STUDY PERFORMANCE REPORT

State: Michigan

Project No.: F-81-R-3

Study No.: 451

Title: Evaluation of lake trout stocks in Lake Huron

Period Covered: October 1, 2001 to September 30, 2002

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

Summary: Assessment sampling for lake trout in U.S. waters of Lake Huron was conducted with graded, large-mesh gillnets during the springs of 2001 and 2002 at 12 sites. Four of these index sites have been sampled annually since the mid-1970s. Statistical-catch-at-age model results show that, in general, mortality rates are too high to allow spawning stocks to build. Commercial fishing and sea lampreys are the most prominent sources of mortality in the north, while lampreys and recreational fishing are the most prominent sources in the south. Recent improvements in catch per effort and age distributions suggest suppression of sea lampreys and significant reductions in fishing effort are beginning to affect lake trout stocks, however, further reductions in mortality rates are needed to allow the main basin lake trout population to advance towards rehabilitation. Weight-length regressions and lake trout body condition were similar across statistical districts. Smelt and alewives comprised the majority of the spring diet in 2001. Fall gillnet catches on spawning reefs near Alpena yielded low catches of wild spawning lake trout. For the second time since 1985, no age-0 lake trout were sampled in trawling at the annual North Point index station.

Findings: Jobs 1, 2, 3, 4, and 5 were scheduled this year, and progress is reported below.

Job 1. Title: Fish graded-mesh, experimental gillnets at assessment stations.–A total of 12 assessment stations were sampled in 2001 and 2002. Lake trout marked with coded-wire tags were stocked at each of four sites along the Michigan coastline; returns of the coded-wire tags will be used by the Great Lakes Fishery Commission Lake Huron Technical Committee to document movements and create a lakewide movement matrix used for modeling lake trout population dynamics. The locations of assessment stations were designed to document distribution of these marked lake trout at and between the four stocking sites. Data from all assessment sites within each statistical district were combined for the purpose of estimating area stock parameters using statistical catch at age models. Statistical catch at age models for northern (MH-1 and adjacent Canadian waters) and north-central (MH-2 and adjacent Canadian waters) Lake Huron are used by the Modeling Subcommittee of the Technical Fisheries Committee as mandated by the Year 2000 Consent Decree for 1836 Treaty Waters. The southern (MH-3,4,5 and adjacent Canadian waters) Lake Huron statistical catch at age model covers waters south of the treaty area. All models will be updated by November 2002.

Survival–Instantaneous mortality rates have been variable and relatively high in northern Lake Huron (Figure 1). From 1977 to 1990, commercial fishing mortality was the leading source of lake trout mortality. After 1990, commercial fishing mortality decreased as lamprey-induced mortality increased. Lampreys were the largest source of lake trout mortality in the 1990s. From 1990 to 1998, lamprey-induced instantaneous mortality averaged 0.26/year and commercial fishing instantaneous mortality averaged 0.14/year. Recreational fishing mortality was low in all years relative to commercial fishing mortality in northern Lake Huron (Figure 1).

The high rates of both lamprey-induced and commercial fishing mortality caused the age structure in northern Lake Huron to be truncated just before the age of first maturity. As a result, spawning stock biomass is extremely low in northern Lake Huron and total lake trout biomass remains stable, oscillating around a 20 year average of 518,000 kg (Figure 2).

The dominant source of mortality for lake trout in north-central Lake Huron was lamprey-induced (Figure 3). Lamprey-induced mortality was greater than all other mortality sources from 1984-2000 with the exception of 1986, 1987, and 1990, when natural mortality was the largest single mortality source (Figure 3). Sea lamprey mortality rates have been cyclic in north-central Lake Huron, reaching peaks in 1989, 1994, and 1997 (Figure 3). From 1990 to 2000, lamprey-induced mortality averaged 0.30/year. Recreational and commercial fishing mortality were low in all years relative to lamprey-induced mortality (Figure 3).

