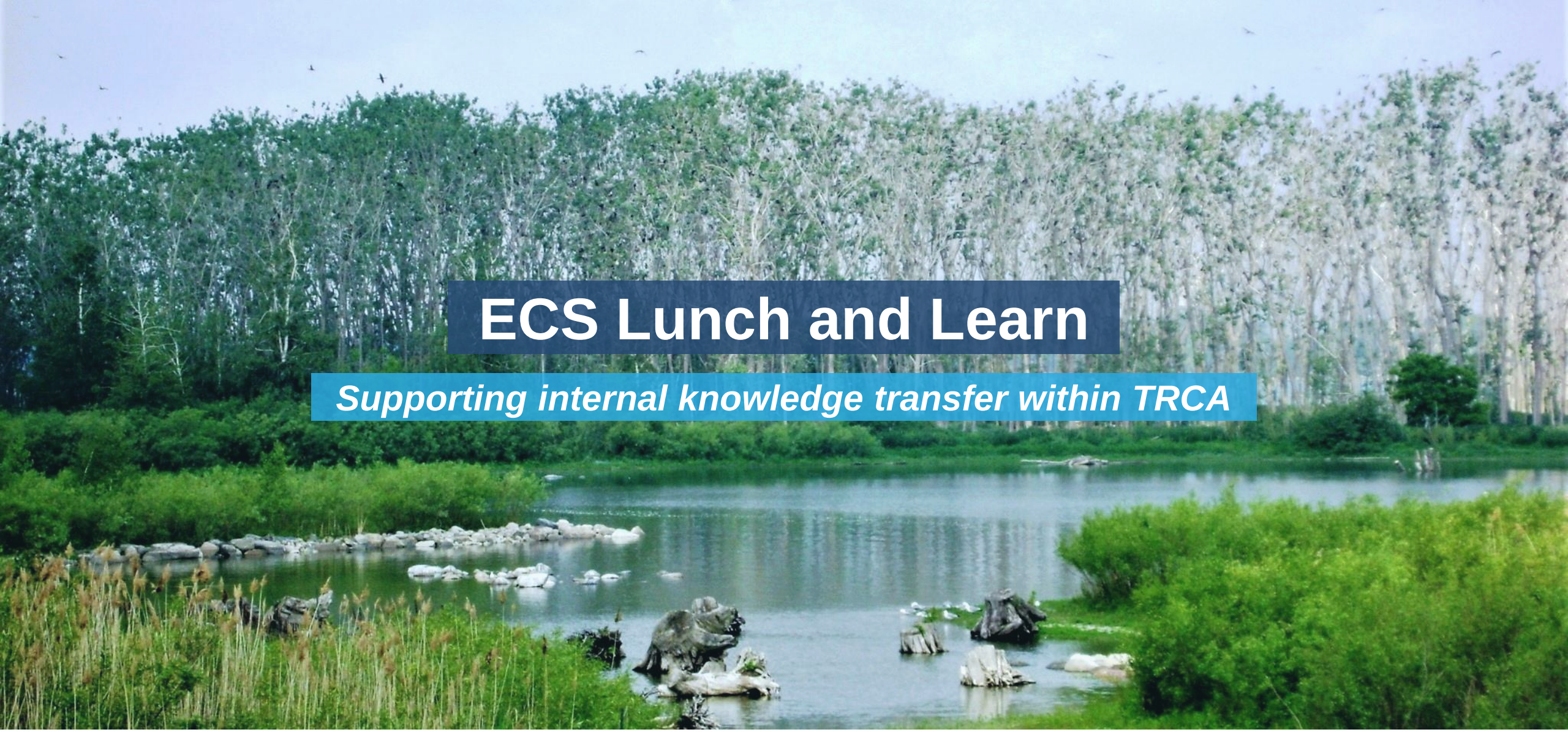

ECS Lunch and Learn

Supporting internal knowledge transfer within TRCA

July 14, 2021

Toronto and Region Conservation Authority

TRCA Water Resource System

Methods and analysis for delineating Key Hydrologic Features & Areas

Presented by: Jonathan Ruppert, Research Scientist, Ecosystem & Climate Science, WPES, DES

July 14, 2021

Toronto and Region Conservation Authority

Outline

1. Quick Background

2. Layer Creation/Updates
   - New Layers (ESGRAs, Seepages/Springs, SSWCAs)
   - Refinements (Wetlands, Inland Lakes)
   - New Classifications (Permanent/Intermittent Streams)

3. Overview of WRS Identification and Mapping

Definition & Relevant Policies

- Water Resource System (WRS)

  > *"ground water features and areas and surface water features (including shoreline areas), and hydrologic functions, which provide the water resources necessary to sustain healthy aquatic and terrestrial ecosystems and human water consumption."* - *Growth Plan* (2020)

- Relevant policies for Water Resource System (WRS), include:
  - *Provincial Policy Statement* (2020)
  - *Growth Plan* (2020)
  - *Greenbelt Plan* (2017)
  - *Oak Ridges Moraine Conservation Plan* (ORMCP; 2017)

Water Resource System (WRS)

Key Hydrologic Areas (KHAs)

- Significant Groundwater Recharge Areas (SGRAs);
- Highly Vulnerable Aquifers (HVAs);
- Significant Surface Water Contribution Areas (SSWCAs);
- Ecologically Significant Groundwater Recharge Areas (ESGRAs);

Key Hydrologic Features (KHFs)

- Permanent streams;
- Intermittent streams;
- Inland lakes and their littoral zones;
- Seepage areas and springs;
- Wetlands.

Overview of WRS at start of 2020

WRS Component	2019 Availability	New Areas Mapped	Lead	Partner
Seepages areas and Springs	N	Y	WPES	ORMGP
Wetlands	Y	N	WPES	BIDA
Inland lakes and their littoral zones	Y	N	WPES	BIDA
Permanent and Intermittent Streams	N	N	WPES	-
ESGRAs	Y	Y	WPES	BIDA/ORMGP
SSWCAs	N	N	WPES	-
HVAs*	Y	N	-	-
SGRAs*	Y	N	-	-

*Source Water Protection data layers.

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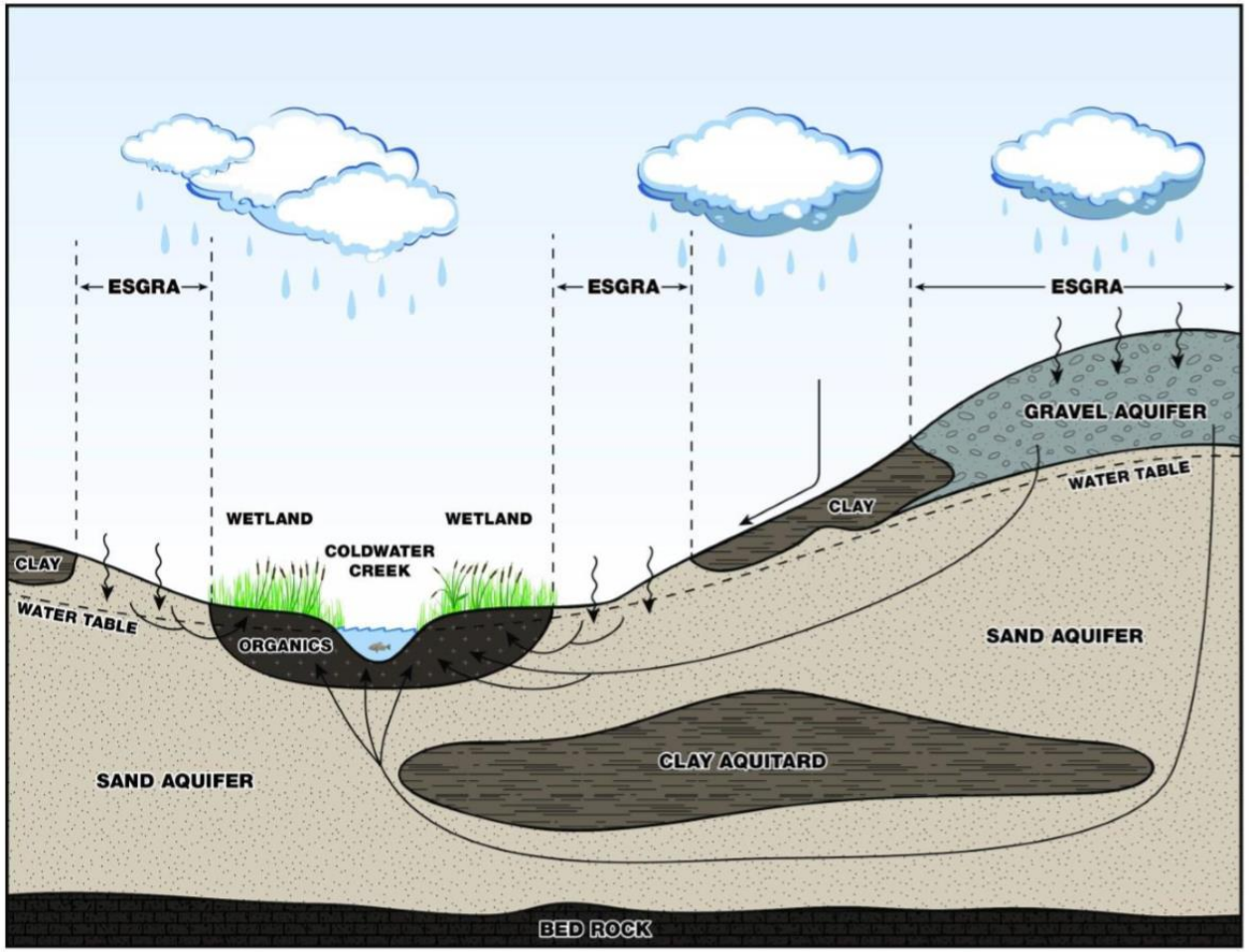
3. Quick Overview of WRS Mapping

Ecologically Significant Groundwater Recharge Area (ESGRA): Definition

"Areas of land that are responsible for replenishing groundwater systems that directly support sensitive areas like coldwater streams and wetlands" (LSRCA, 2014)

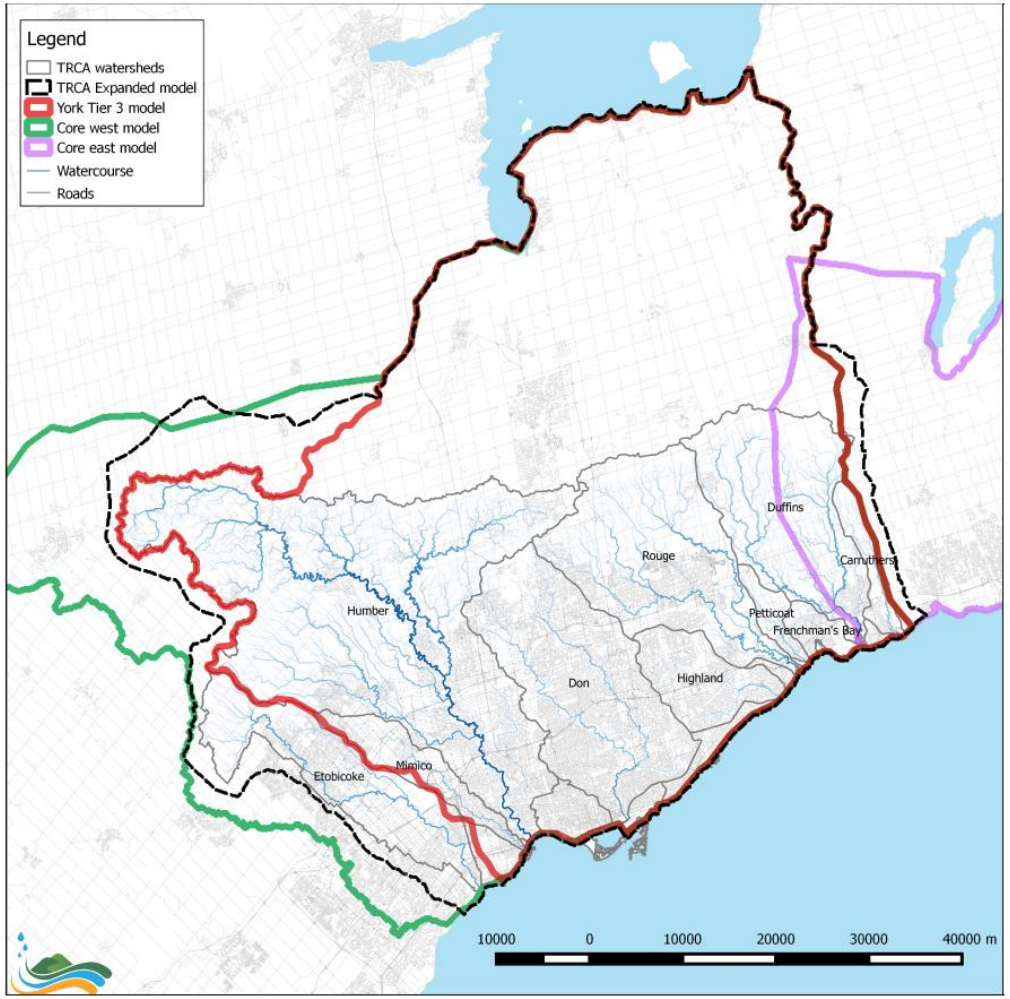


ESGRA precedents

- LSRCA – Western Lake Simcoe watersheds – 2012-2013 (Earth FX)
- LSRCA – Southern Lake Simcoe Watershed – 2015 (Golder)
- CLOCA – All watersheds – 2014 (Earth FX)
- Previous coarse-scale TRCA mapping based on surficial geology and known coldwater ecosystems – 2007-2008

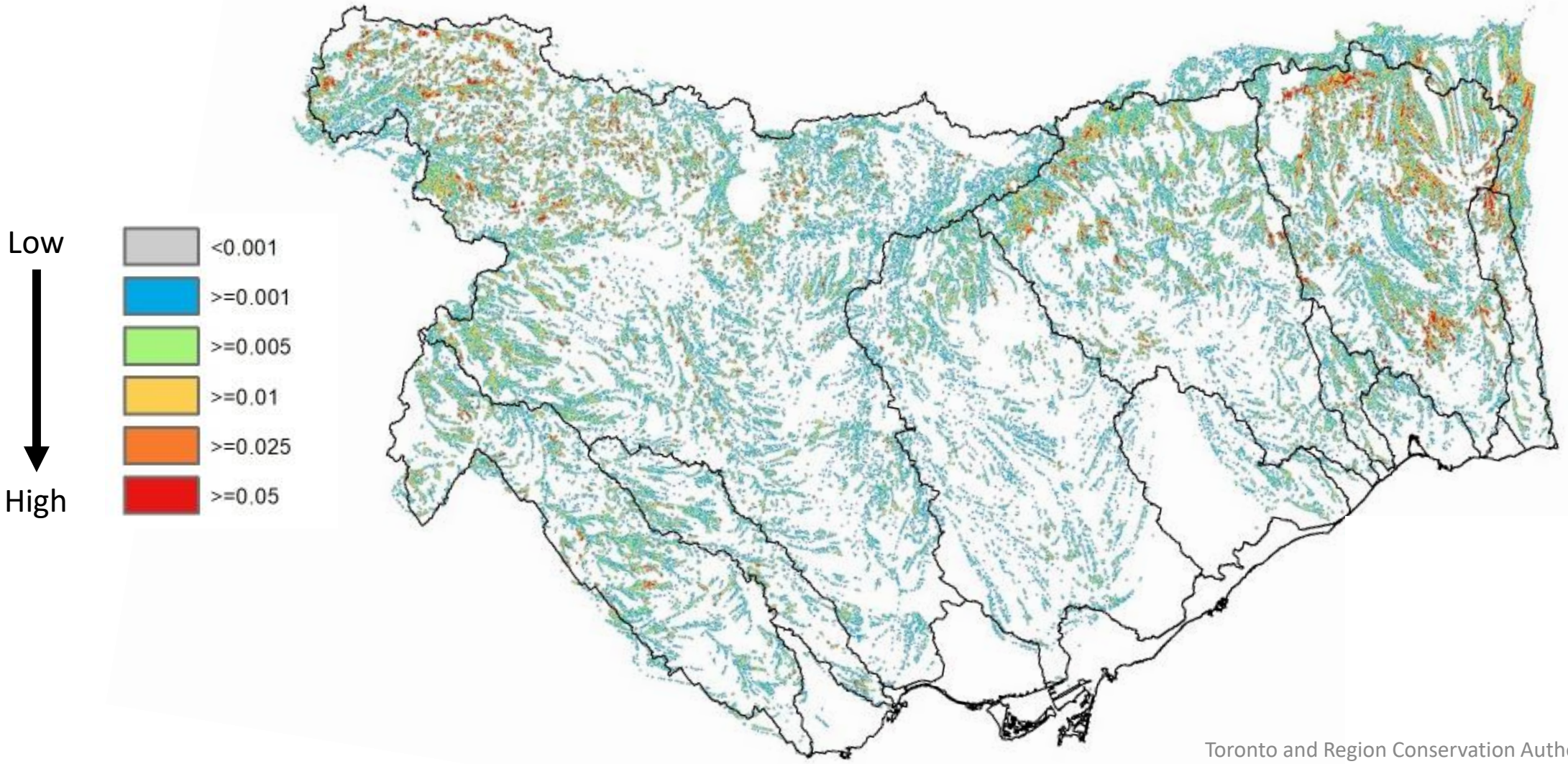
Development of mapping scenarios

1. ORMGP expanded York Tier 3 Water Balance Model to create **TRCA Expanded Groundwater Flow Model**
2. Reverse particle tracking used to determine recharge pathways for ecologically significant features (all wetlands and all streams)
3. TRCA technical cmte. reviewed ESGRA mapping scenarios based on model outputs to find optimal solution



Raw model output (endpoint density)

No Ecological Links & No Polygons!



