STUDY PERFORMANCE REPORT

State: Michigan **Project No.:** F-81-R-16

Study No.: 230436 **Title:** Vital statistics of Walleyes *Zander vitreus* in Saginaw Bay

Period Covered: October 1, 2014 to September 30, 2015

Study Objective: The objectives of this study are: (1) to estimate total annual mortality and the corresponding instantaneous (per capita) rates of total mortality and recreational fishing mortality; (2) to annually estimate the Walleye recreational exploitation rate; (3) to annually estimate the total abundance of the Saginaw Bay stock of Walleye; and (4) to regularly monitor Walleye movement beyond the boundaries of Saginaw Bay.

Summary: A total of 3,300 Walleyes were tagged and released across four Saginaw Bay tributaries in April 2015. This year's tagging effort represented the second year where Walleyes were tagged in tributaries other than the Tittabawassee River to gain a better representation of fish behavior and improve estimation of Walleye population metrics in Saginaw Bay. A total of 750 tags spanning 15 different tagging years were returned in 2014. Greater return rates were observed from the new tagging sites compared to the original Tittabawassee River tagging site, which may trace back to sex and size differences of the fish tagged. Analysis of tag return data was conducted using the AD Model Builder version of the Brownie Model which adjusts for tag loss. The analysis was run two ways in order to compare the effect of the additional of tagging locations (besides the Tittabawassee River) on estimation of population metrics; first using tag returns from the Tittabawassee River site (representative of the original study design) and second using tag returns from all sites. Based on the analysis for the original Tittabawassee River tag returns, total annual mortality (A) was estimated to be 0.2646 for 2013 (the most recent year that can be estimated from this analysis) and exploitation rate to be 0.2367 in 2014 fishing year (April 2014 to April 2015). Mortality was estimated to be greater for the analysis including the new tagging sites.

Findings: Jobs 1, 2, 3, and 6 were scheduled for 2014-15, and progress is reported below.

Job 1. Apply Tags.–A total of 3,300 Walleyes were tagged and released during the annual tagging operation in April 2015. This year's tagging effort represented the second year Walleyes were tagged in tributaries other than the Tittabawassee River to gain a better representation of fish behavior and improved Walleye population metrics in Saginaw Bay. Tagging totals across all sites were: Tittabawassee River (1,625); Au Gres River (181); Kawkawlin River (725); and Shiawassee River (469). Three hundred tags (10% of the total number of tags applied throughout all Saginaw Bay tributaries) included a $100 reward so a reporting noncompliance (nonreporting) rate could be calculated. Most Walleyes (71%) tagged in 2015 were male.

Job 2. Manage and maintain databases.–This was the first year of use for the newly revised web reporting form and tag return database that includes various improvements such as tagging site name and data entry verification. A total of 750 tags spanning 15 different tagging years were returned in 2014 fishing year, and 57 reward tags were paid out. Letters of appreciation were mailed out to all anglers who reported tags. The reward payment disbursement system was overhauled in 2015 to better comply with Michigan Department of Treasury financial practices.

Job 3. <u>Analyze data and run models.</u>–Tag returns for the 2014 fishing year varied considerably by tagging location (Table 1). The original Tittabawassee River tagging site had the second-lowest rate of first-year tag returns for both reward and nonreward tags compared to the other tagging locations. Using reward tags to compensate for nonreporting indicated that the difference in first year reporting (which is used to estimate the exploitation rate) differed by as much as 14% across sites. This suggests that exploitation rate varies by spawning run within Saginaw Bay, with an alternative explanation that anglers who frequent the new tagging sites may be reporting tags at a higher rate because of their novel occurrence. However, the majority of tag returns came from the mixed Saginaw Bay fishery where tagging site is unknown to the reporting angler. It is also possible that the differences in exploitation trace back to size or sex differences of the tagged fish; for example the tagged lot of Walleyes in the Tittabawassee River had a greater proportion of females than males relative to the other locations and in some fisheries, smaller males will sometime be more vulnerable to harvest than larger females. Additional analysis is planned to isolate the relative effects of tagging site, size, and sex of fish on return rates.