The high rate of lamprey-induced mortality caused the lake trout age structure in north-central Lake Huron to be truncated at the age of first maturity. As a result, spawning stock biomass was low in north-central Lake Huron (Figure 4). Total lake trout biomass has steadily increased since 1984, averaging 759,000 kg in the 1990s (Figure 4); however, the majority of this biomass was young, immature, hatchery fish. Spawning stock and total biomass are higher in north-central Lake Huron (Figure 4) than in northern Lake Huron (Figure 2). This larger spawning stock might contribute to the wild recruitment documented at North Point off Alpena (Johnson and VanAmberg 1995).

The dominant source of mortality for lake trout in southern Lake Huron from 1984 to 1998 was lamprey-induced (Figure 5). Recreational fishing mortality increased from 1994 to 1998 but was still secondary to lamprey-induced mortality (Figure 5). Commercial fishing mortality was uniformly low in all years. From 1990 to 1998, lamprey-induced mortality averaged 0.34/year.

Total lake trout biomass and spawning stock biomass are higher in southern Lake Huron than in northern or north-central Lake Huron (Figure 6). From 1990 to 1998, spawning stock biomass in southern Lake Huron averaged 168,000 kg versus 63,000 kg in north-central Lake Huron and 10,000 kg in northern Lake Huron. The higher levels of spawning stock biomass in southern Lake Huron are encouraging, but the majority of the historic lake trout spawning habitat is located in northern and north-central Lake Huron (Ebener 1998; Eshenroder et al. 1995). The presence of a moderate number of spawners but limited spawning habitat, combined with high rates of lamprey-induced mortality on adult lake trout and lower stocking rates after 1985, may explain why both total and spawning stock biomass steadily declined from 1984 to 1998 for lake trout in southern Lake Huron (Figure 6).

Sea Lamprey Control–Chemical control of sea lampreys began in 1998 on the St. Marys River. 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. A significant chemical treatment of the river took place in 1999, which theoretically should have reduced parasitic-phase lampreys by 50% in 2000. The effect of reduced lamprey predation should have been evident in our spring 2001 survey. In fact, sea lamprey wounding rates were significantly lower in 2001 and 2002 than in prior years (Mann-Whitney U; $p<0.001$).

In anticipation of this sea lamprey control effect, the Lake Huron Committee resumed stocking lake trout in some of the northern grids of Lake Huron in 1998. With increasing recreational and commercial harvest, further regulation of fishing will be required to attain target survival levels.

The Year-2000 Consent Decree recently signed by the State of Michigan, the federal government, and 5 Chippewa/Ottawa tribes limits commercial harvest of lake trout and stipulates new recreational size limits in north and north-central Lake Huron. Similar regulations are needed for southern Lake Huron to control lake trout mortality.

Movement–In 1992, the Great Lakes Fishery Commission 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 every other year beginning in 1992. The sites were Adams Point, Middle Island, Sturgeon Point, and Point aux Barques. In addition, coded-wire tagged lake trout have been stocked at Drummond Island and 6-Fathom Bank since 1985.

Tagged lake trout from all of the six stocking sites were represented in catches of spring gillnet surveys from 1995 to 2001 (Table 1). Although some lake trout had moved considerable distances, there was a tendency for those lots stocked south of Sturgeon Pt. south to be sampled in the south and those stocked north of Sturgeon Pt. to be found at the northern stations (Table 1). A total of 1,341 coded-wire tagged lake trout have been taken in this assessment since 1995 (Table 1). The sample size indicates that the number of marked fish and the survey effort were both adequate to meet objectives of the study.

Two hundred and fifty eight lake trout stocked at 6-Fathom Bank were taken from 1995 to 2001, and they appeared at all of the ten study stations (Tables 1). Stockings at 6-Fathom have been equally divided among three groups of lake trout strains. However, for age 7 fish and older, 3.3 times as many of the Seneca-Ontario group were taken at the near-shore sites than Lewis-Jenny group (Table 2). Assessment nettings by the United States Geological Survey Biological Resource Division on 6-Fathom Bank have likewise found that Seneca strain composes the majority of older fish on this mid-lake reef.

An in-depth analysis of lake trout movements based on coded-wire tag data was conducted as part of the statistical catch at age modeling analyses by the Modeling Subcommittee of the Technical Fisheries Committee. In 1998, the Lake Huron Technical Committee designed a common lake trout coded-wire tag data base for Lake Huron that contained data from Michigan Department of Natural Resources, United States Fish and Wildlife Service, United States Geological Survey Biological Resource Division, Chippewa/Ottawa Resource Authority and Ontario Ministry of Natural Resources. These movement data have been developed into a lakewide movement matrix that was included in the statistical catch at age models.

