

STUDY PERFORMANCE REPORT

State: Michigan

Project No.: F-53-R-15

Study No.: 465

Title: Assessment of lake whitefish populations
in Michigan waters of Lake Superior.

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

Study Objective: (1) To specify what areal, and size or age, segments of the whitefish stocks the trap-net, gill-net, and hook-and-line fisheries harvest. (2) To gather trap-net data needed to determine total allowable catches.

Summary: During 1998, an estimated total of 5,773 lake whitefish was harvested by sport anglers in MS-4 and none were estimated harvested in MS-3. The estimated lake whitefish sport harvest was 5,259 in MM-4. In Michigan waters of Lake Superior between Ontonagon and Munising, tribal commercial gill-net fishers harvested 218,199 kg of lake whitefish and state-licensed commercial trap-net fishers harvested 110,619 kg. Largest values for mean length, mean weight, and mean age were found for lake whitefish at Marquette and Munising during 1998. Lake whitefish total annual mortality ranged from 35% at Grand Marais (1997 data) to 76% at Upper Entry (1998 data). In management units where 1996-98 data were pooled, total annual mortality ranged from 44% at Marquette to 69% at Big Bay.

Job 1. Title: Summarize creel survey data.

Findings: Lake whitefish catch data were collected in 1998 sport fishery creel surveys conducted under Study 427. Sport harvest of lake whitefish was estimated in Lake Superior management zones MS-3 (Keweenaw Bay) and MS-4 (Marquette and Munising). The sport-harvest estimate from Lake Michigan management zone MM-4 (Grand Traverse Bay) was used to put Lake Superior harvests in perspective. There was no estimated sport catch of lake whitefish in MS-3 (Keweenaw Bay) for the second year in a row. An estimated 5,773 lake whitefish were caught in the MS-4 (Marquette and Munising) sport fishery, the highest catch since 1988 (Table 1). Seventy-five percent of the 1998 Lake Superior sport harvest was caught during the ice-fishing season. In MM-4, estimated sport harvest during 1998 (5,259 lake whitefish) was less than one-fourth the 1997 estimate but was more in line with estimates from the early 1990s (Table 1).

Job 2. Title: Summarize tribal data.

Findings: Commercial gill-net fisheries data were reported by the Chippewa/Ottawa Treaty Fisheries Management Authority for the Munising area (1836 Treaty Ceded waters) and by the Great Lakes Indian Fish and Wildlife Commission for Lake Superior waters near Marquette, Big Bay, Keweenaw Bay, Upper Entry, and Ontonagon (1842 Treaty Ceded waters). Native American commercial gill-net harvest was 218,199 kg in Michigan waters of Lake Superior during 1998 (Table 2). Gill-net harvests have fluctuated from 81,753 to 175,482 kg during the 1990s.

Job 3. Title: Collect trap-net lake whitefish data.

Findings: State-licensed fishers harvested lake whitefish with trap nets. Lake whitefish commercial catch and effort data (Table 2) were tabulated from catch reports submitted to the Michigan Department of Natural Resources by each fisher. Marquette Station personnel collected lake whitefish data dock-side in 1998 during June, July, August, and October (7 days total) at Munising, during June and July (3 days total) at Marquette, during June and July (2 days total) at Big Bay, and during June and October (2 days total) at Upper Entry. No state-licensed fishing was done at Ontonagon, Keweenaw Bay, or Grand Marais during 1998. All sampled whitefish were measured (total length) and scales were taken for age determination. In addition, between 196 and 1,357 fish from each sampling area were weighed (round weight) to determine weight-length relationships.

Of 234 kidney swabs taken from Lake Michigan lake whitefish in 1997, 32% tested positive for *Renibacterium salmoninarum*, the bacterium that causes bacterial kidney disease in trout and salmon. These findings led to expanded testing during 1998, including examination of 54 lake whitefish from Lake Superior. Only 2% of the Lake Michigan whitefish tested positive in 1998 and none of the lake whitefish from Lake Superior tested positive.

Job 4. Title: Analyze lake whitefish data.

