

Five Years of Monitoring the Benthic Invertebrate Community in the Laurel Creek Subwatershed Using Environmental DNA

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Presentation Overview



Introduction and project background



Project objectives



What is environmental DNA?



Sampling approach and methods



Habitat quality indices

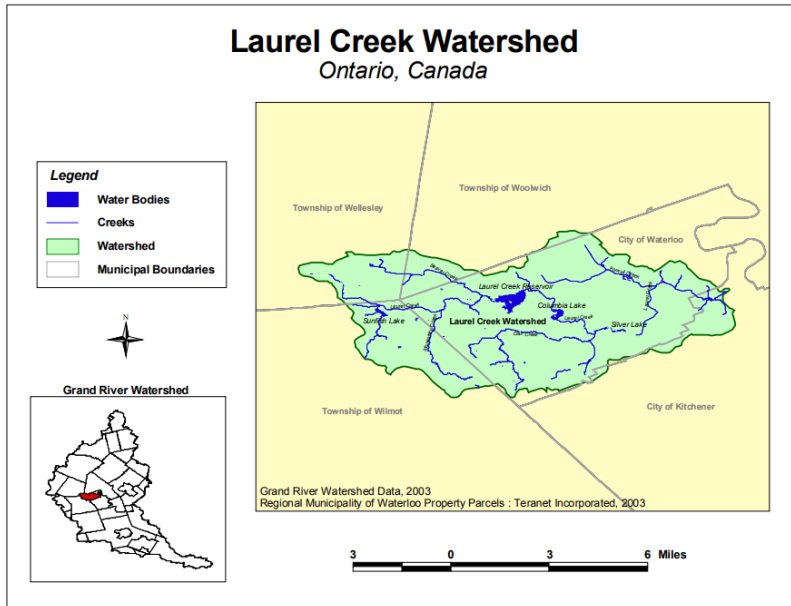


Results and habitat trends

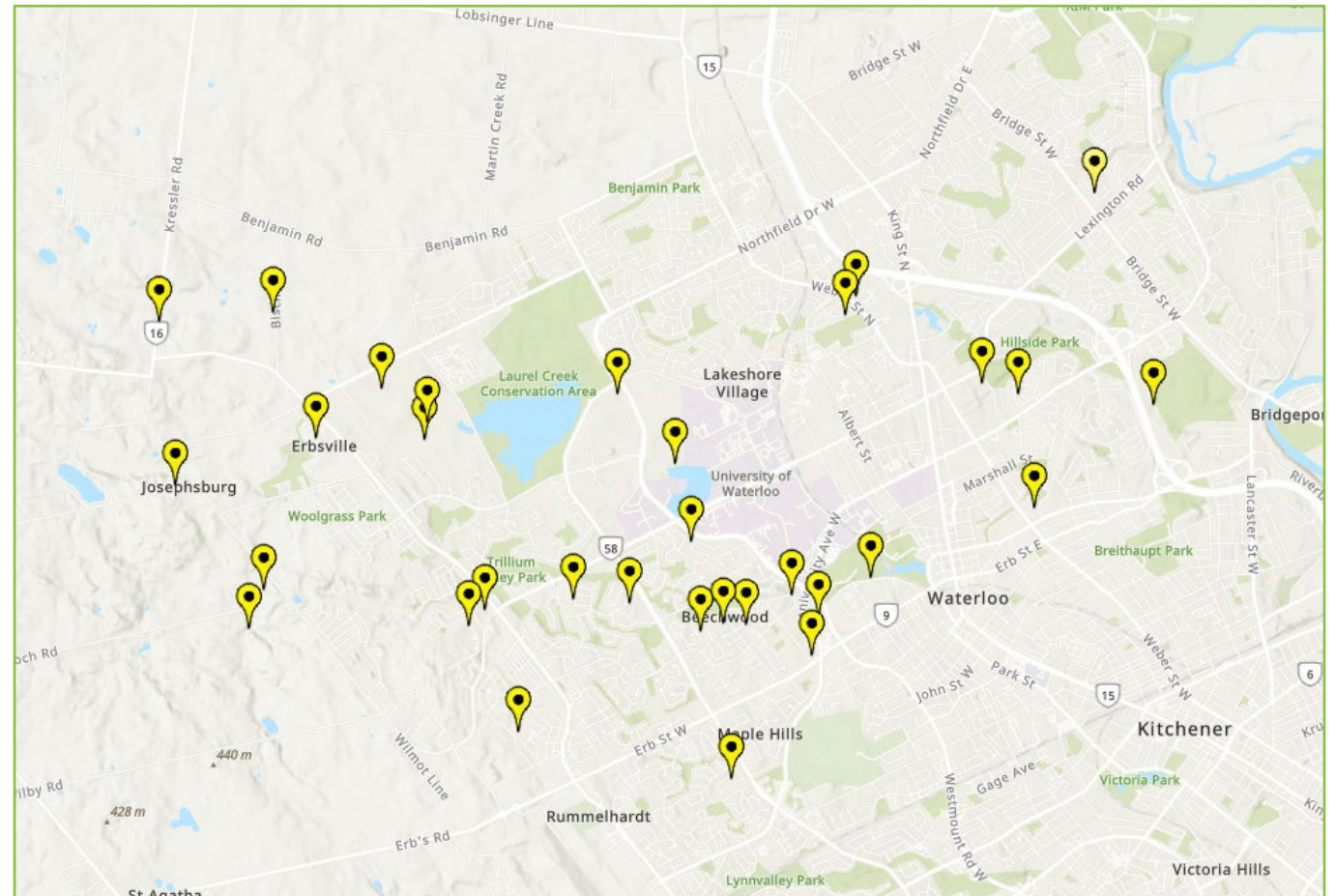


Discussion and recommendations

Introduction and project background



- City of Waterloo initiated aquatic (benthic) monitoring of the Laurel Creek Subwatershed in 1996
- In 2017 D&A & CBG were retained to continue the monitoring program using eDNA
- 32 monitoring locations



Project Objectives

- Continue a 20-year benthic monitoring program that was completed using traditional taxonomic identification methods (1996-2016)
