

## STUDY PERFORMANCE REPORT

**State:** Michigan

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

**Study No.:** 485

**Title:** Assessment of chinook and coho salmon populations and their prey in eastern Lake Michigan

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

**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 (MDNR) 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.

In 2000, we were only able to complete an abbreviated assessment cruise. As a result, chinook salmon and coho salmon were sampled only during May-July, between St. Joseph and Arcadia. As in previous years, total catch of chinook salmon (N=134) was greater than coho salmon catch (N=33). Results of this limited sampling also showed that spring chinook and coho salmon distributions were similar to those observed in previous years.

Complete biological data were recorded for all salmonines collected. This data included information on age and growth, incidence of bacterial kidney disease (BKD), diet, and lamprey wounding. Ages of salmon collected in 2000 have not yet been determined, but age distribution of chinook salmon collected in 1999 was most similar to that observed in pre-1998 collections. Total length at age 2 for both chinook and coho salmon was the highest recorded since lakewide assessments began in 1994, probably as a result of more abundant forage (in the form of a strong 1998 alewife year class). Average lakewide incidence of BKD for both chinook and coho salmon declined again in 1999. Processing of diet samples has been completed only for fish collected through 1996.

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 was composed primarily of alewife; other fish collected included several not previously recorded in MDNR assessments of salmonine diets. Analysis of forage fish data collected in 1997-2000 is ongoing.

**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.* –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 inshore and offshore thermal habitats, 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.

In 2000, we were only able to complete the first (spring) south-to-north assessment cruise, as the S.V. *Steelhead* was in the shipyard for scheduled repairs in July and August. As a result, chinook salmon and coho salmon were sampled only during May-July, between St. Joseph and Arcadia. As in previous years, total catch of chinook salmon (N=134) was greater than coho salmon catch (N=33; Table 1). Results of this limited sampling also showed that spring chinook salmon distribution was similar to that observed in previous years. A higher percentage of chinook salmon were captured in surface nets in the southernmost district (MM-8) in spring assessment netting (Table 2). The majority (85%) of coho salmon captured during spring sampling were also taken in the southern portion of the lake (MM-8).

**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 MDNR research summaries to the Great Lakes Fishery Commission and Lake Michigan Technical Committee. A poster titled “Sampling Considerations for Assessment of Salmon and Trout Populations in the Laurentian Great Lakes” was presented at the 1999 Midwest Fish and Wildlife Conference. Coordination activities included study design assistance and fish collection for a Great Lakes Fishery Trust-funded study investigating disease incidence and energy dynamics in Lake Michigan chinook salmon (Mike Jones and Jim Bence, Michigan State University unit of the Partnership for Ecosystem Research and Management - PERM, principal investigators).

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

**Findings:** Ages of all chinook salmon and coho salmon collected in 1994-99 were determined based on scale and coded-wire tag analysis. Scales were collected from chinook and coho salmon captured in 2000 assessment netting but age determinations have not been completed.

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 1-2 salmon, whereas in 1996-97, age 2 and 3 salmon combined made up a higher proportion (84% and 80% in 1996 and 1997, respectively) of the catch (Table 3). In 1998, age 2 and 3 chinook salmon made up 72% of the assessment catch, and percent of age 4 chinook salmon increased significantly (22%, Table 3). Age distribution of chinook salmon collected in 1999 was most similar to that observed in pre-1998 collections (Table 3).

Chinook salmon average total length at age remained relatively constant from 1994-1997, but declined dramatically in 1998, especially for age 2 and 3 salmon (Table 4). Total length at age for both chinook and coho salmon increased again in 1999, probably as a result of more abundant forage (in the form of a strong 1998 alewife year class). Length at age 2 for both species was the highest recorded since lakewide assessments began in 1994 (Table 4).

**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. We are continuing to collect chinook and coho salmon with standard sampling gear to obtain better estimates of mortality. This information will be presented in future reports.

For chinook and coho salmon collected during the 1999-2000 reporting period, 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 assessment-caught chinook and coho salmon in 1997-2000. Processing of these samples is not yet complete. During the 1999-2000 reporting period, processing was completed for stomach samples from 26 chinook salmon collected during 1997 sampling.

Data on chinook salmon diets from MDNR survey vessel collections is combined with that collected in other jurisdictions according to the Lake Michigan Technical Committee lakewide diet assessment protocol (Elliott et al. 1996); this collaborative effort will continue for the foreseeable future. One use of this information is in ongoing work by the Lake Michigan Technical Committee to revise the SIMPLE (Sustainability of Intensively Managed Populations in Lake Ecosystems) model of lakewide predator-prey dynamics.

**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. Year-to-year variation in BKD incidence was similar across species. Average lakewide incidence of BKD for both chinook and coho salmon was highest in 1997 (over two times higher than levels recorded in any year since the beginning of lakewide assessment), but declined significantly in 1998-99 (Table 5). Laboratory sample processing and data analyses have not yet been completed for samples collected in 2000.

