STUDY PERFORMANCE REPORT

State: Michigan   **Project No.:** F-80-R-5

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

Period Covered: October 1, 2003 - September 30, 2004

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 have included literature review, development and application of a decision model for stocking of salmon on Lake Michigan, expansion and further development of a fishery projection model for Lake Huron, parameterization of a functional response for sea lampreys, analyzing and synthesizing information on Chinook salmon energetics, and comparing top down effects of salmonines across the Great Lakes. Substantial progress has been made in each of these diverse areas. The improved information provides incremental progress that will help make a system-based approach to managing salmonines practical.

Findings: Jobs 1 through 7 were scheduled for 2003-04, and progress is reported below.

Job 1 Title: <u>Literature review.</u>–Literature review was done on topics related to decision analysis, top-down and bottom-up effects, Great Lakes fisheries and systems, sea lamprey biology, Chinook salmon biology, bioenergetics, and fish energy dynamics. This literature review supported active research and communication of results.

Job 2 Title: <u>Lake Michigan decision analysis.</u>–Dr. Bence continued to provide oversight on ongoing analyses of alewife and bloater dynamics. Part of this work led to a collaborative manuscript (with U.S.G.S. and University of Michigan scientists) in which an alewife stock-recruitment model was developed based directly on trawl survey data (accepted for publication in the *Transactions of the American Fisheries Society*). We also completed our detailed model-based assessment of alewife and bloater dynamics, and submitted a manuscript to the *Canadian Journal of Fisheries and Aquatic Sciences* based on this work. This analysis combined age-specific indices of alewife and bloater abundance from bottom trawl and hydroacoustic surveys, and estimates of predation calculated on the basis of predator stock assessments and bioenergetics calculations. The results of this analysis provided estimates of alewife and bloater recruitment over time, stock sizes over time, alewife and bloater stock recruitment functions, and parameters of the functional response for Chinook salmon. In addition to point estimates, posterior distributions for these parameters were calculated. Results from the above tasks and other analyses have been integrated into a stochastic model of the fish community.

Dr. Bence continued to participate as a member of a multi-investigator working group, which applied the stochastic simulation model we developed of the salmonine-prey fish community of Lake Michigan, with a view toward evaluating alternative decisions about the numbers and

species composition of hatchery-reared fish to be planted in Lake Michigan. The simulation results continue to be reviewed as we work toward a journal paper based on a chapter in Emily Szalai's dissertation.

Job 3 Title: Lake Huron projection model–Dr. Bence provided oversight of a postdoctoral researcher (Norine Dobiesz) on this job. We expanded an existing software program containing information needed to describe current abundance at age and consumption of prey fish by key predators in Lake Huron, and project stock sizes into the future. Expansions included incorporation of predator stocks in the North Channel and Georgian Bay, and the inclusion of lake whitefish. We had originally hoped to include information on sucker abundance but were not able to obtain information that could support that work. These changes and expansions were undertaken because the Lake Huron Committee and the Lake Huron Technical Committee supports use of this information for management purposes, and they need summary status over a wider geographic range and for species that are important to fisheries and serve as hosts for sea lampreys (lake whitefish). We have provided our resulting database and model code to the Lake Huron Technical Committee and have instructed key personnel working with that committee on how to use and continue to update the projection model.

Job 4 Title: Sea lamprey lethality and functional response.–Oversight continued to be provided on work by a Ph.D. student (Michael Rutter) in developing a joint sea lamprey functional response and lake trout assessment for the main basin of Lake Huron. This analysis was completed and a Ph.D. dissertation was finished. Manuscripts are now in preparation. Results show that successful limitation of mortality rates on lake trout requires a comprehensive approach of high levels of lake trout stocking, limits on fishing mortality and enhanced control of sea lampreys. Increased lake trout recruitment and lowering of other sources of mortality can reduce per capita mortality caused by sea lampreys by "saturating" the sea lampreys (so they are near the asymptote of their functional response). We are using the results to estimate economic injury levels on Lake Huron so as to help better define appropriate levels of expenditures on sea lamprey control, and Dr. Bence is supervising the work of a postdoctoral associate (Emily Szalai) in this area.

Job 5 Title: Chinook salmon energetics.–Guidance was provided by Dr. Bence to collaborators (Dr. Michael Jones and others) on approaches to data analysis regarding Chinook salmon energetic status. Work to date 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, and (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. In the past year the emphasis has been on the third topic. Limited numbers of samples are available from all three lakes from 2002 and 2003. Our past work has shown a strong relationship between lipid levels and water content. Average water content was particularly high in the Lake Huron samples, and low in the Lake Ontario samples, with Lake Michigan samples having intermediate levels. This result was confirmed by ANCOVA, which adjusts for effects of fish size on water content. These results are consistent with our *a priori* expectations based on the observations that (1) Chinook salmon growth rates vary in a similar fashion among the three lakes (highest growth in Lake Ontario) and (2) earlier work from 1997 identified high water and low energy content for Chinook salmon collected in Lake Huron.

Job 6 Title: Top down effects and cross-lake comparisons.–Work in this area has focused on contributions to the Salmonid Communities of Oligotrophic Lakes (SCOL) initiative of the Great Lakes Fishery Commission. Specific activities have been work to bring the Lake Huron case study paper to fruition, and to prepare a paper comparing top down effects of salmonines (particularly emphasizing Chinook salmon). The Lake Huron case study paper has been

submitted to the *Canadian Journal of Fisheries and Aquatic Sciences* (CJFAS) and is now being revised based on reviewer comments. This case study is a critical underpinning to the cross-lake comparisons, and an important repository of information on the system. Dr. Bence participated in writing and literature review as well as overseeing the work of a postdoctoral researcher (Norine Dobiesz). Dr. Bence is the lead author on a cross-lake comparison of top down effects of salmonines in the Great Lakes. A manuscript was reviewed by the guest editor for CJFAS and a revised version is being prepared based on these comments. Results continue to indicate marked differences among lakes, especially when comparing Lake Ontario with lakes Michigan and Huron. Lake Ontario appears to have higher growth rates of Chinook salmon, more abundant alewife, higher planktivory, and lower growth rates of alewife.

Job 7 Title: Prepare annual reports.–This report was prepared on time.

Prepared by: James Bence
Date: September 30, 2004