STUDY PERFORMANCE REPORT

State: Michigan **Project No.:** F-53-R-14

Study No.: 451 **Title:** Evaluation of lake trout stocks in Lake Huron

Period Covered: April 1, 1997 to March 31, 1998

Study Objective: To determine stock parameters for lake trout in Lake Huron from index sampling.

Summary: During the spring of 1997, index sampling for lake trout in U.S. waters of Lake Huron was conducted with graded, large-mesh gill nets at 10 sites. Four of these index sites have been sampled annually since the mid-1970's. The project design was modified in 1995 to accommodate more stations, as required for the Lake Huron Technical Committee's movement studies. Annual mortality estimates from the 1997 spring assessment catch curves were: >80% at MH-1 (9-Mile Pt., the northern-most station); 68% at MH-2 (Thunder Bay); 45% at MH-3 (Oscoda); and 37% at MH-4 ("Thumb" area of south-central Lake Huron). Excessive mortality rates in northern Lake Huron appear to preclude lake trout rehabilitation there. Mortality rates in the southern two statistical districts, on the other hand, were at or below the 45% target level set by the Lake Huron Technical Committee. Currently, sea lamprey predation is a leading cause of mortality, especially in the north. Annual mortality attributable to sea lampreys for fish over 630 mm was estimated to range from 27% to 42%. Growth rates and body condition were greater in the south. There was no clear difference in growth parameters from previous years. Smelt and alewives have consistently made up about 98% of the spring diet.

Job 1. Title: Fish graded-mesh experimental gill nets at assessment stations.

Findings: Six assessment stations were added to the study design in 1995. Therefore, a total of 10 assessment stations were to be sampled in 1997. One station, Adams Point, was to be sampled by the Biological Resources Division of the Geological Survey, U.S. Dept. Interior, (BRD), but they were unable to do so. Thus, there are no data for that station in 1997. Lake trout marked with coded wire tags are being stocked at each of four sites along the Michigan coastline; returns of the coded wire tags will be used by the Lake Huron Technical Committee to document movement and will become the basis for delineation of lake trout management unit boundaries. The locations of assessment stations were designed to document distribution of these marked lake trout on and between the four stocking sites. The data from all assessment sites within each statistical district were combined for the purpose of estimating area stock parameters.

Survival–Age-specific catch per 1,000 ft of gill net from the 1997 spring assessment, adjusted for stocking rate, was calculated for each of four statistical districts. Mortality rates were estimated using the methods of Robson and Chapman (1961) for catch-at-age data (Table 1).

The assessment stations in MH-1 (northern Lake Huron) were Nine-Mile Point and Adams Point. The National Biological Survey was unable to net Adams Pt. and there were insufficient lake trout available at 9-Mile Point to produce an estimate of mortality there in 1997 (Table 1). Catch of lake trout older than age four in MH-1 continued to be extremely low and the near absence of

age 5 and older lake trout suggests annual mortality was in access of 80% there. This area, which included waters deferred from lake trout rehabilitation by the 1985 consent decree, contains some grids that receive no lake trout stockings. Yet, the tribal commercial catch of lake trout ranged from 78 to 232 thousand pounds from 1985 to 1996. With the closure of Hammond Bay (immediately south of Nine-Mile Pt.) to commercial fishing in 1990, annual commercial harvest dropped to below 100,000 pounds during 1991, and 1992, but gradually rose again to 202,000 pounds in 1996. It appears that lamprey-induced mortality, in combination with fishing, is nearly eliminating mature lake trout in MH-1.

Three stations were netted in MH-2 (north-central L. Huron): Presque Isle, Rockport, and Thunder Bay. Since 1981, there has been little evidence of a relationship between stock size and stocking rate. The poor response to stocking may be due to excessive mortality and emigration to MH-1. Catch rates for age 3, 4, 5, and 6 fish increased sharply in 1996 and 1997. As in past years, there was a pronounced decline in catch rate between age 5 and age 8. Swink (1990 and 1991) reported that vulnerability of lake trout to sea lamprey attack increases sharply at about 635 mm in length. In 1997, lake trout from MH-2 averaged 574 mm at age 6 and 623 mm at age 7. Thus, the high losses of lake trout between age 5 and 8 in Thunder Bay may be partly due to size-specific lamprey effects. Annual mortality since 1988 has ranged near or above Lake Huron Committee guidelines (Table 2). There is no commercial fishery for lake trout in MH-2. The sport harvest in 1993 (Study 427) was less than 1,000 lake trout at Alpena and Rockport, combined, but rose steadily to 2,091 in 1994, 4,893 in 1995, 10,958 in 1996, and 12,942 in 1997, suggesting a sustained recovery is occurring. Until recently, lamprey-induced mortality has been the chief cause of the high mortality rates in MH-2. The relatively high harvest in 1997 indicates the recreational fishery has also become a significant source of mortality.

