ABIOTIC FACTORS INFLUENCING ZOOPLANKTON COMMUNITY STRUCTURE IN SMALL ARCTIC LAKES

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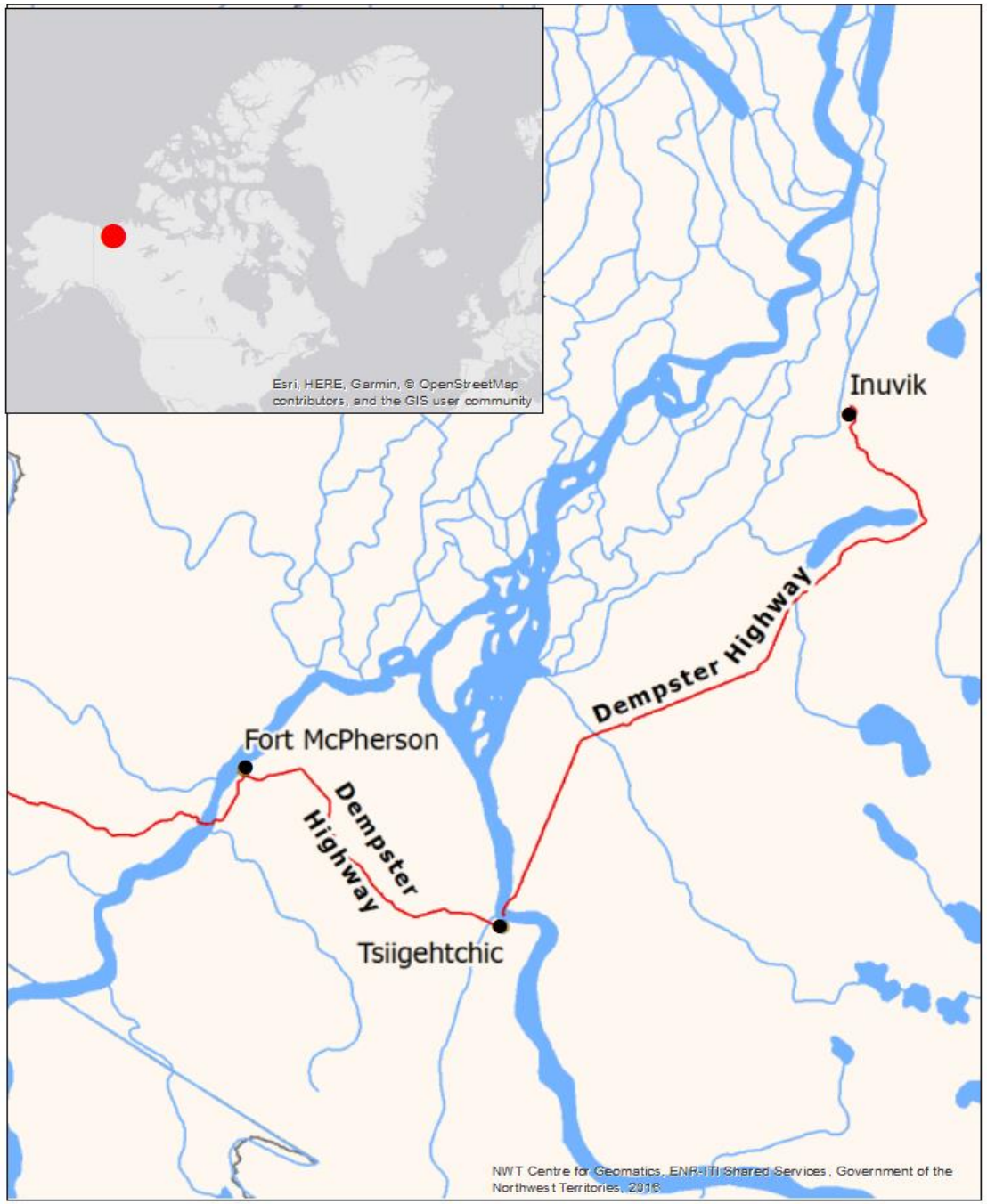
Introduction

- Gwich'in Settlement Area (GSA), Northwest Territories
- Stressors:
  - Climate Change
  - Increased Development



