STUDY PERFORMANCE REPORT

State: Michigan **Project No.:** F-53-R-15

Study No.: 496 **Title:** Develop computer models of lake trout and lake whitefish in 1836 Treaty-ceded waters of lakes Superior, Michigan, and Huron.

Period Covered: April 1, 1998 to September 30, 1999

Study Objective: To construct computer models of lake trout and lake whitefish populations and fisheries in 1836 Treaty-ceded waters of lakes Superior, Michigan, and Huron. Then, to utilize those models to assist with negotiating or litigating state/tribal-fishing agreements in the year 2000.

Summary: Data requirements for development of catch-at-age models have been determined, appropriate software has been selected, and assembly of all pertinent data into a common relational database is nearing completion. Statistical catch-at-age (SCAA) models estimating population parameters of lake trout and lake whitefish populations and fisheries in the upper Great Lakes are in varying stages of development. The general templates for lake whitefish and lake trout SCAA models will be complete and population parameters will be estimated for all State of Michigan management units by mid-October or shortly thereafter. Upon completion of the catch-at-age models, prognosis remains good for development of short and long term simulation models used to predict total allowable catch and the effects of different fishery management scenarios. Several biologists are involved to varying degrees in these stock assessments, including biologists within the Michigan Department of Natural Resources (MDNR), U.S. Fish and Wildlife Service (USFWS), the Chippewa Ottawa Treaty Fishery Management Authority (COTFMA), and individual tribes. A central assumption behind this effort is that the stock assessment and modeling of lake trout and lake whitefish in the upper Great Lakes will be done cooperatively. This has been the case to date.

Job 1. Title: Inventory and assemble all available assessment data on lake trout and lake whitefish into relational databases by species and lake and correct errors.

Findings: To date, all assessment data on lake trout and lake whitefish dating back to 1981 have been inventoried and are currently being checked for errors at all research stations. Assembly of these data into a relational database housed at Fisheries Division, MDNR, Lansing has taken longer than expected, but is nearing completion.

Job 2. Title: Assemble all sport and commercial harvest data, including age compositions, into databases for each lake and correct errors.

Findings: Sport and commercial harvest data have been assembled and error checking is underway. Some difficulty was encountered in re-calculating the sport harvest and effort estimates using new formulas that provide more robust estimates of the variance in those numbers. This was most often due to difficulty recovering data files needed to re-calculate these estimates.

However, where completed, re-calculated point estimates appear similar to those calculated in the past. A full analysis and report will be necessary to show that previously calculated estimates remain the best point estimate of harvest and effort given techniques available at the time for those places where we are unable to calculate new estimates using the new method. The State of Michigan commercial harvest data are complete and have been put into a relational database housed at Fisheries Division, MDNR, Lansing. Tribal commercial fishery harvest data are also complete and have been put into a relational database. Additional data may be requested from Intertribal Fisheries Assessment Program (ITFAP) to supplement this database as required for model development.

Job 3. Title: Assemble all stocking data and correct errors.

Findings: Stocking data for lake trout are maintained by the U.S. Fish and Wildlife Service and the MDNR. Verification of data has been completed, and those data have been put into a relational database housed at Fisheries Division, MDNR, Lansing.

Job 4. Title: Define geographical boundaries for models and migration.

Findings: Lake Superior geographic boundaries for models of lake trout populations and fisheries will be defined as lake trout management units MI-5 - Marquette, MI-6 - Munising, MI-7 - Grand Marais, and MI-8 - Whitefish Bay. Lake Huron geographic boundaries will be statistical districts MH-1 - Northern Lake Huron southward to Rogers City and MH-2 - Rogers City to Sturgeon Point. Lake Michigan geographic boundaries will be statistical districts MM-1 - Green Bay, MM-2 - Point Detour to Seul Choix Point, MM-3 - Seul Choix Point to Norwood, MM-4 - Grand Traverse Bay, MM-5 - Leelanau Point to Arcadia, MM-6 - Arcadia to Little Sable Point, and MM-7 - Little Sable Point to Holland.

Lake Superior geographic boundaries for models of lake whitefish populations and fisheries will be defined as lake whitefish management units WFS-04, WFS-05, WFS-06, WFS-07, and WFS-08. In northern Lake Huron boundaries will include whitefish management units WFH-01 and WFH-02. In Lake Michigan, geographic boundaries will include whitefish management units WFM-01, WFM-02, WFM-03, WFM-04, WFM-05, WFM-06, and WFM-07.

Job 5. Title: Construct age structured lake trout population models and debug.

Findings: Lake trout models are being constructed for management areas as shown in Table 1. Model parameters for use in the construction of the lake trout models will be similar to those used by Sitar (1996).

Prototype age structured models of lake trout populations have been developed for all three lakes. Shawn Sitar (MDNR Marquette Fisheries Station) and Dr. James Bence (Michigan State University) are developing comprehensive versions of the models, which take into account data availability and special considerations on a stock-by-stock basis. Models are being developed using the software AD Model Builder (Otter Research Ltd. 1993). AD Model Builder is the fastest, most powerful software available for rapid development and fitting of general nonlinear statistical models similar to the catch-at-age models of lake trout and lake whitefish being developed here.

Job 6. Title: Construct age structured lake whitefish population models and debug.

Findings: Lake whitefish models are being constructed for management areas as shown in Table 1. Model parameters for use in the construction of the lake whitefish models will be similar to those used by Sitar (1996). Recreational fishing intensity is not high enough in some management areas to include in models for those areas. It is also doubtful if enough data on sea lamprey wounding are available to include in the models, with the possible exception of Lake Huron whitefish.

