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Canada

Monitoring with the CABIN Wadeable Streams Protocol in the Oil Sands Regions of Alberta

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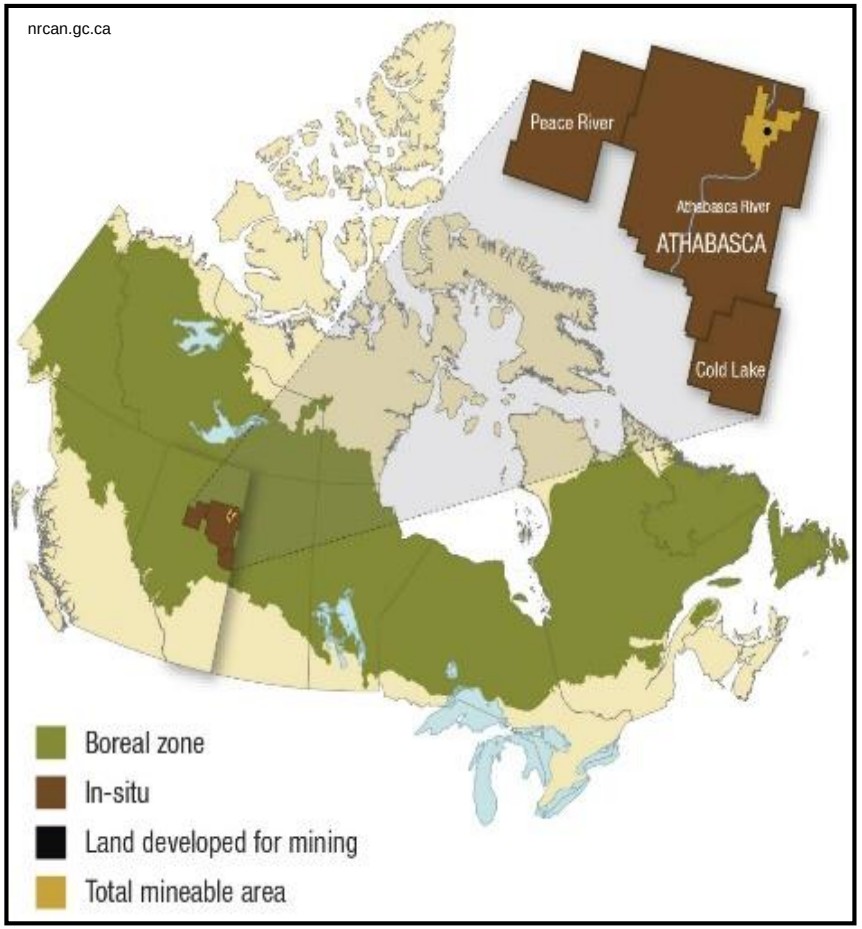
Alberta Environment and Parks

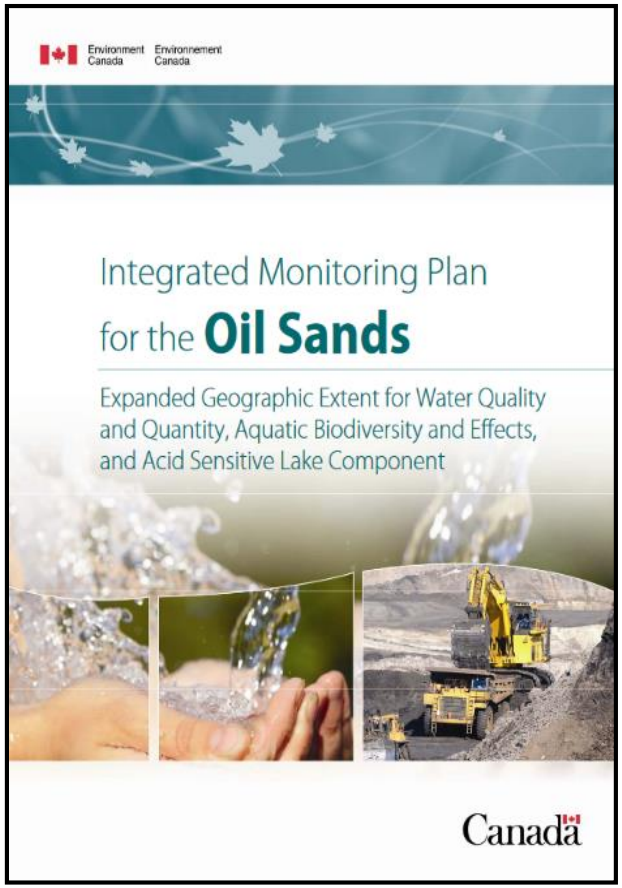
Overview

- History and objectives of the Canada-Alberta oil sands monitoring program
- Study design in the major tributaries of the Lower Athabasca River
- Site selection and limitations
- Challenges in the field
- Data assessments
- Decision framework
- Summary



Oil Sands Monitoring (OSM) Program

- Developed in 2011 by the governments of Canada and Alberta
- Includes monitoring of water quality and quantity, air quality, groundwater quality, benthic invertebrates and fish
- Based on recommendations from the Federal Oil Sands Advisory Panel and other reports that identified key shortcomings of historic monitoring efforts



Benthic Program Objectives

Using standardized protocols (CABIN) and clearly defined habitat (erosional):

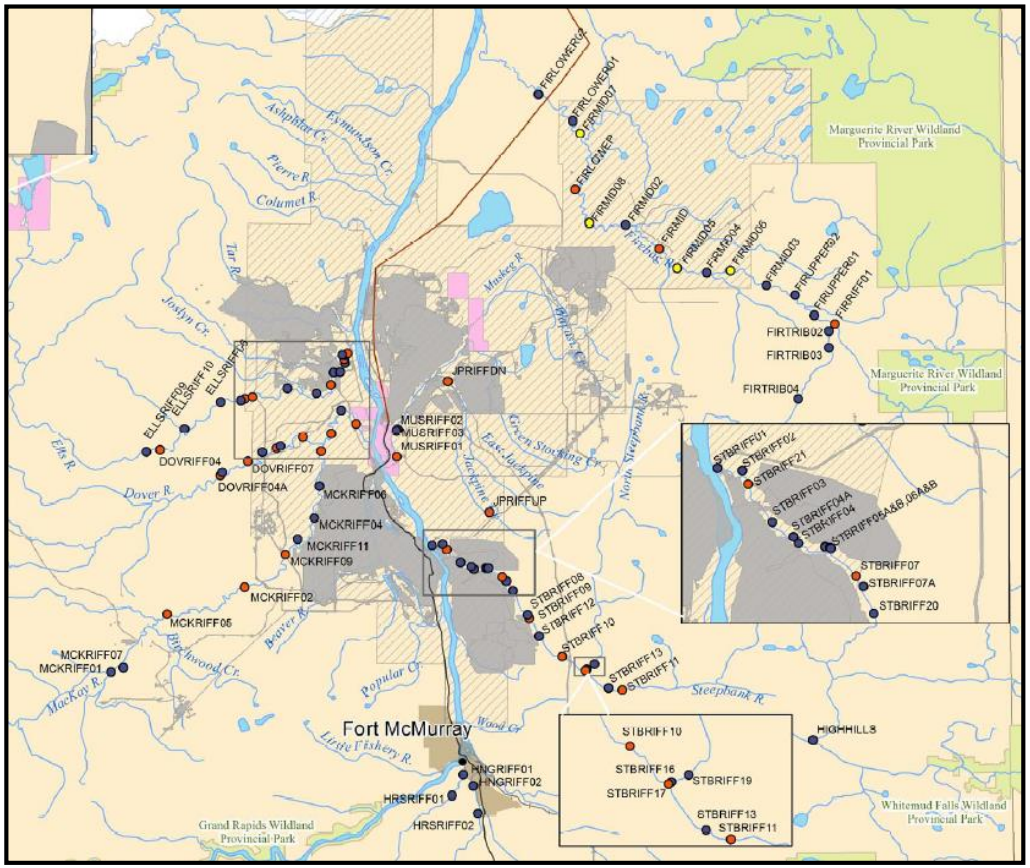
1. Characterize the natural range in assemblage structure in reference areas (inside and outside the natural bitumen deposit)
2. Determine whether assemblages from areas of increasing oil sands development differ from those in reference areas
3. Develop predictive relationships that link environmental drivers to benthic assemblage responses

Scope in the Athabasca Tributaries

- Focus on major tributaries of the Lower Athabasca River north of Fort McMurray
  - Steepbank River
  - Ells River
  - Mackay River
  - Firebag River
- Data collected annually in the fall from 2011 (pilot year) to 2019
- Large spatial coverage (120+ sites sampled)
- Core sites sampled annually with rotational sampling of other sites

Study Design

- Intensive gradient design
- Reference sites
  - Outside bitumen deposit (no bitumen observed at site or upstream)
  - Inside bitumen deposit (bitumen observed and confirmed at site or upstream)
- Test sites
  - > 10% active lease and > 1% land disturbance in the upstream catchment
  - Further subdivided into groups based on level of disturbance in upstream catchment



