Predicting future changes in Muskegon River watershed (Michigan, USA) game fish under land-use alteration and climate change scenarios

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Effect of temperature change and land use change on gamefish through 2100

Identify unprotected land and species- “gaps” in conservation

1. Data
2. Fish Distribution Models
3. Future Scenarios: Climate and land use change
**Habitat Data**

**Landscape variables** were measured on two scales for stream reach A:

B) Entire upstream riparian
C) Entire upstream watershed

1) % Land-use/land-cover (e.g. % urban)
2) % Surficial Geology (e.g. % coarse texture)

**Distance Variables:**
Distance from stream reach to:
1) Great Lake
2) Dam
3) Pond or Lake

**In-Stream Variables** estimated from landscape variables:
1) Water temperature (July mean)
2) Total Phosphorus
3) Exceedence flow
Fish Data

- Fish sampling records were obtained from the Michigan Department of Natural Resources Fish Collection System and Michigan Rivers Inventory (MRI).

- Years 1980-2003
- Presence/Absence Sampling
  - Shocking
  - Rotenone
  - Gillnets
  - Etc.
- Abundance
  - Two pass shocking
  - Standardized to fish/hectare

Grass Pickerel
State-wide stream fish distribution models

Longnose Dace
Brook Trout
Future Changes: Muskegon Watershed

Scenarios:
1. Land-use change
2. Landuse change, slow air temperature increase (3 C by 2100)
3. Landuse change, fast air temperature increase (5 C by 2100)

Water temperature is assumed to increase by 0.8 times the rate of air temperature increase.

Stefan 1993
Eaton and Scheller 1996
Brook Trout

FO = Frequency of Occurrence
Walleye

Small Rivers - left side of tree, not often found.

Large Rivers - right side of tree.

Catchment area (km²), 657

Total Phosphorus, 40 ppb

% Urbanization (watershed), 9%

Terminal Node 1
Train: 1 / 248
Test: 7 / 267
Combined: 8 / 515

Terminal Node 2
Train: 1 / 72
Test: 1 / 98
Combined: 2 / 170

Terminal Node 3
Train: 4 / 55
Test: 10 / 36
Combined: 14 / 91

Terminal Node 4
Train: 48 / 111
Test: 45 / 53
Combined: 93 / 164

Terminal Node 5
Train: 0 / 13
Test: 5 / 6
Combined: 5 / 19

Catchment area (km²), 237

FO: 0.02

FO: 0.01

FO: 0.15

FO: 0.57

FO: 0.26
Management Implications

Water Temperature, 20.2°C

90% Ex. Flow Yield, 0.0042

% Wetland (watershed), 13%

Terminal Node 1
Train: 36 / 61
Test: 88 / 152
Combined: 124 / 213
FO: 0.58

Terminal Node 2
Train: 17 / 83
Test: 64 / 156
Combined: 81 / 139
FO: 0.34

Terminal Node 3
Train: 98 / 139
Test: 176 / 210
Combined: 274 / 359
FO: 0.76

Terminal Node 4
Train: 11 / 176
Test: 37 / 122
Combined: 48 / 297
FO: 0.16

Terminal Node 5
Train: 16 / 54
Test: 30 / 73
Combined: 46 / 128
FO: 0.36

% Forest (watershed), 31%

Brown Trout

90% Ex. Flow Yield, 0.0042

% Wetland (watershed), 13%

Terminal Node 1
Train: 36 / 61
Test: 88 / 152
Combined: 124 / 213
FO: 0.58

Terminal Node 2
Train: 17 / 83
Test: 64 / 156
Combined: 81 / 139
FO: 0.34

Terminal Node 3
Train: 98 / 139
Test: 176 / 210
Combined: 274 / 359
FO: 0.76

Terminal Node 4
Train: 11 / 176
Test: 37 / 122
Combined: 48 / 297
FO: 0.16

Terminal Node 5
Train: 16 / 54
Test: 30 / 73
Combined: 46 / 128
FO: 0.36

Brown Trout
Water Temperature, 19.7 °C

Terminal Node 1
Train: 44 / 58
Test: 100 / 152
Combined: 144 / 210
FO: 0.69

Terminal Node 2
Train: 14 / 91
Test: 34 / 169
Combined: 48 / 260
FO: 0.18

Terminal Node 3
Train: 35 / 72
Test: 26 / 84
Combined: 61 / 156
FO: 0.39

Terminal Node 4
Train: 5 / 19
Test: 9 / 49
Combined: 14 / 68
FO: 0.21

Terminal Node 5
Train: 10 / 221
Test: 27 / 183
Combined: 37 / 404
FO: 0.09

Terminal Node 6
Train: 8 / 22
Test: 15 / 24
Combined: 23 / 46
FO: 0.50

Terminal Node 7
Train: 3 / 18
Test: 2 / 6
Combined: 5 / 24
FO: 0.21

90% Ex. Flow Yield, 0.0043

90% Ex. Flow Yield, 0.0049

% Agriculture (watershed), 26%

Left= below dam, Right= above dam

Agriculture (watershed), 20%

Rainbow Trout
Conclusions

• Climate change has winners and losers

• These types of models are useful for future planning.

• Other factors besides climate change have the potential to disrupt or aid fish communities in the future.

• Proper management of these factors can potentially mitigate some of the negative impacts of climate change.
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References:
