STUDY PERFORMANCE REPORT

State: Michigan **Project No.:** F-80-R-2

Study No.: 689 **Title:** Projecting piscivore predation in Lake Huron.

Period Covered: October 1, 2000 to September 30, 2001

Study Objective: Work with other investigators to refine and expand stock assessment models for major predators in Lake Huron; and package the results of these models into an integrated and easy to update projection model for evaluating consequences of stocking levels and changes in mortality rates from sea lamprey or harvest controls.

Summary: During the past year we have updated existing projection models with new data, and revised estimates of mortality and abundance. These models assess the overall consumption of prey fish by predators in the main basin of Lake Huron and exist as a series of linked spreadsheets representing seven piscivore populations (lake trout from three regions, chinook salmon, burbot, and walleye from two regions). The methodology used in these spreadsheets has been implemented in a Visual Basic program to simplify the process of projecting consumption under various management scenarios. A particular management action can be defined for any subset of predators. Various data can be set for each predator to reflect a management action. The program projects consumption using the conversion-efficiency method and presents standard graphical output. We projected consumption for a baseline scenario, a scenario which included estimates of the reduction of sea lamprey induced mortality, and a scenario investigating a reduction in chinook salmon stocking. Our current projections of consumption were summarized and presented as a poster contribution to the DNR In-Service Training event and at the State of Lake Huron Symposium in March 2001. Our consumption models were presented at the IAGLR 2001 conference in June.

Job 1. Title: Review literature on Great Lakes, Lake Huron, and Models.

Findings: The purpose of this task was for the Graduate Student Research Assistant to become familiar with background literature and to develop a comprehensive understanding of past work directly related to this project. Ongoing efforts in this job include keeping up with current literature. To this end, she has reviewed additional literature on predator-prey dynamics, Great Lakes fisheries, and the Lake Huron system.

Job 2. Title: Develop a flexible projection model.

Findings: We currently project consumption for the key predators in Lake Huron using a series of seven linked Microsoft Excel spreadsheets. These spreadsheets include one model for chinook salmon in the main basin, three models for lake trout corresponding to a northern, central and southern region of the main basin, and two models for walleye, corresponding to Saginaw Bay and the region of the main basin south of Saginaw Bay. Estimates of age-specific population abundance and mortality rates from these age-structured models together with information on

weight-at-age are used to estimate production. Production estimates are then divided by gross conversion efficiency (GCE) estimates to compute year- and age-specific consumption. GCE estimates are based on our bioenergetics models using Lake Huron specific data on fish growth, diet, energy density, and water temperature.

The current spreadsheet implementation is readily adaptable to changes in both data and process. However, when projecting consumption under multiple management scenarios, changing these models can be cumbersome and may introduce errors common to spreadsheet structure (i.e. copying cells). To simplify the projection of multiple scenarios and to allow fishery managers to use the projection model, we have implemented our spreadsheet models in a computer program that utilizes a user-friendly interface.

The projection program *Consume* is written in Microsoft Visual Basic and uses Microsoft Access databases for data storage. As in the spreadsheet models, the program uses the conversion-efficiency method to estimate consumption demand by predators. A management scenario can be created for any combination of the seven predator populations. Data that may be manipulated for each predator include: stocking and movement matrix (for lake trout only), recruitment, mortality, relative fishery effort (scaled to a reference year), sea lamprey mortality factor (scaled to a reference year), recreational fishery size limits, weight-at-age, gross conversion efficiency, and diet composition. When these data have been set to represent the desired management scenario, invoking a menu option projects consumption and produces several standard graphs including estimated consumption by year, instantaneous growth by year, gross production by year, and consumption by prey type. Individual data tables and graphs for other projection results can be obtained through another menu option.

Each predator population is contained in a database that mirrors the seven spreadsheets. These databases can be maintained through direct access from the Microsoft Access program or through an "import" facility in *Consume*. The Import facility accepts ADModel Builder formatted report files or specific formatted text files. The ADModel Builder format resulted from earlier work on a projection program for the 1836 Treaty model process and is maintained in *Consume* to allow for future updates from the Treaty Modeling Subgroup. An "export" facility allows any data table or graphed data to be saved in a spreadsheet or text file. Multiple file types can be output including: Microsoft Excel, Quattro Pro, and Lotus 123 spreadsheets; DBASE IV database tables; and tab-, space-, and comma-delimited text files.

The majority of the functions described above are currently implemented in *Consume*. However, several features are still under development including: (1) specification of maturation mortality for chinook salmon; (2) size limits; and (3) print capability. Additionally, error-checking procedures must be included for critical data input such as insuring that the diet composition table sums to 1 or verifying "reasonable" values for mortality, weight-at-age, year/age ranges, etc. We will continue to work on these areas and plan to present the program at the January 2002 Lake Huron Technical Committee meeting.

Job 3. Title: <u>Update projection models.</u>

Findings: The projection model program has been updated to reflect new data and estimates of lake trout mortality and abundance that have resulted from the 1836 Treaty Modeling Subgroup. With this effort beginning for the upcoming year, new estimates should be available that can be included in the projection program. Other associated modeling work using ADModel Builder that has occurred for chinook salmon has produced new data and estimates that have been reflected in the projection model program. New weight-at-age information provided by Jim

Johnson is the only new information available for burbot. The walleye models have not been updated but work over the next period will investigate the availability of updated information on this species. In particular, we will seek new estimates of stocking, mortality, and weight-at-age for Saginaw Bay walleyes.

