STUDY PERFORMANCE REPORT

State: Michigan **Project No.:** F-53-R-14

Study No.: 485 **Title:** Assessment of chinook and coho salmon populations and their prey in eastern Lake Michigan

Period Covered: April 1, 1997 to March 31, 1998

Study Objectives: To assess the health of chinook and coho salmon stocks in Lake Michigan through continuous monitoring of distribution, relative abundance, 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 experimental sampling of Pacific salmon in Michigan waters of Lake Michigan began only 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.

Chinook salmon (N=456) and coho salmon (N=24) were sampled during May-August, 1997 between St. Joseph and Naubinway. As in previous years, catch was higher for chinook salmon than for coho salmon; however, catch of chinook salmon was lower in 1997 than in any year since lakewide (eastern shoreline) sampling began in 1994. This was likely due to the revised sampling design adopted in 1997. Only 7 coded-wire tagged chinook salmon were collected in assessment nets in 1997; three of the seven came from plants in the Swan River (Lake Huron). Forty-eight percent of all chinook salmon collected (tagged and untagged) appeared to be from natural reproduction.

Biological data recorded for salmonines included data on age and growth of salmonines, incidence of bacterial kidney disease (BKD), diet, and lamprey wounding. Forty-seven percent of chinook salmon collected in 1997 were age 0.2, and 62% of coho salmon collected were Age 1. Since lakewide assessment began in 1994, the age composition in the survey catch of both chinook and coho salmon has changed significantly. Average total length at age of chinook salmon has remained relatively constant over this same time period, but average length at age of coho salmon has fluctuated dramatically. Average length of an age 2 coho salmon was 501, 483, and 562 mm in 1995-97, respectively. Average lakewide incidence of BKD for both chinook (54%) and coho salmon (21%) was higher in 1997 than in any year since lakewide sampling began in 1994.

Diet analysis has been completed only through 1995. Chinook salmon collected in 1995 ate primarily alewife, while coho salmon ate primarily insects and amphipods. More chinook salmon (43%) than coho salmon (8%) had empty stomachs. The revised design of our netting program implemented in 1997 included forage fish assessments to enable us to determine selectivity by salmonine predators for piscine prey items. Forage fish catch in 1997 was comprised primarily of alewife (94%); other fish collected included several not previously recorded in MDNR assessments of salmonine diets.

Job 1. Title: **Establish the distribution pattern, relative abundance, and origin of chinook and coho salmon in eastern Lake Michigan.**

Findings: *Distribution and Relative Abundance.* – Chinook salmon (N=456) and coho salmon (N=24) were sampled during May-August, 1997 between St. Joseph and Naubinway. As in previous years, catch was higher for chinook salmon than for coho salmon; however, catch of chinook salmon was lower in 1997 than in any year since lakewide (eastern shoreline) sampling began in 1994 (Table 1). This was likely due to the revised sampling design adopted in 1997 (see below).

Sampling during the 1994-96 seasons was conducted in one sweep of the lake, moving from south to north beginning in the spring. This design was based on the assumption that distribution of salmonine species in Lake Michigan remained constant throughout the sampling period. A revised sampling protocol was implemented in 1997 to better define the 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 hoped to be able to better define the distribution of salmonine populations in Lake Michigan. Based on results of 1997 sampling, it appears that chinook salmon along the eastern shoreline of Lake Michigan move north during the summer months. Percentage of catch in central and northern districts (MM3-MM5) increased during summer sampling (20%) as compared to spring (4%, Table 2). Additionally, 1997 sampling indicated that chinook salmon move offshore as summer progresses and are more likely to suspend than in spring. Catch of chinook salmon in offshore nets (water depth 150' and greater) accounted for 25% of the total in summer and only 9% of the total in spring (Table 3). A slightly higher percentage of chinook salmon were captured in suspended nets in summer (39%) when compared to spring assessment netting (30%, Table 3).

All coho salmon captured during spring sampling in 1997 were taken in the southern portion of the lake (MM-8). Like chinook salmon, coho moved north during the summer; 47% of coho salmon collected in July-August were taken in statistical district MM-5, whereas only 12% were taken in MM-8.

Origin. – As part of MDNR Study 464/471, coded wire tags were collected from 65 assessment-caught chinook salmon in 1996 and 7 salmon in 1997. The majority (35%) of chinook salmon tag returns in 1996 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%).

Three of the seven coded-wire tagged fish collected in assessment nets in 1997 came from plants in the Swan River (Lake Huron). The remaining fish were from plants in the Little Manistee River (N=2), Medusa Creek (1), and the Grand River (1).

