STUDY PERFORMANCE REPORT

State: Michigan

Project No.: F-81-R-8

Study No.: 230741

Title: Towards comprehensive databases and coordinated surveys for ecosystem management in the Great Lakes

Period Covered: October 1, 2006 to September 30, 2007

Study Objective: A first objective is to compile, integrate, and evaluate Lake Huron fish/habitat data sources to undertake the articulation of coordinated monitoring programs that provide necessary information for Great Lakes fish community studies. A second objective is to enhance the use of data available and quantify changes in fish community structure in their relation with to stressors such as invasive species, nutrient fluctuations, and key environmental conditions. A third objective is to evaluate coherence and connectivity between fish communities in Saginaw Bay and Lake Huron main basin.

Summary: During this third study period, data from the Lake Huron forage fish survey were used to derive abundance indices for alewife, rainbow smelt, bloater and lake trout age one and older and for the fraction of the population caught by the trawl for spottail shiner, trout perch, burbot, lake whitefish, deepwater sculpin, slimy sculpin, ninespine stickleback, and Johnny darter. We compared indices derived from the MDNR Saginaw Bay fall gill-net and trawl surveys, and Lake Huron MDNR gill-net lake trout spring and USGS trawl forage fish surveys. Based on these comparisons and results obtained through the analysis of data from individual surveys we evaluated several characteristics of the surveys including survey design.

Findings: This annual report presents results of Jobs 6, 7, 8, 9, and 10 scheduled for 2006-07. Partial results on USGS forage fish surveys are presented in a paper written in collaboration with S. Riley, and J. Adam on development of fishing power corrections for 12 and 21 m trawls used in the USGS Lake Huron fall trawl survey and submitted to the Great Lakes Fishery Commission for publication in a Technical Report.

Job 6. Title: Compare results from analysis of separate surveys.–Comparison includes results from analysis of Saginaw Bay fall gill-net and trawl surveys and Lake Huron gill-net lake trout spring and trawl fall forage fish surveys (Table 1). Data from fishery dependent surveys, namely from Lake Huron creel and charter boat databases, were not included in the analysis as there were difficulties beyond expectations that restricted their use for abundance estimation. These issues were reported in previous annual reports and relate to defining effective effort for individual species, complicated by changes in target definitions and management regulations.

Population trends for selected species from data collected in gill-net and trawl surveys in Saginaw Bay (Table 1) are not directly comparable because gears from the surveys selected different segments of the fish populations represented in the catch. For yellow perch, gill nets caught fish of ages 2 to 4 while the trawl caught younger fish, mostly age 1. Thus, comparison between surveys should be age specific. With estimation of yellow perch indices by age from the trawl survey being not practical, the most likely comparison of the trawl indices was with indices from the gill-net survey for ages 1 and 2. There are common trends from these indices, with similar fluctuations including a sharp decrease from 1989 to 1990 and lowest levels in 1994. The difference is that indices from the trawl catch do not show a decrease indicated by the gill-net catch in 1991. For walleye, the gill-net survey caught fish age 1 and older and the trawl catch was dominated by fish up to age 3, including young of the year. Indices from the trawl survey, not estimated by age, showed fluctuations similar to gill-net indices for ages 1 and 2 with peaks in 1991 and 1998; but gill-net indices showed higher peaks in 1990-91 than in later years which were not observed in the trawl. For white perch, smaller fish were generally caught in the trawl than in the gill-net survey. Indices from both surveys showed no particular trends and lowest levels did not occur in the same years or at similar period intervals.