- Assess and compare habitat quality throughout the Laurel Creek Subwatershed using various metrics
- Evaluate efficiency and efficacy of eDNA identification methods vs traditional approaches

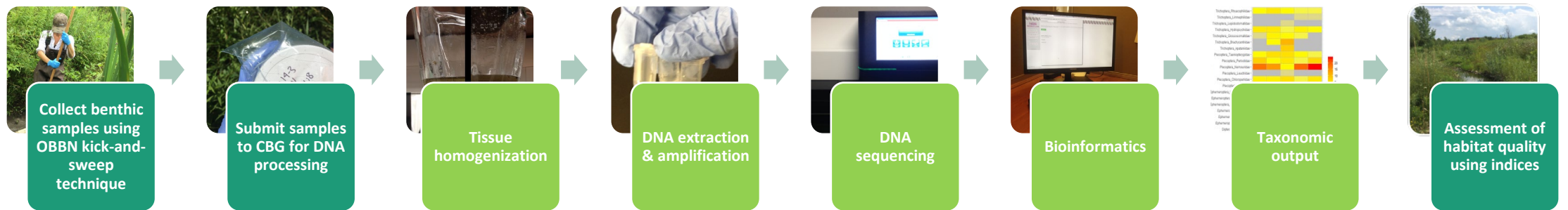


What is environmental DNA (eDNA)?

- DNA originating from cellular material shed by organisms that can be collected through environmental samples (i.e. water, soil, snowmelt, etc.)
- Detection of cryptic or rare species
- Improved specificity of detection through next generation sequencing



Sampling approach and methods



Habitat quality indices

HBI

Hilsenhoff Biotic Index

- Assign known tolerance scores (0-10) for benthic taxa based on sensitivity to organic pollutants
- Calculate HBI which corresponds to habitat quality class (0 = Excellent; 10 = Very Poor)

$$HBI = \frac{\sum(n_i \times a_i)}{N} \quad [eq\ 1]$$

n = number of specimens in taxa i
 a = tolerance value for taxa i
 N = total number of specimens in sample