Two assessment sites were used to represent MH-3: Sturgeon Pt. and Oscoda. Mortality was lower than in the more northerly stations (Table 2). Like MH-2, there was a sharp decline in catch rate for fish older than age 6 (Table 1). Assessment sites in MH-4,5 ("Thumb" area) were at Pte. aux Barques, Harbor Beach north, and Harbor Beach south. Survey catch rates and number of age groups sampled here have consistently been higher than in the north and, therefore, have allowed more accurate estimation of survival. The mortality rates for this area have remained much lower than in the north. In 1997, the mortality estimate was well below target at 37% (Table 2). The 1989 year class, which was stocked as fall fingerlings, was nearly absent (Table 1). All other year classes originated with yearling plants. To compensate for this year class failure, the catch rate for the 1989 year class was replaced with an interpolated value for purposes of mortality estimation.

Offshore stocking began at all sites in 1989 and 1990, and this may have increased survival of more recent year classes, which in turn, would increase apparent mortality (by violating the assumption of equal recruitment rates over time).

Sea lamprey control is scheduled to begin in 1998 on the St. Marys River and will be nearly complete by year 2000. Because most sea lampreys are believed to originate there, the St. Marys treatment is expected to significantly enhance lake trout survival, particularly in northern Lake Huron. With increasing recreational and commercial harvest, further regulation of fishing may be required to attain target survival levels.

Movement–In 1992, the Lake Huron Technical Committee initiated a lake trout movement study with the stocking of 60,000 coded-wire-tagged lake trout at each of 4 sites: Adams Pt., Rockport, Sturgeon Pt., and Pte. aux Barques. In addition, coded-wire-tagged lake trout have been stocked

at Drummond Island and 6-Fathom Bank since 1985. To capture information on distribution of these marked fish, we increased the number of stations along the Michigan shore of Lake Huron such that one station was on each stocking site and other stations were located equal distances between them.

Lake trout originating from all the research stocking sites were represented in each year's samples from 1995 through 1997. Although some lake trout had moved considerable distances, there was a tendency for those lots stocked from Sturgeon Pt. south to be sampled in the south and those stocked north of Sturgeon Pt. to be found in the northern stations (Table 3). A total of 354 coded-wire tagged lake trout have been taken since 1995. This sample size indicates the number of marked fish and the survey effort deployed are both adequate to meet study objectives. One-hundred-four lake trout from 6-Fathom Bank were taken at the near-shore sites (40 in 1995, 43 in 1996, and 20 in 1997), and they appeared at all 10 stations (Table 3). Stockings at 6-Fathom have been equally divided between three strains. However, for fish age 7 and older, nearly three times as many Seneca strain were taken at the near-shore sites than the other two strains combined (Table 4). Assessment nettings by the National Biological Survey on 6-Fathom Bank have likewise found that Seneca strain composes the majority of older fish on this mid-lake reef.

Lamprey wounding–Lamprey-induced mortality was estimated using rates of A1-A3 wounds from spring assessment netting, survival rates from laboratory studies by Swink (1990), and the equation:

$$ZL=W(1-P)/P,$$

After Koonce and Pycha (unpublished) where ZL = instantaneous lamprey-induced mortality, W = the number of A1-A3 type wounds (King and Edsall 1979) per lake trout, and P = probability of surviving a single lamprey attack (Swink 1990).

The annual mortality rate for lake trout attributable to lamprey ranged from 27% to 42% for lake trout over 630 mm (Table 5). Indexing of lamprey wounding on lake trout requires large samples of fish larger than 535 mm. Unfortunately, few lake trout of larger size groups were available from spring assessments at MH-1. The high loss to lampreys, in combination with natural mortality, leaves little, if any, surplus production for harvest in any of the Lake Huron statistical districts. Wounding generally increased with host size and was most pronounced in fish over 630 mm (Table 5). This pattern is consistent with laboratory observations of Swink (1991).

Growth–Parameters of weight-length regressions for the assessment stations have varied little in recent years. Lake trout from northern stations have consistently demonstrated lower body condition, as reflected by the lower calculated weight at 600-mm total length (Table 6). Average length at age five has consistently been greatest in the south (Table 7). Also, growth rates increase from north to south, probably reflecting the transition from colder, less productive conditions of northern Lake Huron to warmer, more productive conditions of southern Lake Huron.

