Climate vulnerability assessment of streams and the adaptation potential within the TRCA jurisdiction

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Presented by: Jonathan Ruppert, Research Scientist, E&CS

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Toronto and Region Conservation Authority

Presentation Overview

1. Quick Introduction (Bio)
2. Introduction: key issues & objectives
3. Approach/analysis
4. Patterns of thermal temperature and resulting fish communities
5. Significance: Prioritization of enhancements and restoration for desirable aquatic outcomes
6. Conclusions & Future Work

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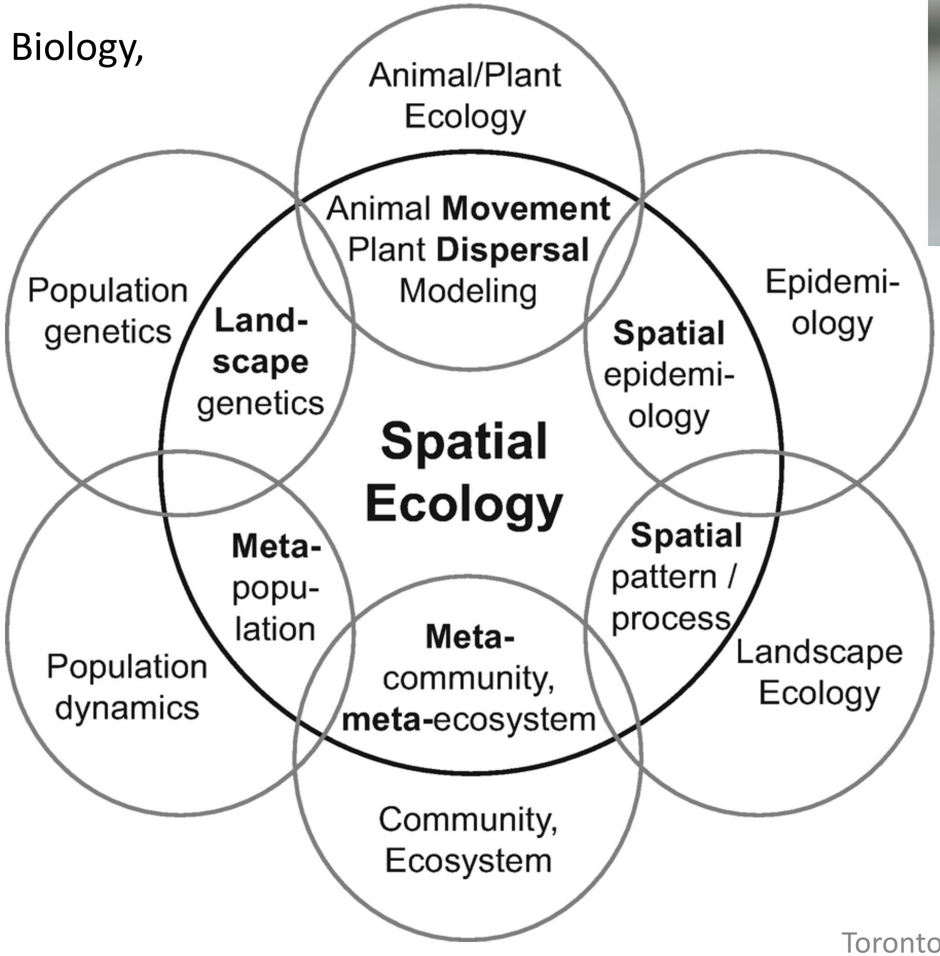
Research Areas

