STUDY PERFORMANCE REPORT

State: Michigan **Project No.:** F-81-R-1

Study No.: 495 **Title:** Assessment of lake trout populations in Michigan waters of Lake Superior

Period Covered: October 1, 1999 to September 30, 2000

Cooperators: Bay Mills Indian Community, Brimley, Michigan; Charlevoix Fisheries Station, Michigan Department of Natural Resources, Charlevoix, Michigan; Chippewa Ottawa Resource Authority (formerly called Chippewa/Ottawa Treaty Fisheries Management Authority, Sault Ste. Marie, Michigan; College of Natural Resources, University of Wisconsin-Stevens Point; Department of Fisheries and Wildlife, Michigan State University; Great Lakes Indian Fish and Wildlife Commission, Odanah, Wisconsin; Isle Royale National Park, National Park Service; Peterson Fisheries, Hancock, MI; Keweenaw Bay Indian Community, Baraga, Michigan; Sivertson Fisheries, Duluth, Minnesota; Red Cliff Band of Lake Superior Chippewas, Bayfield, Wisconsin; Thill Fisheries, Marquette, Michigan; and U. S. Geological Survey, Biological Research Division, Ashland, Wisconsin.

Study Objectives: (1) To annually (or semi-annually) determine relative abundance, length and age composition, sex and maturity, sea lamprey wounding, growth, and mortality for lean and siscowet lake trout in Michigan's Lake Superior lake trout management units. (2) To periodically determine relative abundance, diet, and biological variables (age, growth, etc.) of lake trout varieties, other predator fish, and forage fish at various depth strata in Lake Superior. (3) To calculate total allowable catch (TAC) for lake trout in Michigan's Lake Superior management units.

Summary: In 1999, relative abundance of lean lake trout was higher than during 1998 in management units MI-4, MI-5, MI-6, and MI-7 and was lower in MI-3. Siscowet relative abundance in the 1999 spring survey remained relatively constant. Pre-recruit lean lake trout relative abundance in 1999 declined in management units west of Big Bay (MI-2, MI-3, and MI-4) but increased in management units east of Big Bay (MI-5, MI-6, and MI-7). Pre-recruit siscowet relative abundance in 1991 was lower than lean values in all management units, and declined from 1998 values in MI-3, MI-6, and MI-7. Based on 1999 spring diet samples, lean lake trout primarily ate rainbow smelt and coregonines. In MI-3, insects were observed in over 30% of lean lake trout stomachs. Fishes were the most frequent prey items observed in siscowet stomachs with the exception in MI-3, where insects were observed in 44.3% of sampled stomachs. The most frequent prey fish observed in siscowet stomachs were sculpins in MI-3, coregonines in MI-4, and rainbow smelt in MI-7. Statistical catch-at-age models were developed for wild lake trout populations in MI-5, MI-6, and MI-7. Model results indicated abundant wild lake trout in MI-5 and MI-7, with recent (mean of 1996-98) mortality rates below the established target maximum total annual mortality rate of 40%. The MI-6 model estimated lower wild lake trout abundance than the other areas and indicated that recent mortality rates were above the target maximum at 43%.

Job 1. Title: Assess commercial-sized lake trout.

Findings: Commercial-sized lean lake trout were sampled in the spring starting on 24 April and ending 08 June 2000. Contracted commercial fishers fished five stations in management unit MI-3 (Peterson Fisheries) and six stations in MI-5 (Thill fisheries) (Figure 1). Marquette Fisheries Research Station (MFRS) personnel aboard the R/V Judy sampled 14 stations in MI-4 and eight stations in MI-6. Chippewa Ottawa Resource Authority personnel sampled eight stations in MI-7. The total number of fish sampled was 6,362, including 4,240 lake trout. All data collected during this performance period have been entered into a computer database and were proofed for errors by MFRS personnel. Stratified-random subsamples of the total fish catch for each management unit will be aged using scales or otoliths collected from each fish.

During this performance period, commercial-sized lean lake trout were also sampled in MI-1 (Isle Royale) by the National Park Service (June-August 2000) and Sivertson Fisheries (September-October 1999). These data have not been processed due to staff shortages at MFRS.

Job 2. Title: Assess pre-recruit lake trout.

Findings: Pre-recruit lake trout were sampled in the summer starting on 01 August and ending 06 September 2000. Marquette Fisheries Research Station personnel aboard the R/V Judy sampled five stations in MI-2, seven stations in MI-3, eight stations in MI-4, four stations in MI-5, four stations in MI-6, and two stations in MI-7 (Figure 1). The total number of fish sampled was 3,950, including 2,053 lake trout. Stomach samples were collected from 464 fish and will be analyzed during the winter months. All data have been entered into a computer database and are currently being proofed for errors. All fish will be aged during the winter months using scales or otoliths collected during sampling.

