Date of Report: June 30, 2000
LCMR Work Program Final Report

Project Completion Date: June 30, 2000

LCMR Workprogram 1997

I. Project title: Improved decisions for walleye stocking and special regulations (K-1)

Project Manager: Ira R. Adelman
Affiliation: University of Minnesota
Address: Department of Fisheries and Wildlife, 1980 Folwell Ave., St. Paul, MN 55108-6124
Phone: 612-624-4228 **E-mail:** ira@fw.umn.edu
Fax: 612-625-5299
Web site address: http://www.fw.umn.edu/

Total Biennial Budget:	
$ LCMR	$245,000
$ Other (not required)	$20,000
Amount Spent:	$245,000
Balance:	$0

A. Legal Citation: ML 1997, Chap. 216, Sec. 15, Subd. 15(a).
Appropriation Language: Improved Decisions for Walleye Stocking and Special Regulations
This appropriation is from the future resources fund to the University of Minnesota to evaluate outcomes of various stocking and harvest strategies through modeling and genetic-marker tracking of the best performing strains to maximize benefits of walleye stocking and harvest regulations on individual lakes. This appropriation is available until June 30, 2000, at which time the project must be completed and final products delivered, unless an earlier date is specified in the work program.

II. Project Summary and Results:

Result 1: Simulation model-- Over the past 3 years, University of Minnesota researchers, in cooperation with DNR, have been studying the effectiveness of the DNR's walleye stocking program by analyzing historical stocking and lake survey records. Data from 4,470 surveys in 1,924 lakes and 20,634 walleye stocking records in 1,716 lakes were used in the analysis (Li, et al. 1996 a,b). From this research, a preliminary computer model was developed as a decision making tool that will predict the effect of both stocking activities and harvest regulations on future walleye population structure (Li 1996). During the year preceding this proposed LCMR project, the model will be refined into a highly user-friendly decision making tool that DNR area supervisors can use to make decisions about stocking and harvest regulations on individual lakes. However, a final validation of the model will be needed to prove its effectiveness. That validation will be completed through this proposed project.

Two approaches will be undertaken to validate the model. First, DNR plans to experimentally stock fry in 20-40 lakes in 1997 to determine if the less costly fry stocking can replace the previously used, more expensive fingerling stocking. These lakes have been historically stocked with either or both strains, depending on availability. The computer model will be used to predict the effect of these stockings on the walleye population. Post-stocking, the lakes will be surveyed to determine the walleye population structure and results will be compared to those predicted by the computer model. Second, DNR is using the MANSIM model to develop harvest regulations for individual lakes. In most cases the populations will need about 5 years to adjust to the new regulations. Those five years will have elapsed on a few lakes during the proposed project period so our computer model will be used to predict the effect of the regulations. Our predictions will then be compared to the MANSIM model predictions, and the lakes will be surveyed to determine which model is superior. We believe our model will be better. As an individual-based model, rather than the population-level MANSIM model , it better accounts for the attributes of individuals as they interact with each other and their environment. Data acquired to validate the model may

also be used to improve the model, if warranted. The final product of this portion of the project will be the validated computer model.

Result 2: World Wide Web site--The model will be made available to stakeholders via the World Wide Web, and two workshops will be conducted with potential users, probably individuals associated with fishing organizations. The first workshop, early in the project, will be for gaining an understanding of how stakeholders might use the model so that we can incorporate appropriate options. The second workshop, late in the project, will be for teaching stakeholders how to use the model. The final product of the project will be the web accessible computer model that will be used by fisheries managers as a decision making tool and as an educational, that brings science to the public stakeholders so that they can understand, evaluate, and participate in decisions made by the DNR.

Result 3: Strain evaluation--Over the past 3 years, University of Minnesota researchers have been developing a new genetic tool, called microsatellite DNA markers, for fisheries management (Miller and Kapuscinski 1996). Microsatellites are highly variable regions of DNA dispersed throughout an animal's genetic material. Different strains or populations of fish have different patterns in their microsatellite DNA, making it possible to identify strain-specific "markers." A practical and cost-saving advantage of using microsatellite markers to separate strains is that this tool works on non-lethally collected, tiny amounts of tissue (e.g., fish scales or slivers of fin tissue).

This portion of the project will identify and then apply diagnostic DNA markers that can separate the two walleye strains that DNR uses for stocking in the southern portion of MN. DNR will stock 5-10 lakes with fry of both strains in the spring and will survey the surviving fish during late summer. We will non-lethally collect fish scales or a fin-tissue sliver from each fish and screen this tissue with diagnostic markers to determine if each collected fish belongs to one or the other stocked strain. Then, we will compare performance of the two strains in each lake based on relative survival rates, growth rates, and condition factor of fish of the two strains. Additionally, a reference growth rate of walleye for each strain will be determined in a laboratory experiment under different temperature or other environmental regimes. These reference growth rates will be used in the computer model to predict comparative success of the strains. The final product of this portion of the project will be a determination of which of two walleye strains is superior for stocking in southern Minnesota.