1. Conservation & Strategic Planning
2. Connectivity
3. Compensation & Mitigation



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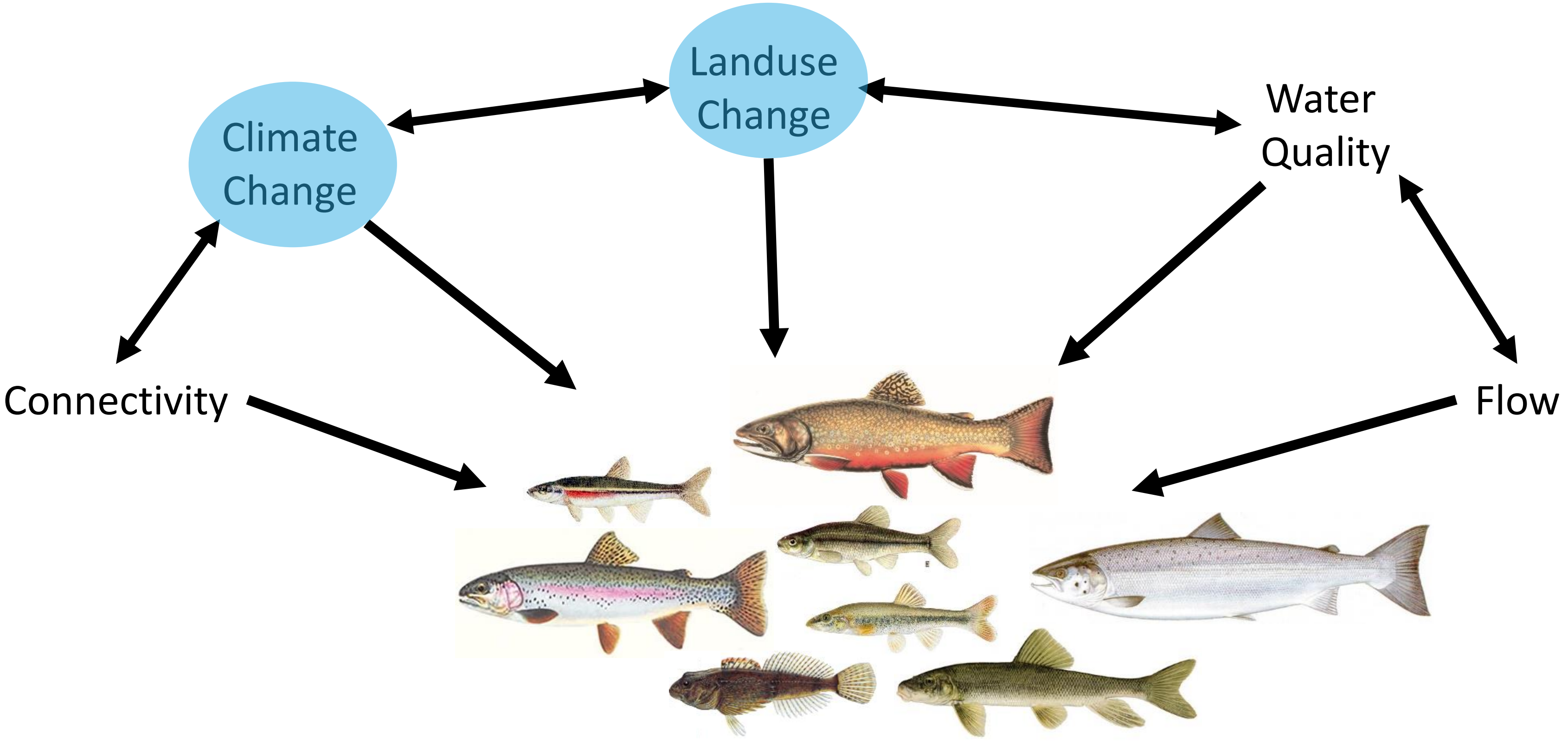
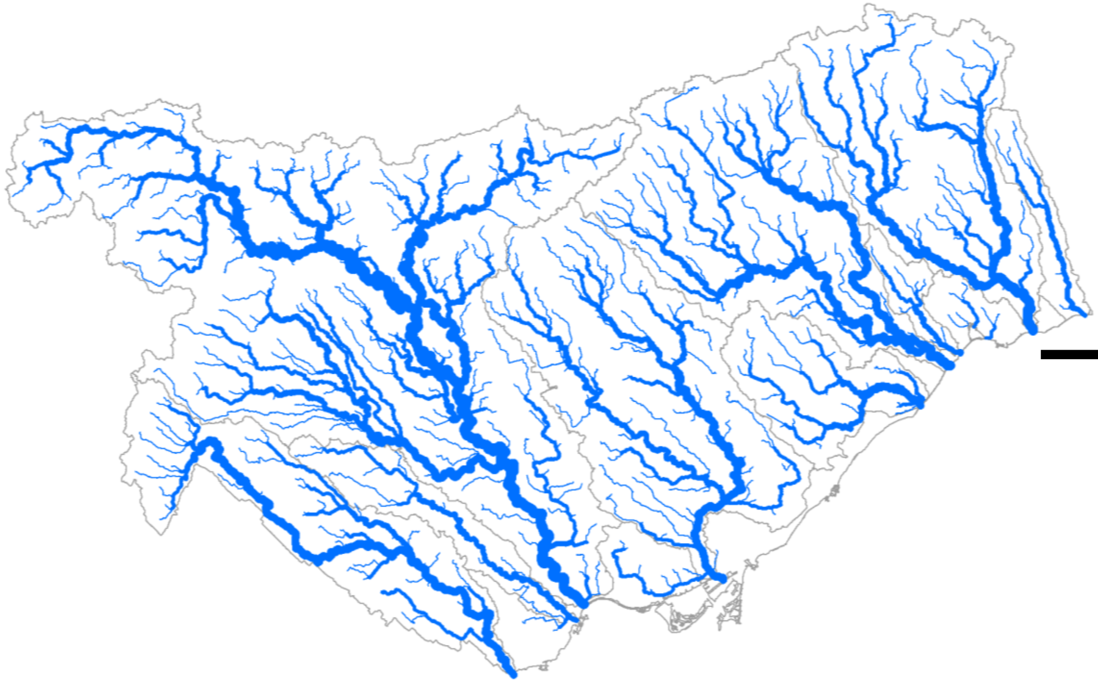
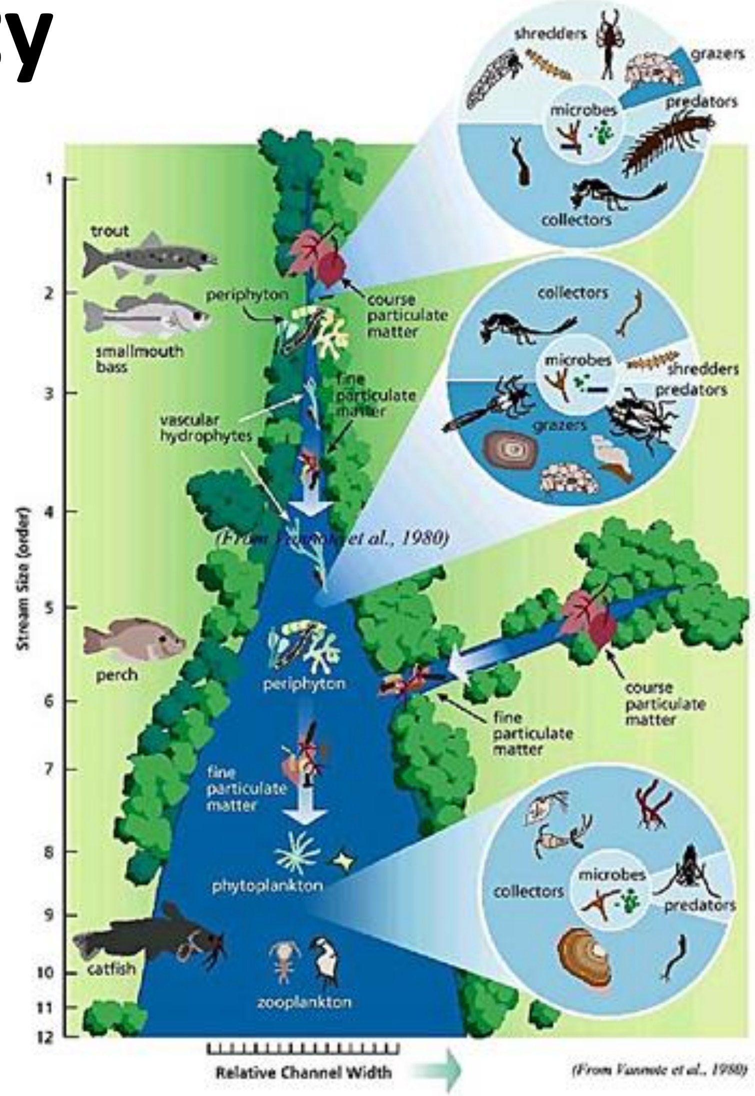
Many stressors acting at multiple spatio-temporal scales in the GTA



Dudgeon et al. 2006; Reid et al. 2019

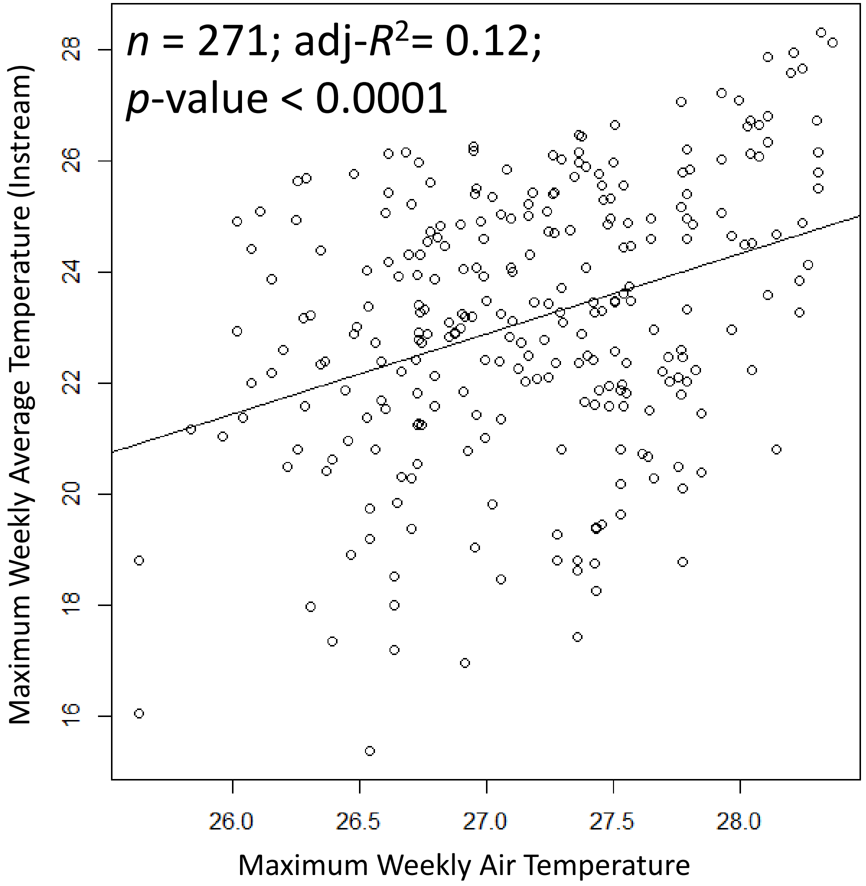
Natural processes that filter local community composition & biodiversity





