STUDY PERFORMANCE REPORT

State: Michigan **Project No.:** F-81-R-7

Study No.: 230522 **Title:** Assessment of predator-prey balance for Lake Huron fishery management.

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

Study Objective: To improve estimates of per-predator and total-population consumption, by synthesizing stock assessments, measuring energy density, measuring diet composition, and developing new models.

Summary: This was the first year of this study. One manuscript was published describing relationships between growth and maturity schedules for hatchery and wild lean lake trout in Lake Superior. Two more manuscripts were submitted for publication on modeling time-varying growth in lake trout and comparing growth characteristics of lake trout and Chinook salmon in Lake Huron. Standard protocols were developed and applied for collecting and recording diet composition, and for measuring percentage of dry weight in dorsal muscle plugs. The models developed this year are the first two steps toward updating the models for describing consumption demand by major predator species in Lake Huron. Biological samples and laboratory analyses continued to reveal the spatial difference in diet composition changes, and the difference between Chinook salmon and lake trout in their growth and body condition changes. All job requirements for 2006 were met.

Findings: Jobs 1 through 5 were scheduled for 2005-06, and the progress is reported below.

Job 1. Title: Synthesize existing stock assessments.–Chinook salmon assessment modeling was in process. The Quantitative Fisheries Center at Michigan State University led the model update with additional funding sources. Alpena Fisheries Research Station, Michigan DNR, summarized data inputs including recreational fishery effort, recreational fishery harvest, age composition of recreational harvests, size at age, Chinook salmon stocking over years, Swan River return, age composition of Swan River return, and the proportion of the fish sample that did not carry an OTC mark and were likely of non-hatchery origin.

Lake trout assessment was updated using data of 2005, including commercial fishery data, recreational fishery data, and fishery independent survey data. The assessment included three catch-at-age models for northern, north-central and southern Lake Huron respectively. The modeling effort included assistance from Ontario Ministry of Natural Resources at Owen Sound, USFWS Fisheries Resource Office at Alpena, and Chippewa/Ottawa Resource Authority.

Time-varying growth models for Chinook salmon and lake trout were developed in cooperation with the Quantitative Fisheries Center at Michigan State University. These models describe cohort-specific growth history for multiple year classes while year-specific growth environment changes over time. Three models were developed for lake trout in northern, north-central, and southern Lake Huron respectively. Modeling methods, with the model for southern Lake Huron lake trout as an example application, is in press at Transactions of the American Fisheries Society.

Also with cooperation of the Quantitative Fisheries Center at Michigan State University, models were developed for Chinook salmon and lake trout, in describing time-varying length-mass

relations and condition indices. Lake trout models included three spatial components for northern, north-central, and southern Lake Huron. The models provided spatial, temporal, size-specific, and inter-specific comparisons of condition indices. The model was presented at 136th American Fisheries Society annual conference at Lake Placid, New York. The modeling results were documented in a manuscript submitted to Transactions of the American Fisheries Society.

Methods were developed for investigating the relation between changes in growth (size at age) and changes in maturity schedule (age and length at maturity). The method was applied in studying Lake Superior lake trout, in cooperation with the Marquette Fisheries Research Station, Michigan DNR. The results were published in Transactions of American Fisheries Society:

Sitar S. P., and J. X. He. 2006. Growth and maturity of hatchery and wild lean lake trout during population recovery in Michigan waters of Lake Superior. Transactions of the American Fisheries Society 135:915-923.

In 2004 and 2005, the first time over the past 40 years, total recreational harvest of Chinook salmon fell below the harvest of lake trout, indicating substantial decline in Chinook salmon abundance. The changes in relative abundance between Chinook salmon and lake trout were directly related to decline in condition indices of the two fish species. Lake trout appeared to better adapt to low food conditions currently observed in Lake Huron, although condition indices for both species have declined.

Job 2. Title: Write and improve protocols.–Survey and monitoring protocols for coldwater species were written, and the protocols were used in the 2006 field season. The same standard procedures developed for lake trout, such as collecting and recording diet information and collecting and analyzing dorsal muscle plugs, were also used for studying Chinook salmon. Dorsal muscle plugs were used in the laboratory for measuring water percentages. Standard data sheets for "Lake Huron Fish Stomach Laboratory" and for "Lake Huron Fish Energetic Laboratory" were developed and used in 2006 field season. Collections of Chinook salmon samples were based on experiences from previous studies because 2006 was the first year of this study. Two new databases were developed, including CHS522 and PREY522. The lake trout spring survey database was expanded to include components for the Study 522.