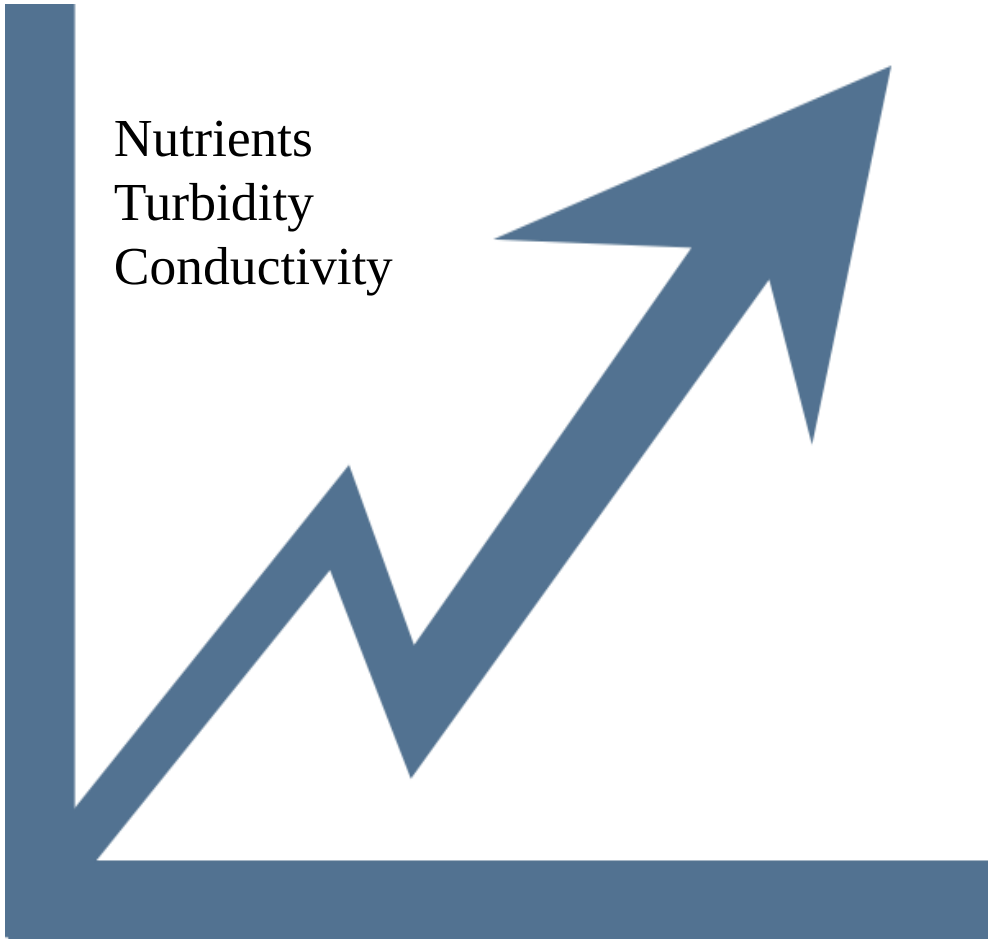
Introduction: Climate Change

Climate change is a threat to the Gwich'in community through changes in:[1]

- Precipitation patterns
- Thinning of ice
- **Permafrost thaw**

Climate change is also impacting:[1,2]

- Local water supplies
- Frequently used transportation routes



There is a need to monitor, mitigate and predict impacts of climate change to help preserve the Gwich'in social, cultural and ecological values[1,2]

Introduction: Increased Development

- Main south-north transportation corridor runs between Fort McPherson and Tuktoyaktuk
  - Dempster Highway
  - Inuvik-Tuktoyaktuk Highway
- Influence on water chemistry and roadside ecosystems due to increased road dust from calcareous gravel roads[3]

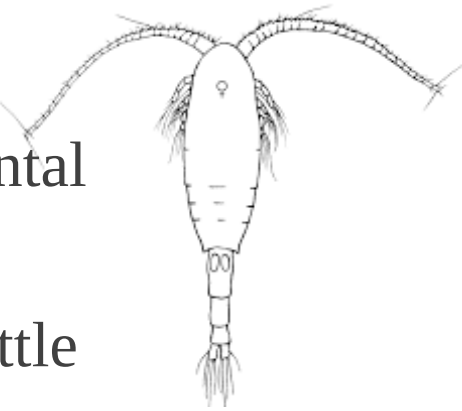
Gunter (2017) → Alkalinity, conductivity, total dissolved solids (TDS), pH, calcium, magnesium, nitrate, sulfate and strontium decreased with distance from the highway

Introduction: Zooplankton Communities

- Many are grazers allowing for the transfer of energy from primary producers to larger organisms such as macroinvertebrates and fish
- Abundant, diverse, and easy to collect
- Changes in abiotic conditions have the potential to alter the structure of zooplankton communities and cause shifts in species composition[4]