Job 3. Title: Assess lake trout variety composition.

Findings: A siscowet lake trout survey was conducted during 19-28 June 2000. Marquette Fisheries Research Station personnel aboard R/V Judy sampled six stations in MI-5 (Figure 1) with depths ranging from 30 to 198 m (98 to 650 ft). The total number of fish sampled was 243 with 198 lake trout. Stomach samples were collected from all lake trout and are scheduled to be processed this winter. All data other than diet data have been entered into a computer database and proofed for errors. All fish will be aged during the winter months using scales or otoliths collected during sampling.

Relative abundance (GMCPUE=Geometric Mean Catch per unit effort) of siscowets in 2000 was lower than during the last summer siscowet survey in 1996 for all depth intervals, with the exception of the 73-109-m (240-359-ft) interval (Figure 4). Lean lake trout GMCPUE was slightly higher during 2000 than in 1996. No lean lake trout were captured in depths greater than 73 m (239 ft). In general, lean lake trout GMCPUE was higher than siscowet GMCPUE in the shallowest two depth intervals, 0-36 m and 37-73 m (0-119 ft and 120-239 ft).

Job 4. Title: Analyze assessment data.

Findings: Data collected during this performance period have not been analyzed.

1999 Spring survey–During 1999, relative abundance of lean lake trout was higher than during 1998 in MI-4, MI-5, MI-6, and MI-7 (Figure 2a). Lean lake trout GMCPUE declined in MI-3 during 1999. Siscowet GMCPUE has remained relatively constant from 1998 to 1999 (Figure 2b). Siscowet GMCPUE was highest in MI-7 and was as high as lean lake trout relative abundance. In all other units, siscowet GMCPUE was lower than lean lake trout GMCPUE. Overall, wild lake trout composed more than 80% of all lean lake trout catch (not adjusted for sampling effort). Spring sea lamprey wounding rates for 534-635 mm lean lake trout was greatest in MI-3 at 10.7 wounds (Type A1-A3) per 100 fish and was less than 5 wounds per 100 fish in MI-4 through MI-7.

1999 Pre-recruit survey–Pre-recruit lean lake trout GMCPUE in 1999 declined in MI-2, MI-3, and MI-4 from 1998 values (Figure 3). Pre-recruit GMCPUE increased in MI-5, MI-6, and MI-7. Pre-recruit siscowet GMCPUE was lower than lean GMCPUE in all units, and declined from 1998 values in MI-3, MI-6, and MI-7.

Job 5. Title: <u>Analyze diet data.</u>

Findings: *1999 Spring Survey*–In general, rainbow smelt were the most frequently observed prey fish in lean lake trout stomachs in all management units (Table 1). Coregonines were the next most frequent fish in lean stomachs, followed by sculpins, burbot, and then salmonines. Insects were observed in 31.5% of lean stomachs in MI-3 and 10.2% of lean stomachs in MI-7. Nearly all these insects were terrestrial, indicating that lean lake trout were foraging at the lake surface during the spring. The percentage of lean lake trout stomachs that were empty ranged from 18% in MI-3 to 58.4% in MI-7.

Siscowet stomachs were only collected in MI-3, MI-4, and MI-7 during 1999. In general, fish were the most frequent prey items observed in siscowet stomachs with the exception in MI-3 where insects were observed in 44.3% of sampled stomachs (Table 2). The most frequent prey fish observed in siscowet stomachs were sculpins in MI-3, coregonines in MI-4, and rainbow smelt in MI-7. Percent frequency of empty stomachs ranged from 10% in MI-4 to 52.3% in MI-7.

1999 Pre-recruit survey–Pre-recruit diet analyses have not been completed. Stomach contents were measured and numerically quantified for lean and siscowet lake trout during the spring 1998 survey. The most abundant fish observed in lean lake trout stomachs was rainbow smelt in MI-3, MI-4, MI-5, and MI-6. Diet data from MI-7 were not available at the time of this report. *Mysis relicta* was the most abundant invertebrate prey item observed in lean lake trout stomachs in MI-3, MI-4, and MI-6. *Diporeia* was the most abundant invertebrate prey item in MI-5. Siscowet lake trout stomach contents were analyzed only in MI-3 and MI-4. Sculpins and unidentified fishes were the most abundant food item in siscowets in MI-3. In MI-3, the number of terrestrial insects observed in siscowet stomachs was greater than all other invertebrates. Rainbow smelt was the most abundant prey fish observed in siscowets in MI-4. *Mysis relicta* and *Diporeia* were the most abundant invertebrate prey observed in siscowet stomachs in MI-4. Very few terrestrial insects were observed in MI-4 siscowet stomachs.

Job 6. Title: Model lean lake trout populations.