Job 3. Title: Collect and analyze data.–A total of 60 lake trout whole-body samples were collected during October 2005, and another 60 whole-body samples were collected during spring 2006. This collection of lake trout samples was a joint effort by Ontario Ministry of Natural Resources at Owen Sound, USFWS Fisheries Resource Office at Alpena, Chippewa/Ottawa Resource Authority, and Alpena Fisheries Research Station, Michigan DNR. These samples were used by the Quantitative Fisheries Center at Michigan State University for developing a predictive relation between water percentage of dorsal muscle plug tissue and whole body energy density.

Dorsal muscle plugs were collected from 99 lake trout during the spring survey and from 347 Chinook salmon biological samples collected from the recreational fishery. Average dry-weight percentage of these muscle plugs was 28% for lake trout, and 24% for Chinook salmon. Standard deviation for both species was 2.6%. Lake trout samples were collected from northern, north-central, and southern Lake Huron. Chinook salmon samples were collected from five ports including Port Huron, Alpena, Rogers City, Cheboygan, and Detour. These samples can be used for spatial and seasonal comparisons and will be compared to samples collected in the future.

Stomach contents were analyzed for 270 lake trout collected during the spring, and 106 lake trout collected during summer. Spring samples were from the MDNR annual spring gill netting survey, and summer samples were provided by USFWS from their fishery-independent lake whitefish

survey. During the spring, major prey items, measured as composition of wet weight, were rainbow smelt (53.3%), round goby (25.3%), and alewife (13.3%). In southern Lake Huron, the percentages were 75.2%, 13.3%, 10.5%, respectively. In north-central Lake Huron, the percentages were 12.7%, 53.2%, and 11.4%, respectively. In northern Lake Huron, the percentages were 14.9%, 34.9%, and 30.9%, respectively. Summer lake trout stomach samples were mostly from the northern and north-central areas, where major prey items were rainbow smelt (59.6%), round goby (31.3%), and alewife (3.9%). Most Chinook salmon stomachs checked were devoid of food. Major diet items for Chinook salmon were rainbow smelt (68.1%) and nine-spine stickleback (25%). Rainbow smelt found in Chinook salmon stomachs were mostly yearlings.

Prey samples were provided by USGS Great Lakes Science Center and USFWS Fisheries Resource Office at Alpena from their bottom trawl surveys. Alpena Fisheries Research Station, Michigan DNR, also collected prey samples from the Thunder Bay area using a bottom trawl. Major prey species included alewives, rainbow smelt, trout-perch, nine spine sticklebacks, lake whitefish, bloater chubs, slimy sculpins, deepwater sculpins, and round gobies. Percentage dry weight of these prey species ranged from 18% to 24%, with standard deviations from 0.3% to 4%. Percentage of dry weight for sticklebacks, bloaters, and round were about 24% or slightly higher, similar to the percentage of dry weight for Chinook salmon. Sub-samples for each prey species were sent to the Quantitative Fisheries Center at Michigan State University, for direct measurement of energy density.

The cooperative work with the Quantitative Fisheries Center at Michigan State University and other management agencies around Lake Huron was partially funded by a grant under the USFWS Great Lakes Restoration Act.

Job 4. Title: Develop, improve, and apply models.–A hierarchical Bayesian approach to statistical inference was developed and applied in time-varying growth models. The same approach was also applied in models for spatial- and time-varying length-mass relations and condition indices. The hierarchical Bayesian modeling adequately specified covariance among growth parameters, and between the parameters for length-mass structure. The time-varying growth models now include a Chinook salmon model for Lake Huron, and three lake trout models for southern, north-central, and northern Lake Huron, respectively. The models for spatial- and time-varying length-mass relations now include a Chinook salmon model for Lake Huron, and a lake trout model for Lake Huron, which includes the southern, north-central, and northern areas as three spatial components. The three time-varying growth models for lake trout will also be combined for adequate comparisons of time-varying growth among the three spatial units.

The overall modeling framework is designed to update the model that describes predator consumption demand in Lake Huron. The next component of the framework will be models for time-varying maturity schedules. These time-varying models for growth, condition indices, and maturity schedules will be used to better describe time-varying consumption by individual predators. The time-varying consumption models will be further combined with population assessment models for estimating the consumption at the population level.

Job 5. Title: Write annual report.–This progress report was prepared as scheduled.

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