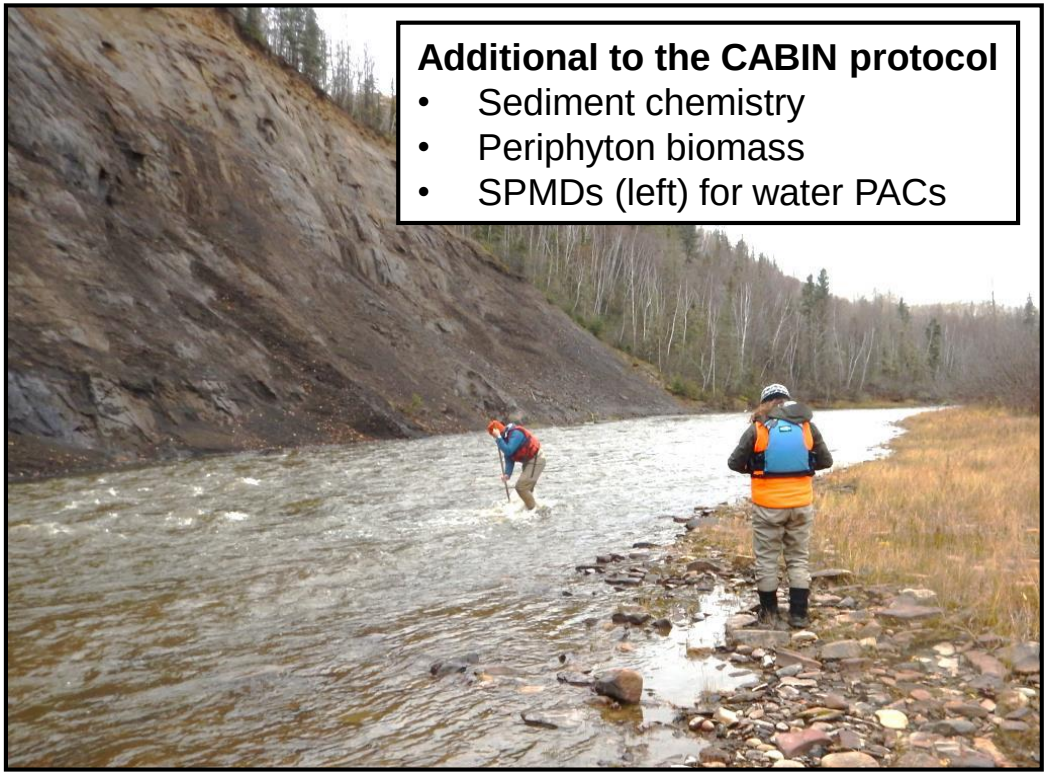
Study Design Considerations

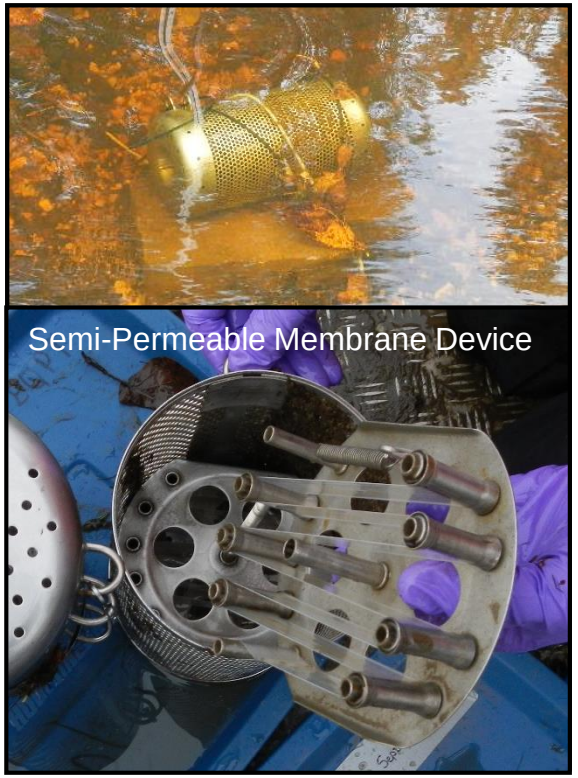
Natural co-occurring gradients:

- Slope
- Groundwater inputs
- Nutrients (bogs/fens in upper catchment)
- Natural bitumen seepage and presence in substrate

Sampling Methods

CABIN protocol for wadeable streams with additional measurements for habitat/chemistry data





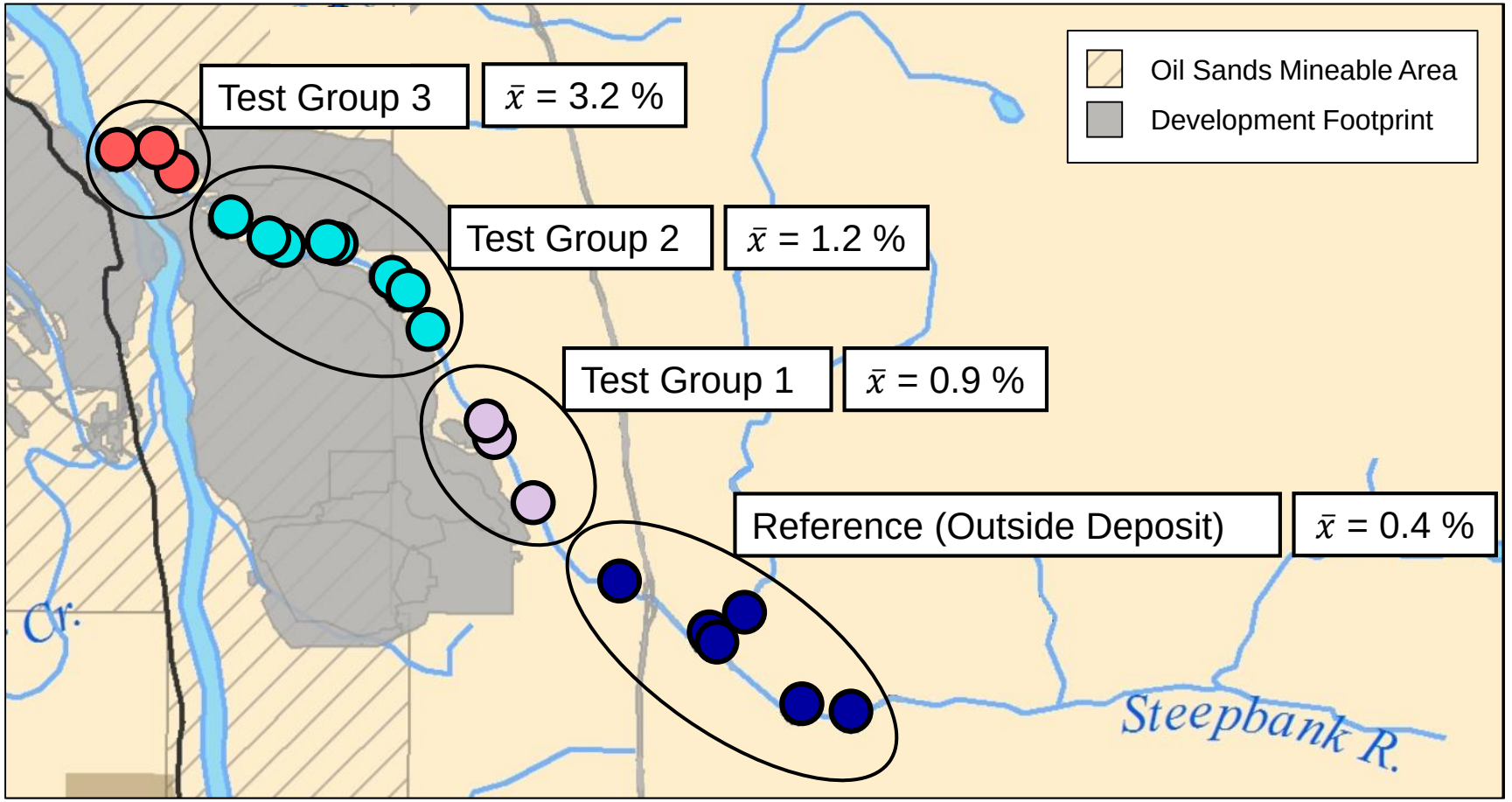
Site Selection and Limitations

- Desktop and aerial reconnaissance to find suitable erosional habitat and landing areas
- All sites are accessed by helicopter due to the scale (50+ sites per year over hundreds of km) and remoteness of sampling locations
- Helicopter access can be limited during high water years