As in Job 5 above, AD Model Builder has been used to develop a comprehensive model of lake whitefish populations and fisheries. Kurt Newman (MDNR Fisheries Division Lansing) has been working closely with Dr. James Bence in the development of this model. The basic model includes two fisheries (i.e., trap and gill net). Development of the model was done with a time series of the necessary data compiled by Mark Ebener (COTFMA) from whitefish management unit WFM-03.

A workshop was hosted at Michigan State University on December 29, 1998 that trained participants in the use of AD Model Builder and demonstrated the simple lake trout and lake whitefish models described above. Dr. James Bence and Kurt Newman organized the workshop. Participants included biologists and modelers from MDNR, USFWS, and COTFMA.

Job 7. Title: Run catch-at-age analysis and estimate the optimum suite of parameters that best describe the population dynamics of lake trout and lake whitefish.

Findings: Fisheries catch-at-age models are used to estimate exploitation rates, population size at age, and recruitment to the fishery in exploited fish populations. Preliminary results from catcho-at-age models we have built for lake trout and whitefish are being evaluated. Consensus among the modeling group is that the basic template for each model is in place, and that a full time series of data inputs needs to be compiled in order to further evaluate model predictions on a unit by unit basis as described in Table 1. A workshop conducted for the modeling group April 14th and 15th, 1999 helped us to focus on model development and data needs. Model and data development were delegated among group members at that meeting. A second meeting on August 19th and 20th, 1999 was convened to finalize the status of all stocks being modeled, and the remaining data requirements for model development. Preliminary results from prototype models were discussed and delegation of assignments centered on model completion and draft report development was made.

Job 8. Title: Run model simulations according to various management options to estimate future population dynamics.

Findings: This modeling effort is a three-part process. It begins with parameter estimation, which leads to short-term projections of total allowable catches (TAC's), and long-term projections under different management scenarios (gaming). As the parameter estimation phase of this modeling effort is not yet complete, any simulation of populations and fisheries into the future is only preliminary and not likely to represent realistic projections. AD Model Builder also provides simple methods for calculating the profile likelihood and Markov chain simulation estimates of the posterior distribution of parameters of interest. For example, the code for our catch-at-age models could be used to estimate the profile likelihood for the projected biomass of an age class of fish in the fishery. As a typical application of the method, the user of the model

could estimate the probability that the biomass of fish for next year will be larger or smaller than a certain value. Estimates like these would obviously be of great interest to negotiating or litigating parties. Development of a short-term projection model that makes use of the parameters estimated from the SCAA models described above is nearly complete. Once the first two parts of this modeling process are completed, attention will shift to long-term projection models.

Job 9. Title: Update models as data become available and recalibrate if necessary.

Findings: Updates to models are ongoing as described above.

Job 10. Title: Assist the negotiating or litigating parties in predicting how differing settlement scenarios will effect lake trout and whitefish populations.

Findings: On January 25, 1999, Richard Schorfhaar, Dr. James Bence, and Kurt Newman, along with other key MDNR personnel, met with John Wernet, the Assistant in Charge of the Native American Affairs Division of the Attorney General Office to discuss the development of the catch-at-age models. The extent of our collaborative efforts with tribal biologists to date was also discussed. At that meeting, the attorneys became familiar with the ongoing modeling process. It is expected that the attorneys will need to meet with modelers again in the future as models are refined and negotiations continue.

The modeling group continues to provide the litigating parties preliminary results based on model development. A meeting of the Technical Fisheries Review Committee (TFRC) was convened on August 20th, 1999. At that meeting, the modeling group discussed the status of the modeling process with members of the TFRC who are also involved in negotiations. The TFRC was satisfied with model development to date.

Job 11. Title: Write annual Federal Aid reports and reports documenting construction of the models, how they were used in the negotiation or litigation process, and how well any settlements conformed to the model outputs.

Findings: Dr. James Bence and Kurt Newman are currently drafting a report/paper that will document the construction of the catch-at-age models. It is expected that Richard Schorfhaar and Dr. James Bence will review and edit the manuscript, after which all collaborating parties will have an opportunity to make suggestions and/or additions to the paper. A copy of the manuscript will be provided to John Wernet to assist his attorney group in their understanding of the modeling process being employed. To date, no new settlements have been agreed to.

Literature Cited:

Otter Research Ltd. 1993. AD Model Builder software. Box 265, Station A, Nanaimo, B.C., Canada.

Pauly, D. 1980. On the interrelationships between natural mortality, growth parameters, and mean environmental temperature in 175 fish stocks. J. Cons. Int. Explor. Mer 39:175-192.

Sitar, S. P. 1996. Estimation of lake trout (Salvelinus namaycush) abundance and mortality due to sea lampreys (Petromyzon marinus) and fishing in the main basin of Lake Huron, 1984-93. Michigan Department of Natural Resources, Fisheries Research Report 2030, Ann Arbor, Michigan.

Smith, S.H., H.J. Buettner, and R. Hile. 1961. Fishery statistical districts of the Great Lakes. Great Lakes Fishery Commission Technical Report No. 2, Ann Arbor, Michigan.

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Table 1.–Lakes Michigan, Superior, and Huron management units[a] requiring modeling efforts (x) for lake trout, whitefish, or both species.

Management	Michigan		Superior		Huron	
Unit	Lake trout	Whitefish	Lake trout	Whitefish	Lake trout	Whitefish
M-1		x			x	x
M-2	x	x			x	x
M-3	x	x				
M-4	x	x	x	x		
M-5	x	x	x	x		
M-6	x	x	x	x		
M-7	x	x	x	x		
M-8			x	x		

[a] Lake Superior management units are subdivisions of statistical districts and lakes Michigan and Huron are statistical districts as described by Smith et al. (1961).