FINAL REPORT

State: Michigan

Project No.: F-81-R-4

Study No.: 490

Title: Assessment of steelhead and brown trout populations in eastern Lake Michigan.

Period Covered: April 1, 1997 to September 30, 2003

Study Objectives: To evaluate the status and health of steelhead and brown trout stocks by assessing growth, abundance, diet composition, general health, and incidence of disease.

Summary: Unless steelhead *Oncorhynchus mykiss* and brown trout *Salmo trutta*) are targeted in surveys independent of chinook salmon *Oncorhynchus tshawytscha*) and lake trout *Salvelinus namaycush*), it will be difficult to obtain sample sizes large enough to estimate survival and growth of populations from gill net assessments. Catch rates were extremely low for both species, averaging 0.72 fish per 305 meters of gill net for steelhead and 0.11 for brown trout. Steelhead, though more common than brown trout in survey nets, produced catch rates that were highly variable from year to year and were generally limited to central and southern Lake Michigan. Brown trout were more uniformly distributed throughout central and southern Lake Michigan than steelhead. Steelhead were captured exclusively in surface and suspended gill nets. Brown trout, though also captured more frequently in surface nets, were occasionally captured in bottom gill nets. Steelhead diets were dominated in numbers by invertebrates (96%), but fish contributed the most by weight (90%). Fish dominated the diets of brown trout in both numbers (58%) and weight (99.5%). In the last 4 years (1998 - 2001), no vessel-sampled steelhead or brown trout have tested positive for the *Renibacterium salmoninarum* antigen.

Findings: Only Job 7 was scheduled for 2002-03. However, no manuscript was prepared for publication. Instead, this Final Report is submitted providing comprehensive findings for the duration of the study.

Job 1. Title: <u>Evaluate relevant literature on steelhead.</u>–Literature on steelhead and brown trout physiology, behavior, and habitats has been collected and catalogued in an Endnote bibliographic software library. We conducted "Current Contents" searches twice a month on relevant fisheries journals to identify journal articles and publications that might be of interest.

Job 2. Title: <u>Establish the distribution pattern and origin of steelhead trout and brown trout during spring and summer in eastern Lake Michigan.</u>–Keller et al. (1990) stated that we have much to learn regarding the movement patterns and distributions of steelhead and brown trout within Lake Michigan. Thirteen years later, those words still hold true. General trends in catch rates can be described, but it is not possible to determine distributional patterns or to evaluate relative abundance with the small number of steelhead and brown trout observed in our surveys.

Standard assessment netting efforts on Lake Michigan generally target species other than steelhead or brown trout. Three types of standard assessment nets collected information on steelhead and brown trout populations in Lake Michigan: 1) Graded-mesh bottom gill nets (height = 2 meters; mesh size range = 0.8 to 15 centimeters), typical of nets set for lake trout and yellow perch *Perca flavescens*) assessment surveys. 2) Graded-mesh suspended gill nets (height = 9 meters; mesh size range = 0.9 to 18 centimeters), set at depths of 9-18 meters or deeper suspended in the water column to target the preferred 55°C water temperature of chinook salmon.

3) Surface gill nets that are the same dimensions as suspended nets but are deployed on the surface.

We looked at the depth of capture in survey nets to determine if there were patterns in the distribution of steelhead and brown trout within the water column. Steelhead were exclusively captured in surface and suspended gill nets and with the exception of 2001, the majority were captured in surface nets (Table 1). Brown trout were also captured more frequently in surface nets. However, unlike steelhead, brown trout were occasionally captured in bottom gill nets (Table 1).

We evaluated the spatial distribution of steelhead and brown trout within Lake Michigan from the limited amount of data available. The greatest numbers of steelhead were captured in the southern districts (MM- 6, 7, and 8). The catch-rate data (number per 305 meters of gillnet) were higher in MM-7 and 8 than in MM-6 (Tables 2 and 3). Brown trout were more uniformly distributed in the lake than steelhead. The highest catch rates for brown trout were observed in MM-5 followed by MM-6, 7, and 8 (Table 3).

