STUDY PERFORMANCE REPORT

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

Study No.: 230486 **Title:** Assessment of Lake Trout populations in Michigan's waters of Lake Michigan.

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

Study Objectives: (1) To determine the relative abundance, length and age composition, and Sea Lamprey wounding and mortality rates for Lake Trout in Lake Michigan using existing data from state, federal, commercial, sport, university, and private sources; (2) To conduct assessment netting to update biological data; (3) To determine the total allowable catch (TAC) of Lake Trout from management units within 1836 treaty waters; (4) To assess egg deposition on index spawning sites in Lake Michigan; and (5) To evaluate extant or naturally reproducing populations of Lake Trout within the Lake Michigan basin.

Summary: During the 2015 field season, Lake Trout sampling efforts focused on assessments of populations in eastern Lake Michigan from May to June. In total 1,504 Lake Trout were captured during the 2015 field season. Aging and bio-data entry remain to be completed. Mixed-model analyses for 2010-14 indicate that relative abundance estimates are lowest in the north. Summaries of mortality rates and other information gained from assessments through 2014 are summarized in reports created to meet requirements of the 2000 Consent Decree. Numbers of deposited Lake Trout eggs remain low and predator densities were slightly higher at sites in Little Traverse Bay and Elk Rapids when compared to the previous year.

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

Job 1. Survey design and coordination. Lake Trout population assessments in 2015 were conducted as following multi-agency lake-wide assessment protocols (Schneeberger et al. 1998). Coordination occurred through the Lake Michigan Technical Committee Lake Trout Working Group and through the Modeling Subcommittee (2000 Consent Decree).

Lake Trout egg deposition rates and the abundance of interstitial predators were measured at four sites in northern Lake Michigan. Standardized egg bags (N = 30) were buried at each site in September and recovered in mid-November. The survey design for this work is based on previously published research evaluations (Jonas et al. 2005).

We continued to assess the population of Lake Trout in Elk Lake. We reduced the level of gillnetting effort used to capture and mark live Lake Trout in the fall of 2014. Returns of marked fish will aid in the estimation of population size and individual growth rates.

In collaboration with Central Michigan University, we initiated an acoustic telemetry study in the fall of 2014 to track movements and spawning behaviors of Lake Trout in Elk Lake.

Job 2. Conduct surveys and process samples.–We conducted bottom gill-net surveys from May to June 2015. Nets were set at four depth strata near each of eight ports; a total of 1,504 Lake Trout were captured (Table 1).

In 2014, egg bags were recovered from the four sites in northern Lake Michigan. We counted all Lake Trout, Cisco and Lake Whitefish eggs, and recorded the number observed in each bag. Lake

Trout eggs were placed in incubation trays and embryos preserved for potential genetic analysis. For each bag, we counted, weighed, and measured all egg predators (crayfish and fish).

In 2014, we marked an additional 36 Lake Trout in Elk Lake. In collaboration with Central Michigan University, a Master's thesis project on movement patterns and spawning behaviors of Lake Trout in Elk Lake began in fall 2014. The study utilizes acoustic telemetry to track individuals, increasing our understanding of thermal and depth preferences.

Job 3. Manage data and maintain database.–A relational database has been developed and refined for storing and managing vessel survey data. Catch data from the 2015 surveys have been entered into the standard database. Aging and diet samples remain to be processed; when available, this information will be entered into the database.

Records from egg bag evaluations, as well as marking and tagging information from Elk Lake surveys, are archived in a relational database kept on the server at the Charlevoix Fisheries Research Station. Images for aging and morphometric analyses were kept on portable hard-drives.

Job 4. Analyze data, modeling.–From 2010 through 2014, Lake Trout relative abundance estimates have been lower from the northern regions of Lake Michigan compared to more southern regions and Grand Traverse Bay (Table 2). We provide a more thorough discussion of mortality rates and other aspects of Lake Trout populations in modeled regions (MM-1/2/3, MM-4, MM-5, and MM-6/7; Figure 1) in summary reports submitted as part of the 2000 Consent Decree process (see Job 6).

Statistical catch-at-age models have been developed for Lake Trout populations in 1836 treaty-ceded waters (MM-1/2/3, MM-4, MM-5, and MM-6/7) and have been used to estimate 2015 TAC's using data collected through 2014. The 2015 TAC report sections are written and submitted to the Modeling Subcommittee (MSC) chairs for inclusion in the final report. Additionally, in collaboration with field biologists and the Michigan DNR Tribal Coordination Unit, I developed models and provided technical advice on the influence of size and harvest limits on Lake Trout populations in Michigan waters of Lake Michigan.

Annually, we summarize the information on Lake Trout egg deposition and interstitial predator densities in time series (Tables 3 and 4) describing northern Lake Michigan spawning locations. We provide the summaries to the Grand Traverse and Little Traverse Bay tribal representatives who collaborate on the project and to the Lake Michigan Technical Committee Lake Trout Working Group representative for inclusion in the annual report.