Food habits–Stomach contents (number of items by species of prey) were examined during the spring index sampling. A summary of stomach contents from 1997 spring index netting is given in Table 8. As with past years, smelt and alewives composed over 98% of the diet lakewide. Alewife have been the dominant prey in MH-4 since the early 1980s; however, in 1996 and 1997 they were second to smelt in terms of number consumed. In MH-2, alewife were the dominant prey

Job 2. Title: Net for adults on spawning reefs.

Findings: We sampled Mischleys Reef in Thunder Bay to index the incidence of wild spawning lake trout there. The reef was last sampled there in fall of 1992 and 1993, when the catch rate averaged 37.7 per 1,000 ft of net. The catch was again composed principally of unclipped fish in 1997 but the catch rate dropped to 21.7 per 1,000 ft. All fish caught were tagged and released.

Job 3. Title: Analyze field data and coordinate with other agencies. Participate in interagency planning and management of lake trout.

Findings: All data from the 1997 surveys were checked and entered into the Alpena Station data base. Analysis included preparation of findings for the coordinated interagency studies of the Lake Huron Technical Committee, presentation of lake trout status reports at the annual Upper Lakes meetings, presentation of a rehabilitation status report to the Great Lakes Fishery Commission Board of Technical Experts task area meeting and to a Commission meeting in Ann Arbor, and application of the data base for a Lake Huron bioenergetics model. I also prepared the annual lake trout stocking plan for Michigan waters of Lake Huron and attended the summer and winter Lake Huron Technical Committee meetings where updates on lake trout progress and technical reports were presented. I participated as a member of the St. Marys River Control Task Force, where I provided lake trout data for modeling population responses to sea lamprey control options under consideration for the St. Marys River.

Job 4. Title: Write annual and final reports.

Findings: The required reports and documents were completed as scheduled.

Job 5. Title: Trawl for age-0 wild lake trout in Thunder Bay and monitor other evidence of lake trout reproduction.

Findings: Trawling was completed as scheduled at the annual index station near North Point of Thunder Bay. A semi-balloon otter trawl with a 23-m bridle, 11-m foot rope, and 13-mm mesh (stretch measure) cod-end liner was used to sample age-0 lake trout. Age-0 wild lake trout were taken in bottom trawls every year at the North Point station from 1986 through 1997, but the catch decreased to the lowest levels of the study in 1995, 1996, and 1997 (Table 9).

The number of unclipped lake trout in spring assessment stations has been used as another index of reproduction. The contribution of unclipped, potentially wild, lake trout to the assessment catch in MH-2 was 10-18% for the 1984, 1985, and 1986 year classes (Johnson and VanAmberg 1995). In 1997, however, the contribution of unclipped fish, averaged over all year classes, was only 0.0%, 1.5%, 0.6%, and 0.8% for MH-1, 2, 3, and 4 respectively. There was no evidence that unclipped fish composed a larger than expected proportion of any one year class. Although reproduction continues, its contribution to the fishery is almost too weak to be measurable.

Literature Cited:

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Table 1.—Annual age-specific lake trout catch, adjusted for stocking and effort (ft), by statistical district, Michigan waters of Lake Huron, 1997.

Age	Year class	Stocking adjustment factor[1]	Count	Catch per 1000'	Adjusted CPE[2]
MH-1: Effort=12,600					
2	1995	1.17	4	0.32	0.37
3	1994	1.37	11	0.87	1.20
4	1993	1.03	8	0.63	0.65
5	1992	0.70	2	0.16	0.11
6	1991	0.52	0	0.00	0.00
MH-2: Effort=13,500'					
2	1995	2.12	3	.22	0.47
3	1994	1.03	30	2.22	4.69
4	1993	1.03	53	3.93	4.59
5	1992	0.70	82	6.07	7.41
6	1991	0.52	73	5.41	5.68
7	1990	0.53	15	1.11	1.16
8	1989	1.00	4	0.3	0.77
9	1988	0.83	3	0.22	0.34
10	1987	0.79	0	0.00	0.00
11	1986	1.33	0	0.00	0.00
MH-3: Effort=10,800'					
2	1995	.84	2	0.19	0.16
3	1994	.65	1	0.09	0.06
4	1993	0.57	43	3.98	2.27
5	1992	0.80	48	4.44	3.56
6	1991	0.73	53	4.91	3.58
7	1990	0.83	11	1.02	0.85
8	1989	0.94	8	0.74	0.70
9	1988	0.67	3	0.28	0.19
10	1987	1.07	1	0.09	0.10
11	1986	0.93	5	0.46	0.43
MH-4, 5: Effort= 9,900'					
2	1995	1.55	3	0.30	0.47
3	1994	1.68	0	0.00	0.00
4	1993	1.02	24	2.42	2.47
5	1992	1.52	78	7.88	11.98
6	1991	1.37	81	8.18	11.21
7	1990	1.73	21	2.12	3.67
8	1989	2.08	1	0.10	0.21
9	1988	1.48	12	1.21	1.79
10	1987	3.18	4	0.40	1.28
11	1986	3.53	1	0.10	0.36
12	1985	0.97	2	0.20	0.20
13	1984	1.51	5	0.51	0.76
14	1983	2.08	1	0.10	0.21
15	1982	1.04	4	0.40	0.42
16	1981	1.16	2	0.20	0.23