Ecological evaluation component

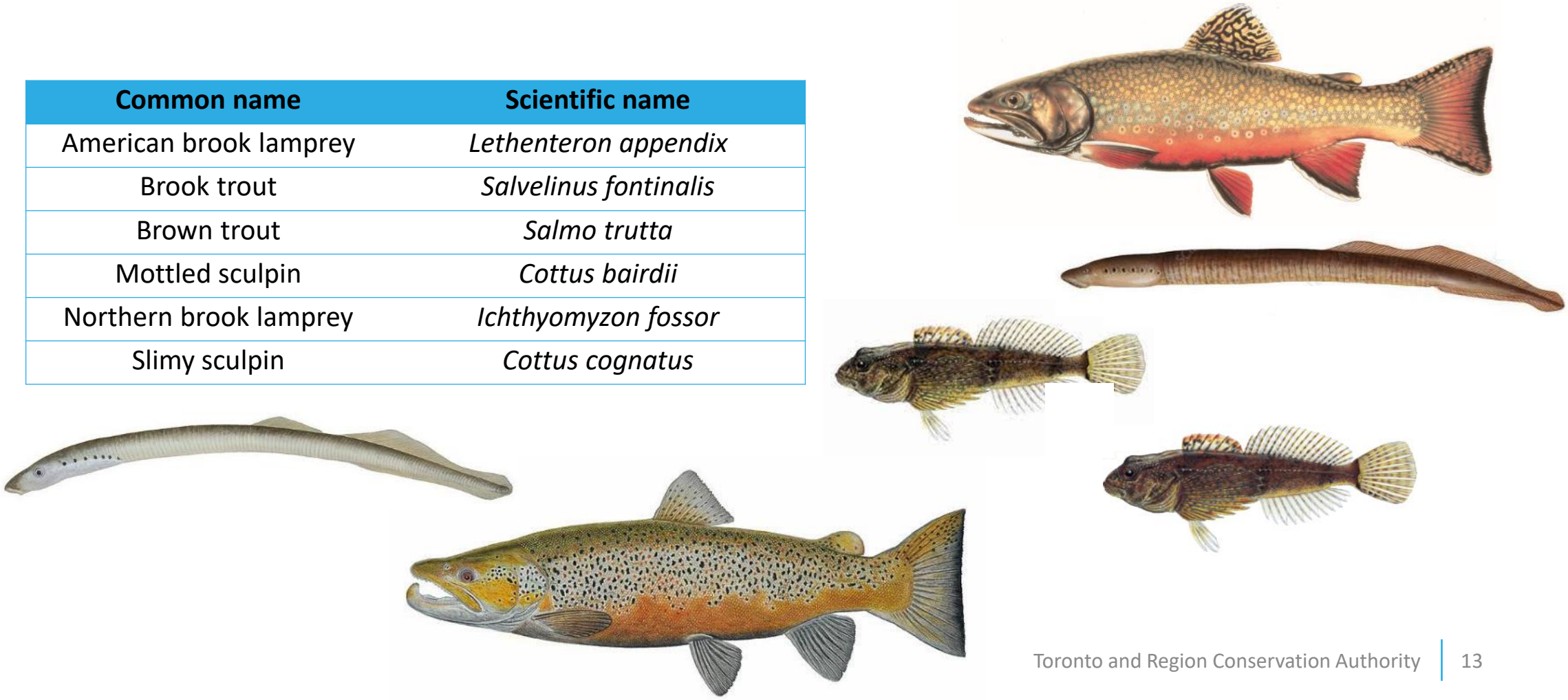
- Objective: evaluated ESGRA scenarios to determine the *proportion of highly groundwater-dependent ecosystems* (**HGDEs**) *whose recharge areas are covered*

- Evaluated 3 types of **HGDEs**:
  - **Coldwater fish** clusters (highest density of records; spp. determined by aquatic biologists)
  - Groundwater-obligate **wetland flora** clusters (highest density of records; spp. determined by terrestrial biologists)
  - **Fen wetlands** (understood to be HGDEs)

Ecological evaluation component

- **Coldwater fish** clusters (high density areas)

Common name	Scientific name
American brook lamprey	*Lethenteron appendix*
Brook trout	*Salvelinus fontinalis*
Brown trout	*Salmo trutta*
Mottled sculpin	*Cottus bairdii*
Northern brook lamprey	*Ichthyomyzon fossor*
Slimy sculpin	*Cottus cognatus*

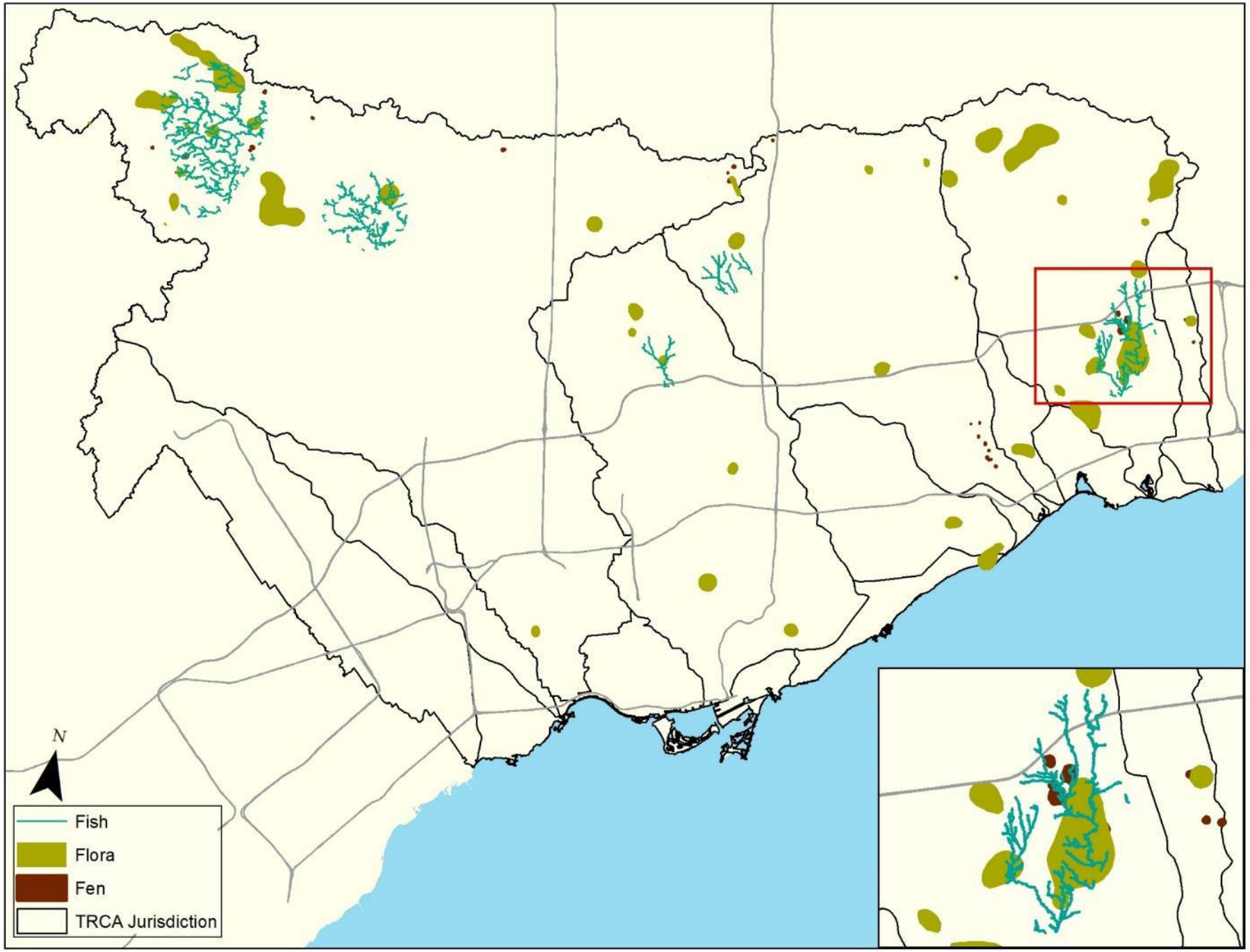


Ecological evaluation component

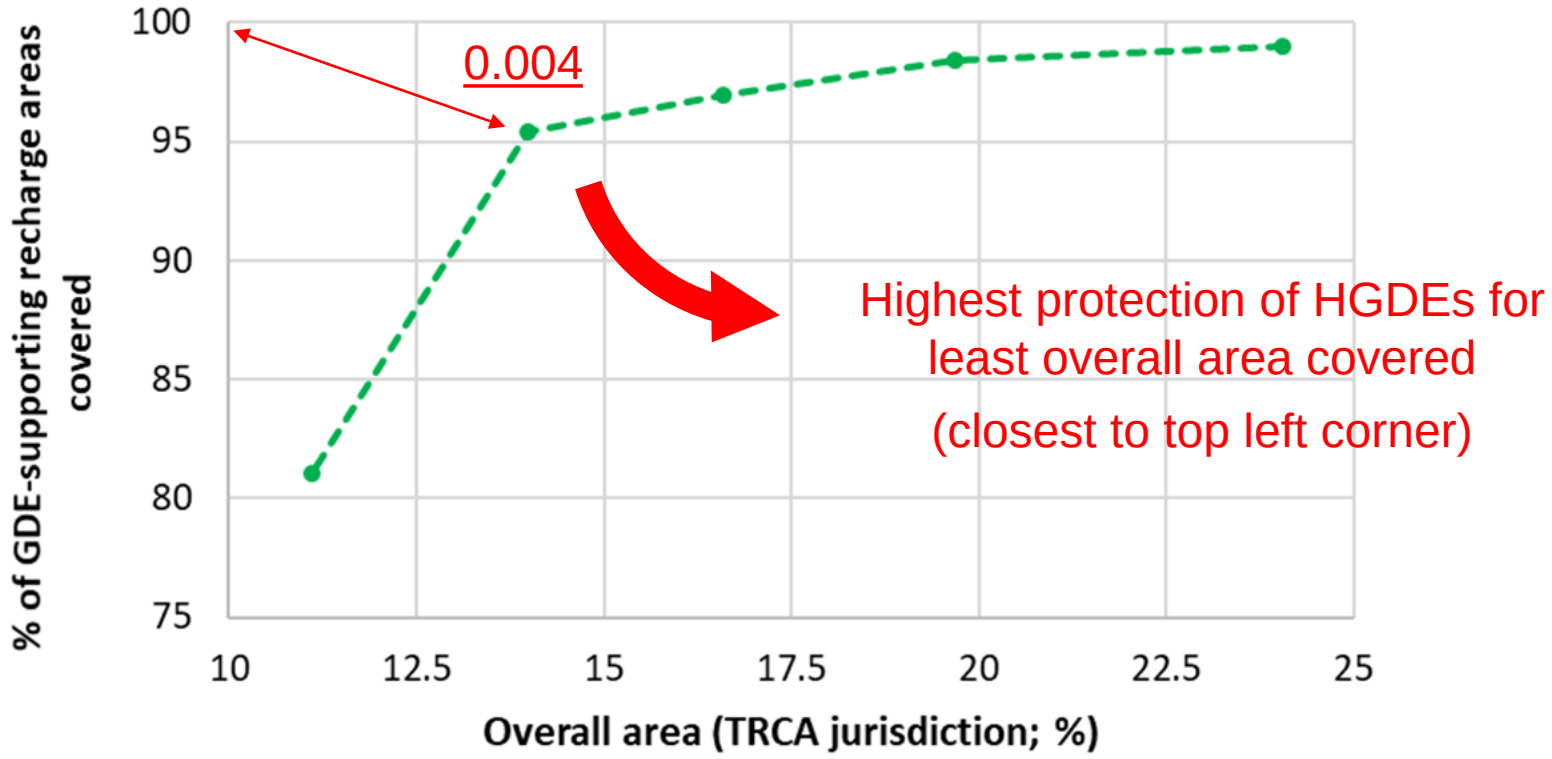
- Groundwater-obligate **wetland flora** clusters (high density areas)

Common name	Scientific name	Common name	Scientific name
American speedwell	*Veronica americana*	Schweinitz' sedge	*Carex schweinitzii*
Bristle-stalked sedge	*Carex leptalea*	Shining ladies' tresses	*Spiranthes lucida*
Bulblet fern	*Cystopteris bulbifera*	Showy lady's slipper	*Cypripedium reginae*
Fen star sedge	*Carex interior*	Skunk cabbage	*Symplocarpus foetidus*
Fringed brome grass	*Bromus ciliates*	Smooth-sheathed sedge	*Carex laevivaginata*
Fringed gentian	*Gentianopsis crinita*	Thin-leaved cotton-grass	*Eriophorum viridicarinatum*
Golden saxifrage	*Chrysosplenium americanum*	Three-seeded sedge	*Carex trisperma*
Hooded ladies' tresses	*Spiranthes romanzoffiana*	Turtlehead	*Chelone glabra*
Loesel's twayblade	*Liparis loeselii*	Two-seeded sedge	*Carex disperma*
Marsh marigold	*Caltha palustris*	Variegated scouring-rush	*Equisetum variegatum ssp. variegatum*
Marsh pennywort	*Hydrocotyle americana*		
Naked mitrewort	*Mitella nuda*	Water avens	*Geum rivale*
Rough sedge	*Carex scabrata*	Yellow sedge	*Carex flava*

HGDEs (indicators)



Scenario #9 – “optimized” scenario

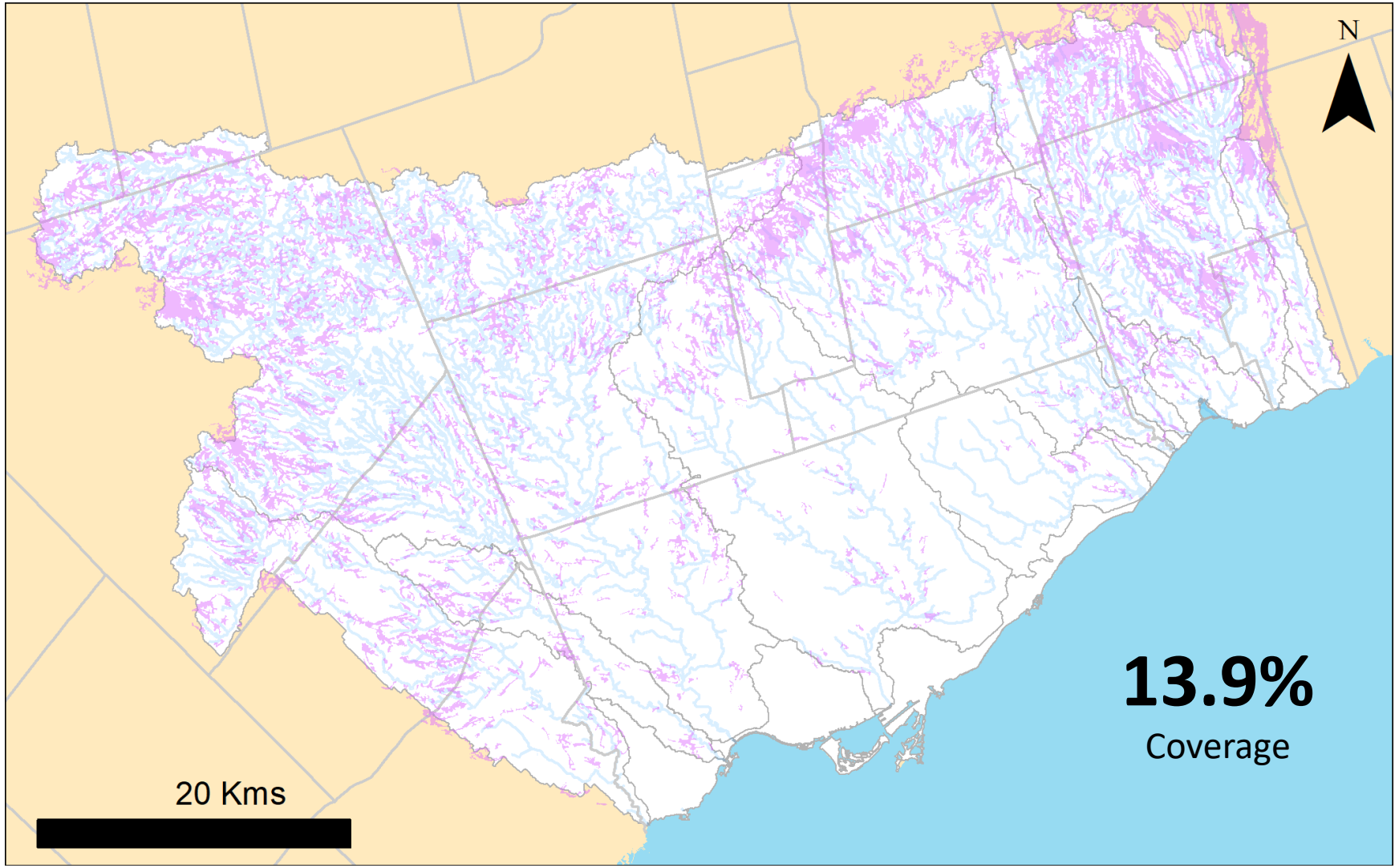


Comparison with precedents

	TRCA (2019)	LSRCA (2012)	LSRCA (2013)	LSRCA (2015)	CLOCA (2014)
Density Thres.	0.004	0.01	0.005	0.0005*	0.05*
Min. Size (ha)	5	4.5	4.5	10	4.5
Area of watershed (%)	13.9	15.3	21.3	29.0	38.0