Growth–Condition factors for lake trout sampled during spring gillnet surveys were fairly similar across statistical districts during 1995-2001 (Table 3). Parameter values for length-mass relations were different among districts partially because size distributions of samples were different. More explicit comparative analyses on length at age and weight at a number of ranges of total length were designed, and the results will be available in near future. Average total length at age five followed a north-south gradient for the Michigan assessment stations (Table 4), likely reflecting the colder, less productive conditions of northern Lake Huron.

Food habits–The stomach contents of all gillnetted lake trout were examined, and a sub-sample of stomach contents was brought back to the lab to obtain lengths and weights of individual prey items. A summary of stomach contents from the 2001 spring gillnet survey is given in Table 5. As with past years, smelt and alewives comprised the majority (88-100%) of the diet lakewide, except for samples from MH3. Alewife was a dominant prey in all statistical districts and was more frequently found in stomachs in southern statistical districts. Average weights of prey items are also given in Table 5. Approximately 5.1% of the lake trout sampled in 2001 had void stomachs (Table 5). This is much lower than the long-term average (12.7%) of void stomachs in the spring lake trout survey. In 2000, the percent of void stomachs was 15%. In 1998, it was an all time high of 27.7%, but recent strong year classes of alewives have bolstered the forage base.

Job 2. Title: <u>Net for adults on spawning reefs.</u>–In 2001 we sampled reefs at 4 near-shore sites in the Grindstone City area (south-central Lake Huron) and one offshore reef site (Monrovia wreck) to index the incidence of wild spawning lake trout. Only one unclipped lake trout out of a sample of 63 mature fish was captured at Grindstone. Only 7 lake trout were sampled on the Monrovia wreck reef and all were fin clipped. This represents a much lower contribution of wild fish in fall than the 1998 and 1997 wild lake trout catch rates of 26.7 and 21.7 per 305 m at Mischley's Reef, the one nearshore index station where reproduction is known to occur. We did not sample Mischley's Reef in 2001. A sample of 50 fish from the Grindstone area was sent to the International Joint Commission for contaminant analysis.

Job 3. Title: <u>Analyze field data and coordinate with other agencies. Participate in interagency planning and management of lake trout.</u>–We prepared analyses for the coordinated interagency studies of the Lake Huron Technical Committee, presented a rehabilitation status report to the Great Lakes Fishery Commission Board of Technical Experts task area meeting, and presented lake trout regulatory options (length limits) to the Michigan's three Great Lakes citizen advisory committees. We also attended the summer Lake Huron Technical Committee meeting where updates on lake trout progress and technical reports were presented. We worked on manuscript edits for the lake trout section of the Great Lakes Fishery Commission *State of Lake Huron in 1999* report. We are also a member of the Modeling Subcommittee of the Technical Fisheries Committee under the Year 2000 Consent Decree with the 1836 tribes of Chippewa/Ottawa Indians. We compiled Lake Huron lake trout biological data, coded-wire tag movement data, and updated Technical Fisheries Committee lake trout stock assessment models for Lake Huron. We attended statistical catch at age modeling training sessions. We designed 2002-2004 stocking plans for Lake Huron and began work on long-term stocking strategies in conjunction with the Year-2000 Consent Decree and Lake Huron Technical Committee.

Job 4. Title: <u>Write annual and final reports</u>.–The required reports and documents were completed as scheduled. A paper on survival of juvenile lake trout stocked in Lake Huron, as evidenced by spring gillnet catch rates, was published in the North American Journal of Fisheries Management (Wilberg et al. 2002).

Job 5. Title: <u>Trawl for age-0 wild lake trout in Thunder Bay and monitor for other evidence of lake trout reproduction</u>.–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 2000. Trawl catches have been steadily dropping since the early 1990s, and no age-0 lake trout were caught in either 2000 or 2001 (Table 6).