Instream Thermal Regime Drivers of Change

Climate Change



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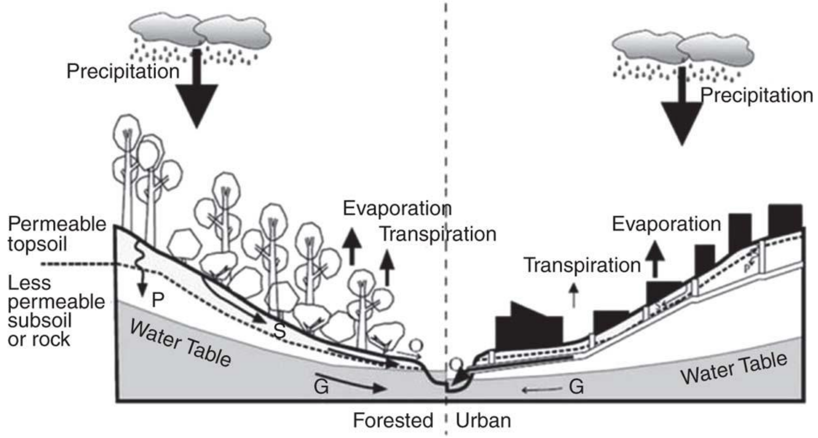
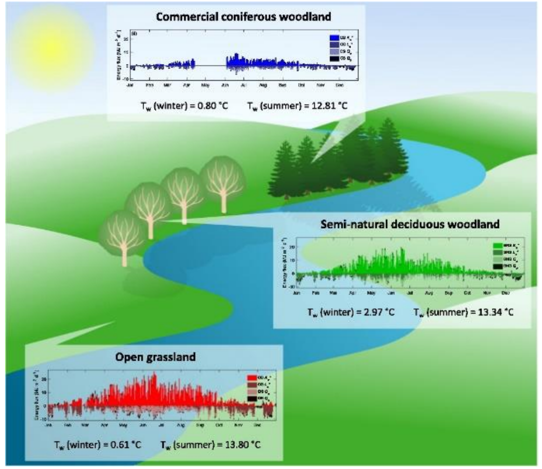
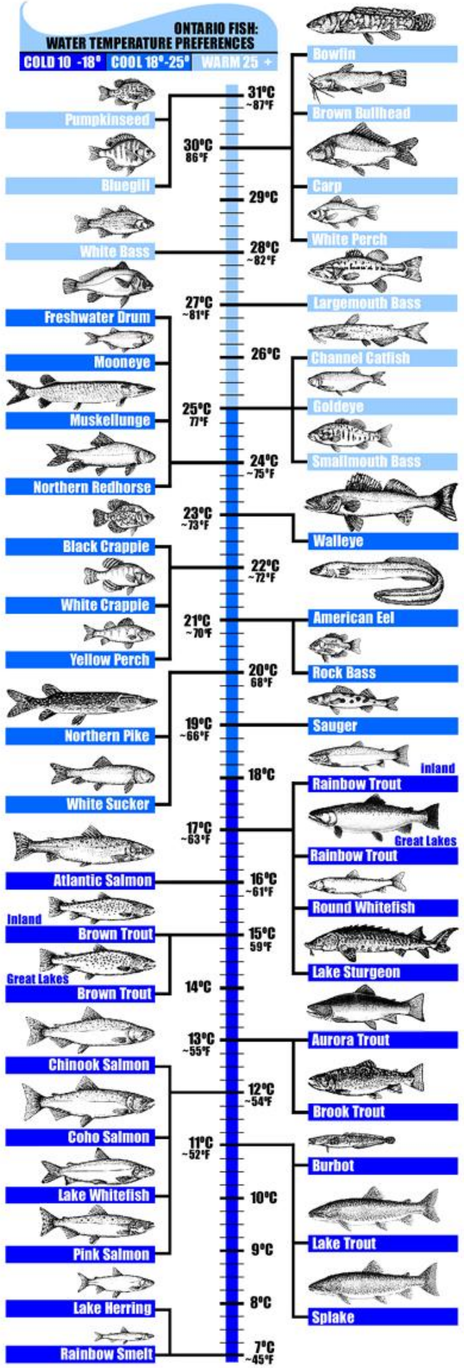
Land Use Change





Dugdale *et al.* 2018 *Science of the Total Environment*



Freshwater Ecosystems & Temperature Regimes

- Fish and Benthic Invertebrates are ectotherms
- Aquatic species & communities have adapted to exploit different thermal regimes (ecological niches)
- A diversity of thermal regimes, supports a diversity of species and communities within freshwater systems

Objectives

1. Determine the potential change in the thermal regime of streams within the Toronto region with climate and land use change
2. Assess whether there are distinct cold, cool, and warm water fish communities
3. Identify where can you prioritize climate adaptation efforts on the landscape

