

STUDY PERFORMANCE REPORT

State: Michigan

Project No.: F-81-R-2

Study No.: 681

Title: Development of multi-lake management strategies for Michigan's inland lakes

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

Study Objective: Develop a classification system for management of Michigan's inland lakes by determining how and why fish communities - and their response to management practices - vary among lakes (i.e., intersystem variability), along abiotic (e.g., longitudinal) and biotic (e.g., productivity) gradients, as well as across years (i.e., interannual variability).

Summary: We completed assembly of the historic fish population assessment database and have begun quantifying growth rates of key fish species. Assembly of a GIS database, characterizing lake watersheds, is well underway. Additional research in Michigan lakes has continued to investigate: (1) the effects of chemical control of Eurasian watermilfoil *Myriophyllum spicatum* on recruitment and production of littoral fishes, and (2) the effects of artificial structures on fish populations and impoundments along the Au Sable River. Participation in several Fisheries Division committees continued and provided insight into how the findings of these research projects can be implemented to improve fisheries management in Michigan.

Job 1. Title: Assemble fish population assessment data.

Findings: Data entry of historic growth summaries began during the summer of 2000 and was completed in August 2001. Growth summary records (from the initial targeted data set of 697 lakes) were photocopied from IFR files, entered into an Access 97 database at MSU, and error-checked by a separate individual. Additional proofing of this database is ongoing.

The growth summary database primarily consists of two main tables. The Effort table (master) contains 2823 records of survey effort on 598 of the original 697 targeted lakes for the period 1960-1999. The Growth table (detail) contains 49,740 mean length at age records for all species listed in the growth summary. The variables in the growth table include species, number of fish aged in the sub-sample, age, mean length, and minimum and maximum length. Similar data from the Fish Collection System for years 1994-99 were also summarized and integrated with the historic growth summary database. We have successfully linked the growth summary database to GIS coverages and are able to view the distribution of lakes by species sampled.

Nancy Nate, Ph.D. candidate, completed coursework requirements for the pH, including a course in quantification of fish population dynamics. In addition, Nancy's research study proposal was approved by her graduate committee in January, 2001.

Job 2. Title: Assemble abiotic, biotic, and meteorological data.

Findings: Our progress in this component of the research has received additional support from USGS and MSU-MAES (see Job 8), and is directed by Dr. Pat Soranno, MSU. Our goal is to quantify the spatial attributes of land adjacent to Michigan inland lakes. We are using Jim Breck's (MDNR Fisheries Division) comprehensive digital lake map (vector format) as our lake base map and are coordinating our efforts with him. The majority of the spatial analyses have been done using ESRI's ArcView GIS and/or ArcGIS software packages. To quantify landscape

characteristics around lakes, we created two buffers of different distances - 100 meter and 500 meter. Then, within the buffer areas, we calculated the following characteristics:

100M lake buffer analysis:

- Albert’s Ecoregion
- MIRIS 1978 Land Use/Land Cover
- National Wetlands Inventory

500M lake buffer analysis:

- Bedrock geology
- Albert’s Ecoregion
- STASGO/MLRA Soils
- National Wetlands Inventory
- MIRIS 1978 Land Use/Land Cover

In addition to the above buffer maps, a number of additional data base map layers have been archived for direct/indirect use in the study. Among these data layers* are:

- Bedrock geology (statewide)
- Breck’s lake maps (statewide in Michigan georef and decimal degrees)
- Topographic maps (Rectified Digital Raster Graphics) by county
- Digital Elevation Models (DEM) for every county
- Albert’s Ecoregion in both coverage and shapefile
- MIRIS for the whole state and by county
- National Hydrography Dataset for sections of Michigan (INCOMPLETE) by catalogue #
- National Wetlands Inventory in both coverage and shapefile format
- Quarternary geology (statewide)
- Soils map (statewide – with linkable tables)

* a more detailed list of themes, theme sources and spatial extend are listed below:

Chart 1: Details pertaining to base map data

Layer Name	Spatial Extent	Projection	Original Source	Scale/Resolution	Raster/Vector	Date Created	Arc Format
Albert's Ecoregion	statewide	Michigan Georef	Albert & Denton (UofM)	1:100,000	vector	Updated 1995	shapefile/coverage
Bedrock Geology	statewide	Michigan Georef	Mich DEQ	1:63,000	vector	1987	shapefile
Breck's Lake Theme	statewide	Mich. Geo/ Dec. Deg	Breck/Ivanovich	unknown	vector	spring, 2001	shapefile
DEM	by county (complete)	Decimal Degrees	USGS	30 Meter Res.	raster	september, 1999	coverage (grid)
MIRIS Landuse	state/county	Michigan Georef	Mich DNR	1:24,000	vector	1978-1985	shapefile
NHD	state-partial by cat #	Decimal Degrees	US EPA/ USGS	1:100,000	vector	1999	shapefile/coverage
NWI	state/county (partial)	Michigan Georef	US FWFS	1:24,000	vector	1979-94	shapefile
Quarternary Geology	statewide	Michigan Georef	MI Nat. Feat. Inventory	1:500,000	vector	1998	shapefile
MI TOPO maps	county	Michigan Georef	Mich DNR	1:24,000	raster	1978 TOPO's	8-bit TIFF
MI Soils (STATSGO)	statewide	Albers Conical Equal Area	USDA/NRCS	1:250,000	vector	1994	shapefile w/ tables

