

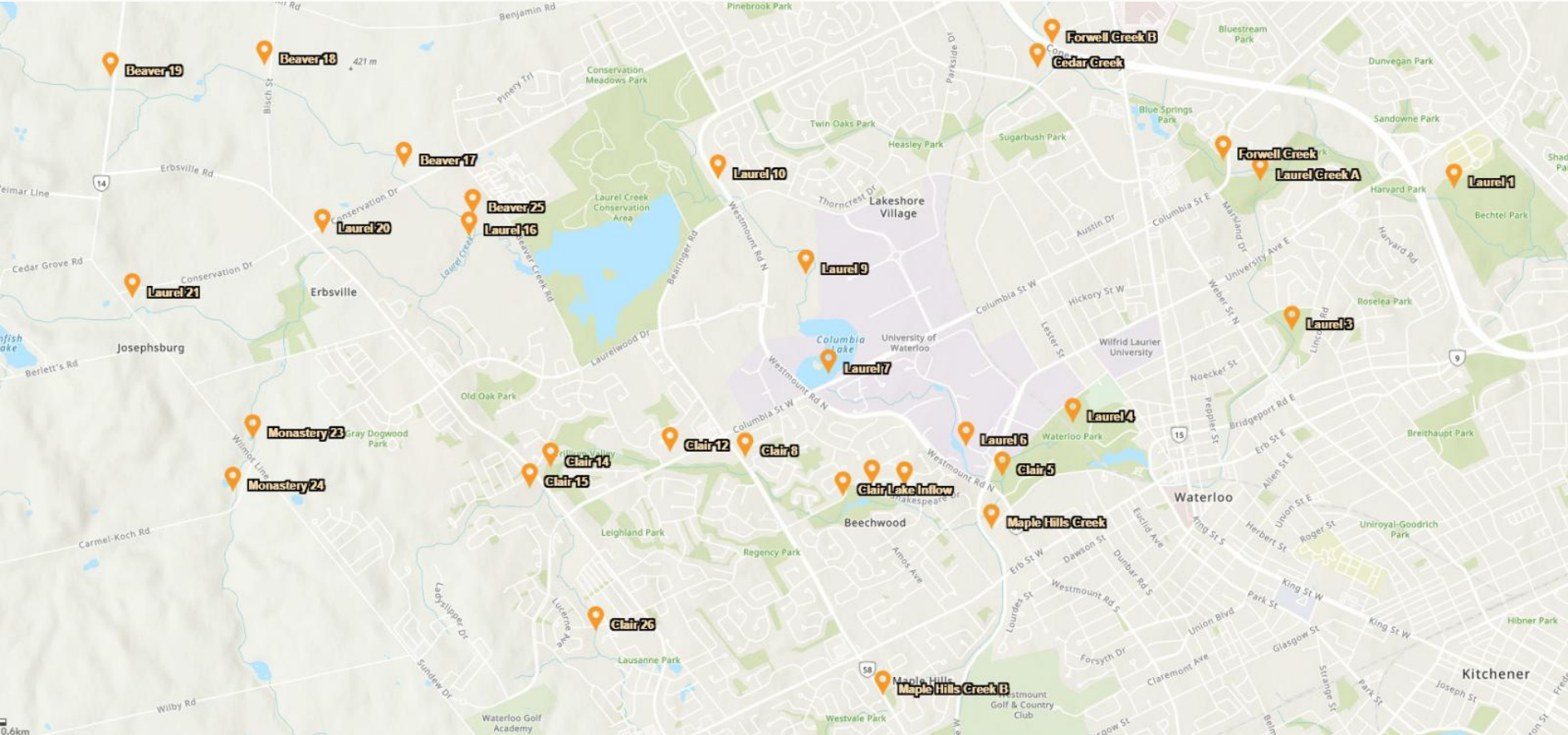
Monitoring the Ecological Condition of Urban/ Agricultural Watersheds Using eDNA: A Case Study in the Laurel Creek Subwatershed

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Project Background



Objectives

- Evaluate the efficacy of using an eDNA-based monitoring program for aquatic monitoring of benthic invertebrates
- Recognize the City of Waterloo as a leader in advancing the use of cutting-edge Genomic tools in understanding ecosystem function in urban environments