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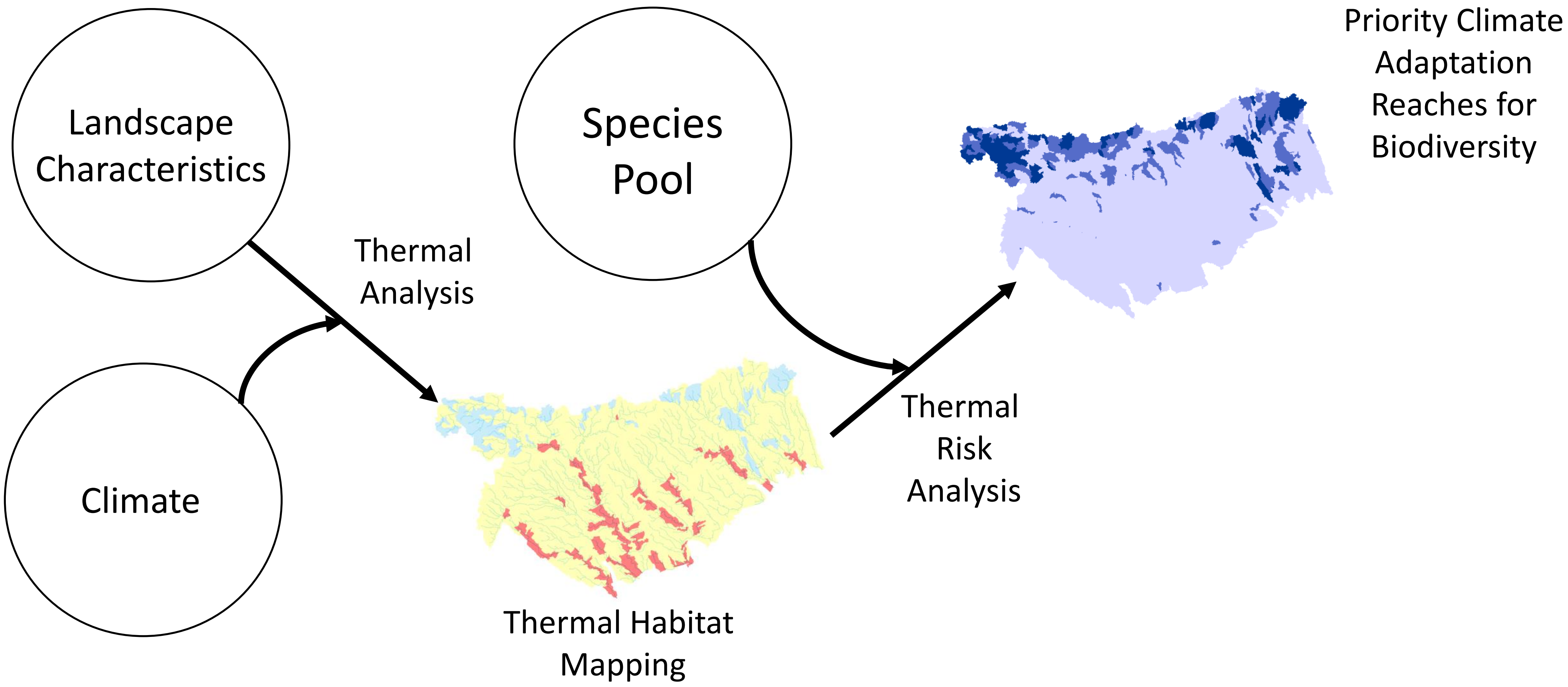
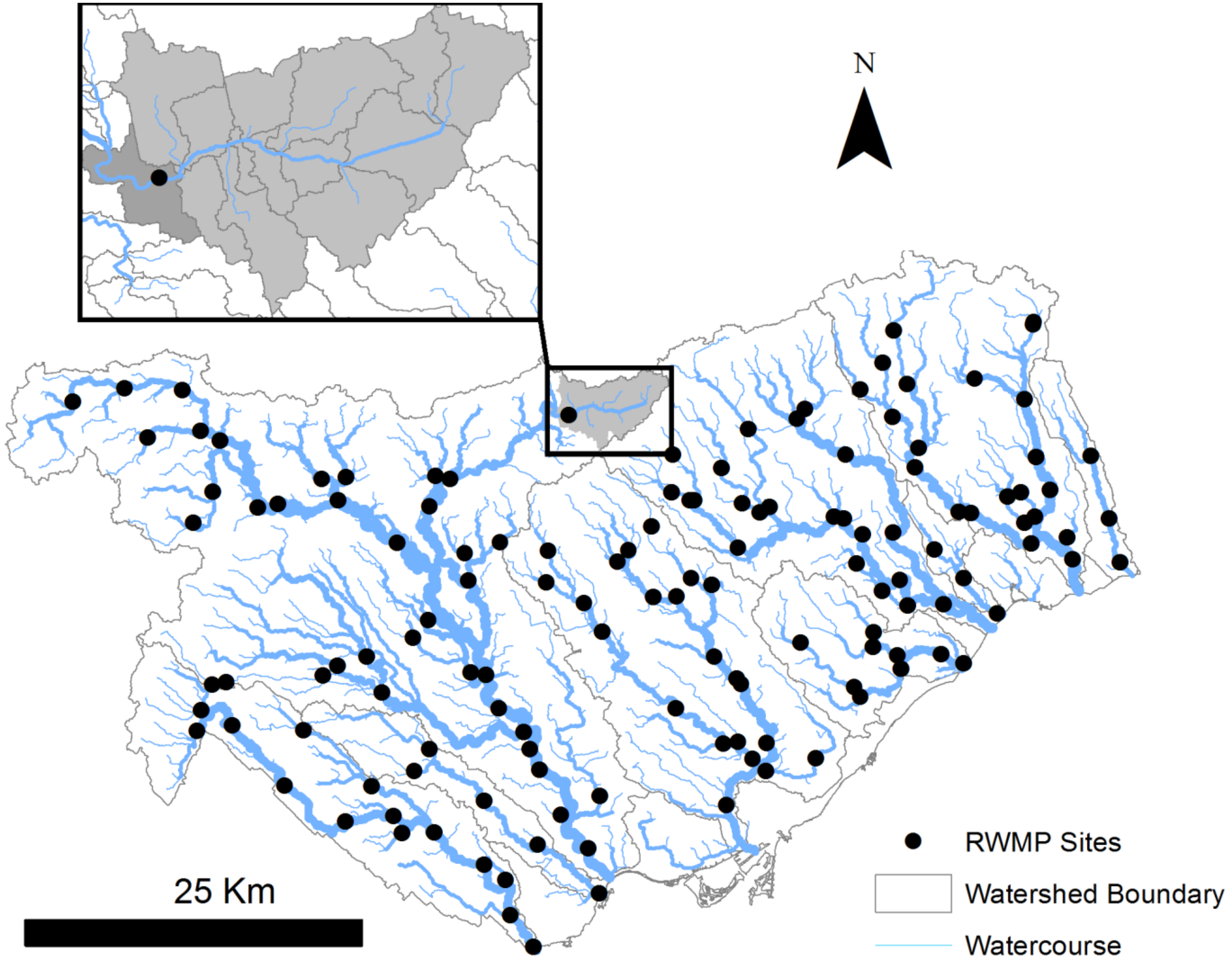
Process to address objectives



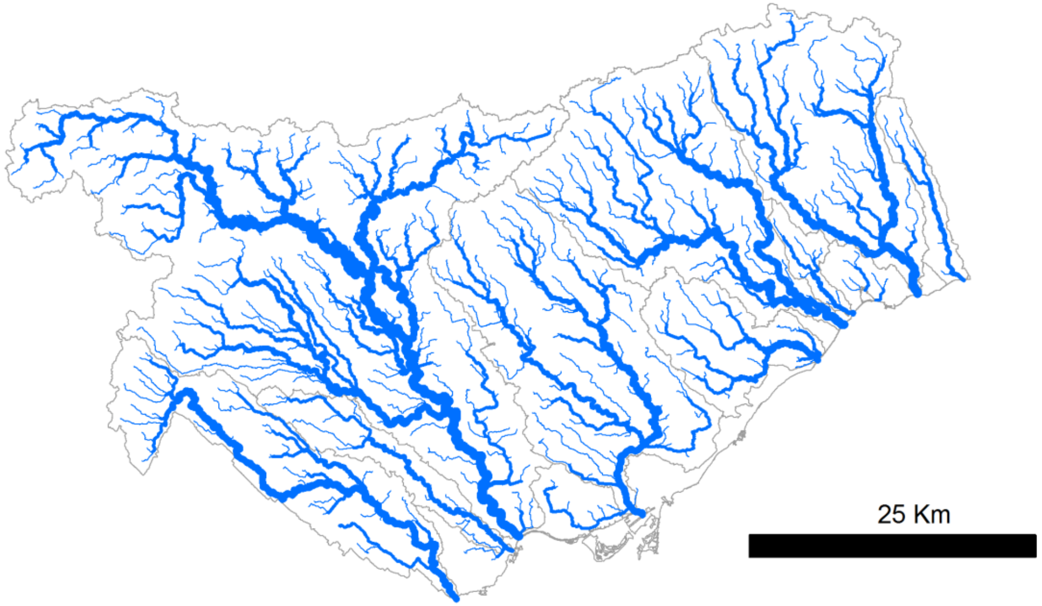
Data, Reach Contributing Areas and RWMP Sampling

