

STUDY PERFORMANCE REPORT

State: Michigan

Project No.: F-53-R-15

Study No.: 486

Title: Assessment of lake trout populations in Michigan's waters of Lake Michigan.

Period Covered: April 1, 1998 to September 30, 1999

Study Objectives: To determine the population structure, health, and reproductive success of lake trout in Michigan's waters of eastern Lake Michigan. To determine if spawning adults are present at the three stocked spawning reefs within the northern refuge (NGS Crew) and at traditional spawning reefs that lie within (Big Reef) and outside (Fisherman's Island and Dahlia Shoals) the boundaries of the northern refuge.

Summary: During the 1998 field season, lake trout sampling efforts focused on assessments of populations in eastern and northern Lake Michigan from April-August and spawning reef assessments in northern Lake Michigan in October and November.

A total of 754 lake trout were captured throughout Lake Michigan during the 1998 field season, 347 of which were collected during fall spawning reef assessments in northern Lake Michigan. As expected, a greater size and age range of fish were collected in summer netting efforts than in fall spawning reef assessments. Fish collected on fall spawning reefs tended to be older and larger. The majority of the fish collected in northern Lake Michigan originated from plantings in the northern refuge area. Incidence of BKD in lake trout populations decreased in 1998 compared to that observed in 1997. We collected stomach samples from 456 lake trout in 1998. As in the past, we did not detect any notable indications of feral lake trout.

Job 2. Title: Search for feral lake trout.

Findings: The number of unmarked fish collected from each statistical district is within the range expected for clipping or tagging error. In 1996, 5% from Statistical District MM-8, 5% from District MM-7, 15% from District MM-6, 1% from District MM-5 and 2% from District MM-3 were unmarked fish. Due to the high ratio of marked to unmarked fish in Statistical District 6, scales were evaluated to determine if anything other than typical hatchery growth was observed inside the first annuli. All unmarked fish exhibited similar growth patterns to known hatchery-raised fish. Only five of the 850 lake trout captured in 1997 had no fin clips. In 1998, 38 of the 754 lake trout captured did not have fin clips. Twenty of the 38 fish were from MM-3. Scales were re-checked and there was no obvious evidence of early growth patterns indicative of lake-spawned fish. We will continue to watch for evidence of natural reproduction. Currently, there is not evidence to show that there has been a significant increase in the number of feral lake trout in Lake Michigan.

Job 3. Title: Coordinate with other studies, process and analyze data; write reports.

Findings: In 1998, we initiated a new lake wide spring/early summer monitoring program. All agencies on Lake Michigan have agreed to standardized protocols that will enable us to better compare data with other agencies, and help provide a lake-wide perspective to fishery population assessments. In 1998, we also standardized protocols for conducting fall spawning assessments. We are playing an active role in the implementation and revision of both the spring/summer, and fall spawning assessment protocols. Further, we will be coordinating closely with other states to standardize common analyses on present and past data sets. In further efforts, we are working with the U.S. Fish and Wildlife Service to coordinate a second year of lake trout egg plantings on Big Reef in Lake Michigan. We are conducting astro-turf egg plantings to enhance lake trout populations on Big Reef, a historically important lake trout spawning reef located in northern Lake Michigan. In 1998, we placed two million lake trout eggs on Big Reef in 100 astro-turf bundles. In 1999, we intend to increase the stocking density, placing three million lake trout eggs in 150 astro-turf bundles.

We produced this annual progress report as scheduled.

Job 4. Title: Evaluate relevant literature on lake trout.

Findings: Literature on lake trout physiology, behavior, and habitats are being collected and catalogued in an Endnote bibliographic software library. Twice monthly, we evaluate Current Contents search results from relevant fisheries journals to identify current journal articles and publications that we will obtain and integrate into the database.

Job 5. Title: Establish the distribution pattern, relative abundance, and origin of lake trout collected throughout eastern Lake Michigan from May through August.

Findings: We implemented a revised salmonid sampling protocol in 1997 to better define spatial and temporal variation in fish distributions. Our lake-wide netting efforts covered the entire lake in two south to north sweeps during the spring and summer. We set 30 foot deep suspended gill nets, hoping to be able to better define the distribution of salmonid populations at depth strata in Lake Michigan. We suspended one gang (1,600-ft) at the surface fishing in 0-30 ft of water. The other gang (1,600-ft) was suspended at a minimum of 30-60 feet, or at a depth where the bottom of the net would rest in 55°F (13°C) water. We frequently catch lake trout in these surface and suspended gill nets. A second mode of sampling lake trout in the spring/summer period is through targeted bottom gill nets set as part of the newly adopted lake-wide lake trout assessment plan. Six bottom gill nets (3-5.5" mesh, 800 foot gang) were set at each of three Lake Michigan sites (Saugatuck, Arcadia and Leland) in April and May.

