

Predicting the Large Scale and Long Term Distribution of Invasive Species using Habitat Suitability Models

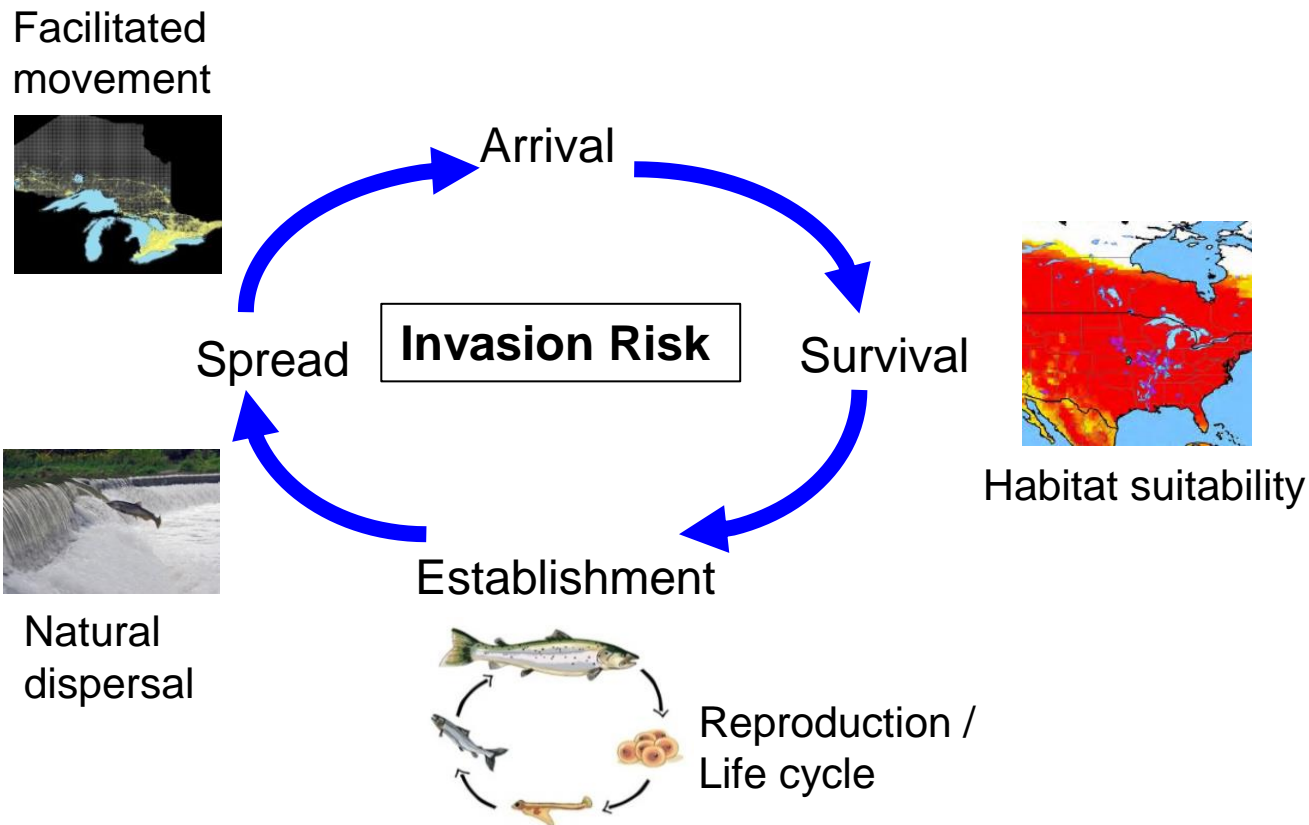
Jeffrey D. Buckley¹, D. Andrew R. Drake²,
Len M. Hunt¹, and Timothy B. Johnson¹

¹ Ontario Ministry of Natural Resources and Forestry

² Fisheries and Oceans Canada

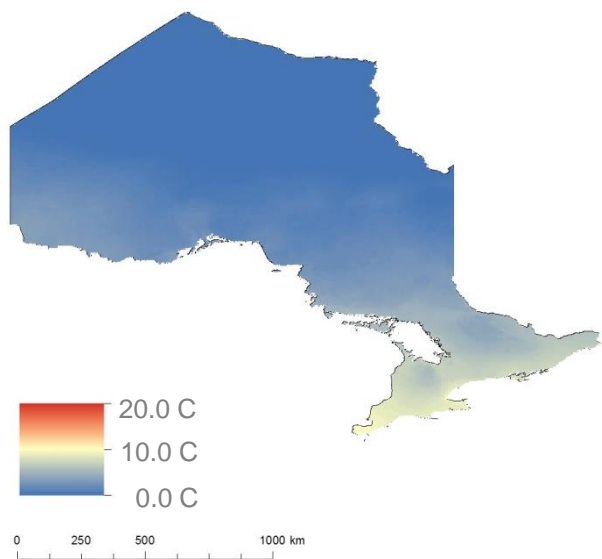
Vulnerability of Ontario and the Laurentian Great Lakes to AIS