Findings: Statistical catch-at-age models have been developed for wild lake trout populations in MI-5, MI-6, and MI-7 (Figure 1). Finalized model parameters have been estimated for MI-5 and MI-7, but more evaluations are necessary for the MI-6 model. Overall, model results indicated abundant wild lake trout populations in MI-5 and MI-7 with mortality rates below the target maximum rate established by the Great Lakes Fishery Commission (target maximum A=40%). The model for MI-6 indicated that the population is suffering mortality rates slightly above the target maximum rate. The status of the lake trout populations was indexed by comparing Spawning Stock Biomass produced per Recruit (SSBR) values with the target value. This index is a measure of the reproductive capacity of the population in the context of mortality rates. The SSBR for each population is the sum of the mature female biomass produced per recruit under recent mortality rates (mean of 1996-98 rates). The target SSBR is the theoretical amount of SSBR produced if all fish older than age 7 suffer the target maximum total annual mortality rate of 40%. This approach of indexing population health accounts for the age-specific differences in mortality rates from fishing and sea lamprey predation, and incorporates the reproductive capacities of each population.

Recent total abundance (mean of 1996-98) of wild lake trout ages 3 to 15 was estimated to be about 994,000 in MI-5; 93,700 in MI-6; and 1.1 million in MI-7 (Figure 5). Mean total annual mortality rates during 1996 to 1998 for ages 6 to 11 wild lake trout were 0.25 in MI-5, 0.43 in MI-6, and 0.28 in MI-7 (Figure 6). Recreational fishing mortality was the dominant mortality source in MI-6 during 1996-98. Sea lamprey mortality was the dominant mortality source in MI-5 and MI-7. The SSBR values were above the target in MI-5 and MI-7 (Figure 7). In MI-6, SSBR was 37% below the target value. These modeling results have been used to estimate lake trout Total Allowable Catch (TAC) for the 1836 Great Lakes fishery treaty negotiations between the State of Michigan and 1836 treaty Native American tribes. Currently, hatchery lake trout models have been partially developed for MI-5, MI-6, and MI-7. Data have been partially assembled for MI-2, MI-3, and MI-4 wild and hatchery lake trout models.

Job 7. Title: Prepare reports.

Findings: This study performance report was written during this performance period.

