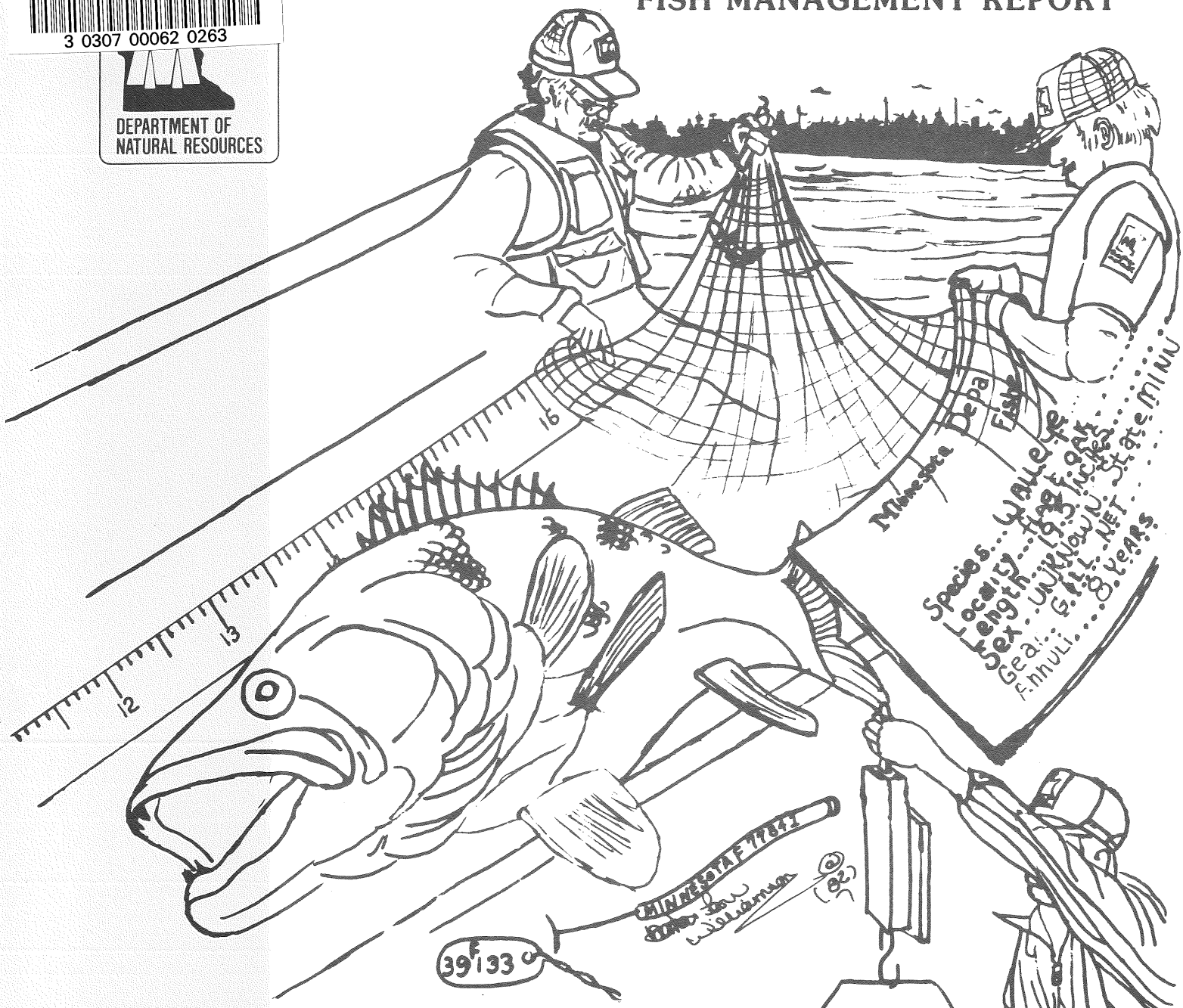
Section of Fisheries

FISH MANAGEMENT REPORT



No. 33

CONTRIBUTION OF 1988 - 1990 YEAR CLASSES OF STOCKED AND WILD CHINOOK SALMON TO SPORTFISHING AND SPAWNING IN MINNESOTA WATERS OF LAKE SUPERIOR

October 1997

Division of Fish and Wildlife

Minnesota Department of Natural Resources
Fish Management 33, 1997

CONTRIBUTION OF 1988 - 1990 YEAR CLASSES OF STOCKED AND WILD CHINOOK SALMON TO SPORTFISHING AND SPAWNING IN MINNESOTA WATERS OF LAKE SUPERIOR[1]

Thomas S. Jones
Donald R. Schreiner
Lake Superior Area Fisheries

Minnesota Department of Natural Resources
Section of Fisheries
500 Lafayette Road
St. Paul, MN 55155