http://cfb.unh.edu/cfbkey/html/begin.html

Introduction: Zooplankton Communities in the GSA



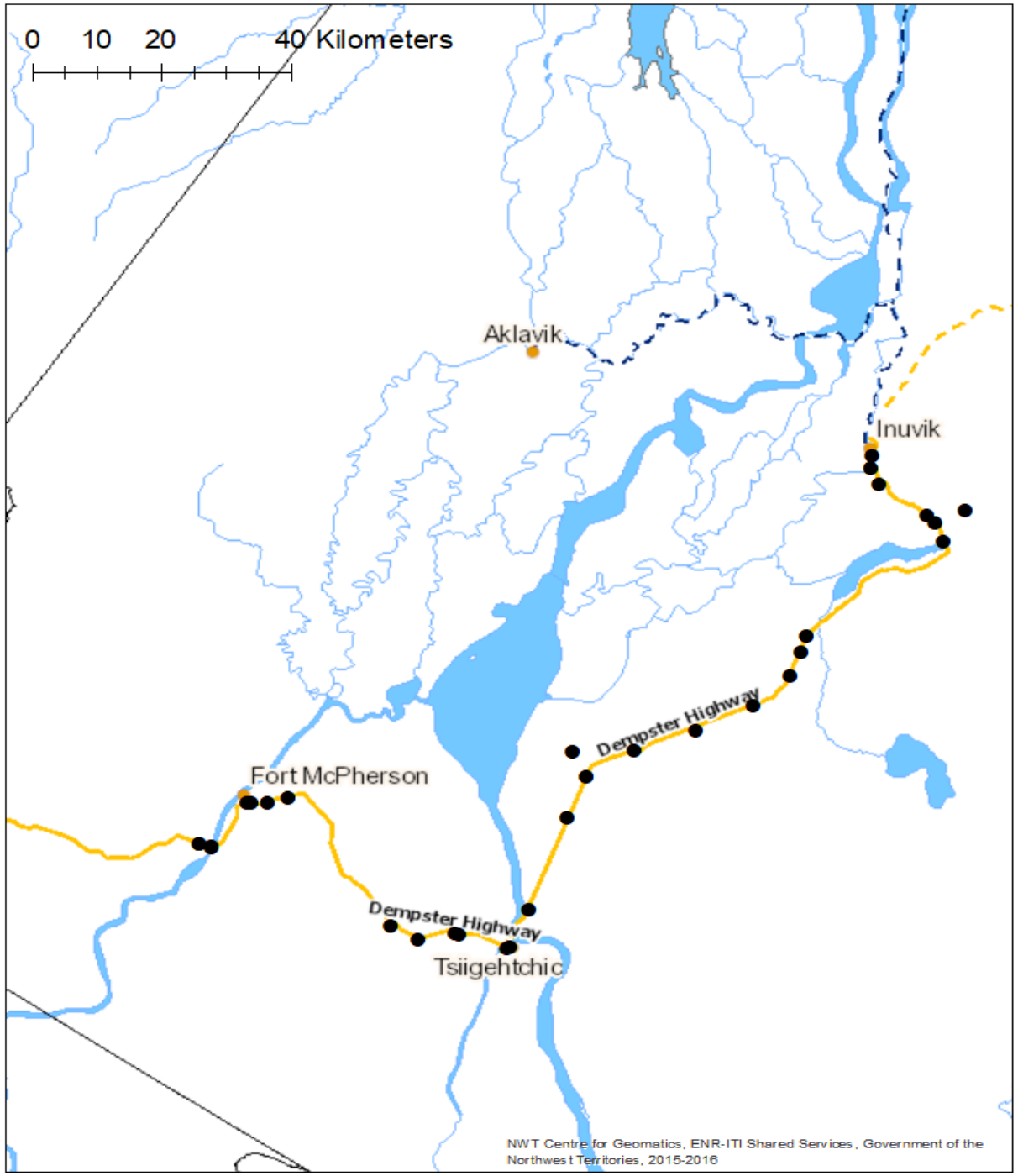
- Zooplankton diversity will be limited by both dispersal and environmental conditions
- Low productivity and extended periods with ice cover that allow for little movement of individuals among lakes[5]
- In Gwich'in and Inuvialuit lakes species richness may be low with few species having the opportunity for colonization
- Zooplankton species capable of high dispersal rates, are able to withstand shifts in water chemistry and extreme temperatures will be most successful in these Arctic lakes[5]

Objectives

1. Collect baseline data on water chemistry and zooplankton communities for lakes along the Dempster Highway in the GSA
2. Describe variability in water quality and water chemistry for lakes along the Dempster Highway in the GSA
3. Develop statistical models to identify the main factors that influence zooplankton community structure in these lakes

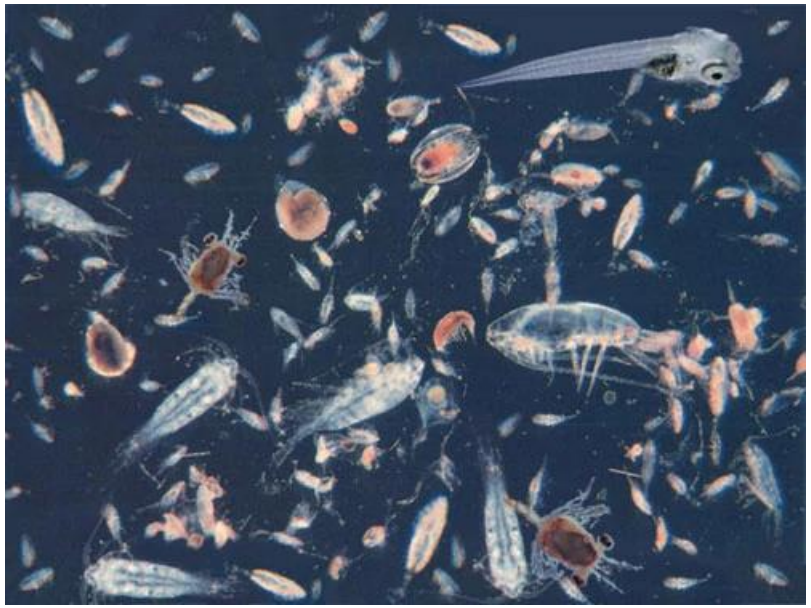
Methods: Study Site

- Study will be conducted along the main transportation corridor in the NWT
- Why GSA?
  - Sensitive to changes in climate
  - Experiencing permafrost degradation
  - Lack of research in area



Methods: Objective 1

- Survey small-to-medium sized lakes (<100ha) along the highway and collect morphometric, biological and water quality data



http://uncyclopedia.wikia.com/wiki/File:Zooplankton.jpeg

Objective 1: Methods for Collection of Water Quality and Morphometric Variables

Data Type	Methodology	Notes
Lake Depth Profile	Humminbird chart plotter in combination with Reefmaster bathymetry software (Reefmaster Ltd.).	Will provide data on mean depth and maximum depth
Secchi Depth	Secchi Disk	Determined as the depth mid-way between where the disc first disappears on descent and then reappears with recovery
Water Chemistry	Shimadzu TOC-LCPH, ICP-OES	Analysis includes: TN, NPOC and a suite of 33 elements
pH, Conductivity, Dissolved Oxygen, Temperature, Chlorophyll-*a*, Turbidity	A Multiparameter Probe will be used to take depth profiles at deepest point on lake	Deployed from boat

Objective 1: Methods of Collection for Biological Data

- Zooplankton samples collected at a point of max depth
- 35-cm diameter, 50-µm mesh size zooplankton net will be used to collected samples
- A mechanical flowmeter attached to the mouth of the net to determine the amount of water that passes through the net