Field Methodology

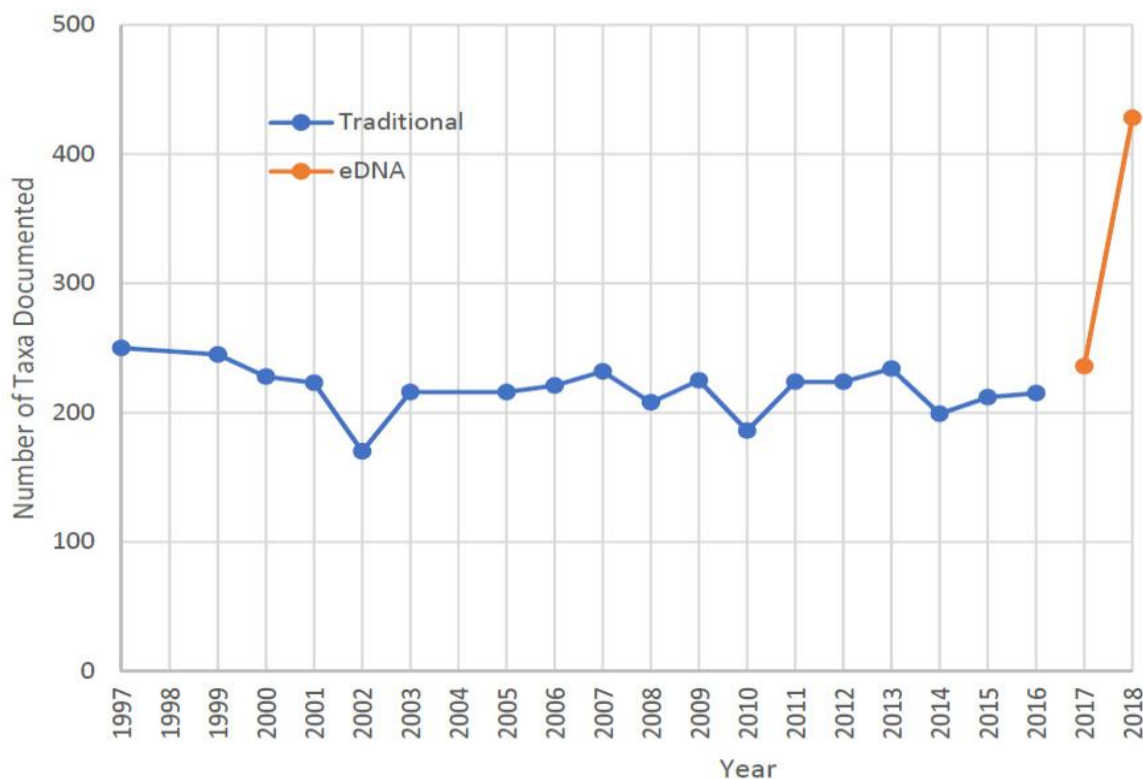
- Samples were collected using OBBN (Ontario Benthos Biomonitoring Network) Protocol
- Special sanitation measures to avoid eDNA contamination



Next Generation Sequencing & eDNA

- Benthic samples were processed at the Hajibabaei Lab at the Centre for Biodiversity Genomics at U of G using Next Generation Sequencing
 - Resulting DNA sequences were compared with existing data libraries
 - Sequences were only considered a positive match if there was >98% similarity with library sequences
 - From these sequences, a list of benthic invertebrates was generated for each sampling site
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Results



2017

Diptera (38.3%)
Haptotaxida (27.0%)
Trichoptera (11.6%)
Ephemeroptera (9.8%)
Coleoptera (7.7%)

2018

Diptera (44.3%)
Haptotaxida (21.2%)
Ephemeroptera (9.85%)
Trichoptera (9.24%)
Coleoptera (7.36%)

2019

Results pending

Number of taxa identified by sample year. Note that years 1998 and 2004 are missing as data was not available in a format for summarizing. Also, the low richness for 2002 is likely related to fewer than normal locations being included in the May sample for that year. Monitoring undertaken using eDNA commenced in 2017.