ABSTRACT.--Chinook salmon *Oncorhynchus tschawytscha* have been stocked into Minnesota waters of Lake Superior annually since 1974. Other agencies have also stocked chinook salmon, and naturalized populations have become established in many Lake Superior tributaries. To determine the relative contribution of stocked and wild chinook salmon to Lake Superior populations, all chinook salmon stocked from 1988 - 1990 were given agency-specific fin clips. From 1989 - 1995, harvested chinook salmon were examined for fin clips in summer and fall creel surveys in Minnesota waters. Adult chinook salmon returning to the French River trap were also inspected. In the summer creel survey, 31% of the caught chinook salmon were stocked in Minnesota, 30% were stocked by other agencies, and 39% were wild. In the fall creel survey, 74% of the chinook salmon were stocked in Minnesota, 2% were stocked by other agencies, and 24% were wild. At the French River trap, 89% were stocked in Minnesota, 2% by other agencies, and 9% were wild. Most of the chinook salmon caught in the summer fishery were ages 1 through 3, while most of the fish observed in the fall creel survey and at the French River trap were age 3 or 4 spawning adults. During this study, stocked fish contributed substantially to the chinook salmon populations in Minnesota waters. Strong natural year classes lakewide may reduce the relative contribution of stocked fish to the summer boat fishery, but would have minimal effect on fall spawning runs in Minnesota tributaries because little natural reproduction occurs in them.

---

[1] Funding was provided in part from federal aid by the Sport Fish Restoration Act to Minnesota F-29-R(P).

Introduction

Chinook salmon *Oncorhynchus tschawytscha* were first introduced into Minnesota waters of Lake Superior in the late 1800s. These early introductions of a California strain were largely unsuccessful, and stocking was discontinued. However, after sea lamprey *Petromyzon marinus* and commercial fishing reduced the abundance of lake trout *Salvelinus namaycush*, chinook salmon were reintroduced in Michigan waters of Lake Superior in 1967. Minnesota began stocking chinook salmon in 1974, and Wisconsin and Ontario also initiated hatchery chinook salmon programs in 1977 and 1988, respectively. The intent of the Minnesota stocking was to diversify angler opportunities by providing a put-grow-and-take chinook salmon fishery with no expectations of natural reproduction (Schreiner 1995). Initially, a spring-run Columbia River strain was chosen, but was replaced with a fall-run strain in 1979 because fall-run fish returned slightly later when water levels were considered better for fishing. Additionally, fall-run fish demonstrated better growth rates (Close et al. 1984), and disease free eggs for spring-run chinook salmon became unavailable (Schreiner 1995). The fall strain was also of Columbia River origin, although the eggs obtained for Minnesota came from the Little Manistee River on Lake Michigan.

This study in Minnesota waters of Lake Superior is part of a lakewide effort to estimate the contributions of stocked and wild chinook salmon to sport fishing and spawning runs, and to examine the dispersal of stocked chinook salmon. Specifically, we looked at the contribution of hatchery-reared chinook salmon to the Lake Superior summer and fall creel surveys, and to the spawning run at French River. The relative contribution of hatchery and wild fish to the Lake Superior fish community is critical to the evaluation of Minnesota's chinook salmon stocking program.

Methods

All chinook salmon stocked into Lake Superior from 1988 through 1990 received agency-specific fin clips prior to stocking. Fin clips assigned through the Great Lakes Fishery Commission were left pectoral for Minnesota, right pectoral for Ontario, left ventral for Wisconsin, and adipose for Michigan. All of the Minnesota chinook salmon were reared at the French River Coldwater State Fish Hatchery near Duluth. Chinook salmon from 5 to 5.5 months of age were stocked in June at an average rate of 84/lb. Chinook salmon were stocked in five locations during this study (Figure 1). Minnesota stocked 1,405,000 chinook salmon, distributed as 390,000 in 1988, 518,000 in 1989, and 497,000 in 1990 (Table 1). During the same three years, chinook salmon stocked by Michigan, Wisconsin, and Ontario totaled 1,051,000, 1,201,000, and 1,285,000, respectively (Table 1).

Chinook salmon were recovered from 1989-1994 in summer creel surveys, from 1991-1994 in fall creel surveys, and from 1990-1995 at the French River trap (mid-September through mid-November). Summer creel surveys included nine boat accesses and marinas from Memorial Day weekend through 30 September (Figure 1). Fall creel surveys covered seven rivers from 1 October through approximately 8 November (Figure 1). Ages of wild and hatchery-reared chinook salmon were determined by examining scale impressions in acetate. Scales were usually interpreted by at least two people. In 1991 and 1992, the ages of chinook salmon that returned to the French River trap were determined using both scales and otoliths. The use of otoliths allowed trained readers to recognize when scale annuli were mostly or entirely reabsorbed prior to spawning.