Job 3. Title: Determine the extent of interannual and intersystem variability in fish population parameters.

Findings: Analysis of historic growth summaries began during the summer of 2001 and is ongoing. VonBertalanffy growth parameters have been estimated for walleye populations on

approximately 50 lakes. Growth parameters will be estimated for all surveys conducted during 1960-1999 where walleyes, yellow perch, largemouth bass, northern pike, bluegills, or lake trout were collected.

Job 4. Title: Combine historic fisheries data with abiotic and biotic data.

Findings: This analysis will be conducted upon completion of Job 3. In the meantime, Drs. Bremigan and Soranno are attending a class at MSU on hierarchical linear modeling. Skills learned in this class will be an important component of our analysis during the coming year.

Job 5. Title: Conduct research to assess bluegill recruitment.

Findings: Research on bluegill recruitment represents a portion of a larger research project evaluating the indirect effects of selective removal of Eurasian watermilfoil (using the herbicide Sonar®) on largemouth bass and bluegill populations. Two MS graduate students (Ray Valley and Steve Hanson) on this project have successfully completed their degrees. We have begun to publish their findings (see Job 8). In addition, we have presented the findings from our research at scientific meetings, lake associations, and management agencies.

We completed a second successful field season for our project evaluating the effects of structures (half logs and aqua cribs) on fish populations in impoundments of the Au Sable River. I am advising one MS student, Todd Wills, on this project. Our collaborator is Dr. Dan Hayes. Through a combination of snorkeling observations, sampling, and angling, we are comparing fish presence, diet, vulnerability to angling, and nesting success between areas with and without the artificial structures. Because our study impoundments span a range of habitat conditions (in terms of macrophyte abundance, turbidity, etc.), we will be able to evaluate the extent to which the effects of artificial structures depend on "background habitat". In so doing, we hope to distinguish habitat conditions in which artificial structures are an effective management tool from those conditions in which artificial structures provide no tangible benefits. During summer 2001 we evaluated paired sites with and without structures in Alcona, Cooke, Foote, and Loud impoundments.

I also continued to participate in the Lake Michigan Yellow Perch Task Group. Abby Mahan, an undergraduate in my lab, completed an independent research project to evaluate the relationship between larval yellow perch diet and prey availability in Green Bay. Abby presented the results of her project at the International Association of Great Lakes Research and we currently are preparing a manuscript for publication (see Job 8).

Job 6. Title: Participate in assessment and inventory committee.

Findings: I continued to participate in the Resource Inventory and Assessment Committee, served as a member on a job interview committee for Fisheries Division, and presented my teaching, research, and extension efforts to Fisheries Division's Management Team.

Job 7. Title: Expand research into related areas.

Findings:

Proposals:

Bremigan, M.T. and P.A. Soranno. Fisheries Division, MDNR: "Resource Inventory and Assessment in Michigan Lakes: Evaluation and Integration with GIS-Based Landscape Data." Funding denied.

Soranno, P.A. and M.T. Bremigan. United States Geological Survey: "A multiscaled landscape-context model to predict abiotic and biotic lake characteristics." Funded. Duration: 1 year, \$15,000.

Soranno, P.A. and M.T. Bremigan. Michigan Agriculture Experiment Station Research Competitive Grants Program: "Predicting chemical and biological characteristics of lakes using landscape-context features from multiple spatial scales." Funded. Duration: 3 years, \$90,000.

Job 8. Title: Prepare annual reports and publications.

Findings:

Manuscript published

Bremigan, M.T. and R.A. Stein. 2001. Variability in larval gizzard shad recruitment across Ohio reservoirs: exploring causal mechanisms and implications for fisheries management. *Ecological Applications* 11:1425-1437.

Nate, N.A., M.A. Bozek, M.J. Hansen, S.W. Hewett. 2001. Variation of adult walleye abundance in relation to recruitment and limnological variables in northern Wisconsin lakes. *North American Journal of Fisheries Management* 21:441-447.