III. Progress Summary

Final products from this project include two Master's Degree theses (attached): 1) Walleye Population Identification Using Parentage Assignment by William H. Eldridge, 2) Growth and Survival of Two Populations of Stocked Walleye and Naturally Spawned Walleye in the Same Lakes by Marc Bacigalupi. Both of these will be submitted for peer reviewed journal publication. In addition, a web site was developed. A paper on the model and its validation will also be submitted for publication and details of the model description are attached to this report. The following is a brief summary of accomplishments on each objective.

Result 1: Simulation model-- The general objectives for development of this individual-based simulation model (IBSM) are to provide a management tool to explore the effects of fisheries management activities, such as stocking and fishing regulations, on walleye populations. To achieve these objectives, we incorporated many state-of-art modeling methods and technologies to build a biologically sound model to describe walleye population dynamics. In addition, we also developed a user-friendly interface for easy use of model. The model provides an excellent educational tool for understanding how walleye population abundance and age structure responds to changes in stocking frequency and amount, changes in harvest regulations, and changes in biological and physical factors such as food availability and lake characteristics. The model appears to track longer term changes in population changes and abundance, 10 years or more, with considerable accuracy, but as with other simulation models it does not perform well in predicting short term changes, 6 years or less. The reason for this is that annual variation in events such as weather conditions have major impact on the success of walleye reproduction. And because these events are unpredictable from year to year, the response of walleye populations in forming strong or weak year classes is unpredictable. Over the long term, the annual variations average out so predictions of abundance become more accurate. Nevertheless, the model is useful in helping managers and the public understand the impact of the various management activities over the long term. Details of the model are attached.

Result 2: World Wide Web site--The model is up and running on the web. The site includes a general description of the model, a tutorial on how to use it, and the model itself. At present, the model is passwor protected to give DNR managers a chance to become familiar with it before it is opened to the general public. We plan to release the model to the public with a presentation at the next fisheries roundtable. The web site URL is: http://www.fw.umn.edu/Walleyemodel

Result 3: Strain evaluation--The objective was divided into two parts. One is focused on the field work, i.e., stocking the fish and assessing survival and growth. The second focused on the laboratory techniques, i.e., developing and applying the molecular techniques to distinguish the two strains, Pike River or Cutfoot Sioux, and to distinguish stocked walleye from walleye naturally reproduced in the lakes.

From the lab study we found that parentage assignment using microsatellite markers inherent in a fish's DNA provided a powerful alternative to physical or chemical tagging of fish. We applied genetic markers to distinguish walleye from the two populations that had been simultaneously stocked as fry into six southwestern Minnesota lakes. We also distinguished the stocked walleye from wild walleye of the same year class. Stocked fish were assigned to their source population by comparing their genotypes at nine microsatellite loci to the known genotypes of the parents crossed in the hatchery (parentage assignment). Fish that did not assign to a parent pair were considered to be the product of natural reproduction, or in the case of one sample of fry, to be a related species, yellow perch. Proportions of these wild walleye varied from 4% to 85% in the study lakes. We determined that the wild walleye descended from a number of different sources including the two populations that were stocked. Simulations revealed that we could expect less than 1% of the sampled fish to assign incorrectly.

In the field study, we simultaneously stocked walleye fry from two populations, Pike River and Cutfoot Souix from neighboring drainage basins in Northern Minnesota. into six shallow, eutrophic prairie lakes of two different lake-types (based on limnological characteristics) in southern Minnesota. To determine if either source population showed superior performance, we measured the growth rates and survivorship over the first two growing seasons. We also determined if changes in survival of stocked and naturally spawned walleye occurred and if growth rates differed. Parentage assignment, using highly polymorphic DNA micro-satellite markers, identified the population origin of sampled walleyes. This study suggested that even closely related walleye populations will perform differently when stocked into the same lakes. Pike River walleye survived in higher numbers than Cutfoot Sioux walleye to Age 1, but with no relationship to lake-type. Source population growth rates did not differ significantly. The selection of a source population for stocking in a given system should be based on long term lake specific studies as it appears that source population walleye survival may be life-stage or time-period dependent and lake specific. Over time, naturally spawned walleye constituted an increasing percentage of the year-class. Periodic natural reproduction may contribute a larger than believed percentage of walleye populations in lakes that are managed as put-grow-take fisheries. The use of DNA microsatellite markers and parentage assignment for monitoring the performance of both naturally spawned and stocked fish, as done in this study, is a powerful tool for future stocking evaluation studies.

