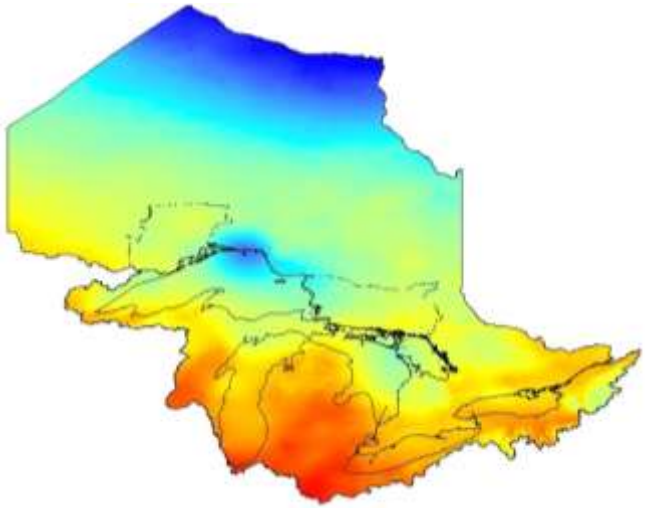
Prioritizing species of concern under projected climate changes using a temperature matching model

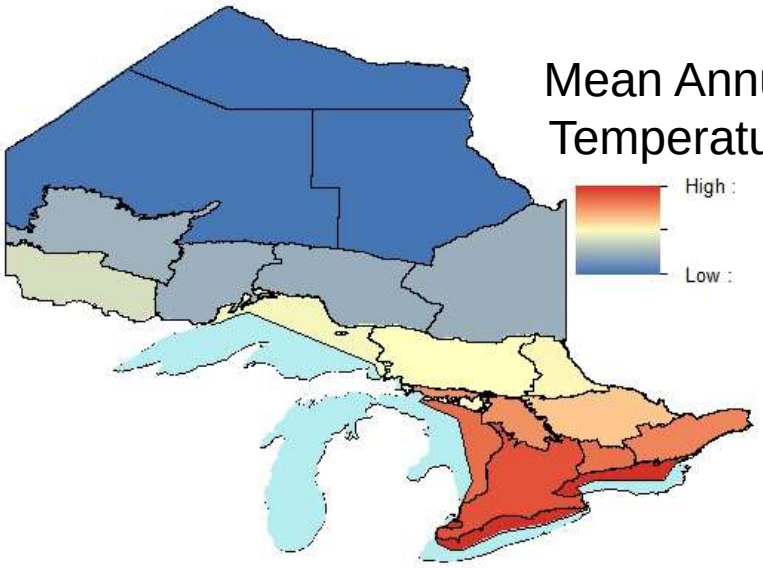


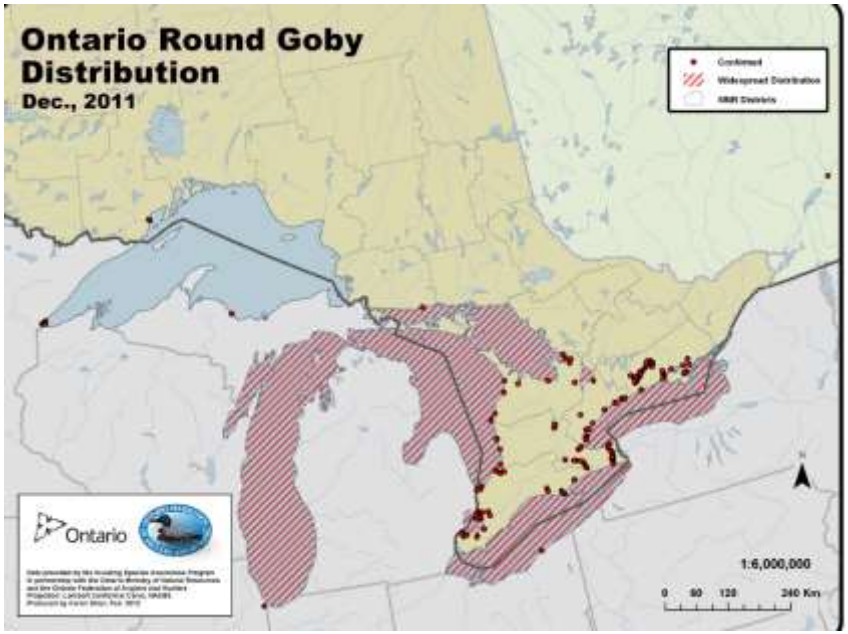
Shannon Fera and Tim Johnson, Aquatic Research and Monitoring Section
Allison Bannister and Len Hunt, Centre for Northern Forest Ecosystem Research
Andrew Drake, University of Toronto Scarborough