Prepared by: S.P. Sitar
Dated: September 30, 2000

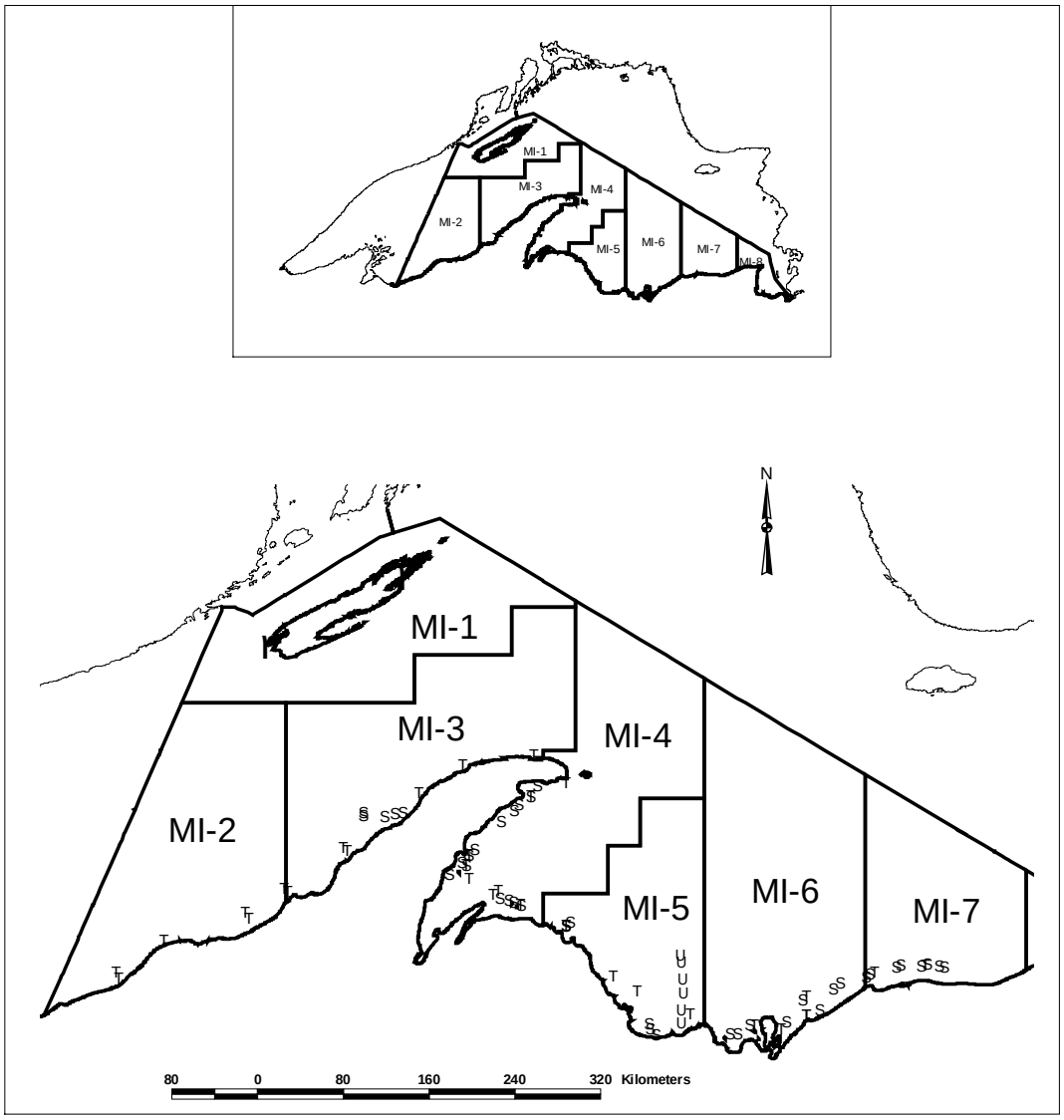

Figure 1.–Lake trout management units and lake trout survey sampling stations in Michigan waters of Lake Superior for 1999-2000. Circles represent spring survey stations, triangles represent summer pre-recruit survey stations, asterisks represent Isle Royale survey stations, and squares represent siscowet survey stations.