The number of unclipped lake trout at 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 2002, however, the contribution of unclipped fish, averaged over all year classes, was only 4.0%, 4.5%, 3.7%, and 1.6% for MH-1, 2, 3, and 4,5 respectively. There was no evidence that unclipped fish composed a larger than expected proportion of any one year class in either 2001 or 2002. Although reproduction continues, its contribution to the fishery is almost too weak to be measurable.

Literature Cited:

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Eshenroder, R.L., N.R. Payne, J.E. Johnson, C.B. Bowen, and M.P. Ebener. 1995. Lake trout rehabilitation in Lake Huron. J. of Great Lakes Res. 21(Supplement 1):108-127.

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Wilberg, M. J., J. R. Bence, and J. E. Johnson. 2002. Survival of juvenile lake trout stocked in western Lake Huron during 1974-1992. North American Journal of Fisheries Management 22:213-218.

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Table 1.–Total effort of spring gillnet survey at 10 near-shore Michigan stations in Lake Huron (from south to north) and total catch of coded-wire-tagged lake trout that were stocked at 6 sites (from north to south), 1995-2001.

	Survey stations										
	S. Harbor Beach	N. Harbor Beach	Grindstone	AuSable Pt.	Sturgeon Pt.	Thunder Bay	Nordmeer	Presque Isle	Adams Pt.	Nine-mile Pt.	Total
Effort (m of net)	10,425	10,974	8,230	12,892	11,522	9,601	8,779	9,053	15,944	27,984	125,404
Catch # by stocking site:											
Drummond Island	0	0	0	0	1	1	5	5	7	5	24
Adams Pt.	2	1	6	3	4	14	27	29	132	64	343
Middle Island	0	0	4	10	6	18	61	47	54	16	267
Six-Fathom	18	17	28	12	20	17	44	5	17	6	257
Sturgeon Pt.	16	9	17	22	29	41	22	8	2	5	208
Pt. Aux Barques	32	58	70	11	7	5	4	3	0	0	242
Total by station	68	120	163	63	93	119	192	118	242	163	1341
Catch per effort (number per 3,050 m of net):											
Drummond Island	0.00	0.00	0.00	0.00	0.26	0.64	1.04	1.68	1.72	0.44	0.58
Adams Pt.	0.59	0.28	2.59	0.71	1.32	5.08	9.73	11.45	26.78	11.66	8.34
Middle Island	0.00	0.00	1.48	2.60	3.44	6.35	23.28	18.87	11.67	3.81	6.49
Six-Fathom	5.27	6.95	12.97	3.31	7.41	9.21	21.89	2.70	5.16	1.09	6.25
Sturgeon Pt.	4.68	2.50	9.26	5.68	9.79	14.93	9.03	4.04	0.96	0.76	5.06
Pt. Aux Barques	9.36	23.62	34.09	2.60	2.38	1.59	1.74	1.01	0.00	0.00	5.89
Total	19.89	33.35	60.41	14.90	24.62	37.80	66.70	39.75	46.29	17.77	32.61

Table 2.–Age composition of five strains of coded-wire-tagged lake trout sampled at near-shore stations during spring gill-net survey, from 1995 to 2001. Those lake trout were all stocked on 6-Fathom Bank, Lake Huron, and stocking numbers were equally divided among the indicated three groups.

	Strains				
	Group 1		Group 2	Group 3	
Age	Seneca	Ontario	Marquette	Jenny	Lewis
2					
3	2		6		4
4	4	2	20		7
5	16	4	26		23
6	8	9	15		32
7	7	3	14	2	5
8	7	3	4		5
9	11		4	1	
10	1		1		
11	6				
12	3				
13	1				
14					
15	1		1		
Totals	67	21	91	3	76
Age >=7	37	6	24	3	10

Table 3.–Condition factors, length-mass relations, and estimated weight (g) at 600 mm total length from spring gillnet survey in Michigan waters of Lake Huron, 1995-2001.

Statistical District	Area	Ktl @600 mm	a	b	R squared	Wt (g) @600 mm
MH-1	North	1.028	3.67E-06	3.161	0.978	2221
MH-2	North Central	1.022	4.42E-06	3.131	0.976	2209
MH-3	Central	1.033	6.48E-06	3.073	0.957	2231
MH-4,5,6	“Thumb”	1.029	1.21E-05	2.975	0.946	2224

Ktl=(W/L3)*105
Length-weight regression: W=aLb

Table 4.–Average total lengths (mm) of age 5 lake trout sampled from 5 statistical districts of Lake Huron, 2000-2001.