ESGRA: Mapping

Watershed area (%)	13.9
HGDE protected (%)	95.4
Minimum size	5 ha
Overlap: ORMCP (%)	40.5
Greenbelt (%)	62.4
2017.Nat.Cov (%)	29.4
TNHS (%)	38.7
Other NHS designations (%)	46.4
SGRA (%)	56.2

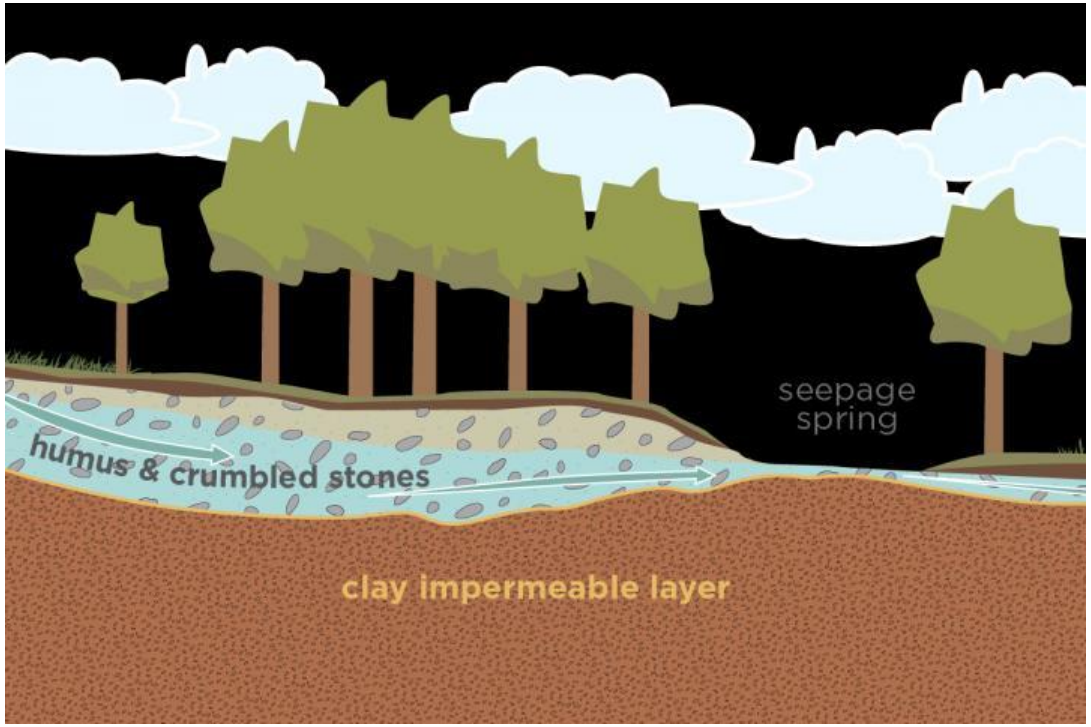


Seepage areas and Springs: Definition & Issues

"Sites of emergence of groundwater where the water table is present at the ground surface"

– *Growth Plan* (2020)

- No comprehensive sampling or database exists for seepages/springs
- Layer was developed that best approximates the location of this key hydrologic feature



Seepage areas and Springs: Methods

Final layer is comprised of two sub-components:

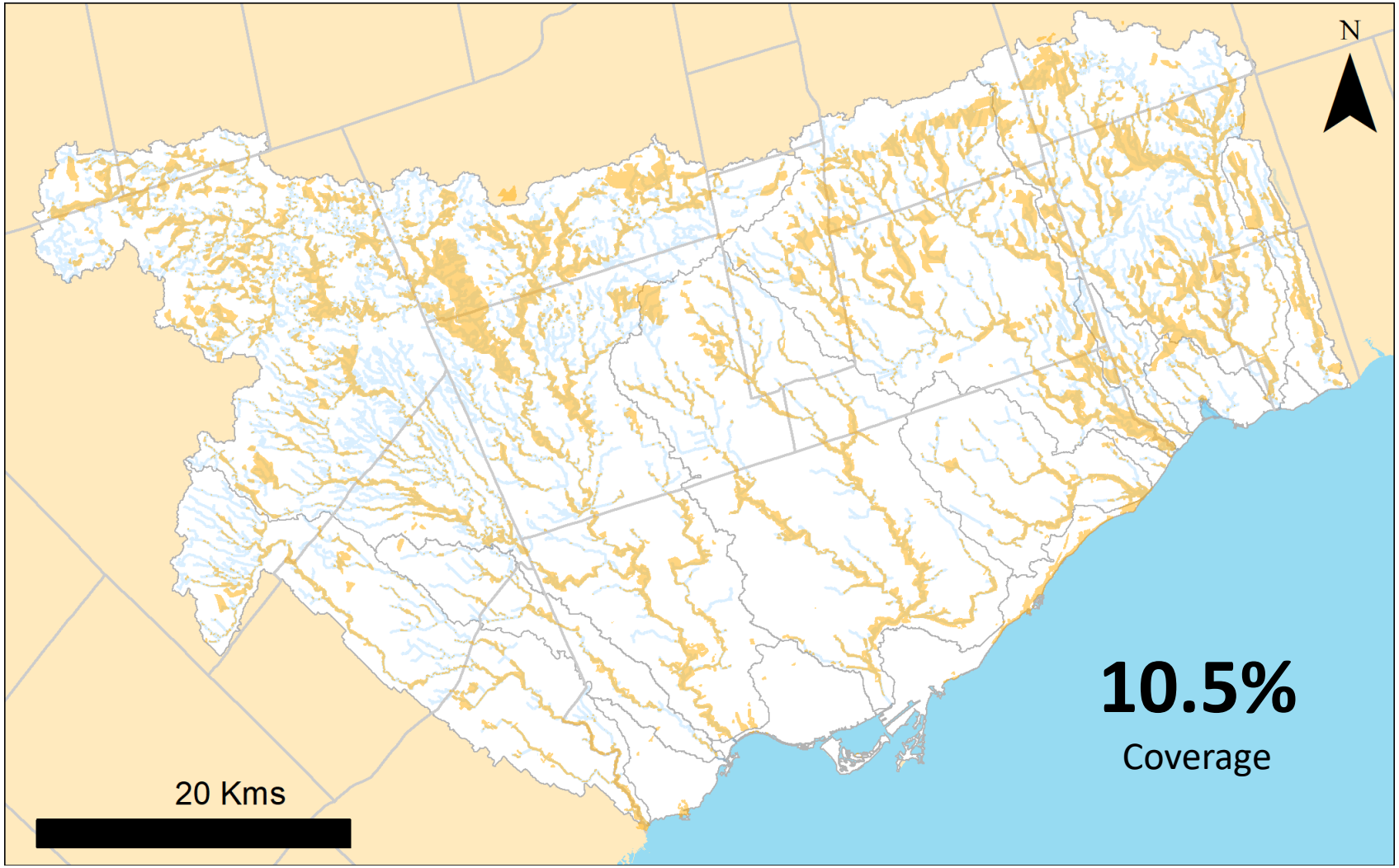
1. A linear layer describing the watercourses where groundwater discharge in the stream is predicted to be stronger than the regional average stream discharge (i.e., describing strongly discharging streams; Polyline)

2. A polygon layer describing areas with strong potential for groundwater discharge at surface (i.e., water seeping out of the ground, at least during part of the year; Polygon).

Seepage areas and Springs: Mapping

- Post-processing to remove areas that intersected with urban land uses (*this includes airport, commercial, high density residential, industrial, institutional, landfill, medium density residential, mixed commercial entertainment, railway, and roads*)

- Removed small features (> 1 hectare in size)



Significant Surface Water Contribution Area (SSWCA): Definition

"Areas, generally associated with headwater catchments, that contribute to baseflow volumes which are significant to the overall surface water flow volumes within a watershed." – *Growth Plan* (2020)

"SSWCAs are those areas which are both SGRAs and ESGRAs; the methodologies used to delineate SGRAs and ESGRAs should be used to identify SSWCAs." – *Further Clarification from Province* (early 2021)

SSWCA = SGRA + ESGRA: Methods

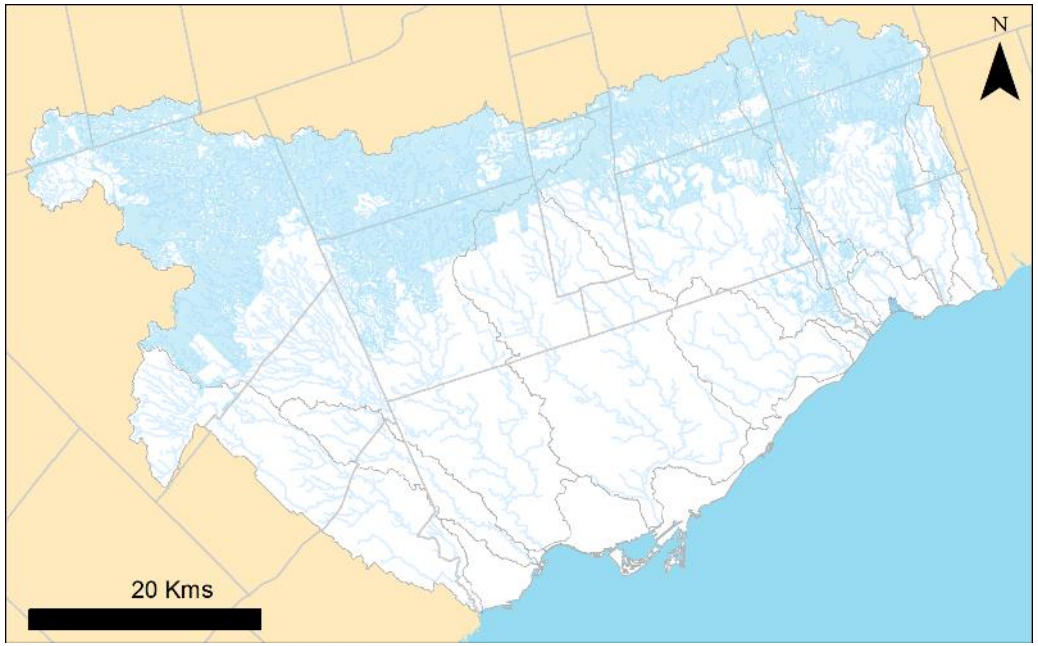
- **SGRAs – Significant Groundwater Recharge Areas**
  - Identified by Source Water Protection Program and based on the volume of recharge that occurs, not where water resources contributing to recharge expresses itself (e.g., streams)

- **ESGRAs – Ecological Significant Groundwater Recharge Areas**
  - Identified as a likely site of groundwater recharge for the receiving feature that they support (streams and wetlands), but not based on the volume that they contribute.

- **SSWCAs** - overlap of areas that provide a large volume of groundwater recharge, and where that recharge has been found through groundwater modelling to support sensitive areas like coldwater streams and wetlands.

SSWCAs: Mapping

SGRAs



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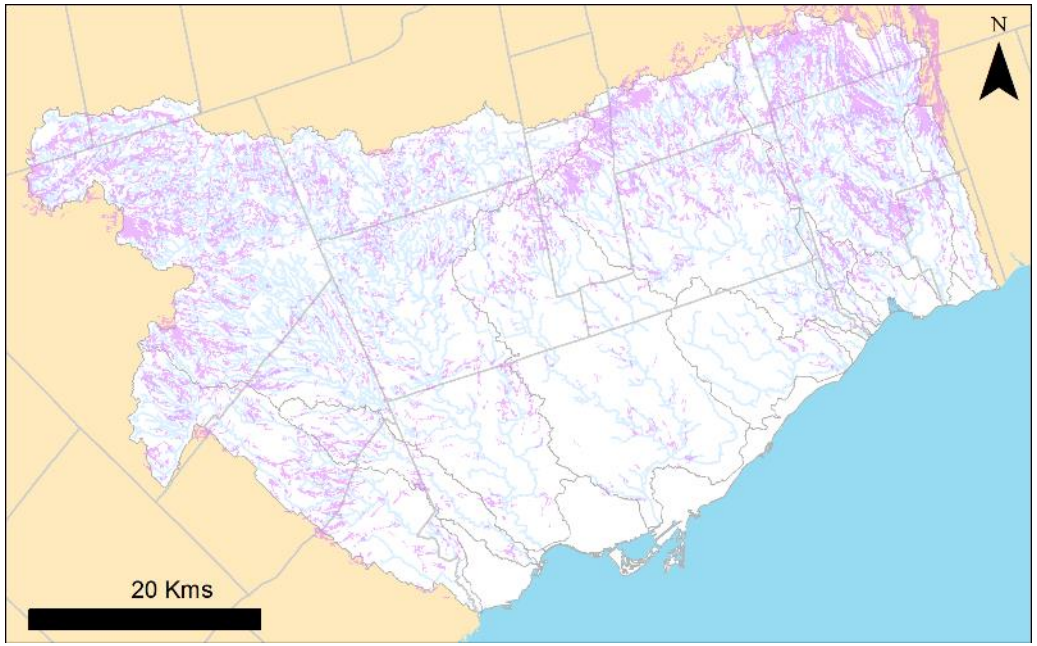
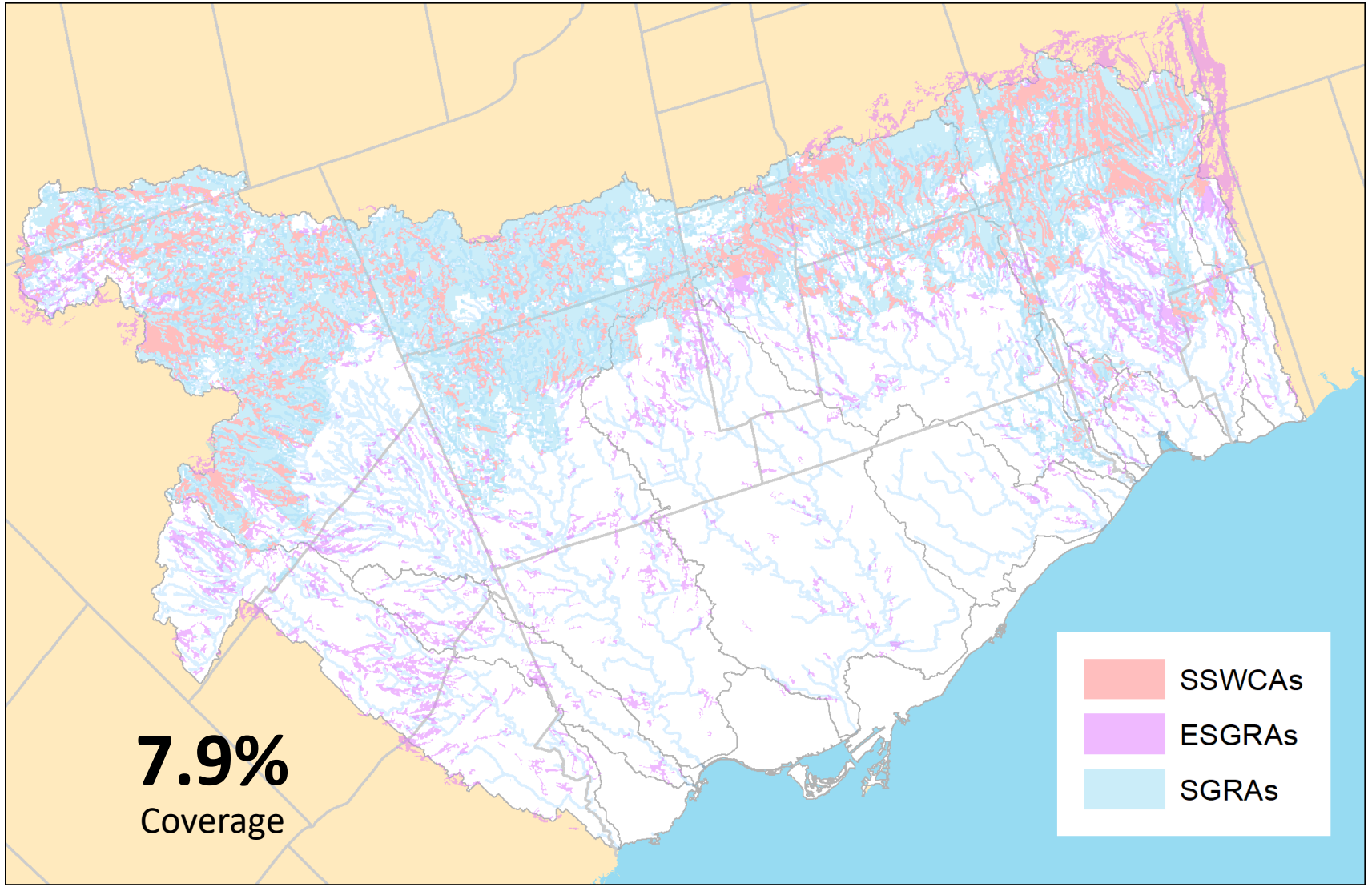
ESGRAs