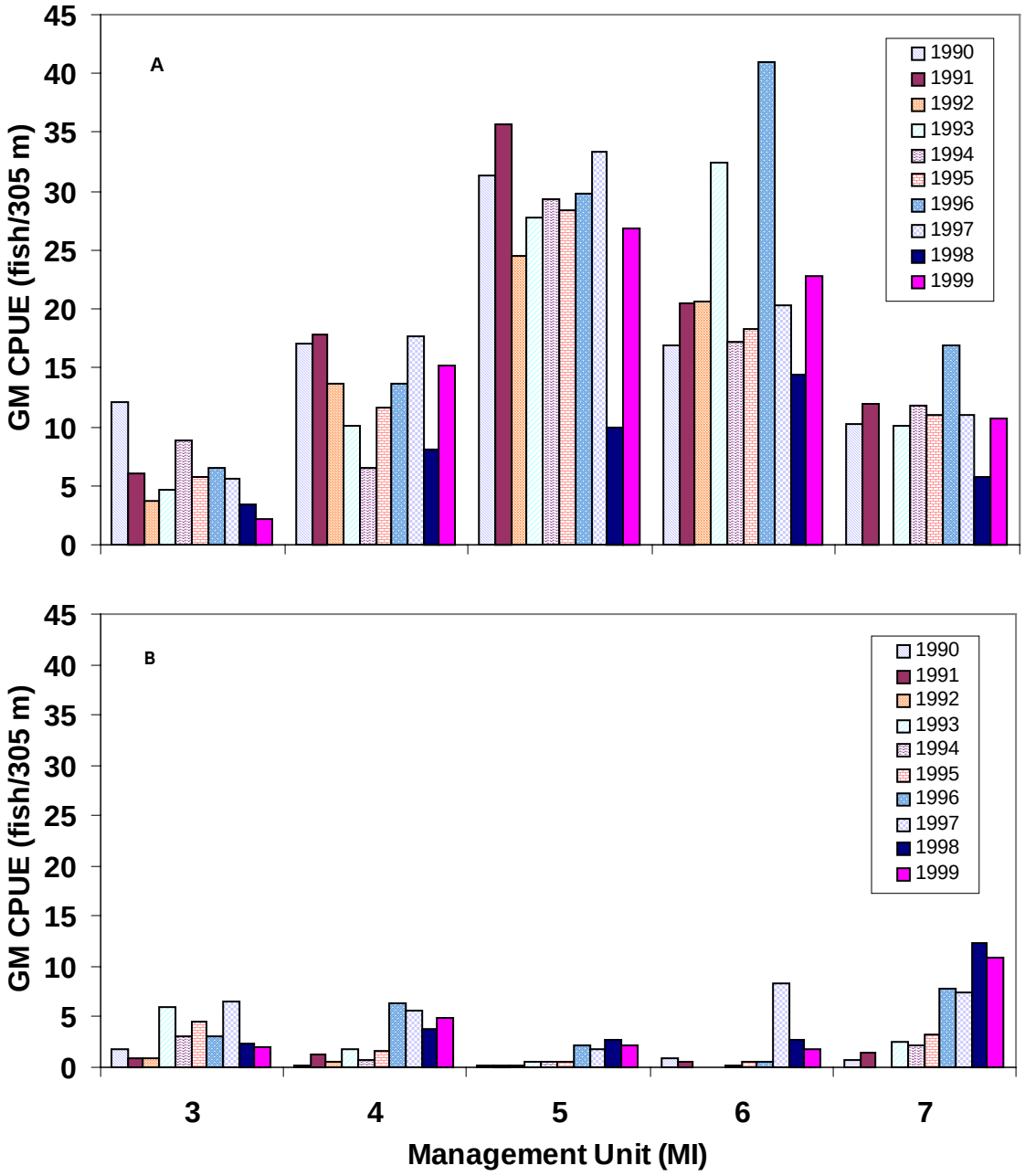

Figure 2.–Relative abundance of (A) lean, and (B) siscowet lake trout during spring surveys from 1990 to 1999 in Michigan waters of Lake Superior. Data expressed as geometric mean catch per unit effort (GM GMCPUE) based on 11.4 cm stretched-mesh bottom gill nets set for three nights. No survey was conducted in MI-7 during 1992.

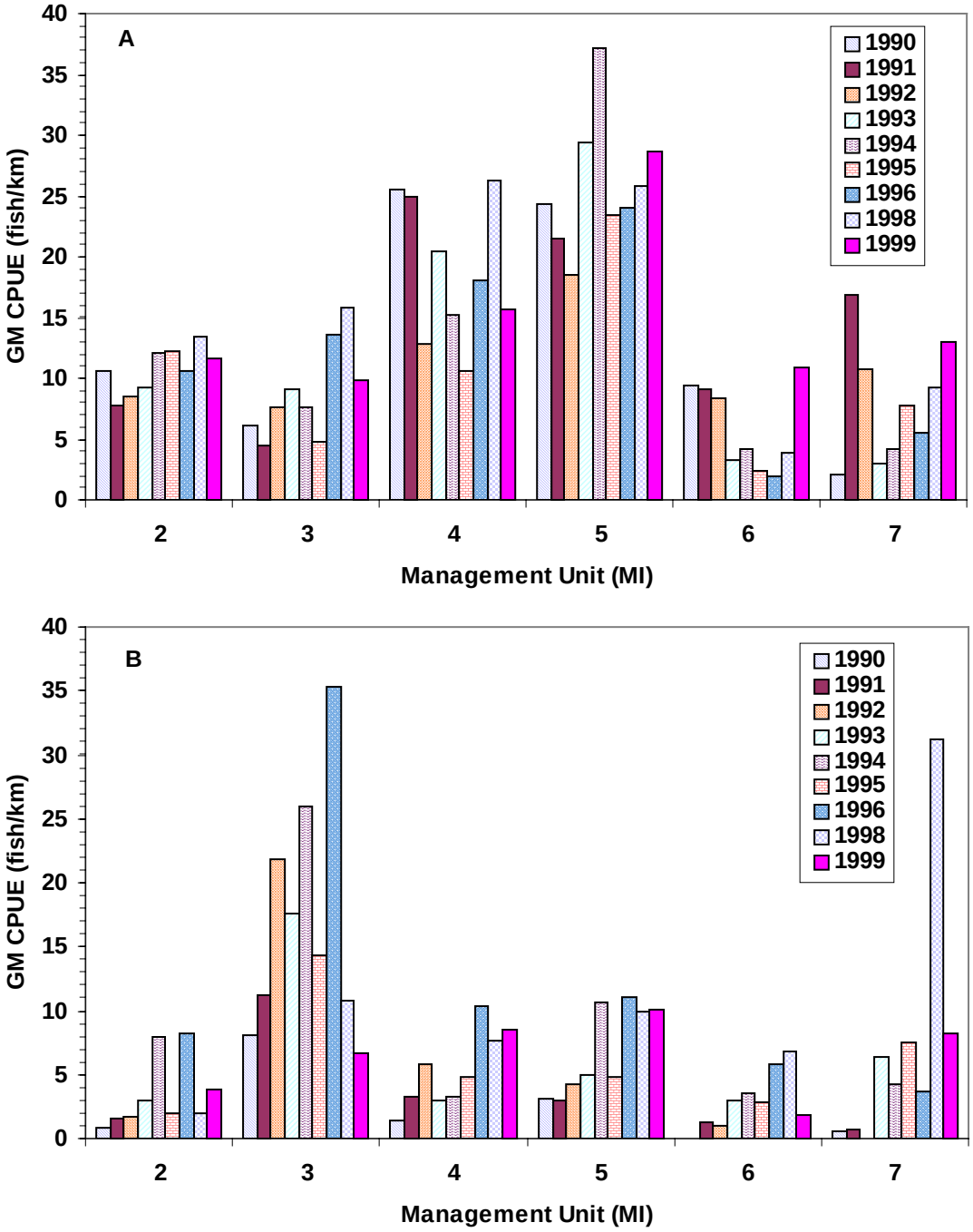

Figure 3.–Relative abundance of (A) lean, and (B) siscowet lake trout during summer pre-recruit surveys from 1990 to 1999 in Michigan waters of Lake Superior. Data expressed as geometric mean catch per unit effort (GM GMCPUE) based on 11.4 cm stretched-mesh bottom gill nets set for one night. No survey was conducted in 1997.