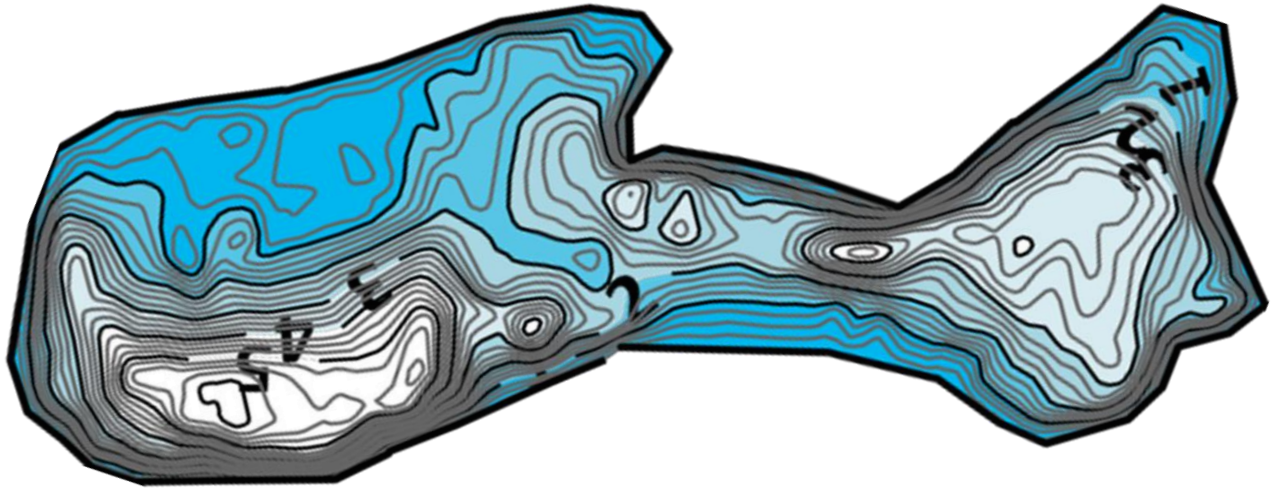
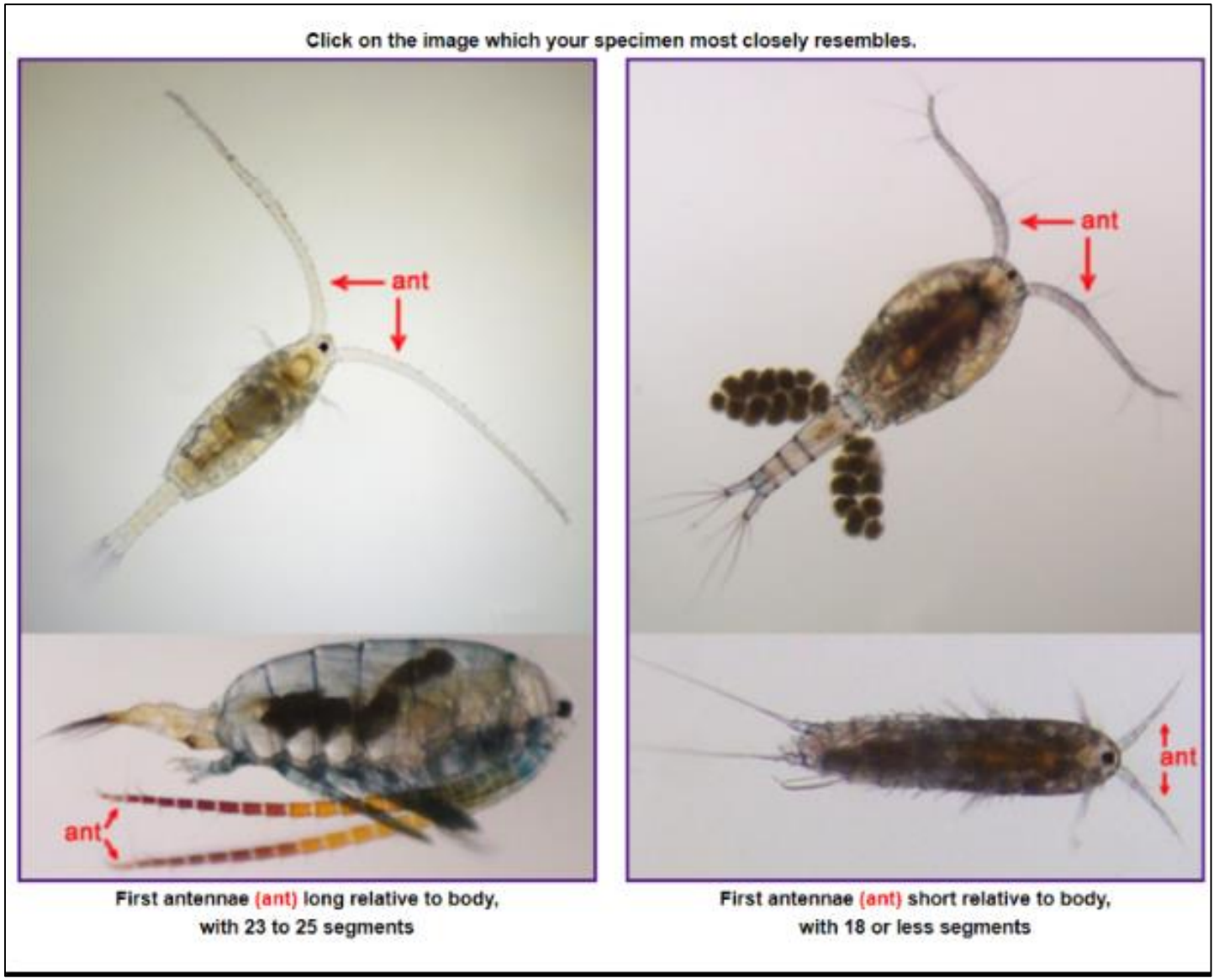