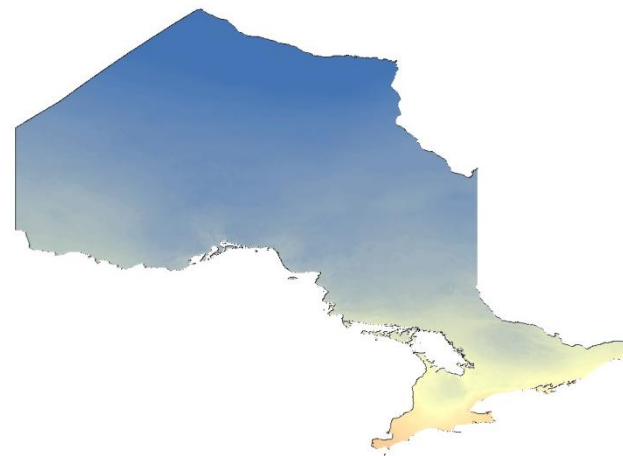


Climate Change – Projected Air Temperatures

Mean annual air temperature



2010

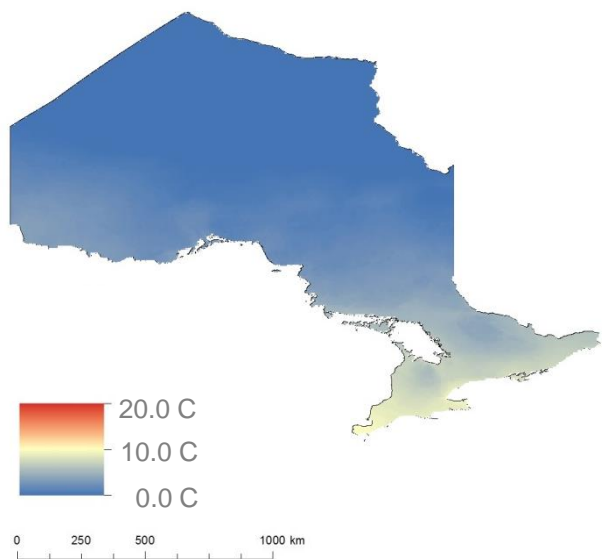


High mitigation

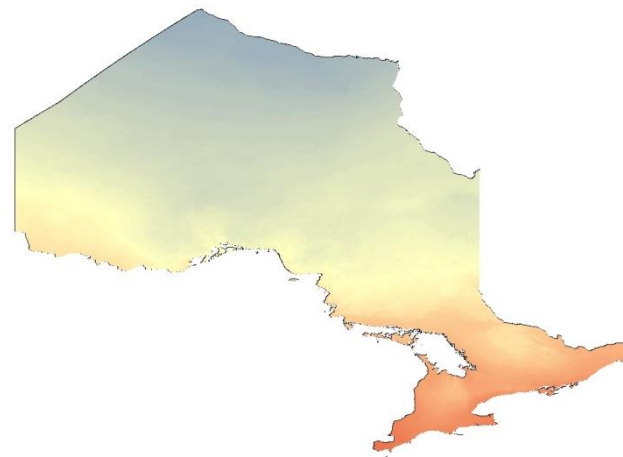
2085

Climate Change – Projected Air Temperatures

Mean annual air temperature



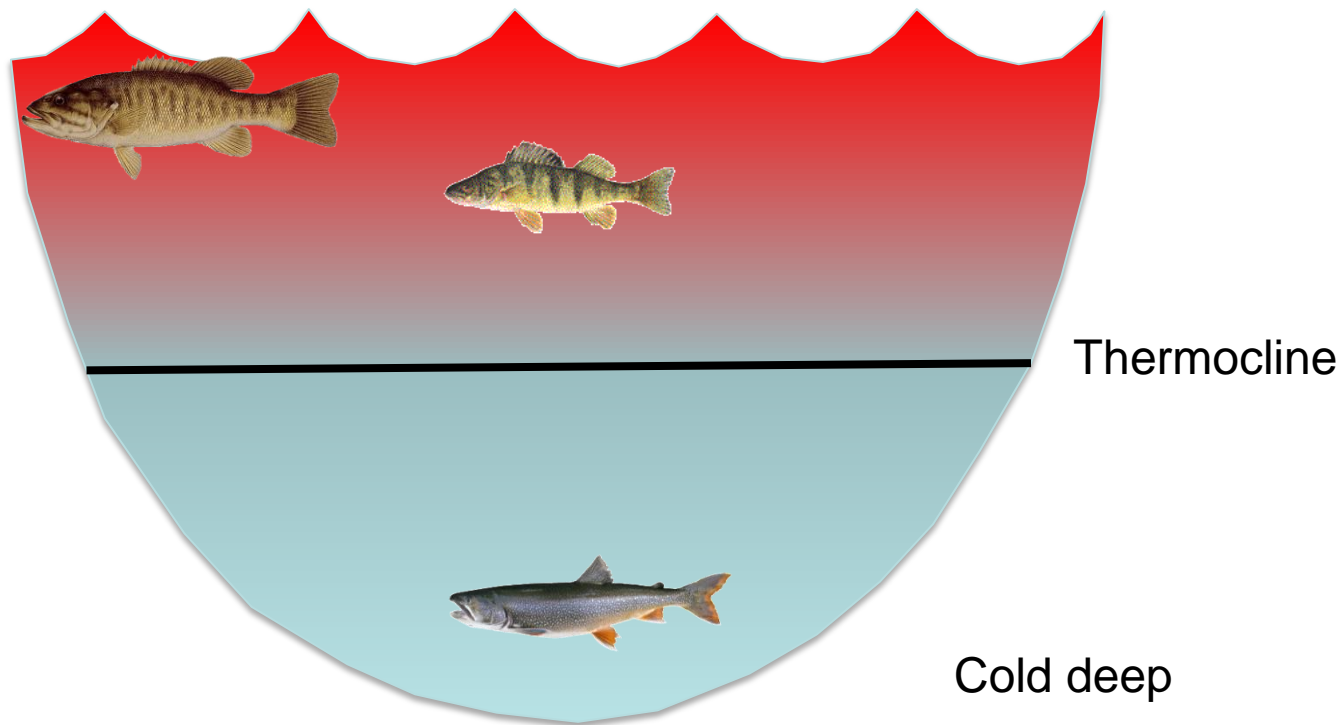
2010



Low mitigation

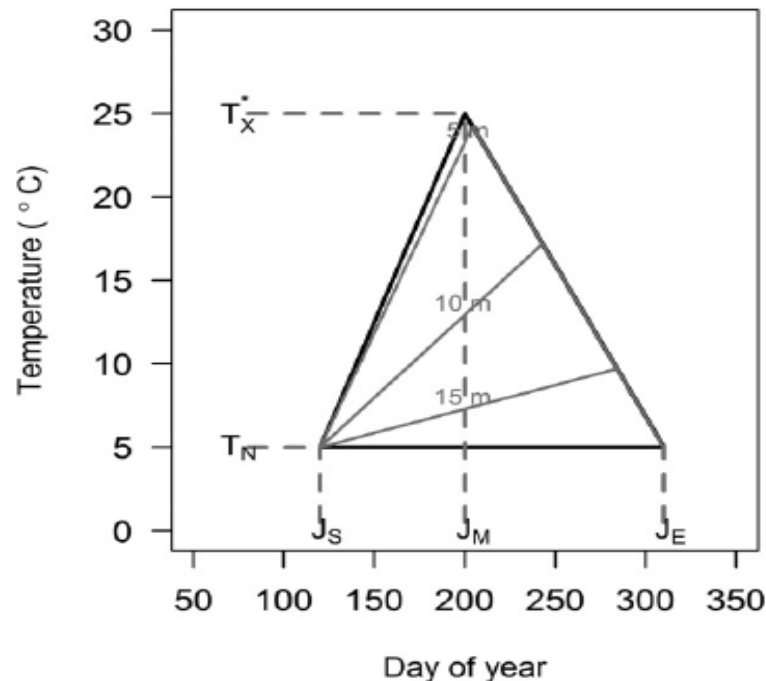
2085

Thermal Habitat – Lake Physics 101



Translating Air Temperature to Thermal Habitat

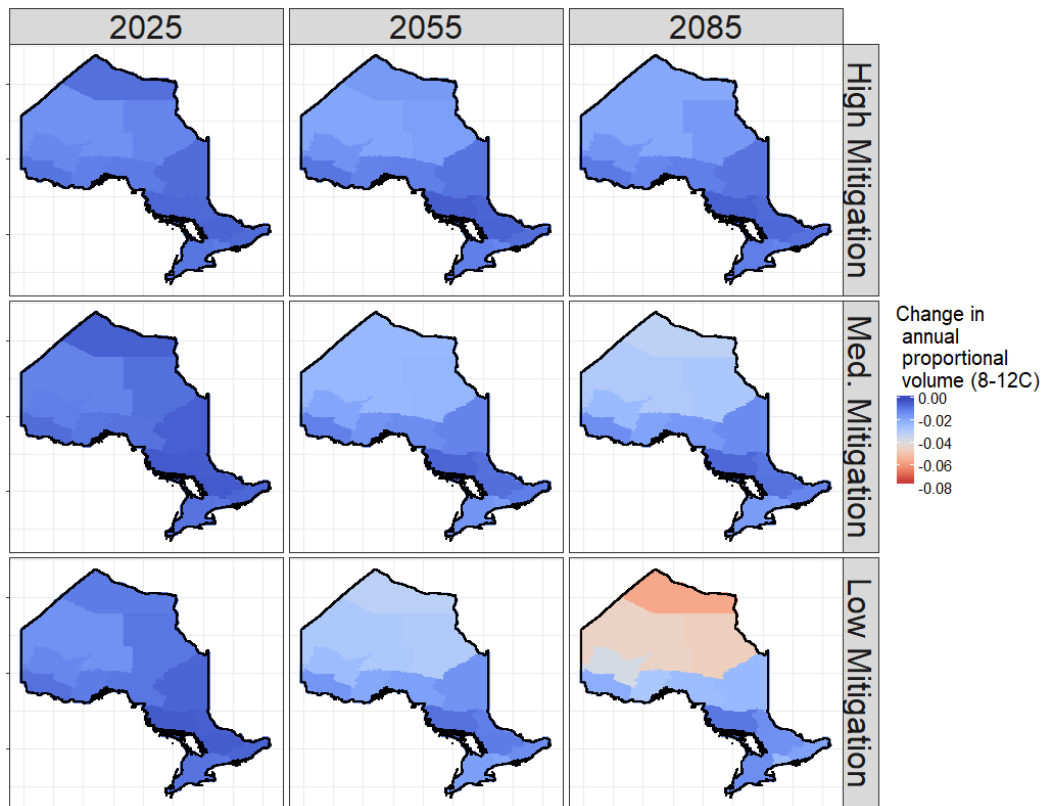
- Seasonal Temperature-Profile Model
- Inputs:
 - Air temperature, latitude, longitude, elevation, lake area, maximum depth, DOC/Secchi
- Output:
 - Predict temperature @ depth @ day of year



(Minns and Shuter 2013, Minns et al. 2015)