Summaries of information collected from Elk Lake are available upon request and will be included in a Master's thesis conducted through Central Michigan University.

Job 5. Write annual performance report.–This annual progress report was produced as scheduled. In addition, a project summary was completed (Attachment 1).

Job 6. Write manuscripts and reports.–Sections have been provided for the following 2015 report covering court-mandated settlement (2000 Consent Decree) responsibilities:

Modeling Subcommittee, Technical Fisheries Committee. 2015. Technical Fisheries Committee Administrative Report 2015: Status of Lake Trout and Lake Whitefish Populations in the 1836 Treaty-Ceded Waters of Lakes Superior, Huron and Michigan, with Recommended Yield and Effort Levels for 2015. Available: http://www.michigan.gov/greatlakesconsentdecree (September 2015).

Summaries of egg deposition are included in the annual Lake Michigan Lake Trout Working Group report to the Lake Michigan Committee:

Lake Michigan Technical Committee, Lake Trout Working Group. 2015. 2014 Lake Michigan Lake Trout Working Group Report. Annual report to the Lake Michigan Committee, Ypsilanti, Michigan.

References:

Jonas, J. L., R. M. Claramunt, J. D. Fitzsimons, J. E. Marsden, and B. J. Ellrott. 2005. Estimates of egg deposition and effects of lake trout (*Salvelinus namaycush*) egg predators in three regions of the Great Lakes. Canadian Journal of Fisheries and Aquatic Sciences 62:2254-2264.

Schneeberger, P., M. Toneys, R. Elliott, J. Jonas, D. Clapp, R. Hess, and D. Passino-Reader. 1998. Lakewide assessment plan for Lake Michigan fish communities. Lake Michigan Technical Committee Report. Great Lakes Fishery Commission, Ann Arbor, Michigan. Available: http://www.glfc.org/pubs/SpecialPubs/lwasses01.pdf (September 2015).