ICAIS, April 2016

Ontario

Multiple stressors



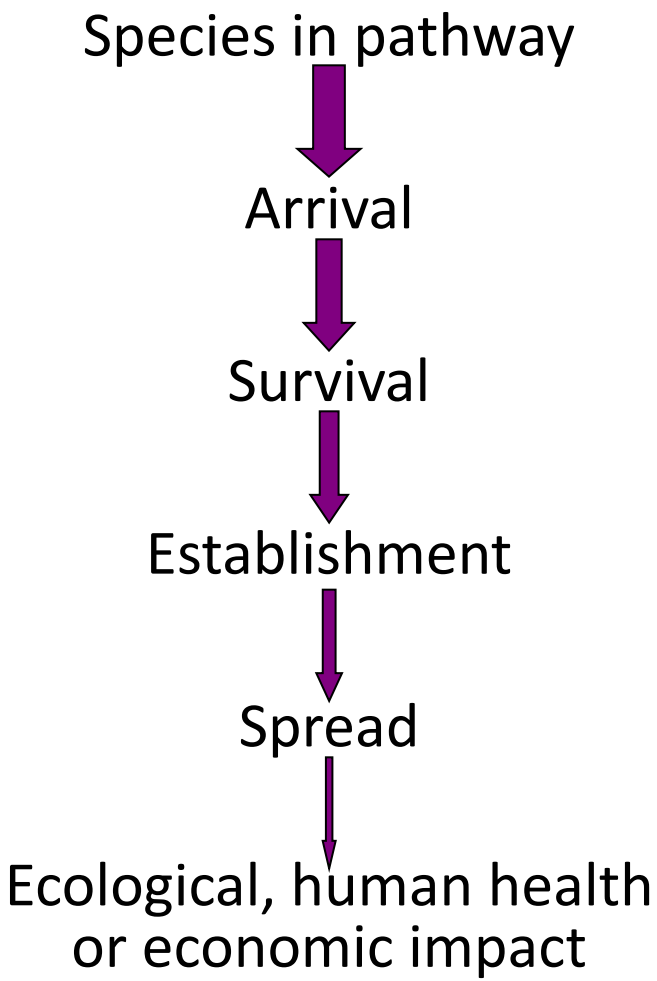


Changing temperatures may cause habitat shifts

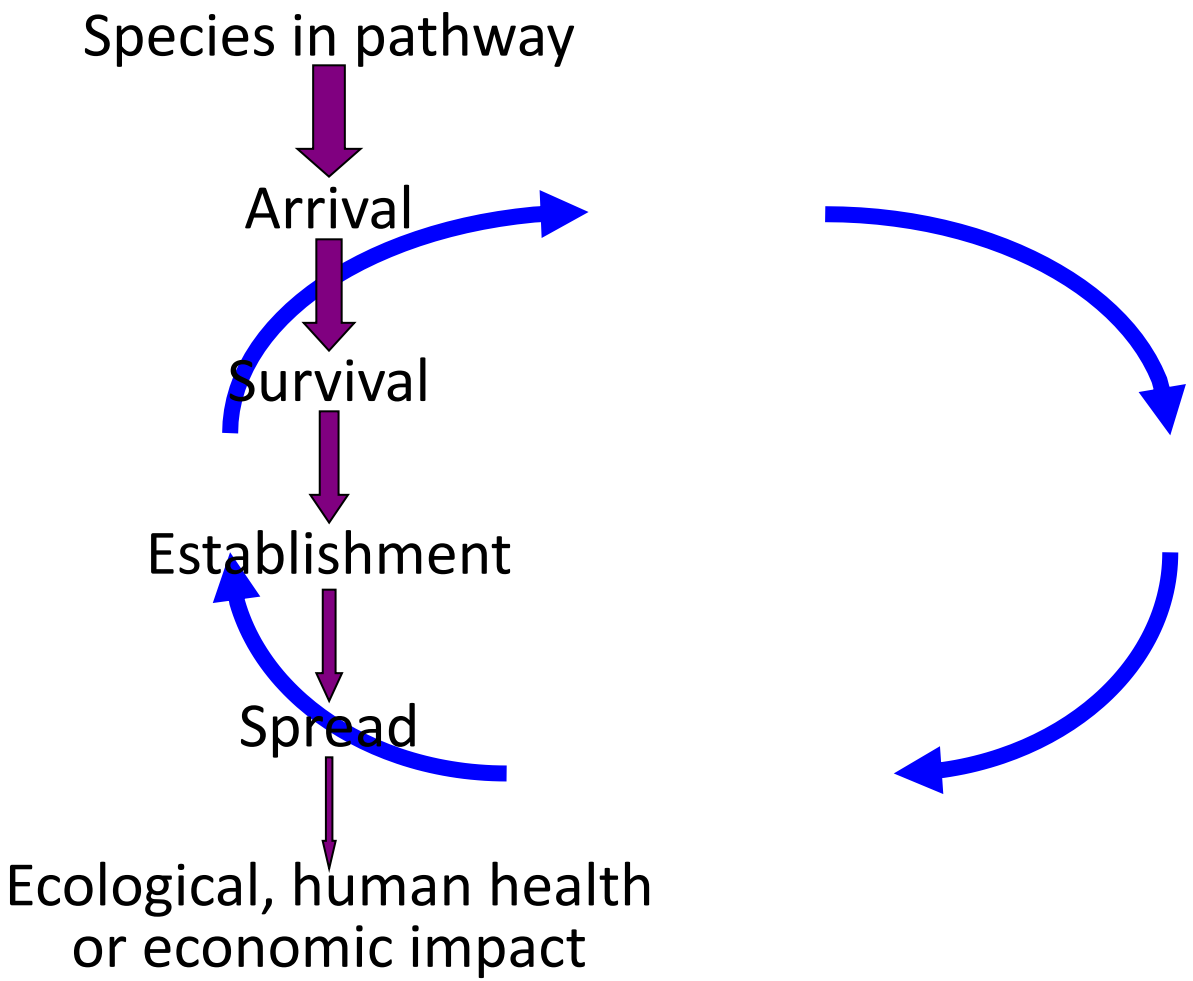
+

186+ AIS in Great Lakes basin

Invasion Risk



Invasion Risk



Invasion Risk

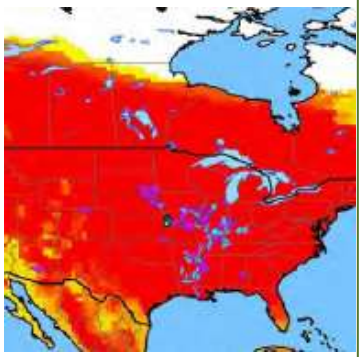
Arrival

Facilitated movement

Spread

Invasion Risk

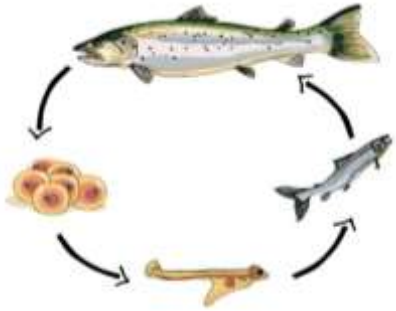
Survival



Habitat suitability

Natural dispersal

Establishment

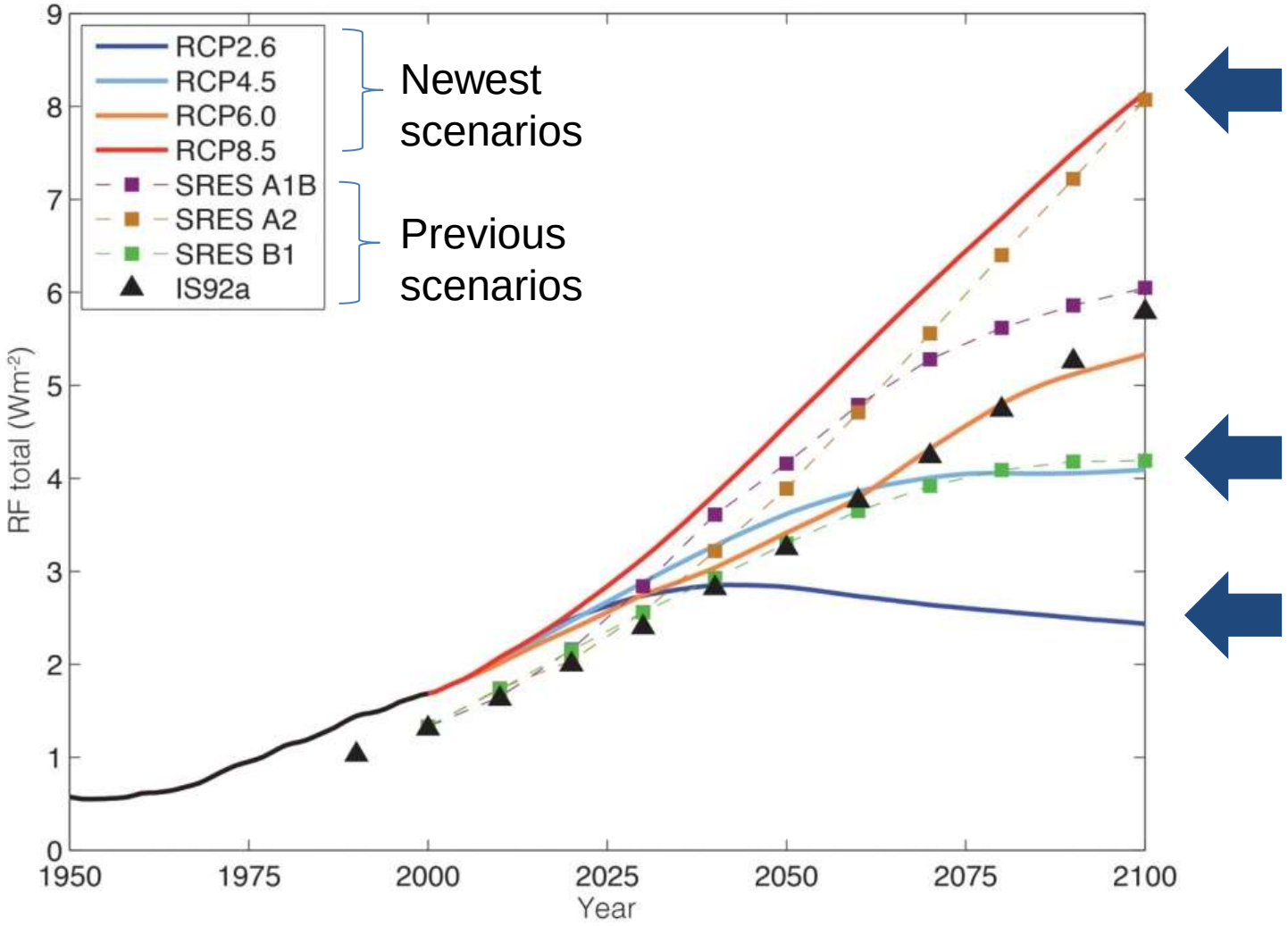


Reproduction /