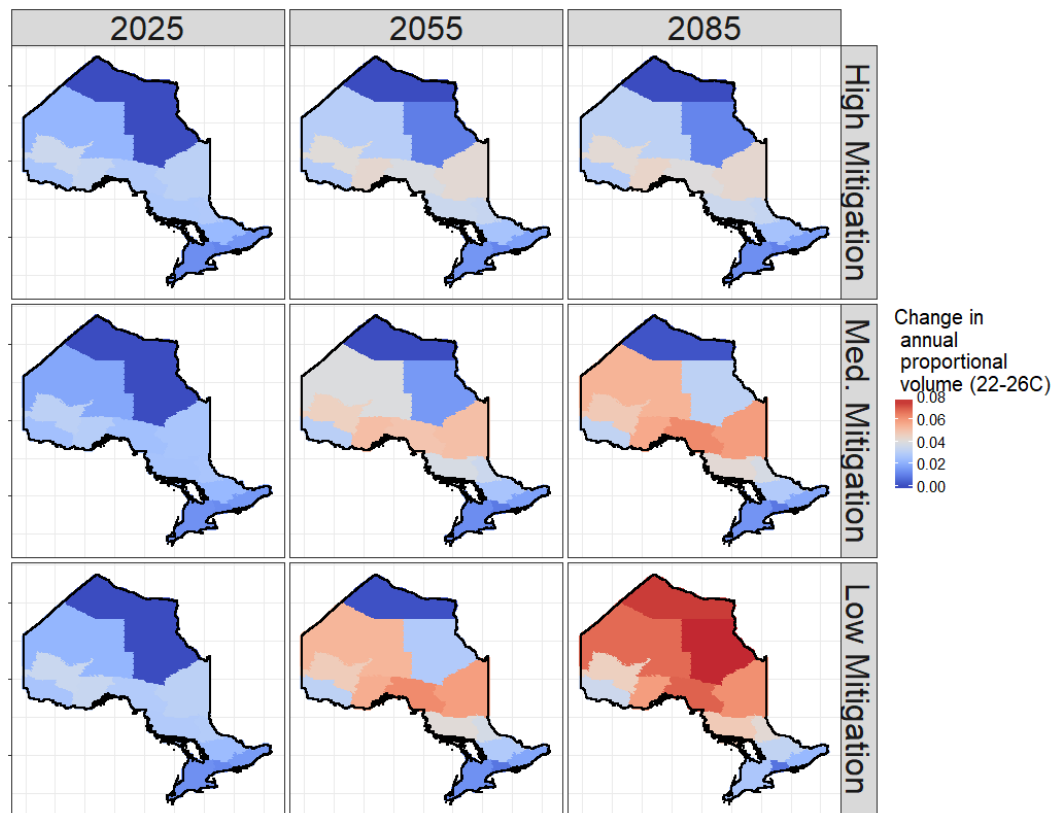
Loss of cold water habitat

- 3 times periods
 - Short term
 - Medium term
 - Long term
- 3 mitigation scenarios
 - High mitigation
 - Medium mitigation
 - Low mitigation

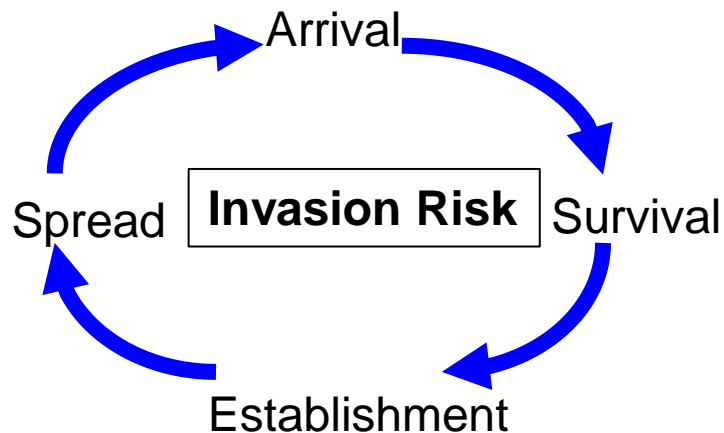


Increase in warm water habitat

- 3 times periods
 - Short term
 - Medium term
 - Long term
- 3 mitigation scenarios
 - High mitigation
 - Medium mitigation
 - Low mitigation