SSWCAs: Mapping

- Largely confined to upper headwaters and within greenbelt areas
- No new areas are mapped
- Patterns follow SGRAs and ESGRAs



Outline

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   - New Layers (ESGRAs, SSWCAs, Seepages/Springs)
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   - New Classifications (Permanent/Intermittent Streams)

3. Quick Overview of WRS Mapping

Wetlands: Definition

"Lands that are seasonally or permanently covered by shallow water, as well as lands where the water table is close to or at the surface. In either case the presence of abundant water has caused the formation of hydric soils and has favoured the dominance of either hydrophytic plants or water tolerant plants. The four major types of wetlands are swamps, marshes, bogs and fens."

– Growth Plan (2020)

Wetlands: Methods – Identified Issues

- **Many different wetland layers exist in the TRCA database**

- **Why would this be the case?**
  - Serve different purposes (e.g. strategic direction to site level planning)
  - Fulfill need for data at multiple spatial scales (e.g. regional level to site level)
  - Created using different methods (e.g. remotely sensed to field collected)
  - This results in varying levels of accuracy and spatial coverage (e.g. spatial coverage of remotely sensed data to accuracy of field collected data in surveyed areas only)

- **Many issues were arising, including:**
  - Municipal partners are seeking consolidated data for regional initiatives like WRS and NHS
  - Integrating multiple objectives into one strategic watershed plan
  - Inconsistent designation of features (e.g. wetlands, inland lakes, stormwater ponds)

Wetlands: Methods – Data Layers

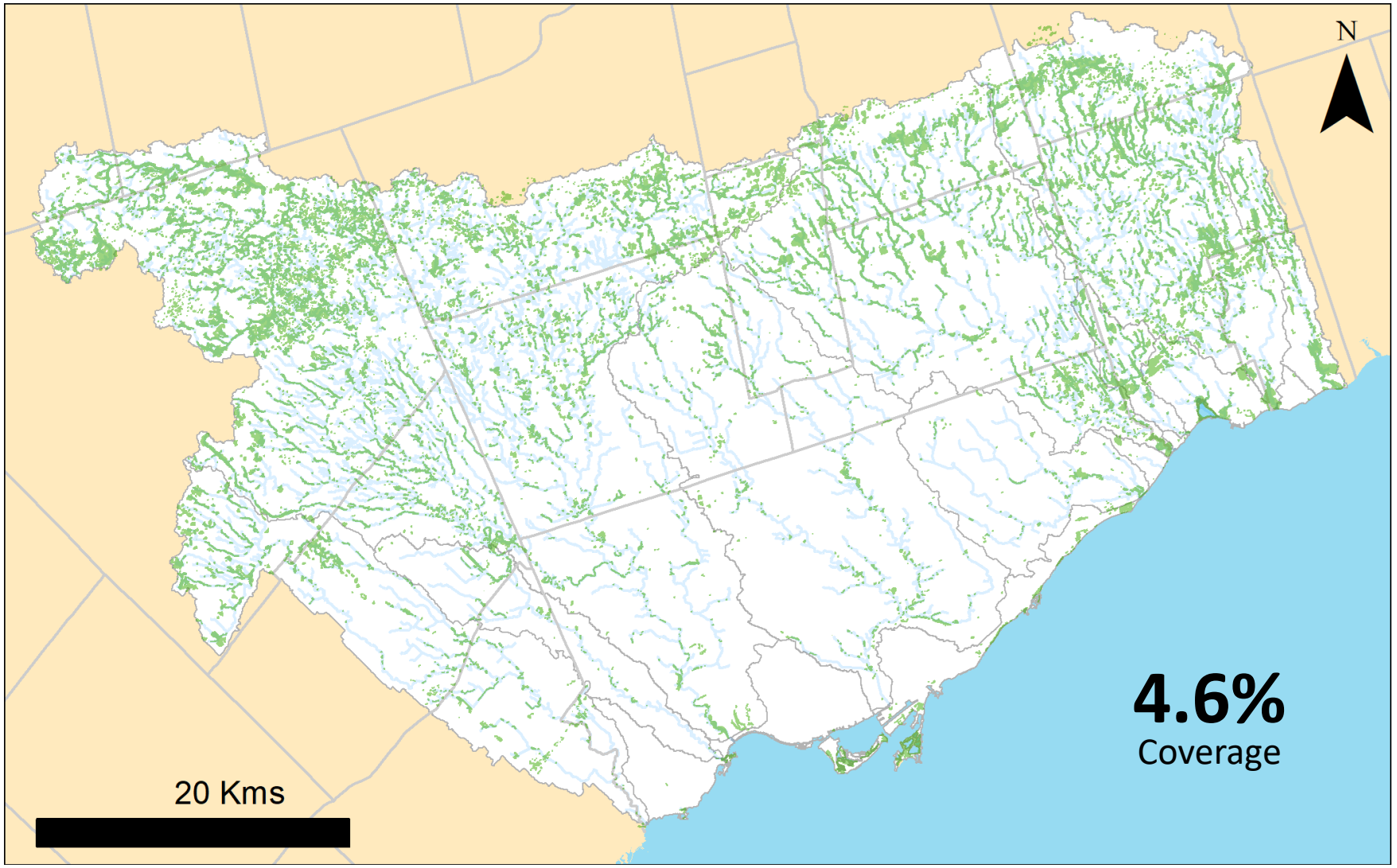
Layer	Method Used	Spatial Coverage	Accuracy Level	Date
Natural Cover Wetlands	Ortho-photo interpretation	Entire jurisdiction	Medium	2017
ELC Wetlands	Field collected by TRCA	Surveyed Areas Only	High	2019 (>15 years is obsolete)
MNRF Wetlands (3 layers) *ELC_MNR_unevalueated_wetland* *MNR_PSW_wetlands* *MNR_LocalSignif_wetlands*	Field evaluated by trained personnel and/ flagged for evaluation	Surveyed Areas Only	High	2020
All Regulation Layers	Combining three MNRF layers	ELC+MNRF areas only	High	2018
TRCA MNRF Combined	Combining ELC+MNRF	ELC+MNRF areas only	High	2018

Wetlands: Methods – Refinement

- Create a more inclusive wetland "*TRCA refined wetland*" *layer*
  - Overlay TRCA ELC + TRCA Restored +MNRF Wetlands + Natural Cover Wetlands
- Conduct desktop level QA/QC to remove any discrepancies
  - Use orthophoto and other documented up-to-date information (from variety of expert sources)
  - The tracking tool developed by GIS will document every change made, rationale, and other comments associated with them
- This "*TRCA refined wetland"* layer will be used in the WRS

Wetlands: Mapping

- One final “refined” comprehensive wetland layer
- **32,352 wetland records were reviewed**
- Includes 2019 and 2020 regulation update (113 wetlands added)
- QA/QC on ~1600 wetlands revealed **93.4% accuracy**



Inland Lakes and their Littoral Zones: Definition

Inland Lake - “*any inland body of standing water, usually fresh water, larger than a pool or pond or a body of water filling a depression in the earth’s surface.*”

– Greenbelt Plan (2017)

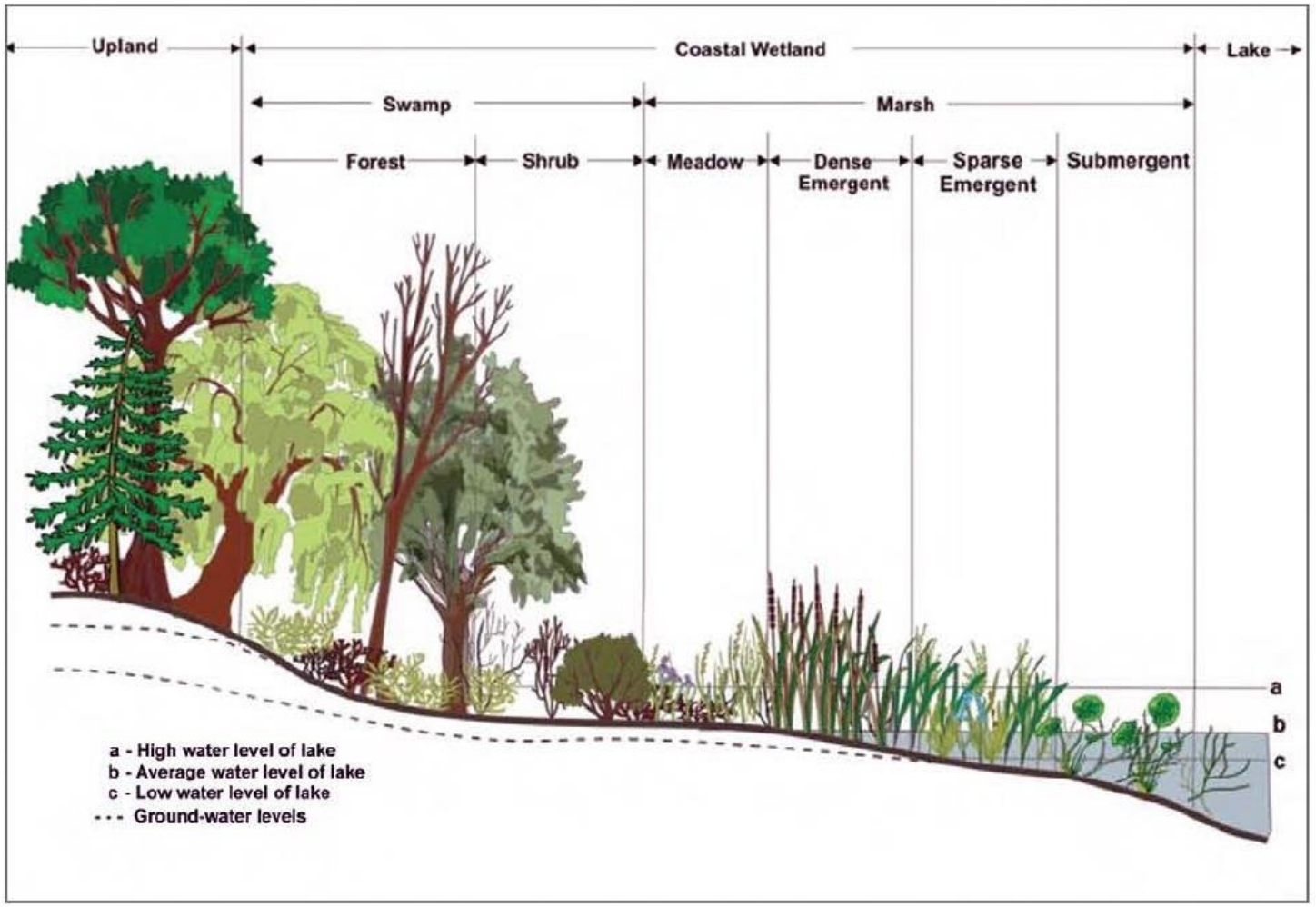
Littoral zone - Developed shoreline policies - Growth Plan (2020)

- No good definition of “littoral” in these policy documents

Inland Lakes and their Littoral Zones: Definition

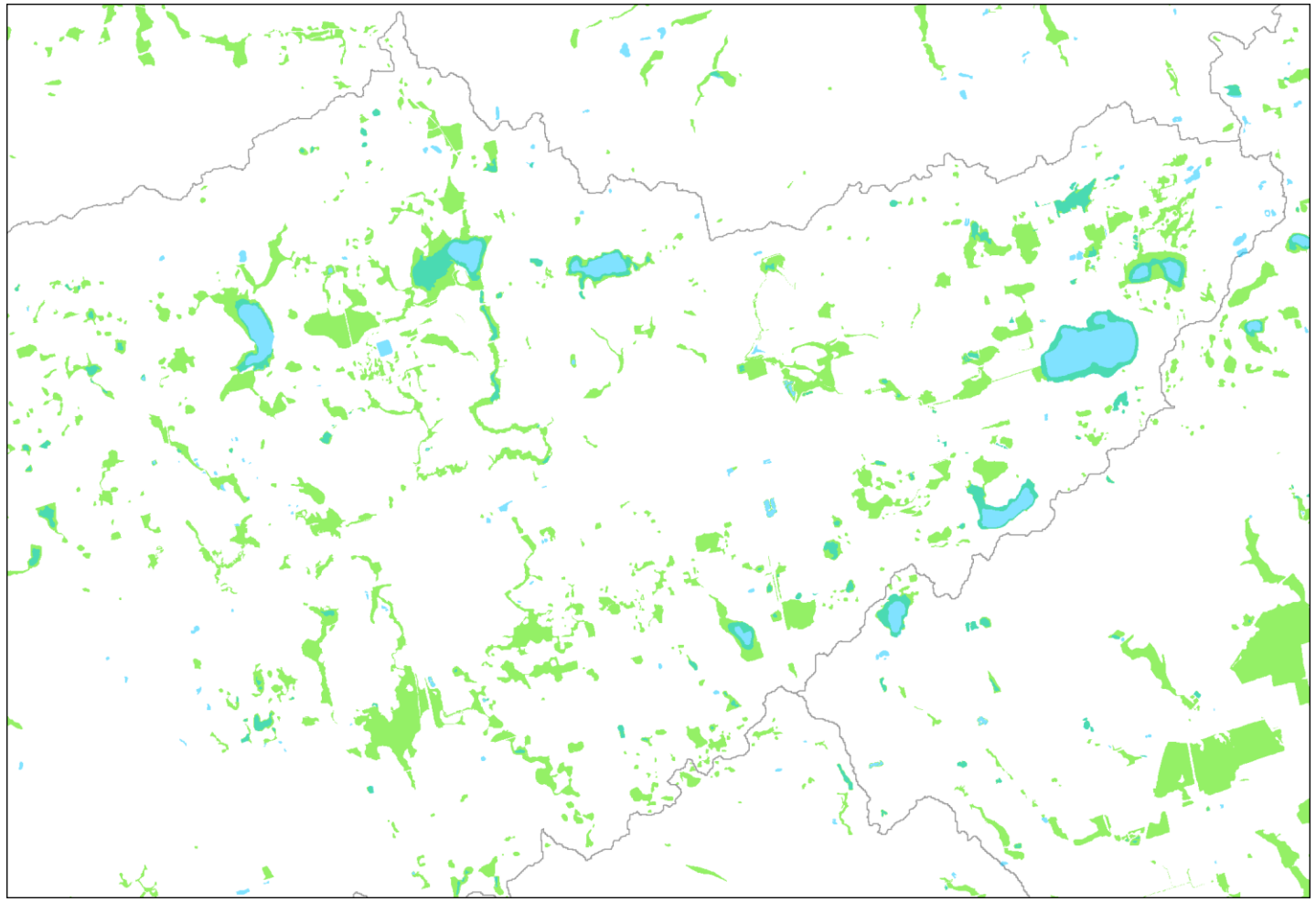
Littoral Zones - *"The shallow water zone in a lake, pond or river, where most of the aquatic plants (emergents, submergents and floating plants) exist, and within which most of the primary production occurs. The width and depth of the littoral zone depends on dissolved nutrients, soils, depth contours, water temperature, and water clarity (which affects light penetration). Marshes as a rule are entirely in the littoral zone."*