Photo By: Derek Gray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First antennae (ant) long relative to body, with 23 to 25 segments
First antennae (ant) short relative to body, with 18 or less segments

Methods: Objectives 2 & 3

- Principal Components Analysis to understand the variability in water quality and water chemistry for lakes along the transportation corridor

- Redundancy Analysis to identify the morphometric and water quality variables that structure zooplankton communities

  Response Variables → Zooplankton

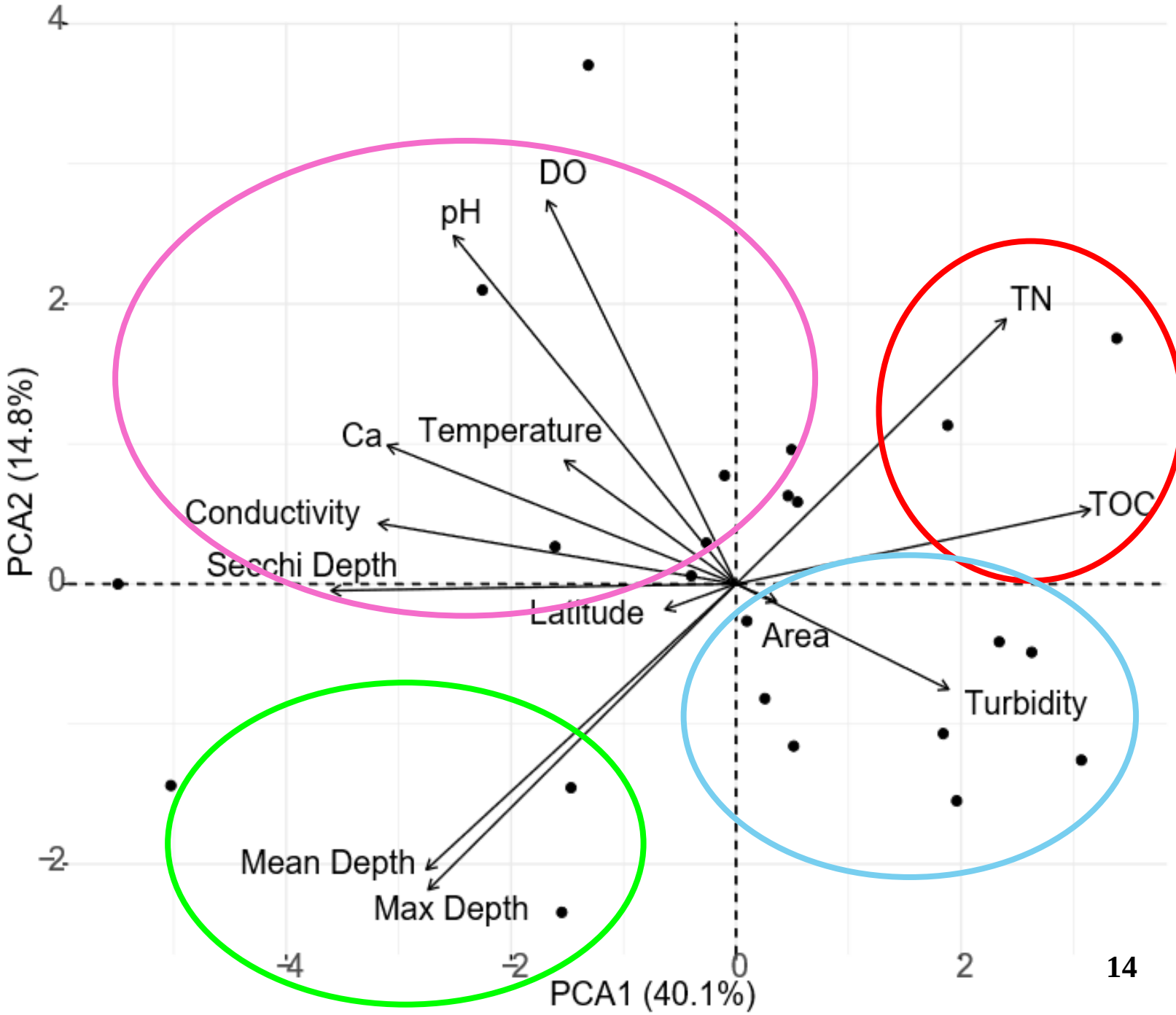
  Predictor Variables → Spatial, TN, DO, Conductivity, Elemental Analysis, pH, Temperature, Mean Depth, Turbidity, etc.