There was not an identifiable trend in the number of lake trout collected in surface, suspended, or bottom gill nets (Table 1). Further, there did not seem to be a trend in the strain composition of the catch at the different depth strata (Table 2). In the future, we intend to evaluate if diets vary in the nets at different depth strata.

In bottom gill nets set in 1998, overall catch rates were low. In MM-3, no fish were captured in six gill-net sets (Table 3). The greatest numbers of burbot were collected in statistical districts MM-5 and 6, while lake whitefish catch rates were similar among districts and a single lake herring was captured in MM-5 (Table 3). We observed the highest lake trout catch rates in MM-

6 where approximately nine trout were captured per 800 feet of net (Table 3). We doubled the amount of net set in 1999 to increase catch for biological sampling.

The age composition of the lake trout May-July assessments ranged from 2 to 18 years. The majority of fish fell into the 3 to 7 year old age groups (Table 4).

Job 6. Title: Determine the timing of spawning, distribution patterns, relative abundance, and origin of lake trout collected on traditional spawning reefs from October through November.

Findings: In 1998, the USGS decommissioned the vessel that normally conducted spawning assessments on stocked off-shore reefs in northern Lake Michigan. In order to keep consistent data at the stocked off-shore reef sites, our vessel (the S.V. Steelhead) sampled Richard's, Boulder, and Gull Island reefs in 1998. Near-shore and non-stocked spawning reef assessments were continued for a second year by the Little Traverse and Sioux tribes. The Sioux tribe set nets at Good Hart, Ile Aux Galets, and Sturgeon Bay; while the Little Traverse Band set nets at Fisherman's Island Reef, 9-Mile Point and Menonaqua Bay.

Evaluation of catch rates at both near-shore and off-shore stocked and non-stocked sites was used to determine whether stocked lake trout are using historically important spawning sites or staying near the locations they were planted at. In 1998, catch rates at stocked sites were substantially higher than on non-stocked reefs (Table 5). In 1997, we captured the majority of the lake trout at the near-shore site (Fisherman's Island) when compared to the off-shore sites (Table 5). In 1998, stocked near-shore sites continued to produce slightly higher catch rates than even stocked off-shore sites.

All off-shore refuge-planted lake trout have an adipose fin clip indicating they have a coded-wire-tag inserted in their snout. At all sites (near- and off-shore; stocked and non-stocked) adipose-clipped fish made up 31-100% of fish that were captured and levels remained consistent at a given site across years (Table 6). The above information (CPUE, CWT data) provided evidence that lake trout of spawning ages are straying from the northern refuge area, and seem to be orienting towards the shoreline.

The majority of fish captured in northern Lake Michigan range in age from five to eight years old (Table 7). The age structure on Fisherman's Island reef did not change appreciably from 1996 to 1997, but seems to have declined slightly in 1998 (Table 7). We intend to further explore other non-stocked offshore sites in 1999 and to extend the near-shore sampling. Age structures at sites throughout northern Lake Michigan were relatively similar except at Il Aux Galets where few fish were observed over age 6 and no fish older than 9 were observed.

In 1998, the majority of adipose-clipped lake trout captured at near-shore sites originated from planting events in the northern refuge of Lake Michigan (Table 8). Richard's Reef was the single largest contributor of lake trout to the near-shore zone. Fish from northern refuge plants were the second most common group of marked lake trout in the near-shore zones (Table 8). The off-shore stocked sites were 50 to 80 percent occupied by fish that originated at the site.

The presence of ripe and spent females indicated that some level of spawning is occurring on populated areas of both near-shore and off-shore-reefs. Almost all individuals collected on fall spawning reefs in 1998 were mature, ripe or spent (Table 9). At the near-shore sites, there were

more ripe females than at off-shore stocked reefs. Females at off-shore reefs were mature and mostly gravid (Table 9). Males were mostly ripe at both on and off-shore locations (Table 9).

Job 7. Title: Obtain information on diets of lake trout in surface vs. bottom nets, throughout the spring and summer and during spawning, and from different spatial locations in eastern Lake Michigan.

Findings: We collected stomach samples from 456 lake trout for diet analysis in 1998. The evaluation of 1996 and 1997 stomach contents is not yet complete. We have evaluated all stomachs collected in 1995, and will participate in a collaborative lake-wide effort to consolidate information and publish a paper describing the diets and foraging relationships of lake trout collected throughout Lake Michigan in 1994 and 1995.