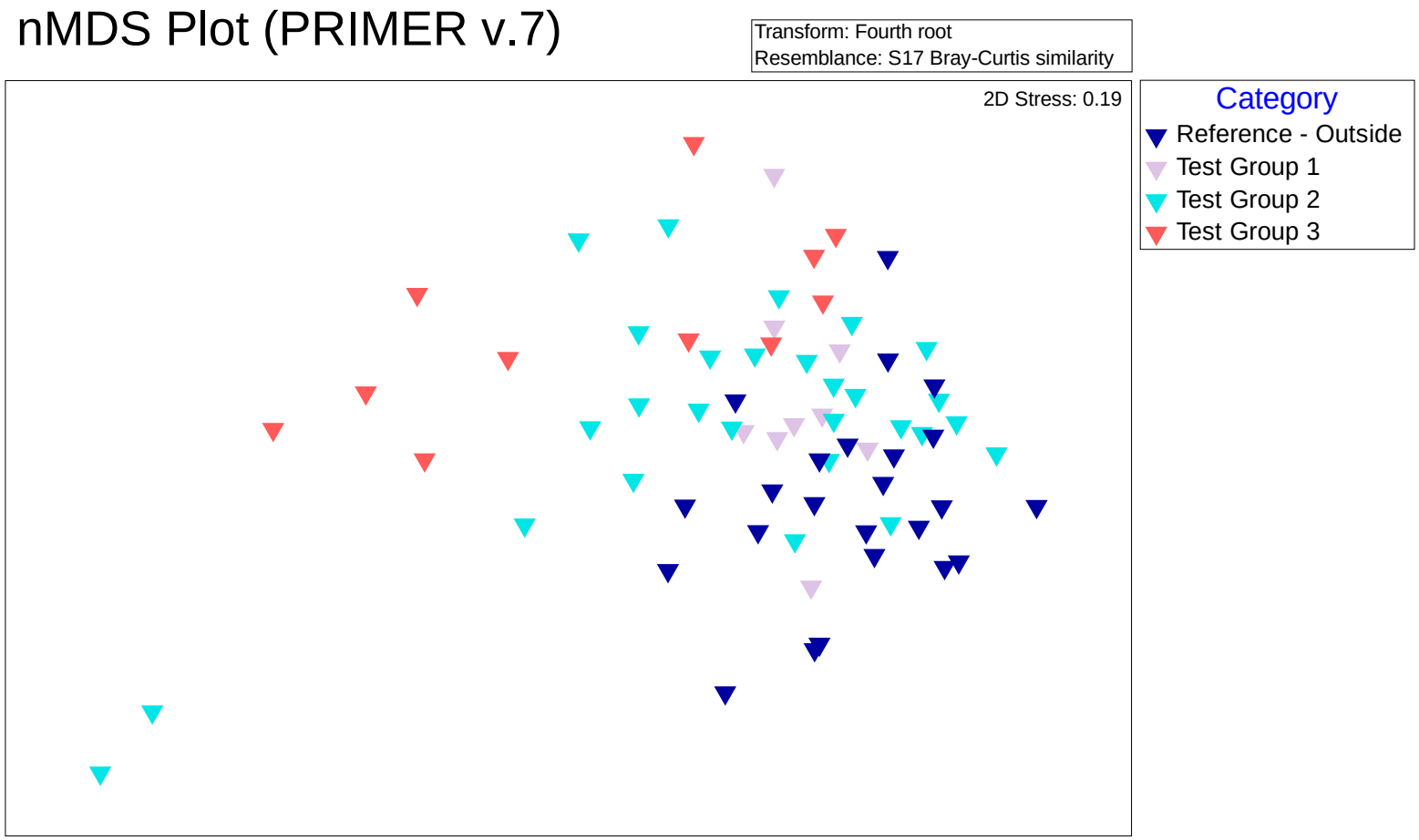
Challenges in the Field

- Intensive field logistics and budget
  - Multiple crews (some years 12+ staff)
  - Multiple helicopters
  - Multiple sets of sampling gear
  - Shipping water samples to labs daily
- High (swift) water years
  - Difficulty accessing sites
  - Difficulty completing the benthic kick and other measurements
- Weather delays common in the fall (snow, fog)
- Beaver dams
- Keeping samples cool (water and sediment) or frozen (SPMDs)

Steepbank River Gradient

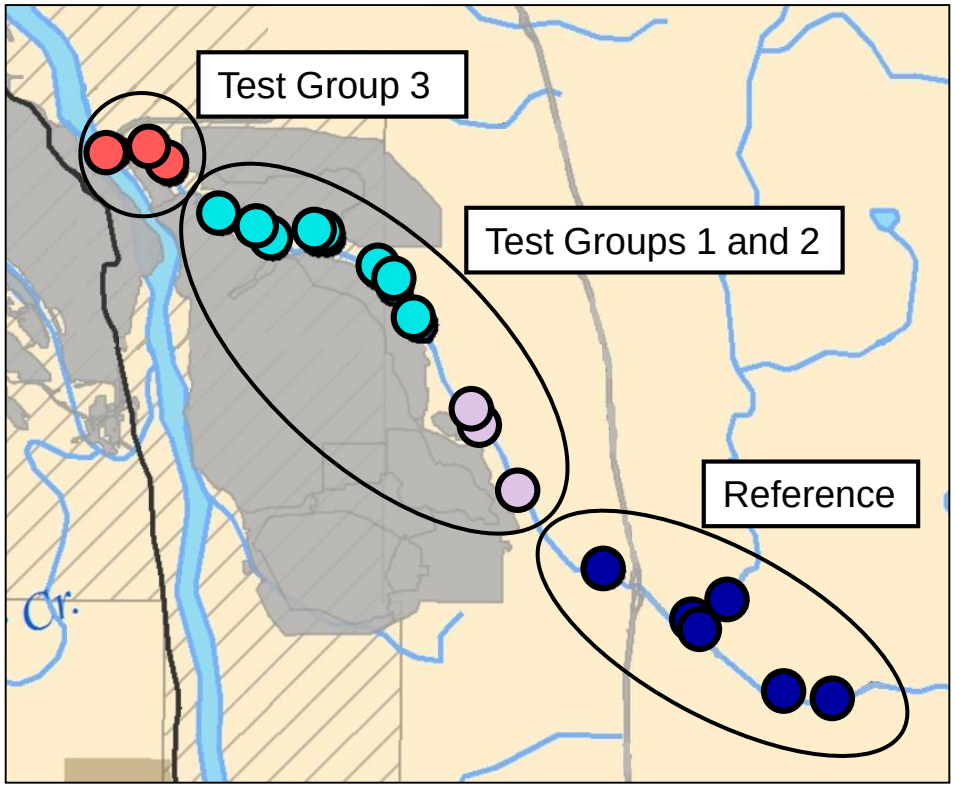


Steepbank River Invertebrates



Steepbank River Invertebrates

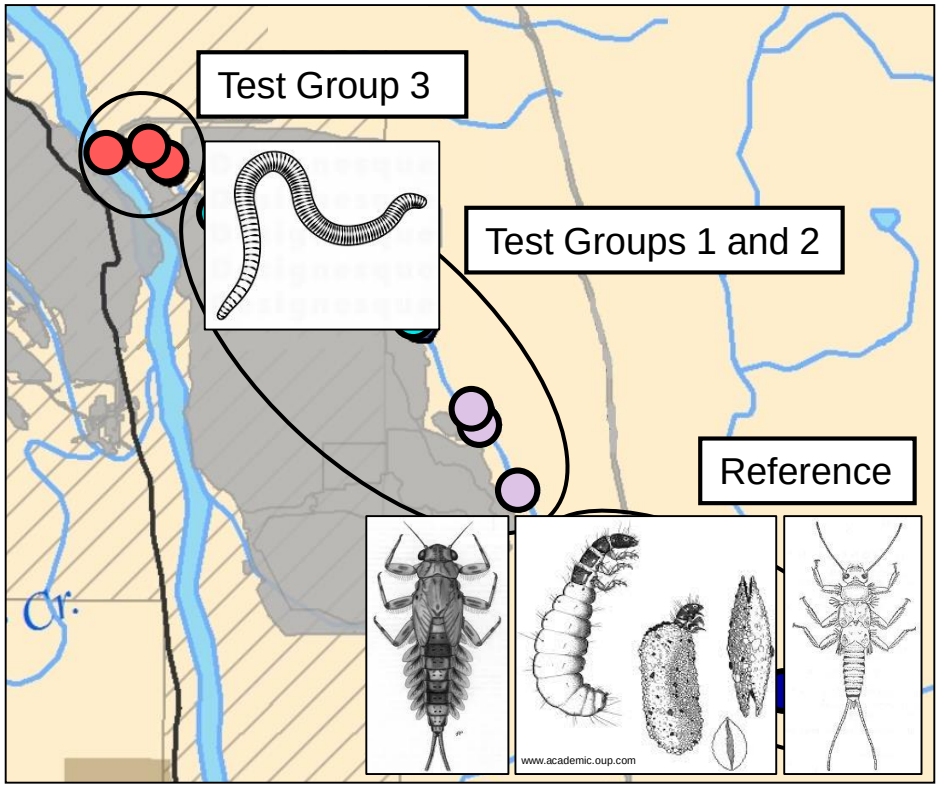
PERMANOVA (Permutational MANOVA; PRIMER v.7)



p values				
	Ref	***Test 1***	***Test 2***	***Test 3***
Ref		0.0031*	0.0002*	0.0001*
Test 1			0.2863	0.0004*
Test 2				0.0104*
Test 3				

Steepbank River Invertebrates

SIMPER (Similarity Percentages; PRIMER v.7)



Reference vs. Test Groups

Plecoptera	Nemouridae	↑ Ref
Trichoptera	Brachycentridae	↑ Ref
	Hydropsychidae	↑ Ref
	Lepidostomatidae	↑ Ref
Annelida	Naididae	↑ Test

Steepbank River Invertebrates

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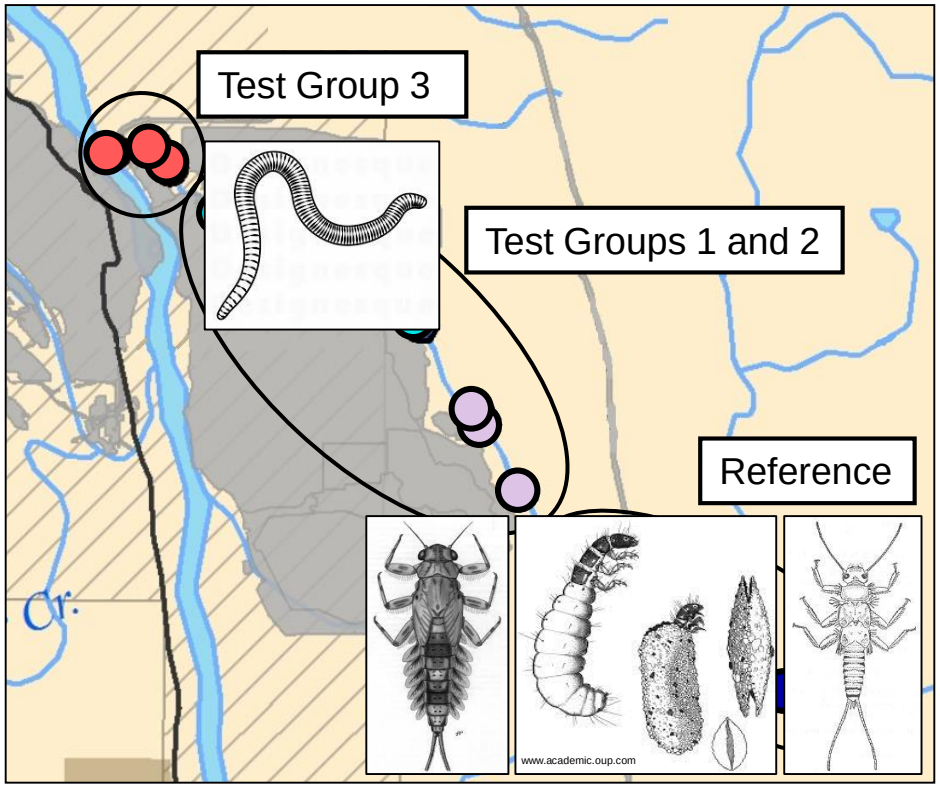