%EPT

Percent Ephemeroptera, Plecoptera, Trichoptera

- Total number of Mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) divided by total number of individuals in the sample
- %EPT and habitat quality are positively correlated

$$\%EPT = \frac{\text{Number of EPT taxa}}{\text{Total number of taxa}}$$

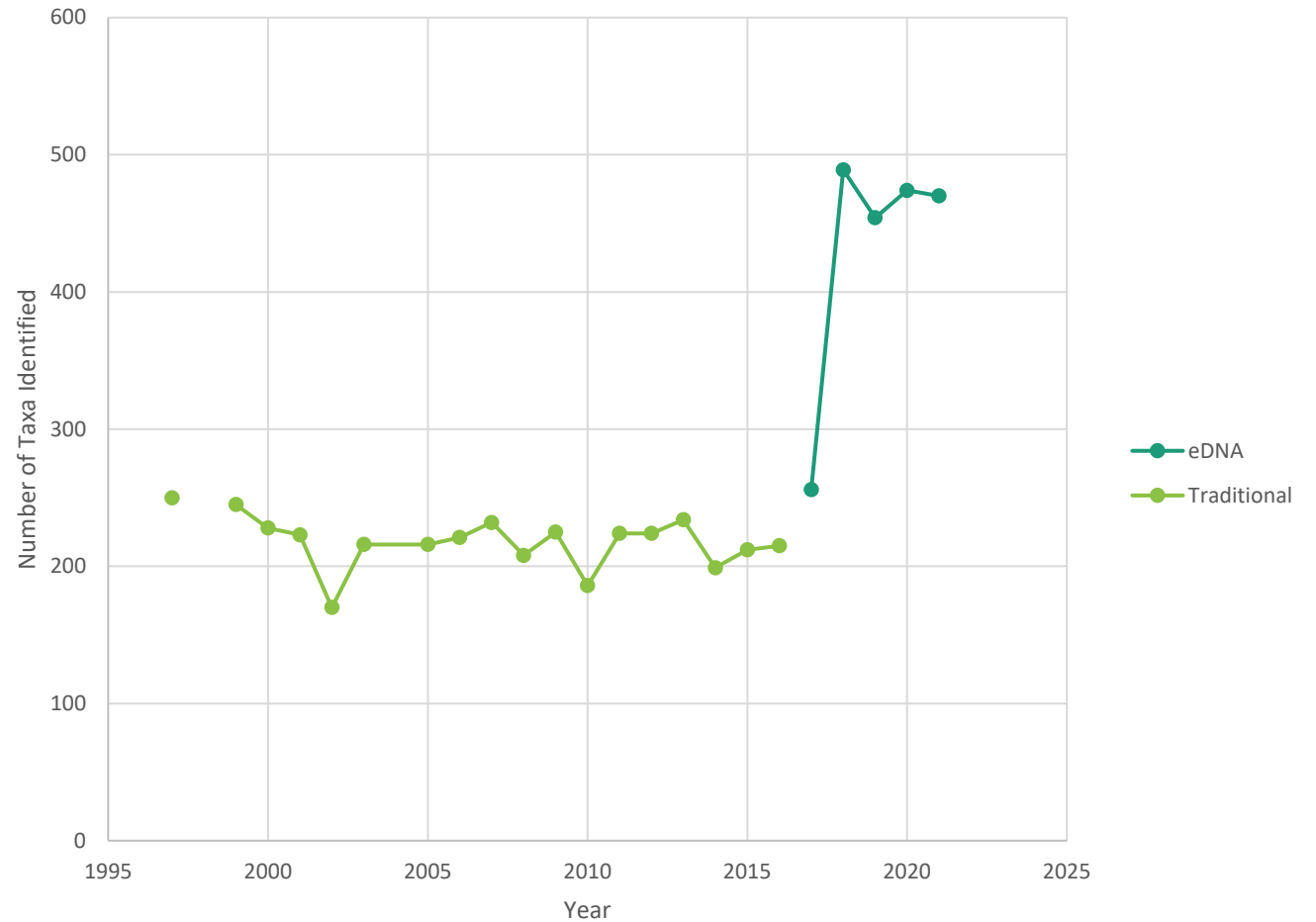
Results and habitat trends – Taxa Richness

1996-2016 (Traditional ID)

- Average: 218 taxa
- 495 taxa total

2017-2021 (eDNA ID)