- Toronto and Region Conservation Authority jurisdiction
- 125 Ha drainage lines; Reach Contributing Areas (*n* = 1,003)
- RWMP data (Fish and Temperature; 2001-2017)
- Average decadal (2001-2009; 2010-2017) MWAT temperature records (*n* = 265) paired with fish data (OSAP; *n* = 243)
- Median ensemble climate projections of maximum temperatures (RCP 2.6, 4.5 and 8.5)



Scenarios & Model

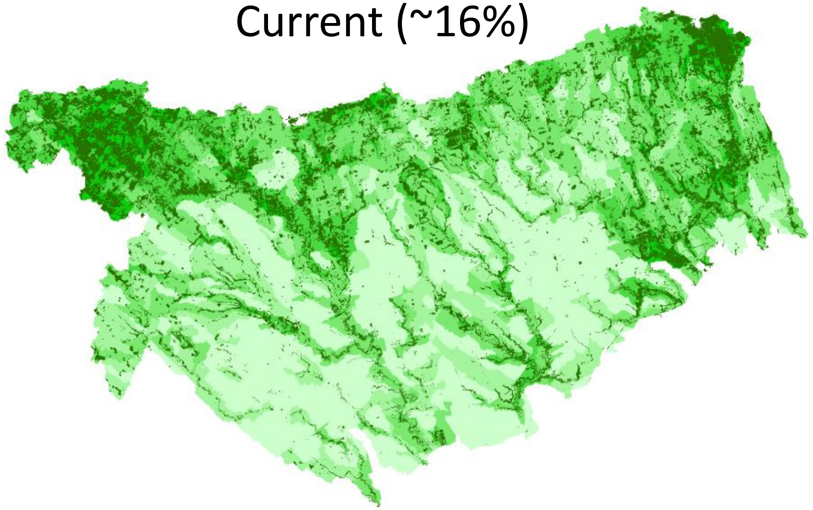
- Three median ensemble climate projections of maximum temperatures (RCP 2.6, 4.5 and 8.5)
- Three land use scenarios (current, future OP and future aggressive)
- Simple linear regression to predict Maximum Weekly Average Temperature (MWAT)



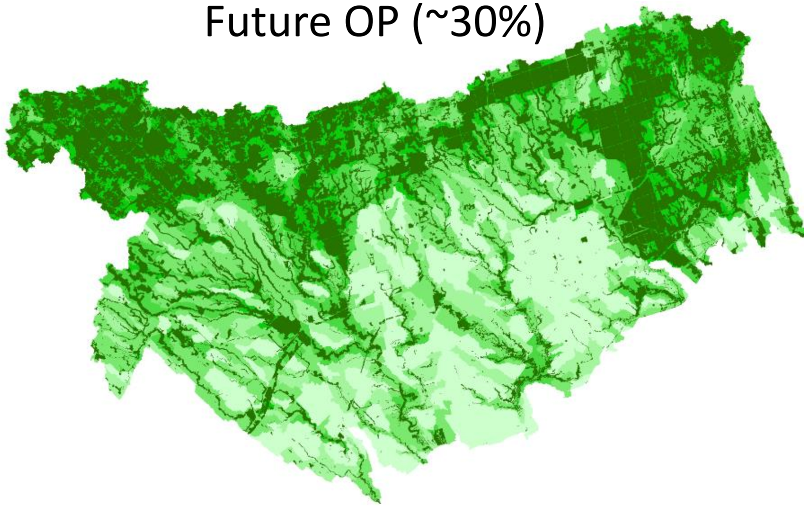
Response	Predictors
MWAT	**Percent Forest (RCA** & UCA)
	Discharge (RCA & UCA)
	Slope
	Stream Order (Shreve)
	RCA Area
	Maximum Air Temperature

Land use scenarios

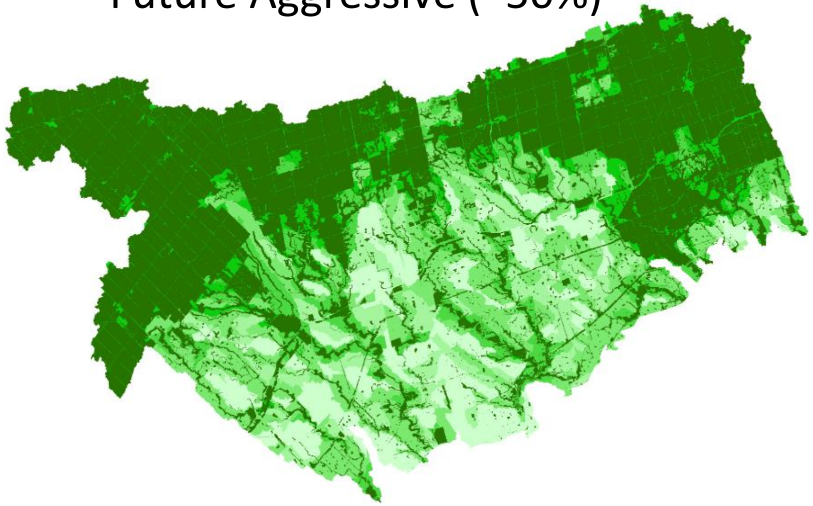
Current (~16%)

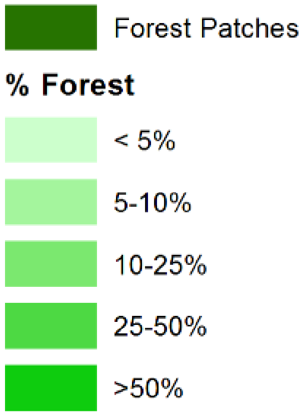


Future OP (~30%)



Future Aggressive (~50%)