Reference vs. Test Groups

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	Hydropsychidae	↑ Ref
	Lepidostomatidae	↑ Ref
Annelida	Naididae	↑ Test

Test Groups 1 and 2 vs. Group 3

Ephemeroptera	Baetidae	↓ Test 3
Trichoptera	Lepidostomatidae	↓ Test 3
	Hydropsychidae	↓ Test 3
	Glossosomatidae	↓ Test 3
	Brachycentridae	↓ Test 3

Decision Framework

Level	Trigger	Magnitude
1	Effect detected	Statistical change
2	Confirmation of effect	Statistical change in same direction
3	Exceeds critical effect size	Under development
Action Level	Exceeds critical effect size and is getting worse	Prolonged exceedance of critical effect size

Integrated Monitoring Plan for the Oil Sands (ECCC 2011)

Summary

- OSM benthic program in Lower Athabasca River tributaries uses standardized CABIN protocols to assess invertebrate assemblages along a longitudinal gradient of increased oil sands mining development
- There are statistical differences in benthic assemblages from upstream reference areas and downstream test groups (in all major tributaries)
- A large portion of the dissimilarity between groups was explained by the abundances of several EPT (Ephemeroptera Plecoptera Trichoptera) families which are in higher abundance in reference areas and upstream test groups
- A critical effects size is being developed to assess the ecological importance of these changes and an investigation of potential environmental drivers is underway

CABIN Biomonitoring in the In Situ Oil Sands Regions of Alberta

Introduction to the Canadian Aquatic Biomonitoring Network

Environment and Climate Change Canada and Alberta Environment and Parks

February 24, 2021

Alberta

CABIN Monitoring in In Situ Regions

- Bitumen extraction in the in situ regions of Alberta often occurs in a complex landscape of multiple stressors, including agriculture and urban development

- How can a monitoring program be designed that teases potential oil sands impacts from other stressors?

https://www.aer.ca/providing-information/by-topic/oil-sands

CABIN Monitoring in In Situ Regions

Roadmap for talk:

1) Choosing sample sites in a complex landscape using GIS analysis

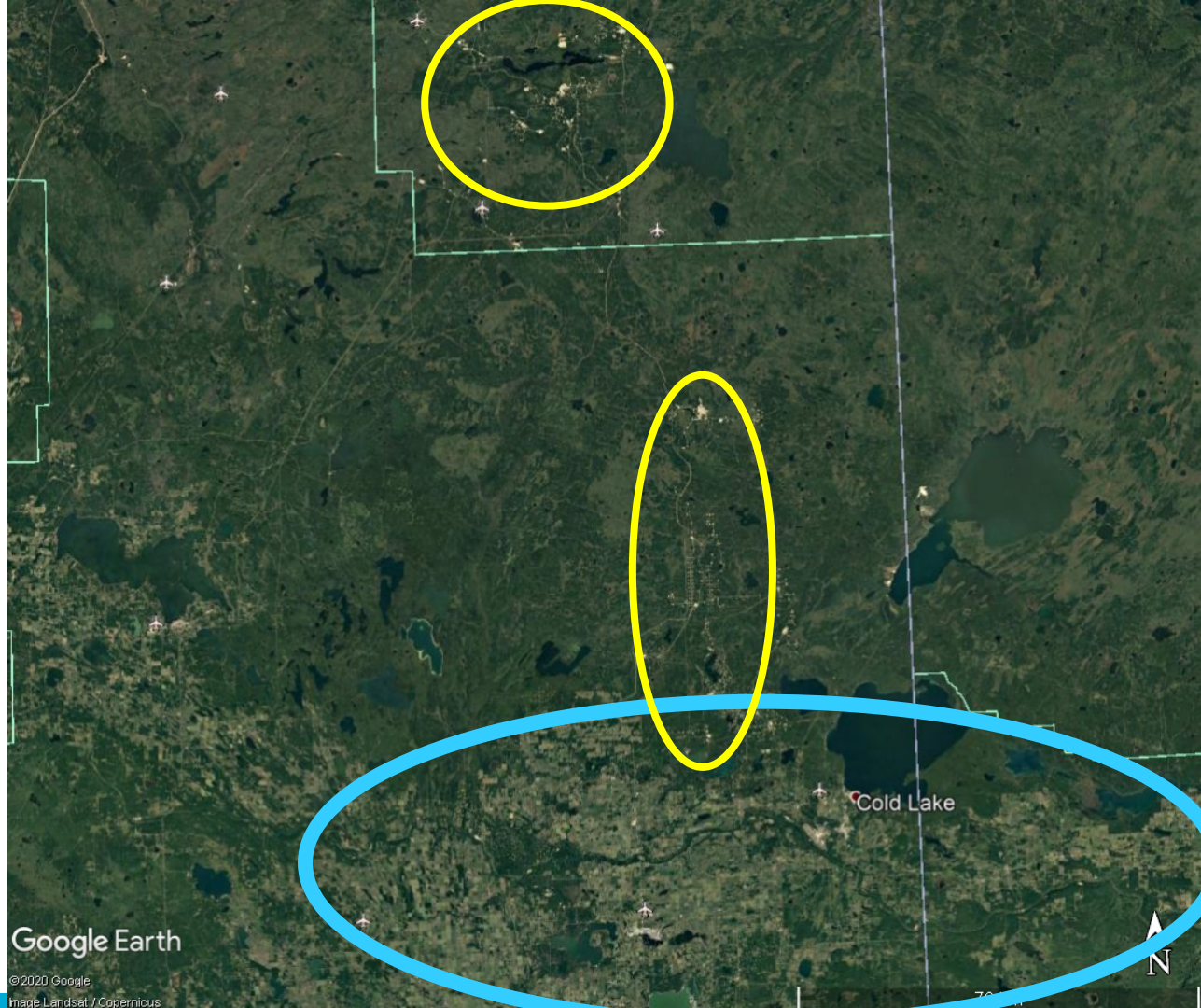
2) Using desktop resources to identify erosional habitat in areas targeted for sampling