Based on the comparison between Saginaw Bay surveys, it is likely that yellow perch data from the gill-net survey were not always reliable to estimate indices of abundance as they seamed influenced by changes in water clarity, either affecting fish gill-net avoidance or fish distribution. One reason to suspect the data is that indices for each age class were high in 1990 and decreased simultaneously in 1991 and 1992, and it is unlikely that fish abundance fluctuated in that way. These fluctuations follow closely Secchi disk depth, measured during the MDNR Saginaw Bay trawl survey, showing lowest levels of 0.6 m in 1990 and an increase to 1.2 m in 1991 and 1992. A further reason to suspect changes in catchability is that we found no coherent patterns of yellow perch cohorts declining through time. Walleye data from the gill-net survey were less susceptible to changes in water clarity than those for yellow perch as the indices do not show a decrease in 1991. These data are probably more reliable for estimating annual indices and the consistent decline shown by the analysis can be considered as a decreasing trend in abundance. The different effect of the change in water clarity on gill-net walleye catches than for yellow perch can be explained by differences in the species behaviors since walleye are active at night while yellow perch are active during the day. There are other issues with the gill-net walleye data that could be of consequence to abundance indices. First, indices for ages 1 to 6 were high in 1990 which is suspect. However, walleye are migratory fish and there are numerous mechanisms that could explain high catch rates during that year. Second, walleye catch shows decreasing trends at depths greater than 20 m, including station 4 in the inner bay. The distribution of the fish in the water column might limit catchability in gill nets to the fraction of the population susceptible near the bottom, where the gear was set. Thus, caution is required in accounting for spatial effects of depth on walleye catchability when interpreting data from gill-net surveys.

Indices from data collected in more than one survey in the main basin of Lake Huron and also in Saginaw Bay were developed for several species (Table 1). For alewife and smelt, data were available from the Saginaw Bay trawl and both surveys in Lake Huron. Based on the Saginaw Bay trawl survey, alewife levels increased after 1990. Based on both surveys from Lake Huron alewife levels decreased in later years but at different times: after 1994 based on the gill-net lake trout survey and after 1996 based on the trawl forage fish survey. Coincidentally, indices for smelt also showed discrepancies between the two areas. Based on main basin surveys, levels decreased: after 1975 in the gill-net lake trout survey and 1995 in the trawl forage fish survey while levels fluctuated without clear trend based on the Saginaw Bay trawl survey. The differences among timing in declines for both species can be expected as the size composition in the gill-net catch, for example, were mostly larger than fish caught by the trawl. Differences in trends between Saginaw Bay and the main basin open hypothesis related to population dynamics and forces regulating the population fractions in the two areas.

Data for estimating yellow perch indices were available from both Saginaw Bay surveys and the lake trout gill-net survey in Lake Huron. Indices based on the gill-net surveys (Saginaw Bay excluding the fine mesh net) steadily decreased while indices from the trawl recovered after 1994. Differences indicate that declines in the adult fraction of the population were somehow independent of levels of recruitment.

Data for estimating indices for lake trout, burbot, and lake whitefish were available from the surveys in Lake Huron main basin (Table 1). Lake trout indices from the Lake trout gill-net and the forage fish trawl surveys showed a decreasing tendency in southern Lake Huron and a recovery around 2000 in the north. Since lake trout are mostly of hatchery origin, a difference in trends reflects stocking levels and biological differences. Burbot indices showed increases up to the 1980s and decreases after the 1990s in both surveys. Indices for lake whitefish showed an increase up to the early 1990s and a decrease after 1995 in both surveys.

Job 7. Title: <u>Integrate results into maps of distribution of populations analyzed.</u>–The results of analysis of Saginaw Bay surveys indicated higher catch rates between inner and outer bay areas but minor spatial patterns in catch rates within the two areas. Those differences seem to reflect effects of bathymetry on gear catchability rather than in distribution of fish. Thus, maps were not developed for Saginaw Bay species selected for the analysis. Further, the spatial resolution of the Lake Huron surveys was too coarse and not amenable to producing maps of distributions for selected species. Ranges of depth distribution for each species selected for the analysis from Lake Huron surveys were produced instead.

Job 8. Title: <u>Evaluate survey designs.</u>–Analysis of data from the Saginaw Bay fall gill-net surveys showed similar catch rate levels within the inner and the outer bay areas for most species analyzed. This result has implications for optimizing survey design as well as for interpreting the data from the complete time series. This result indicates that the number of stations in the current survey (as of 2002) is larger than necessary to develop annual indices and can be reduced in the future without consequences for stock assessments. This is an aspect to consider when faced with reduced budgets. For interpretation of the data, the implication is that the reduced number of stations during the first years of the survey should not be of consequences to generate model-based annual indices for fish populations. Population annual trends based on straight means, nevertheless, can be affected by the variation in the number of stations as different proportions of data originated from inner and outer bay stations.