Linking Bioenergetics and Invasion Biology



Survival

- Upper incipient lethal temperature
- Critical thermal maximum

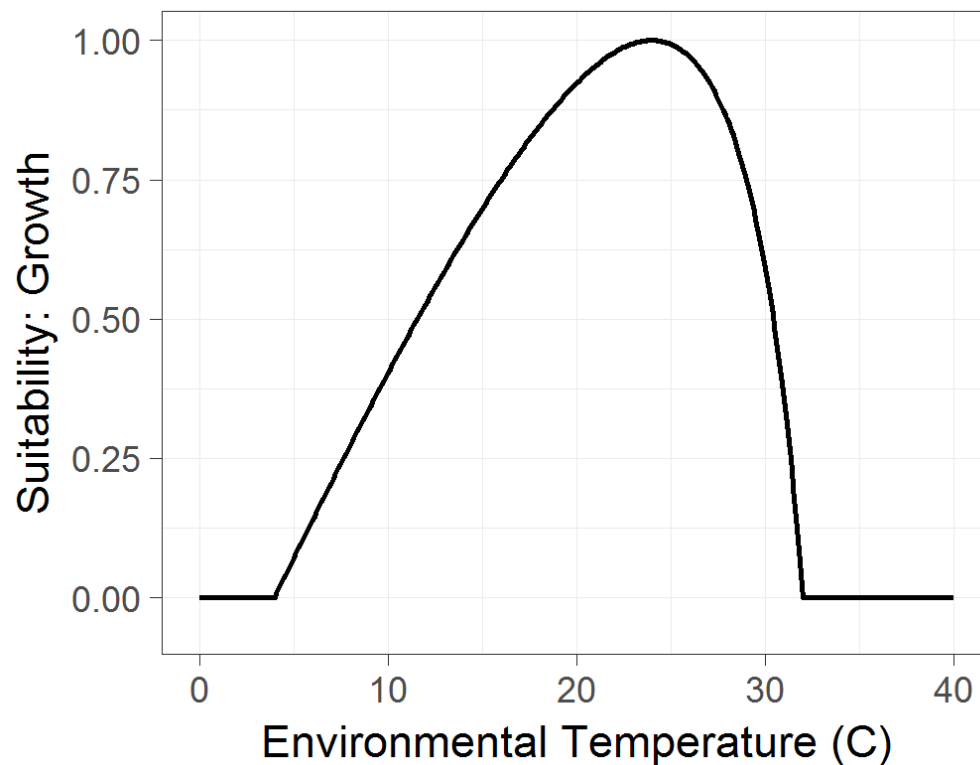
Growth

- Optimum growth temperature
- Final temperature preferendum

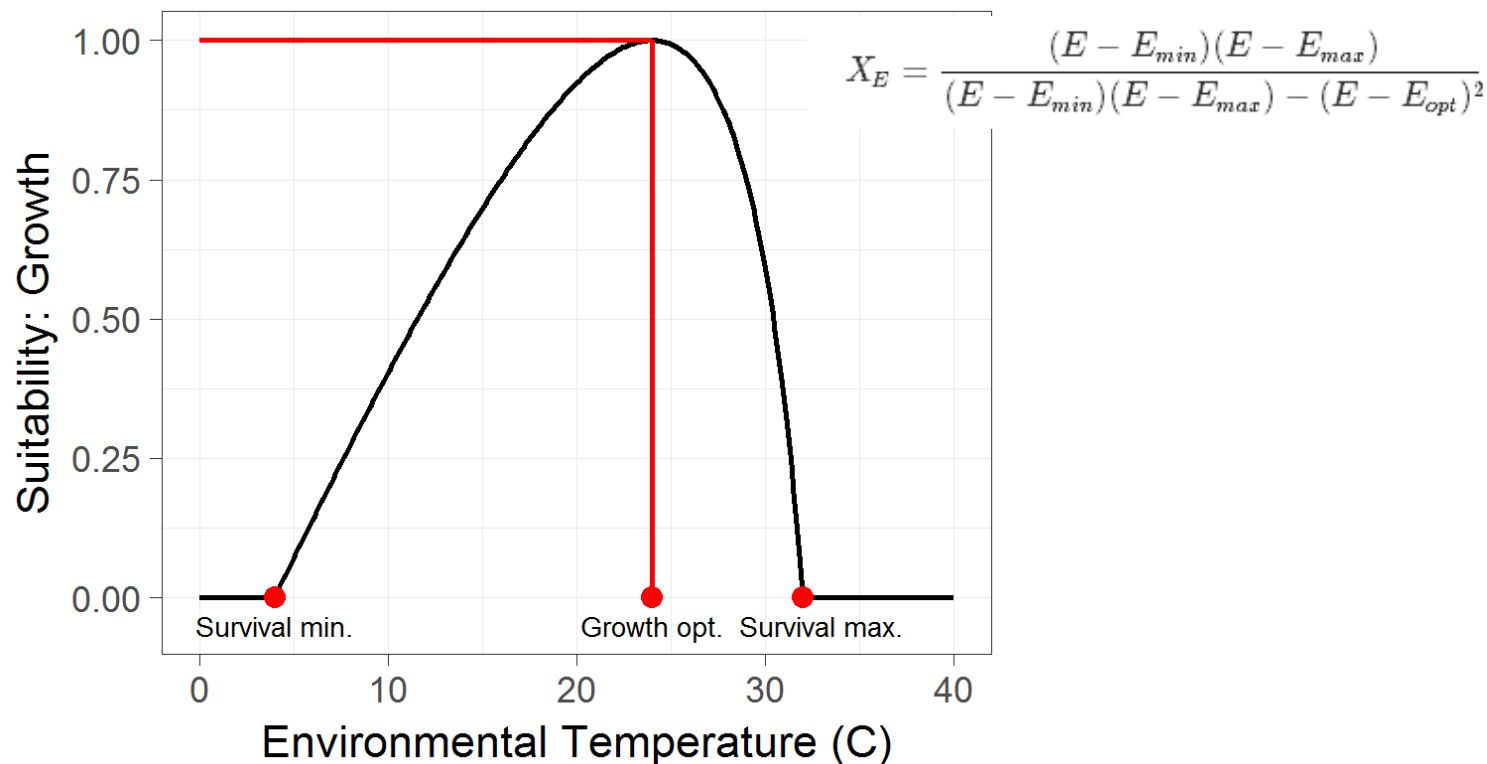
Reproduction

- Optimum spawning temperature
- Optimum egg development temperature

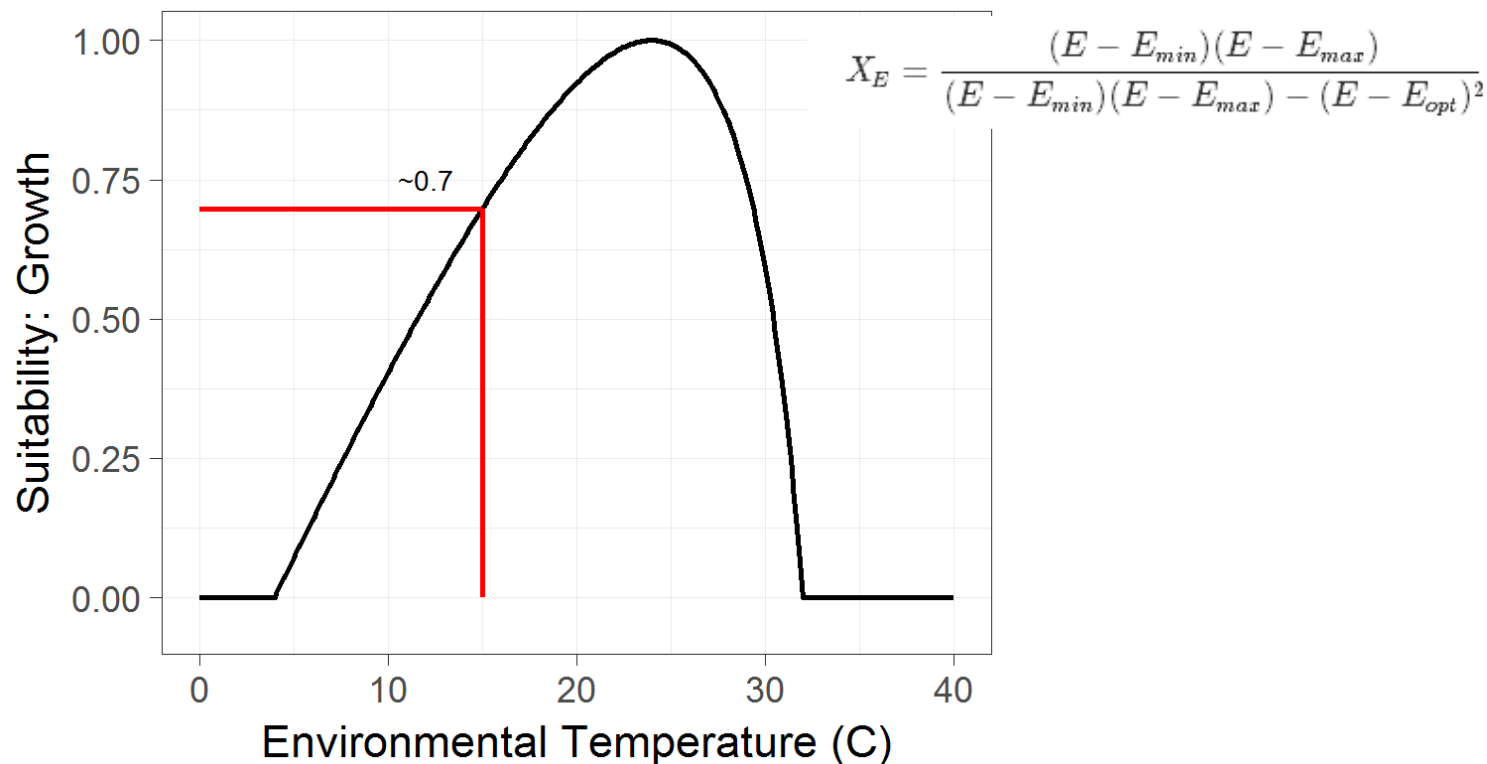
Suitability: Survival & Growth



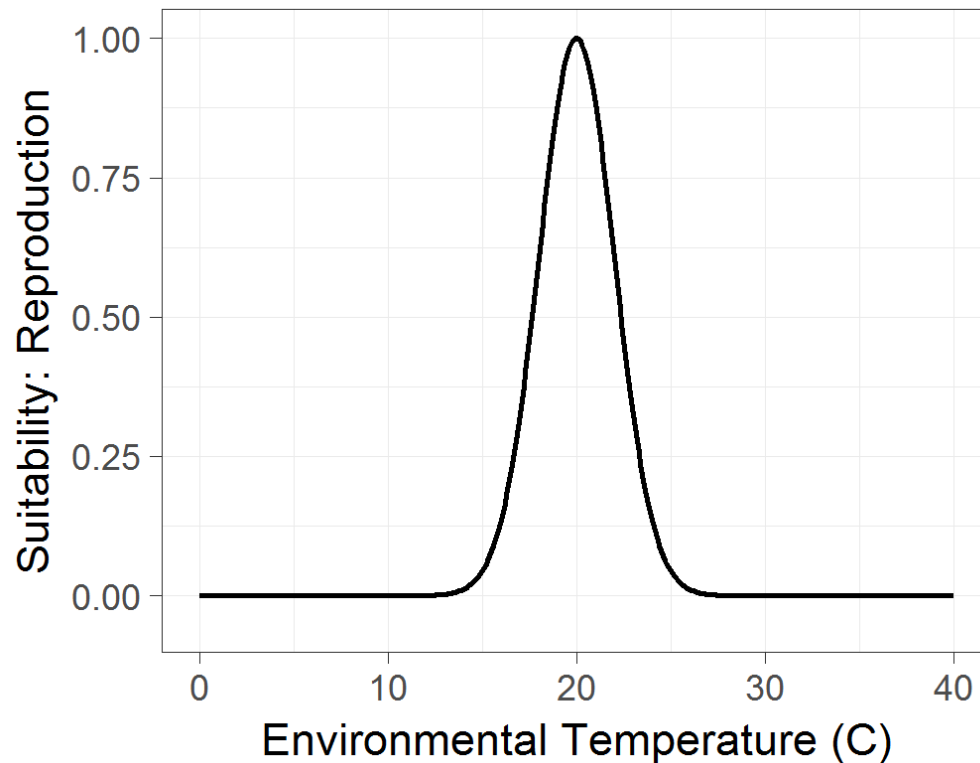