In Situ: Cold Lake OSR

In situ facilities exist in agricultural/urban context

- Agriculture/Urban
- In situ facilities

Some facilities are closer to agriculture and urban areas than others

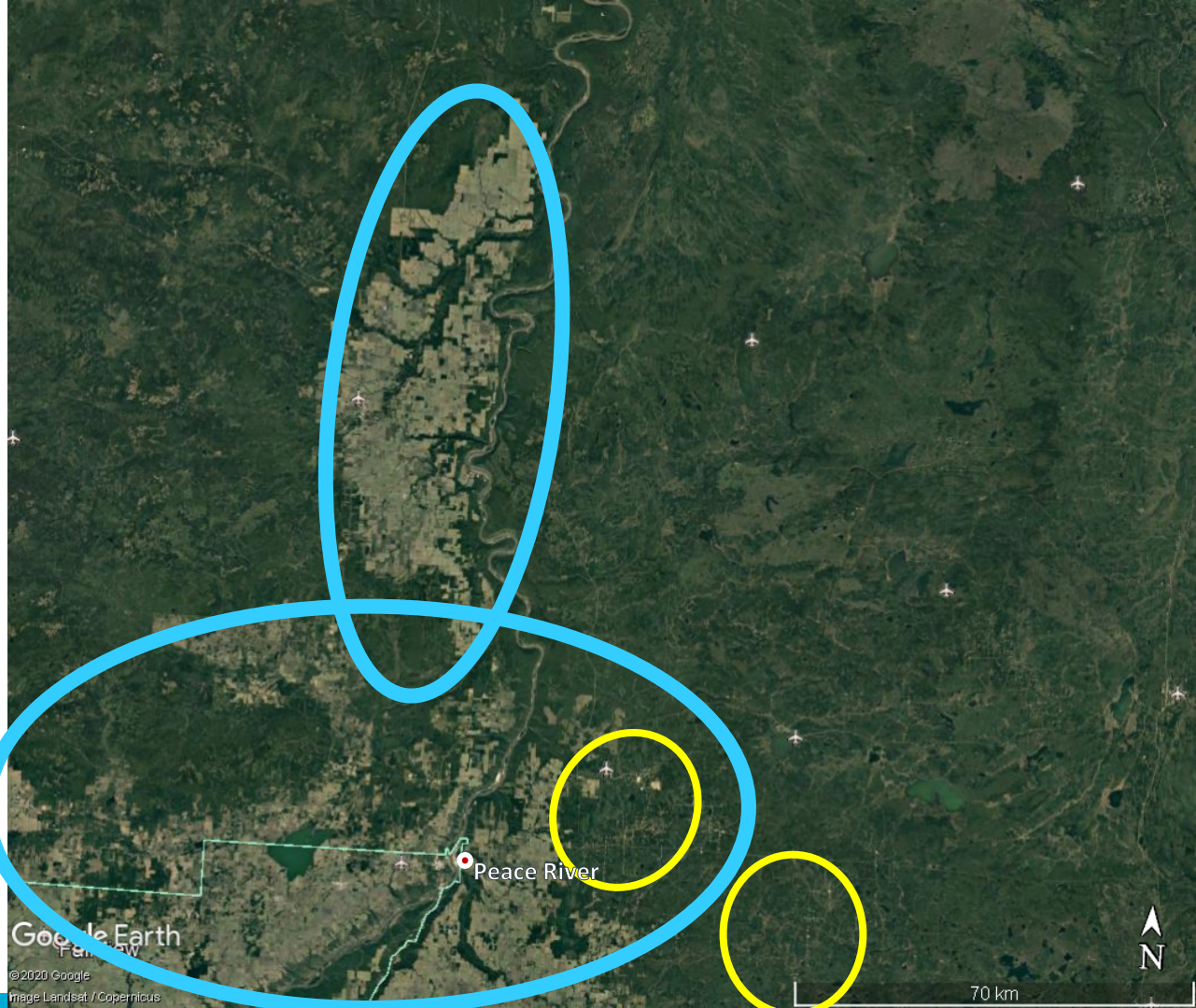


In Situ: Peace River OSR

In situ facilities exist in agricultural/urban context

- Agriculture/Urban
- In situ facilities

Some facilities are closer to agriculture and urban areas than others



In Situ Regions: CABIN in complex landscapes

- Study design and sampling are ongoing in the in situ regions of the province, and effort is focused on using GIS to define types and intensities of human activities on the landscape. This allows us to:

- Choose test sites in areas likely to have potential oil sands impacts.

- Choose reference sites in areas unlikely to have potential oil sands impacts.

What about other potential anthropogenic impacts– urban development? Agriculture?

Using GIS to identify potential sample sites

- Geospatial programs (GIS) can be used to extract data for many types of human stressors in sub-watersheds and determine what the primary source(s) of potential impacts are

- There are many publically-available data layers, including the Alberta Biodiversity Monitoring Institute's Human Footprint Inventory (2016)

Using GIS to identify potential sample sites

For the in situ regions of oil sands extraction, we work with a GIS specialist to:

1) Identify the spatial extent of our study areas including potential test and reference areas,

2) Identify the scale to extract stressor information (e.g., “microbasins,” or small watersheds at least 25 km^2),

3) Identify all potential stressors of interest, including those related to oil sands extraction (e.g., facilities, pipeline crossings, etc.) and those related to other potential impacts (e.g., forestry, farming, and urban development).

Using GIS to identify potential sample sites

4) Once values for stressors are extracted for all microbasins of interest, we can quantify the types and intensities of potential impacts across our defined study area to help determine test and reference areas.

What do the results of these analyses look like?

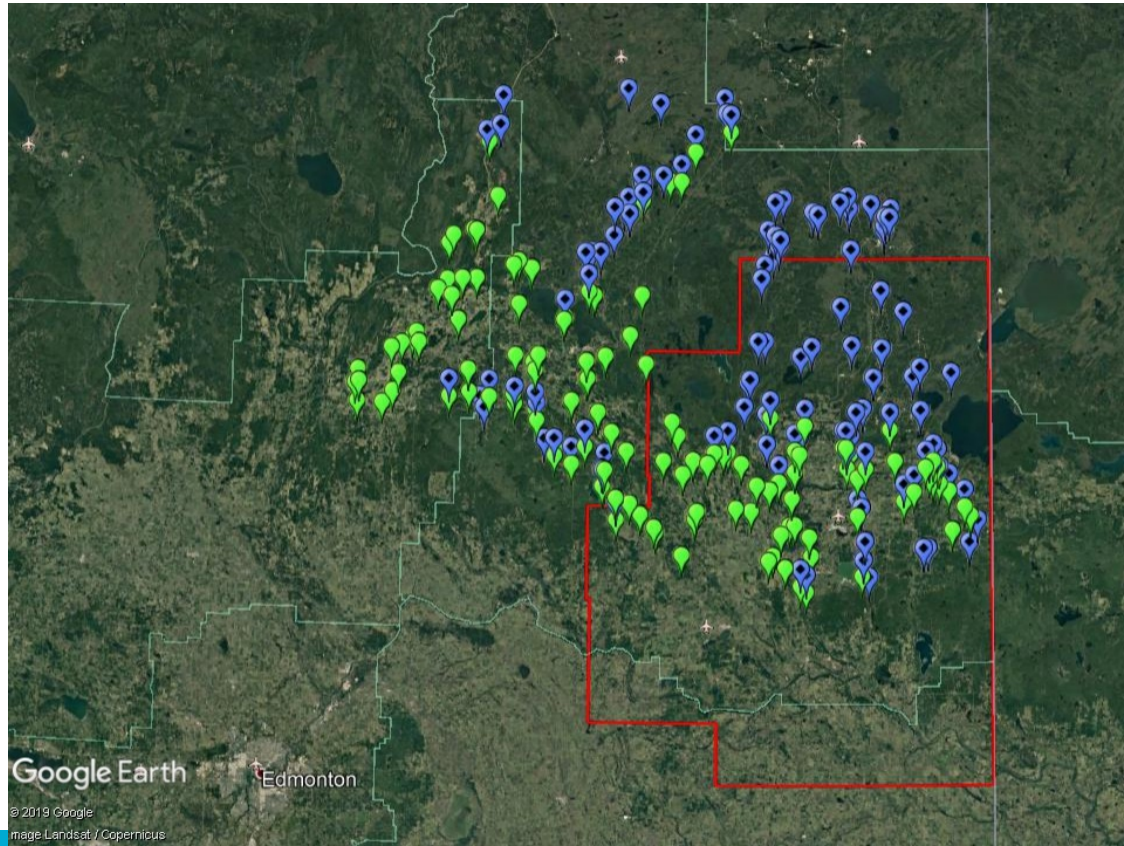
Using GIS to identify potential sample sites

In Situ: Cold Lake

Microbasins in Green have primarily agricultural and/or urban activities

Microbasins in Blue have primarily oil and gas-related activities

Microbasins in **Black** represent the top 25% of microbasins with highest measured oil and gas-related activities