[1] Stocking adjustment factor = number stocked/500,000.

[2] Adjusted catch = count x stocking adjustment factor. Adjusted CPE = adjusted catch/1,000'.

Table 2.–Mortality rates (%) by station and agency, from spring gill-net assessments, Michigan waters of Lake Huron. Agencies are MDNR =Michigan Department of Natural Resources and BRD = Biological Resources Division of United States Geological Survey.

Year	"Thumb" (MH-4) MDNR	Central (MH-3) MDNR	North Central (MH-2) MDNR	North (MH-1) MDNR and BRD
1982-86 (average)	28	42	49	76
1986-87	36	NA	NA	87
1987-88	40	43	NA	76
1988-89	37	43	52	89
1989-90	46	47	52	NA
1990-91	31	43	35	>70
1991-92	27	48	42	>70
1992-93	28	62	69	>70
1993-94	32	51	55	>70
1994-95	37	49	52	74
1995-96	53	54	55	81
1996-97	37	45	68	>80

Table 3.–Total gill net catch and catch per effort (number per 1,000 ft) 1995, 1996 and 1997 of coded-wire-tagged lake trout at 10 near-shore Michigan stations.

	Survey station and effort (combined 1995-1997 in parenthesis)										
	S. Harbor Beach (12,600)	N. Harbor Beach (14,400)	Grindstone (10,800)	AuSable Pt. (15,300)	Sturgeon Pt. (15,300)	Thunder Bay (15,300)	Nordmeer (15,300)	Presque Isle (15,300)	Adams Pt. (31,600)	Nine-mile Pt. (52,200)	Total by stocking site
Catch by stocking site:											
Pt. Aux Barques	4	8	19	6	4	0	0	1	0	0	42
Sturgeon Pt.	6	2	8	11	12	6	7	5	2	2	61
Middle Island	0	0	1	4	5	3	17	12	7	6	55
Adams Pt.	0	1	3	3	0	1	9	9	31	17	74
Six-Fathom	7	8	22	9	15	4	24	5	7	3	104
Drummond Island	0	0	0	0	0	0	4	5	5	4	18
Total by station	17	19	53	33	36	14	61	37	52	32	354
Catch/10,000' by stocking site:											
Pt. Aux Barques	3.17	5.56	17.59	3.92	2.61	0.00	0.00	0.65	0.00	0.00	33.51
Sturgeon Pt.	4.76	1.39	7.41	7.19	7.84	3.92	4.58	3.27	0.63	0.38	41.37
Middle Island	0.00	0.00	0.93	2.61	3.27	1.96	11.11	7.84	2.22	1.15	31.09
Adams Pt.	0.00	0.69	2.78	1.96	0.00	0.65	5.88	5.88	9.81	3.26	30.92
Six-Fathom	5.56	5.56	20.37	5.88	9.80	2.61	15.69	3.27	2.22	0.57	71.53
Drummond Island	0.00	0.00	0.00	0.00	0.00	0.00	2.61	3.27	1.58	0.77	8.23
Total	13.49	13.19	49.07	21.57	23.53	9.15	39.87	24.18	16.46	6.13	

Table 4.–Age composition, by strain, of coded-wire-tagged lake trout stocked on 6-Fathom Bank and sampled at 10 nearshore stations, 1995, 1996 and 1997 spring gill-netting.

	Strain								
	Seneca/Ontario			Marquette			Jenny/Lewis		
Age	1995	1996	1997	1995	1996	1997	1995	1996	1997
2	0	0	0	0	0	0	0	0	0
3	0	0	0	0	1	0	0	0	0
4	1	1	0	5	3	0	5	0	1
5	2	3	0	2	3	1	1	4	2
6	6	3	2	3	5	0	0	3	2
7	0	2	0	1	1	1	0	3	0
8	5	1	3	1	0	0	0	0	0
9	6	2	0	0	2	1	1	0	0
10	1	3	0	0	1	0	0	1	0
11	0	2	6	0	0	0	0	0	0
12	0	0	1	0	0	3	0	0	0
Totals	21	17	12	12	16	1	7	11	5
Older than age 7	12	10	10	2	4		1	4	0

Table 5.–Estimated mortality attributable to sea lamprey attacks, Lake Huron, 1996-97, based on wounding rates measured in 1997. Agencies supplying data are MDNR = Michigan Department of Natural Resources, BRD = Biological Resources Division of United States Geological Survey, and COTFMA = Chippewa-Ottawa Tribal Fishery Management Authority.

