MICHIGAN STATE UNIVERSITY

Quantitative Fisheries Center (QFC) Completed Project Briefing

Slimy Sculpin Population Trends in Lake Michigan and Southern Lake Ontario

Project Lead: Joshua Hoekwater (former QFC PhD student)
Contact info: Joshua.Hoekwater@utoledo.edu
QFC Collaborators: Kelly Robinson, Lisa Chong

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Caption: A slimy sculpin surrounded by rocks in Lake Superior. Dwyer, Scott (USGS). Public domain. https://www.usgs.gov/media/images/ slimy-sculpin

Goal: Quantify long-term spatial and temporal variation in slimy sculpin population abundance and evaluate the relative roles of lake trout predation, round goby competition, and dreissenid mussel abundance as possible drivers of observed declines across Lakes Michigan and southern Lake Ontario

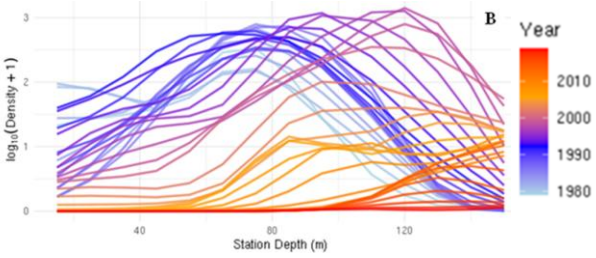
Objectives:

1. Reconstruct long-term, regionally-explicit trends in slimy sculpin abundance and depth distribution using USGS benthic trawl survey data spanning the 1970s–2019, including imputation of missing observations
2. Evaluate hypothesized drivers of slimy sculpin population trends, testing the relative influence of lake trout predation pressure, round goby competition, and dreissenid mussel abundance as covariates
3. Apply state-space population modeling to separate observation error from process dynamics and assess temporal changes in slimy sculpin populations across Lakes Michigan and southern Lake Ontario

Management Implications: Provides evidence-based insight into the mechanisms underlying slimy sculpin declines, clarifying when and where invasive species competition, altered benthic habitats, and changing predator pressures are most likely to affect this key prey fish. By identifying the relative roles of these different factors, the research supports more informed ecosystem-based management decisions aimed at preserving native benthic prey fish diversity and the stability of Great Lakes food webs.

Methods:

- Compiled and processed long-term USGS benthic trawl survey data (1970s–2019) from multiple ports in Lakes Michigan and southern Lake Ontario to develop regional time series of slimy sculpin density and depth distribution
- Imputed missing observations and standardized survey data to create consistent observational datasets suitable for longitudinal population analysis across space and time.
- Applied state-space population modeling using Kalman filtering and smoothing, allowing separation of observation error from underlying population dynamics and estimation of temporal trends.
- Tested hypothesized ecological drivers as covariates, including lake trout predation pressure, round goby abundance (competition), and dreissenid mussel abundance, to evaluate their relative influence on slimy sculpin population dynamics.



Caption: Estimated slimy sculpin density across depth and overtime at 30-mile pt in Lake Ontario estimated from a delta generalized additive model.

Key Findings:

- Slimy sculpin abundance declined non-uniformly across regions and depths, with patterns consistent with spatially heterogeneous ecosystem change rather than a single lake-wide driver.
- Covariate effects varied regionally, indicating that lake trout predation, round goby competition, and dreissenid mussel abundance influenced slimy sculpin dynamics differently across ports and depth strata.
- Results supported a multi-driver explanation for slimy sculpin declines, suggesting that combined effects of invasive species, altered benthic food webs, and changing predator pressure better explain trends than any single factor alone.

Deliverables: Hoekwater, J.C. 2025. Understanding slimy sculpin population declines in the Great Lakes. Ph.D. dissertation, Michigan State University, East Lansing. Download here.

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