Job 5. Title: Evaluate potential future.

Findings: Projecting consumption under various management scenarios can improve our understanding of how these actions may affect prey consumption by the key predators (chinook salmon, lake trout, burbot, and walleye) in Lake Huron. During this reporting period, we produced projected consumption estimates for a variety of possible management scenarios. First, we established a "baseline" scenario that included: (1) changes to lake trout stocking and harvest regulations resulting from the 2000 consent decree for waters ceded by the 1836 Treaty of Washington; and (2) the 20% reduction in chinook salmon stocking that began in 1999. All other factors that affect abundance and consumption were held constant, at 1998 levels. The other scenarios start with this "baseline" configuration while altering factor(s) associated with specific management actions. Here we report the results of the baseline scenario and two example alternatives. Results of all projections are given as the mean for the period 2010-2020, the timeframe where consumption is stable (Figure 1). For the "baseline" scenario, the projected mean consumption for 2010-2020 was 47 million kg.

Our first example alternative explores the effects of the projected reduction in sea lamprey abundance resulting from the sea lamprey control effort in the St Marys River. In our projection model, reducing sea lamprey abundance reduced lake trout and burbot mortality, thereby increasing their abundance and consumption. Mean consumption for the "sea lamprey reduction" scenario was 51.5 million kg, representing an increase of 9% over the "baseline" scenario consumption levels. This increase is exclusively related to the reduction of sea lamprey induced mortality on lake trout and burbot.

Chinook salmon have dominated prey consumption, especially in recent years, so it is informative to explore a scenario resulting in decreased chinook salmon abundance. Our second alternative scenario, "chinook salmon reduction", includes the projected reduction in sea lamprey abundance and adds a 50% reduction in chinook salmon stocking beginning in the year 2002. Mean consumption for the period 2010-2020 under this scenario is 35.5 million kg. Mean consumption decreased from the "sea lamprey reduction" scenario by 31% and decreased from the "Baseline" scenario by 25%.

Job 6. Title: Publish results and prepare annual reports.

Findings: This progress report was prepared. Our current estimates of consumption and projected consumption associated with several management scenario were summarized and presented as a poster contribution to the DNR In-Service training event and at the State of Lake Huron Symposium (as part of the GLFC Lake Committee process) in March 2001 and at the IAGLR 2001 conference.

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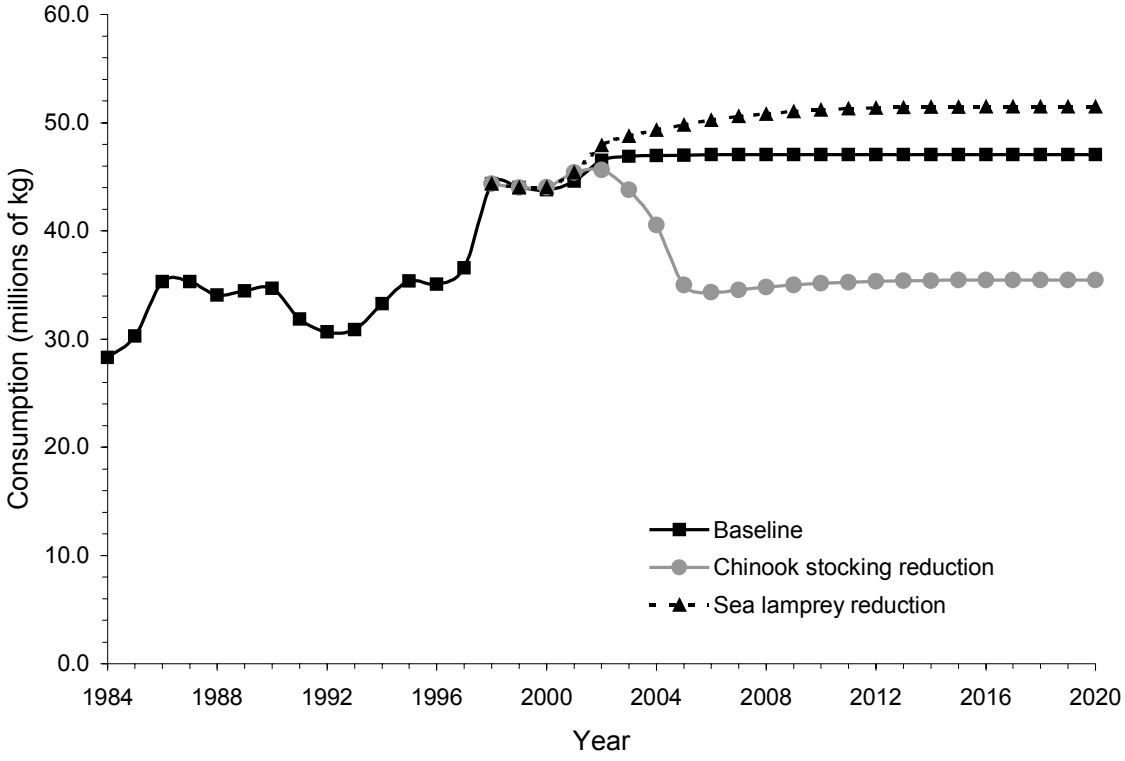

Figure 1–Projected consumption by key predators in the main basin of Lake Huron through 2020 under three management scenarios.