- Multiple Regression to determine which variables most influence richness, diversity and evenness

Results – Water Quality

4 groups:

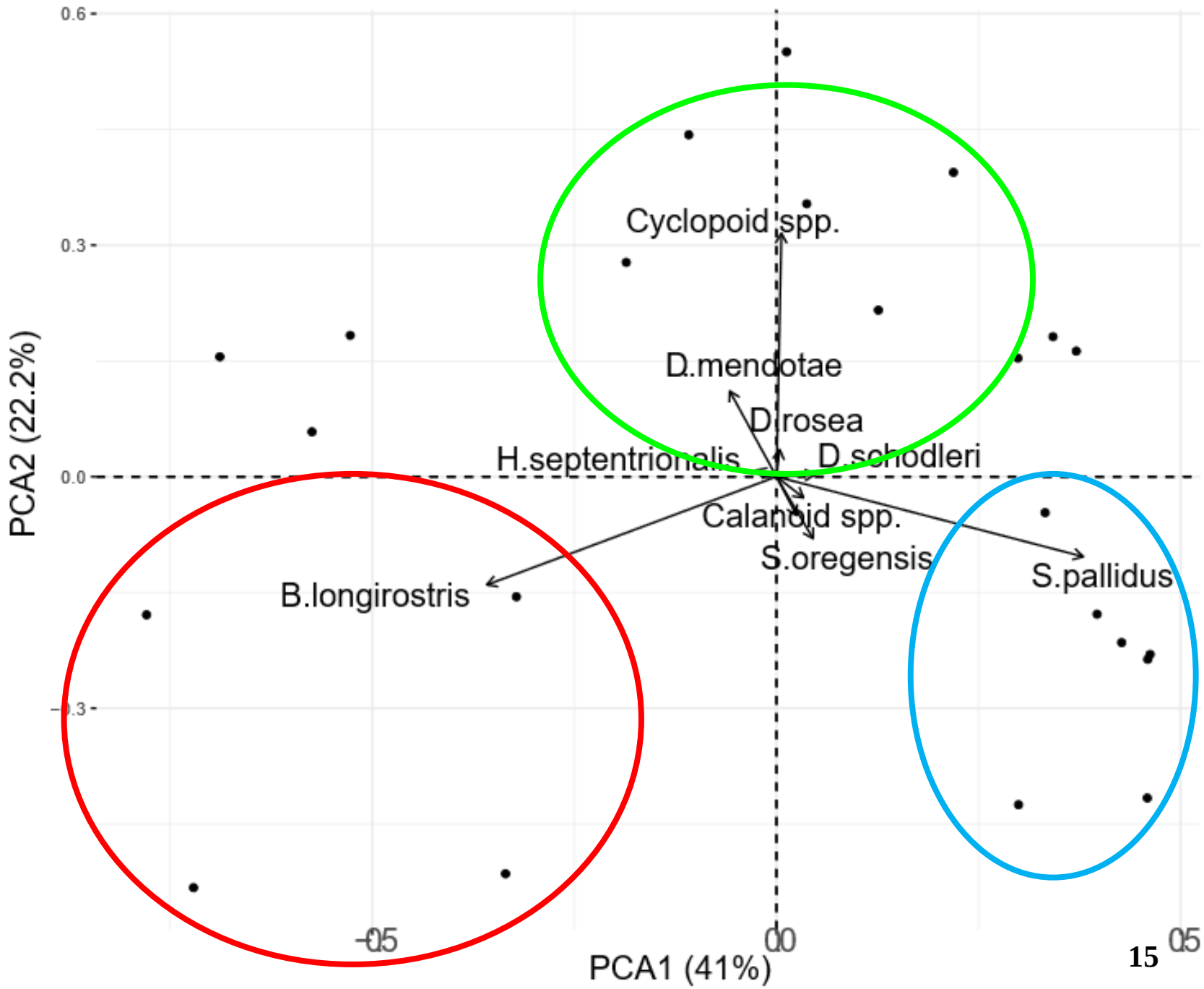
1. TN and TOC
2. Area and Turbidity
3. Mean and Max Depth
4. DO, pH, Temperature, Ca, Conductivity, Secchi



Results – Zooplankton

3 groups:

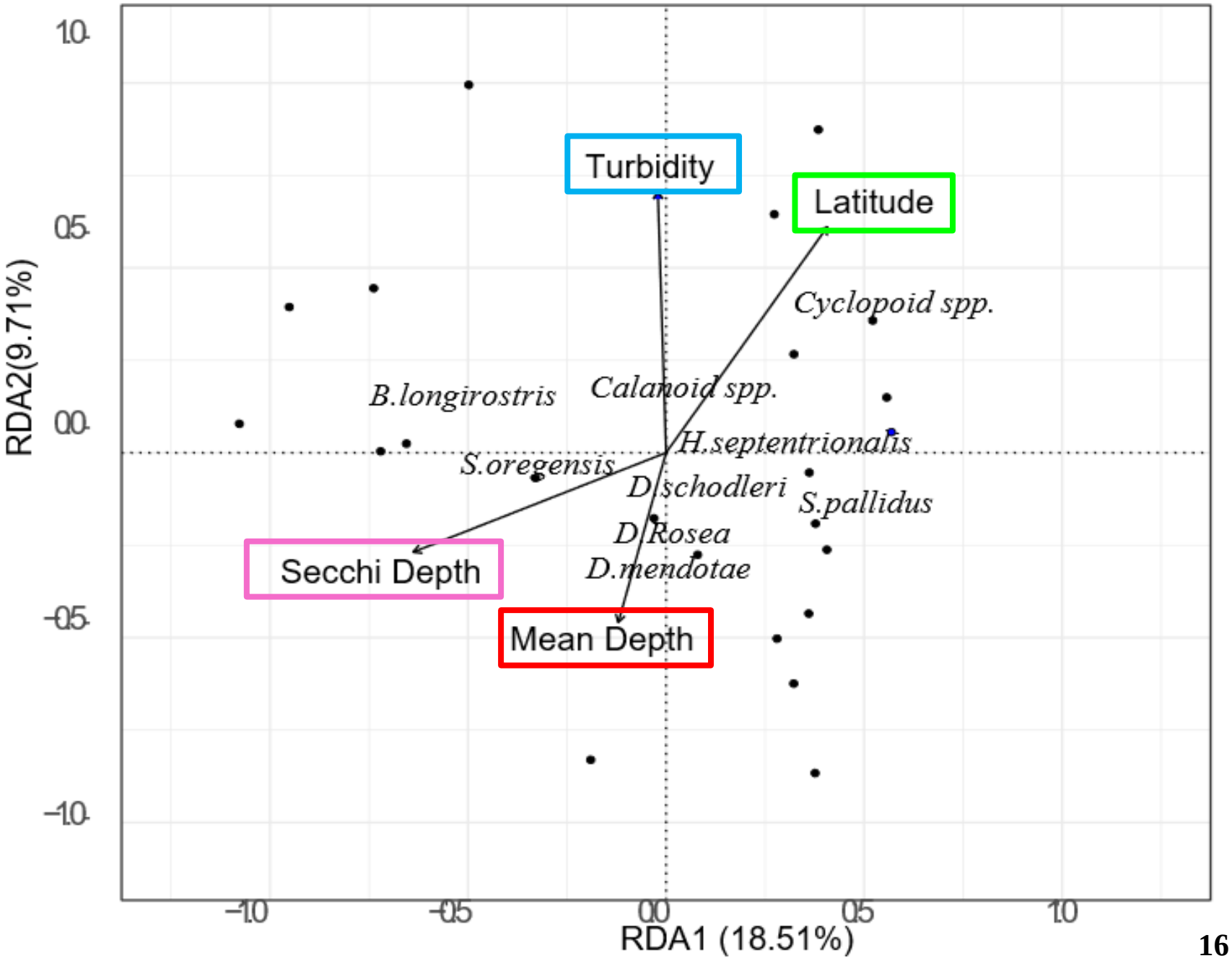
1. *Bosmina longirostris*
2. *Skistodiaptomus pallidus*
3. *Cyclopoid spp. and Daphnia spp.*