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Date: September 30, 2015

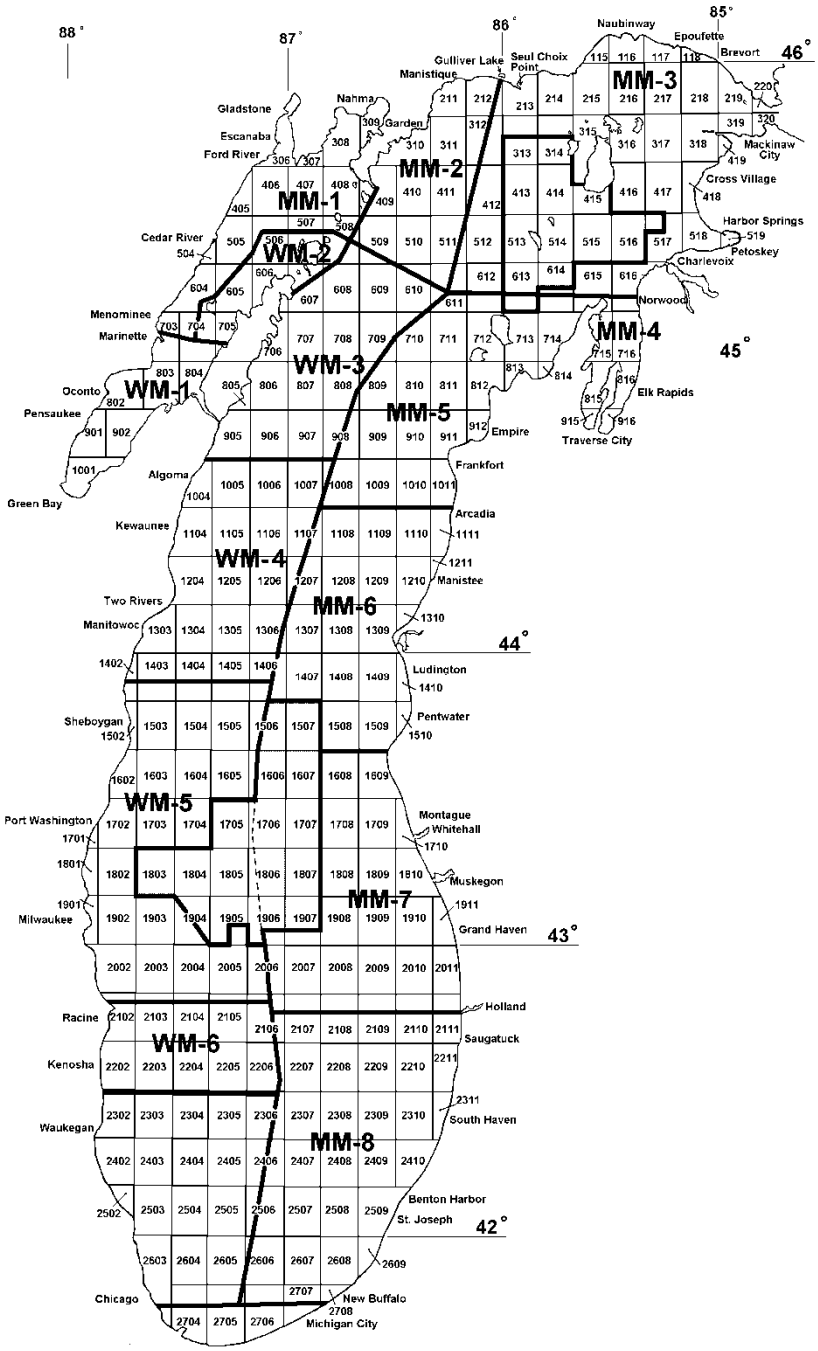

Figure 1.–Map of statistical districts/Lake Trout management units in Lake Michigan.

Table 1.–Lake-wide assessment plan (LWAP) Lake Trout survey summary for Michigan waters of Lake Michigan, 2015. "Nylon" and "Mono" refer to assessment net material, fished in a paired comparison.

Port	Number of nets	Depth strata (ft.)	Number of Lake Trout	
			Nylon	Mono
Charlevoix	2	<50	70	63
	4	50–150	45	47
	2	>150	15	10
	8	All	130	120
Elk Rapids	2	All	153	197
Leland	2	<50	56	42
	2	50-100	35	21
	2	100-150	18	9
	2	>150	12	7
	8	All	121	79
Arcadia	2	<50	22	20
	2	50–100	20	27
	2	100–150	18	22
	2	>150	14	17
	8	All	74	86
Grand Haven	2	<50	3	11
	2	50–100	3	4
	2	100–150	7	13
	2	>150	3	6
	8	All	16	34
Saugatuck	2	<50	18	38
	2	50–100	42	40
	2	100–150	14	16
	2	>150	10	30
	8	All	84	114
South Haven	2	<50	18	32
	2	50–100	27	27
	2	100–150	19	10
	2	>150	14	23
	8	All	78	92
St. Joseph	2	<50	17	4
	2	50–100	22	17
	2	100–150	15	16
	2	>150	16	19
	8	All	70	56

Table 2.–Summary of mixed-model analyses of the relative abundance (gillnet catch-per-unit effort) of Lake Trout captured in annual surveys from four regions of Lake Michigan. MM designations are Lake Trout management units (Figure 1); "–" indicates missing data.

	Modeled region			
Year	North (MM1/2/3)	Grand Traverse Bay (MM4)	Frankfort to Leland (MM5)	Arcadia to Holland (MM6/7)
1981	0.824	1.641	2.341	3.151
1982	0.286	1.496	2.309	1.834
1983	0.547	1.655	2.173	3.312
1984	0.446	1.534	1.942	1.088
1985	-0.005	1.119	2.760	–
1986	0.015	1.566	3.765	2.202
1987	0.397	2.005	2.112	2.800
1988	1.142	2.767	2.205	1.546
1989	0.893	2.282	2.285	1.979
1990	1.238	2.362	–	1.452
1991	–	–	–	–
1992	–	1.934	–	–
1993	–	1.621	–	–
1994	–	1.991	–	–
1995	–	1.809	–	–
1996	–	1.877	–	0.741
1997	–	1.756	3.325	1.444
1998	0.232	2.343	0.988	1.886
1999	0.393	1.341	1.220	1.954
2000	0.804	1.733	2.163	2.124
2001	0.927	1.601	2.326	2.072
2002	0.504	1.484	2.210	2.078
2003	0.530	1.677	2.480	2.396
2004	0.805	1.853	2.552	2.041
2005	0.737	1.769	2.371	2.131
2006	0.511	2.549	2.468	2.335
2007	0.735	2.171	2.454	2.395
2008	1.001	2.362	2.329	2.574
2009	1.010	1.827	2.440	2.191
2010	0.612	1.859	1.340	1.925
2011	0.647	2.102	1.527	2.206
2012	0.765	2.317	1.868	1.751
2013	1.143	2.629	1.836	1.735
2014	1.138	2.191	2.163	1.646
2010–14 average	0.861	2.220	1.747	1.852

Table 3.–Density (number per m^2) of Lake Trout eggs at four sites in northern Lake Michigan. Egg densities were measured from egg bags (N = 30) buried in the substrate at identified spawning locations. "–" indicates years in which samples were not collected at the identified site.