Manuscripts in press

Garvey, J.E., R.A. Stein, R.A. Wright, and M.T. Bremigan. In press. Largemouth bass recruitment in North America: quantifying underlying ecological mechanisms along environmental gradients. *Proceedings of the Black Bass Symposium 2000*, American Fisheries Society.

Seelbach, P.W., M.J. Wiley, P.A. Soranno and M.T. Bremigan. In press. Predicting characteristics of aquatic ecosystems from landscape-scale information. In K. Gutzwiller, Editor. Concepts and Applications of Landscape Ecology in Biological Conservation. Springer-Verlag, New York, NY.

Valley, R.D. and M.T. Bremigan. In press. Effects of macrophyte bed architecture on largemouth bass foraging: implications of exotic macrophyte invasions. *Transactions of the American Fisheries Society*.

Manuscript in review

Valley, R.D. and M.T. Bremigan. In review. Effects of herbicide control of Eurasian watermilfoil on age-0 largemouth bass piscivory and growth. Submitted to the Journal of Aquatic Plant Management.

Manuscripts in preparation

Nate, N.A., M.A. Bozek, C.W. Ramm, M.J. Hansen, M.T. Bremigan, S.W. Hewett. Predicting walleye presence from physical and biological features of northern Wisconsin lakes. *To be submitted to North American Journal of Fisheries Management in October, 2001.*

Bremigan, M.T., P.A. Soranno, K.S. Cheruvilil, S.M. Hanson, K.L. Rogers, R.D. Valley, and J.D. Madsen. Effects of selective removal of Eurasian watermilfoil on littoral and pelagic food webs: implications for aquatic plant management. *To be submitted to Fisheries in December, 2001.*

Soranno, P.A., M.T. Bremigan, K.S. Cheruvilil, S.M. Hanson, K.L. Rogers, R.D. Valley, and J.D. Madsen. Effects of the exotic macrophyte, *Myriophyllum spicatum*, on littoral and pelagic zone foodwebs: results from whole-lake macrophyte manipulations. *To be submitted to Ecological Applications in December, 2001.*

Mahan, A.L., M.T. Bremigan, and J.M. Dettmers. Taxonomic and size selection of zooplankton by larval yellow perch in Green Bay, Lake Michigan: implications for recruitment success. *To be submitted to Journal of Great Lakes Research in February 2002.*

Hanson, S.M., M.T. Bremigan, and D.B. Hayes. Evaluating the indirect effects of chemical control of Eurasian watermilfoil on largemouth bass diet and growth. *To be submitted to North American Journal of Fisheries Management in March 2002.*

Bremigan, M.T., R.A. Stein, J.E. Garvey, R.A. Wright, D. Bunnell, and K. Arend. Variability in gizzard shad recruitment and subsequent effects on sportfish recruitment in reservoir ecosystems. *To be submitted to Ecological Applications in June, 2002.*

Poster

Mahan, A.L., M.T. Bremigan, and J.M. Dettmers. 2000. Interactions between larval yellow perch and zooplankton in Green Bay, Wisconsin. Poster presentation at the annual Midwest Fisheries and Wildlife Conference, Minneapolis, MN.

Presentations

Bremigan, M.T. 2000. Variable gizzard shad recruitment and its effects on sportfish recruitment: multi-system management along a productivity gradient. Invited presentation to the annual Larval Fish Conference, Gulf Shores, AL.

Bremigan, M.T. 2000. When do gizzard shad rule the world?: Variability in recruitment and subsequent effects of a highly influential species in reservoir ecosystems. Invited presentation to the Department of Zoology, Southern Illinois University, Carbondale, IL.

- Bremigan, M.T. and P.A. Soranno. 2001. Integrating fisheries and limnological perspectives to evaluate indirect effects of Sonar herbicide control of Eurasian watermilfoil on Michigan lakes. Invited presentation to the Michigan chapter of the American Fisheries Society, Higgins Lake, MI.
- Mahan, A.L., M.T. Bremigan, and J.M. Dettmers. 2001. Interactions between larval yellow perch and zooplankton in Green Bay, Lake Michigan. International Association for Great Lakes Research, Green Bay, WI.
- Bremigan, M.T., P.A. Soranno, K.S. Cheruvellil, S.M. Hanson, K.L. Rogers, R.D. Valley, and J.D. Madsen. 2001. Control of Eurasian watermilfoil using Sonar herbicide: effects on littoral and pelagic zone foodwebs. Aquatic Plant Management Society, Minneapolis, MN.
- Soranno, P.A., M.T. Bremigan, K.S. Cheruvellil, S.M. Hanson, K.L. Rogers, R.D. Valley, and J.D. Madsen. The importance of macrophyte cover in lakes to littoral and pelagic foodwebs. Ecological Society of America, Madison, WI.

Prepared by: Mary Bremigan

Date: September 30, 2001