– OWES (2013)



Inland Lakes and their Littoral Zones: Methods - Issues

- Layer being used was created for cartographic purposes
- Artificial and natural features combined are combined
  - Lake, Natural pond, Estuary, Stormwater management pond, Artificial, Unknown
  - Features can have very different intended functions
  - Stormwater management, Irrigation (golf course), Ornamental, Recreational, Natural – habitat provisioning
- Accuracy issues are apparent as well (photo interpretation)
- Overlap apparent with other KHFs, such as wetlands



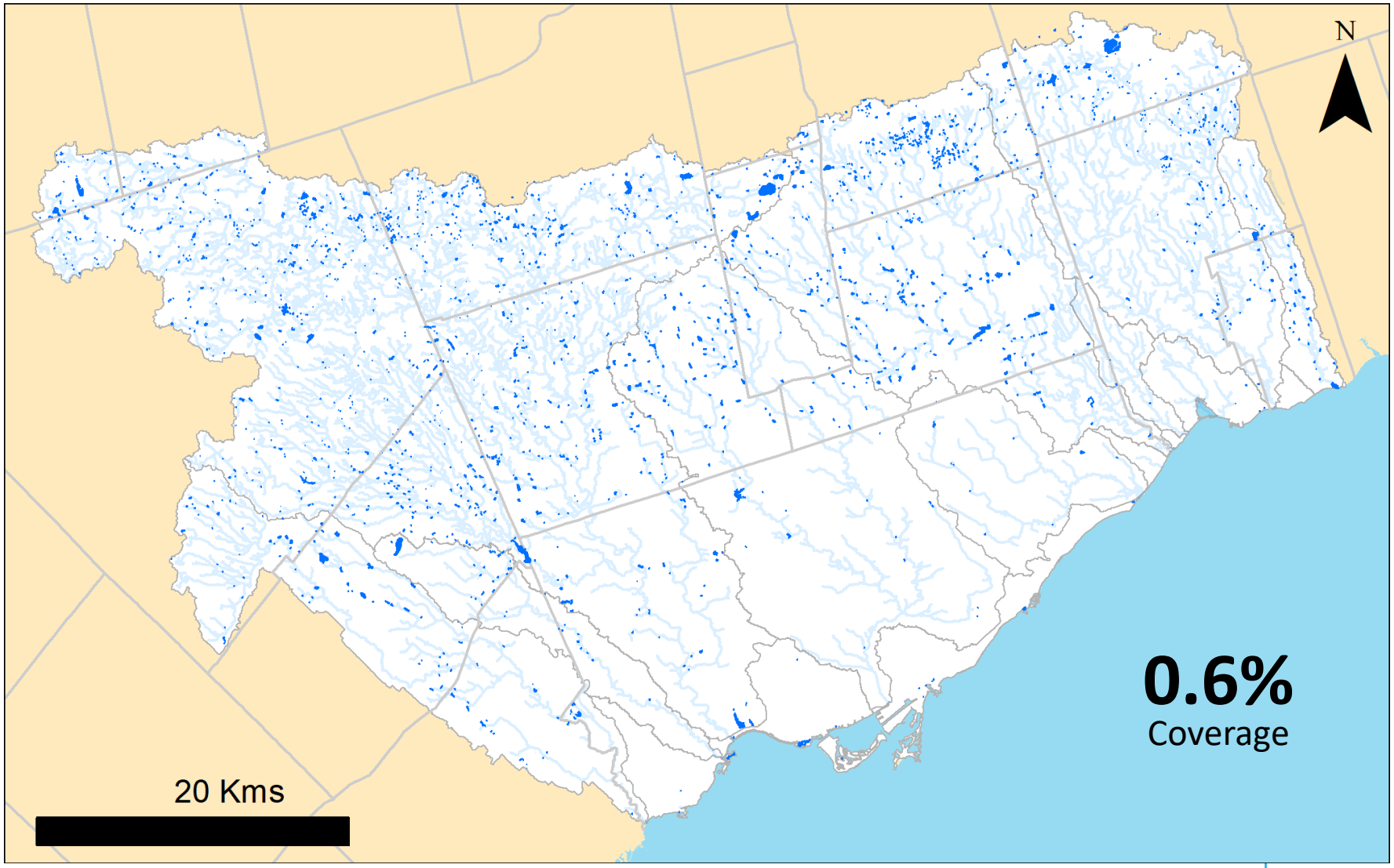
Inland Lakes and their Littoral Zones: Methods - Refinement

- Using the new refined wetland layer, the following steps were taken to refine the inland lakes and littoral zones layer:

1. A waterbody was removed if layer overlapped with refined wetland layer (when it was 2/3 or more covered);
2. Field verified data took precedence for delineating the outline of a particular feature;
3. Orthophotography verification was completed to determine if the feature is still on the landscape via most recent data from 2019 (remove/edit if it is not still on the landscape or changed in shape);
4. Identify stormwater infrastructure where possible, using existing data and orthophotography, so it can be separated from non-stormwater features (where possible).

Inland Lakes and their Littoral Zones: Mapping

- One final “refined” comprehensive layer
- **3,887 records** were reviewed (1,433 removed; 125 added)
- 2,329 inland lakes in the final layer
- Of these 649 are identified as SWMPs



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3. Quick Overview of WRS Mapping

Permanent and Intermittent streams: Definition

- **Permanent streams**

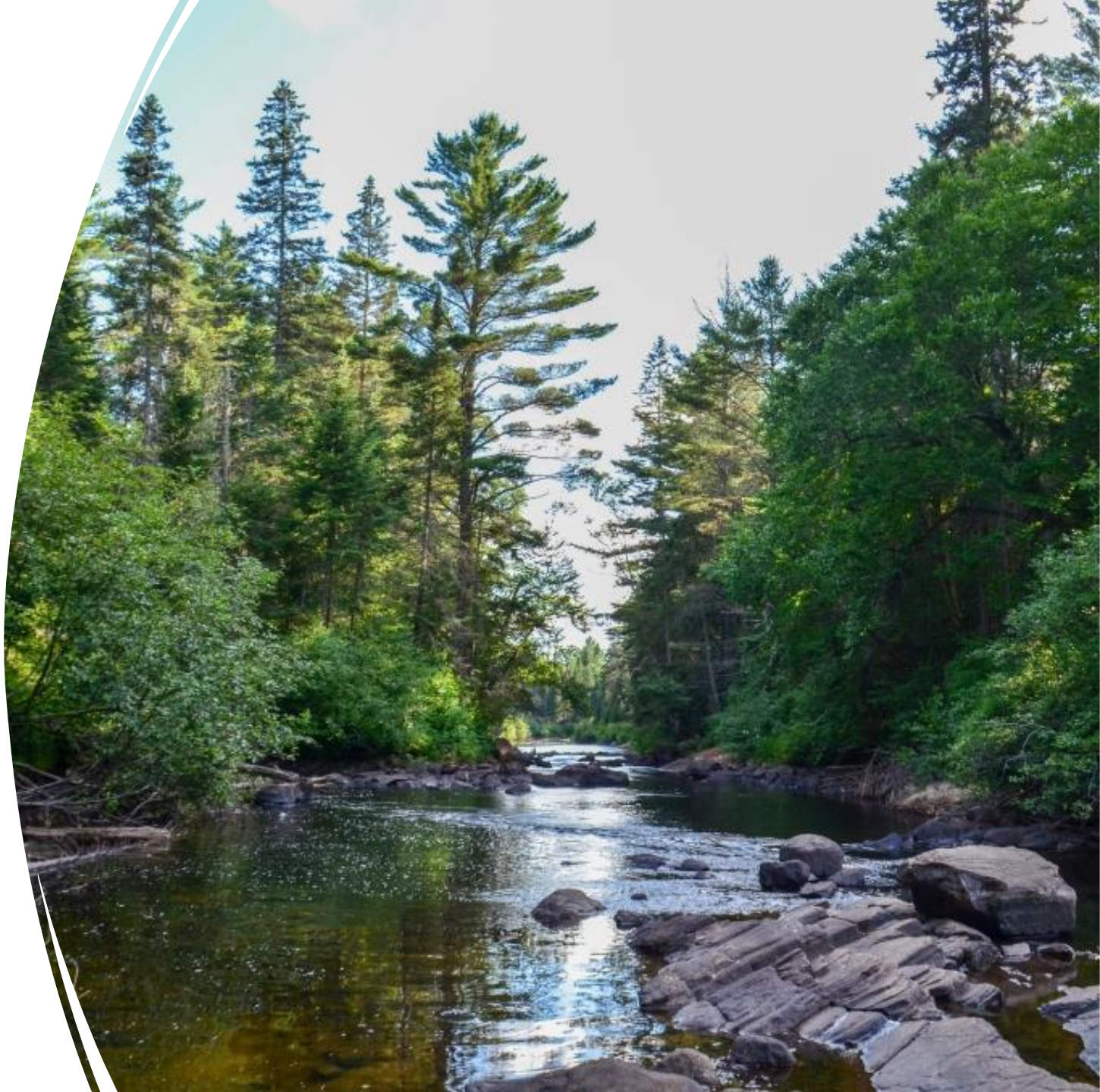
“a stream that continually flows in an average year. ”

– Greenbelt Plan (2017)

- **Intermittent streams**

“watercourses that contain water or are dry at times of the year that are more or less predictable, generally flowing during wet seasons of the year but not the entire year, and where the water table is above the stream bottom during parts of the year. ”

– Greenbelt Plan (2017)



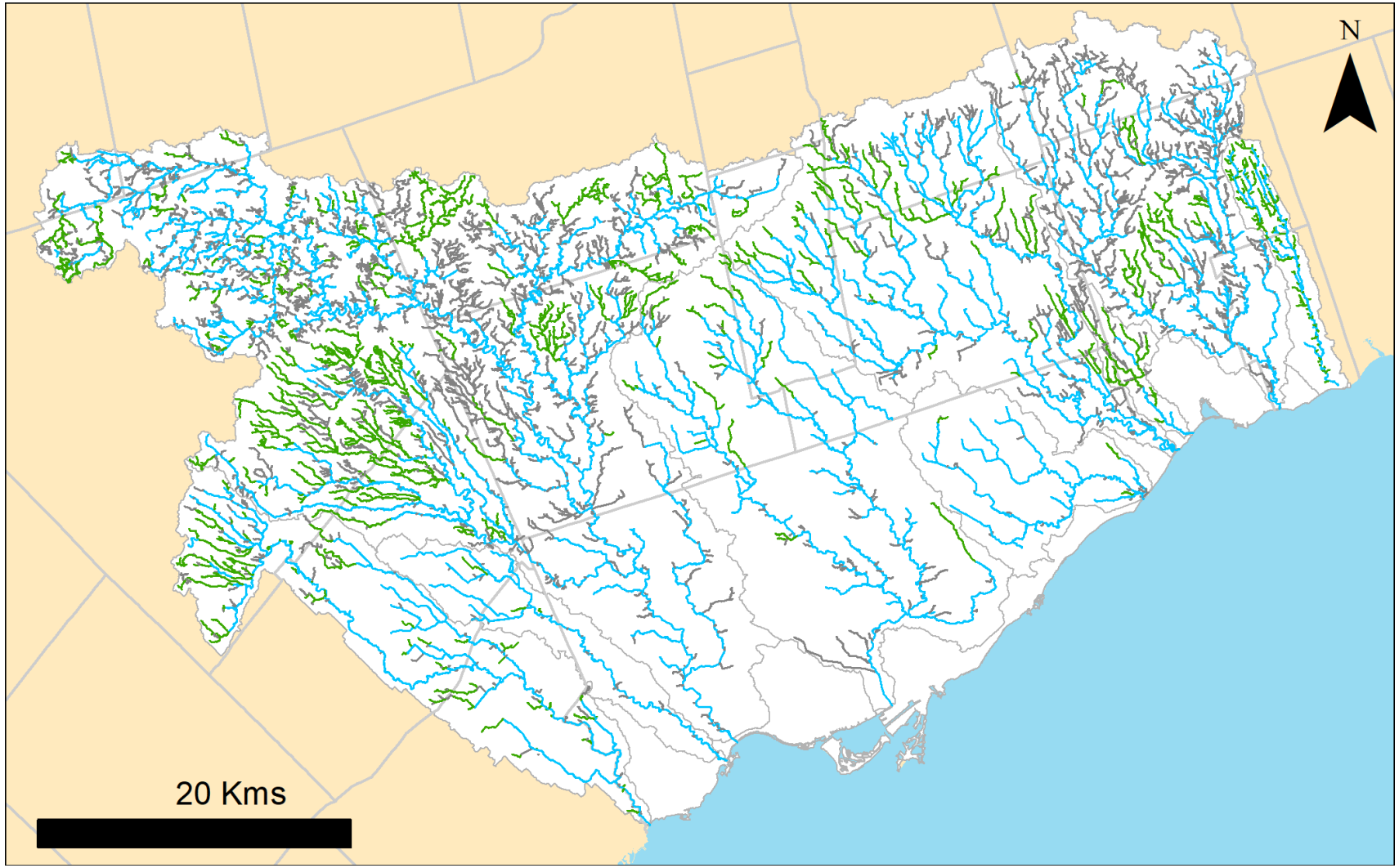
Permanent and Intermittent streams: Methods

- No intermittent/permanent stream layer existed for the jurisdiction
- The base layer for this work was the 2020 TRCA regulated watercourse layer
- The data used to infer permanency of flow within reaches includes:
    1. Headwater Drainage Features Survey Data (Etobicoke and Carruthers only)
    2. Baseflow Data
    3. TRCA Instream Temperature Data
    4. TRCA Instream Barrier Survey Data
    5. RWMP Fisheries and Temperature Data
    6. TRCA Historical Fisheries Data
    7. Orthophotography Interpreted 2017 and 2018 Imagery
    8. Valley and Stream Crossings Survey Data

Permanent and Intermittent streams: Mapping

- Permanent (Blue) – 46.2% (~1800 km)
- Intermittent (green) – 21.2% (~820 km)
- Unknown (grey) – 32.6% (~1250 km)

- Humber (~38%) and Duffins (~50%) of watercourse is unknown



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3. **Quick Overview of WRS Mapping**

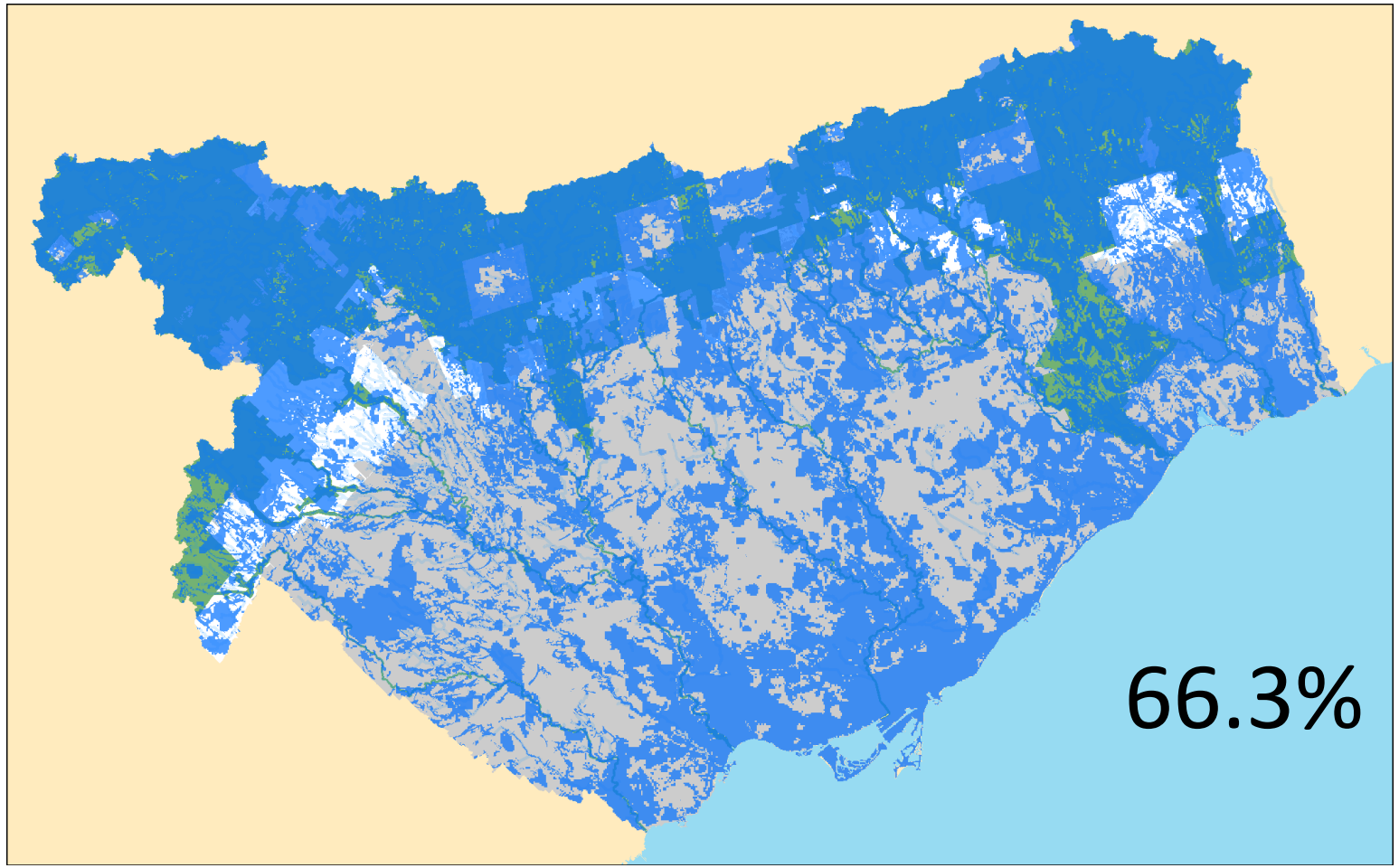
WRS: Mapping – All KHAs & KHFs

Key Hydrologic Areas (KHAs)

- SGRAs
- HVAs
- SSWCAs
- ESGRAs

Key Hydrologic Features (KHFs)

- ~~Permanent streams;~~
- ~~Intermittent streams;~~
- Inland lakes and their littoral zones;
- Seepage areas and springs;
- Wetlands.