Suitability: Survival & Growth



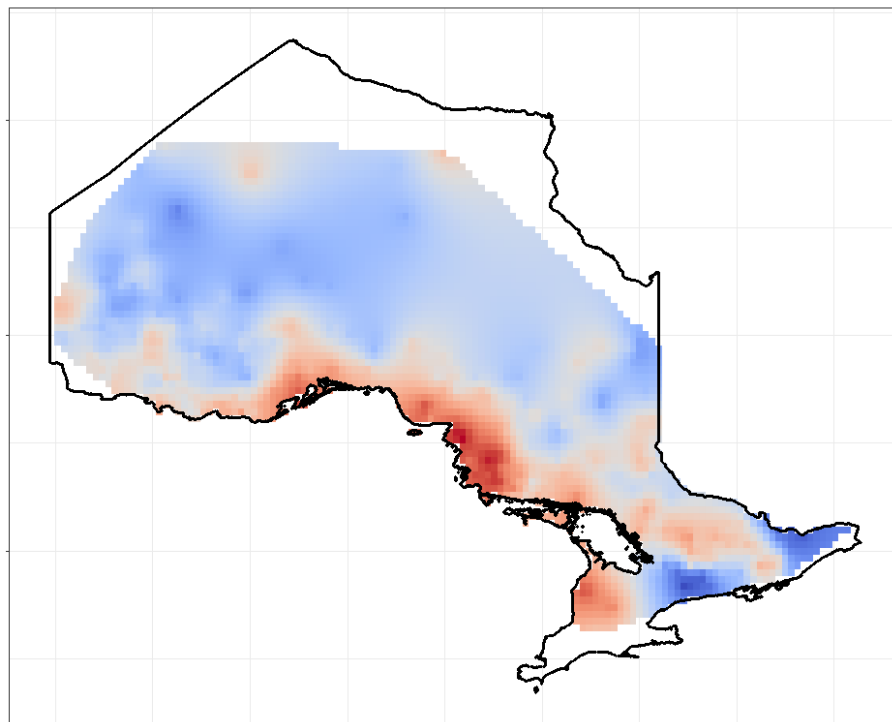
Suitability: Survival & Growth



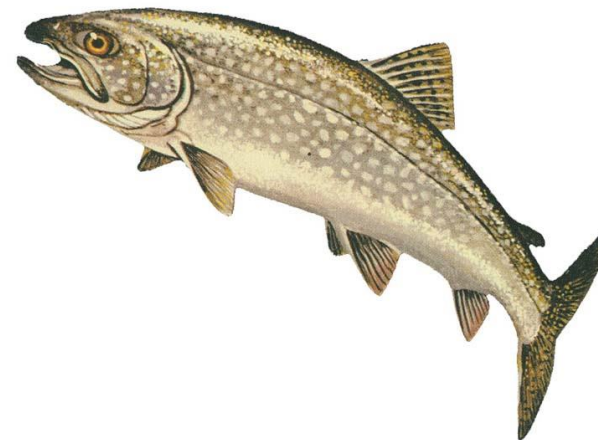
Suitability: Reproduction



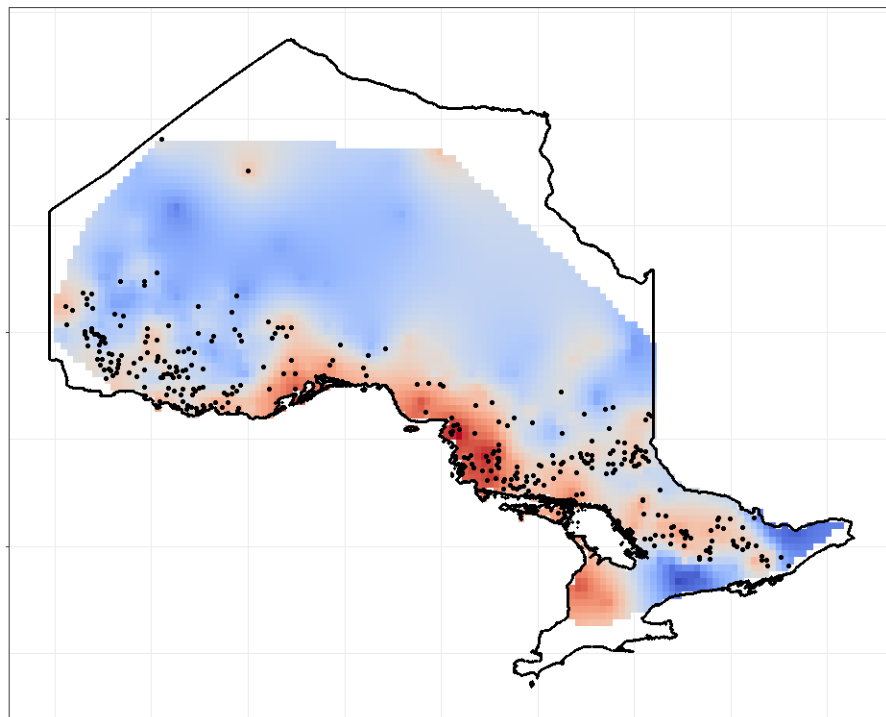
Habitat Suitability Index – Native Cold Water Species



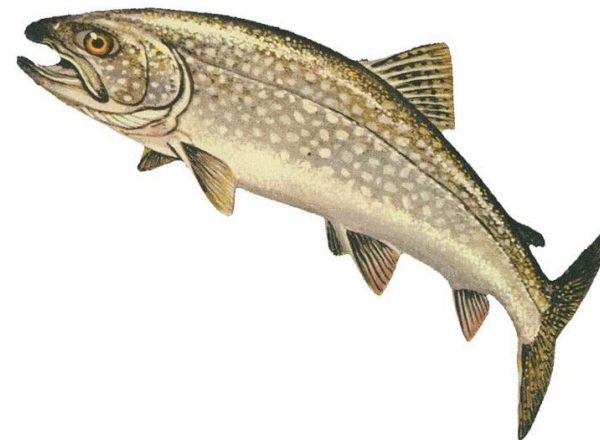
- Lake trout
(*Salvelinus namaycush*)



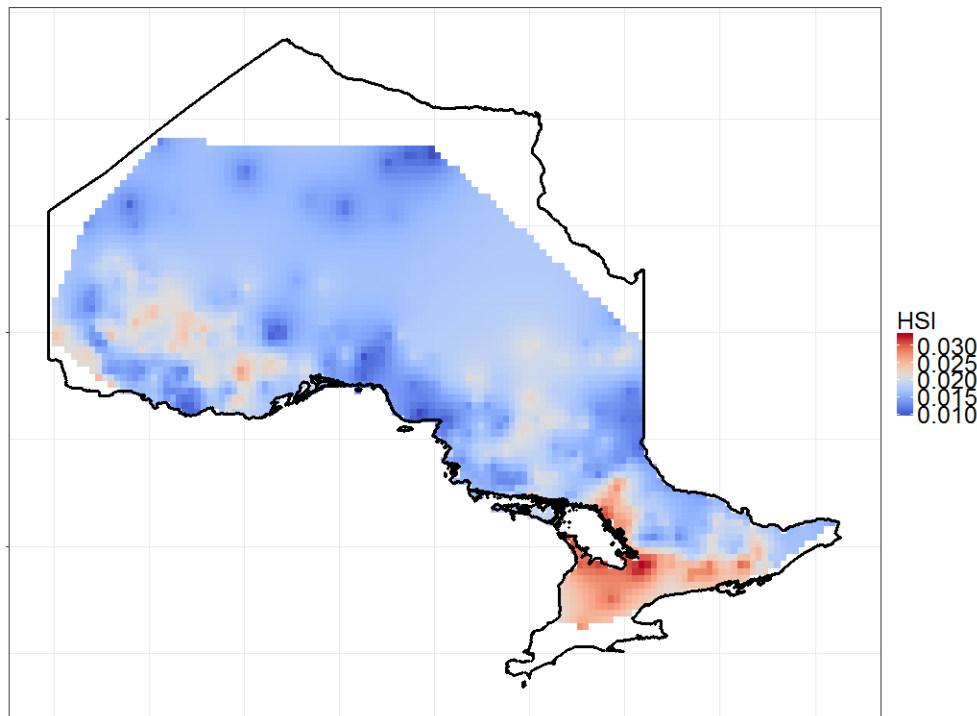
Habitat Suitability Index – Native Cold Water Species



