STUDY PERFORMANCE REPORT

State: Michigan **Project No.:** F-53-R-13

Study No.: 485 **Title:** Assessment of chinook salmon and steelhead trout populations in eastern Lake Michigan

Period Covered: April 1, 1996 to March 31, 1997

Study Objectives: To assess health of chinook salmon and steelhead trout stocks using parameters of growth, mortality, diet composition, and clinical indicators of disease.

Summary: Data collection through fishery-independent sampling programs is an essential component of fisheries stock assessment and management. Michigan Department of Natural Resources (MDNR) experimental sampling of chinook salmon and steelhead using surface gill nets began in 1990, and we were not routinely successful in collecting these fish until 1994. This study is a continuation of the sampling program initiated in 1990.

During 1996, chinook salmon (N=1,072) and steelhead (N=411) were sampled from statistical districts MM-8 to MM-3 (Figure 1) during May to August. Samples were collected using graded-mesh, monofilament gill nets (9 m deep and 975 m long). Overall catch per unit effort (number of fish per 4 h of net effort) was higher for chinook salmon (32 fish per 4 h) than for steelhead (12 fish per 4 h). The highest catch rates for both species were observed in the southern districts and in shallower (<46 m deep), inshore waters. Most tagged chinook salmon collected (35%) were from plants in the Grand River, Michigan, but 34% of all chinook salmon collected (tagged and untagged) appeared to be from natural reproduction. Complete biological data were recorded for all salmonines collected. This data included information on age and growth of salmonines, diet, lamprey wounding, and incidence of bacterial kidney disease (BKD). Lamprey wounding rates were less than three percent for both chinook salmon and steelhead in all districts. All observed wounds were classified as either A4 or B-type wounds, indicating old wounds or sea lamprey attacks of short duration. The highest incidence of BKD in chinook salmon (27%) was observed in the southern-most district (MM-8); observed incidence of BKD in MM-7 to MM-5 ranged from 9-16%. Among steelhead populations, BKD was only observed in fish collected in the southern districts. Stomach samples from 834 chinook salmon and 106 steelhead collected in 1995 were processed during 1996. These data, along with information on age of salmonines collected in 1996, are currently being analyzed.

Job 1. Title: Establish the distribution pattern of chinook salmon and steelhead trout in the defined sampling area and time.

Findings: Chinook salmon (N=1,072) and steelhead trout (N=411) were sampled during May-August between St. Joseph and Charlevoix. Overall catch per unit effort (number of fish per 4 h of net effort) was higher for chinook salmon (32 fish per 4 h) than for steelhead (12 fish per 4 h). The highest catch rates for both species were observed in the southern districts (Table 1). Surface nets were set over three different water depth strata (<46 m, 46-91 m, and >91 m) at

each port sampled. Catch of both chinook salmon and steelhead declined with increasing depth or distance from shore (Table 2).

As part of MDNR Study 464, coded wire tags were collected from 65 chinook salmon and 3 steelhead during 1996 sampling. The majority of chinook salmon tag returns (35%) were from fish stocked in the Grand River, Michigan. Additional fish were from plants at Medusa Creek (17%), Kids Creek (15%), the Little Manistee River (9%), and the St. Joseph River (8%). Sixteen percent of fish sampled were from plants in Lake Huron (8%) and Wisconsin tributaries to Lake Michigan (8%). These tag returns will be used in the future to assess movement rates and seasonal distribution of fish in Lake Michigan.

Sampling during the 1996 season was conducted in one sweep of the eastern shore of Lake Michigan, moving from south to north beginning in the spring. The 1996 design was based on the assumption that we were following the seasonal movements of salmonine species. For 1997, the sampling protocol has been revised (MDNR 1997) to allow us to better define spatial and temporal variation in fish distribution. By sampling thermal bars and thermal clines, and by covering the entire lake in two south to north sweeps during the spring and summer, we hope to better define the distribution of salmonine populations in Lake Michigan.

Job 2. Title: <u>Obtain biological and BKD data on chinook salmon and steelhead trout.</u>

Findings: Complete biological data were recorded for all salmonines collected in 1996. This data included information on age and growth of salmonines, diet, lamprey wounding, and incidence of bacterial kidney disease (BKD).

Age, growth, and mortality.–Length frequency distributions of both chinook salmon (Table 3) and steelhead (Table 4) were similar across statistical districts. The majority of chinook salmon captured ranged in length from 600 to 800 mm, and most steelhead were between 500 and 800 mm long. Scale samples were collected from all chinook salmon and steelhead captured. These scales have been pressed, but fish ages have not yet been determined. Age distributions and mean length at age of chinook salmon and steelhead collected in 1996 will be presented in future reports.