Findings: Biological data gathered from the 1998 sport fishery were too limited (length, weight, sex, age for 25 fish) to provide any meaningful comparisons between areas or among years. Schorfhaar and Schneeberger (1997) analyzed and compared size-at-age, age composition, and mortality rates of lake whitefish caught by sport anglers between 1985 and 1996. Biological data from the trap-net fishery were analyzed and used to estimate various population parameters.

Catch, effort, and CPE statistics for state-licensed trap-net fisheries (Table 2) showed that 1998 harvests were similar to those from 1997 at Marquette and Big Bay. Harvest at Munising increased 164% between 1997 and 1998. Harvest at Upper Entry was low relative to other years during the 1990s when fishers operated in the area. Overall, commercial trap-net catch was higher than any year since 1994. Trap-net effort increased at Big Bay (106%), Marquette (135%), and Munising (235%). CPEs were lower for 1998 than for 1997 at Big Bay, Marquette, and Munising. CPE for Upper Entry was higher in 1998 than in other years since 1993. No state-licensed fishing occurred at Ontonagon or Keweenaw Bay during 1998.

Lake whitefish total annual mortality rates were derived from estimates of survival using coded age frequencies (Robson and Chapman 1961). The Tripartite Technical Fisheries Review Committee recommended that total annual mortality rate not exceed 50-55% (depending on area) to adequately protect Lake Superior whitefish stocks. Mortality estimated from pooled data exceeded the target maximum rate at Keweenaw Bay (1996-97 data), and Big Bay (1996-98 data), but was well below the target maximum rate at Marquette (1996-98 data) and Munising (1996-98 data) (Table 3). Total annual mortality was high for fish at Upper Entry (1998 data) similar to relatively high estimates made from years when pooled data were used for calculations.

Weight-length relationships and von Bertalanffy growth coefficients (Table 4) were calculated using 3-yr pooled data as available. Parameters generally varied without trend.

Mean values for length and weight were greatest in 1998 for lake whitefish at Marquette and Munising, lower at Big Bay, and lowest at Upper Entry (Table 5). Mean age of fish in

commercial catches was oldest at Marquette, slightly, younger at Upper Entry and Munising, and youngest at Big Bay. Values for mean length, weight, and age increased between 1997 and 1998 at Marquette and Munising, and differences were significant for length (Marquette and Munising), weight (Munising), and age (Marquette). Values for fish at Big Bay were statistically unchanged between 1997 and 1998. During 1993-98, mean length, mean weight, and mean age have generally fluctuated without trend in all fishing areas.

As was the case last year, no total allowable catch (TAC) calculations were made for 1998. Past TACs were calculated using the Stock Assessment Package One (Clark and Smith 1985) computer program. There has been little correspondence between TAC and actual catch because commercial fishing effort has varied unpredictably (Schorfhaar and Schneeberger 1997). Efforts are now focused on calculating TACs using an age-structured stock-assessment model that is currently being developed as part of the negotiations for the court-ordered consent agreement that has been in place since 1985 and will expire in May of 2000.

Job 5. Title: Prepare reports.

Findings: A report for the Great Lakes Fishery Commission and this 1998-99 Study Performance Report were prepared during this study segment.

Literature Cited:

- Clark, R. D., Jr., and K. D. Smith. 1985. Methods for determining catch quotas for Great Lakes fish. Michigan Department of Natural Resources, Fisheries Federal Aid Final Report Study 524, Ann Arbor, Michigan.
- Robson, D. S., and D. G. Chapman. 1961. Catch curves and mortality rates. Transactions of the American Fisheries Society 90:181-189.
- Schorfhaar, R.G. and P.J. Schneeberger. 1997. Commercial and sport fisheries for lake whitefish in Michigan waters of Lake Superior, 1983-1996. Michigan Department of Natural Resources, Fisheries Research Report No. 2034, Ann Arbor, Michigan.

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Table 1.—Creel survey estimate data for lake whitefish in Lake Michigan and Lake Superior. Estimated harvest in numbers of fish, round weight in kg, and effort in non-targeted angler hours.