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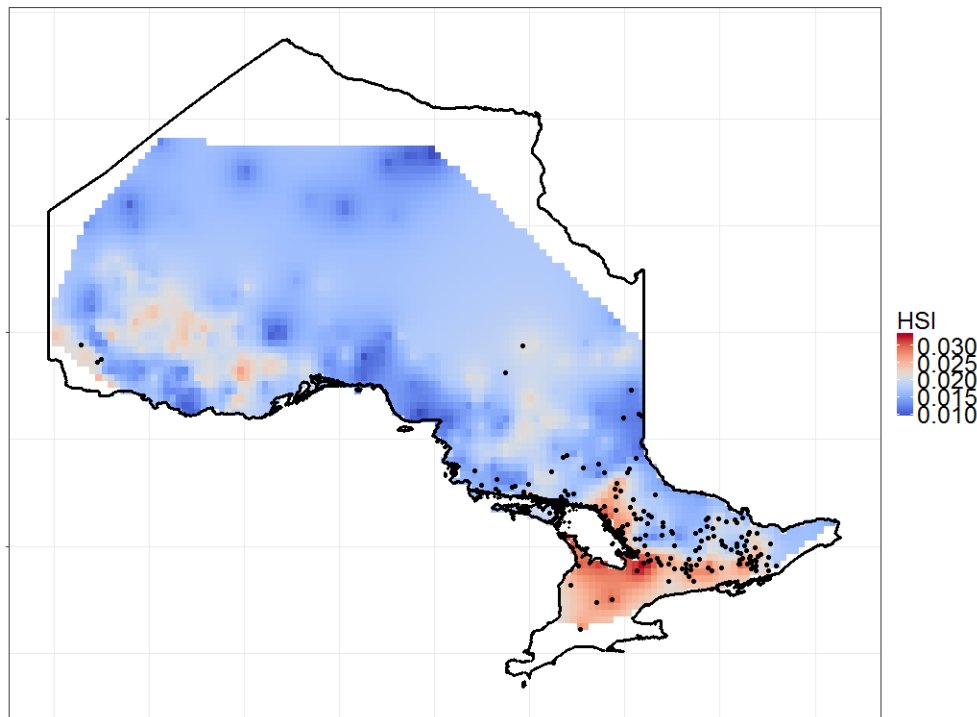
Habitat Suitability Index – Native Warm Water Species



- Brown bullhead
(*Ameiurus nebulosus*)



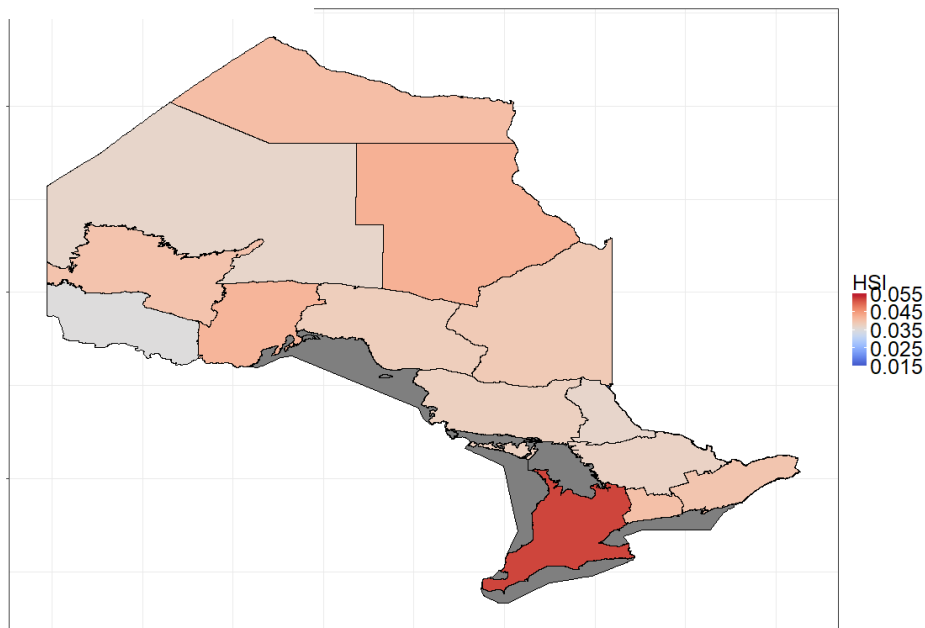
Habitat Suitability Index – Native Warm Water Species



- Brown bullhead (*Ameiurus nebulosus*)



Habitat Suitability Index – AIS Cool Water Species

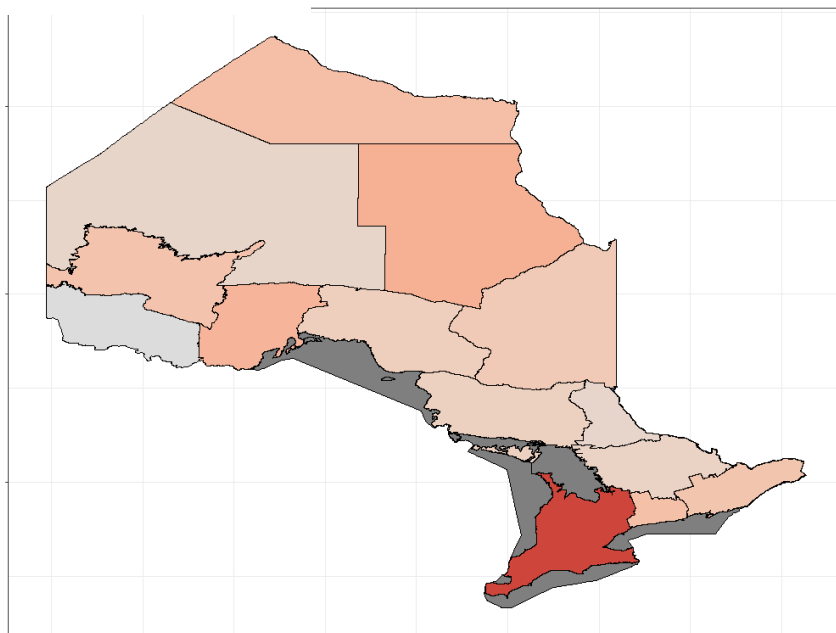


Current Climate

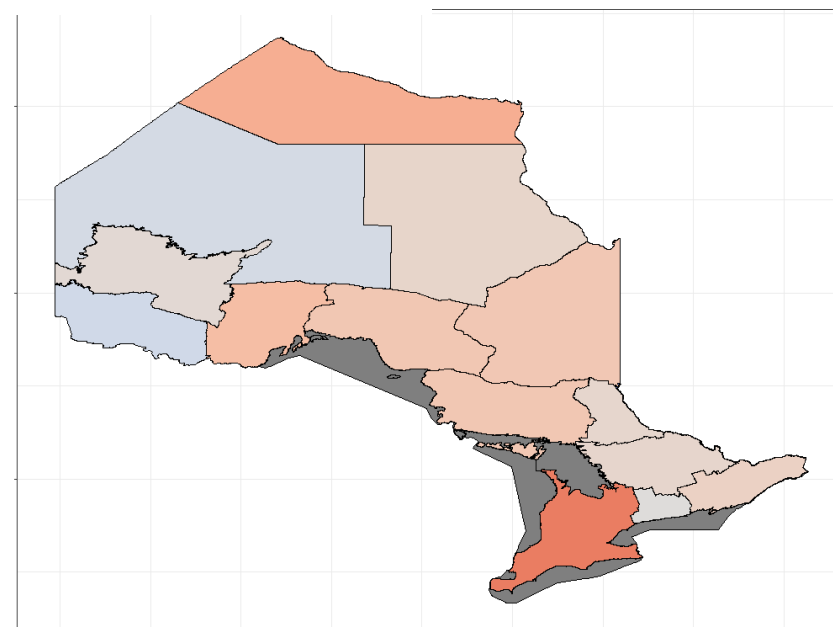
- Eurasian ruffe
(*Gymnocephalus cernua*)