Incidence of BKD in chinook salmon increased with age of fish (Table 6), but was similar for male and female fish (Table 7). No pattern was apparent with age or sex for coho salmon, probably due to small sample sizes in most years.

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

**Findings:** The survey revisions implemented in 1997 included forage fish assessments. Forage fish assessment nets (50' or 100' deep, 1-2.5" graded mesh gill nets) were attached to suspended gill nets designed for salmonine assessments. In 2000, two samples were collected in each statistical district to determine selectivity by salmonine predators for piscine prey items. Forage fish catch

was composed primarily of alewife; other fish collected included spottail shiner, bloater chub, lake whitefish, chinook salmon, and yellow perch. Spottail shiner, lake whitefish, and yellow perch have not been recorded in chinook or coho salmon stomachs collected in MDNR assessments during 1990-1996. Analysis of forage fish data collected in 1997-2000 is ongoing.

**Literature Cited:**

Elliott, R.F., and eight co-authors. 1996. Conducting diet studies of Lake Michigan piscivores – a protocol. Lake Michigan Technical Committee (internal report).

**Prepared by:** David F. Clapp

**Dated:** September 30, 2000

Table 1.—Catch (number of fish) of chinook salmon and coho salmon in assessment netting in eastern Lake Michigan, 1994-2000.

Sample year	Chinook salmon	Coho salmon
1994	719	4
1995	898	20
1996	1,072	12
1997	409	24
1998	479	42
1999	186	181
2000	134	33

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), 1998-2000.

Statistical district	Season			
	Spring		Summer	
	Surface	Suspended	Surface	Suspended
	<u>1998</u>			
MM-3	0	<1	0	6
MM-6	10	9	37	37
MM-8	79	2	2	18
	<u>1999</u>			
MM-3	0	1	0	16
MM-6	20	9	26	43
MM-8	51	18	1	13
	<u>2000</u>			
MM-3	---	---	---	---
MM-6	27	16	---	---
MM-8	43	14	---	---

1 – Samples not collected due to vessel maintenance.

Table 3.—Age frequency (percent) of chinook and coho salmon collected in Michigan Department of Natural Resources survey vessel assessment netting, 1994-99. NA = Age determinations not completed.

Sample year	Age				
	0	1	2	3	4
<u>Chinook salmon</u>					
1994	---	25	57	17	1
1995	---	24	66	10	<1
1996	---	12	39	45	3
1997	---	17	47	33	3
1998	---	5	20	52	22
1999	3	27	42	27	1
<u>Coho salmon</u>					
1994	---	NA	NA	---	---
1995	---	5	95	---	---
1996	---	13	87	---	---
1997	---	62	38	---	---
1998	---	NA	NA	---	---
1999	---	12	86	2	---

Table 4.—Average length at age (mm) of chinook and coho salmon collected in Michigan Department of Natural Resources survey vessel assessment netting, 1994-99.

Sample year	Age		
	1	2	3
<u>Chinook salmon</u>			
1994	445	607	792
1995	408	604	783
1996	404	603	720
1997	434	612	776
1998	396	504	620
1999	491	626	745
<u>Coho salmon</u>			
1994	NA	NA	---
1995	---	501	---
1996	414	483	---
1997	483	562	---
1998	NA	NA	---
1999	416	637	---

Table 5.—Incidence of bacterial kidney disease (BKD) in chinook and coho salmon sampled in Lake Michigan during 1994-99. 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.

Year	Chinook salmon		Coho salmon	
	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
1998	484	14.0	42	0.0
1999	160	5.0	81	1.0

Table 6.—Incidence of bacterial kidney disease (BKD) by age in chinook and coho salmon sampled in Lake Michigan during 1994-99. 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.

Year	Age				All ages
	1	2	3	4	
	<u>Chinook salmon</u>				
1994	5.0	23.2	38.1	---	22.7
1995	15.0	26.0	22.1	0.0	22.9
1996	7.6	18.1	20.0	13.9	17.6
1997	20.3	58.9	66.9	77.8	55.3
1998	0.0	5.9	15.3	22.4	14.1
1999	0.0	3.0	11.6	50.0	5.2
	<u>Coho salmon</u>				
1994	---	---	---	---	---
1995	0.0	16.7	---	---	15.8
1996	0.0	0.0	---	---	0.0
1997	26.7	11.1	---	---	20.8
1998	0.0	0.0	---	---	0.0
1999	0.0	1.5	0.0	---	1.2

Table 7.—Incidence of bacterial kidney disease (BKD) by sex in chinook and coho salmon sampled in Lake Michigan during 1994-99. 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.

Year	Sex		All fish
	Male	Female	
<u>Chinook salmon</u>			
1994	24.6	20.8	22.7
1995	24.3	21.6	22.9
1996	18.3	16.8	17.5
1997	52.6	57.1	55.0
1998	12.2	16.3	14.0
1999	4.8	5.6	5.1
<u>Coho salmon</u>			
1994	---	---	---
1995	18.2	12.5	15.8
1996	0.0	0.0	0.0
1997	36.4	16.7	29.0
1998	0.0	0.0	0.0
1999	2.3	0.0	1.2