Life cycle

Objective

Prioritise species of concern using a temperature matching algorithm

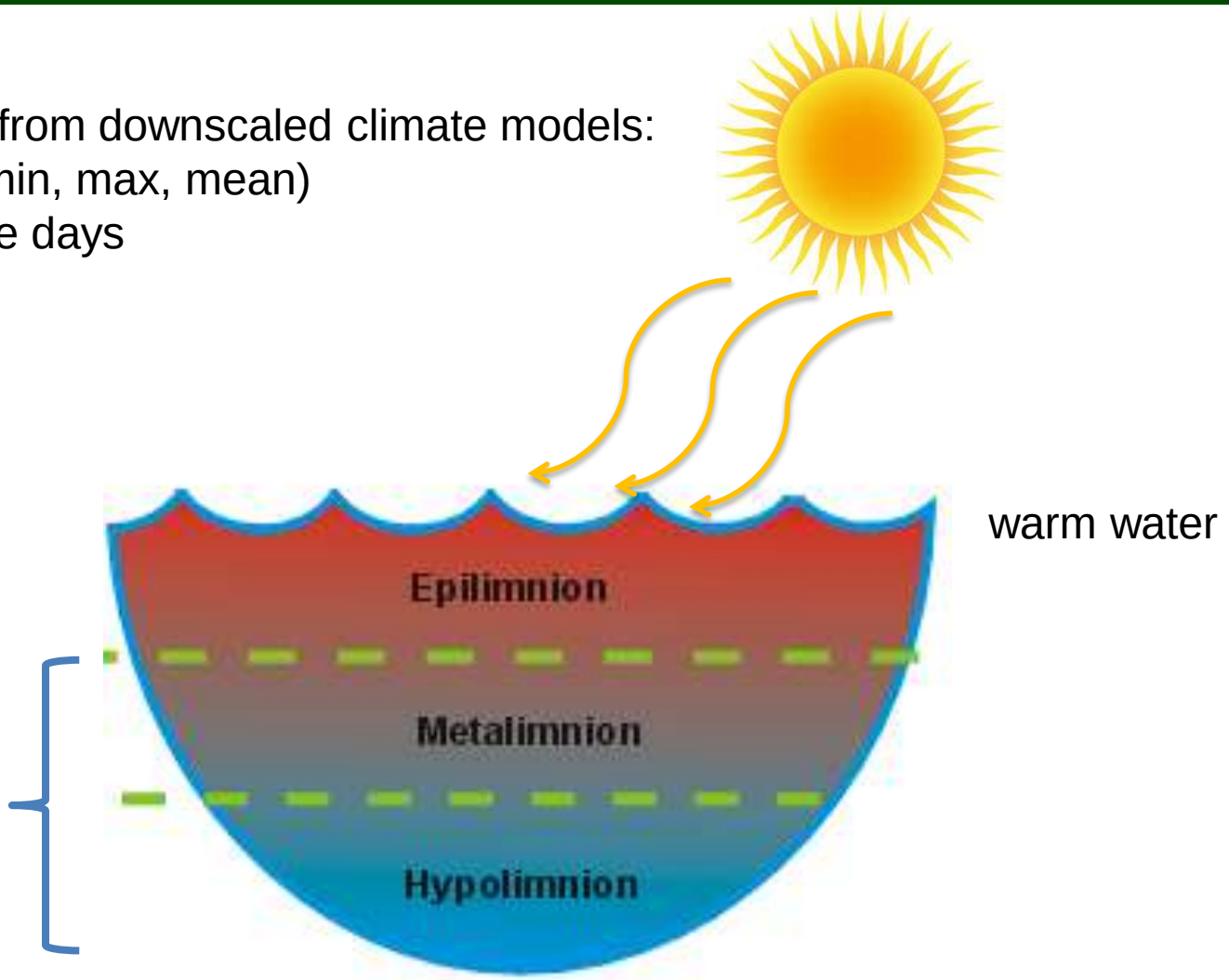
Climate Change Projections



Thermal Proxies – Air to Water

Available outputs from downscaled climate models:

- Temperature (min, max, mean)
- Growing degree days
- Precipitation



Prioritizing Species

GL Governors' list
GLANSIS

Literature Review

Provincial lists
Ontario
Manitoba
Quebec

State Lists
New York
Pennsylvania
Ohio
Michigan
Indiana
Illinois
Wisconsin
Minnesota