A combination of survey design and gear selectivity aspects from the Saginaw Bay gill-net survey can affect reliability of indices estimated from the catch data. An aspect that requires attention is the distribution of fish in shallow areas not covered by the standard stations which can be relevant to interpret data from the survey. Additional sets were made near shore to investigate this aspect in 1995 and 1996, but did not provide adequate data. It is still necessary to carry out a fishing experiment with similar gear at different depths. The gear catchability seems influenced by depth at which gill nets are set as well as by water clarity. The survey provided data to estimate reliable annual indices from the complete time series available for the adult fraction of the walleye population in the bay during fall and less consistent data for yellow perch estimates. The survey provided data to estimate indices for drum, white sucker, catfish, shad and white perch, but levels for most species were lowest at the deepest outer bay sites (stations 8, 9 and 10) suggesting that catch rates need to be interpreted with care. Fishing experiments to investigate factors affecting gear catchability in Saginaw Bay would improve the value of the data provided by the survey. A further aspect affecting the data quality from the survey is the protocols used to process the catch before 1995. This affected data for all species except walleye and restricted the use of the data to obtain age specific indices. The main obstacle to obtain age specific indices was that fish in the targeted catch and bycatch were processed differently. Since fish in the bycatch, which were not aged, were measured to the nearest inch rather than to the nearest millimeter, the conversion to age from length is imprecise. Further, the size (and age) structure of the bycatch was different than that in the targeted catch which precluded developing age-length keys from a large fraction the fish caught. One modification to the gear in the Saginaw Bay survey that has affected the data quality is the addition the 38.1 mm mesh net to the survey in 1993. Although the modification was meant to improve the information obtained through the survey, the value of the addition might be limited. When indices are estimated from the whole species catch, irrespective of ages, trends are less informative as most of the catch obtained in the added panel consists of small fish and the combined catch represents a mix of adults and juveniles. Recording data by panel allows making choices in types of analysis for years after 1993 and indices reported from the survey by MDNR are calculated both excluding and including the additional panel. Reporting an index from the smaller mesh panel would be very valuable.

The Saginaw Bay fall trawl survey provided data to estimate reliable indices for the fraction of the species populations caught by the gear, mostly young fish. One issue in deriving abundance indices from the trawl survey relates to the potential effect of fishing depth. For all species except white perch, General Linear Model (GLM) levels were highest in quadrant IV, where average depth is highest. For example, catch rates for walleye increased with depth up to 20 m. It is unclear if this trend reflects fish distribution, and this aspect should be further investigated as it could introduce bias in population estimates if the survey covers different depths by year and depth is not accounted for in estimating indices. Our estimates accounted for fishing depth with the introduction of quadrant as a factor in the models. An issue related with the implementation of the survey is the complexity of the protocols to process the catch before 1995. These procedures hampered reconstructing the size/age composition of the catch by tow and generating age/size specific indices for the time series. Quality of the data generated from the surveys benefited from simplifying some procedures after 1994. Another aspect that needs to be addressed beyond the accomplishments of this study is the data storage. The structure of the data currently available is unsystematic and does not provide easy access to the information. We devoted significant amount of time assembling the data to perform our data evaluation but the situation persists. The value and accessibility of the data for researchers would greatly benefit from reorganization by a database manager. Investing in a relational MDNR database is a key for future studies in Saginaw Bay.

The Lake Huron gill-net lake trout survey provided reliable data for evaluating long-term size/age specific population trends for lake trout. For other species necessary length information was only available since 1996. Nevertheless, a general difficulty that needs to be addressed when estimating indices based on data from this survey is the effect of the change in location of stations during the time series. An evaluation of the consequences in changing sampling distribution among years was not practical from the data available because few stations were sampled in a given year. We used subsets of the data as considered appropriate for particular analysis but other options can be explored depending of the issues that might be under investigation. Another shortcoming of the data provided by the survey is the change of the gill-net length in 1997 because the depth at which the nets were set differed and that can affect estimated annual trends. Our GLM indices were estimated accounting for depth. To avoid bias in indices estimated from the gill-net survey, the catch data should be recorded by panel and the depth at which the panels are set should be made available. An analysis to determine the best number and location of the stations will depend on the objectives of the survey and will require one year of extensive coverage to compare catch rates of species of interest along the Lake Huron east coast.