During 1997, 334 age 0.2-0.4 chinook salmon were collected in MDNR assessment netting on Lake Michigan. Of these, 48% appeared to be from natural reproduction. There did not appear to be significant spatial variation in the contribution of natural reproduction to the open-lake fishery. These data are also presented as part of the progress report for Study 471.

Job 3. Title: Coordination with other studies, process and analyze data; write report.

Findings: This performance report was completed on schedule. The information presented was also used in preparing the MDNR-Charlevoix Great Lakes Station annual report to the Great Lakes Fishery Commission. A presentation was made to the Michigan State University Extension Fisheries Workshop in Benzonia. Samples were provided to Dr. Jim Bence (MSU-PERM) for a study of chinook salmon energetics.

Job 4. Title: Determine growth rates of chinook and coho salmon in eastern Lake Michigan.

Findings: Age of all chinook salmon and coho salmon collected was determined based on scale or coded-wire tag analysis. Forty-seven percent of chinook salmon collected in 1997 were age 0.2 (Table 4). Since lakewide assessment began in 1994, the age composition of chinook salmon in the survey catch has changed significantly. In 1994-95, the catch was composed primarily (>80%) of age 0.1-0.2 salmon, while in 1996-97, age 0.2 and 0.3 salmon combined made up a higher proportion (84% and 80% in 1996 and 1997, respectively) of the catch (Table 4). Average total length at age has remained relatively constant over this same time period, although length of age 0.3 chinook salmon was slightly lower in 1996 (Table 5).

Sixty-two percent of coho salmon collected in 1997 were Age 1. This is a significant increase from previous years; 13% of coho collected in 1996, and only 5% of those collected in 1995, were age 1. Average length at age of coho salmon has also fluctuated during this period. Average length of an age 2 coho was 501, 483, and 562 mm in 1995-97, respectively.

Job 5. Title: Determine survival rates of chinook and coho salmon in eastern Lake Michigan.

Findings: Preliminary estimates of total annual mortality were calculated for chinook salmon based on catch-at-age data from assessment netting conducted during 1994-95. These estimates were presented in previous reports. Based on the age distribution of fish collected in 1996-97, it appears that mortality has declined. However, estimates of mortality have not yet been made for these years. We are continuing to collect chinook and coho salmon with (now) standard sampling gear to obtain better estimates of mortality. This information will be presented in future reports.

For chinook and coho salmon collected in 1997, rate of lamprey wounding was extremely low. Wounds were observed on less than 1% of chinook salmon in all districts; none of the coho salmon collected showed any evidence of lamprey attack.

Job 6. Title: Obtain data on diet of chinook and coho salmon.

Findings: Stomach contents were collected from 456 chinook salmon and 24 coho salmon in 1997. Processing of these samples is not yet complete. During 1997-98, data analysis was completed for stomach samples from 834 chinook salmon and 13 coho salmon collected during 1995. Chinook salmon ate primarily alewife, and to a lesser extent amphipods and bloater chub (Table 6). Coho salmon ate primarily insects and amphipods (Table 6). More chinook salmon (43%) than coho salmon (8%) had empty stomachs.

Data on chinook salmon diets from 1995 MDNR survey vessel collections was combined with that collected in other jurisdictions according to the lakewide diet assessment protocol; this collaborative effort will continue for the foreseeable future.

Job 7. Title: Monitor prevalence of bacterial kidney disease in populations of chinook and coho salmon in eastern Lake Michigan.

Findings: The incidence of bacterial kidney disease (BKD) among populations of chinook salmon and coho salmon was assessed using FELISA procedures. Chinook salmon tested positive for BKD in all statistical districts; however, no spatial trend was apparent in BKD incidence for chinook salmon (Table 7). Year-to-year variation in BKD incidence was similar across species. Average lakewide incidence of BKD for both chinook and coho salmon was higher in 1995 and 1997 than in 1996 (Table 8). In 1997, levels of BKD incidence in chinook salmon were over three times higher than levels recorded in 1996 and over two times higher than levels recorded in 1994 or 1995.

Incidence of BKD in chinook and coho salmon varied more with age of fish (Table 9) than with sex (Table 10). In 1996, BKD incidence in chinook salmon was higher for age 0.2 and 0.3 fish than for age 0.1 (Table 9).

Job 8. Title: Measure relative abundance, species composition, and size structure of forage fish in the vicinity of salmonine sampling locations.

Findings: The revised design of our netting program implemented in 1997 included forage fish assessments. Forage fish assessment nets (100' deep, 1-2.5" graded mesh gill nets) were attached to suspended gill nets designed for salmonid assessments. Two samples were collected in each statistical district between May and August, to enable us to determine selectivity by salmonine predators for piscine prey items. Forage fish catch in 1997 was comprised primarily of alewife (94%); other fish collected included spottail shiner, bloater chub, lake whitefish, and yellow perch. Spottail shiner, whitefish, and yellow perch have not been recorded in chinook or coho salmon stomachs collected in MDNR assessments during 1990-95.

