Diving in: Aquatic Research and Development Project Profile Series

Thermal diversity of fish in southern Ontario watersheds & climate change

Fishy Factoids

- Rainfall has three main fates: runoff, evaporation, and infiltration as groundwater.
- The mean annual air temperature in Southern Ontario is roughly 7-9^{o}C, the same temperature as our groundwater.
- Groundwater comprises over 90% of our freshwater resources, whereas lakes comprise less than 10%.
- Coldwater species require water colder than 19^{o}C.
- Warmwater species are expected to increase their range in Ontario as the climate gets warmer. However, the movement of fish across the landscape is limited by suitable habitat and hydrologic connections: fish cannot fly!
- The increasing water temperatures may allow invasive species to colonize new areas of Ontario.
- In rivers, the cold headwater reaches are expected to contract while the warm water lower reaches are expected to increase in size.

Skimming the Surface

Climate change is expected to increase stream temperatures, alter the timing of the spring melt, and reduce summer stream flow. These effects may lead to a reduction in suitable fish habitat across Ontario.

Water temperature strongly influences:

- fish physiology and life history
- the distribution and abundance patterns of fishes
- ecosystem productivity e.g., nutrient release and uptake

The successful management of streams will depend on our ability to assess, adapt and mitigate future climate change impacts.

This study examines the influence of air temperature and groundwater discharge on the thermal diversity of stream fish communities in southern Ontario. Climate change scenario data were used to forecast the potential changes in coldwater and warmwater fish distributions in 2055.

A likelihood index was developed to identify which watersheds may retain coldwater fishes in the face of climate change. This index may be used to set conservation priorities and watershed management strategies in southern Ontario.

Research Team Partners & Collaborators

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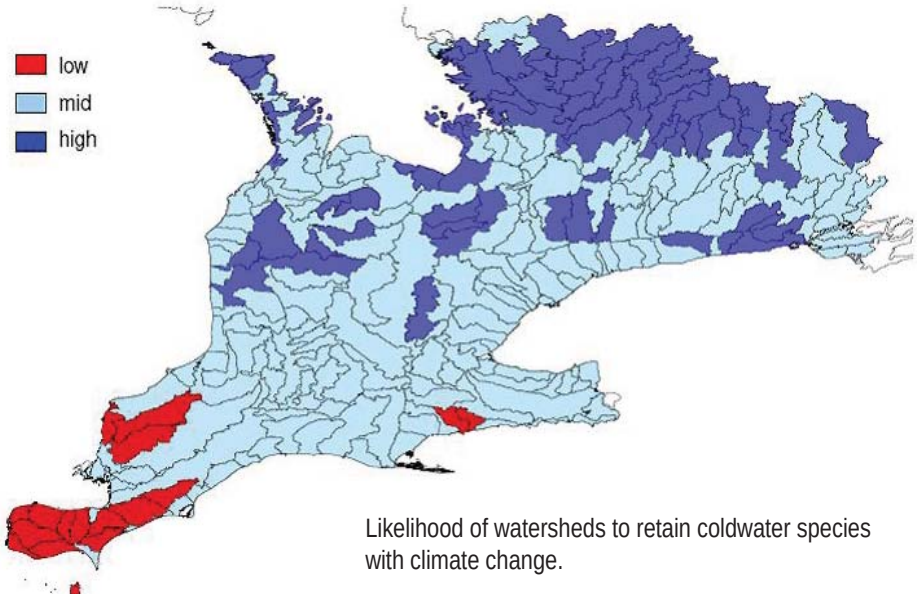
Diving Deeper

Current Thermal Diversity of Coldwater, Coolwater & Warmwater Stream Fishes in Ontario Watersheds

Site-level fish sampling data were used to assess the thermal diversity of 43 quaternary (groups of four) watersheds using three metrics, the proportion of sites within a watershed having 1) coldwater (e.g. lake trout), 2) coolwater (e.g. walleye) and 3) warmwater fishes (e.g. bass). Air temperature and groundwater discharge variables explained 53.9% of the variances in coldwater and 54.1% of the variances in warmwater fish distributions but did not explain the variance in, intermediate and common, coolwater distributions within the watersheds. This means that the future distribution of coldwater and warmwater species can be predicted using air temperature and groundwater, whereas, the future scenarios for coolwater species' distributions are far less predictable.

Forecasted Thermal Diversity of Coldwater & Warmwater Fishes in Southern Ontario in 2055

The Canadian Global Coupled Model 2 (CGCM2) and the Hadley Centre Coupled Model 3 (HadCM3) climate models and the A2 and B2 emissions scenarios were used to forecast climate change impacts. The scenarios indicate a reduction of coldwater and expansion of warmwater species distributions in the future.



Likelihood of watersheds to retain coldwater species with climate change.

Likelihood of Watersheds to Retain Coldwater Species with Climate Change in 2055

Warmwater species distributions will likely remain the same or increase within each watershed with climate change. Therefore, we developed an index of the likelihood of watersheds to retain coldwater species in the future.

Our results suggest two management approaches to conserve coldwater species. One option is to protect streams with low groundwater discharge because they are at the greatest risk of temperature and species changes in case streams return to pre-climate change conditions.

Alternatively, if climate change is assumed to be inevitable, then give streams with high groundwater discharge and colder waters greater protection because they will offer a suitable habitat and temperature refuge in the future. In both cases, additional manmade changes that may alter stream temperatures needs to be minimized.

More Information

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