The trawl fall forage survey provided reliable data to estimate indices for the time period covered by the survey. The change in gear from a 12 m to a 21 m trawl should not present a problem to making use of the full time series. In this analysis, indices were developed taking into account the gear change. These indices are reliable and represent population trends in US waters of Lake Huron. Another survey issue, besides the change in gear, which has been of concern when using data collected by the survey is, that the survey did not cover all stations during early years (1973 to 1976). This analysis showed that patterns in distribution among stations remained similar in time and incomplete sampling should not prevent the use of the complete survey time series to investigate population trends. Data from those early years can be used to develop abundance indices when incorporated into models that account for location of the samples as in the GLM used in this study. Despite value of data generated by the trawl fall forage survey, a serious shortcoming of the survey design is that it has fixed stations stratified by depth at each port with only one tow conducted per strata. The lack of repeated sampling precludes estimation of catch rate variability among tows. Conducting a fishing experiment with random stations to provide adequate data to complement the standard survey is recommended. An issue indirectly related to the survey design is the potential problem of accounting for the depth effect in catch rates. Currently catch rates are corrected by a unique factor for all species depending on fishing depth to account for time of the gear on bottom. This factor should be revised. This is not a direct conclusion from this study but results indicate that populations sampled by the gear, and age groups within populations, are distributed differently within the water column. Thus, it is expected that because of these differences, catch rates will be affected differently by the gear response to fishing depth. The fixed design stratified by depth does not allow estimating the effect of depth on towing time independent of factors affecting fish distribution.

An issue that became evident when analyzing data from all surveys is that age information for species other than the survey targets, or even for targets, was not available or not reliable or numbers of aged fish were low. Age data are essential to understand fish population dynamics and do not need to be collected by every survey when surveys are conducted in the same general areas. Coordinating those activities could significantly improve the value of the information generated by Lake Huron surveys.

In summary, data evaluated from Lake Huron surveys can be used to estimate trends in fish populations in Lake Huron and provide a basis to investigating responses to environmental and biological stresses since the 1970s. These data extend through periods of fluctuating nutrient levels in the lake, numerous invasions of exotic species such as the zebra mussels, and variation in stocking levels of introduced and native species. These data can be analyzed to advance our understanding of the Lake Huron ecosystem and also to address specific questions about survey design to optimize and improve the value of future surveys in the lake. Although keeping consistency of ongoing surveys is vital to assess population trends, alteration of the species composition and community structure might require design modifications. Making appropriate adjustments to monitoring efforts requires deep understanding of a wide range of aspects ranging from population distributions to individual fish behavior and interaction with sampling gear. Data available can certainly guide future directions. Finally, a centralized, well-documented, and managed database for MDNR surveys is essential.

Job 9. Title: Write research manuscripts.–A paper on comparison of gear fishing power between trawl gears used in the Lake Huron forage fish trawl surveys was prepared in collaboration with USGS-GLSC researchers and submitted for publication to the Great Lakes Fishery Commission. A draft on population trends based on the Lake Huron Fall Forage Fish Trawl survey in collaboration with S. Riley from the USGS-GLSC is in preparation.

Job 10. Title: Write progress report.–This progress report has been prepared.

Prepared by: Sara Adlerstein
Date: September 30, 2007

Table 1.–Species found in more than one of the surveys for which abundance indices were estimated in the study.

Species		code	Saginaw gill net	Saginaw trawl	Trout gill net	Huron trawl
Yellow perch	*Perca flavescens*	801	X	X	X	
Walleye	*Sander canadense*	803	X	X		
White sucker	*Catostomus commersonii*	405	X			
Channel catfish	*Ictalurus punctatus*	119	X			
Freshwater drum	*Aplodinotus grunniens*	134	X			
White perch	*Morone americanus*	132	X			
Gizzard shad	*Dorosoma cepedianum*	108	X			
Spottail shiner	*Notropis hudsonius*	508				X
Trout perch	*Percopsis omiscomaycus*	131				X
Alewife	*Alosa pseudoharengus*	106			X	X
Rainbow smelt	*Osmerus mordax*	109			X	X
Lake trout	*Salvelinus namaycush*	307			X	X
Burbot	*Lota lota*	127			X	X
Lake whitefish	*Coregonus clupeaformis*	203			X	X
Round whitefish	*Prosopium cylindraceum*	212				
Bloater	*Coregonus hoyi*	204				X
Deepwater sculpin	*Myoxocephalus thompsoni*	904				X
Slimy sculpin	*Cottus cognatus*	902				X
Ninespine stickleback	*Pungitius pungitius*	130				X
Johnny darter	*Etheostoma nigrum*	706				X