The composition of the chinook salmon catch for each creel survey was determined by expanding the proportion of each fin clip observed on harvested salmon to the entire estimated catch from that year. Total contribution was obtained for each of the 1988 - 1990 year classes by summing the number of chinook salmon from each year class estimated in each of the creel surveys. From these totals, we determined the percent contribution from each agency to the summer and fall sport catches in Minnesota waters of Lake Superior.

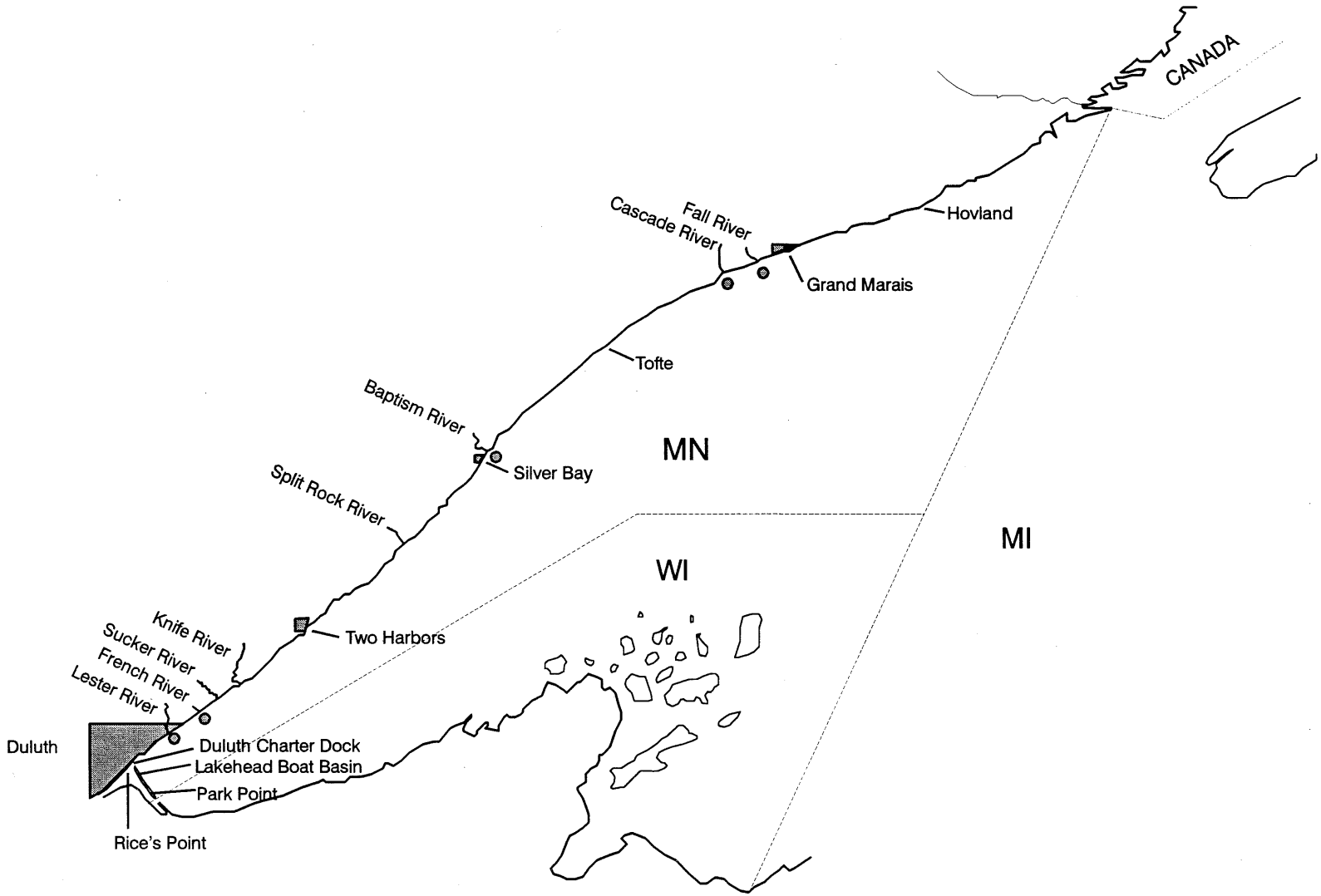


Figure 1. Chinook salmon sampling and stocking locations for Minnesota waters of Lake Superior. The seven rivers other than the Fall River were sampled during the Lake Superior fall anadromous creel surveys, 1991 -1994. Marinas and public accesses were sampled durine thesummer Lake Superior creel surveys, 1989 - 1994. The round symbols show stocking locations.

Table 1. Chinook salmon fingerlings stocked in Lake Superior, 1988-1990.