Tag return analysis completed during 2015 for the 2014 fishing year made use of the AD Model Builder (Fournier et al. 2012) model variant that includes the effects of tag shedding (Fielder 2014). This model version is predicated on the Brownie et al. (1985) Model 1 for year-specific survival and recovery rates. The analysis was run two ways in order to compare the effect of the additional tagging locations (besides the Tittabawassee River) on estimation of population metrics; first using tag returns from the Tittabawassee River site (representative of the original study design) and second using tag returns from all sites. Generally the metrics limited to the Tittabawassee River Walleye source reflected greater survival and lower mortality and exploitation rates (Table 2).

An important analytical note is that model estimation was forced to make use of the curve-estimated nonreporting values discussed by Fielder (2014) instead of the actual empirical values derived from tag returns in 2014. The actual rates observed were lower than the curve-derived method and using them caused estimation problems in the model because there were no year-specific values of nonreporting available for recent years prior to 2014. The higher curve-estimated values caused the model fitting issues when abrupt changes were attempted to estimate nonreporting rates; more years of data will be necessary before empirical nonreporting rates can be fully incorporated into the model data. It is also noteworthy that substantially higher tag reporting rates were observed for an unrelated Walleye telemetry study in 2011 and 2012 (mean adjustment factor of 3.12 versus 1.38 for the empirical observations in 2014). Although for different years, it suggests that noncompliance may be a function of more than just nonreporting (failing to report a tag on the caught fish after the tag is examined) and may also include nonobservance (where the tag is either not noticed, or the angler chooses not to remove and examine the tag, and doesn't realize that it includes a $100 reward). The difference between the curve-estimated and empirical nonreporting data suggests that nonobservance may be substantial. Noncompliance issues continue to vex this and most tag-based studies and will require further analytical consideration.

No analysis of Walleye movement or population estimates was conducted or generated in this reporting cycle. Movement and population estimates will be summarized in the final report.

Job 6. Title: <u>Write annual performance report.</u>–This annual performance report was written.

Literature cited:

Brownie, C., D. R. Anderson, K. P. Burnham, and D. S. Robson. 1985. Statistical inference from band recovery data – a handbook (2nd edition). U. S. Department of the Interior, Fish and Wildlife Service, Resource Publication No. 156, Washington, D.C.

Fielder, D. G. 2014. Mortality, Exploitation, Movement, and Stock Size of Saginaw Bay Walleyes, 1981-2011; 31 years of tag return analysis. Michigan Department of Natural Resources, Fisheries Report 04, Lansing.

Fournier, D. A., H. J. Skaug, J. Ancheta, J. Ianelli, A. Magnusson, M. N. Maunder, A. Nielsen, and J. Sibert. 2012. AD Model Builder: using automatic differentiation for statistical inference of highly parameterized complex nonlinear models. Optimization Methods and Software 27:233-249.

Prepared by: David Fielder
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Table 1.–Walleyes tagged and reported (returns) by site and reward status for Saginaw Bay in the 2014 fishing year (April 2014 to April 2015).

Site (River)	Total number tagged	Number of nonreward tags	Number of first year nonreward tag returns	First year nonreward tag return rate (%)	Number of reward tags	Number of first year reward tag returns	First year reward tag return rate (%)
Tittabawassee	1,000	900	78	8.7	100	12	12.0
Au Gres	300	300	16	5.3	0	–	–
Kawkawlin	700	600	69	11.5	100	19	19.0
Shiawassee	1,000	900	112	12.4	100	26	26.0
Total	3,000	2,700	275	10.2	300	57	19.0

Table 2.–Model-estimated Saginaw Bay Walleye population metrics based on analysis for tag returns restricted to only those released at the Tittabawassee River and tag returns pooled across all tagging sites in 2014. Analysis is limited to the 2014 fishing year (April 2014 – April 2015); all metrics except exploitation cannot be estimated for the 2014 fishing year and instead reflect 2013, the most recent year estimable.