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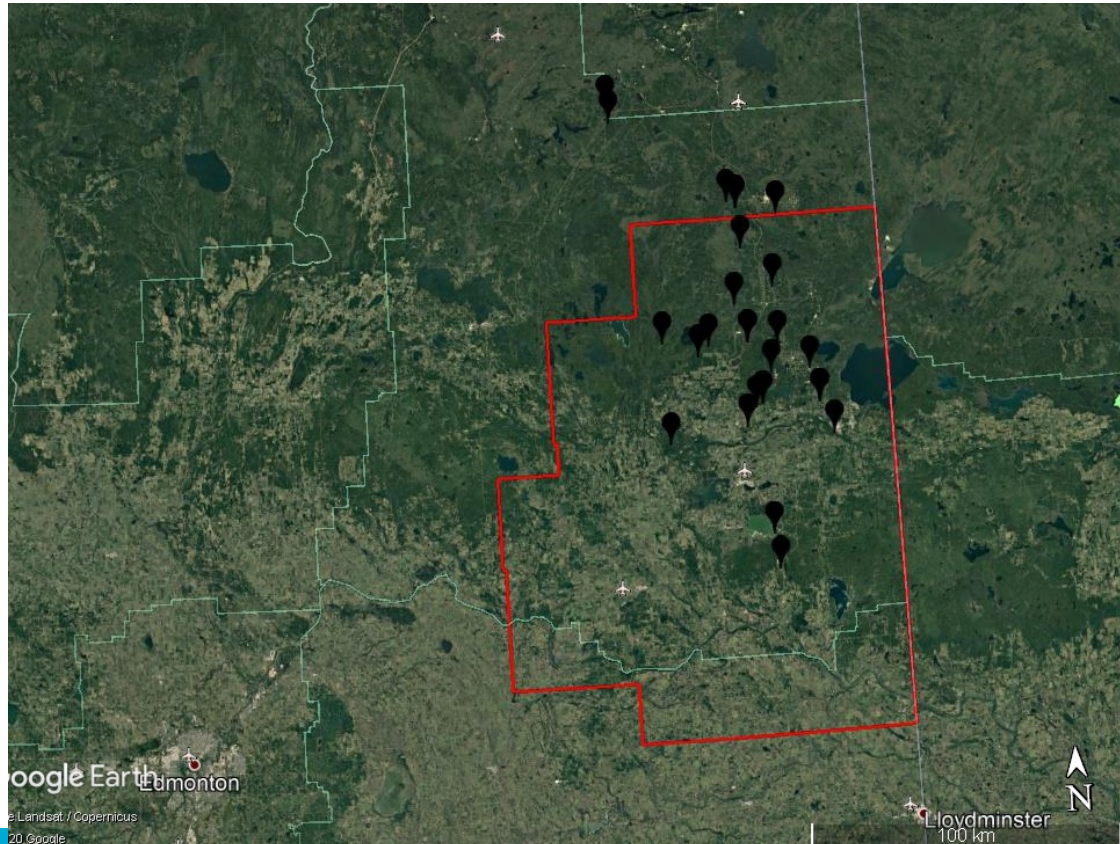
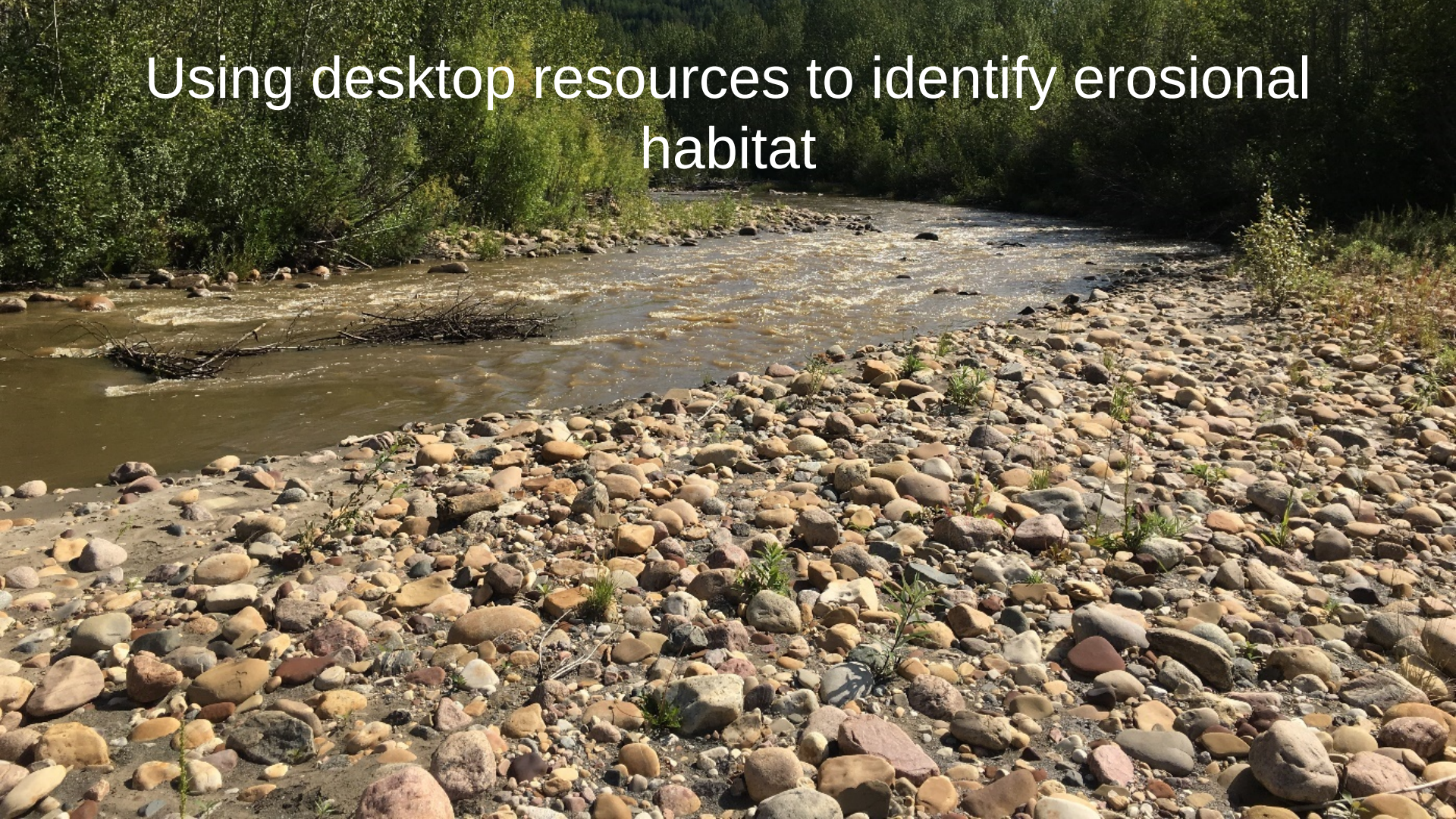


Using desktop resources to identify erosional habitat



Using desktop resources to identify erosional habitat

- Finding erosional sites appropriate for CABIN sampling can be a challenge in some regions
  - E.g., low gradient areas with slow-moving streams.

- Field reconnaissance is essential, but some tools do exist to help guide effective “desktop” searches for erosional habitat.

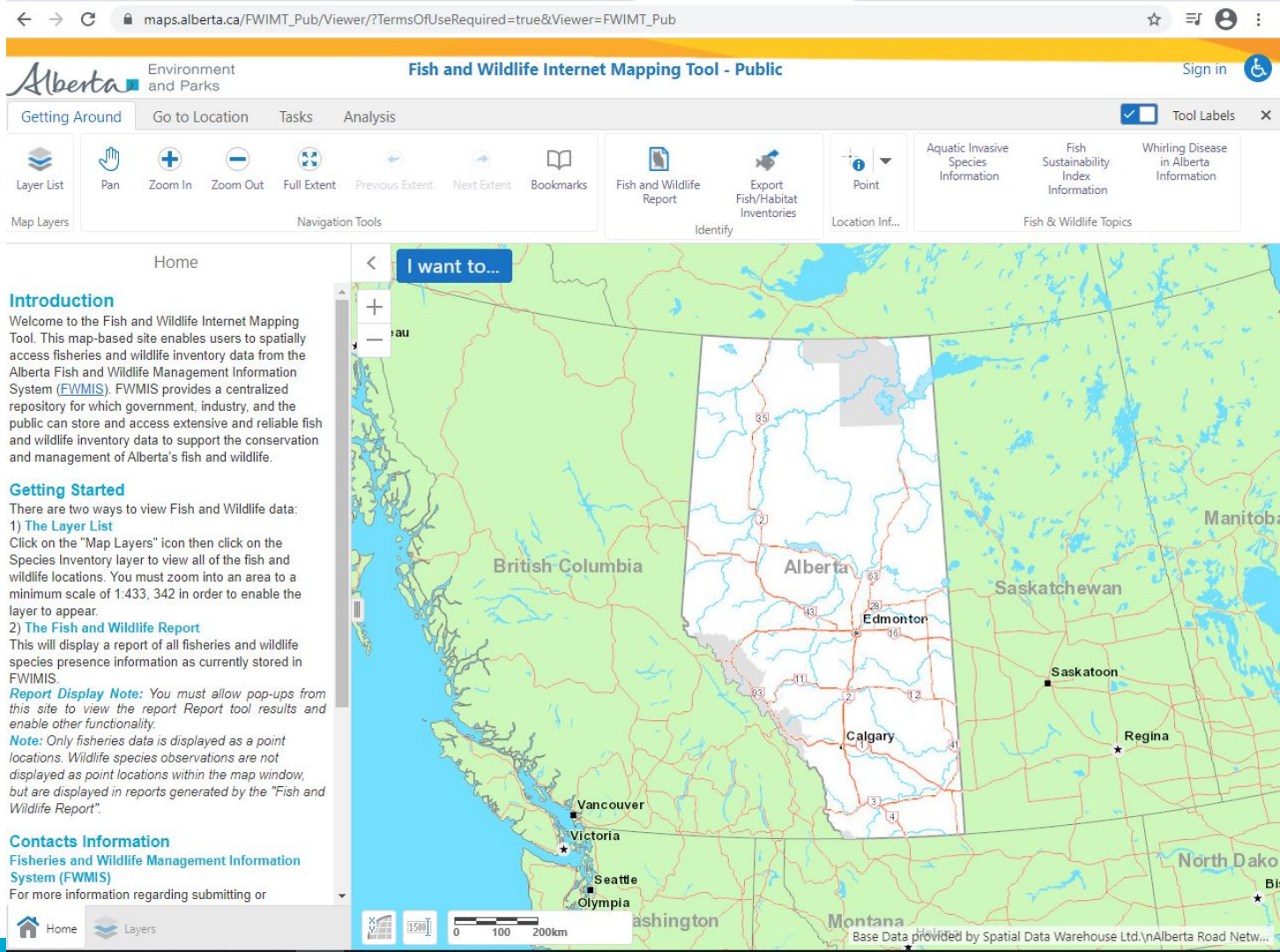
- Alberta’s Fisheries and Wildlife Internet Mapping Tool (FWMIT) can be used to locate potential erosional habitat.

FWMIT Landing Page

Everyone who applies to conduct a fish and fish habitat assessment in Alberta must submit the results of their assessments to AEP