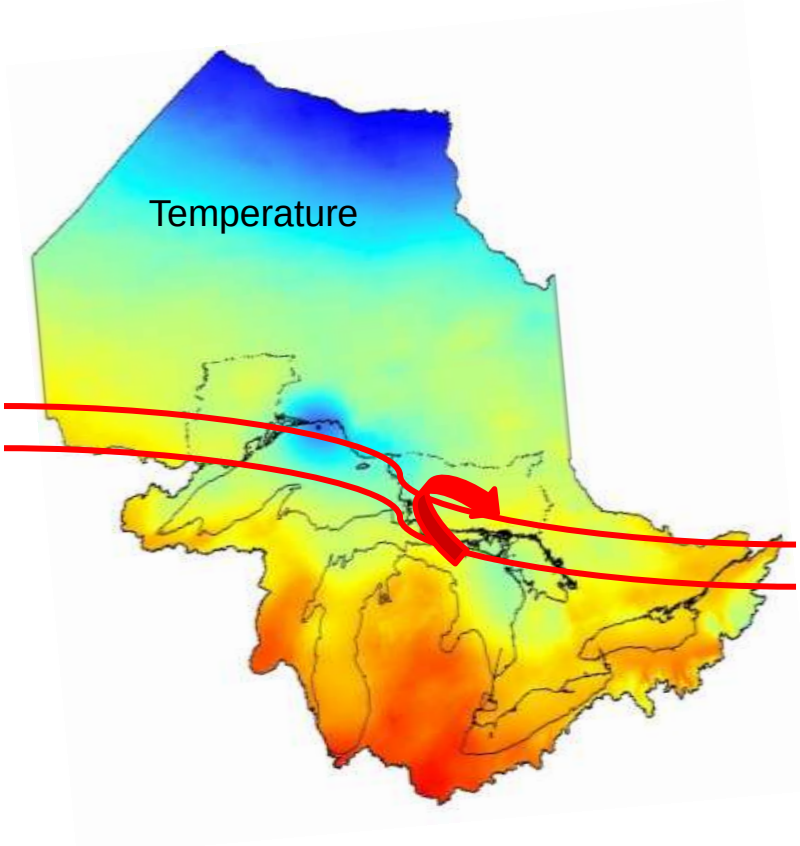
Master List

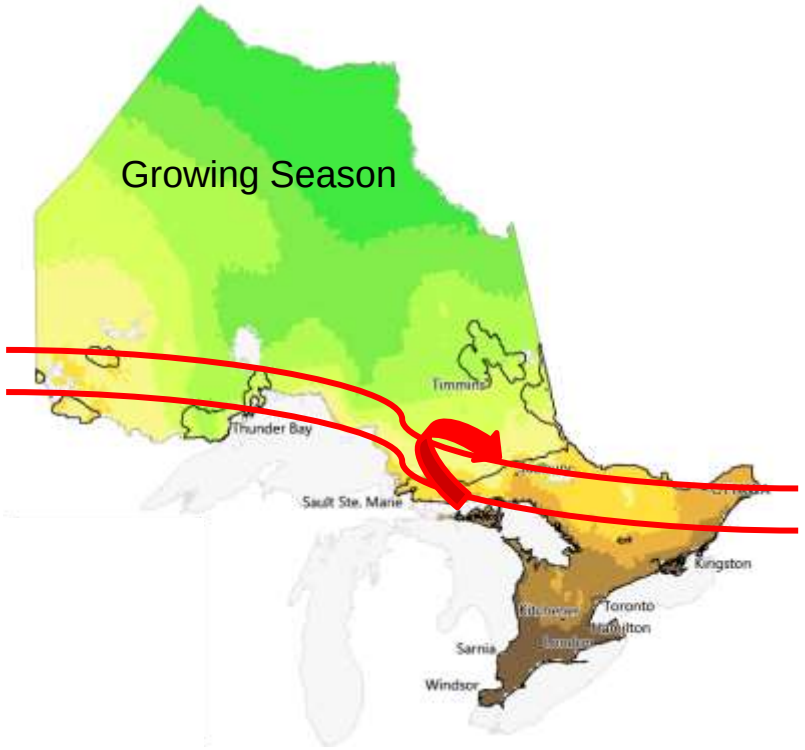
N=212

Prioritizing Species

Master List

Fish | Invertebrates | Plants





Round Goby Distribution - 2020

Neogobius melanostomus

Current

RCP2.6 - 2020

* Temperature only

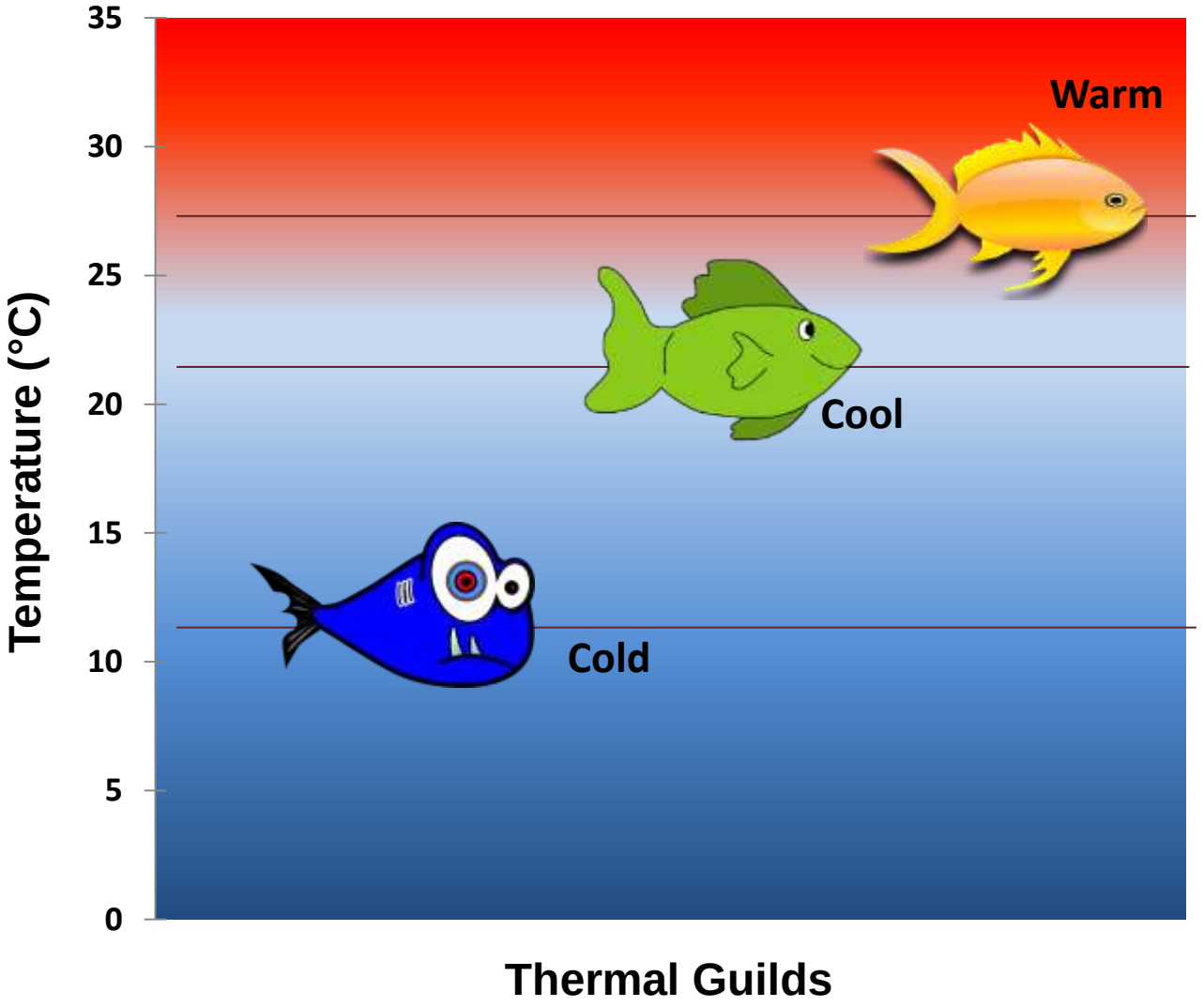