Preliminary estimates of total annual mortality were calculated for chinook salmon based on catch at age data from assessment netting conducted during 1994-95. Estimated mortality for age 2-4 salmon (Z=2.46) was higher than that previously (1990-93) estimated for age 1-4 chinook salmon (Z=1.22). However, sampling effort, in particular gill net mesh sizes, varied significantly across years, and assumptions necessary for catch curve analysis were probably not met. We are currently investigating ways in which abundance estimates might be corrected for gill net selectivity, and are continuing to collect chinook salmon and steelhead with (now) standard sampling gear to obtain better future estimates of mortality.

Natural reproduction.–One priority recommendation to come out of the 1995 MDNR chinook salmon conference was the need for better estimates of the contribution of natural reproduction to Great Lakes chinook salmon fisheries. Of the 1,072 chinook salmon collected in MDNR assessment netting on Lake Michigan during 1996, 34% appeared to be from natural reproduction (Table 5). There did not appear to be significant spatial variation in the contribution of natural reproduction. Contribution in statistical districts MM-8 to MM-5 ranged

from 28-37%. Percent of assessment samples from natural reproduction was 54% in MM-3, but this was based on a sample of only nine chinook salmon.

Salmonine diets.–Stomach contents were collected from 1,072 chinook salmon and 411 steelhead in 1996. Processing of these samples is not yet complete. During 1996, stomach samples from 834 chinook salmon and 106 steelhead collected during 1995 were processed. This data has been entered into the MDNR standard database (Card 4) and is currently being analyzed. The results of these analyses will be presented in future reports.

We have revised the design of our netting program for 1997 to include forage fish assessments. Samples will be collected on two occasions in each statistical district between May and August. This sampling will use forage fish nets (25-64 mm stretched mesh vertical gill nets) attached to the suspended gill nets designed for salmonine assessments. The results of these netting efforts for forage fish will enable us to determine selectivity by various predators for piscine prey items.

Lamprey Wounding Rates.–In 1996, the highest incidence of lamprey wounding on chinook salmon was observed in the central districts (MM-5 to MM-7) of the eastern shore of Lake Michigan, whereas lamprey wounding rates on steelhead were highest in the southern-most districts (MM-7 and MM-8; Table 6). Wounding rates were less than three percent for both species in all districts, and all observed wounds were classified as either A4 or B1-B4, indicating old wounds or sea lamprey attacks of short duration (King 1980).

BKD Incidence.–The incidence of bacterial kidney disease (BKD) among populations of chinook salmon and steelhead was assessed using FELISA procedures. Kidney swabs were collected from most salmonines sampled (batches of fish were subsampled in some cases) and sent to the Fish Quality Lab at the Wolf Lake Hatchery (MDNR) for analysis. The highest incidence of BKD in chinook salmon was observed in the southern-most district (MM-8). Disease incidence was relatively consistent (9-16%) in central districts (Table 7), and only nine fish were tested in MM-3. Among steelhead populations, BKD was only observed in fish collected in the southern districts (Table 7). The observed decrease in BKD incidence from south to north has several possible explanations; 1) not enough individuals were sampled in the northern districts to accurately determine the presence of BKD, 2) the higher numbers of individuals in the southern zones may be causing higher infection rates, or 3) fish infected early in the year may have died by the time we sample in the northern districts in late summer. Our revised sampling design for 1997 should help in answering this question.

Job 3. Title: <u>Process and analyze data; write report.</u>

Findings: This performance report was completed on schedule. The information presented in this report was also used in preparing the MDNR annual report to the Lake Michigan Committee of the Great Lakes Fishery Commission.

Additional sample processing and data analysis are in various stages of completion. In particular, processing of 1996 diet samples and scale age interpretation for fish collected in 1996 are just beginning.

Literature Cited:

King, E. L., Jr. 1980. Classification of sea lamprey (*Petromyzon marinus*) attack marks on Great Lakes lake trout (*Salvelinus namaycush*). Canadian Journal of Fisheries and Aquatic Sciences 37:1989-2006.

Michigan Department of Natural Resources. 1997. Sampling design to assess salmonine populations in eastern Lake Michigan. Internal document.

Table 1.–Summary of 1996 surface gill net effort, and catch of chinook salmon and steelhead trout by statistical district. N is the number of fish captured in each statistical district. Catch per unit effort (CPUE) is the number of fish captured per 975 m of graded mesh (76-178 mm stretched mesh) experimental gill net in 4 h.