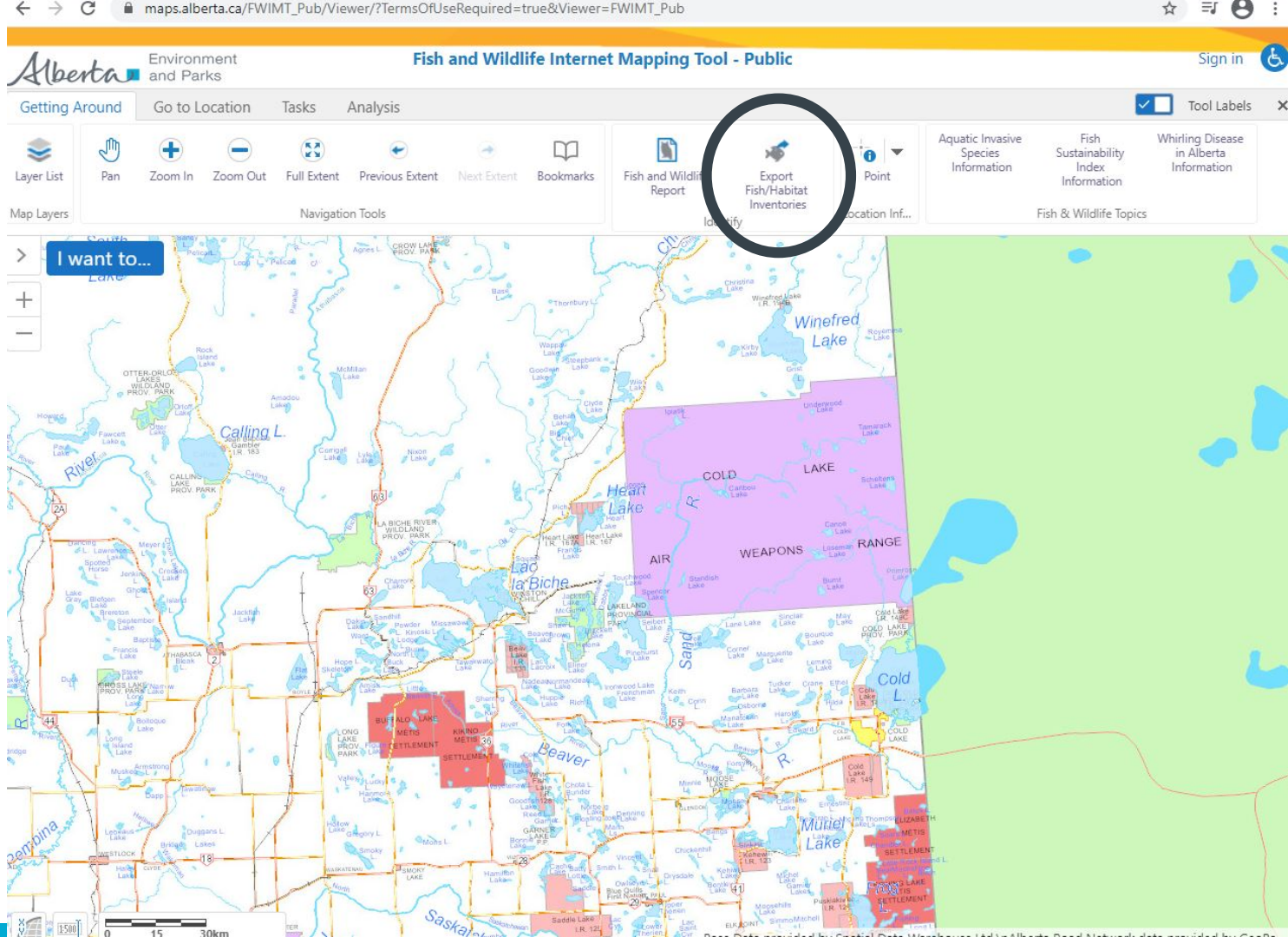
Results are publically available via the Fish and Wildlife Internet Mapping Tool

Most people use the tool to query fish records, but **habitat** records are also available



Export Fish/Habitat Inventories

Results of fish and habitat surveys are available via a button at the top of the page



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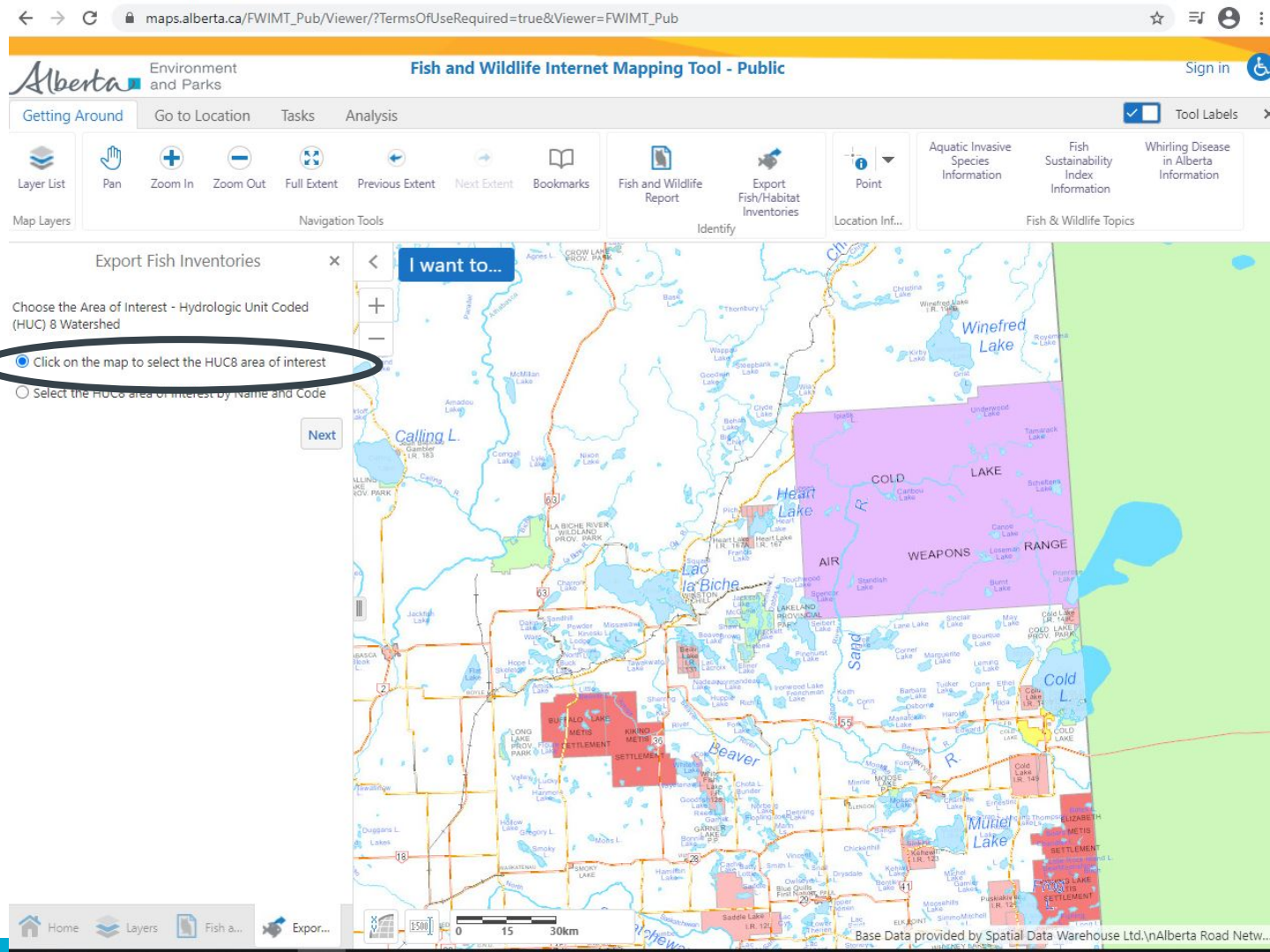
All surveys can be queried within a HUC 8