Year	MM-4 Grand Traverse Bay			MS-3 Keweenaw Bay			MS-4 Marquette and Munising		
	Harvest	Weight	Effort	Harvest	Weight	Effort	Harvest	Weight	Effort
1985	89,866	126,365	466,505						
1986	53,875	75,757	335,002						
1987	20,011	21,784	284,478	1,184	1,558	29,365	9,587	3,479	157,697
1988	13,636	11,752	262,402	5,160	6,085	102,597	8,023	4,003	138,865
1989	13,806	13,151	251,561	5,421	4,180	107,951			
1990	12,102	10,430	191,901	121	137	32,551	698	380	69,777
1991 ^a	10,746	11,698	233,139	212	240	57,647	4,082	1,481	168,410
1992	4,978	5,419	191,459	364	479	67,137	1,192	433	150,663
1993	2,480	3,375	179,805	471	620	94,709	2,536	805	152,316
1994	4,152	4,897	184,550	408	518	125,975	1,102	550	116,497
1995	4,428	4,619	196,525	10	12	69,297	4,225	1,533	94,848
1996	10,490	11,420	191,401	97	119	86,569	2,515	1,141	118,204
1997 ^b	21,932	~23,029	278,426	0	0	48,386	2,729	990	134,001
1998	5,259	~5,522	304,638	0	0	40,553	5,773	2,357	103,097

^a Only month of May was surveyed at Keweenaw Bay.

^b Winter ice fishery was not surveyed at Keweenaw Bay and Munising.

Table 2.—Lake whitefish harvest (kg), effort (trap-net lifts, 305 m of gill net), and catch per unit effort (CPE - kg per trap-net lift, kg per 305 m of gill net) in Lake Superior commercial fisheries, 1993-98.

Fishing area (stat. district)	Year	Trap net ^a			Gill net ^b			Total catch
		Catch	Effort	CPE	Catch	Effort	CPE	
Ontonagon (MS-2)	1994				9,954	294	34	9,954
	1995	3,708	72	52	9,552	302	32	13,260
	1996				32,152	658	49	32,152
	1997				29,440	^c	^c	29,440
	1998				58,273	913	64	58,273
Upper Entry (MS-3)	1993	39,189	378	104	50,979	1,370	37	90,168
	1994	51,966	434	120	20,302	1,316	15	72,268
	1995	40,610	352	115	25,930	1,059	24	66,540
	1996				31,823	797	40	31,823
	1997				53,607	^c	^c	53,607
	1998	27,202	200	136	67,673	1,739	39	70,393
Keweenaw Bay (MS-3)	1993	19,277	154	125	68,222	5,529	12	87,499
	1994	17,799	190	94	39,990	3,581	11	57,789
	1995				38,412	1,994	19	38,412
	1996	18,072	133	136	49,088	2,587	19	67,160
	1997	14,292	135	106	68,516	^c	^c	82,808
	1998				63,224	2,492	25	63,224
Big Bay (MS-4)	1993	14,902	129	116	15,657	759	21	30,559
	1994	11,712	95	123	4,558	294	16	16,270
	1995	8,584	50	172	3,648	101	36	12,232
	1996	11,755	46	256				11,755
	1997	24,043	136	177				24,043
	1998	20,370	144	141				20,370
Marquette (MS-4)	1993	16,134	272	59	738	61	12	16,872
	1994	18,212	260	70	524	36	15	18,736
	1995	15,407	222	69	565	12	47	15,972
	1996	20,360	196	104				20,360
	1997	13,414	151	89	9,994	^c	^c	23,418
	1998	13,957	204	68	11,091	355	31	25,048
Munising (MS-4)	1993	38,215	935	41	5,588	656	9	43,803
	1994	29,897	695	43	12,254	1,184	10	42,151
	1995	23,976	520	46	3,646	360	10	27,622
	1996	13,740	284	48	12,994	896	14	26,734
	1997	29,839	337	88	13,925	657	21	43,764
	1998	49,090	791	62	17,938	607	30	67,028

Table 2. Continued.