Job 8. Title: Monitor prevalence of bacterial kidney disease in populations of lake trout in eastern Lake Michigan.

Findings: Lake trout were tested for the presence of bacterial kidney disease (BKD) with the ELISA (enzyme-linked immunosorbant assay) technique (Kwik Dtect¹) for laboratory and field use. BKD levels increased substantially in 1997 (31%) and decreased again in 1998 (1%; Table 10). Of the 499 lake trout evaluated from Michigan's waters of eastern and northern Lake Michigan in 1998, 3 fish tested positive for BKD. These fish were collected in the southern sections (MM-6 through MM-8) of the lake (Table 11).

¹Diagnostics, Inc., Wilton, CT

Table 1.—Catch rates of lake trout in bottom, suspended, or surface gill nets in Lake Michigan in 1994-1997 and in 1998.

Net Type	1994-1997 (mean)	1998
Bottom gill net	427	145
Suspended gill net	52	51
Surface gill net	439	211

Table 2.—Strain composition (percent) of lake trout captured in bottom, suspended, and surface gill nets in Lake Michigan 1997 and 1998. All rows sum to 100 percent.

Net Type	Strain											
	Apostle Island		Green Lake		Jenny Lake		Lewis Lake		Marquette		Ontario	
	1997	1998	1997	1998	1997	1998	1997	1998	1997	1998	1997	1998
Bottom gill net	8.7	7.2	3.9	0.9	2.4	2.3	18.1	28.0	44.1	24.0	20.5	3.6
Suspended gill net	2.2	0.5	10.9	0.0	6.5	0.0	8.7	0.0	39.1	2.7	28.3	0.9
Surface gill net	3.7	0.9	4.9	2.3	6.2	2.3	22.2	4.1	24.7	6.3	33.3	12.7

Table 3.—Catch per overnight set of 800 foot graded mesh bottom gill nets (CPUE) in statistical districts MM-5, 6, and 8 in Lake Michigan during April-July, 1998. Six nets were set per statistical district.

Statistical District	Lake Trout	Burbot	Lake Herring	Lake Whitefish
MM-3	0.0	0.0	0.0	0.0
MM-5	1.8	4.5	0.3	3.3
MM-6	8.8	4.5	0.0	6.6
MM-8	4.2	0.4	0.0	5.7

Table 4.—Age composition of lake trout collected in April-July 1998 assessments, in statistical districts MM-5, 6, and 8. Percent values given in parentheses.

Statistical district	Age										
	2	3	4	5	6	7	8	9	10	11	12+
MM-5	0	0	4(29)	4(29)	4(29)	2(14)	0	0	0	0	0
MM-6	1(2)	15(34)	10(23)	7(16)	6(14)	4(9)	0	0	1(2)	0	0
MM-8	0	2(10)	2(10)	1(5)	5(24)	4(19)	0	0	4(19)	1(5)	2(10)
TOTAL	1(1)	17(22)	16(20)	12(15)	15(19)	10(13)	0	0	5(6)	1(1)	2(3)

Table 5.—Lake trout catch per net night per 1,000 ft. of bottom gill net (CPUE) on spawning reefs in northern Lake Michigan during 1996 - 1998.

Year	Location	Number of Nets	CPUE
1996	Fisherman's Island	4	23
1997	Fisherman's Island	4	22
1998	Fisherman's Island	2	56
1997	Big Reef	6	3
1997	Il Aux Galets (Dahlia)	4	3
1998	Il Aux Galets (Dahlia)	3	2
1998	Good Hart	3	9
1998	Sturgeon Bay	3	1
1998	9-Mile Point	2	47
1998	Menonaqua Bay	3	86
1998	Boulder Reef	4	29
1998	Gull Island Reef	4	20
1998	Richard's Reef	4	5

Table 6.—Number and percent of lake trout captured with adipose fin clips (indicating origination from offshore plants) at each site for the years 1996-1998.

Classification	Location	1996		1997		1998	
		Number	%	Number	%	Number	%
Onshore/Stocked	Fisherman's Island	39	43	49	55	82	59
Offshore/Non-stocked	Big Reef			8	47		
Offshore/Non-stocked	Il Aux Galets (Dahlia)			4	40	2	50
Onshore/Non-stocked	Good Hart					15	58
Onshore/Non-stocked	Sturgeon Bay					2	100
Onshore/Stocked	9-Mile Point					26	33
Onshore/Stocked	Menonaqua Bay					66	31
Offshore/Stocked	Boulder Reef					74	76
Offshore/Stocked	Gull Island Reef					53	82
Offshore/Stocked	Richard's Reef					13	81

Table 7.—Age composition of lake trout collected in northern Lake Michigan fall assessments 1996-1998, for onshore vs. offshore and stocked vs. non-stocked locations.