Round Goby Distribution - 2020

RCP 2.6

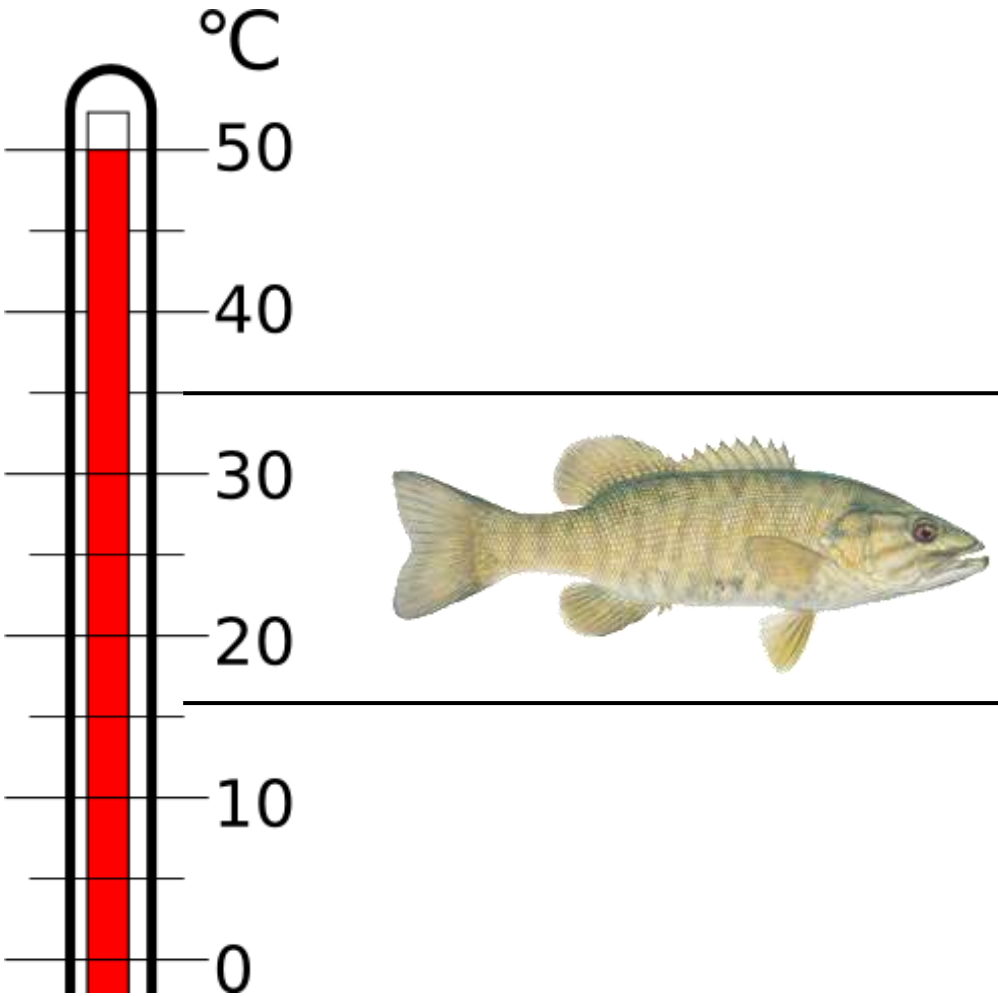
RCP 4.5

RCP 8.5

RoboFish


35
30
25
20
15
10
5
0
Temperature (°C)
Warm
Cool
Cold
Thermal Guilds

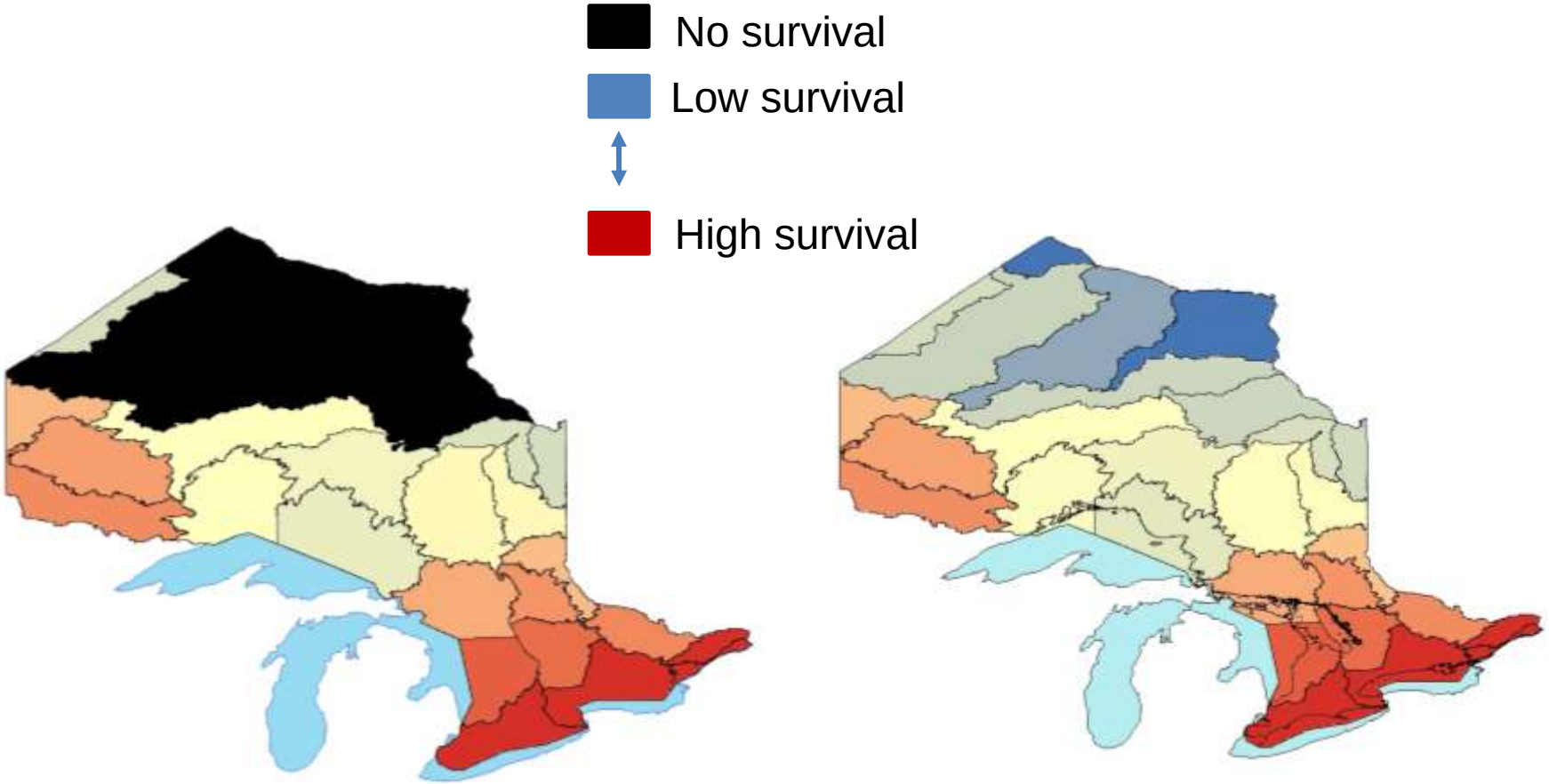
Warm water: Smallmouth bass (*Micropterus dolomieui*)