Taxonomic Diversity

Traditional Approach (1997 – 2016)

Taxonomic Level	Diversity	Number of Records Identified	Percent of Records Identified
Class	12	501	100
Order	32	498	99.4
Family	104	495	98.8
Genus	277	446	89
Species	225	233	46.5

eDNA Approach (2017 – 2018)

Taxonomic Level	Diversity	Number of Records Identified	Percent of Records Identified
Class	12	550	100
Order	41	550	100
Family	172	550	100
Genus	369	550	100
Species	550	550	100

Taxonomic Similarity

Jaccard Similarity Index between
Traditional and eDNA Species Lists

Taxonomic Level	Unique to Traditional	Unique to eDNA	Overlap	Similarity
Class	5	5	7	41.2%
Order	17	24	15	43.6%
Family	38	106	66	45.8%
Genus	174	266	103	23.4%
Species	182	507	43	6.2%

Habitat Quality Assessment

Hilsenhoff Biotic Index (HBI):

HBI Value	Water Quality	Degree of Organic Pollution
0.00-3.50	Excellent	No apparent organic pollution
3.51-4.50	Very Good	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

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

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

Amended Equations:

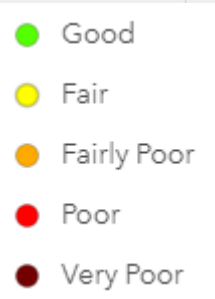
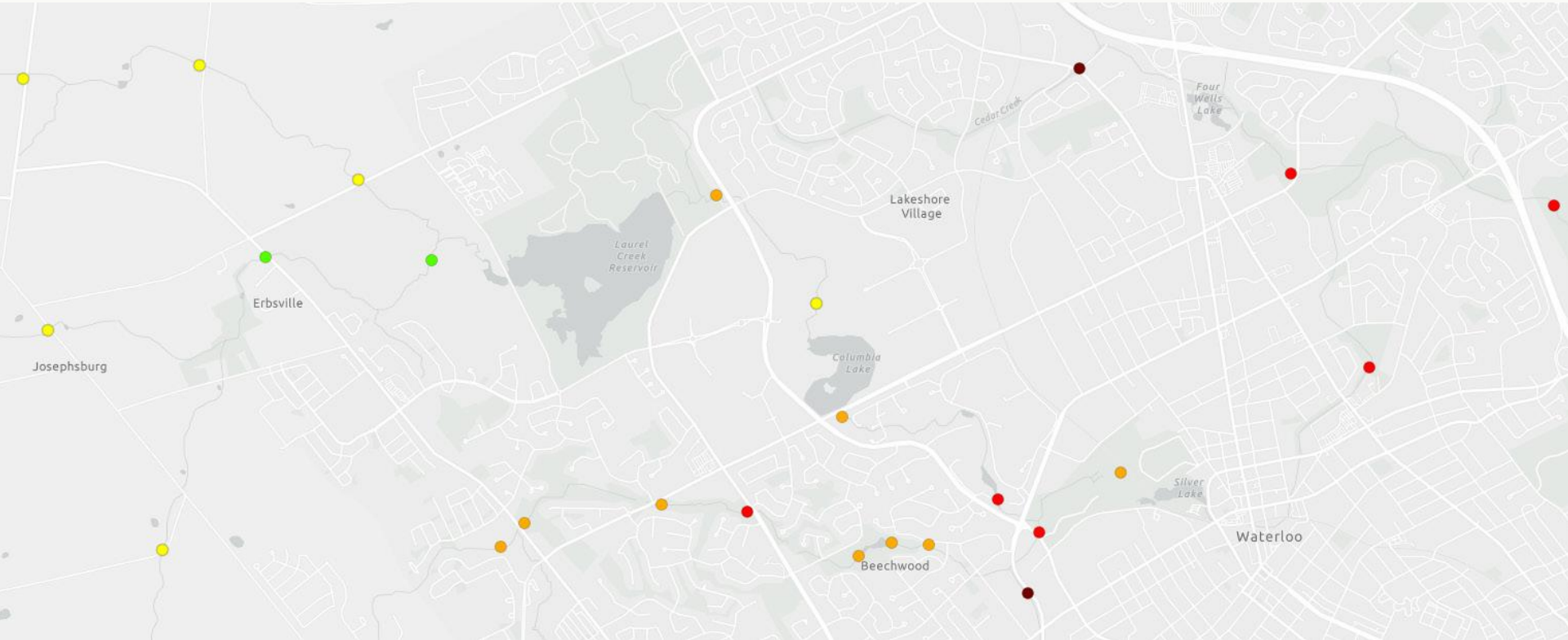
$$HBI_{ESV} = \frac{\sum(ESV_i \times a_i)}{N_{ESV}} \quad [eq\ 2]$$