Fisherman's Island

Year	Age								
	4	5	6	7	8	9	10	11	12+
1996	5	14	35	15	7	2	4	5	4
1997	3	23	23	20	6	6	4	2	2
1998	1	3	10	18	9	2	0	0	0
TOTAL	9	40	68	53	22	10	8	7	6

Il Aux Galets (Dahlia)

Year	Age					
	4	5	6	7	8	9
1997	2	3	4	1	0	0
1998	0	0	2	1	0	1
TOTAL	2	3	6	2	0	1

1997-1998 non-stocked reefs

Reef-Year	Age								
	4	5	6	7	8	9	10	11	12+
Big Reef-1997	1	3	5	3	2	0	0	2	1
Good Hart-1998	0	5	6	9	3	0	0	2	0
TOTAL	1	8	11	12	5	0	0	4	1

1998 Off-shore stocked reefs

Reef Name	Age								
	4	5	6	7	8	9	10	11	12+
Boulder	1	6	17	19	26	11	4	1	7
Gull Is	0	4	13	11	12	9	3	1	11
Richard's	0	3	5	4	2	1	1	0	0
TOTAL	1	13	35	24	40	21	8	2	18

1998 Near-shore stocked reefs

Reef Name	Age								
	4	5	6	7	8	9	10	11	12+
9-Mile	0	0	7	5	5	0	0	0	1
Menonaqua	1	4	8	10	3	3	0	0	1
TOTAL	1	4	15	15	8	3	0	0	2

Table 8.—Summary of the plant site of origin for adipose clipped lake trout captured both on off-shore stocked reefs and at near-shore stocked locations in 1998. The value in parentheses is the percentage value for a give sampling location.

Original Plant Site	Offshore Sampling Locations				Nearshore Sampling Locations			
	Richard's Reef	Gull Island	Boulder Reef	Total	Fisherman's Island	Nine mile Point	Menonaqua Bay	Total
Boulder Reef	1(9)	8(18)	31(44)	40(31)	4(9)	2(11)	1(3)	7(8)
Gull Island Reef	1(9)	23(51)	11(15)	35(28)	5(12)	5(28)	6(20)	16(18)
Richard's Reef	5(45)	5(11)	9(13)	19(15)	22(51)	4(22)	15(50)	41(45)
Northern Refuge	4(36)	9(20)	16(23)	29(23)	10(23)	5(28)	6(20)	21(23)
East Reef			1(1)	1(1)				
Northeast Reef			1(1)	1(1)		1(6)		1(1)
Sheboygan Reef			1(1)	1(1)				
Mixed Plant			1(1)	1(1)				
Other					2(5)	1(6)	2(7)	5(5)
TOTAL:	100	100	100	127	100	100	100	91

Table 9.—Number and percent of immature, mature, and ripe male and female lake trout in 1998, by site. Mature fish includes gravid fish, and ripe fish includes spent fish.

Capture Site	Mature		Ripe		Immature	
	Male	Female	Male	Female	Male	Female
OFF-SHORE						
Gull Island	3(5)	20(31)	36(55)	6(9)	0(0)	0(0)
Boulder Reef	10(11)	19(20)	57(61)	3(3)	3(3)	1(1)
Richard's Reef	3(19)	4(25)	6(38)	1(6)	0(0)	2(13)
TOTAL	16(9)	42(24)	99(57)	10(6)	3(2)	3(2)
NEAR-SHORE						
Menonaqua Bay	11(5)	11(5)	152(71)	32(15)	7(3)	0(0)
Fisherman's Island	15(11)	12(9)	73(53)	39(28)	0(0)	0(0)
Nine-Mile Point	5(6)	2(3)	43(55)	28(36)	0(0)	0(0)
TOTAL	31(7)	25(6)	268(62)	99(23)	7(2)	0(0)

Table 10.—Prevalence (percent and 95% confidence limits) of BKD in lake trout from Michigan waters of Lake Michigan, 1995-1998.

Year	Percent Positive	95% Confidence Limits
1995	11.9	2.4
1996	1.4	1.6
1997	31.4	3.4
1998	0.6	0.7

Table 11.—Prevalence (percent and 95% confidence limits) of BKD in lake trout from statistical districts MM-3 through MM-8 of Lake Michigan during 1998.

Statistical District	Percent Positive	95% Confidence Limits
MM-3	0.0	0.0
MM-4	0.0	0.0
MM-5	0.0	0.0
MM-6	1.4	1.9
MM-7	0.0	0.0
MM-8	0.5	0.9