Habitat Suitability Index – AIS Cool Water Species

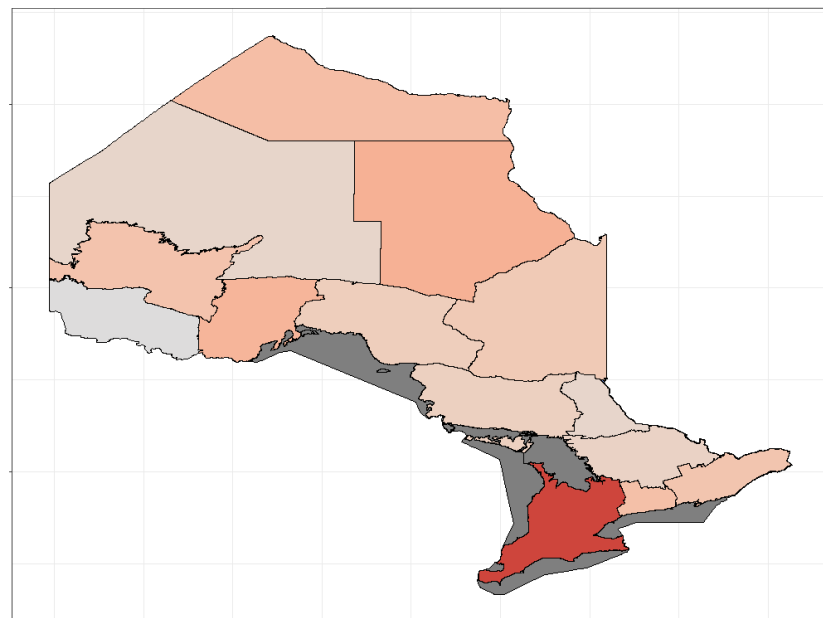


Current Climate

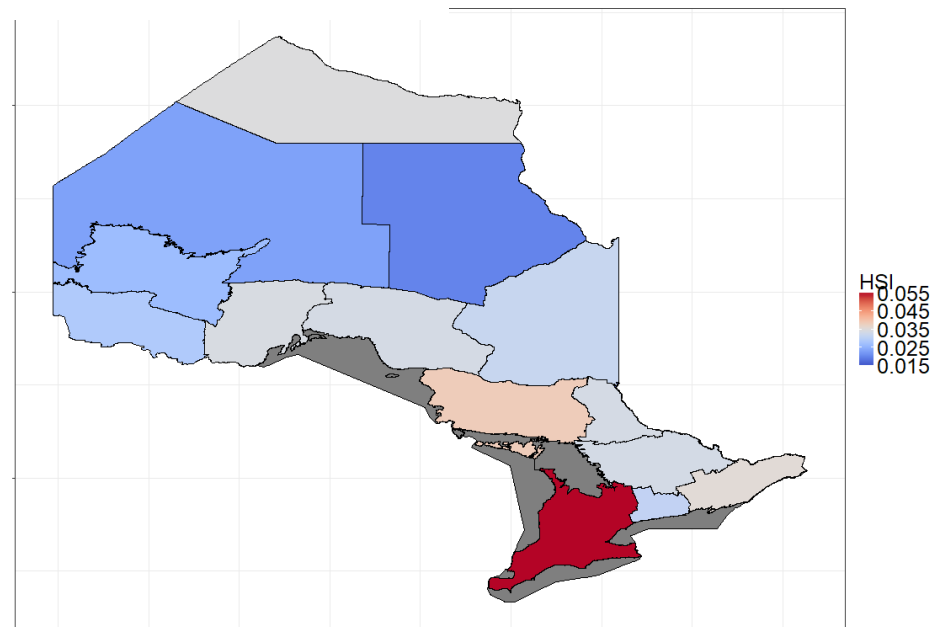


High Mitigation - 2085

Habitat Suitability Index – AIS Cool Water Species



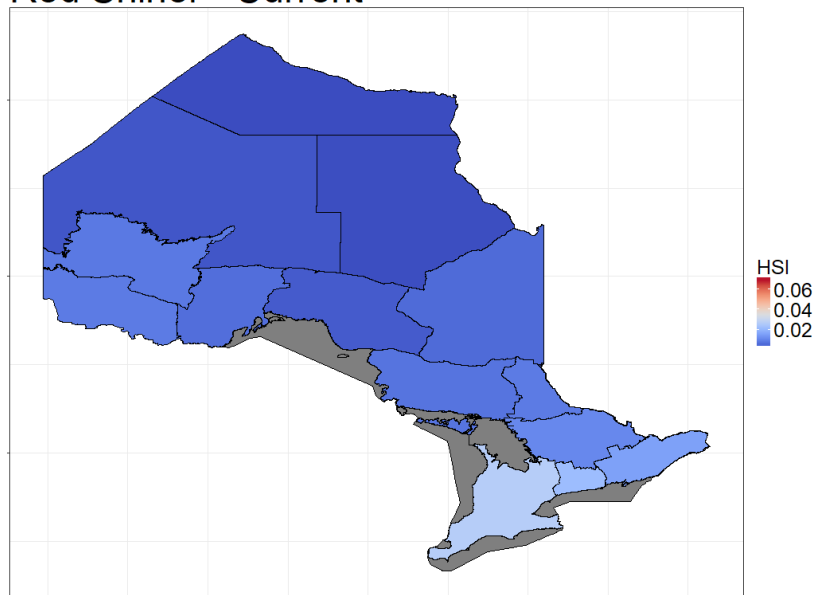
Current Climate



Low Mitigation - 2085

Habitat Suitability Index – AIS Warm Water Species

Red Shiner - Current



- Red shiner
(*Cyprinella lutrensis*)