Year	Statistical district	Mean	Standard deviation	N
2000	MH-1	504	45	65
	MH-2	545	44	93
	MH-3	545	44	78
	MH-4	544	41	33
	MH-5	568	42	76
2001	MH-1	508	59	13
	MH-2	555	44	29
	MH-3	557	34	76
	MH-4	567	36	12
	MH-5	585	36	39

Table 5.–Stomach contents of lake trout in five statistical districts of Lake Huron during 2001.

	MH-1			MH-2			MH-3			MH-4			MH-5		
Prey	No.	%	Avg. weight (g)	No.	%	Avg. weight (g)	No.	%	Avg. weight (g)	No.	%	Avg. weight (g)	No.	%	Avg. weight (g)
Crayfish	3	0.7	1.5	25	3.7	3.0	3	8.1	2.0						
Zebra mussels	1	0.2	0.3	3	0.4	0.6									
Snails							1	2.7	0.6						
Terrestrial insects	1	0.2	1.0	6	0.9	2.4									
Alewife	86	20.9	9.9	302	44.9	10.8	6	16.2	9.2	398	99.3	10.2	343	87.3	10.8
Smelt	276	67.2	5.5	303	45.0	5.6	3	8.1	4.4	3	0.7	3.6	46	11.7	6.3
Stickleback	31	7.5	1.4	25	3.7	1.2	21	56.8	1.5				1	0.3	0.4
Johnny Darter							1	2.7	0.7						
Slimy sculpin	13	3.2	3.5	9	1.3	5.5	2	5.4	2.6				1	0.3	15.8
Deepwater sculpin													2	0.5	7.3
Total identifiable	411			673			37			401			393		
Unidentifiable fish	410		3.6	434		6.2	18		4.3	47		4.7	225		5.6
Void	8	5.5		9	5.7		1	6.3		2	2.9		4	5.1	
Number examined	137			150			15			68			74		

Table 6.–Trawl catch of age-0 lake trout from Thunder Bay, Lake Huron, 1984-2002.

Year	North Point			Mischley Reef			Black River		
	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	–	–
1998	40	3	0.08	0	–	–	0	–	–
1999	38	2	0.05	0	–	–	0	–	–
2000	36	1	0.03	0	–	–	0	–	–
2001	36	0	0.00	0	–	–	0	–	–
2002	36	0	0.00	0			0		