<35

>16 in July

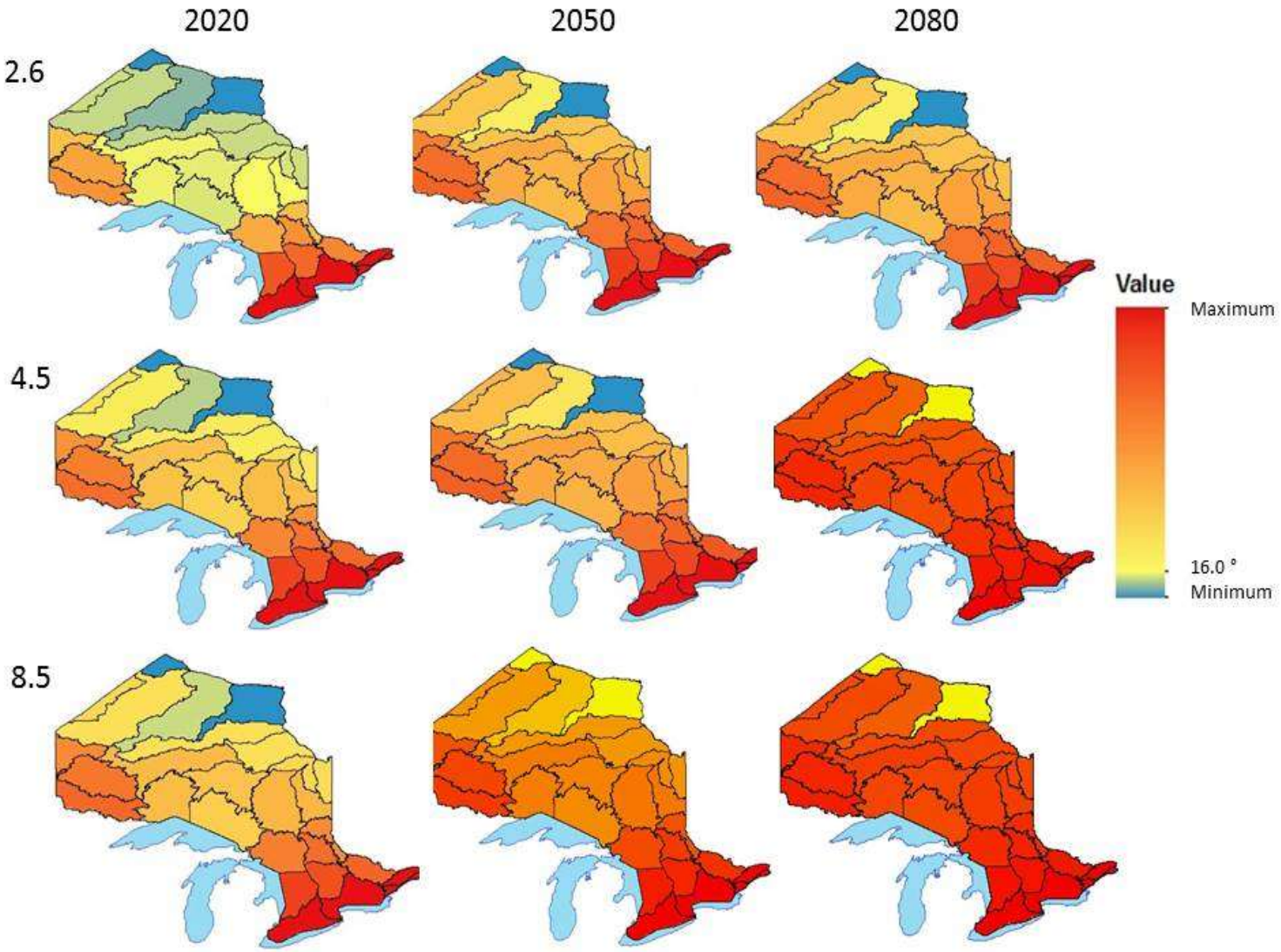
Warm water fish



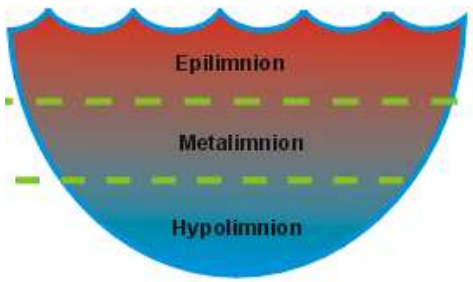
Low CC Scenario (RCP 2.6):
82% of waterbodies can support warm water fish in 2100

High CC Scenario (RCP 8.5):
100% of waterbodies can support warm water fish in 2100

Warm water fish



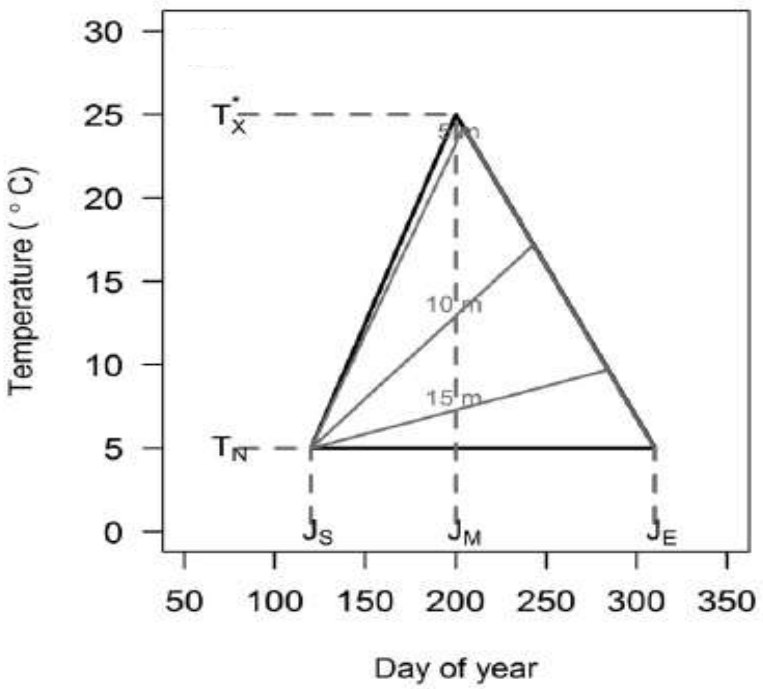
Cool and cold water fish



Cool and
cold water

Lake physics

Seasonal temperature-profile model (Minns and Shuter 2013, Minns et al. 2015)