Table 1.–Catch (number of fish) of chinook salmon and coho salmon in Michigan Department of Natural Resources assessment netting in eastern Lake Michigan, 1994-97.

Sample year	Chinook salmon	Coho salmon
1994	726	4
1995	900	20
1996	1,073	15
1997	456	24

Table 2.–Percent of total assessment catch of chinook salmon in spring (May-June) and summer (July-August) by statistical district and net type (surface or suspended gillnet).

Statistical district	Season			
	Spring		Summer	
	Surface	Suspended	Surface	Suspended
MM-3	0	1	4	2
MM-5	2	1	10	4
MM-6	16	3	14	11
MM-7	28	13	24	12
MM-8	23	12	10	9

Table 3.–Percent of total assessment catch of chinook salmon in spring (May-June) and summer (July-August) by water depth and net type (surface or suspended gillnet).

Depth range (feet)	Season			
	Spring		Summer	
	Surface	Suspended	Surface	Suspended
<150	62	29	53	22
150-299	<1	<1	7	12
>299	8	<1	2	5

Table 4.–Age frequency (percent) of chinook salmon collected in Michigan Department of Natural Resources survey vessel assessment netting, 1994-97.

Sample	Age			
year	0.1	0.2	0.3	0.4
1994	25.3	56.7	17.2	0.7
1995	23.7	66.1	9.8	0.4
1996	12.2	38.8	45.4	3.4
1997	16.6	47.4	32.8	2.7

Table 5.–Average length at age (mm) of chinook salmon collected in Michigan Department of Natural Resources survey vessel assessment netting, 1994-97.

Sample	Age		
year	0.1	0.2	0.3
1994	445	607	792
1995	408	604	783
1996	404	603	720
1997	434	612	776

Table 6.–Percent frequency of occurrence of various prey items in chinook and coho salmon diets, 1995. Forty-three percent of chinook salmon stomachs and 8% of coho salmon stomachs were empty.

	Predator species	
Prey item	Chinook salmon	Coho salmon
Alewife	34.7	15.4
Bloater chub	7.1	---
Amphipoda	9.6	30.8
Coleoptera	---	61.5
Diptera	---	61.5
Hemiptera	---	46.2
Larval fish	5.6	---

Table 7.–Incidence of bacterial kidney disease (BKD) in chinook and coho salmon sampled in Lake Michigan statistical districts MM-3 to MM-8 during 1997. Values are percent of fish testing positive for BKD in each district. N is the number of individuals tested. BKD results are determined from FELISA tests of kidney tissue.

	Chinook salmon		Coho salmon	
Statistical district	N	%	N	%
MM-3	8	50.0	0	---
MM-4	0	---	0	---
MM-5	23	47.8	8	0.0
MM-6	69	43.5	5	60.0
MM-7	154	74.0	2	100.0
MM-8	158	41.1	9	0.0
Total	412	54.4	24	20.8

Table 8.–Incidence of bacterial kidney disease (BKD) in chinook and coho salmon sampled in Lake Michigan during 1994-97. Values are percent of fish testing positive for BKD in each year. N is the number of individuals tested. BKD results are determined from FELISA tests of kidney tissue.

	Chinook salmon		Coho salmon	
Year	N	%	N	%
1994	116	21.6	0	---
1995	855	22.9	19	15.8
1996	1,043	17.6	12	0.0
1997	412	54.4	24	20.8
Total	2,426	25.9	55	14.5

Table 9.–Incidence of bacterial kidney disease (BKD) by age in chinook and coho salmon sampled in Lake Michigan during 1996-97. Values are percent of fish of each age class testing positive for BKD in each year. BKD results are determined from FELISA tests of kidney tissue.

	Age				All
Year	1	2	3	4	ages
			Chinook salmon		
1996	7.6	18.1	20.0	13.9	17.6
1997	20.3	58.9	66.9	77.8	55.3
			Coho salmon		
1996	0.0	0.0	---	---	0.0
1997	26.7	11.1	---	---	20.8

Table 10.–Incidence of bacterial kidney disease (BKD) by sex in chinook and coho salmon sampled in Lake Michigan during 1996-97. Values are percent of male and female fish testing positive for BKD in each year. BKD results are determined from FELISA tests of kidney tissue.

	Sex		All
Year	Male	Female	fish
	Chinook salmon		
1996	18.3	16.8	17.5
1997	52.6	57.1	55.0
	Coho salmon		
1996	0.0	0.0	0.0
1997	36.4	16.7	29.0

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