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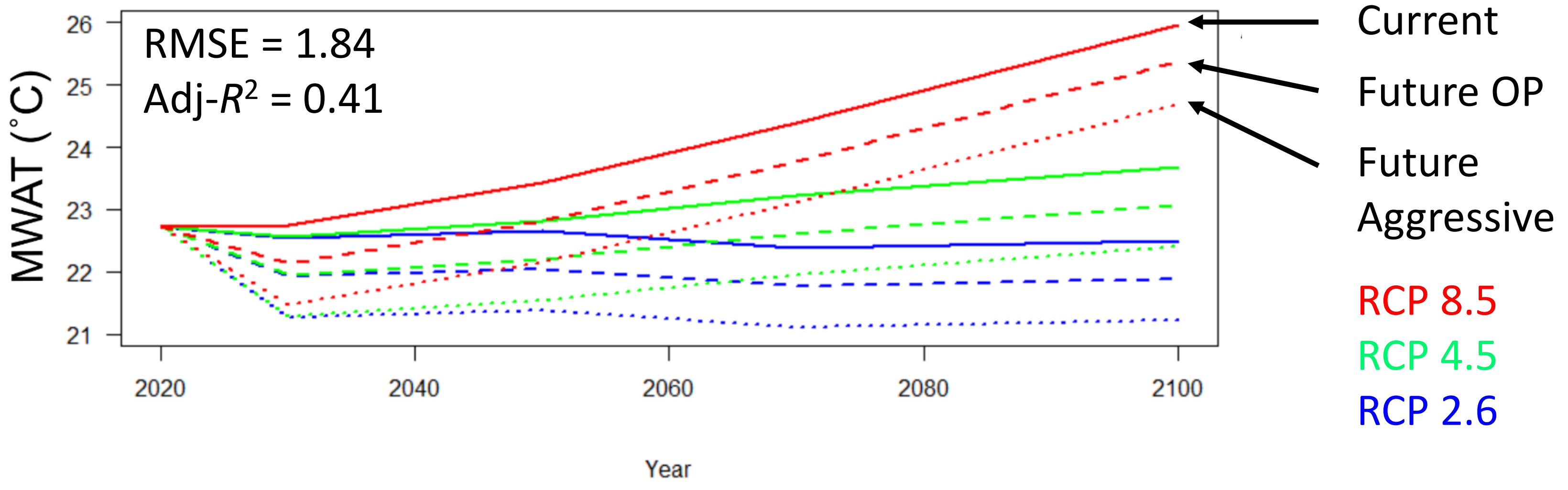
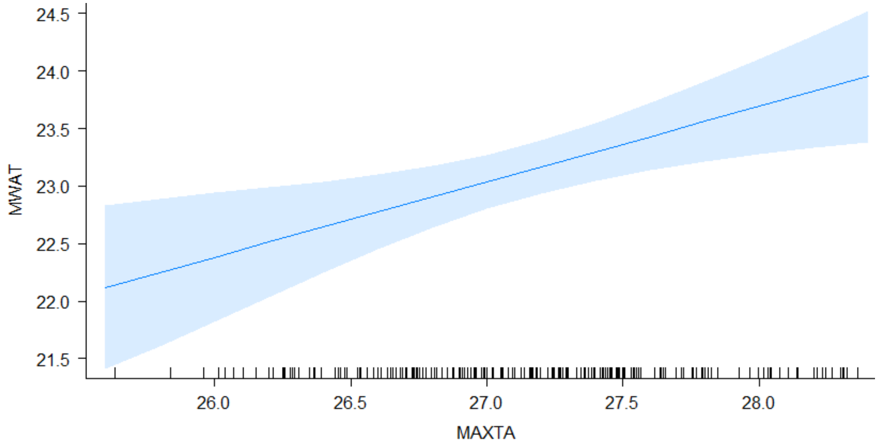
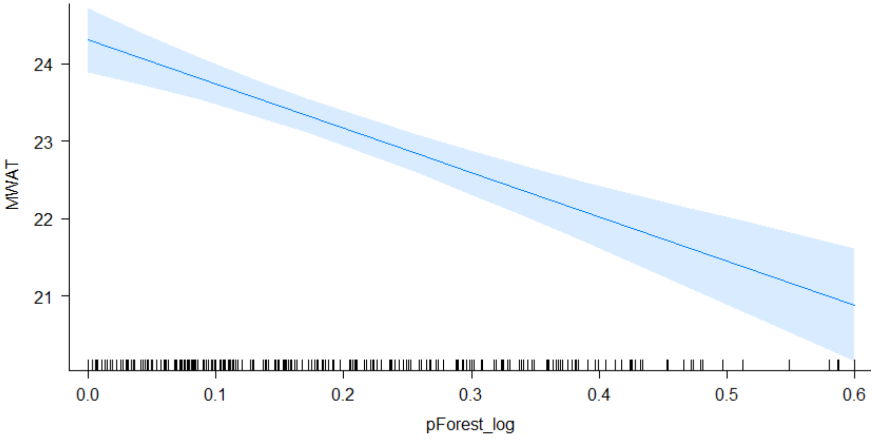
Mean Reach Contributing Area Instream Temperature (MWAT)