Population metric	Tittabawassee River	All tagging sites combined
Survival (S)	0.7354	0.5183
Total annual mortality (A)	0.2646	0.4817
Exploitation rate	0.2367	0.3358
Instantaneous total mortality (Z)	0.3074	0.6572
Instantaneous recreational fishing mortality (F)	0.2051	0.2409
Instantaneous natural mortality (M)	0.1023	0.4163

Vital Statistics of Walleye in Saginaw Bay

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Background

A fishery stock assessment is a tool that fisheries managers and researchers use to describe the characteristics of a fish population (also known as a fish stock). The "vital statistics" of a fish stock, such as the total number of fish present, mortality rates (how many fish die each year due to fishing or natural causes), and exploitation rate (the proportion of fish that are removed from the population each year by fishing) are critical components of any fish stock assessment. Since 1981, this project has been Fisheries Division's primary stock assessment for Walleye in Saginaw Bay, and by extension, all of the Michigan waters of Lake Huron.

As part of this project, the Southern Lake Huron Management Unit fisheries staff uses electrofishing to collect Walleye from the annual spawning run in the Tittabawassee River. The Walleyes are momentarily stunned with electricity from a boat-mounted generator, captured, tagged, and released alive. The collection effort is also used for Walleye egg collection when the eggs are needed for hatchery production and to obtain other tissue samples for genetics or disease testing. Each year about 3,000 metal jaw tags are affixed to Walleye (Photos 1 and 2). Anglers who catch tagged fish are encouraged to report their catch, including tag number, fish length, and when and where the fish was captured, to Fisheries Division online (http://www.michigan.gov/taggedfish) or by mail. In return, the angler is provided a letter of appreciation and details about when and where their fish was tagged. The annual returns over time are used in analyses that provide estimates of vital statistics including mortality, survival, exploitation rate, and population size.

Photo 1. Jaw tagging Walleye.

Photo 2. Walleye with jaw tag.

Recent work by the MDNR exposed some limitations of the tag return analysis, which lead to the development of an alternative population analysis tool, known as a statistical catch-at-age model, for the Saginaw Bay Walleye stock. The limitations of the tagging analysis were addressed by improvements to this project, which include a greater number of annual tagging locations around Saginaw Bay than just the Tittabawassee River and the inclusion of $100 reward tags that allow the MDNR to account for anglers who don't report the tagged fish that they catch. In the future, it may be possible to merge the tag return analysis and statistical catch-at-age model into a stock assessment that is superior

to its predecessors. If not, there is value to continuing the measurement of Walleye vital statistics using both techniques.

What are some of the key current results?

Returns of jaw tags in 2015, reported by anglers, revealed tag returns between the different tagging sites around the bay differed by as much as 14%. Differences in exploitation (harvest) rate within a single fishery like Saginaw Bay may be caused by age and sex differences of the fish tagged in each spawning run, or by angler behavior with more fishing taking place in some locations. Additional years of data should help reveal what is driving this difference. Tags that included a $100 reward were reported 38% more than nonreward tags providing biologists with a valuable correction factor for nonreporting. Annual survival was 52% in 2014 (the most recent year that can be estimated by this method) meaning that on average, 52% of the walleye in the population will survive to the following year. Most of the losses are made up for by annual reproduction, entering or "recruiting" to the population as juveniles.

Where can I find detailed results?

A Fisheries Division report that summarizes the 30-year history of this project was recently written and is in the process of being published. This report will be available on Fisheries Division's website when it is complete. Additional information can be found at http://www.michigan.gov/dnr/0,4570,7-153-10364_52259_19056-333302--,00.html.

What does this project do for fisheries managers and anglers?

The information generated by this project is critical for fisheries managers to understand the Saginaw Bay Walleye population, make informed decisions about this key fishery, and to ensure sustainability of the Saginaw Bay Walleye population. Fisheries managers use the information from this project to set fishing regulations, such as minimum length limits and daily bag limits, which specify the size and number of fish that an angler can harvest in one day. Walleye regulations for Michigan's waters of Saginaw Bay and other areas of Lake Huron can be found along with the rules for other species by clicking "Rules & Regs" on the MDNR Fisheries Division website at http://www.michigan.gov/fishing.