Two papers on the project were presented at the National Conference of the American Fisheries Society in Charlotte, North Carolina, August 30 to September 3, 1999.

IV. Outline of Project Results:

Result 1: Validation of the simulation model including determination of experimental lakes, input of lake characteristics, collection of field data and comparison with model predictions. (July 1997-June 2000)

LCMR Budget: $108,273 Balance: $0
Completion date: June 30, 2000

Result 2: Completion of the World Wide Web site for access to the model and completion of the instructional workshops. First workshop in late 1997 or early 1998, second workshop in early 2000.

LCMR Budget: $20,000 Balance: $0
Completion date: June 30, 2000

Result 3: Determination of the performance characteristics of the two walleye strains and recommendations to DNR on which to stock. Identification of genetic markers by mid-1997, laboratory growth experiment in early 1998, collection and screening of field samples in late 1998-late 1999.

LCMR Budget: $116,727 Balance: $0
Completion date: June 30, 2000

V. Dissemination

We will be working closely with DNR on all aspects of the project so that they will have input into directions of the work and will be a recipient of the final report on performance of the two walleye strains and an electronic copy of the model. The World Wide Web site to be developed will provide the general public with access to the model, and two workshops on use of the model will be held with fishing organizations.

VI. Context

A. Significance:

A simulation model will be used to predict the outcome of stocking regimes and harvest regulations. Once validated, the model will be made available on the World Wide Web, to be used by DNR managers and stakeholders. It will be an educational tool, that brings science to the public stakeholders so that they can understand, evaluate, and participate in decisions made by the DNR.

DNA-based genetic markers will be identified and used to distinguish walleye from the two strains currently stocked by DNR into southern Minnesota lakes. If a superior strain is found, DNR will focus its future stockings on this strain, thereby achieving maximum return to the angler for the stocking effort.

B. Time: The project will require 3 years to complete. The fry stockings will occur in spring 1998. To fully evaluate the impact of the stocking on population structure, the fish should be sampled as young-of-the-year and 1 and 1 1/2-year-old fish. Therefore, field collections will need to be done in September 1998, spring '99, and fall '99. The report will be completed by June 2000.

C. Budget Context:

This project has received no previous support from LCMR. However, key projects providing the background necessary for conducting this research are as follows for the period 1992-1996:

1. LCMR Budget History: $0
2. Non-LCMR Budget History:
   - Success of the Minnesota Walleye Stocking Program--$33,000 (MN DNR)
   - Individual-based Simulation Model for Walleye Management--$29,000 (MN DNR)
   - Assessment of Trends in Genetic Diversity--$70,000 (Sea Grant Program)
   - Walleye DNA Markers - $1,000 (Undergraduate Research Opportunity Program, Univ. of MN)
3. Total: $133,000

	July 1992-June 1997 Prior expenditures on **RELATED** projects	**July 1997-Jun. 2000** Proposed expenditures on this project	**Jul. 2000-June 2001** Anticipated future expenditures on this project
1. LCMR	$0	$245,000	$0
2. Other state	$63,000	$0	$0
3. Non-state cash	$70,000	$20,000	$0
Total	**$133,000**	**$265,000**	**$0**

BUDGET:

Personnel (incl. fringe):	$218,016	
Research associate (100% time, 2.5 yr)		$80,480
Junior scientist (15% time, 2.5 yr)		$15,809
Graduate student assistant (2@50% time, 2 yr)		$86,097
Faculty (3 @ 5% time each, 2 @ 2.5 yr, 1 @ 2 yr)		$35,630
Equipment	$2,400	
Acquisition		
Development		
Supplies	$16,584	
Publication	$2,000	
Travel	$6,000	
Total	**$245,000**	

VII. Cooperation:

Anne R. Kapuscinski--University of Minnesota, Department of Fisheries and Wildlife (5% time for 2 years, $8,646 including fringe benefits)

Yosef Cohen--University of Minnesota, Department of Fisheries and Wildlife (5% time for 2.5 years, $10,912 including fringe benefits)

Paul J. Wingate and Steven Hirsch--MN Department of Natural Resources, Fisheries Section (in-kind contribution by DNR estimated at $67,000, largely field staff conducting lake surveys)

VIII. Location:

Possible lakes to be stocked and surveyed will be in a number of "ecological classification locations" of the state, but primarily in the southern half. A decision on specific sites will be made at a future date in consultation with DNR area supervisors.

IX. Reporting Requirements:

Periodic workprogram progress reports will be submitted not later than January 31, 1998, January 31, 1999, June 30, 1999, January 31, 2000. A final workprogram report and associated products will be submitted by June 30, 2000.