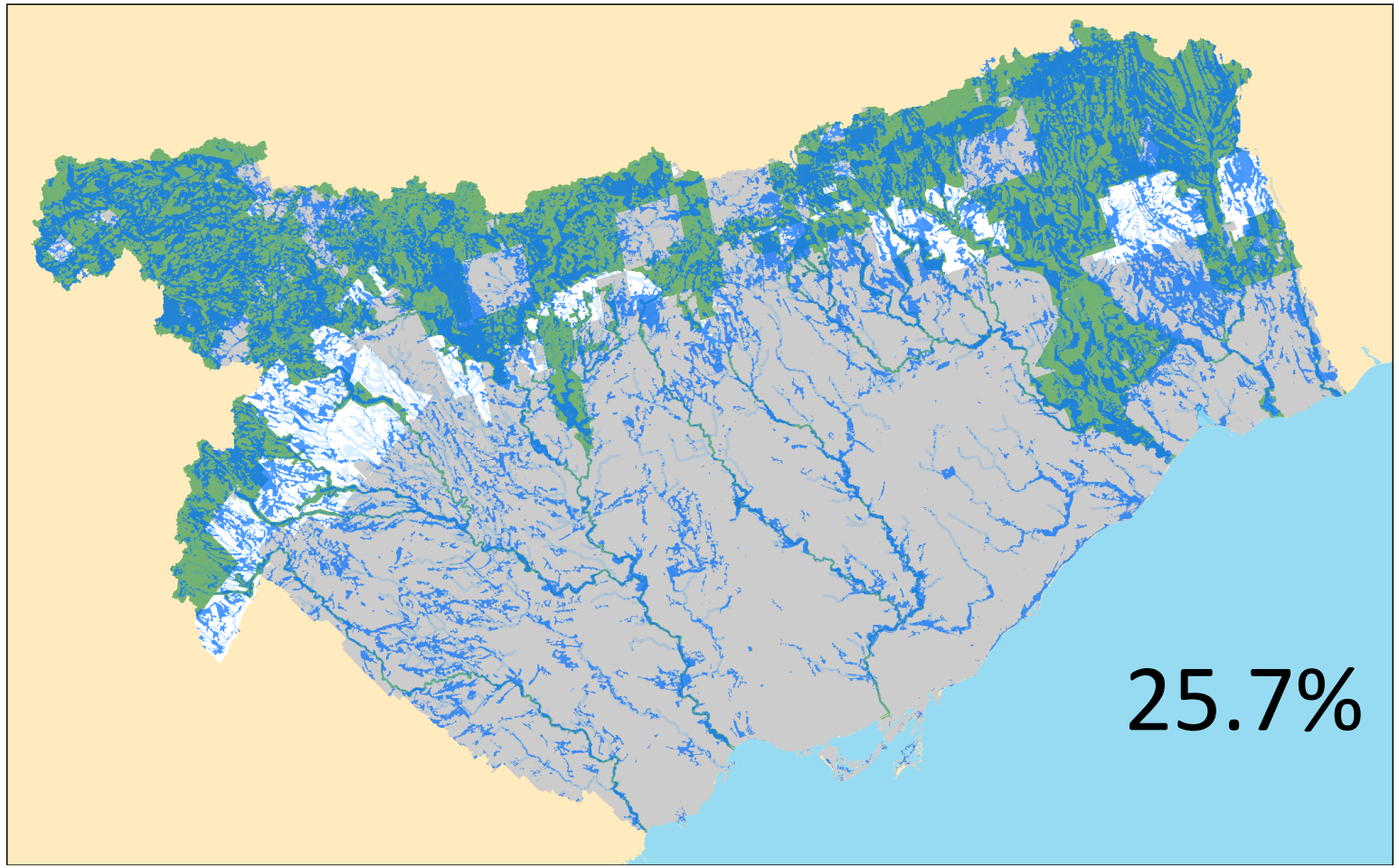
WRS: Mapping – Remove Source Water Protection Areas

Key Hydrologic Areas (KHAs)

- ~~SGRAs~~
- ~~HVAs~~
- SSWCAs
- ESGRAs

Key Hydrologic Features (KHFs)

- ~~Permanent streams;~~
- ~~Intermittent streams;~~
- Inland lakes and their littoral zones;
- Seepage areas and springs;
- Wetlands.



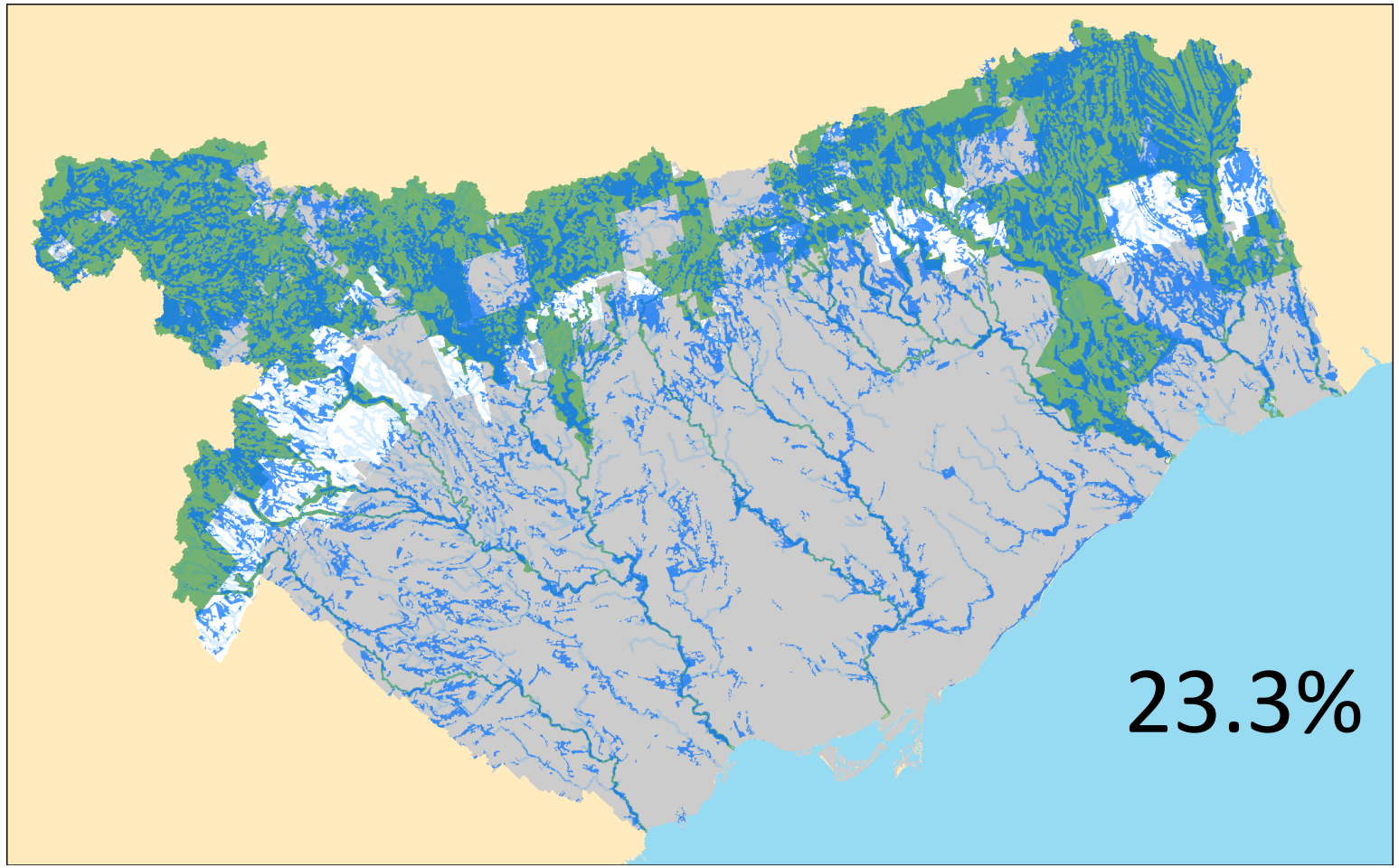
WRS: Mapping – Newly Mapped Layers

Key Hydrologic Areas (KHAs)

- ~~SGRAs~~
- ~~HVAs~~
- ~~SSWCAs~~
- ESGRAs

Key Hydrologic Features (KHFs)

- ~~Permanent streams;~~
- ~~Intermittent streams;~~
- ~~Inland lakes and their littoral zones;~~
- Seepage areas and springs;
- ~~Wetlands.~~



WRS: Mapping – New Additions to WRS

Key Hydrologic Areas (KHAs)

- ~~SGRAs~~
- ~~HVAs~~
- ~~SSWCAs~~
- ESGRAs

Key Hydrologic Features (KHFs)

- ~~Permanent streams;~~
- ~~Intermittent streams;~~
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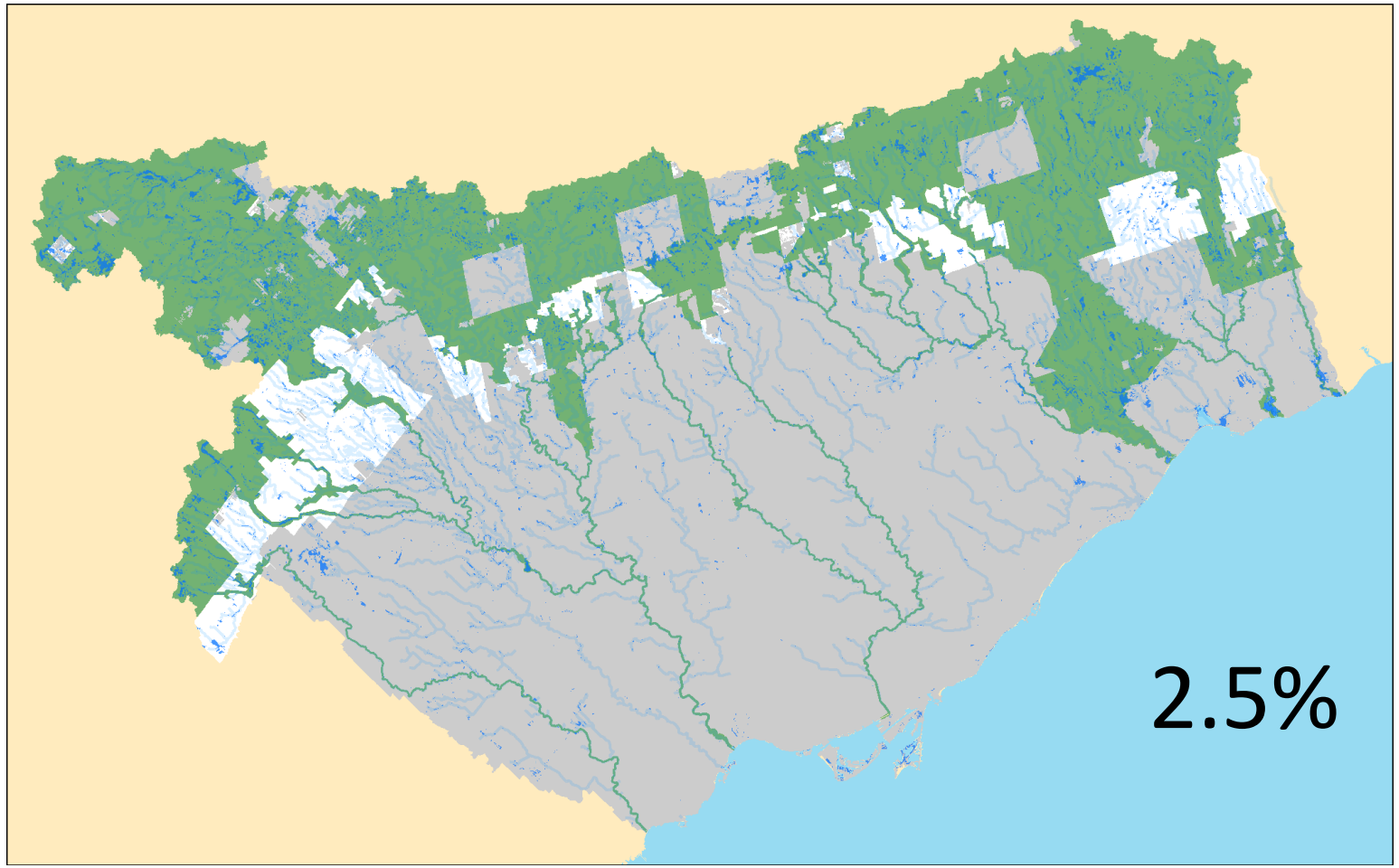
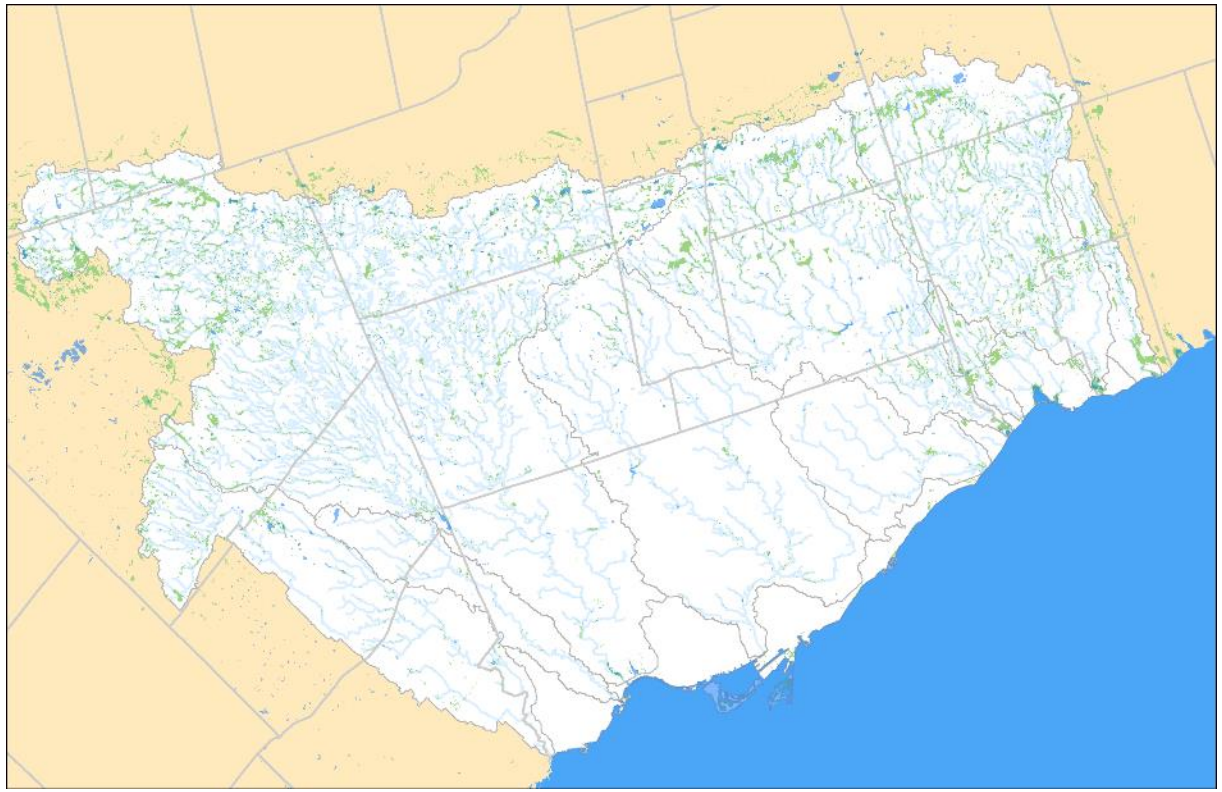
- Seepage areas and springs;
- ~~Wetlands.~~