- Average: 429 taxa
- 862 species
- 95% confidence

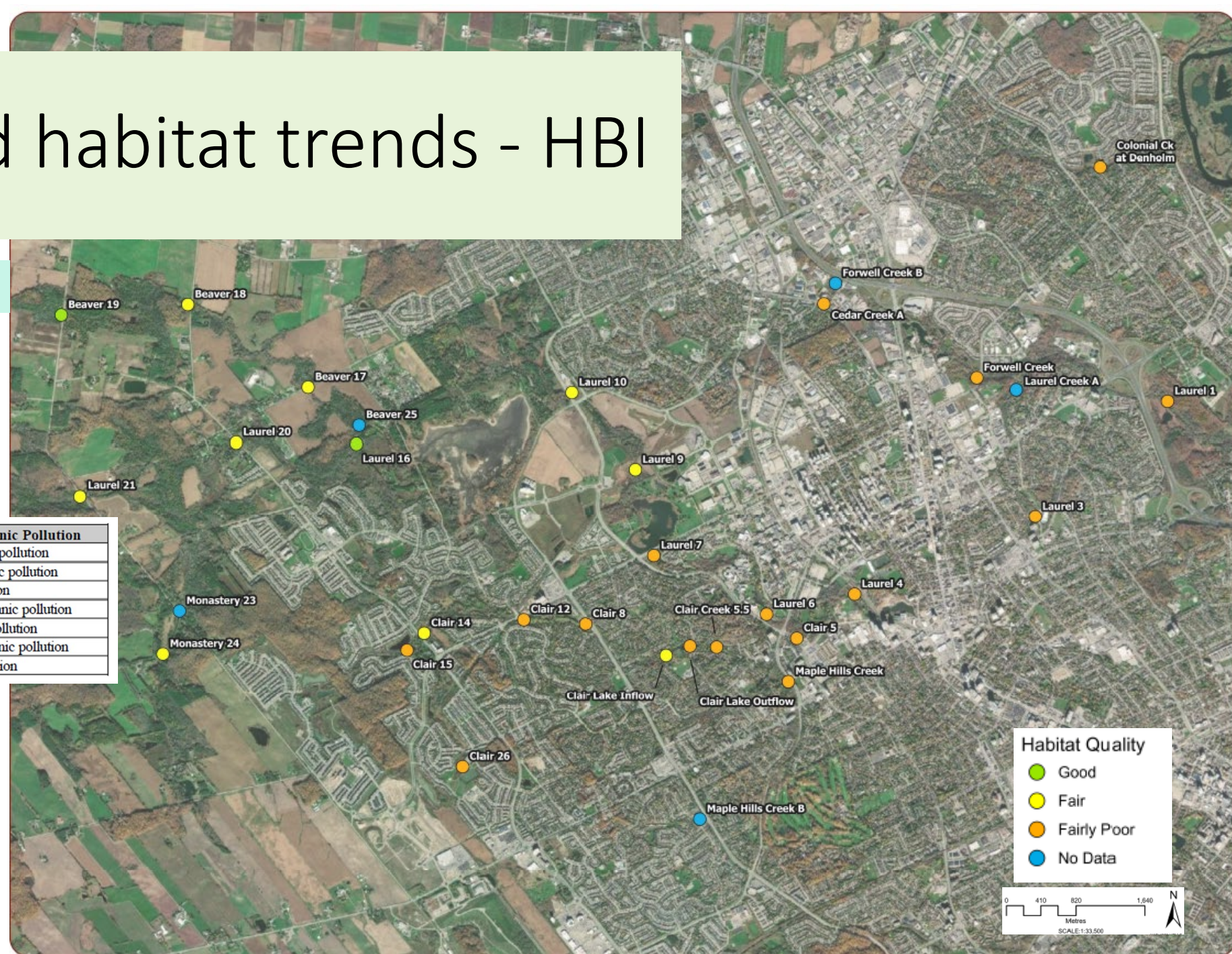


Results and habitat trends - HBI

1996-2016

HBI average: 6.44 (Fair)

Biotic Index	Water Quality	Degree of Organic Pollution
0.00-3.50	Excellent	No apparent organic pollution
3.51-4.50	Very good	Possible slight organic pollution
4.51-5.50	Good	Some organic pollution
5.51-6.50	Fair	Fairly significant organic pollution
6.51-7.50	Fairly Poor	Significant organic pollution
7.51-8.50	Poor	Very significant organic pollution
8.51-10.00	Very Poor	Severe organic pollution

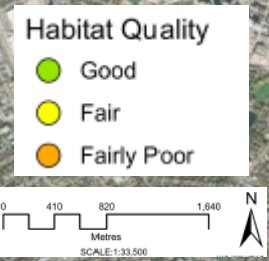
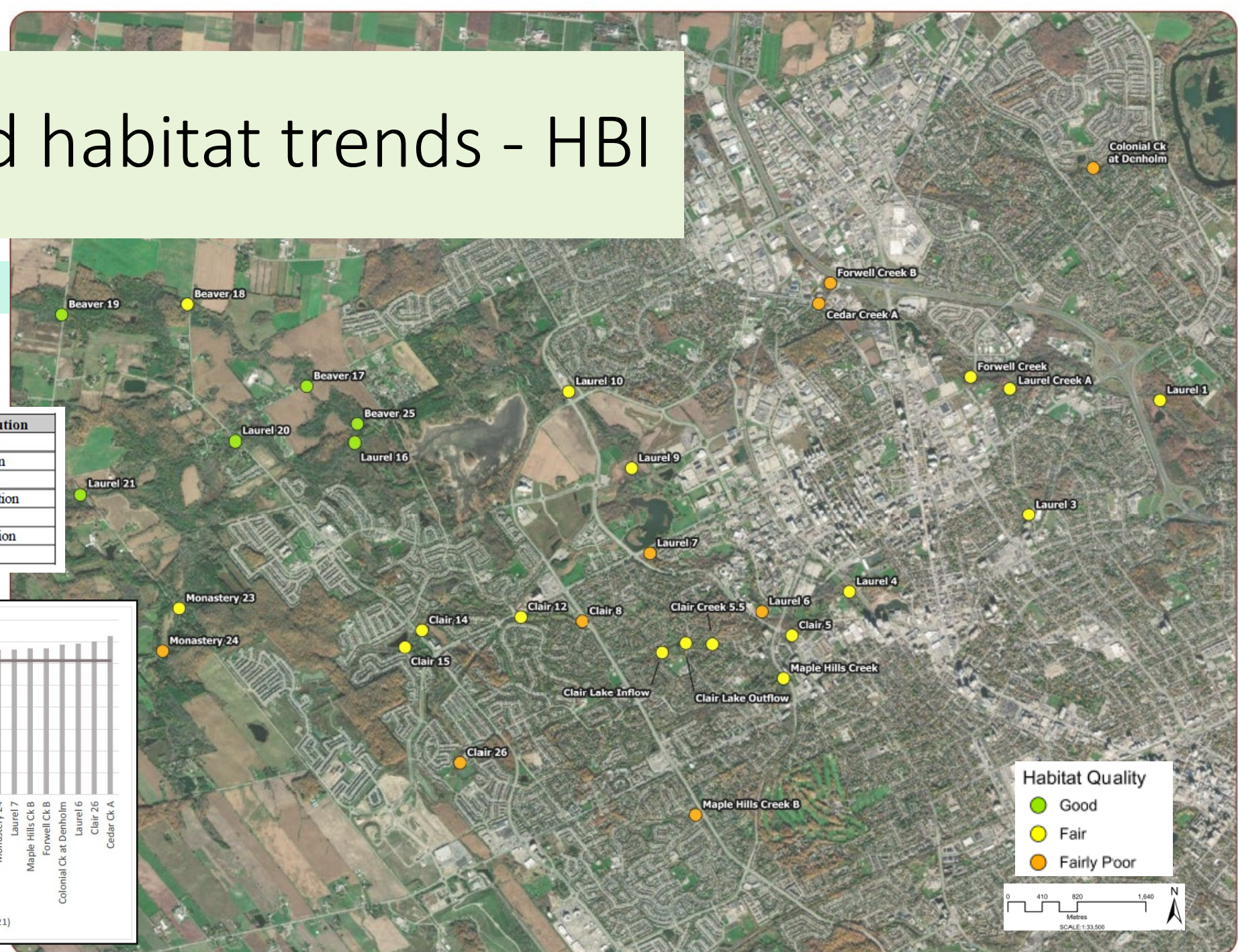
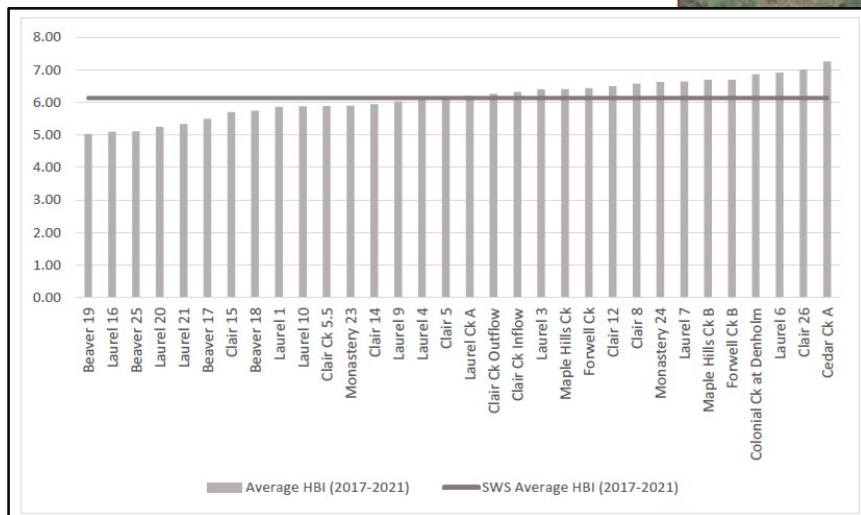