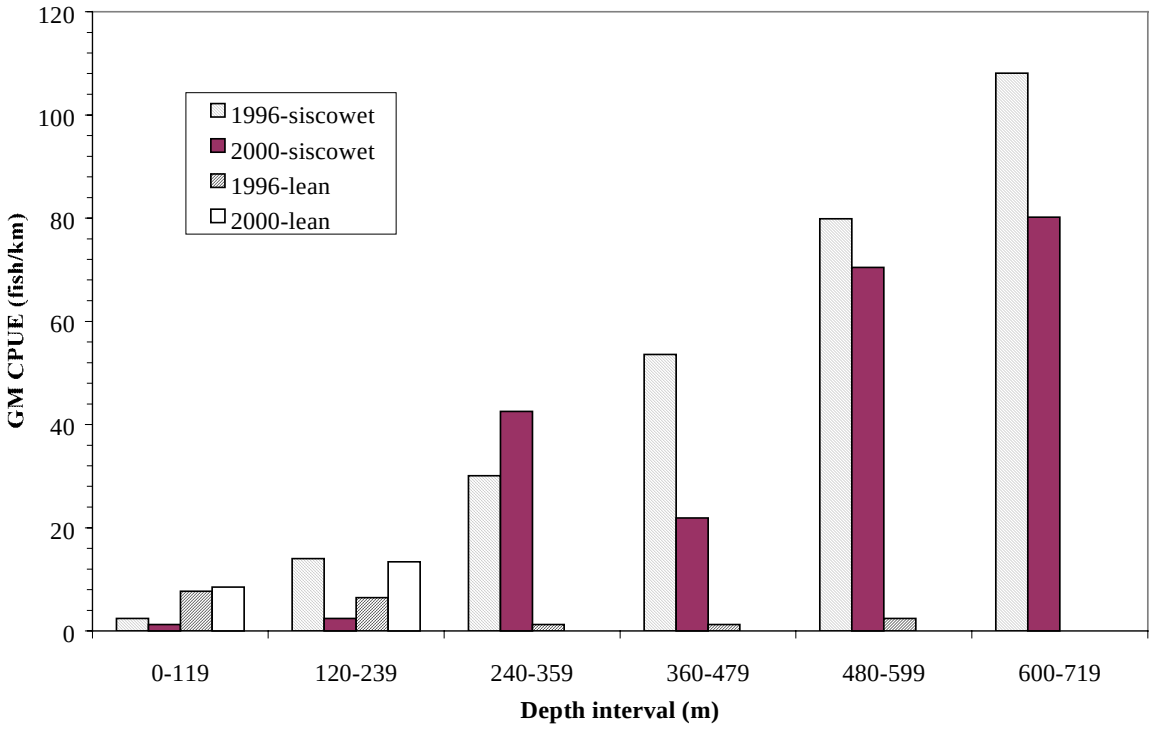

Figure 4.–Relative abundance of lake trout sampled in summer siscowet surveys in MI-5 during 1996 and 2000.