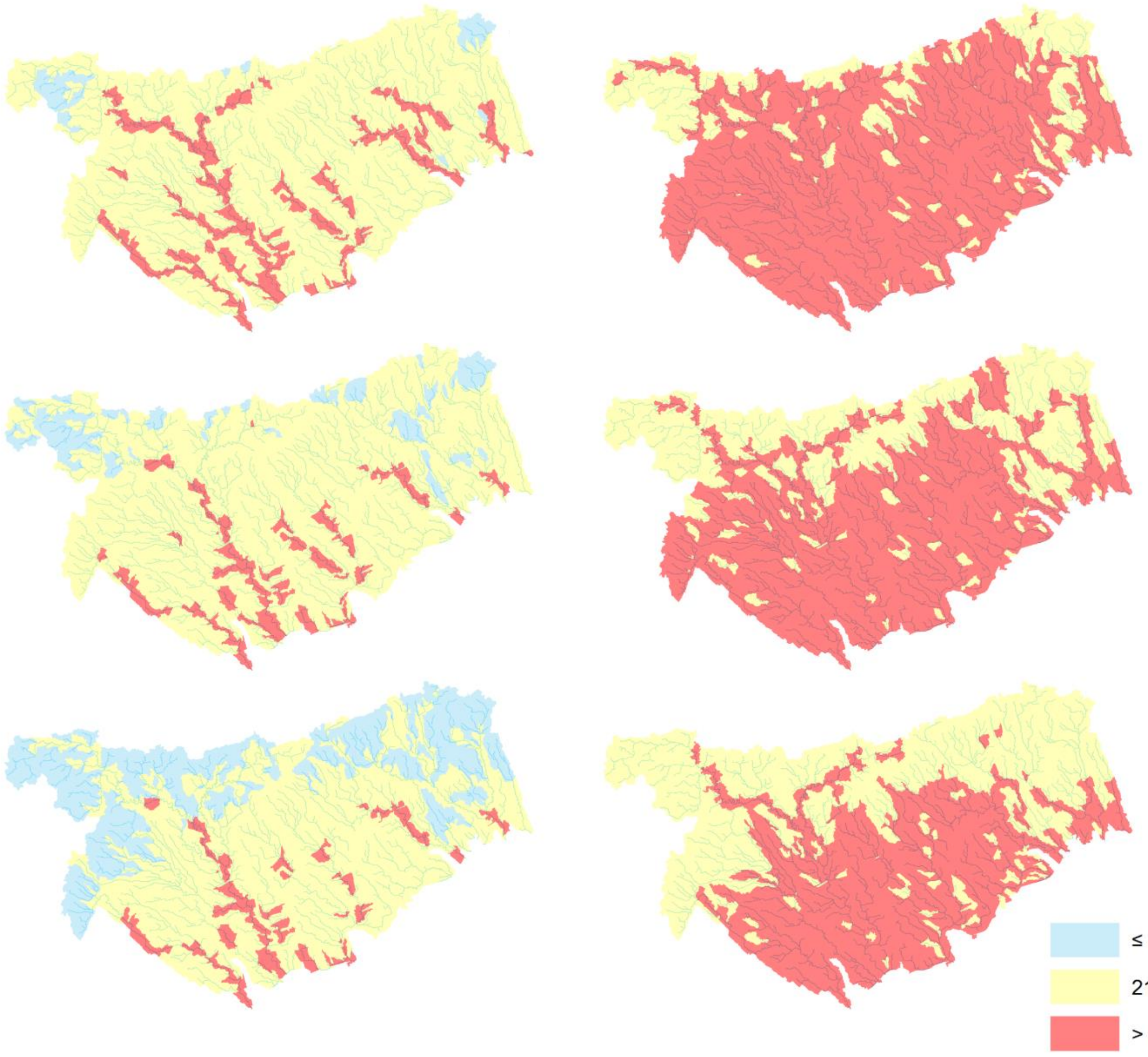
Spatial variability in MWAT by 2100

RCP 4.5 | RCP 8.5

Current

Future OP

Future Aggressive



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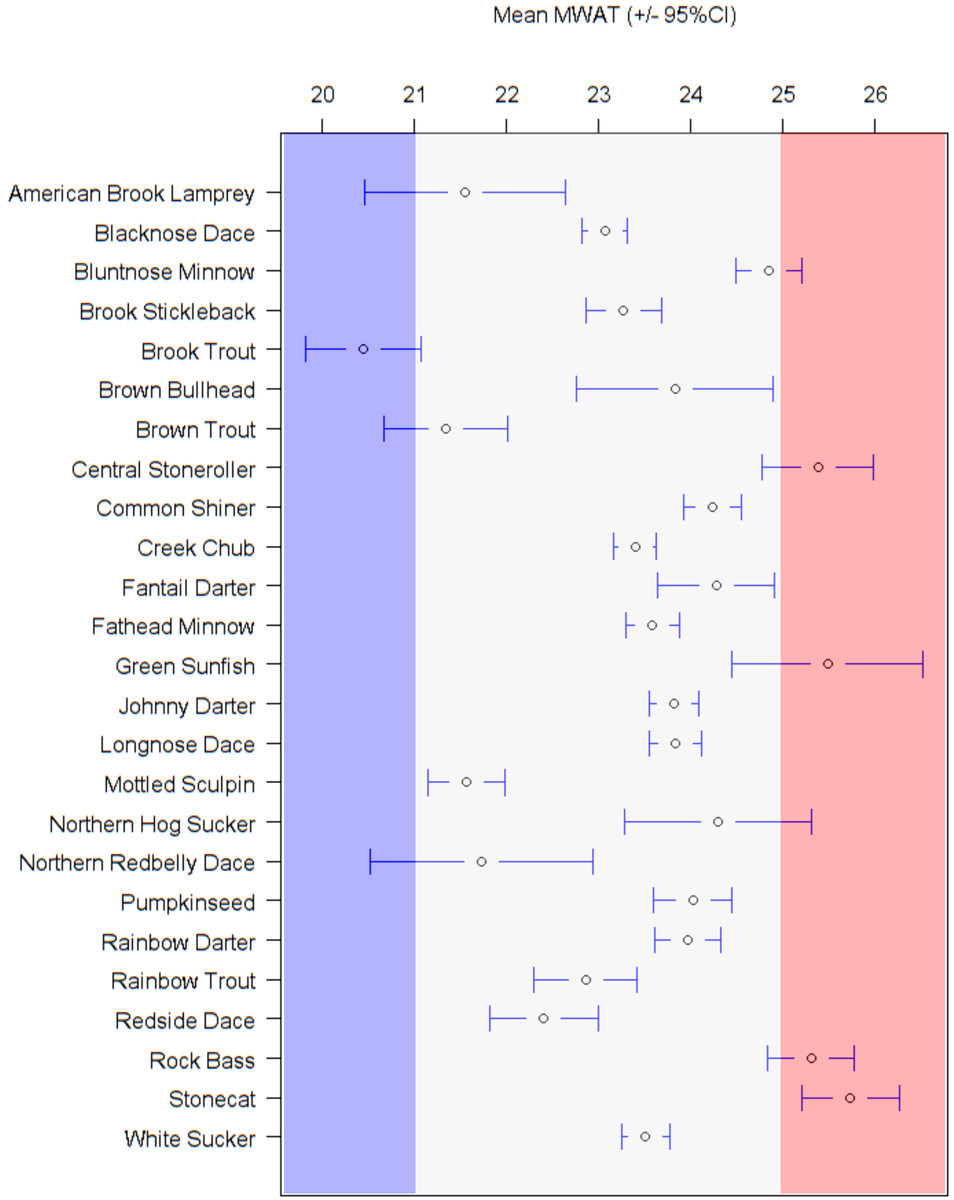
Mean MWAT for prevalent species



n = 25 species present in > 5% of sites

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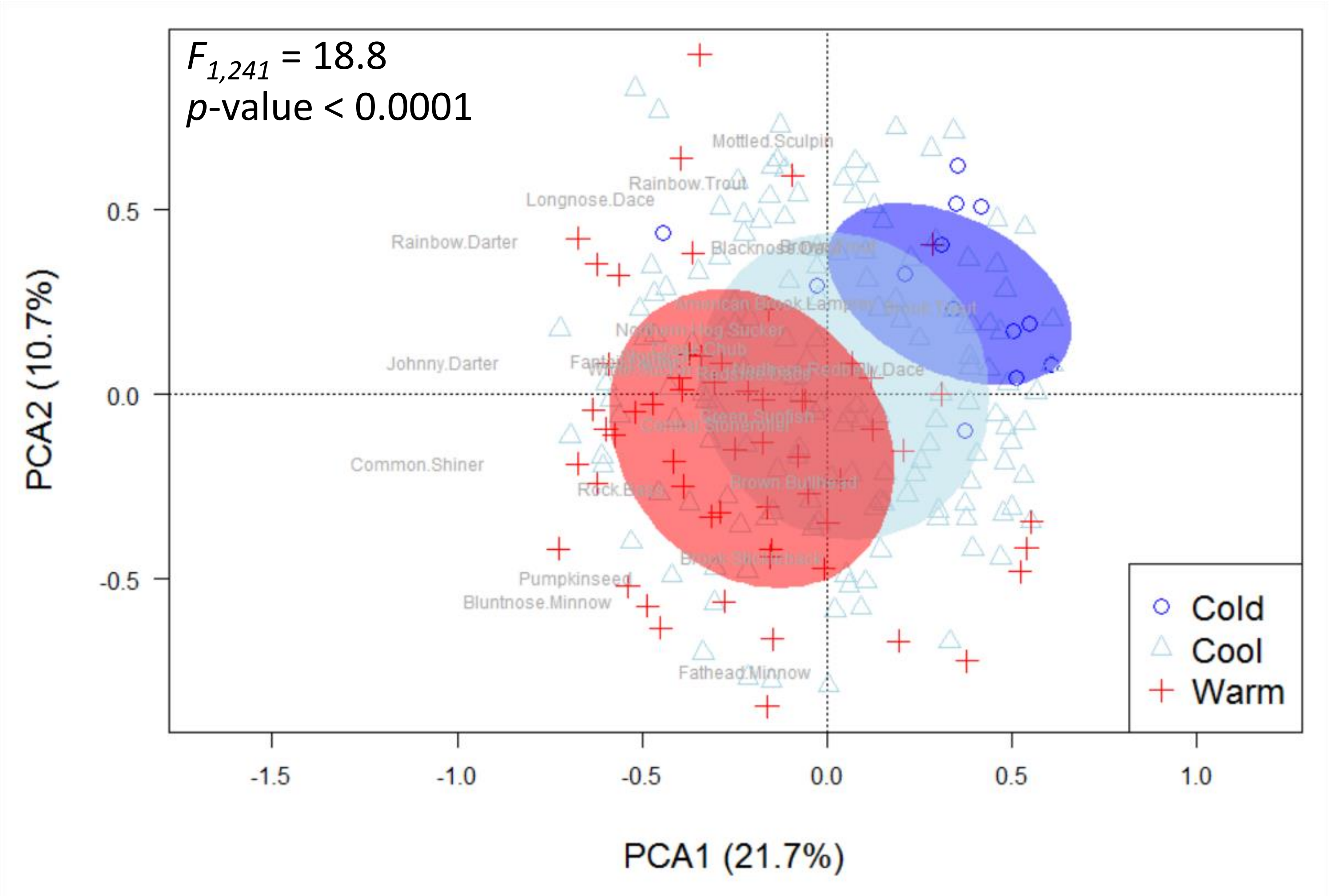
Fish community differences across thermal regimes