Length group (mm)	Probability of survival	Marks per fish (M)	Sample size (N)	Lamprey instantaneous (ZL)	Annual lamprey (AZ)
MH-1: Drummond Island to Rogers City (combined MDNR, BRD & COTFMA)					
430-529	0.35	0.160	25	0.30	0.26
530-629	0.45	0.370	19	0.45	0.36
630-734	0.45	0.400	5	0.49	0.39
735+	0.55	---	0	---	---
MH-2: North-Central					
430-529	0.35	0.040	71	0.07	0.07
530-629	0.45	0.040	81	0.17	0.16
630-734	0.45	0.320	23	0.39	0.32
735+	0.55	0.400	5	0.33	0.28
MH-3,4,5: "Thumb" and Central					
430-529	0.35	0.042	95	0.08	0.08
530-629	0.45	0.125	289	0.25	0.14
630-734	0.45	0.456	68	0.56	0.42
735+	0.55	0.378	37	0.31	0.27

Table 6.–Condition factors, weight-length regressions[1] at assessment stations, and estimated weight (gm) at 600 mm total length from 1997 index netting in Michigan.

Statistical District	Area	Regression parameters[1] a	b	r^2	Wt (gm) at 600 mm
MH-1	North	2.0E-05	2.870	0.962	1878
MH-2	North Central	4.1E-06	3.142	0.981	2201
MH-3	Central	1.9E-06	3.263	0.949	2207
MH-4,5	"Thumb"	3.5E-05	2.806	0.936	2186

[1] Length-weight equation is of the form: $W=aL^b$

Table 7.–Mean total lengths (mm) at age-5 of lake trout sampled from 4 statistical districts of Lake Huron, 1997.

Statistical district	Mean	Standard deviation	N
MH-1	451	50	2
MH-2	504	58	82
MH-3	539	48	48
MH-4	553	78	60

Table 8.–Lake trout stomach contents (number consumed and % of total identifiable prey consumed) by statistical district from MDNR 1997 spring assessments.

	MH-1		MH-2		MH-3		MH-4		Total	
Prey	No.	%	No.	%	No.	%	No.	%	No.	%
Alewife	8	21.1	373	73.1	295	77.6	305	39.2	981	57.5
Smelt	15	39.5	129	25.3	73	19.2	471	60.5	688	40.3
Slimy sculpin	1	2.6	5	1.0	0	0.0	1	0.1	7	0.4
Deepwater sculpin	10	26.3	0	0.0	0	0.0	0	0.0	10	0.6
9-spine stickleback	4	10.5	1	0.2	11	2.9	1	0.1	17	1.0
Trout perch	0	0.0	0	0.0	1	0.3	0	0.0	1	0.1
Crayfish	0	0.0	2	0.4	0	0.0	0	0.0	2	0.1
Total identifiable	38	100.0	510	100.0	380	100.0	778	100.0	1706	100.0
Void	1	4.0	40	15.2	16	9.1	21	8.7	78	4.5
Number examined	25		263		175		241		1743	

Table 9.–Trawl catch of age-0 lake trout from Thunder Bay, 1984-97.

	North Point			Mischley Reef			Black River		
Year	Tows	Catch	CPE	Tows	Catch	CPE	Tows	Catch	CPE
1984	0	---	---	0	---	---	13	9	0.69
1985	8	0	0.00	0	---	---	2	2	1.00
1986	19	41	2.16	0	---	---	0	---	---
1987	23	19	0.83	0	---	---	0	---	---
1988	33	43	1.30	0	---	---	0	---	---
1989	63	39	0.62	0	---	---	0	---	---
1990	54	44	0.81	0	---	---	24	0	0.00
1991	39	6	0.15	0	---	---	0	---	---
1992	36	7	0.19	6	1	0.17	0	---	---
1993	35	13	0.37	11	1	0.09	0	---	---
1994	36	21	0.81	4	2	0.50	3	0	0.00
1995	36	4	0.11	0	---	---	0	---	---
1996	36	2	0.06	0	---	---	0	---	---
1997	48	5	0.10	0	---	---	0	---	---