Because of the limited amount of catch-rate data available from fishery independent netting survey assessments, comparisons were made with creel survey catch-rate data. In contrast to netting surveys, creel survey catch-rate estimates of steelhead (fish per 100 angler hours) were similar among units MM-5, 6, 7 and 8 (Table 4). The catch rates of brown trout in creel surveys displayed similar patterns to those in vessel surveys, with the highest CPEs in units MM-5 and 6. Neither steelhead nor brown trout were common in the northernmost unit MM-3 (Tables 2 and 3). Vessel and creel surveys generally point to similar patterns in the distribution of steelhead and brown trout in the lake. Targeted fishing by anglers could explain the more evenly distributed catch rates of steelhead in creel versus vessel surveys in the central and southern regions.

The majority of steelhead and brown trout captured in survey netting efforts ranged in age from 2 to 4 years, however, 5- to 8-year old steelhead and 5- to 7-year old brown trout were also sampled (Table 5). The average sizes at age for steelhead and brown trout in 1994-2001 survey assessments were similar to those observed in survey vessel sampling (Table 5). Creel estimates of average total length at age tended to be larger and more variable than survey vessel estimates (Table 5). Equal numbers of male and female (50:50 ratios) brown trout and steelhead were captured in both vessel and creel sampling efforts.

Because of the small overall number of steelhead collected and the smaller number with coded-wire tags (N=6 from 1994 to 2001), it was not possible to determine and summarize the origin of fish collected in vessel surveys.

Job 3. Title: Determine relative abundance and survival rates of steelhead and brown trout in eastern Lake Michigan.–Catch rates of steelhead and brown trout were different in our survey nets. Statistical districts MM-3, 6, and 8 were sampled for all 8 years of the study. Lake-wide average catch rates and standard deviations from these units showed catch-per-unit effort levels in overnight sets of 0.68 ± 1.17 (range: 0.06 – 3.51) for steelhead, and 0.10 ± 0.08 (range: 0.05 – 0.27) for brown trout. Steelhead were more common than brown trout in survey nets, though sample sizes were highly variable from year to year and were generally limited to central and southern Lake Michigan (Table 2 and 3). Sample sizes were too small to estimate survival of steelhead and brown trout from survey netting.

Job 4. Title: Obtain data on diets of steelhead and brown trout in eastern Lake Michigan.–We evaluated the diets of 109 brown trout and 580 steelhead collected during the summer over 7 years (1995-2001) in eastern Lake Michigan. All stomachs were removed from fish at the time of collection, then frozen for more detailed analyses of contents in the lab. During lab processing, the stomach was thawed and cut open, and diet items were sorted to lowest practical taxa. Fish were treated as individual prey items; we obtained lengths and weights on each fish item consumed. Invertebrates were weighed in taxonomic groups and counted. If a large number of invertebrates were present in a sample, a sub-sample was counted and the total number of prey was estimated from the total weight of the sample for each taxonomic group.

Approximately 93% of the brown trout and 94% of the steelhead stomachs contained forage items. Steelhead diets consisted of a smaller variety of fish species (3) and a higher diversity of invertebrate species (24 groups) when compared to brown trout (4 fish species, 10 invertebrate groups; Table 6).

Steelhead diets were dominated in numbers by invertebrates (96%; Table 6), but invertebrates composed only 10% of the diet by weight (Table 7). The most common invertebrates in the diets of steelhead were in the orders Diptera, Hemiptera, Amphipoda, and Coleoptera many of which were terrestrial in origin (Tables 6 and 7). Fish composed only 4% of the diet of steelhead by number, but a much higher percent (70%) by weight. The major fish species in the diets of steelhead, in order of importance by weight, were alewife *Alosa pseudoharengus*), three-spine sticklebacks *Gasterosteus aculeatus*), and bloater chubs *Coregonus hoyi*) (Table 7). Lengths of fish prey ranged from 17 to 246 mm in steelhead diets (Table 8).