Significant differences found in fish communities related to thermal regime

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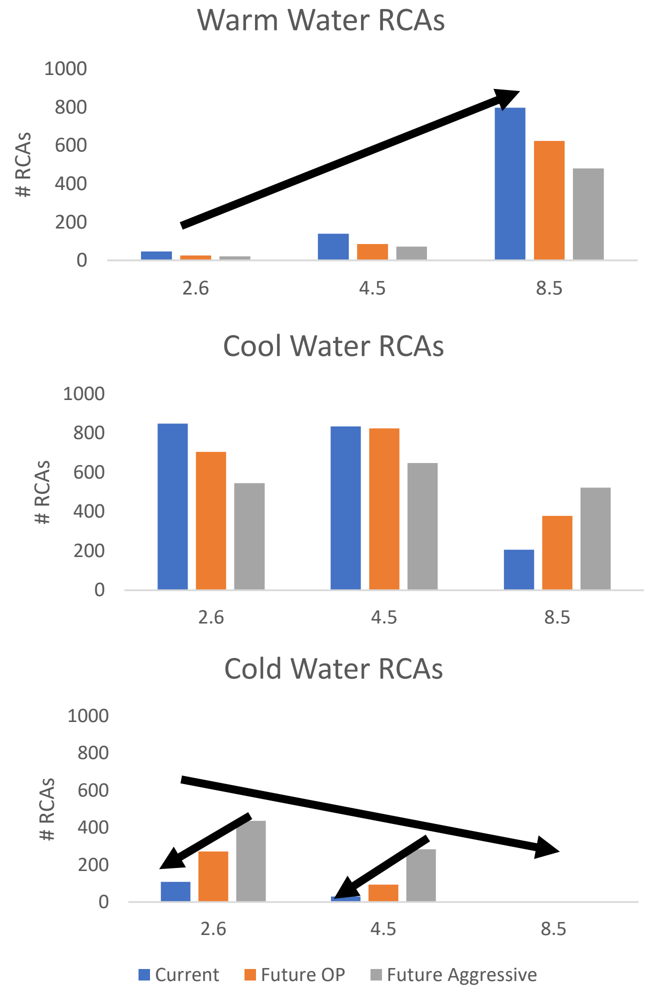
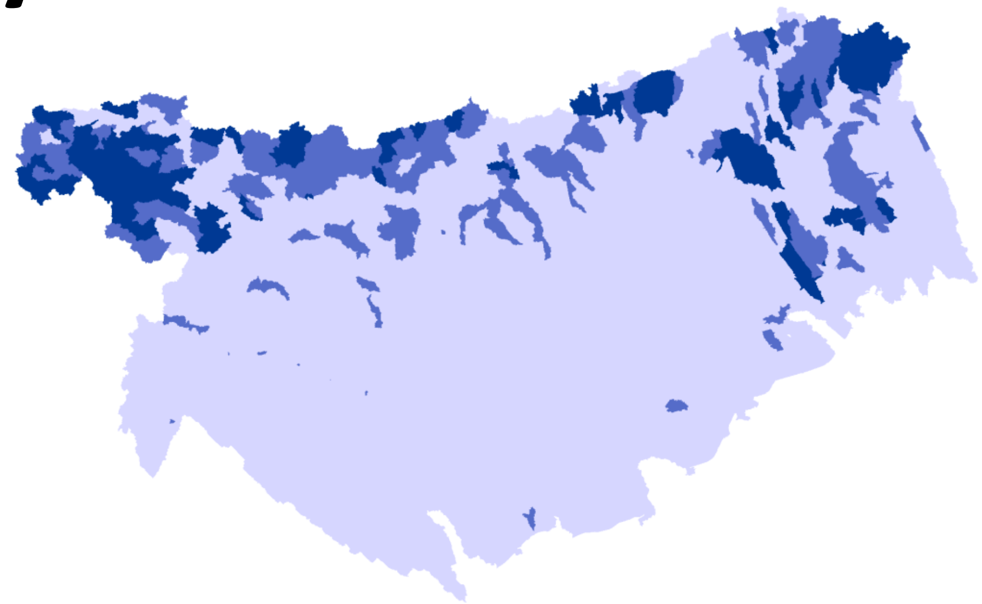
Vulnerability of thermal regimes

- Currently (2010-2017) **cool water** reaches are the most common (warm – 61; **cool – 845**; cold – 97)
- Type of thermal regime related to both climate and land use scenario
- Warm water reaches respond the most to climate scenario (highest with RCP 8.5)
- Cool water reaches sensitive to both climate and land use
- Cold water reaches do not exist in the worst climate scenario none exist (RCP 8.5)



Climate adaptation priority areas

- Climate scenario that is most likely is **RCP 4.5** or higher
- Land use scenario that is most likely is **Official Plans (~30%)**
- **Cold-water habitat** is the most at-risk
- Focus on cold water areas with both long (2100) and medium (2050) term (gain and/or maintain)



High Priority (2050 & 2100)

- 93 RCAs
- 7,720 ha Forest required

Medium Priority (2050 only)

- 130 RCAs
- 8,490 ha Forest required

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Conclusions

- **Forest cover and Air Temperature** will significantly impact the future availability of thermal habitat types

- **Cold-water** fish communities are the **most at-risk** under future climate (RCP 4.5 and 8.5) & natural cover scenarios
- **Cool-water** fish communities are also **at-risk** under more aggressive climate scenarios (RCP 8.5)

- **Adaptation measures** to future climate (e.g., restoration, strategic **natural heritage planning**) can have a positive impact on biodiversity conservation efforts

- One knowledge gap is the impact of **stormwater infrastructure** on thermal regimes
- Further OPs don’t go to year 2100 and are dynamic

Implications: Integration of aquatic needs/ priorities in NHS development

- Natural Heritage System (NHS) update ongoing at TRCA
- Integration of water resource system (Key Hydrologic Features & Key Hydrologic Areas)
- <u>Current gap is aquatic ecological needs/priorities</u>

Key Overall Objectives:

1. Incorporate aquatic ecological values into NHS scenarios
2. Identify areas where establishment of NHS provides habitat for maintaining/improving aquatic biodiversity

Multi-scale system approach

Broad (jurisdiction) scale: climate & land use change risk to maintaining fish habitat within aquatic ecosystems; provide insight into adaptation and conservation prioritization.

↑↓

Medium (reach) scale: assess cumulative impacts of stormwater infrastructure and develop forecasting tool.

↑↓

Fine (stormwater catchment) scale: specific designs within LID, SWMP catchments to identify ecological benefits and losses with development.

Acknowledgements

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Mitacs

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