STUDY PERFORMANCE REPORT

State: Michigan **Project No.:** F-80-R-7

Study No.: 230724 **Title:** The importance of trophic interactions for salmonine fisheries of the Great Lakes

Period Covered: October 1, 2005 to September 30, 2006

Study Objective: The overarching objective of this study is to gain an improved understanding of trophic interactions that influence the salmonine communities of the Great Lakes and how these interactions influence sport fisheries. Research will specifically address understanding uncertainty and variation in response of the salmonine-prey community to management actions, developing an improved understanding (in the form of a feeding model) of sea lamprey-host interactions, and developing new information on the energy dynamics of Chinook salmon.

Summary: Activities during the past year included literature review, continued work on the analysis of Lake Michigan stocking decisions, and further review and consideration of lethality of sea lamprey *Petromyzon marinus* attacks and functional response parameters for use in models being used to estimate Economic Injury Levels (EILs). Only limited work on the Lake Huron projection model was done consistent with the current status of this work. Work on the stocking decision analysis focused on considering a range of dynamic policies, and results are still being evaluated. While lethality and functional responses appear to be determined as well as is possible given available data, the implications of both the current estimates and uncertainty in them remains to be explored. Work on Chinook salmon *Oncorhynchus tshawytscha* energetics and on top down and cross-lake comparisons focused mainly on refining past analyses and interpretations to allow for peer-reviewed publication of this work.

Findings: Jobs 1–7 were scheduled for 2005-06, and progress is reported below.

Job 1. Title: Literature review.– We have continued the literature search and review of relevant articles, especially those pertaining to sea lamprey population dynamics and predation, Chinook salmon biology and energetics, and the salmonine – prey community in the Great Lakes.

Job 2. Title: Lake Michigan decision analysis.–Previous work on salmonine stocking strategies in Lake Michigan demonstrated that strategies that respond to the state of the fishery are likely to be superior to constant stocking strategies, but the range of such strategies that was considered was very limited. This study provides for supervision by Jim Bence of additional work on the Lake Michigan decision analysis, and Bence's participation in manuscript preparation (other work is done by collaborators funded by other sources). Based on the earlier results we have run a number of additional simulations using a variety of additional strategies and based on this work have outlined a plan for producing a manuscript based on the decision analysis. This plan required modification to the decision analysis model software to allow for a wide range of state dependent stocking strategies, and these changes were made. Results from additional policies will be reported to Lake Michigan managers. Work currently is ongoing to identify the general characteristics of superior state-dependent stocking strategies.

Job 3. Title: Lake Huron projection model.–Work on the Lake Huron projection model was limited this year to discussions between Dr. Bence and Dr. Ji He (Michigan DNR Fisheries Division) on future changes and updating, and to work toward updating lake trout *Salvelinus namaycush* and Chinook salmon assessment models. Dr. He has been designated as the coordinator for future use of the model by the Lake Huron Technical Committee.

Job 4. Title: Sea lamprey lethality and functional response.–Dr. Bence worked collaboratively with a postdoctoral associate (Dr. Brian Irwin) and another professor (Dr. Michael Jones) to determine Economic Injury Levels (EILs) for all the Great Lakes. EILs specify a level of investment in sea lamprey control above which costs of control exceed the economic value of increases in harvest, and below which further increases in control efforts can be justified solely on the basis of increased harvest. In principle, the EIL approach can specify the optimal level of control expenditures for each lake and, consequently, the total amount of resources that should be allocated and how they should be allocated among the lakes. In order to calculate EIL estimates for each lake, we are combining economic and ecological analyses, which rely on assumptions of target mortality rates and value of host species and predicted parasite-host interactions. Further, we are using an entire-life-cycle model for sea lamprey in each lake to represent sea lamprey population structure and implementation of control efforts. These EILs make use of attack lethality and functional response parameters for the parasitic sea lamprey phase and a model for sea lamprey recruitment and larval development. In regard to this study, the major contribution was Dr. Bence's review of available information on attack lethality and the functional response parameters used in the EIL calculations. To date we have populated an existing entire-life-cycle model with appropriate information on sea lamprey stream habitat across the Great Lakes, and done preliminary calibrations of the model for each lake so that on average the model can reproduce historical sea lamprey abundance given historical levels of sea lamprey control. We are currently planning a workshop that will take place on October 3, 2006 to obtain input on our modeling approach from sea lamprey biologists and managers.

Job 5. Title: Chinook salmon energetics.–Guidance was provided by Dr. Bence to collaborators (Dr. Michael Jones, Amber Peters, and others) on approaches to data analysis regarding Chinook salmon energetic status. Work to date in this collaborative project has emphasized three areas: (1) how Chinook salmon lipid levels and associated measures in Lake Michigan vary spatially and temporally as well as with age, size, or other characteristics, (2) how might Chinook salmon energetic status be monitored as part of ongoing surveys, and (3) how Chinook energetic status varies among lakes Michigan, Ontario, and Huron. Work in the past year has been in areas 1 and 2. During the past year final pre-submission revisions were made to a manuscript addressing area (1), containing an expanded version of detailed results reported on in the 2004-2005 report of this study. The manuscript was submitted to the Canadian Journal of Fisheries and Aquatic Sciences (CJFAS). Although reviews agreed that the study uncovered interesting patterns, the journal editor decided that the manuscript in its current form was not of broad enough scope for CJFAS. During the next year we plan to revise this manuscript based on the comments on presentation and some others on technical details of our analysis and resubmit it, most likely to a different journal. A manuscript on area (2) was submitted to the *Journal of Great Lakes Research*. Based on generally favorable reviews the manuscript was revised and resubmitted to the Journal. The revised version was accepted for publication pending minor changes in formatting.

Job 6. Title: Top down and cross-lake comparisons.–Past work in this area had focused on contributions to the Salmonid Communities of Oligotrophic Lakes (SCOL) initiative of the Great Lakes Fishery Commission. During the past year Dr. Bence did some work as the lead author on the cross-lake comparison of top down effects of salmonines in the Great Lakes paper. Peer reviews were received on a manuscript submitted to the Canadian Journal of Fisheries and

Aquatic Sciences and Dr. Bence is attempting to address some substantive issues that have been raised.

Job 7. Title: Prepare annual performance report.–This Performance Report was completed as scheduled and work has continued toward publishing results in the peer-reviewed literature as described in other jobs.

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