Our results differ in some key ways from previous investigations evaluating the diets of steelhead in Lake Michigan. The diets of steelhead were investigated in southern Lake Michigan and summarized for the years 1973 and 1984-1986 (McComish 1989), in southeastern Lake Michigan from 1973 through 1982 (Jude et al. 1987), and in Wisconsin's waters of Lake Michigan from 1982 to 1988 (Rand et al. 1993). The common feature of all Lake Michigan steelhead diet studies is that alewife have been the dominant prey item, ranging up to 67% of the diet in the summer. Invertebrates composed 10% of the steelhead diet in the summer, alewife were the dominant prey by weight, and two other species of fish also occurred in the diets, the recently introduced three-spine stickleback and bloater chubs, neither of which were observed in the McComish (1989) or Jude et al. (1987) studies.

Steelhead diet items appeared to reflect the relative abundance of vulnerable fish species in the lake. In comparison with our work, Jude et al. (1987) observed higher numbers of alewife in the stomachs of steelhead (9.5 vs. 2.6 fish per stomach). In other work, yellow perch and rainbow smelt *Osmerus mordax*) accounted for a significant portion of steelhead diets when alewife populations were low, yellow perch populations high, and smelt were more abundant (McComish 1989). Yellow perch were observed in steelhead diets in Wisconsin's waters of Lake Michigan from 1982 to 1988, a time when perch were much more abundant than in recent years (Rand et al. 1993). It is perhaps another indication of the currently low yellow perch population in Lake Michigan that we have not observed them in the diets of steelhead in our investigation.

Fish dominated the diets of brown trout in both numbers (58%) and weight (99.5%). The major species of fish in the diets of brown trout in order of importance by weight were alewife, nine-spine sticklebacks *Pungitius pungitius*), rainbow smelt, and three-spine sticklebacks (Table 7). The lengths of all fish in brown trout diets ranged from 28 to 250 mm (Table 8). The most common invertebrates in the diets of brown trout were *Bythotrephes cederstroemi* (order Cladocera), Hemiptera, and zebra mussels *Dreissena polymorpha* (order Veneroida).

Previous observations by Jude et al. (1987) were similar to ours in that the majority of brown trout diets were composed of fish species with alewives contributing the most (96%). Rainbow smelt were abundant in the diets (14%); smelt were lower in lake-wide abundance during our study and therefore only composed 3% of brown trout diets. Unlike our study, where 93% of brown trout stomachs contained food items, Jude et al. (1987) observed only 72% of brown trout stomachs contained food. They also did not report nine-spine or three-spine sticklebacks in the diets of brown trout while we observed that sticklebacks were nearly 7% of the diet. Spottail shiners *Notropis spilopterus*) composed 4% of brown trout diets, while we never observed spottail shiners in net samples. Further, Jude et al. observed fish eggs in brown trout diets over all seasons and we did not observe any.

It is interesting to note the presence of three-spine sticklebacks in both brown trout and steelhead diets. This species is a relatively recent invader in Lake Michigan, arriving in 1984, likely from nearshore marine environments in bait and/or ballast water introductions (Steadman and Bowan 1985). Evaluation of steelhead diets conducted in Wisconsin waters during 1982-1988 showed sticklebacks present in steelhead diets (Rand et al. 1993). Sticklebacks were most prevalent in the diets of steelhead in our study in 1996 and 1997, and occurred in brown trout diets in 1996 only.

Job 5. Title: Monitor the general health and prevalence of BKD in populations of steelhead and brown trout in eastern Lake Michigan.–We conducted Field Enzyme Linked Immunosorbent Assay (Hsu et al. 1991; DiagXotics 1995) testing for bacterial kidney disease (BKD) on steelhead (N=661) and brown trout (N=94) collected from 1995 through 2001 in lake-wide assessment surveys. Since 1995, brown trout collected in annual surveys have never tested positive for the *Renibacterium salmoninarum* antigen. During the same period, steelhead have tested positive at levels ranging from 9 to 25% from 1995 to 1997 (Table 9). In the last 4 years (1998 - 2001), no vessel-sampled steelhead have tested positive for the *Renibacterium salmoninarum* antigen (Table 9).

Job 6. Title: Coordinate with other studies, process and analyze data, write reports.–Data collection for this project were closely coordinated with studies 486 and 485. Any steelhead collected with coded-wire tags will provide information for study 487. This is the final report for the project.