Results and habitat trends - HBI

2017-2021

HBI average: 6.13 (Fair)

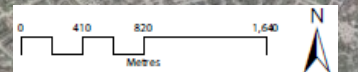
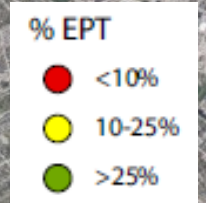
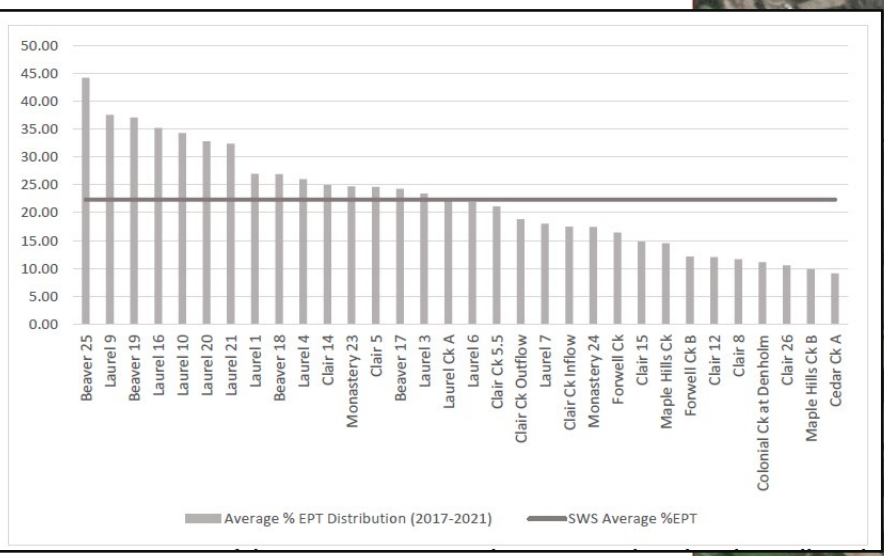
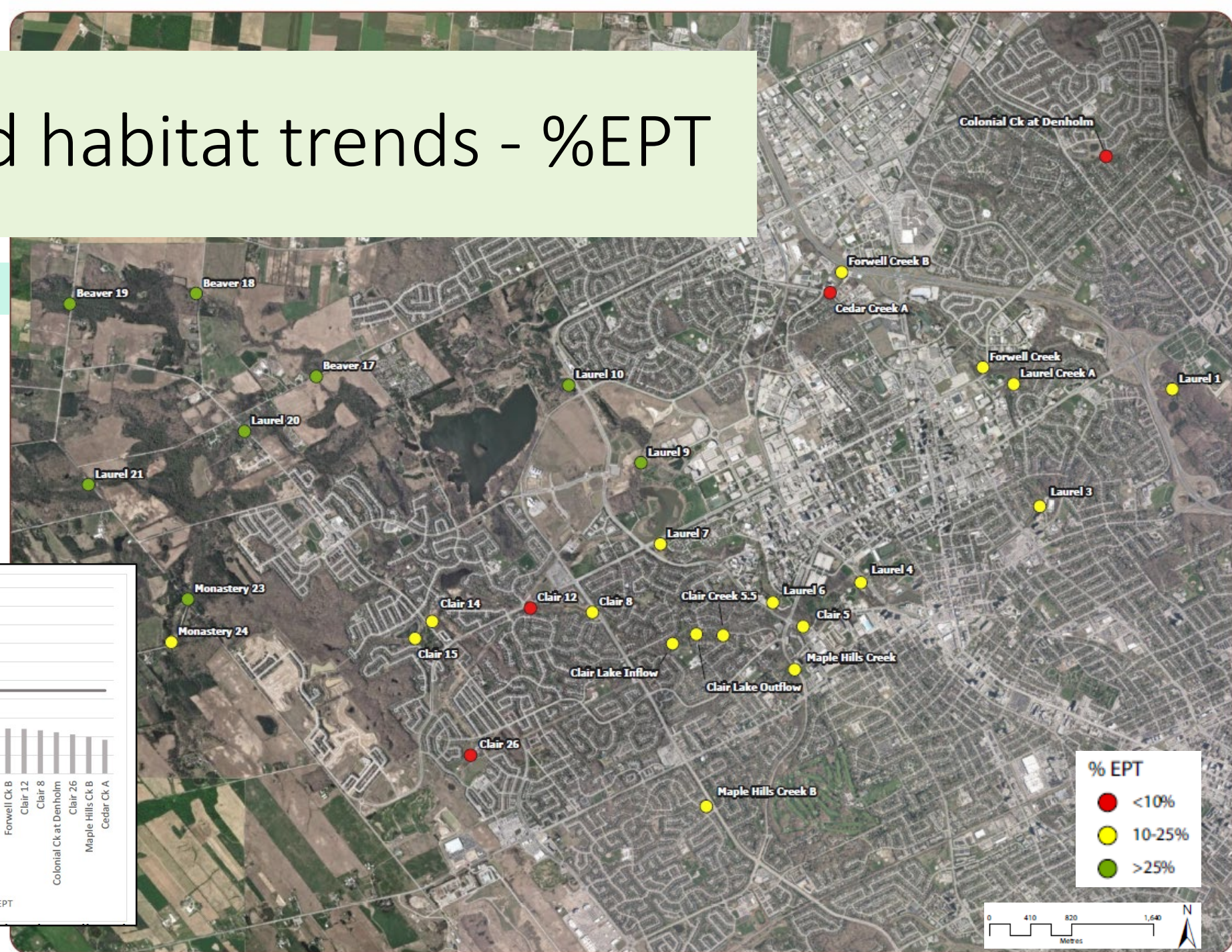
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Results and habitat trends - %EPT