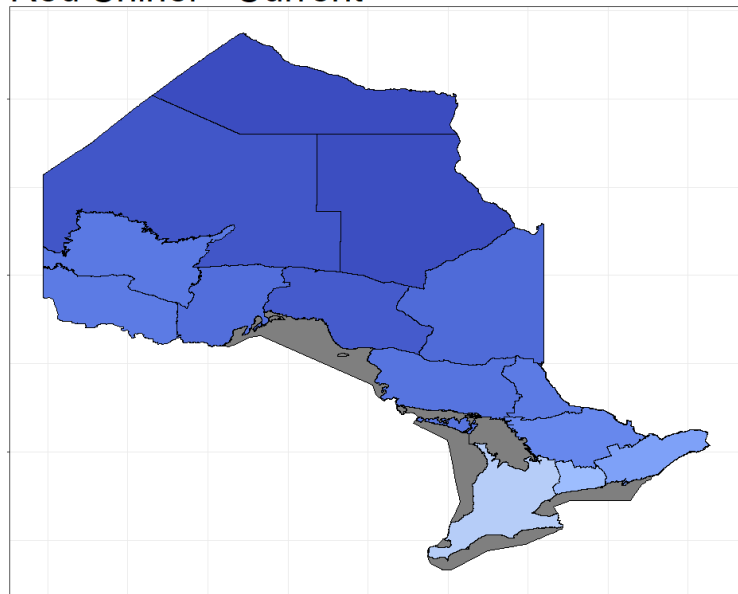


Current Climate

Habitat Suitability Index – AIS Warm Water Species

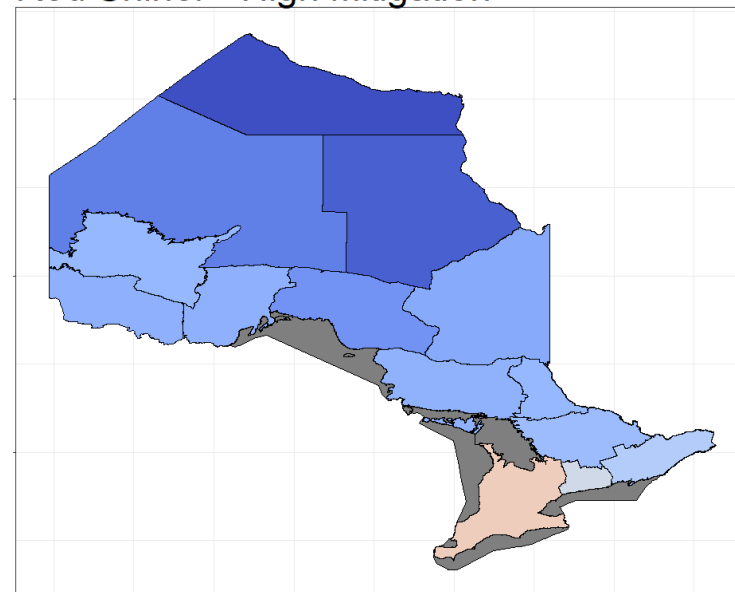


Red Shiner - Current



Current Climate

Red Shiner - High Mitigation

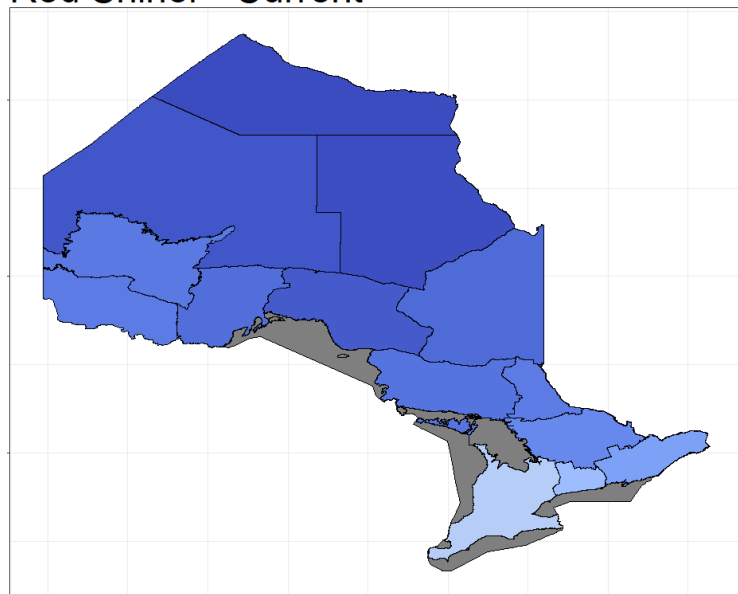


High Mitigation - 2085

Habitat Suitability Index – AIS Warm Water Species

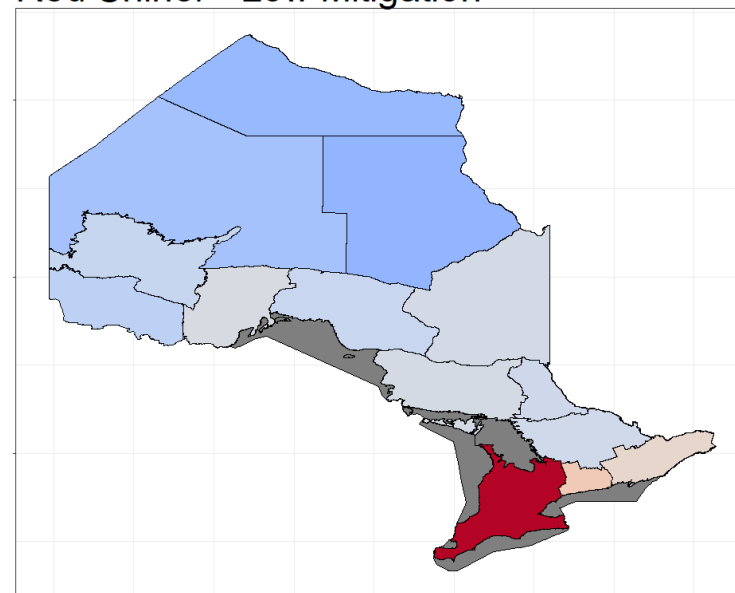


Red Shiner - Current



Current Climate

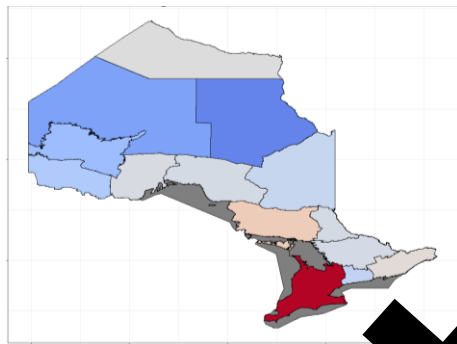
Red Shiner - Low Mitigation



Low Mitigation - 2085

Combine Human Dimensions and Habitat Suitability

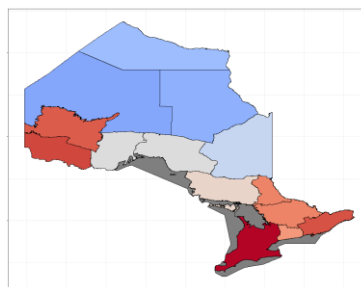
Likelihood of
survival &
establishment

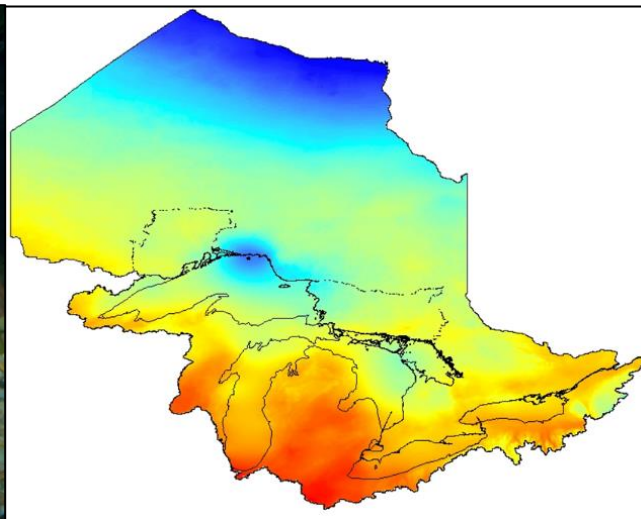


Likelihood of
arrival &
spread



Vulnerability
to Invasion

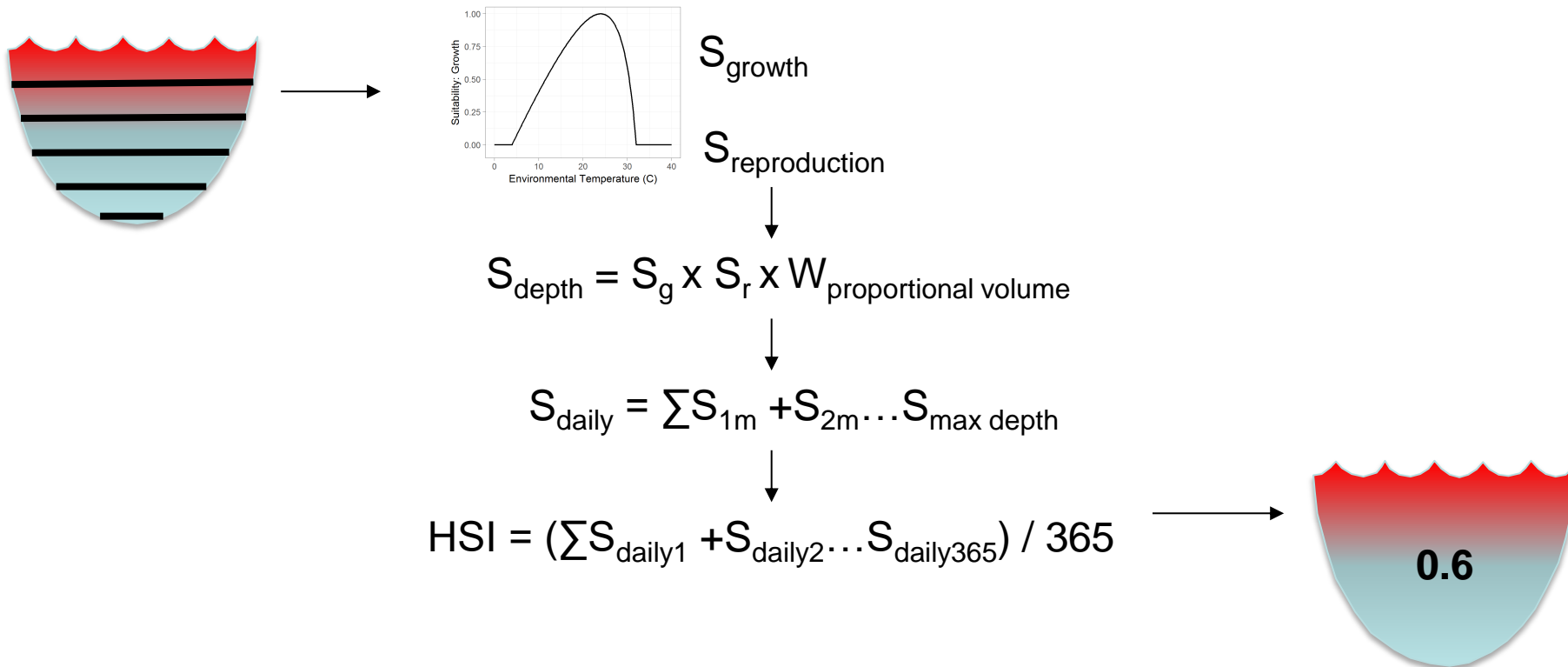




- Canada-Ontario Agreement
- Natural Heritage Policy Section (MNRF)
- Aquatic Invasive Species Programme (DFO)

Contact:
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Calculating Lake Habitat Suitability



Change in suitability – Eurasian ruffe