Fishing area	Year	Trap net ^a			Gill net ^b			Total catch
		Catch	Effort	CPE	Catch	Effort	CPE	
All the above	1993	127,717	1,868	68	141,184	8,375	17	268,901
	1994	129,586	1,674	77	87,582	6,705	13	217,168
	1995	92,285	1,216	76	81,753	3,828	21	174,038
	1996	63,927	659	97	126,057	4,938	26	189,984
	1997	81,588	759	107	175,482	^c	^c	257,070
	1998	110,619	1,339	83	218,199	6,106	36	328,818

^a Large-mesh trap nets used by state-licensed fishers.

^b Large-mesh gill nets used by tribal fishers. Gill-net catch statistics are from Great Lakes Indian Fish & Wildlife Commission (GLIFWC) for Upper Entry, Keweenaw Bay, Big Bay, and Marquette. Statistics from Chippewa-Ottawa Treaty Fishery Management Authority for Munising.

^c 1997 GLIFWC effort data not available for this report.

Table 3.—Total annual mortality rates of lake whitefish in state-licensed commercial trap-net catches, with 2 SE and ages included in calculations. When possible, data from each Lake Superior fishing area were pooled over 3-year intervals.

Fishing area	Years pooled	Mortality	2 SE	Ages included
Ontonagon	1995	0.47	0.04	6-14
Upper Entry	1992-93	0.59	0.04	7-12
	1992-94	0.63	0.03	7-12
	1993-95	0.78	0.03	7-11
	1994-95	0.77	0.04	7-11
	1998	0.76	0.10	9-11
Keweenaw Bay	1993-94	0.71	0.04	7-12
	1994 & 1996	0.62	0.03	6-14
	1996-97	0.65	0.04	7-14
Big Bay	1991-93	0.38	0.02	7-16
	1992-94	0.37	0.02	6-16
	1993-94	0.53	0.03	6-16
	1994 & 1996	0.58	0.05	7-12
	1996-97	0.64	0.05	7-12
	1996-98	0.69	0.06	8-14
Marquette	1991-93	0.42	0.03	8-17
	1992-94	0.41	0.03	9-17
	1993-95	0.49	0.06	13-17
	1994-96	0.30	0.02	8-17
	1995-97	0.32	0.02	7-17
	1996-98	0.44	0.02	7-19
Munising	1991-93	0.54	0.07	12-17
	1992-94	0.55	0.06	12-17
	1993-95	0.51	0.05	12-17
	1994-96	0.40	0.03	10-17
	1995-97	0.35	0.02	7-20
	1996-98	0.47	0.02	7-18
Grand Marais	1997	0.35	0.06	8-17

Table 4.–Vital statistics from state-licensed commercial trap-net data sets (pooled over 3 yr period when possible) used to generate lake whitefish total allowable catches for Lake Superior stocks.

Fishing area	Years pooled	Instantaneous fishing mortality ^a (F)	Weight-length coefficients ^b		Von Bertalanffy coefficients			Mean dressed weight of fish In catch (kg)	Catch (dressed kg) ^c
			Intercept	Slope	K	L _∞ (mm)	t ₀		
Ontonagon	1995	0.38	-13.00	3.22	0.115	894	-0.108	1.5	13,260
Upper Entry	1992-93	0.65	-12.67	3.17	0.314	552	-0.004	1.0	102,911
	1992-94	0.75	-12.05	3.07	0.314	551	-0.005	1.0	92,697
	1993-95	1.26	-12.02	3.07	0.362	531	-0.002	0.9	76,325
	1994-95	1.21	-10.74	2.86	0.496	507	-0.001	0.9	69,404
	1998	1.18	-11.88	3.04	0.429	515	-0.000	1.1	70,393
Keweenaw Bay	1993-94	1.00	-13.26	3.27	0.020	800	-0.500	1.0	72,644
	1994 & 96	0.73	-12.69	3.18	0.129	809	-0.164	1.1	62,474
	1996-97	0.80	-12.98	3.22	0.149	746	-0.276	1.0	74,984
Big Bay	1991-93	0.23	-12.92	3.20	0.358	596	-0.007	1.4	33,479
	1992-94	0.22	-12.25	3.09	0.365	590	-0.006	1.4	26,477
	1993-94	0.50	-12.70	3.17	0.272	662	-0.018	1.5	23,414
	1994 & 96	0.61	-12.52	3.14	0.225	680	-0.008	1.4	14,012
	1996-97	0.78	-13.72	3.34	0.279	627	0.015	1.3	17,899
	1996-98	0.92	-9.12	2.60	0.252	656	-0.057	1.3	18,723
Marquette	1991-93	0.30	-14.67	3.48	0.176	790	-0.040	1.9	30,739
	1992-94	0.28	-14.44	3.45	0.178	792	-0.026	1.9	22,048
	1993-95	0.43	-13.59	3.31	0.183	786	-0.020	2.1	17,193
	1994-96	0.11	-13.51	3.30	0.168	801	-0.022	2.0	18,356
	1995-97	0.14	-13.84	3.35	0.159	805	-0.036	1.9	19,917
	1996-98	0.34	-11.25	2.94	0.202	718	0.015	1.5	22,942
Munising	1991-93	0.52	-11.94	3.05	0.202	731	-0.111	1.8	68,981
	1992-94	0.56	-13.03	3.23	0.212	727	-0.080	2.0	48,691
	1993-95	0.46	-12.23	3.11	0.219	733	-0.016	2.5	37,388
	1994-96	0.27	-14.50	3.46	0.201	740	-0.035	2.2	31,716
	1995-97	0.18	-13.66	3.33	0.196	734	-0.085	1.8	30,913
	1996-98	0.39	-13.92	3.36	0.182	753	-0.178	1.5	38,069