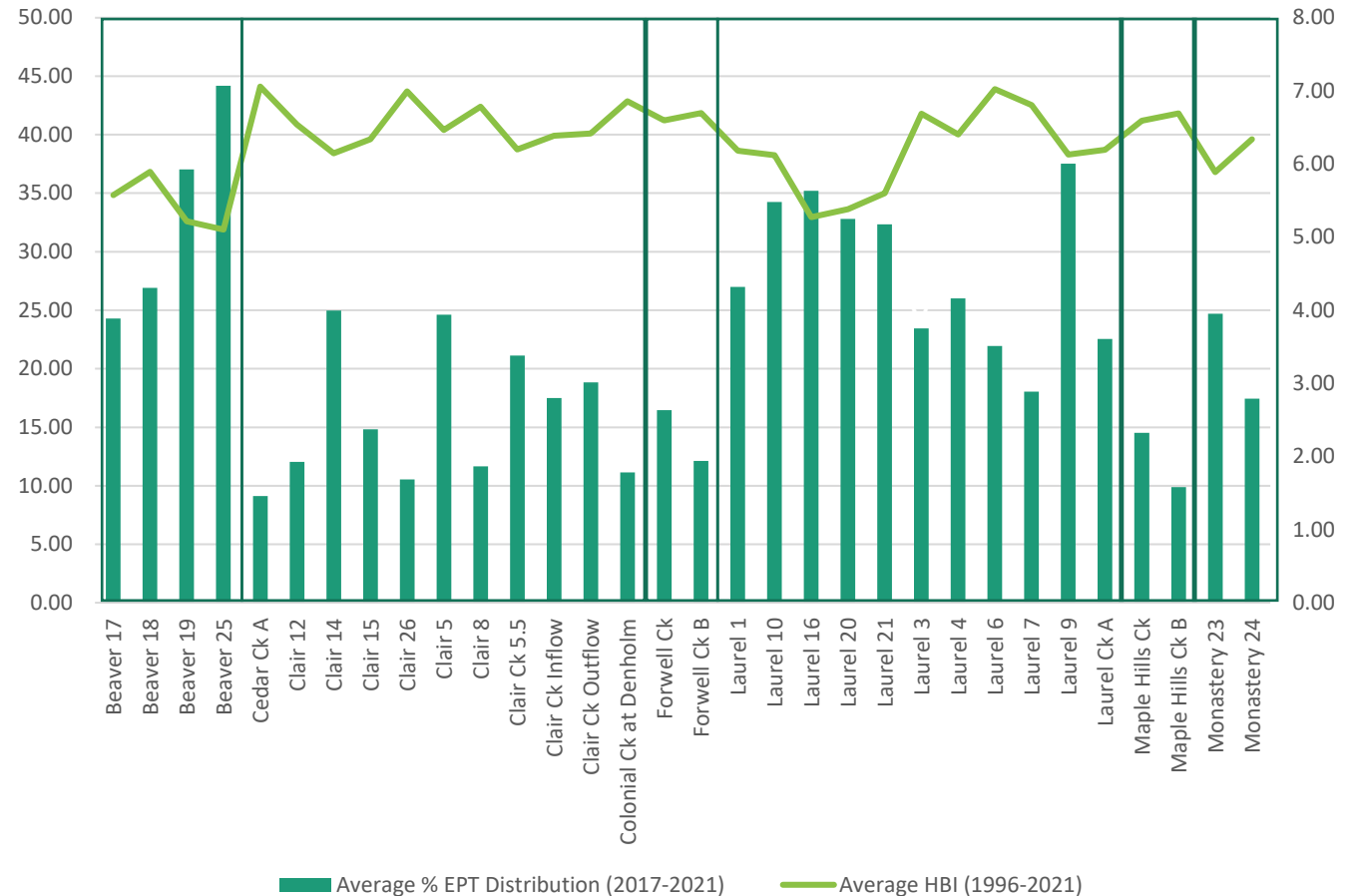
2017-2021

%EPT average: 22.4%



Summary of Results

- Habitat quality (HBI) is relatively consistent between traditional ID and eDNA ID methods
- Higher habitat quality present in less urbanized areas/ passive land use
- Variation amount sub-catchments (needs more investigation)
- Habitat quality generated by HBI and %EPT are generally consistent (inversely correlated)



Discussion

Benefits of eDNA approaches:

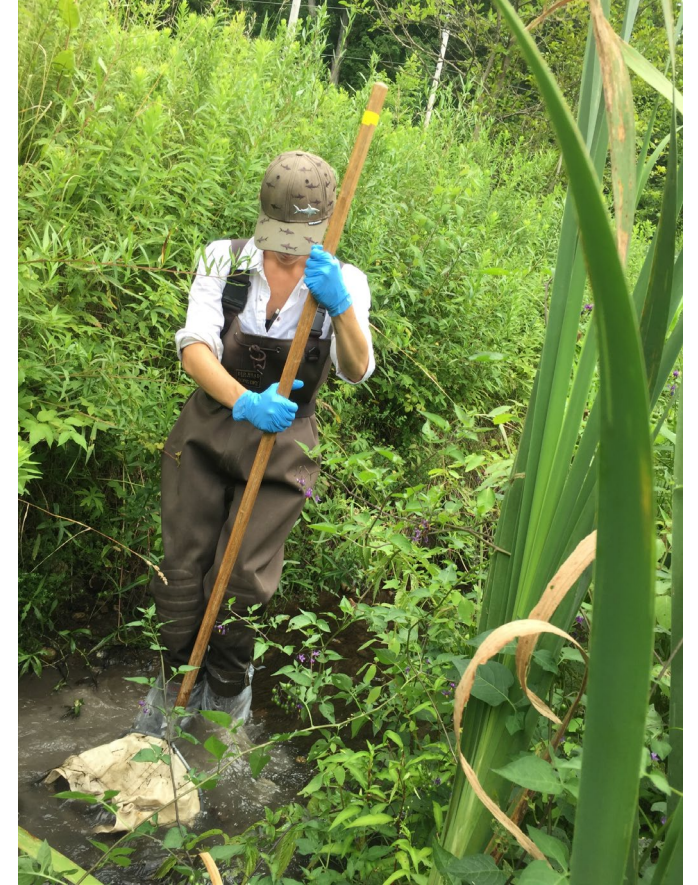
- Improved taxa richness, sensitivity and species resolution; more comprehensive understanding of benthic communities
- High level of confidence in identification (i.e. 95%) and reduced human error
- Allows for detection of highly rare/ discrete species
- Cost-effective and efficient



Discussion

Potential limitations of eDNA approaches:

- Different organisms/ life stages shed DNA at different rates
- DNA degradation rate varies depending on type, size, and environmental factors
- DNA travels through stream
- DNA barcode reference libraries are continually being updated as new data becomes available
- Not currently recognized / widely accepted (by Agencies) for ecological inventory & monitoring



Questions?