Results - RDA

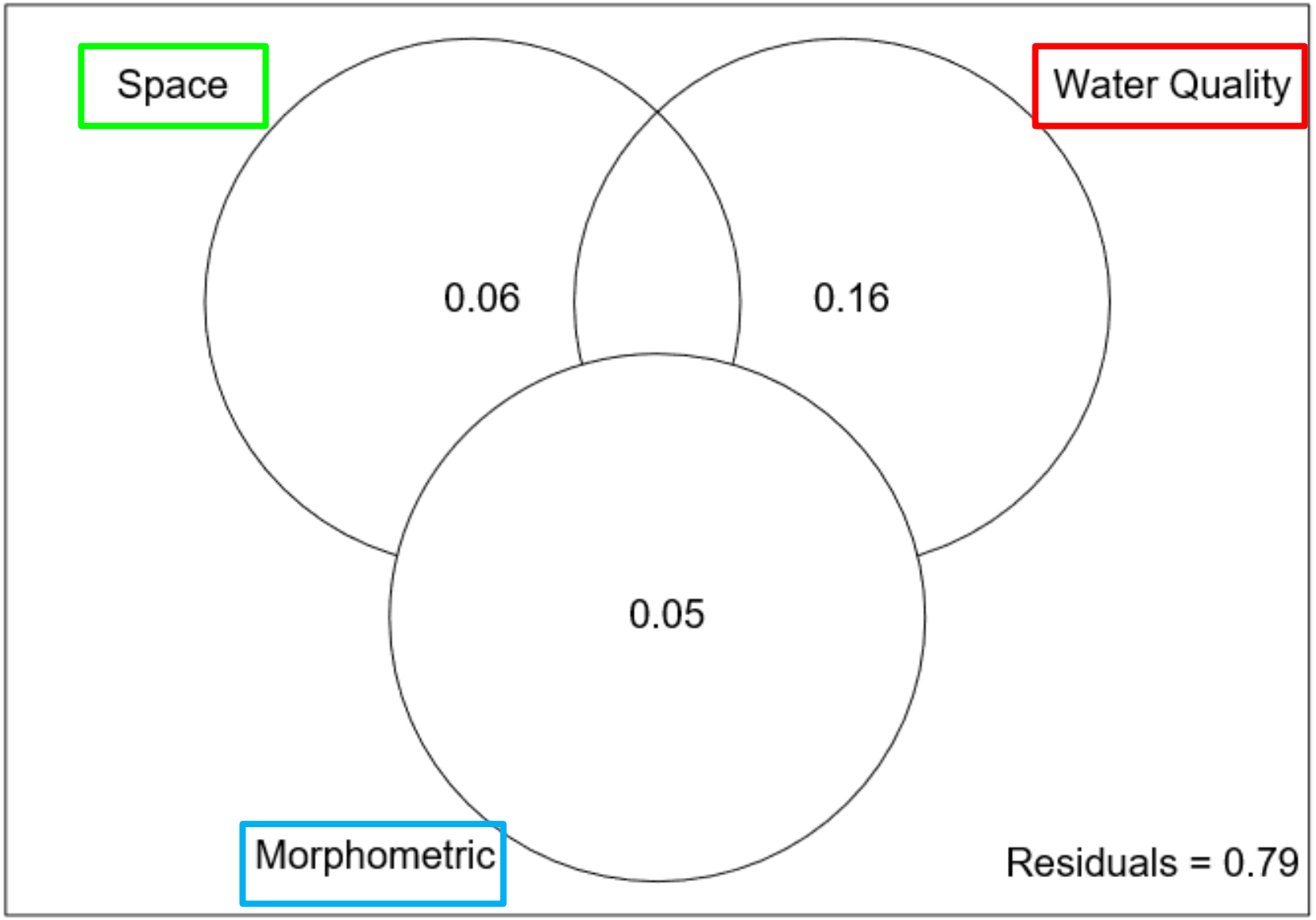
4 associations:

1. Turbidity → Calanoid spp.
2. Latitude → Cyclopoid spp.
3. Mean Depth → Daphnia spp.
4. Secchi Depth →*S.oregonensis*, *B. longirostris*



p<0.05, r2 = 0.21

Results – Variation Partitioning



Values <0 not shown

Diversity and Richness

Univariate Metric	Significant Variables	P-Value	Adjusted r^2
Richness	Latitude Conductivity	P<0.05	0.206
Diversity	Latitude Conductivity Mean Depth Dissolved Oxygen	P<0.05	2.872

Conclusions

- Changes in water quality caused by climate change and increased development in the north may harm aquatic communities due to changes in turbidity and conductivity
- Climate-driven changes in hydrology or decreases in water clarity due to permafrost thaw may have a significant impact on zooplankton
- Latitude plays an important role in zooplankton abundance, richness and diversity however, a larger latitudinal gradient needs to be studied in order to further understand this result

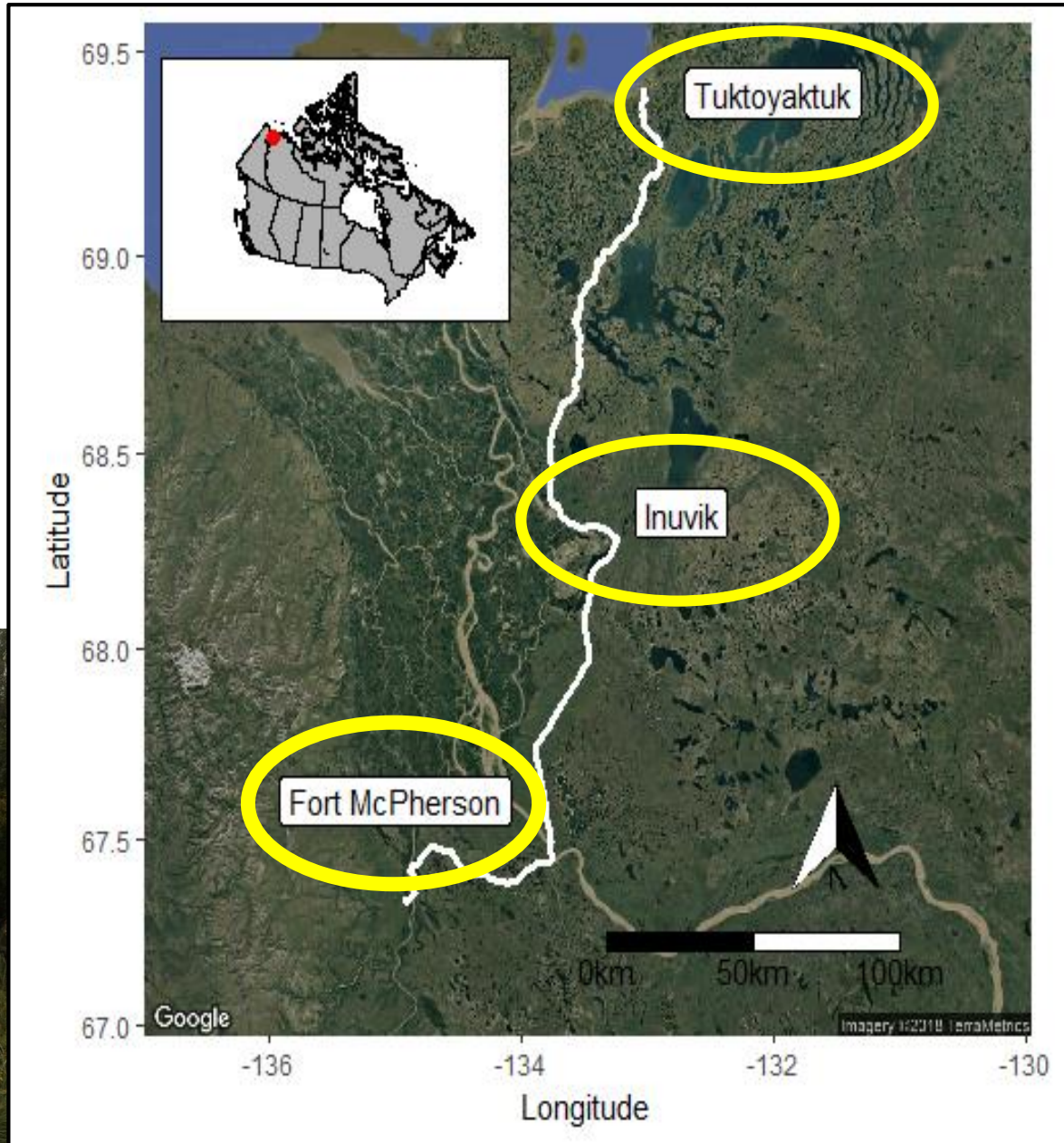
Significance

- Understand the fundamental processes that structure zooplankton communities in GSA lakes
- Collected data will be used in an ongoing project that is assessing the impacts of climate change on fish species in NWT
- Assist in the development of management plans in regions of Canada that are significantly affected by climate change
- Understand food web changes that may occur due to changes in water chemistry



Future Directions

- Sample additional lakes from Inuvik to Tuktoyaktuk
- Compare the richness, diversity and overall structure of zooplankton communities between lakes along the Dempster Highway and Inuvik-Tuktoyaktuk highway
- Sample and compare zooplankton communities that have and have yet to be impacting by permafrost thaw slumping



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Cumulative Impacts Monitoring Program