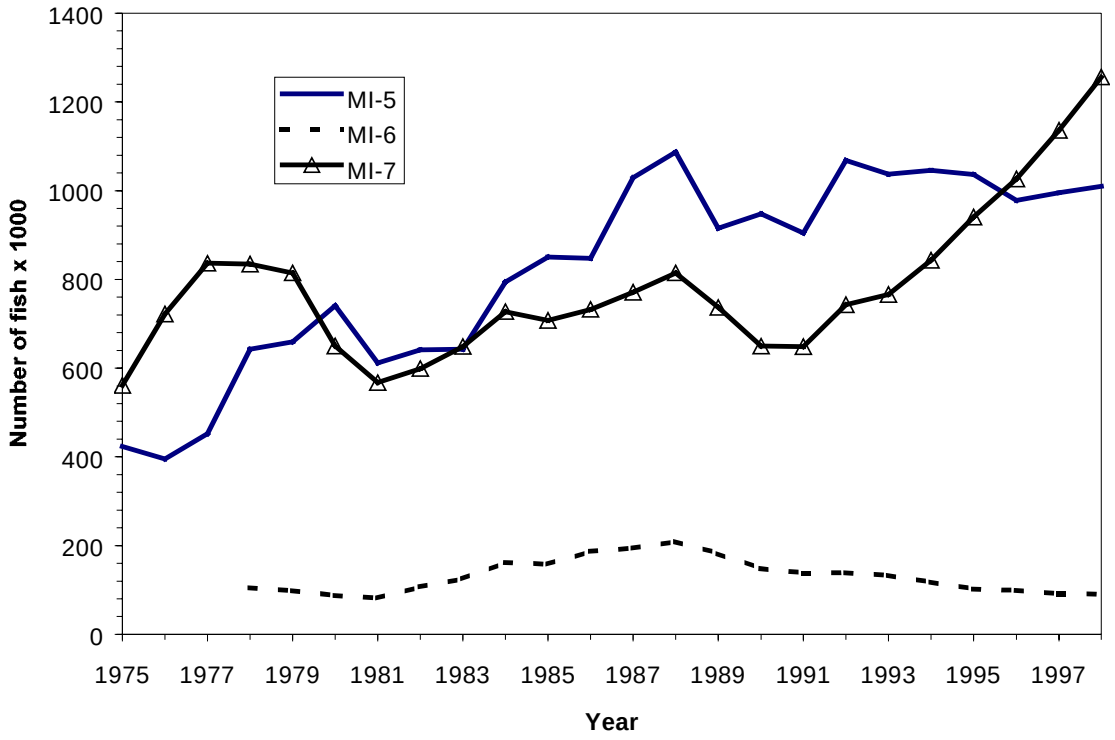

Figure 5.–Abundance of wild lake trout ages 3-15 in MI-5, MI-6, and MI-7 based on estimates from statistical catch-at-age models.

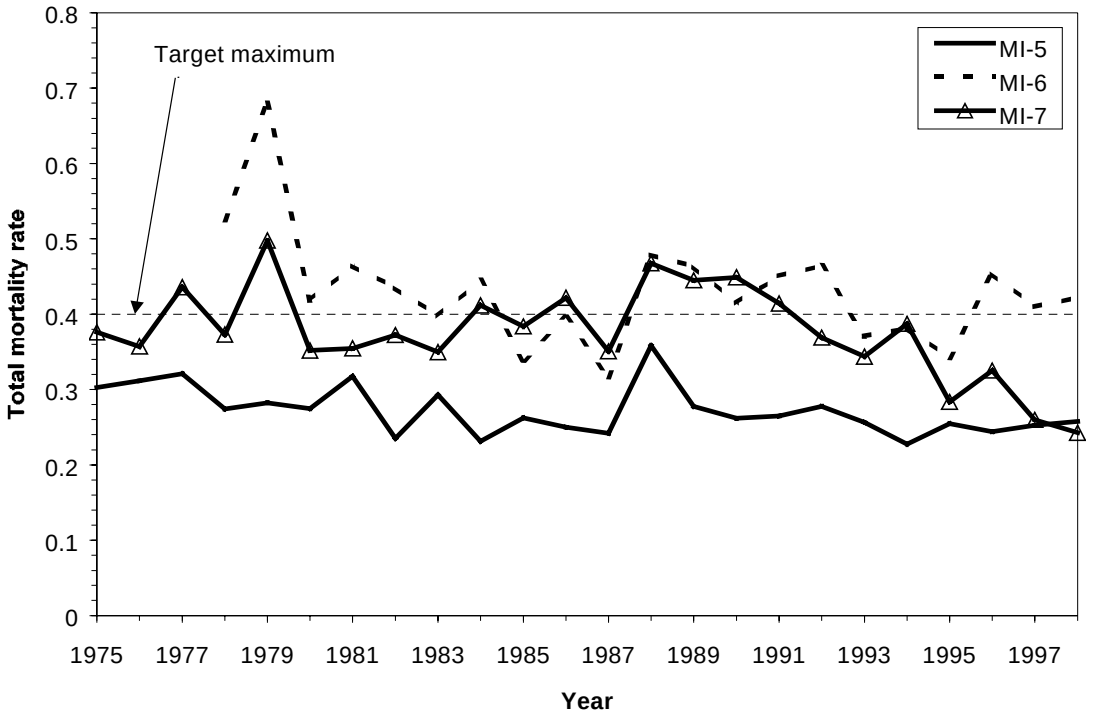

Figure 6.–Average total annual mortality rates for wild lake trout ages 6-11 during 1996-98 in MI-5, MI-6, and MI-7 based on statistical catch-at-age models. The thin dashed line indicates the Great Lakes Fishery Commission's lake trout rehabilitation target maximum mortality rate of 0.4.