Job 7. Title: Publish report through the Fisheries Division's editing and finishing process for Research and Technical reports.–This final report has been prepared and submitted.

Prepared by: Jory Jonas
Date: September 30, 2003

Literature Cited:

DiagXotics. 1995. K-Dtect KwiK-Dtect Monoclonal antibody based capture ELISA's for *Renibacterium salmoninarum*. Sales Brochure.

Hsu, H.-M., P. R. Bowser and J. H. Schachte_Jr. 1991. Development and evaluation of monoclonal-antibody-based enzyme-linked immunosorbent assay for the diagnosis of *Renibacterium salmoninarum* infection. Journal of Animal Health 3: 168-175.

Jude, D. J., F. J. Tesar, S. F. Deboe and T. J. Miller. 1987. Diet and selection of major prey species by Lake Michigan salmonines, 1973-1982. Transactions of the American Fisheries Society 116: 677-691.

Keller, M., K. D. Smith and R. W. Rybicki. 1990. Review of salmon and trout management in Lake Michigan. Michigan Department of Natural Resources, Fisheries Special Report 14, Ann Arbor.

McComish, T. S. 1989. Changes in salmonine predator-prey relationships in extreme southern Lake Michigan. Illinois-Indiana Sea Grant Program, Report IL-IN-SG-R-89-2.

Rand, P. S., D. J. Stewart, P. W. Seelbach, M. L. Jones and L. R. Wedge. 1993. Modeling steelhead population energetics in Lakes Michigan and Ontario. Transactions of the American Fisheries Society 122: 977-1001.

Stedman, R. M., and C. A. Bowen II. 1985. Introduction and spread of the threespine stickleback (*Gasterasteus aculeatus*) in lakes Huron and Michigan. Journal of Great Lakes Research 11: 508-511.

Table 1.–Number of steelhead and brown trout captured in surface, suspended, and bottom gill nets in Lake Michigan. From 1994 to 1996, both surface and suspended net types were not set in each district and we did not separate catches into surface and suspended net categories in our records. Further, since we only collected one fish in a bottom gill net during this period, we have combined years. Numbers in parentheses represent the percent captured in each gear, by year.

		Net Type		
Species	Year	Bottom net	Suspended net	Surface net
Steelhead	1994-96	0 (0%)	–	558 (100%)
	1997	0 (0%)	4 (27%)	11 (73%)
	1998	0 (0%)	6 (35%)	11 (65%)
	1999	0 (0%)	6 (46%)	7 (54%)
	2000	0 (0%)	0 (0%)	5 (100%)
	2001	0 (0%)	12 (71%)	5 (29%)
Brown trout	1994-96	1 (3%)	–	32 (97%)
	1997	6 (15%)	4 (10%)	29 (75%)
	1998	0 (0%)	1 (12%)	7 (88%)
	1999	1 (4%)	3 (11%)	22 (85%)
	2000	5 (36%)	1 (7%)	8 (57%)
	2001	1 (11%)	1 (11%)	7 (78%)

Table 2.–Total catch (number of fish) in assessment nets of brown trout and steelhead in Lake Michigan statistical districts (MM-3 through MM-8). "–" indicates that we did not collect any data for the specified year, species, and location.

		Statistical district					
Species	Year	MM-3	MM-4	MM-5	MM-6	MM-7	MM-8
Steelhead	1994	1	–	0	13	9	19
	1995	1	–	7	31	16	50
	1996	1	–	41	41	85	240
	1997	1	1	1	3	4	5
	1998	4	0	–	5	–	8
	1999	0	–	–	8	–	5
	2000	0	–	–	3	–	2
	2001	0	–	–	7	–	10
Statistical district total		8	1	49	111	114	339
Percent of total over all statistical districts		1%	0%	8%	18%	18%	55%
Brown trout	1994	2	–	1	4	0	0
	1995	1	–	1	2	1	0
	1996	2	–	8	1	8	2
	1997	0	0	18	5	6	10
	1998	0	0	–	4	–	2
	1999	0	–	–	14	–	12
	2000	1	–	–	3	–	8
	2001	0	–	–	5	–	4
Statistical district total		6	0	28	38	15	38
Percent of total over all statistical districts		5%	0%	22%	30%	12%	30%

Table 3.–Catch per 305 meters of gillnet (CPE) of brown trout and steelhead in Lake Michigan statistical districts (MM-3 through MM-8). "–" indicates that we did not collect any data for the specified year, species, and location.