ESV = number of Exact Sequence Variants for a given taxa i
 a = tolerance value for taxa i
 N = total number of ESVs identified

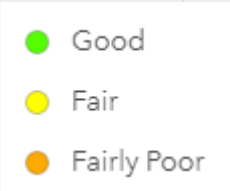
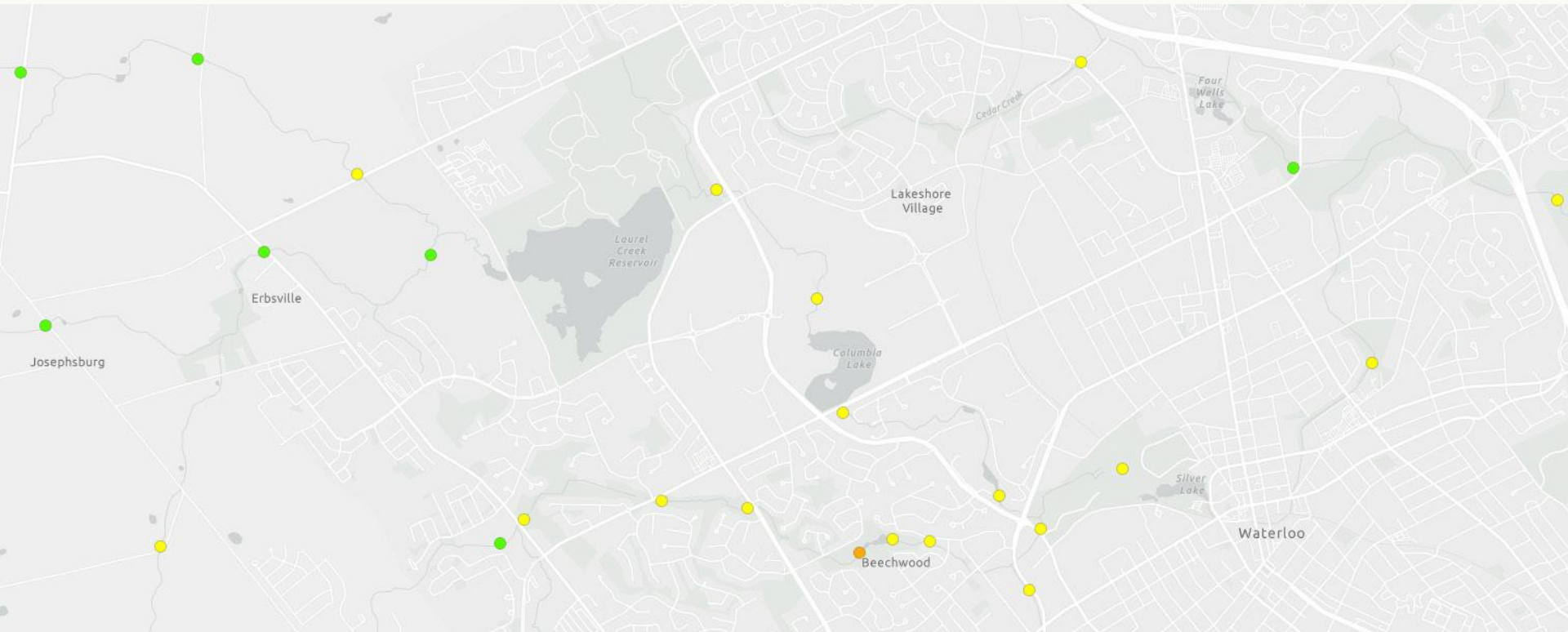
$$HBI_{Species} = \frac{\sum(Taxa_i \times a_i)}{N_{taxa}} \quad [eq\ 3]$$

Taxa = presence of a given taxa i
 a = tolerance value for taxa i
 N = total number of taxa identified