Export Fish/Habitat Inventories

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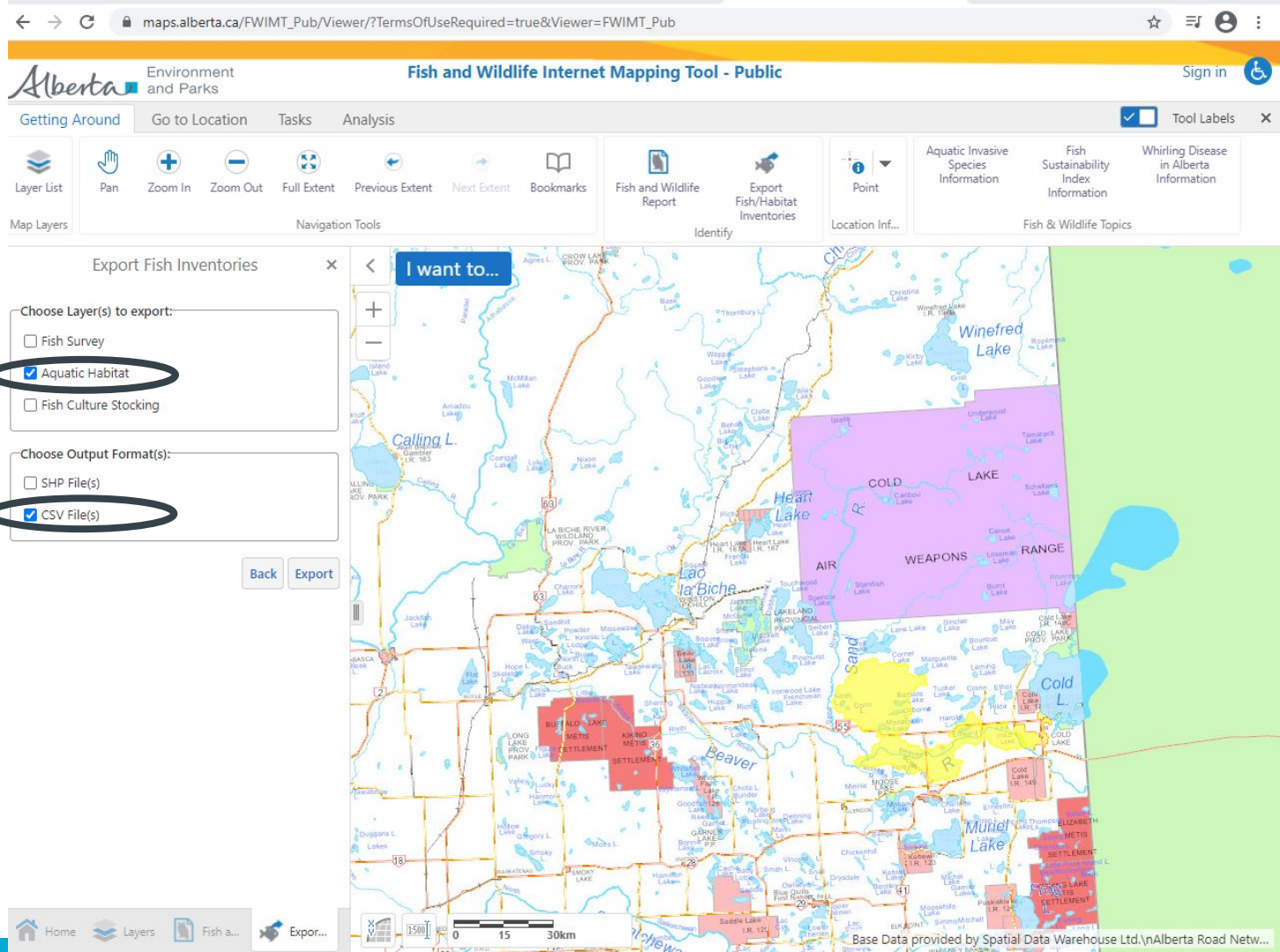
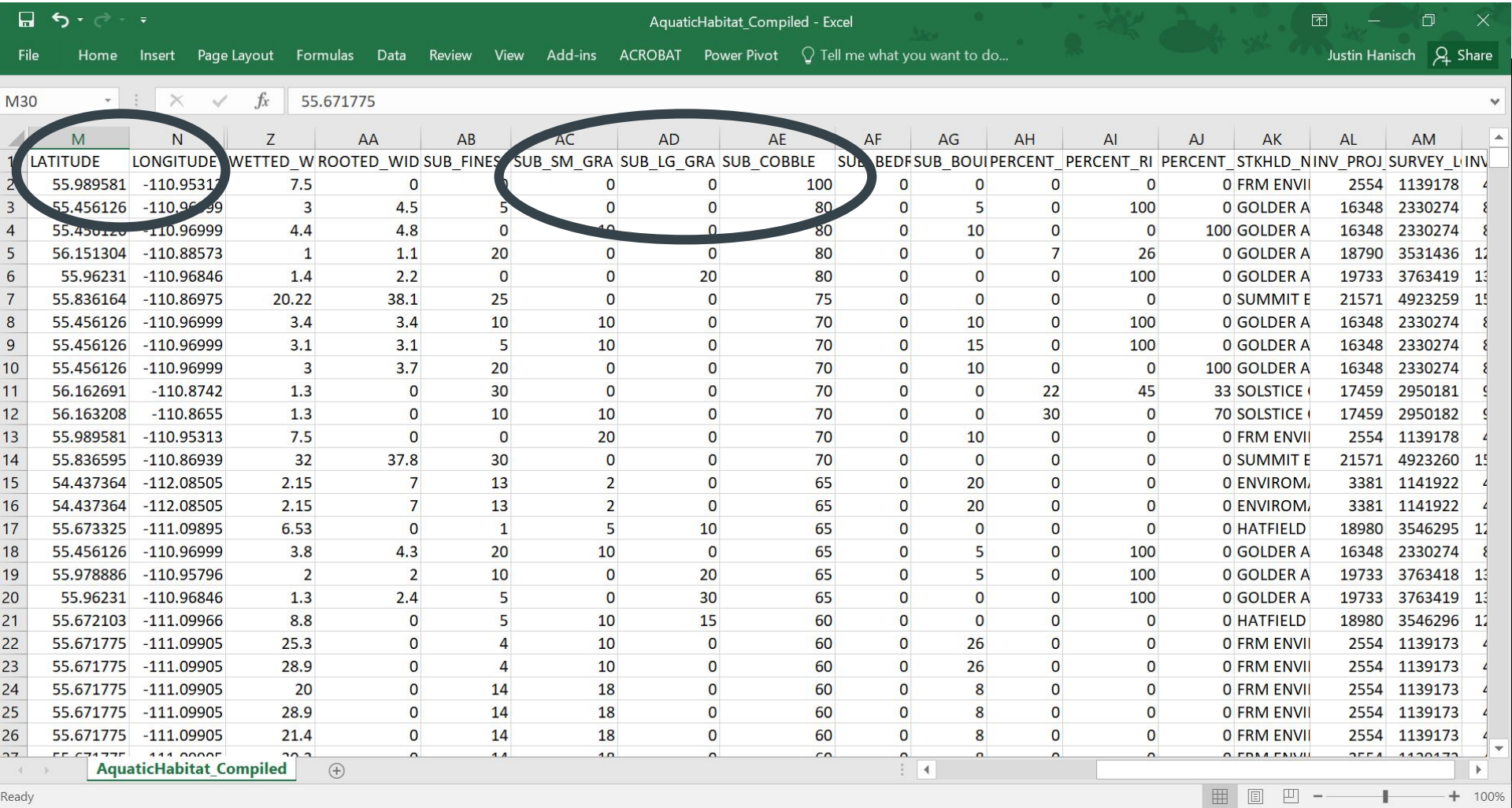
All surveys can be queried within a HUC 8

Aquatic habitat results can be exported to CSV after the desired HUC 8 is chosen on the map

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AquaticHabitat_Compiled
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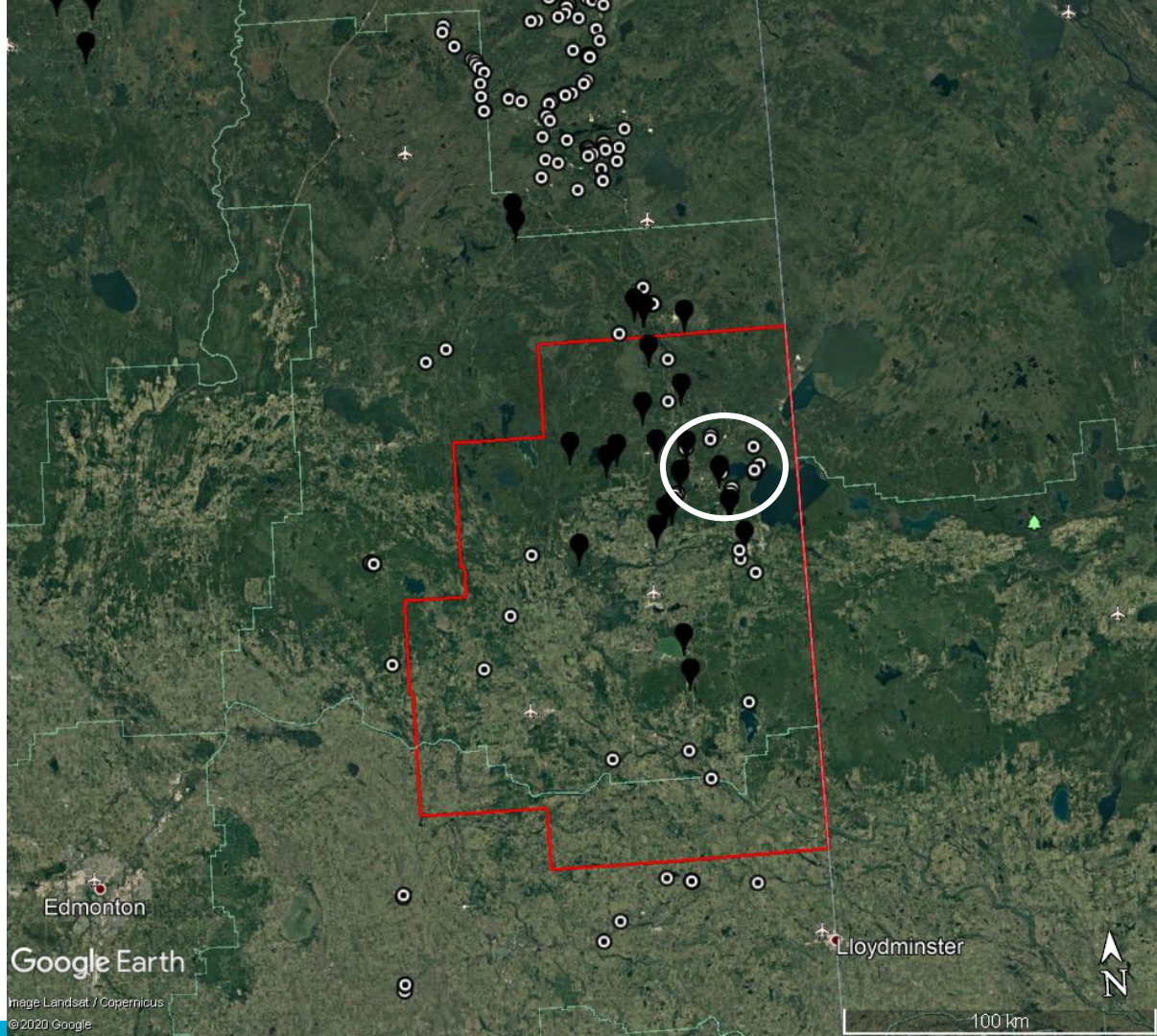
Combining GIS and desktop site reconnaissance

We overlaid sites with > 80 % non-fine substrate with microbasins having the highest calculated oil and gas activities

Conducted fly-over recon in an area with both documented erosional habitat *and* microbasins with potential O&G impact

Located several sites for sampling in a region we were concerned wouldn't be suitable for CABIN



Conclusions

- Process presented here is “screening-level” desktop exercise to identify potential test and reference areas and specific sampling locations.

- FWMIT database is very helpful where lots of previous assessments have occurred (e.g., areas of exploration and development) but less so where exploration/development haven’t occurred.

- Geospatial analyses will be combined with measurements of water and sediment quality at each site to better quantify potential gradients of impacts.

Acknowledgments

- Funding: Canada-Alberta Oil Sands Monitoring Program
- ECCC and AEP scientific and technical staff
- National Laboratory for Environmental Testing

- Reports: https://www.canada.ca/en/environment-climate-change/services/oil-sands-monitoring/documents-reports.html


Questions?