Species	Year	Statistical district						Average
		MM-3	MM-4	MM-5	MM-6	MM-7	MM-8	per year
Steelhead	1994	0.04	–	0.00	0.39	1.07	1.25	0.55
	1995	0.08	–	0.44	0.97	0.71	1.33	0.71
	1996	0.06	–	2.14	2.14	4.43	8.33	3.42
	1997	0.02	0.08	0.02	0.05	0.08	0.10	0.06
	1998	0.10	0.00	–	0.07	–	0.12	0.07
	1999	0.00	–	–	0.26	–	0.16	0.14
	2000	0.00	–	–	0.21	–	0.13	0.11
	2001	0.00	–	–	0.26	–	0.25	0.17
Average per statistical district		0.04	0.04	0.65	0.54	1.57	1.46	0.72
Percent of total over all statistical districts		1%	1%	15%	13%	37%	34%	100%
Brown trout	1994	0.07	–	0.12	0.12	0.00	0.00	0.06
	1995	0.08	–	0.06	0.06	0.04	0.00	0.05
	1996	0.13	–	0.42	0.05	0.42	0.03	0.21
	1997	0.00	0.00	0.40	0.06	0.10	0.16	0.12
	1998	0.00	0.00	–	0.06	–	0.03	0.02
	1999	0.00	–	–	0.46	–	0.36	0.27
	2000	0.06	–	–	0.21	–	0.31	0.19
	2001	0.00	–	–	0.18	–	0.08	0.09
Average per statistical district		0.04	0.00	0.25	0.15	0.14	0.12	0.12
Percent of total over all statistical districts		6%	0%	36%	21%	20%	17%	100%

Table 4.–Creel-estimated catch per 100 angler hours of brown trout and steelhead in Lake Michigan statistical districts (MM-3 through MM-8).

		Statistical district						Average
Species	Year	MM-3	MM-4	MM-5	MM-6	MM-7	MM-8	per year
Steelhead	1994	0.1	1.2	1.7	2.5	3.9	0.9	1.7
	1995	0.3	0.9	1.1	2.1	2.3	0.7	1.2
	1996	0.1	1.1	2.0	3.4	2.2	2.4	1.9
	1997	0.2	1.3	3.0	2.8	1.1	1.7	1.7
	1998	0.7	0.3	2.0	2.6	2.4	5.1	2.2
	1999	0.3	0.9	1.8	2.6	1.0	1.9	1.4
	2000	0.4	0.6	1.1	1.5	1.7	2.6	1.3
	2001	0.0	0.9	1.5	3.4	2.8	2.9	1.9
Average per statistical district		0.3	0.9	1.8	2.6	2.2	2.3	
Percent of total over all statistical districts		3%	9%	18%	26%	22%	23%	
Brown trout	1994	0.3	2.9	4.9	3.1	1.1	0.4	2.1
	1995	0.2	2.0	1.7	1.5	1.2	0.5	1.2
	1996	0.1	2.3	2.3	1.8	1.2	0.4	1.4
	1997	0.3	1.4	1.7	3.1	2.0	1.1	1.6
	1998	0.2	0.7	0.8	0.7	0.9	0.6	0.6
	1999	0.1	0.5	0.6	0.9	0.7	0.6	0.6
	2000	0.3	0.9	2.6	2.1	0.8	0.7	1.2
	2001	0.1	0.2	0.7	0.7	0.5	0.7	0.5
Average per statistical district		0.2	1.4	1.9	1.7	1.1	0.6	
Percent of total over all statistical districts		3%	20%	28%	25%	15%	9%	

Table 5.–Average total length at age and age distributions of steelhead and brown trout determined from Lake Michigan vessel and creel sampling.