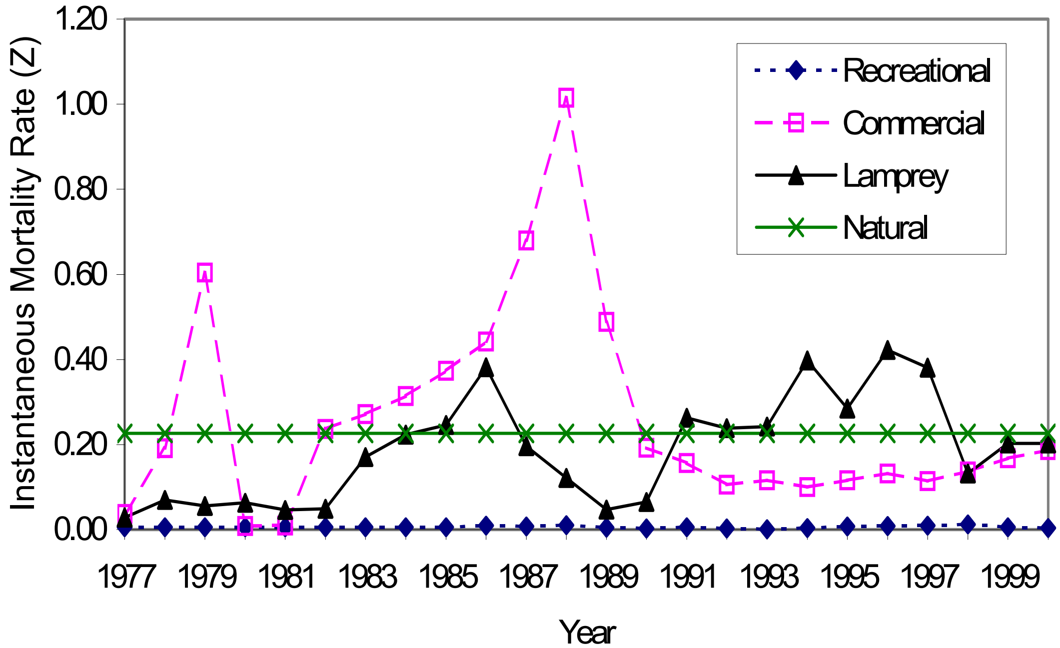

Figure 1.–Statistical-catch-at-age model estimates of average instantaneous mortality rates for age 3-13 lake trout in northern Lake Huron (MH-1 and adjacent Canadian waters).

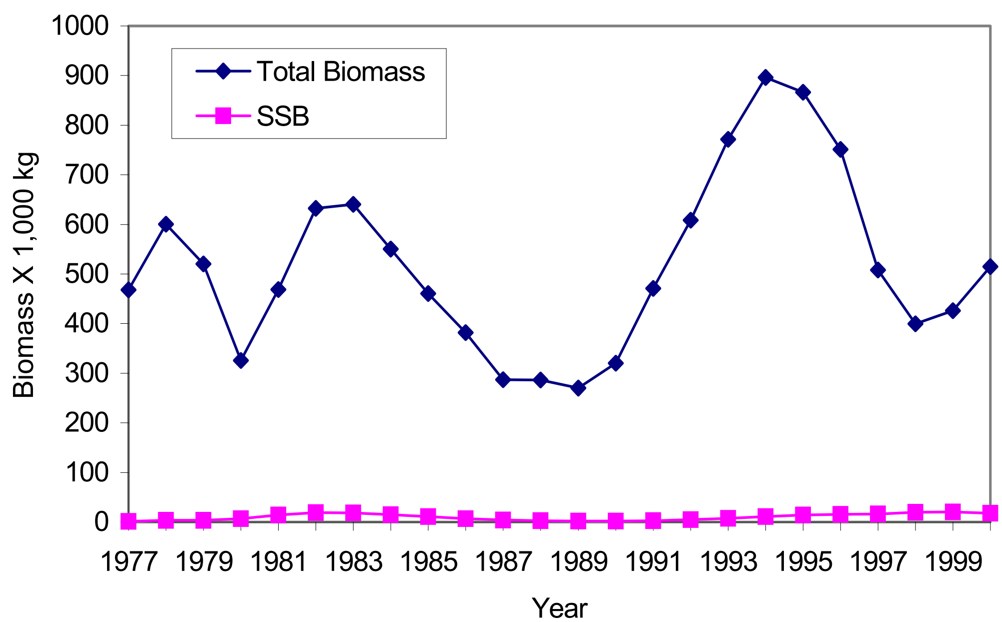

Figure 2.–Statistical-catch-at-age model estimates of lake trout biomass and spawning stock biomass (SSB) in northern Lake Huron (MH-1 and adjacent Canadian waters).