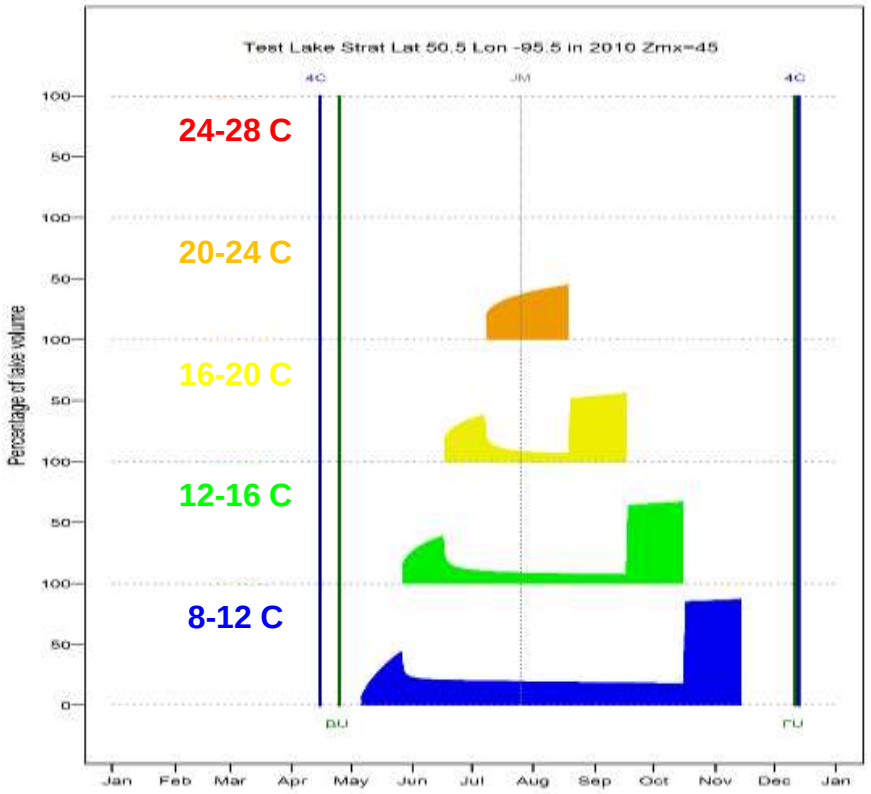


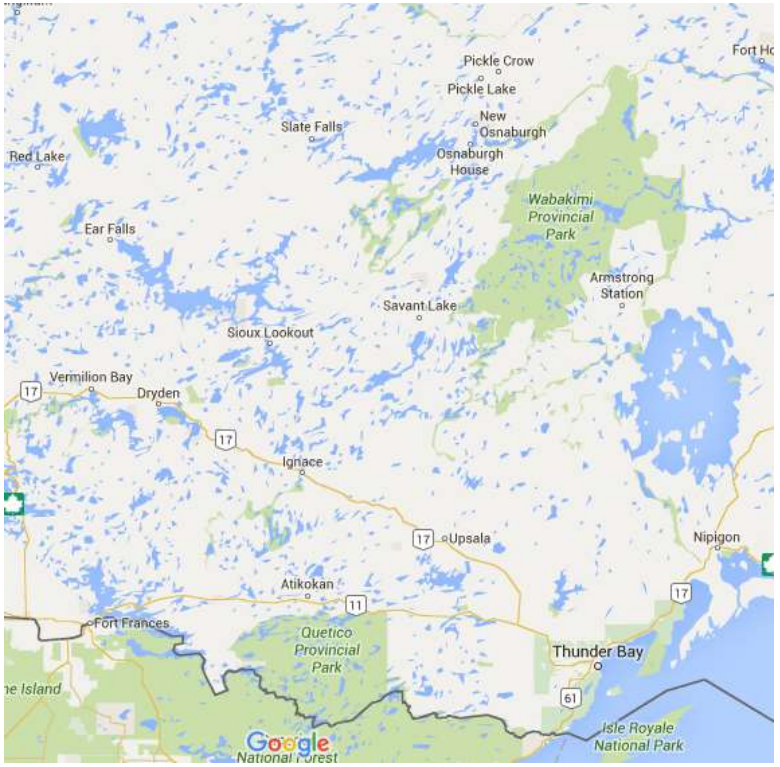
Inputs:
Air temperature, latitude, longitude, elevation, lake area, maximum depth, DOC / Secchi

Output:
Duration of stratification, thermal habitat volume

Seasonal temperature profile model

ThermoPic





- Lake-by-lake or regional estimates of lakes providing suitable habitat for different thermal guilds (or growing seasons)

Summary

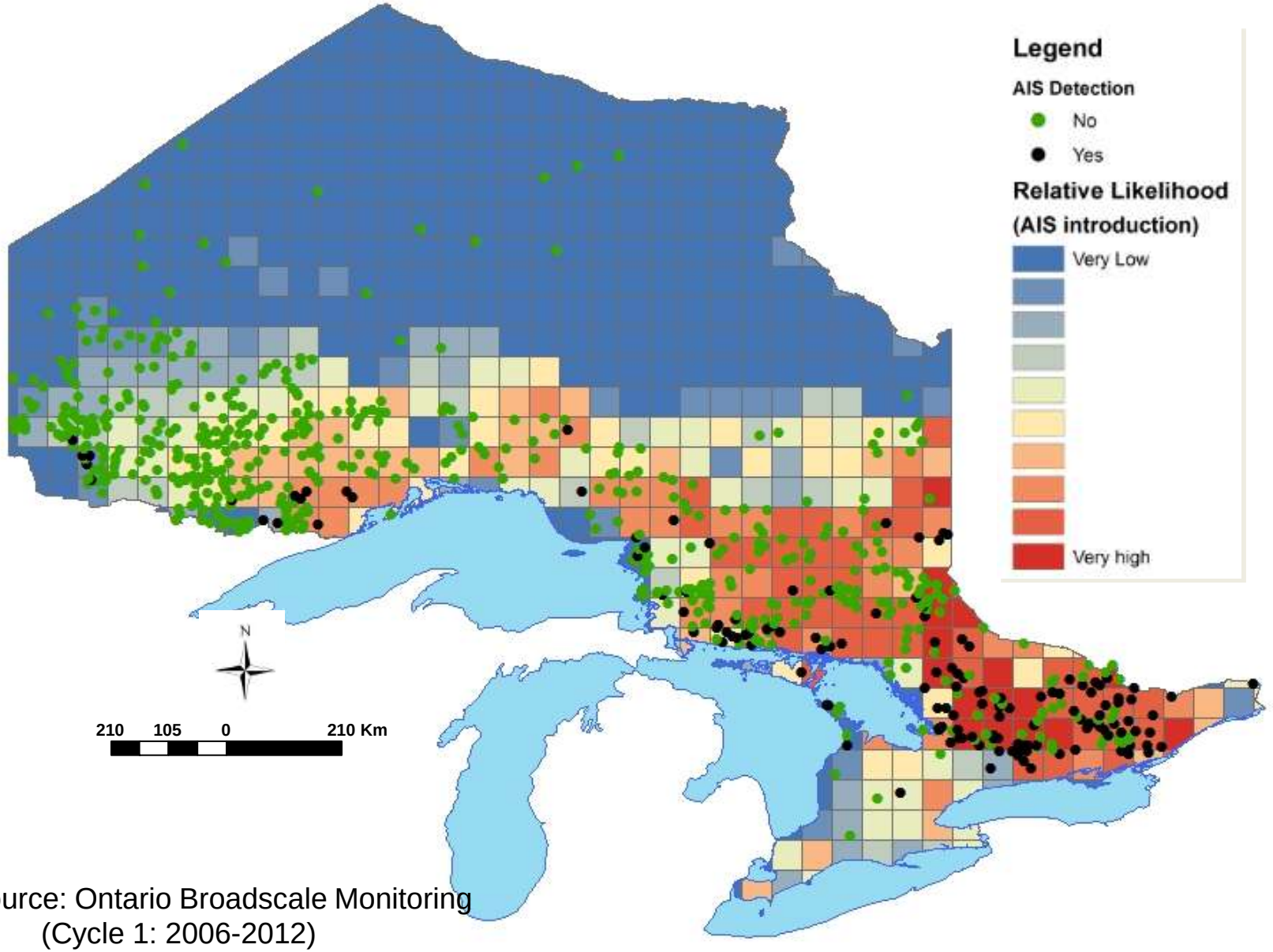
- Large list of listed AIS of concern
- Temperature is a critical determinant in distribution of fish, invertebrates and plants
- Air temperature can predict warm water habitat
- Evaluating a tool to predict cool and cold water habitat
- Tool will enable us to identify habitat suitability (and therefore invasion risk) across a dynamic and heterogenous landscape

Questions

Questions?