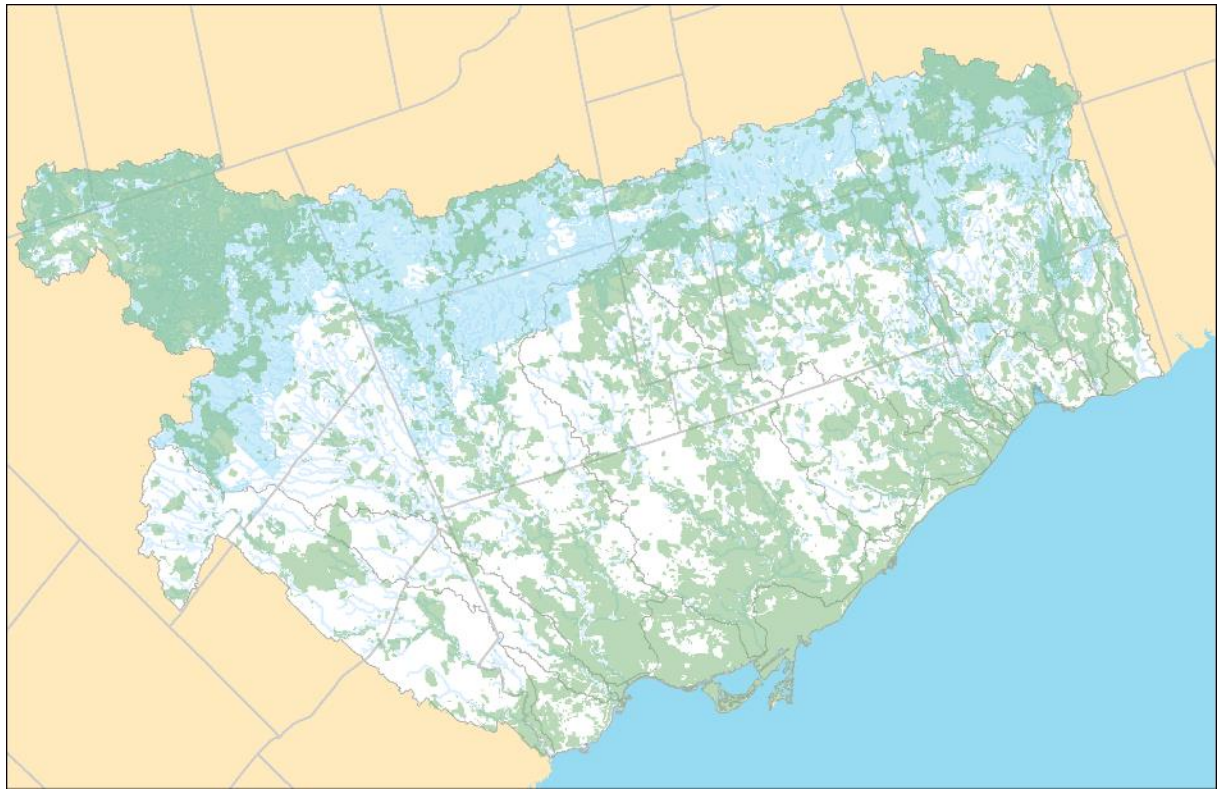


Summary: Prior to WRS Update

KHFs

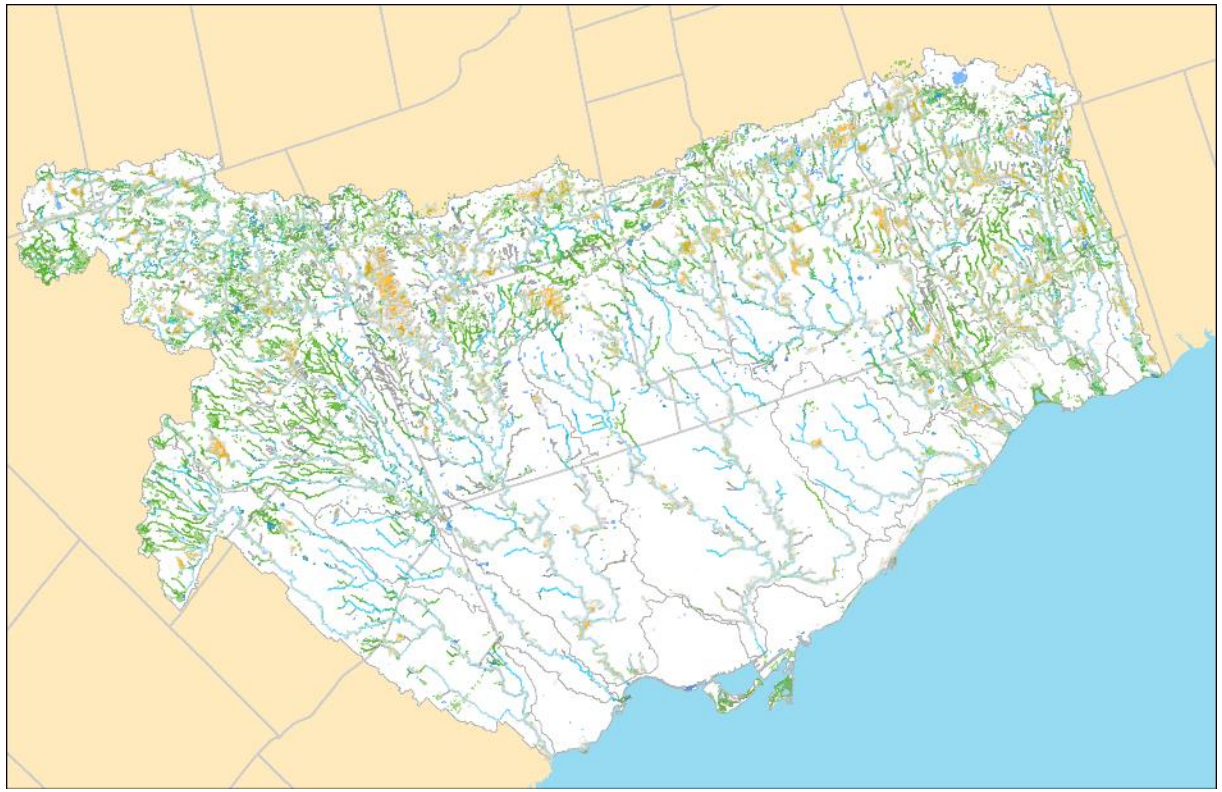


KHAs

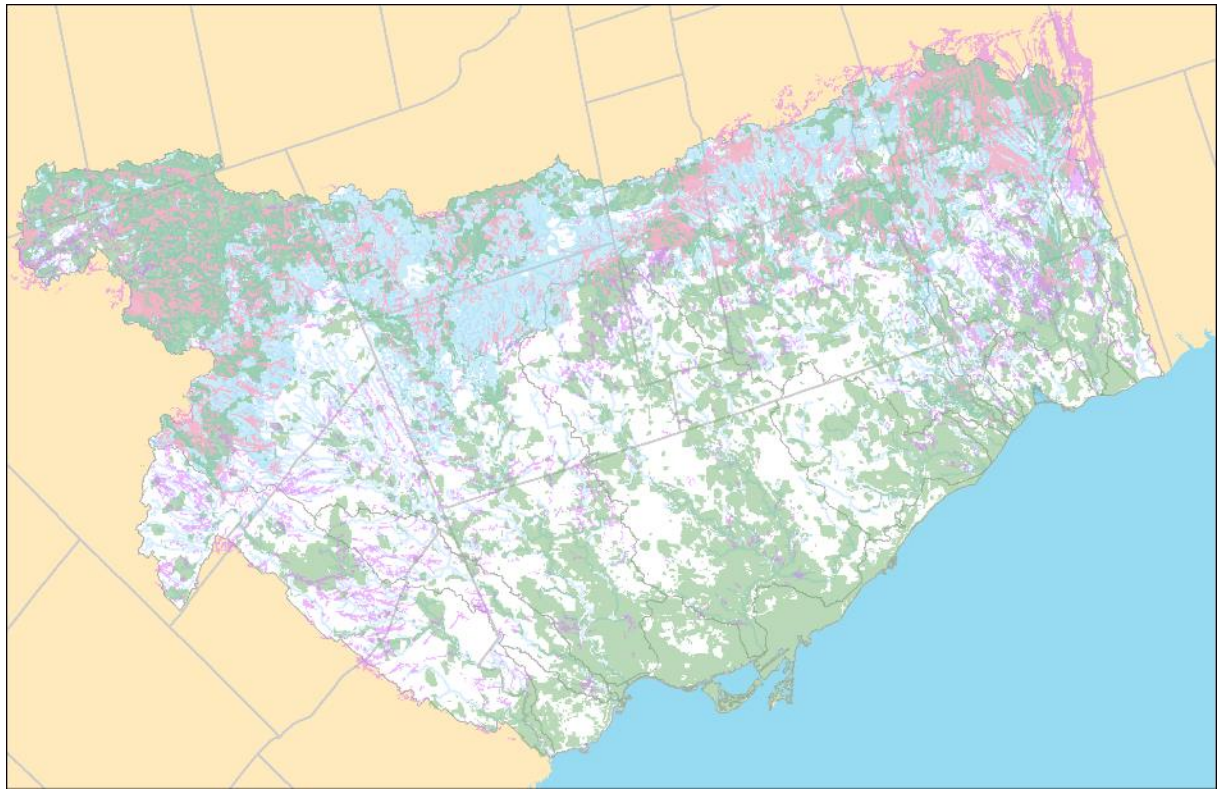


Summary: After WRS Update

KHFs



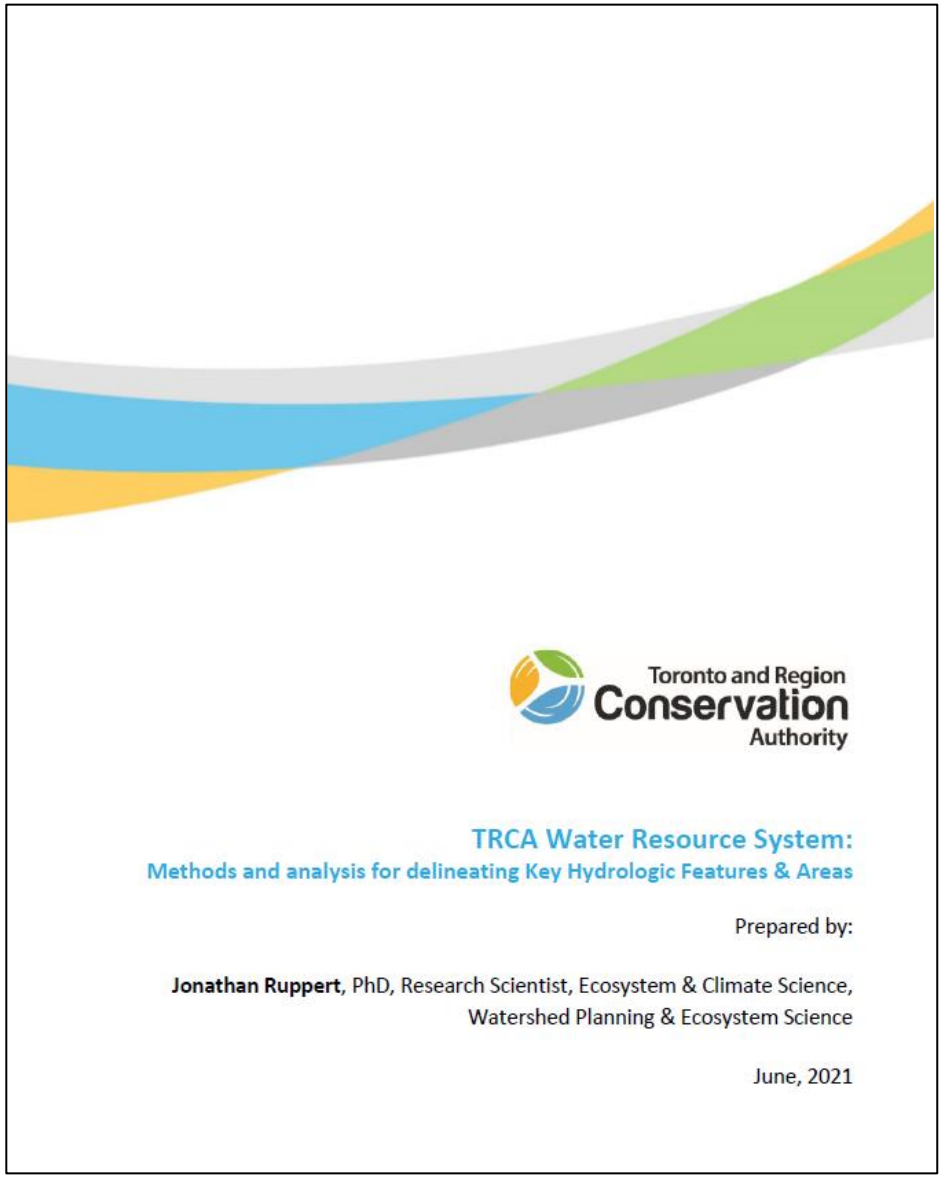
KHAs



Final Draft Report

- Background
- Methods & Analysis
- Mapping & Jurisdiction Overview
- Implications
- Future Considerations

- Draft GIS layers available as well!
- WRS Draft available on the Online Reporting Hub!



Project Team

Laura DelGiudice, Associate Director, Watershed Planning and Ecosystem Science (WPES), Development and Engineering Services (DES)

Jason Tam, Manager, Business Intelligence and Data Analytics (BIDA), Information Technology and Records Management (ITRM), Corporate Services (CS)

Tony Morris, Senior Project Manager, Watershed Planning and Reporting (WPR), WPES, DES

Steven Ling, Technologist, GIS, BIDA, ITRM, CS

Daniela Macleod, Specialist, GIS, BIDA, ITRM, CS

Mason Marchildon, Hydrologist, Oak Ridges Moraine Groundwater Program (ORMGP)

Upcoming ECS Lunch and Learns!