		Survey Vessel			Creel Survey		
Species	Age	Average length (mm)	Standard deviation	Number	Average length (mm)	Standard deviation	Number
Steelhead	1	435	80	5	407	141	139
	2	505	52	170	601	126	1,895
	3	641	65	205	657	76	1,654
	4	679	62	135	713	76	1,504
	5	733	59	40	761	72	475
	6	730	42	12	773	65	99
	7	775		1	760	78	11
	8	808	67	2	841	73	4
Brown trout	1	361	41	5	415	88	36
	2	487	71	26	471	61	1,673
	3	554	78	22	580	90	697
	4	552	48	17	640	75	182
	5	539	47	9	724	93	43
	6	628	81	3	785	99	4
	7	669		1	628	211	5

Table 6.–Total number, average number per stomach, and percent composition of prey items in diets of brown trout and steelhead in Lake Michigan. "–" indicates that there no prey items of the type indicated were detected in the diet of the given species.

	Steelhead			Brown trout		
Category	Number	Average	Percent composition	Number	Average	Percent composition
Fish (total)	2,484	4.3	4.0	457	4.2	58.3
Three-spined stickleback	1,481	2.6	2.3	26	0.2	3.3
Alewife	927	1.6	1.4	218	2.0	27.8
Stickleback	56	0.1	0.1	–	–	–
Bloater	3	0.0	0.0	–	–	–
Ninespine Stickleback	–	–	–	119	1.1	15.2
Smelt	–	–	–	12	0.1	1.5
Unidentified fish	17	0.0	0.0	82	0.8	10.5
Invertebrates (total)	62,995	108.6	96.0	326	3	41.6
Diptera – flies	30,968	53.4	47.2	1	0.0	0.1
Amphipoda	14,314	24.7	21.8	–	–	–
Hemiptera	9,263	16.0	14.1	16	0.2	2.0
Hemiptera – leafhopper	65	0.1	0.1	–	–	–
Hemiptera – Corixidae	53	0.1	0.1	1	0.0	0.1
Coleoptera – beetle	3,876	6.7	5.9	1	0.0	0.1
Coleoptera – ladybug	140	0.2	0.2	–	–	–
Cladocera – *Bythotrephes*	2,656	4.6	4.1	289	2.7	36.9
Lepidoptera – moth	641	1.1	1.0	–	–	–
Mysidacea – *Mysis*	506	0.9	0.8	–	–	–
Nueroptera – lacewing	208	0.4	0.3	–	–	–
Hymenoptera – wasp	180	0.3	0.3	4	0.0	0.5
Hymenoptera – ant	34	0.1	0.1	–	–	–
Hymenoptera – bee	14	0.0	0.0	–	–	–
Odonata – dragon flies	25	0.0	0.0	–	–	–
Trichoptera – caddis flies	11	0.0	0.0	1	0.0	0.1
Araneae – spiders	9	0.0	0.0	–	–	–
Dermaptera – earwig	7	0.0	0.0	–	–	–
Orthoptera – grasshopper	3	0.0	0.0	–	–	–
Annelida – worm	2	0.0	0.0	1	0.0	0.1
Veneroida – zebra mussel	–	–	–	8	0.1	1.0
Gastropoda – snail	–	–	–	2	0.0	0.3
Unidentified inverts	20	0.0	0.0	2	0.0	0.3
Other (total)	66	0.1	0.0	1	0.0	0.1
Plant parts	27	0.1	0.0	1	0.0	0.1
Unidentified	15	0.0	0.0	–	–	–
Plastic	11	0.0	0.0	–	–	–
Rock	7	0.0	0.0	–	–	–
Wood	4	0.0	0.0	–	–	–
Feather	2	0.0	0.0	–	–	–

Table 7.–Total weight (g), average weight per stomach (g), and percent composition by weight for various prey items in the diet of brown trout and steelhead from Lake Michigan. "–" indicates that no prey items of the type indicated were detected in the diet of the given species.