Statistical district	Number of nets set	Chinook Salmon		Steelhead	
		N	CPUE	N	CPUE
MM-3	4	14	2.1	6	0.3
MM-5	6	128	27.3	36	7.8
MM-6	6	169	35.0	44	9.2
MM-7	6	308	43.1	85	12.0
MM-8	9	453	40.4	240	22.7
Total	31	1,072	32.4	411	12.2

Table 2.–Summary of 1996 surface gill net effort, and catch of chinook salmon and steelhead trout in surface nets set over different water depths. N is the number of fish captured over each water depth. Catch per unit effort (CPUE) is the number of fish captured per 975 m of graded mesh (76-178 mm stretched mesh) experimental gill net in 4 h.

Water depth (m)	Number of nets set	Chinook Salmon		Steelhead	
		N	CPUE	N	CPUE
<46	5	560	94.0	201	32.5
46-91	16	376	22.6	150	9.0
>91	10	136	17.3	60	7.3
Total	31	1,072	32.4	411	12.2

Table 3.–Length frequency distribution of chinook salmon collected during 1996 assessment netting in five Lake Michigan statistical districts. Values are number of fish of each size class collected in each statistical district.

	Statistical District					
Length (mm)	MM-3	MM-5	MM-6	MM-7	MM-8	Combined
0-99	0	0	0	0	0	0
100-199	0	0	0	0	0	0
200-299	0	0	0	0	0	0
300-399	0	2	0	0	6	8
400-499	2	17	14	26	46	105
500-599	3	11	6	23	30	73
600-699	2	47	58	114	167	388
700-799	5	36	48	91	120	300
800-899	1	9	35	44	66	155
900-999	1	6	8	9	18	42
>999	0	0	0	1	0	1
Total	14	128	169	308	453	1,072

Table 4.–Length frequency distribution of steelhead collected during 1996 assessment netting in five Lake Michigan statistical districts. Values are number of fish of each size class collected in each statistical district.

	Statistical District					
Length (mm)	MM-3	MM-5	MM-6	MM-7	MM-8	Combined
0-99	0	0	0	0	0	0
100-199	0	0	0	0	0	0
200-299	0	0	0	0	0	0
300-399	0	0	0	0	0	0
400-499	0	0	0	5	5	10
500-599	0	7	12	9	76	104
600-699	4	12	13	22	59	110
700-799	1	17	16	43	84	161
800-899	1	0	3	6	14	24
900-999	0	0	0	0	2	2
>999	0	0	0	0	0	0
Total	6	36	44	85	240	411

Table 5.–Number and percent of chinook salmon from hatchery and wild sources collected by MDNR assessment netting in eastern Lake Michigan. Fish were considered to be from hatchery sources if they displayed a fin clip, coded-wire tag, or oxytetracycline (OTC) mark. Five fish ("Other") could not be classified as hatchery or wild fish.

Year	Source	Age				Total number	%
		1	2	3	4		
1994	Hatchery	152	262	79	0	493	67.6
	Wild	33	150	47	4	234	32.1
	Other	0	1	0	1	2	0.3
1995	Hatchery	161	368	51	2	582	64.7
	Wild	47	231	38	0	316	35.1
	Other	1	1	0	0	2	0.2
1996[1]	Hatchery	56	447	155	29	687	65.7
	Wild	46	186	112	14	358	34.2
	Other	1	0	0	0	1	0.1

[1] Fish collected in 1996 have not yet been aged; preliminary age distribution for these fish is based on length frequency analysis.

Table 6.–Lamprey wounding rates for chinook salmon and steelhead collected during 1996 assessment netting throughout Lake Michigan. Values are percent of fish collected in each statistical district exhibiting each category of wound. Numbers of fish captured in each statistical district are the same as those reported in Table 1.

Statistical district	Lamprey wound classification		
	A1-A3	A4	B1-B4
	Chinook salmon		
MM-3	0.0	0.0	0.0
MM-5	0.0	0.8	0.8
MM-6	0.0	1.8	0.6
MM-7	0.0	0.3	0.6
MM-8	0.0	0.0	0.0
	Steelhead		
MM-3	0.0	0.0	0.0
MM-5	0.0	0.0	0.0
MM-6	0.0	0.0	0.0
MM-7	0.0	2.4	0.0
MM-8	0.0	0.0	0.4

Table 7.–Incidence of bacterial kidney disease (BKD) in chinook salmon and steelhead sampled in Lake Michigan during 1996. Values are percent of fish testing positive for BKD in each statistical district. N is the number of individuals tested. BKD results are determined from FELISA tests of kidney tissue.

	Chinook salmon		Steelhead	
Statistical district	N	%	N	%
MM-3	9	0.0	6	0.0
MM-5	128	15.6	36	0.0
MM-6	146	8.9	44	0.0
MM-7	307	8.8	85	17.6
MM-8	453	27.2	240	10.8

Prepared by: David F. Clapp and Jory L. Jonas
Dated: March 31, 1997