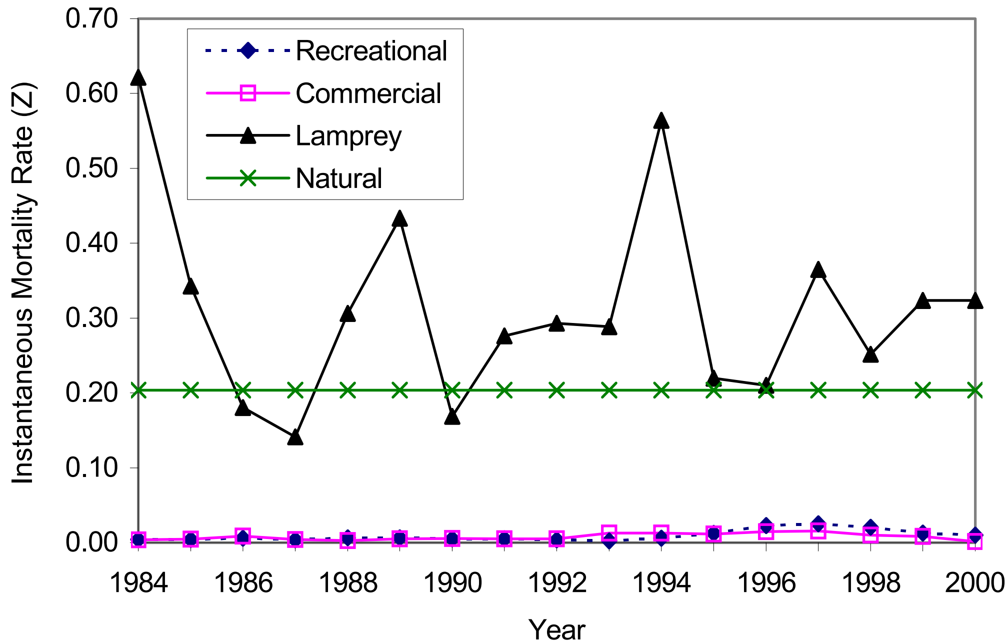

Figure 3.–Statistical-catch-at-age model estimates of average instantaneous mortality rates for age 3-13 lake trout in north-central Lake Huron (MH-2 and adjacent Canadian waters).

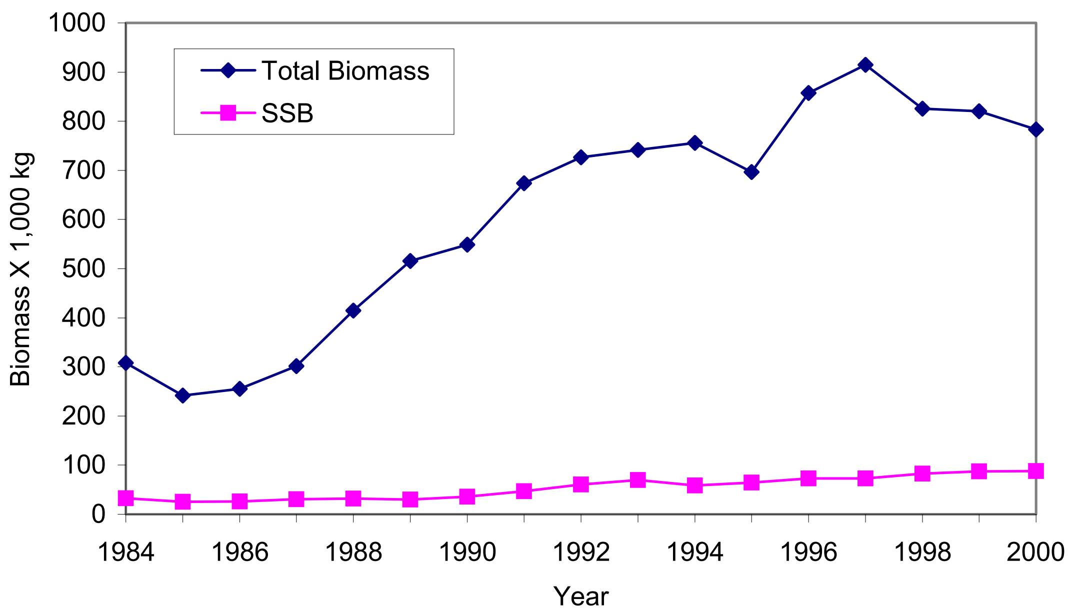

Figure 4.–Statistical-catch-at-age model estimates of lake trout biomass and spawning stock biomass (SSB) in north-central Lake Huron (MH-2 and adjacent Canadian waters).