	Steelhead			Brown trout		
Category	Total	Average	Percent composition	Total	Average	Percent composition
Fish (total)	9,185	15.8	70.4	1,784	17.5	99.6
Alewife	7,292	12.6	55.9	1,573	15.4	87.8
Three-spined stickleback	1,766	3.0	13.5	33.3	0.3	1.9
Stickleback	66.0	0.1	0.5	–	–	–
Bloater	53.0	0.1	0.4	–	–	–
Unidentified fish	7.9	0.0	0.1	31.6	0.3	1.8
Ninespine Stickleback	–	–	–	89.1	0.9	5.0
Smelt	–	–	–	56.8	0.6	3.2
Invertebrates (total)	1,312	2.3	10.1	7.3	0.0	0.3
Diptera – flies	501.5	0.9	3.8	0.0	0.0	0.0
Hemiptera	282.2	0.5	2.2	2.8	0.0	0.2
Hemiptera – leafhopper	3.7	0.0	0.0	–	–	–
Hemiptera – Corixidae	1.5	0.0	0.0	0.0	0.0	0.0
Amphipoda	139.4	0.2	1.1	–	–	–
Coleoptera – beetle	132.9	0.2	1.0	0.1	0.0	0.0
Coleoptera – ladybug	7.4	0.0	0.1	–	–	–
Lepidoptera – moth	86.7	0.2	0.7	–	–	–
Odonata – dragon flies	22.1	0.1	0.2	–	–	–
Hymenoptera – wasp	13.6	0.0	0.1	0.2	0.0	0.0
Hymenoptera – ant	3.2	0.0	0.0	–	–	–
Hymenoptera – bee	1.1	0.0	0.0	–	–	–
Cladocera – *Bythotrephes*	13.5	0.0	0.1	0.7	0.0	0.0
Mysidacea – *Mysis*	5.1	0.0	0.0	–	–	–
Nueroptera – lacewing	3.8	0.0	0.0	–	–	–
Orthoptera – grasshopper	0.9	0.0	0.0	–	–	–
Trichoptera – caddis flies	0.4	0.0	0.0	0.1	0.0	0.0
Araneae – spiders	0.3	0.0	0.0	–	–	–
Dermaptera – earwig	0.1	0.0	0.0	–	–	–
Annelida – worm	0.0	0.0	0.0	0.3	0.0	0.0
Gastropoda – snail	–	–	–	0.6	0.0	0.0
Veneroida – zebra mussel	–	–	–	2.4	0.0	0.1
Unidentified inverts	92.6	0.2	0.8	0.1	0.0	0.0
Other (total)	2,549	4.4	19.6	1.2	0.0	0.1
Unidentified	2,547	4.4	19.6	–	–	–
Plant parts	1.1	0.0	0.0	1.2	0.0	0.1
Wood	0.2	0.0	0.0	–	–	–
Rock	0.2	0.0	0.0	–	–	–
Plastic	0.1	0.0	0.0	–	–	–
Feather	0.0	0.0	0.0	–	–	–

Table 8.–Average length (mm), range (minimum and maximum), and number of fish prey measured from steelhead and brown trout diets in Lake Michigan.

	Steelhead			Brown trout		
Prey type	Average length	Range	Number	Average length	Range	Number
Alewife	137	17-246	730	141	42-250	262
Three-spine stickleback	59	53-68	15	50	44-59	14
Nine-spine stickleback	–	–	–	43	28-66	12
Smelt	–	–	–	104	63-166	12
Bloater chub	180	158-195	3	–	–	–

Table 9.–Incidence of bacterial kidney disease (positive or negative) in Lake Michigan steelhead and brown trout captured in assessment netting for 1995-2001, based on Field Enzyme Linked Immunosorbent Assay (FELISA). The percent frequency is given in parentheses.

		FELISA Result	
	Year	Positive	Negative
Steelhead	1995	30 (23%)	103 (77%)
	1996	41 (9%)	411 (91%)
	1997	5 (25%)	15 (75%)
	1998	0 (0%)	17 (100%)
	1999	0 (0%)	13 (100%)
	2000	0 (0%)	10 (100%)
	2001	0 (0%)	16 (100%)
Brown trout	1995	0 (0%)	5 (100%)
	1996	0 (0%)	20 (100%)
	1997	0 (0%)	35 (100%)
	1998	0 (0%)	5 (100%)
	1999	0 (0%)	24 (100%)
	2000	0 (0%)	5 (100%)
	2001	0 (0%)	0 (0%)