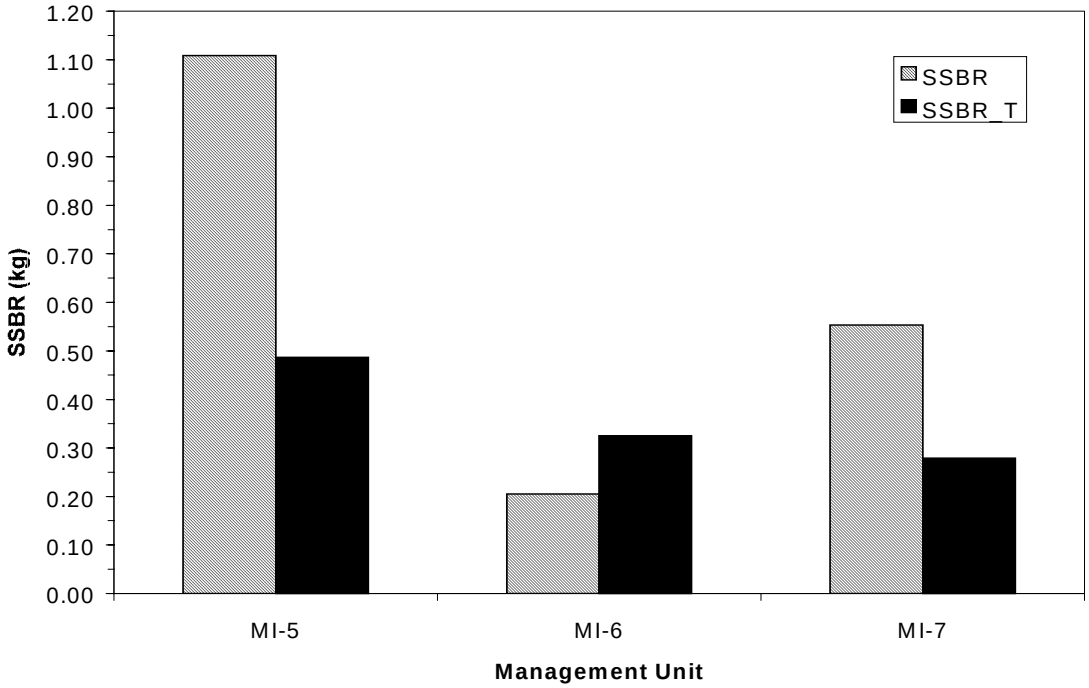

Figure 7.–Reproductive status of wild lake trout populations in MI-5, MI-6, and MI-7 based on results from statistical catch-at-age models. Reproductive status was indexed by Spawning Stock Biomass produced per Recruit (SSBR) values. SSBR was based on the average of 1996-98 mortality rates and female maturity schedules for each management unit. SSBR_T was the target SSBR value based on the Great Lakes Fishery Commission target maximum total annual mortality rate of 40%.

Table 1.–Spring lean lake trout diet compositions for Michigan waters of Lake Superior in 1999. Data expressed as percent frequency occurrence among sampled stomachs in each management unit. Prey category "other fish" comprised mainly unidentified fish remains, which were assumed to be in the same proportion as identified fishes. Prey category "Other" included plant material, stones, sand, and other unidentifiable biological matter.

	Management unit				
Prey category	MI-3	MI-4	MI-5	MI-6	MI-7
Smelt	19.1	40.0	34.7	43.7	13.3
Sculpin	9.0	2.7	4.1	4.9	1.2
Coregonine	14.6	17.3	14.3	10.7	4.8
Burbot	1.1		2.0		
Salmonine		0.9	2.0		
Other fish	27.0	39.1	28.6	41.7	37.3
Insect	31.5	2.7		5.8	10.2
Crustacean	4.5	5.5		1.0	
Bird					0.6
Other	15.7	7.3		1.9	
Empty	18.0	19.1	32.7	28.2	58.4
n	89	110	49	103	166

Table 2.–Spring siscowet lake trout diet compositions for Michigan waters of Lake Superior in 1999. Data expressed as percent frequency occurrence among sampled stomachs in each management unit. Prey category "other fish" comprised mainly unidentified fish remains, which were assumed to be in the same proportion as identified fishes. Prey category "other" included plant material, stones, sand, and other unidentifiable biological matter.

	Management unit		
Prey category	MI-3	MI-4	MI-7
Smelt	3.4	18.0	7.6
Sculpin	21.6	10.0	3.0
Coregonine	14.8	28.0	0.8
Burbot		11.0	0.8
Salmonine	1.1	4.0	0.8
Other fish	20.5	46.0	50.0
Insect	44.3	7.0	10.6
Crustacean	2.3	9.0	
Bird	2.3		1.5
Mollusk	1.1	1.0	0.8
Other	30.7	10.0	
Empty	22.7	10.0	52.3
n	88	100	132