^a Instantaneous rate of natural mortality (M) was assumed to be 0.25 year⁻¹ (Rakoczy 1983) in all fishing areas.

^b $\log_e(\text{Weight})=a + b(\log_e[\text{Length}])$

^c Computed from catch data in Table 1.

Table 5.—Mean length, weight, and age (with \pm factor for 95% confidence intervals) of Lake Superior lake whitefish in state-licensed commercial trap nets, 1993-97. Total length in millimeters, round weight in grams, age in years.

Fishing area	Year	Length		Weight		Age	
		Mean	\pm factor	Mean	\pm factor	Mean	\pm factor
Ontonagon	1995	496.4	6.5	1,536.4	209.9	7.0	0.2
Upper Entry	1993	473.6	2.5	987.4	44.1	6.4	0.1
	1994	465.2	2.3	919.1	29.7	6.5	0.1
	1995	470.8	3.5	910.9	29.5	6.7	0.1
	1998	494.4	3.9	1,066.0	29.4	7.5	0.1
Keweenaw Bay	1993	478.8	3.3	977.7	56.6	6.9	0.1
	1994	473.6	3.0	990.4	39.8	6.2	0.1
	1996	487.5	5.0	1,188.4	85.6	6.6	0.2
	1997	456.8	2.3	845.9	23.9	6.4	0.1
Big Bay	1993	542.6	6.5	1,472.6	128.4	6.3	0.2
	1994	519.6	5.4	1,464.5	65.0	6.5	0.1
	1996	515.9	5.7	1,298.9	72.1	6.6	0.2
	1997	522.3	4.9	1,258.2	51.8	6.8	0.1
	1998	523.7	4.6	1,263.1	39.7	6.8	0.1
Marquette	1993	587.7	7.2	1,771.8	158.1	8.0	0.2
	1994	585.0	7.9	1,695.0	163.3	7.8	0.2
	1995	639.7	5.8	2,841.7	168.1	9.9	0.2
	1996	524.3	6.6	1,474.8	136.8	7.2	0.2
	1997	532.1	4.9	1,453.5	139.6	7.1	0.1
	1998	552.5	6.6	1,578.3	81.1	7.9	0.2
Munising	1993	581.8	7.0	2,225.9	178.5	8.3	0.3
	1994	609.7	6.1	2,475.7	155.3	8.7	0.2
	1995	624.6	5.7	2,790.7	142.9	9.1	0.3
	1996	509.7	5.6	1,191.2	109.2	7.5	0.2
	1997	527.6	6.2	1,214.2	85.5	7.2	0.2
	1998	547.2	3.8	1,544.2	43.9	7.5	0.1