Shannon.Fera @ontario.ca
Tim.Johnson @ontario.ca

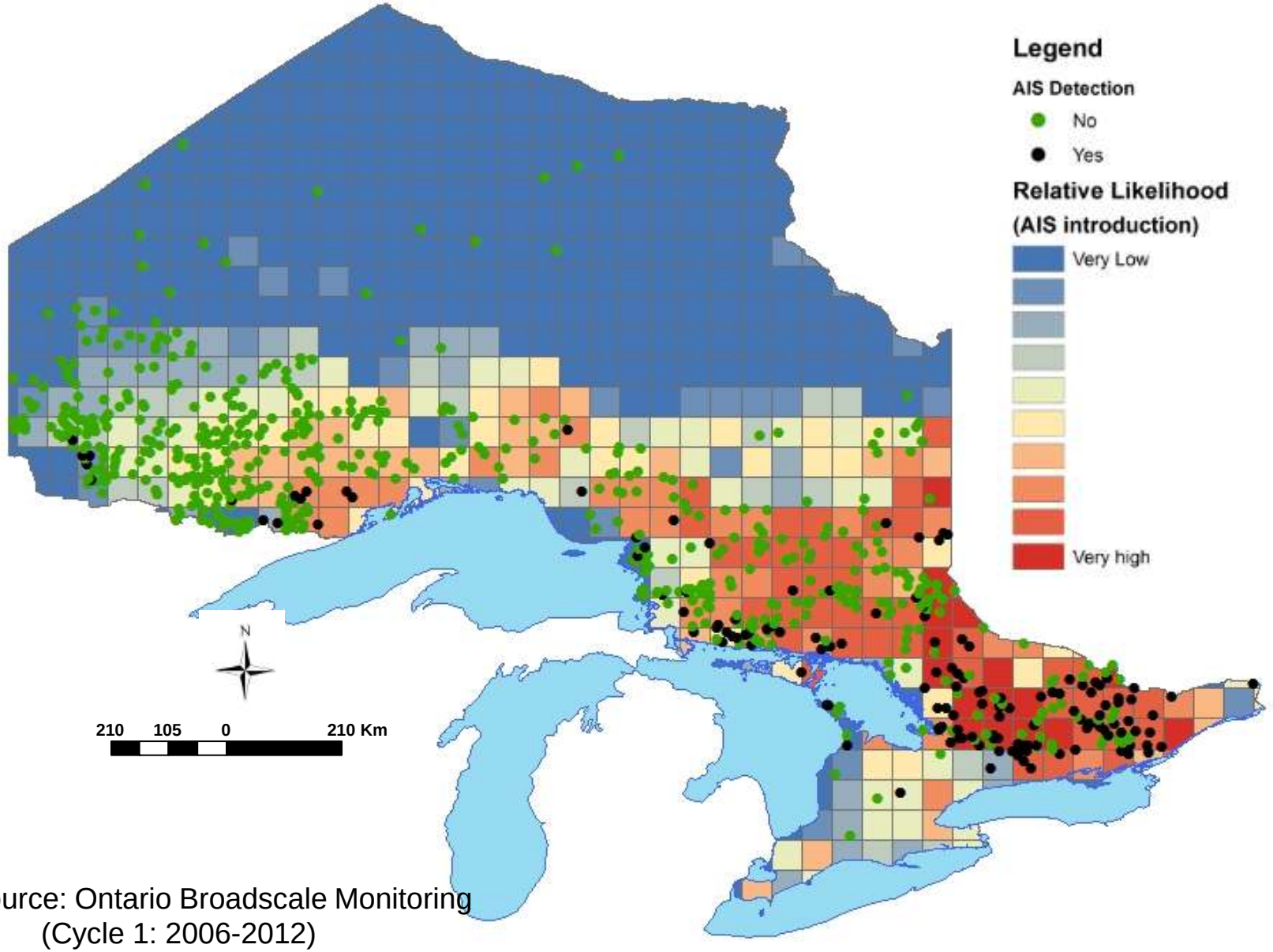
Promising Results



Source: Ontario Broadscale Monitoring
(Cycle 1: 2006-2012)

Changing climate conditions are likely to impact the dispersal and establishment of aquatic invasive species. Our goal was to prioritize the species of highest concern for the Great Lakes basin and the province of Ontario, and to understand how this list may change under different climate scenarios. We performed a risk assessment of species of concern by matching species habitat requirements with the Intergovernmental Panel on Climate Change (IPCC)'s Fifth Assessment Report (AR5) climate models over the next century. The suitable temperatures for survival, reproduction and growth of fish were identified and compared to statistically downscaled temperature projections under three representative concentration pathways from the AR5 (2.6, 4.5, and 8.5) and over three time periods (2011-2040, 2041-2070, and 2071-2100). The likelihood of species spread was evaluated for key fish species that are already established in the Great Lakes basin, as well as a list of potential invaders compiled from the literature. This temperature-matching model allowed us to create a list of the most likely invaders in each scenario, and to identify which parts of the Great Lakes basin and the province of Ontario are most at risk of hosting new species. These predicted futures allow adaptive management practices to be developed under multiple possible climate change scenarios.

Promising Results



Source: Ontario Broadscale Monitoring
(Cycle 1: 2006-2012)

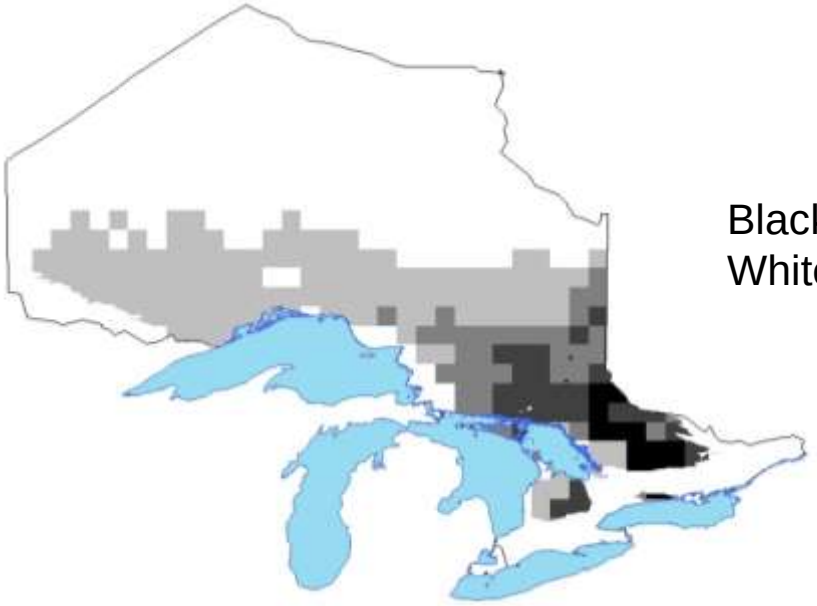
Invasive Species Risk Assessment Tool

Current distribution

Suitable habitat

Likelihood of introduction

Future distribution



Black: high
White: low

Pathways for Spread

- natural dispersal – m/yr

- climate change – km/yr

- facilitated (human) movement – 100s km/yr