Wednesday, August 4
11:00am-12:00pm

Broadview and Eastern EA and Port Lands Flood Protection Implementation

By Meg St John and Maryam Iler

Tuesday, September 14
11:00am-12:00pm

TRCA's Road Ecology Program

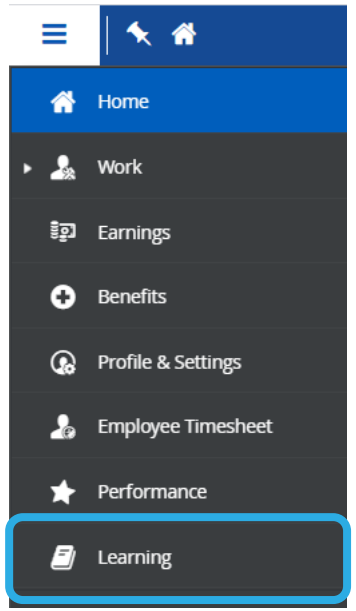
By Lyndsay Cartwright, Andrew Chin, and David Lawrie

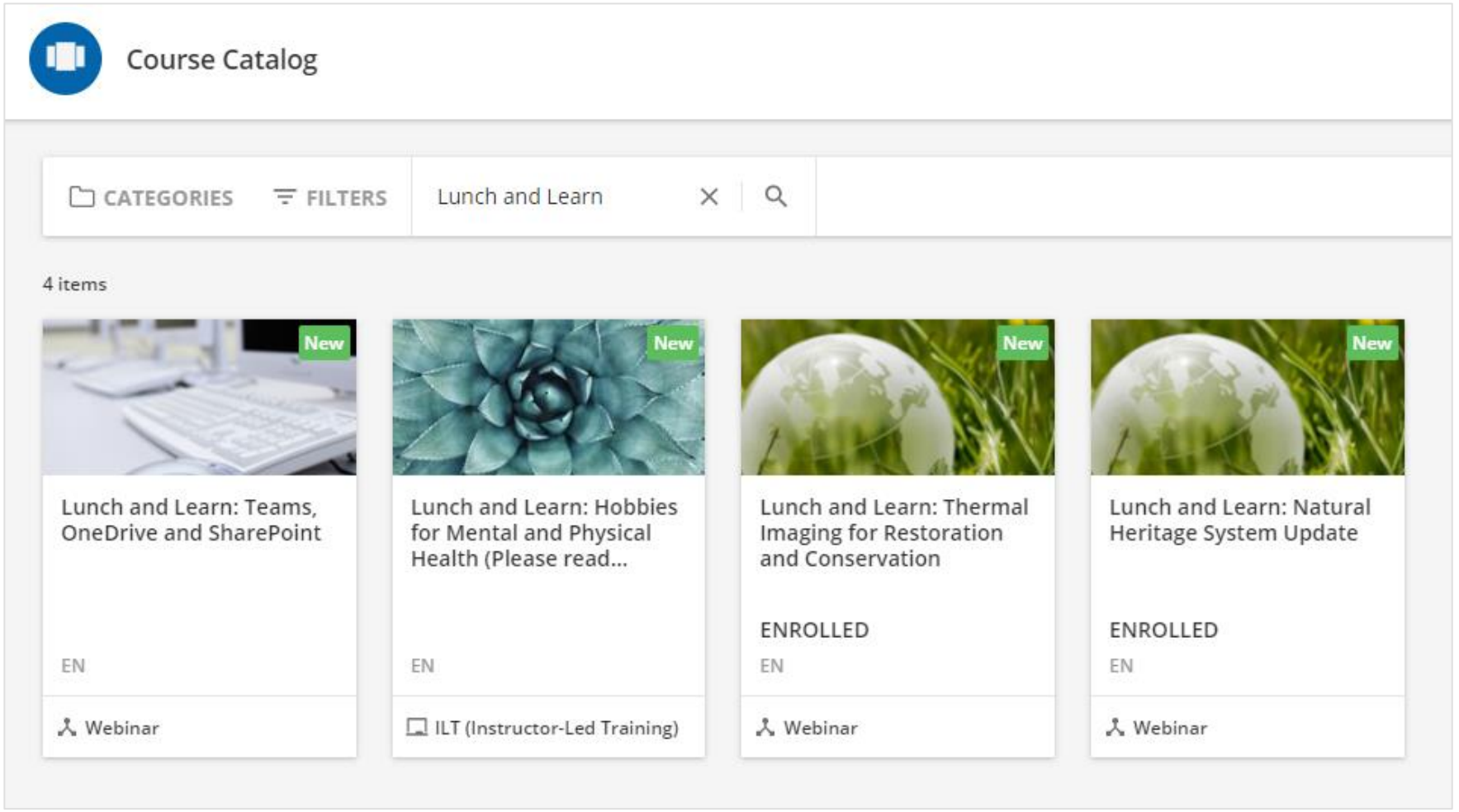
Tuesday, October 26
11:00am-12:00pm

Carruthers Creek Watershed Plan

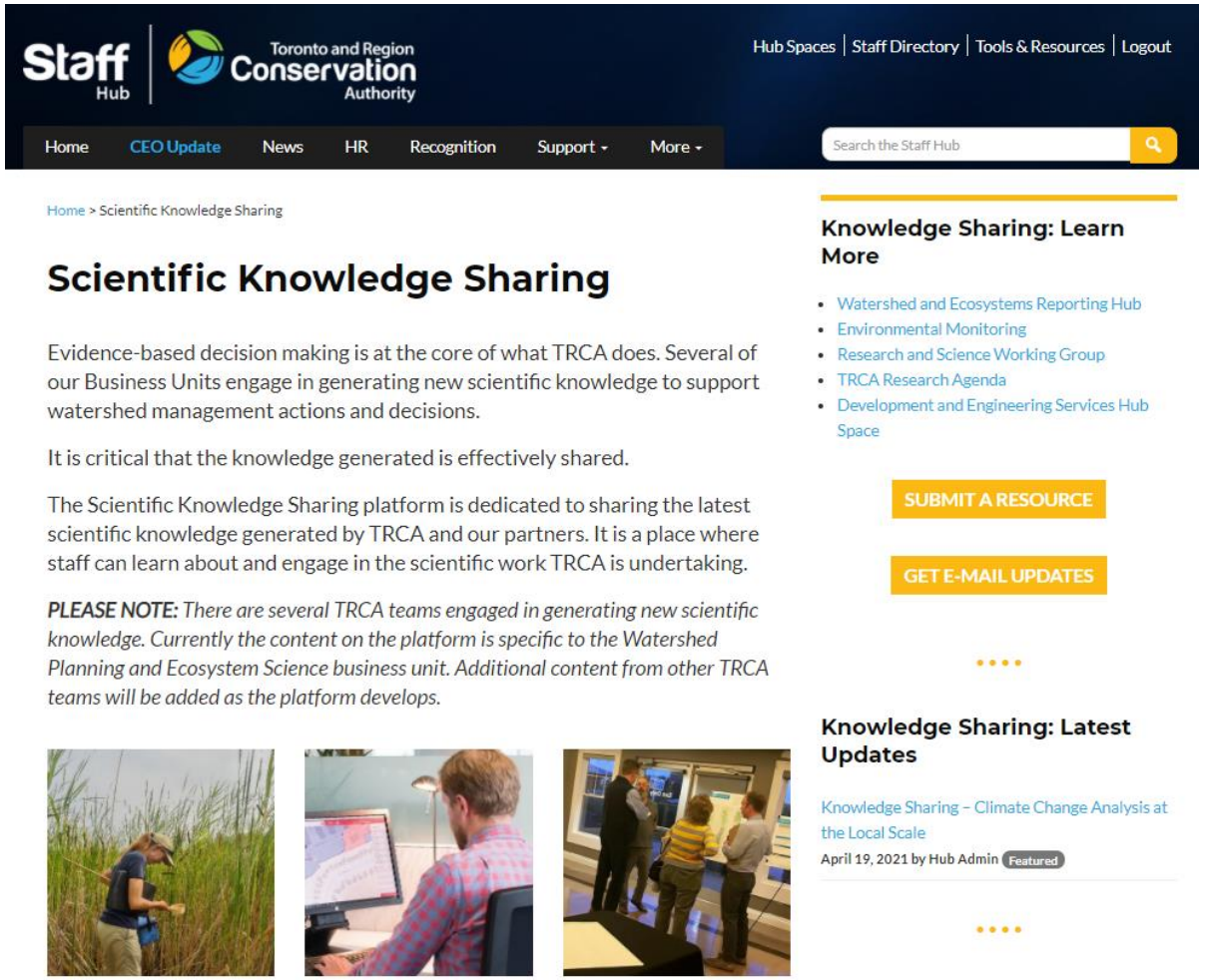
By Tony Morris

Learning Management System





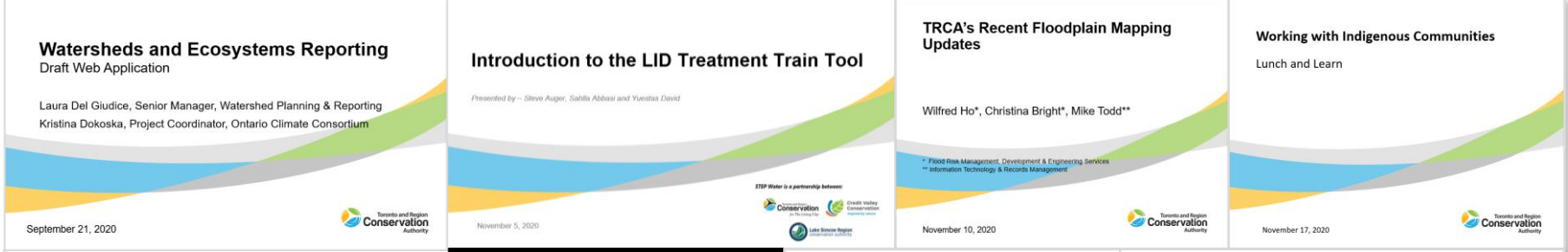
Scientific Knowledge Sharing Hub

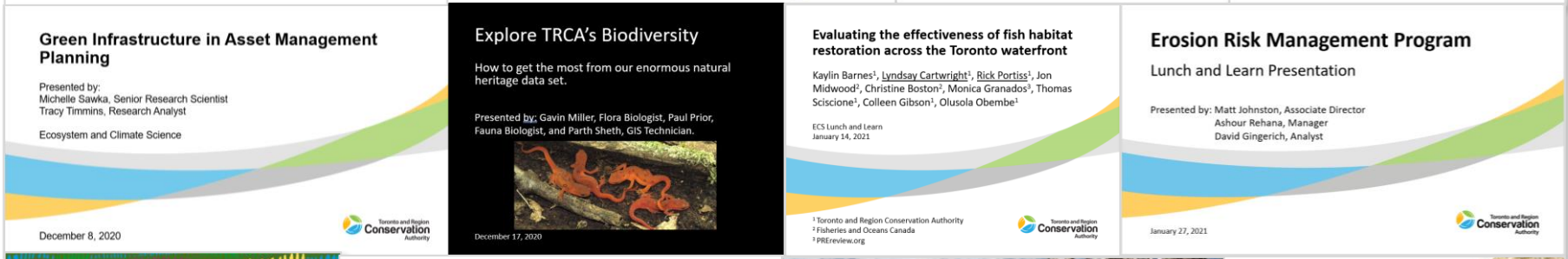


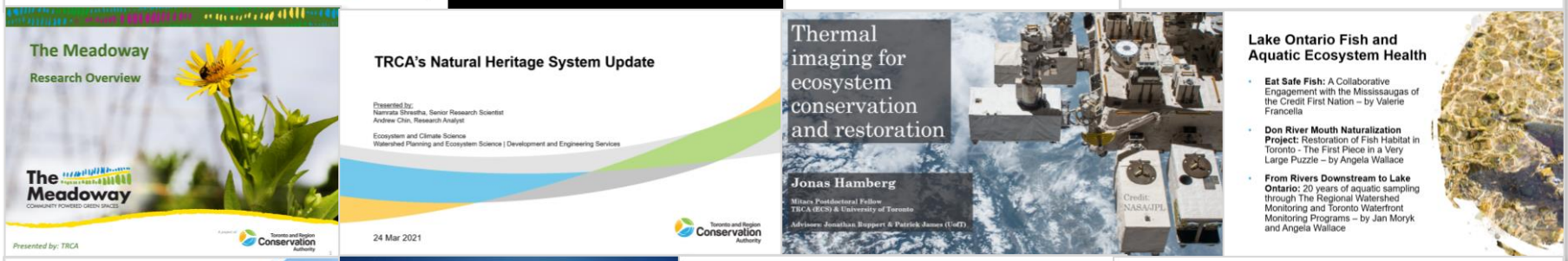
EXPLORE THE RESOURCE LIBRARY

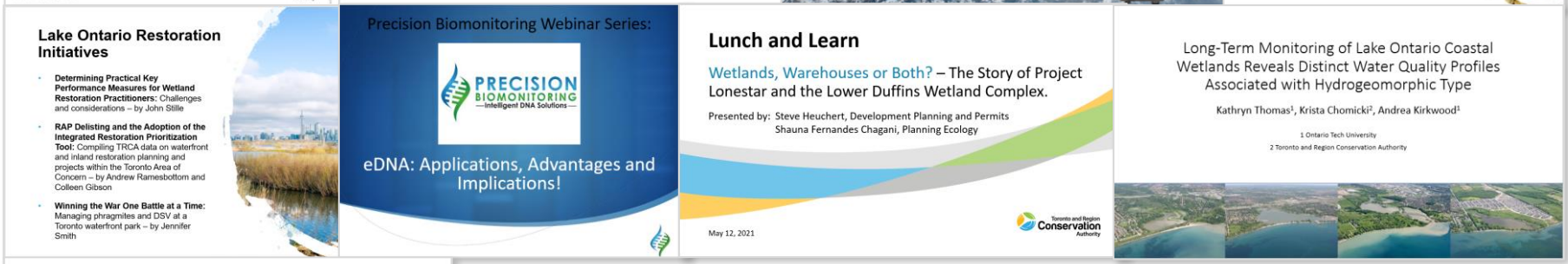
- Newsletters +
- Open Data & Information +
- Plans and Strategies +
- Presentations to Partners +
- Reports and Technical Papers +
- Scientific Papers +
- Technical Protocols & Best Practices +
- Videos +
- Webinars and Lunch & Learns +

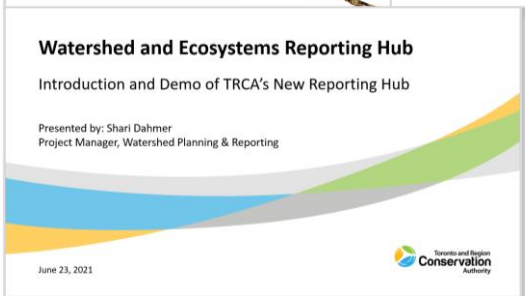
Past Recordings

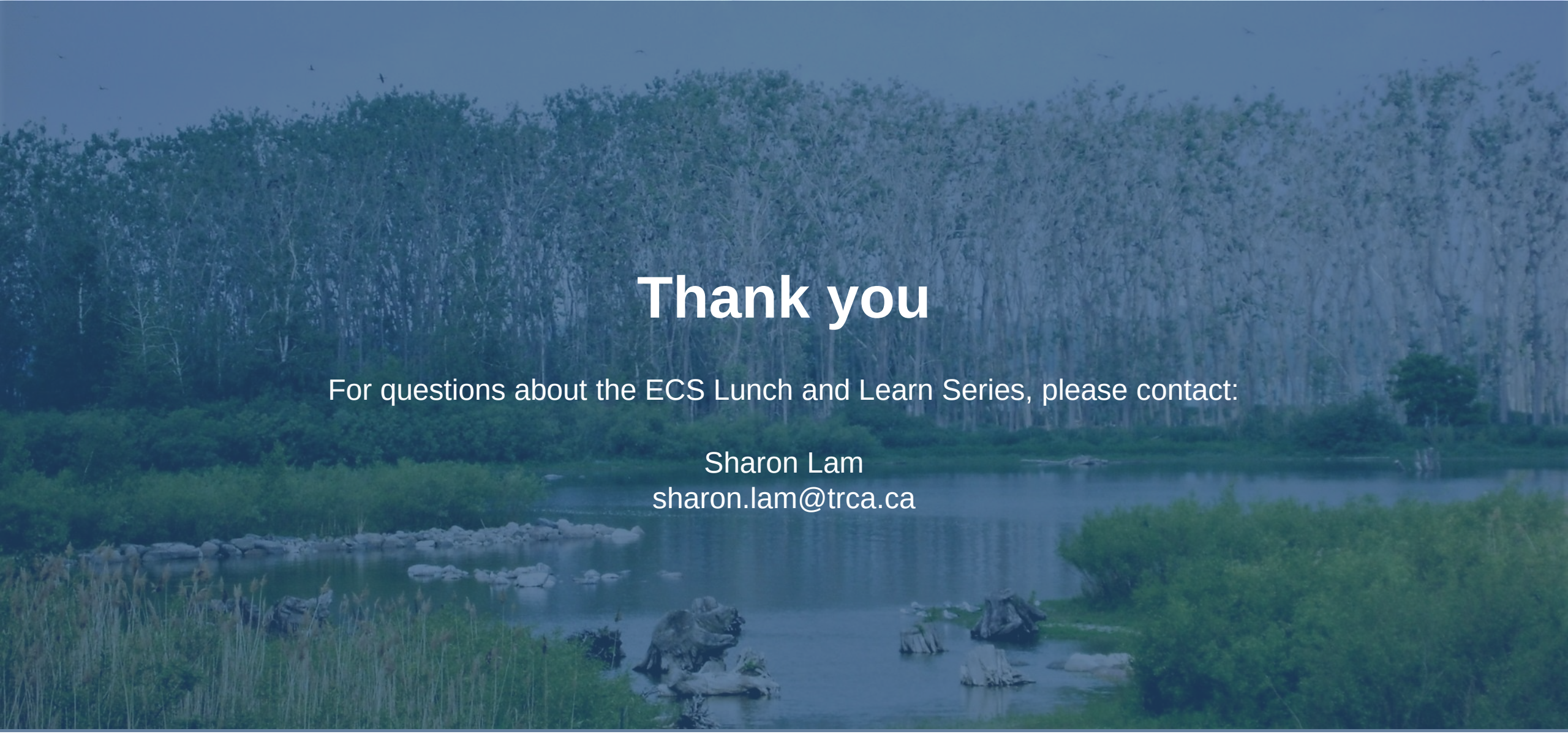












Thank you

For questions about the ECS Lunch and Learn Series, please contact:

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sharon.lam@trca.ca

Toronto and Region Conservation Authority