	Collection site / Spawning location			
Year	GTB-Ingalls Point	GTB-Elk Rapids	LTB-Bay Harbor	LTB-Crib
2000	1.0	–	1.0	366.2
2001	45.9	–	7.3	50.2
2002	0.0	–	4.2	45.5
2003	0.0	–	3.4	52.1
2004	0.0	–	1.9	54.9
2005	1.8	23.0	14.8	25.6
2006	18.8	31.0	10.4	18.3
2007	12.1	0.0	9.4	33.0
2008	4.4	0.9	7.5	34.0
2009	32.8	0.0	10.3	27.7
2010	12.2	17.6	3.9	18.0
2011	2.5	4.0	4.0	3.4
2012	4.7	17.0	14.1	7.8
2013	1.5	7.9	1.5	13.2
2014	0.0	13.4	6.8	17.4

Table 4.–Density of egg predators (number per m^2) measured at four sites in northern Lake Michigan. Densities were determined from collections in egg bags (N = 30) buried in the substrate at identified spawning locations. "–" indicates years in which samples were not collected at the identified site.

	Collection site / Spawning location			
Year	GTB-Ingalls Point	GTB-Elk Rapids	LTB-Bay Harbor	LTB-Crib
2000	15.5	–	11.7	21.6
2001	31.0	–	4.7	21.1
2002	21.1	–	–	19.2
2003	21.6	–	10.7	30.5
2004	29.1	–	3.3	19.7
2005	22.3	10.2	2.7	15.6
2006	26.3	7.5	5.9	20.2
2007	16.0	11.3	7.0	18.9
2008	8.6	17.8	7.0	15.1
2009	24.9	9.7	4.2	12.6
2010	14.6	9.0	3.4	9.6
2011	15.3	9.0	8.6	10.7
2012	9.2	6.8	1.5	8.4
2013	11.5	6.5	4.4	18.3
2014	3.0	19.2	7.8	32.4

Assessment of Lake Trout Stocks in the Lake Michigan Basin

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Background

A combination of overharvest and changes in Great Lakes fish species led to extirpation of Lake Trout populations from Lake Michigan by the mid-1950s. By 1965, significant efforts were being made to restore Lake Trout in Lake Michigan – these efforts, which included stocking and harvest management, continue to this day by federal, tribal and state fisheries agencies. All of the Lake Michigan fisheries agencies work on coordinated lakewide Lake Trout assessment activities that are an important part of evaluating stocking practices (Photo 1). This effort also provides key data to develop total catch limits (also known as TACs), build decision-support tools, and support evaluation of other management activities.

Photo 1. Lake Trout assessments have been a regular part of R/V *Steelhead* operations since 1968.

Along with long-term assessment activities, shorter-term targeted research studies help increase our understanding of Lake Trout population fluctuations and the reasons behind natural recruitment bottlenecks and improve the likelihood of successful Lake Trout management in the Lake Michigan Basin. Some examples of questions answered by such studies are:

- What are the effects of predation on young Lake Trout?
- Are there naturally-reproducing Lake Trout populations in connected water bodies to Lake Michigan such as Elk Lake (Photo 2) and what can we learn about how they are successful?

The objectives of this project are: (1) To determine the relative abundance, length and age composition, and Sea Lamprey wounding and mortality rates for Lake Trout in Lake Michigan; (2) To conduct assessment netting to update biological data; (3) To determine the total allowable harvest limits for Lake Trout from management units within 1836 treaty waters; (4) To assess the amount and distribution of egg deposition on Lake Trout spawning sites in Lake Michigan; (5)To evaluate naturally-reproducing populations of Lake Trout in Elk Lake, a connected water to Lake Michigan.

Key study results

- During the 2015 field season, 1,504 Lake Trout were captured in lakewide assessment netting using the standardized lakewide protocols (Photo 2). Age determination and fish population analysis through 2014 were completed and Lake Michigan Lake Trout fishing regulations were developed using these data.

Photo 2. Fisheries Division technician Pat O'Neill collecting images and biodata to determine physical and genetic characteristics of the Elk Lake Lake Trout.

- Lake Trout egg deposition rates and the abundance of interstitial predators were measured at four sites in northern Lake Michigan. Standardized egg bags (N=30) were buried at each site in September and recovered in mid-November. Predator densities were slightly higher at sites in Little Traverse Bay and Elk Rapids when compared to the previous year. Numbers of deposited Lake Trout eggs remained low when compared to expected values for self-sustaining populations.
- Tissue analysis from inland and Great Lakes Lake Trout populations indicated that Elk Lake fish were genetically distinct from both historic Lake Michigan wild populations and contemporary hatchery populations including the Marquette genetic strain which had previously been stocked into the lake.

Study Details

Summary reports created to meet requirements of the 2000 Consent Decree can be found at (http://www.michigan.gov/dnr/0,1607,7-153-10364_36925---,00.html). Additional study information can be found at http://www.michigan.gov/dnr/0,4570,7-153-10364_52259_19056-333302--,00.html.