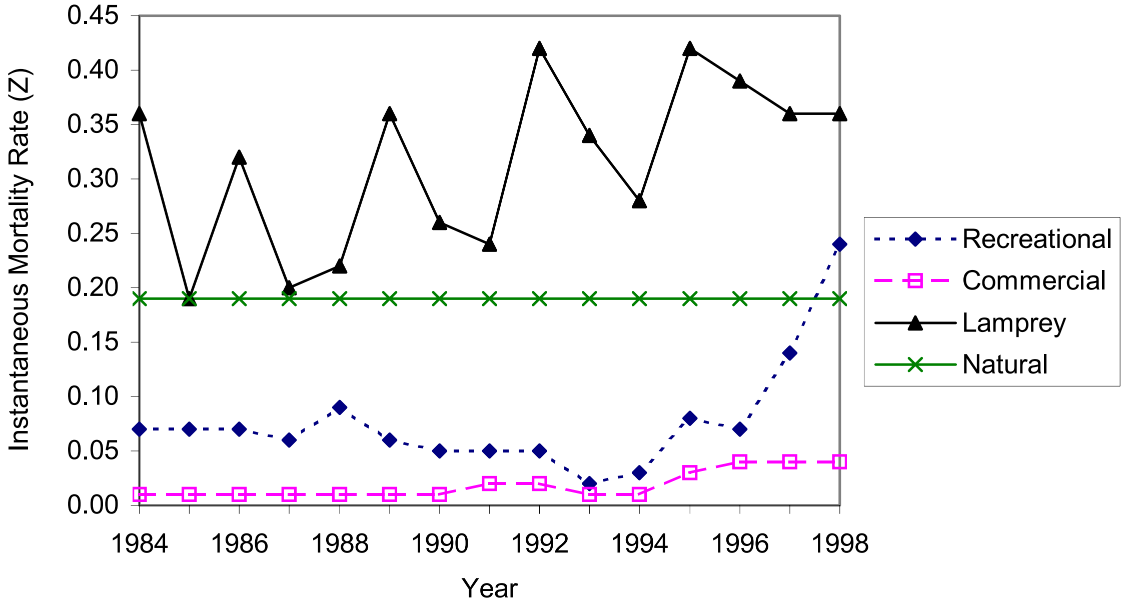

Figure 5.–Statistical-catch-at-age model estimates of average instantaneous mortality rates for age 3-13 lake trout in southern Lake Huron (MH-3, MH-4, MH-5 and adjacent Canadian waters).

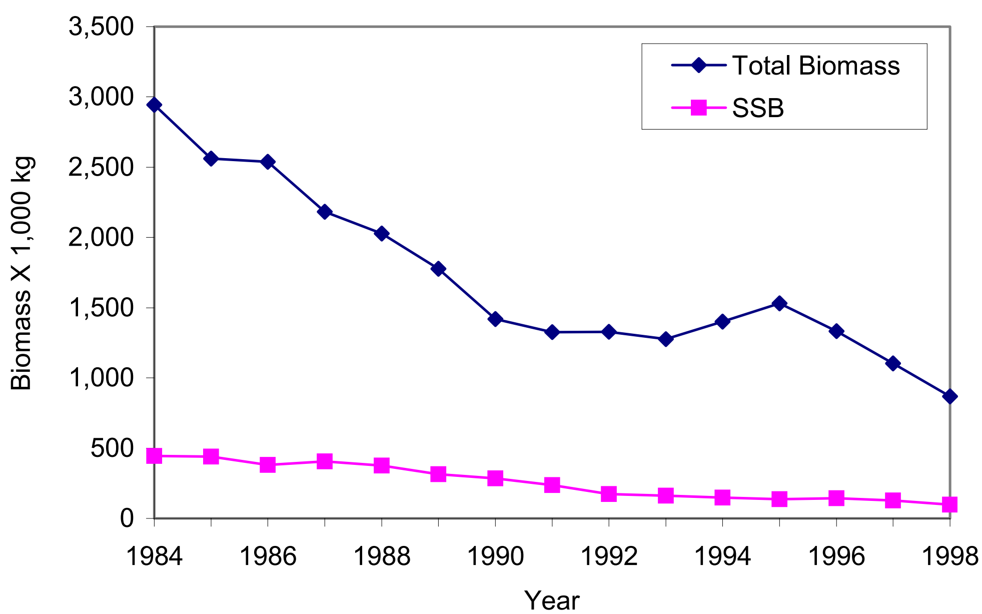

Figure 6.–Statistical-catch-at-age model estimates of lake trout biomass and spawning stock biomass (SSB) in southern Lake Huron (MH-3, MH-4, MH-5 and adjacent Canadian waters).