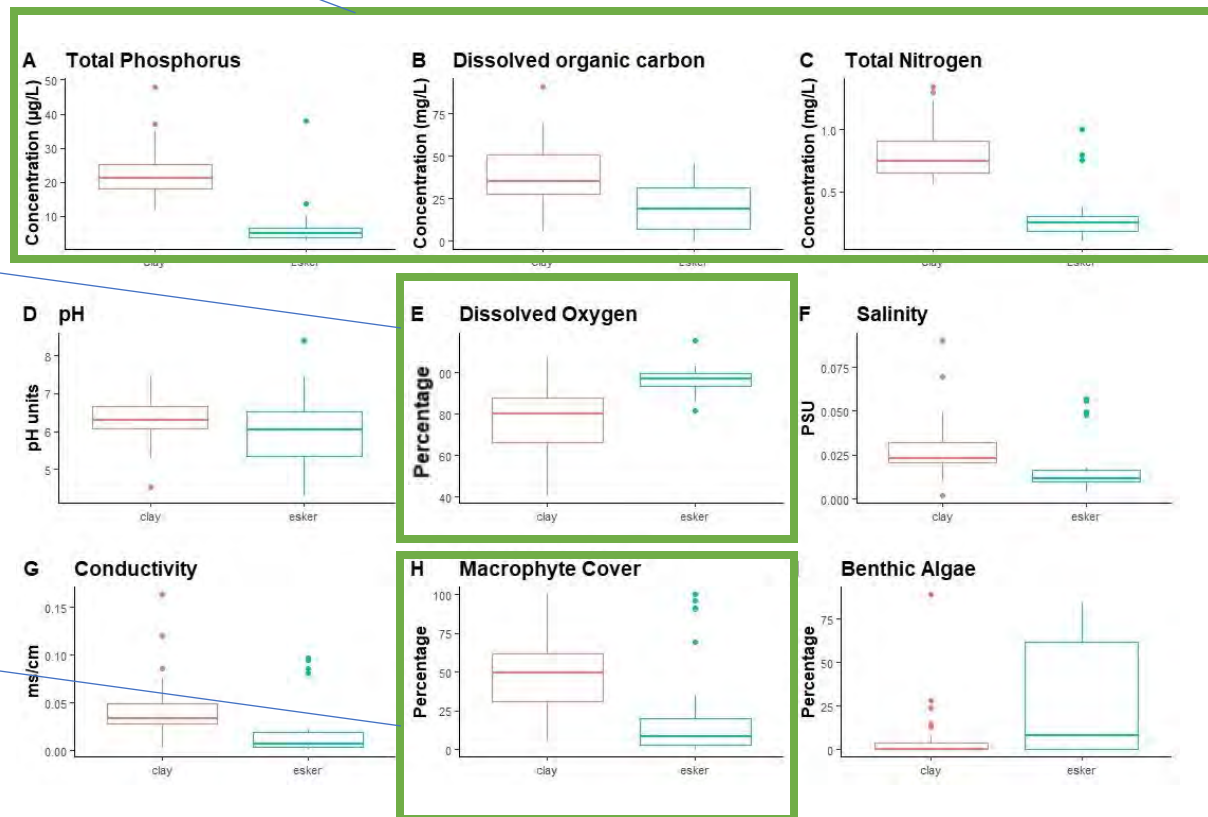


# Discussion – esker vs clay lakes

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**

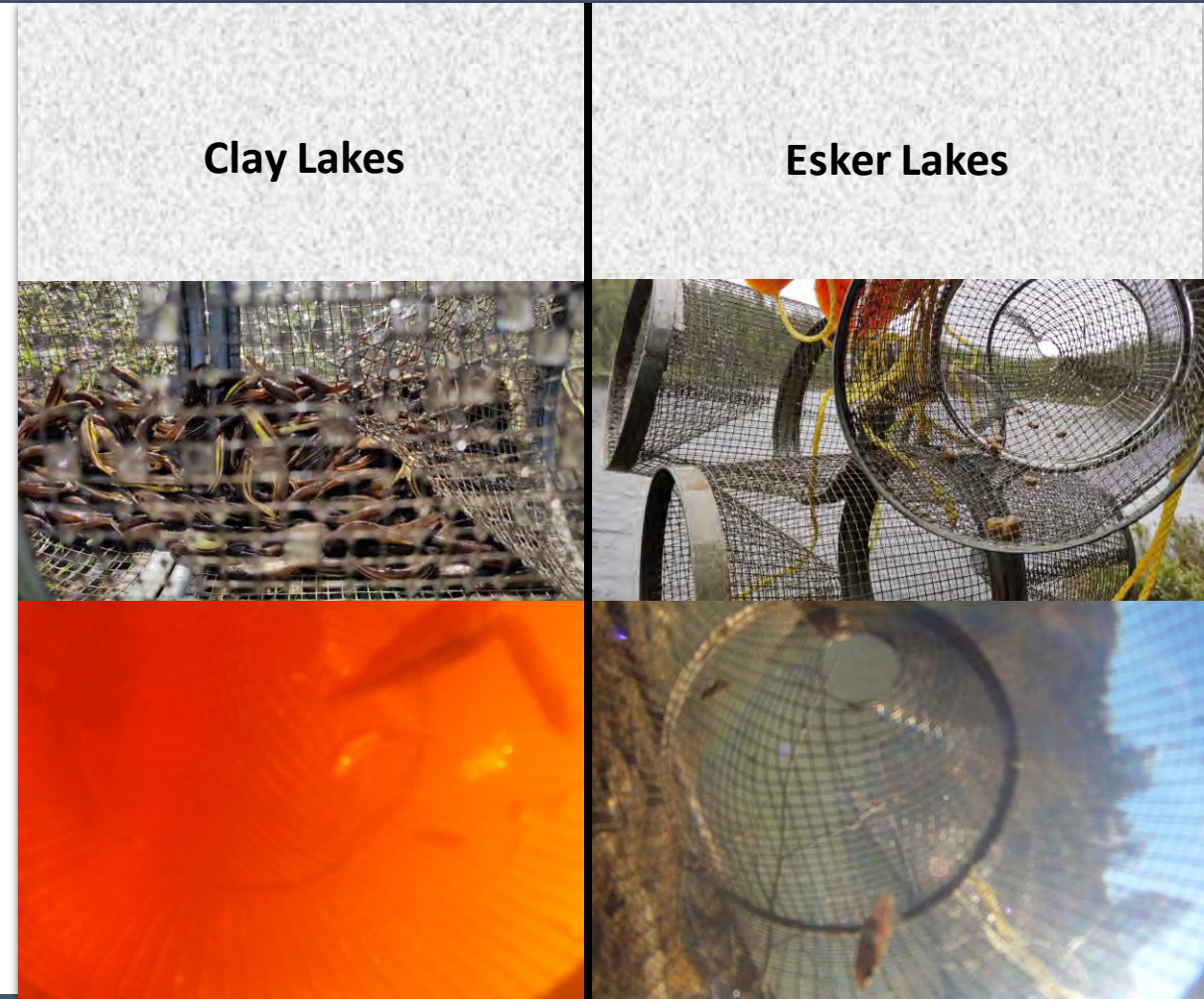
- During breeding season Common Goldeneye prefer fishless lakes (Eriksson 1979).

Common Goldeneye  
 $p = 0.049$



# 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



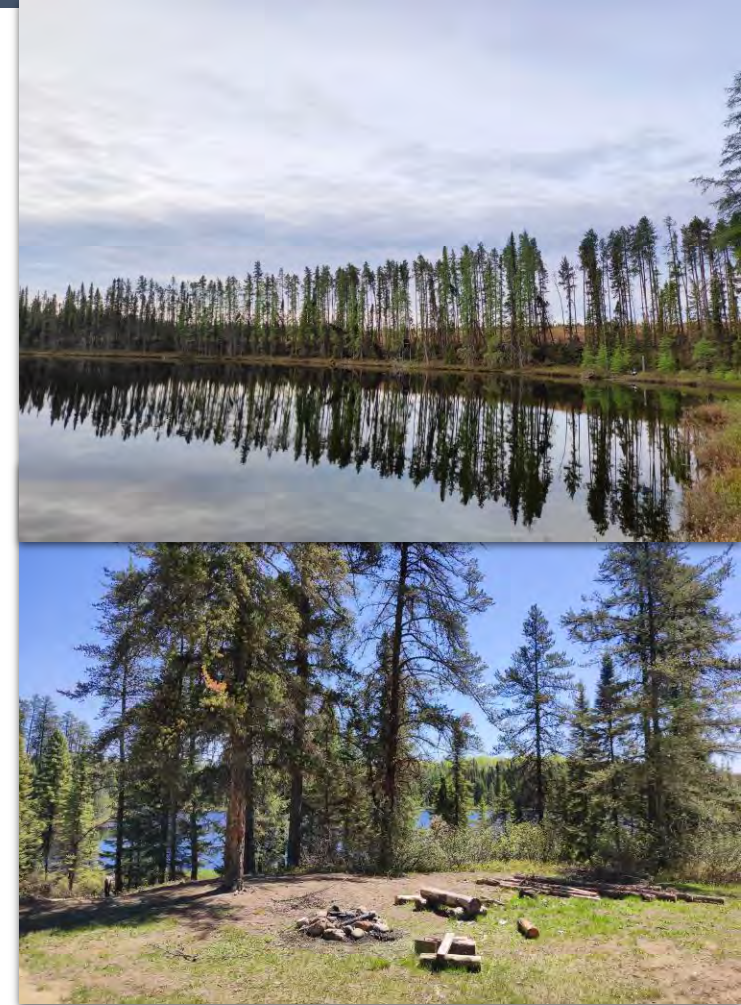
# Discussion – Macroinvertebrate

- 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



# 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

## Supervisors

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## Collaborators

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- Anoj Subedi
- Sanghyun Kim
- Hengyi Bai

# Reference

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