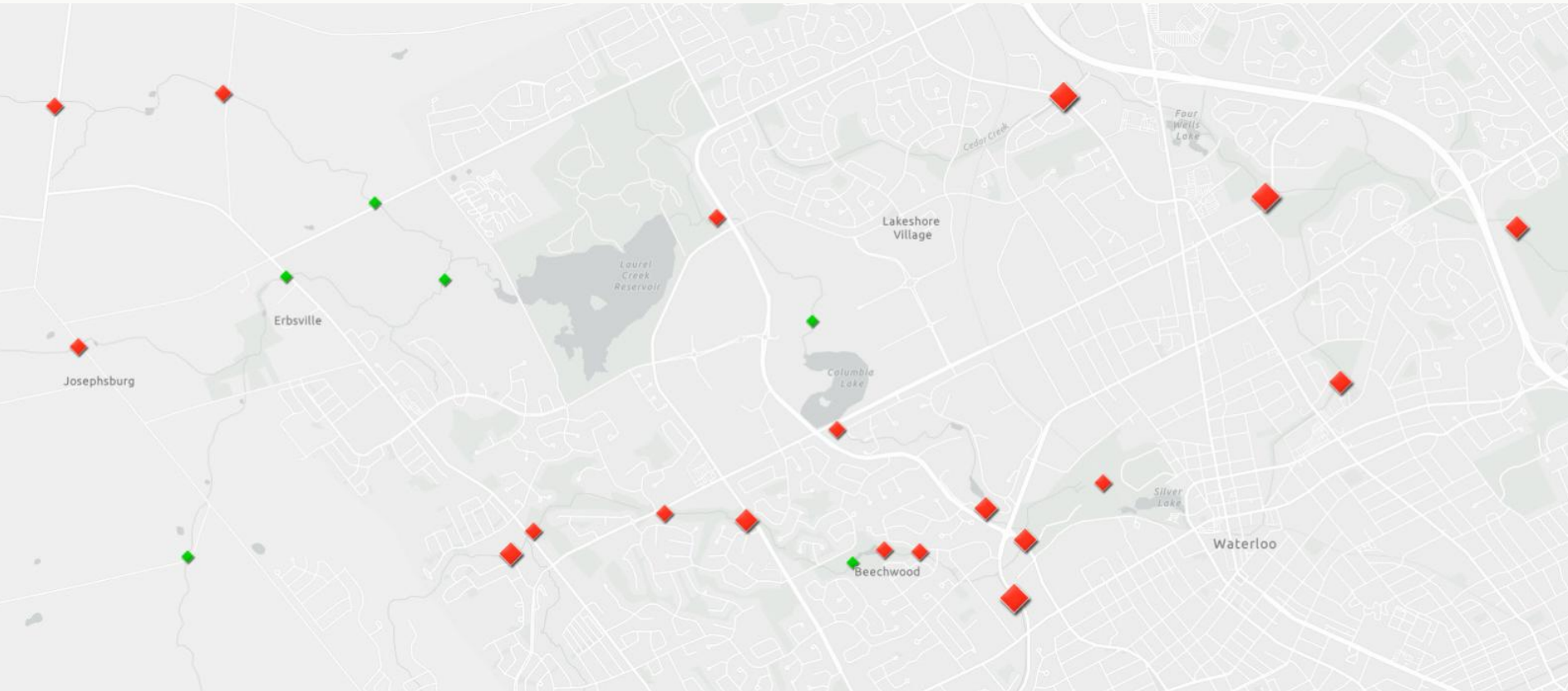
Water Quality 1997-2016







Water Quality 2017-2018



Differences in Water Quality Between Past Data and eDNA Data



-  Same as past data
-  Off by 1 water quality class
-  Off by 2 water quality classes
-  Off by 3 water quality classes

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Summary and Next Steps

Summary

- eDNA Higher diversity of taxonomic groups
- Low degree of taxonomic overlap
- Similar qualitative outcomes when used to interpret habitat quality; eDNA tends towards indicating higher quality

Next Steps:

- Continue to update analyses as reference databases become more robust
 - Explore other biotic indices; consider other organisms that are captured using eDNA
 - Evaluate site, reach, and subcatchment trends (relative to catchment conditions)
 - Identify opportunities to integrate sampling with City initiatives to rehabilitate Laurel Creek watershed
 - Collaboration opportunities
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Thank you!



Traditional Morphological Identification