	1988	1989	1990	Total
Minnesota				
Lester River	100,000	203,000	180,000	483,000
French River	119,000	103,000	115,000	337,000
Baptism River	111,000	112,000	102,000	325,000
Cascade River	50,000	100,000	100,000	250,000
Fall River	10,000			10,000
TOTAL	390,000	518,000	497,000	1,405,000
Wisconsin	400,000	401,000	400,000	1,201,000
Michigan	356,000	359,000	336,000	1,051,000
Ontario	226,000	450,000	609,000	1,285,000

A return rate was determined as the number of chinook salmon caught per 100,000 stocked by each agency.

Chinook salmon collected at the French River adult trap were aged from scales and inspected for fin clips. Fish from the 1988 - 1990 year classes without discernible clips were presumed to be wild. Return rates were calculated as the number of fish caught in the French River per 100,000 stocked.

Results

Summer Fishery

The summer sport catch of chinook salmon from the 1988-1990 year classes during the 1989-1994 fisheries in Minnesota waters of Lake Superior was approximately 4,500 (Table 2). Chinook salmon stocked by Minnesota were more common in the summer creel surveys than chinook salmon stocked by other agencies, and contributed 31%, of the chinook salmon caught. Other stocked chinook salmon contributed 30% of the catch, with 16% from Wisconsin, 7% from Ontario, and 7% from Michigan (Figure 2). The return rates of stocked chinook salmon to the Minnesota summer sport fishery was 98 per 100,000 stocked in Minnesota, 61 per 100,000 stocked in Wisconsin, 28 per 100,000 stocked in Michigan, and 23 per 100,000 stocked in Ontario (Table 3). Wild chinook salmon contributed 39% to the summer catch in Minnesota waters (Figure 2). The contribution of wild chinook salmon ranged from 33% for the 1988 year class to 43% for the 1990 year class, and averaged 39%. Most chinook salmon caught during the summer creel surveys were immature with 69% being age 2 or younger (Table 2).

Fall Fishery

The total estimated catch of chinook salmon from the 1988-1990 year classes during fall creel surveys from 1991-1994 was approximately 1,360 (Table 4). Chinook salmon stocked by Minnesota contributed 74% of the total catch (Figure 3). Contributions of Minnesota fish to the catches from each year class ranged from 61% to 81%. The chinook salmon catch from all other agencies combined was 2%. The return rate to the fall creel surveys of Minnesota chinook salmon was 72 per 100,000 salmon stocked (Table 5). The return rate of chinook salmon stocked in Michigan was 2 per 100,000 stocked. Wild salmon contributed 24% of the total catch. The largest contribution of wild fish from any one year class was 34% (Figure 3). The chinook salmon that were caught in the fall were primarily spawning fish that were age 3 or older (Table 4).

Table 2. Returns of the 1988-1990 year classes of chinook salmon to the Lake Superior summer creel surveys, 1989-1994. Sample sizes in parentheses.

Year and Source	1988	1989	1990	1988-1990
1989	Age 1	Age 0	N/A	
MN	79 (3)	0	N/A	79
WI	79 (3)	26 (1)	N/A	105
MI	26 (1)	0	N/A	26
WILD	26 (1)	0	N/A	26
1990	Age 2	Age 1	Age 0	
MN	214 (7)	214 (7)	61 (1)	489
WI	244 (8)	31 (1)	92 (2)	367
MI	152 (5)	0	0	152
ONT	0	61 (2)	0	61
WILD	275 (9)	92 (3)	0	367
1991	Age 3	Age 2	Age 1	
MN	52 (3)	104 (6)	52 (3)	208
WI	0	69 (4)	34 (2)	103
MI	17 (1)	0	52 (3)	69
ONT	0	86 (5)	0	86
WILD	104 (6)	329 (19)	104 (6)	537
1992	Age 4	Age 3	Age 2	
MN	21 (1)	247 (12)	129 (6)	397
WI	0	21 (1)	64 (3)	85
MI	0	0	21 (1)	21
ONT	0	41 (2)	43 (2)	84
WILD	21 (1)	206 (10)	322 (15)	549
1993	Age 5	Age 4	Age 3	
MN	0	103 (3)	103 (3)	206
WI	0	0	34 (1)	34
MI	0	0	34 (1)	34
ONT	0	34 (1)	34 (1)	68
WILD	0	103 (3)	137 (4)	240
1994	Age 6	Age 5	Age 4	
MN	0	0	0	0
WI	0	0	41 (1)	41
WILD	0	0	41 (1)	41
All Years	1988	1989	1990	1988-1990
MN	366 (14)	668 (28)	345 (13)	1379
WI	323 (11)	147 (7)	265 (9)	735
MI	195 (7)	0	107 (5)	302
ONT	0	222 (10)	77 (3)	299
WILD	426 (17)	730 (35)	604 (26)	1760
Total	1310 (49)	1767 (80)	1398 (68)	4475

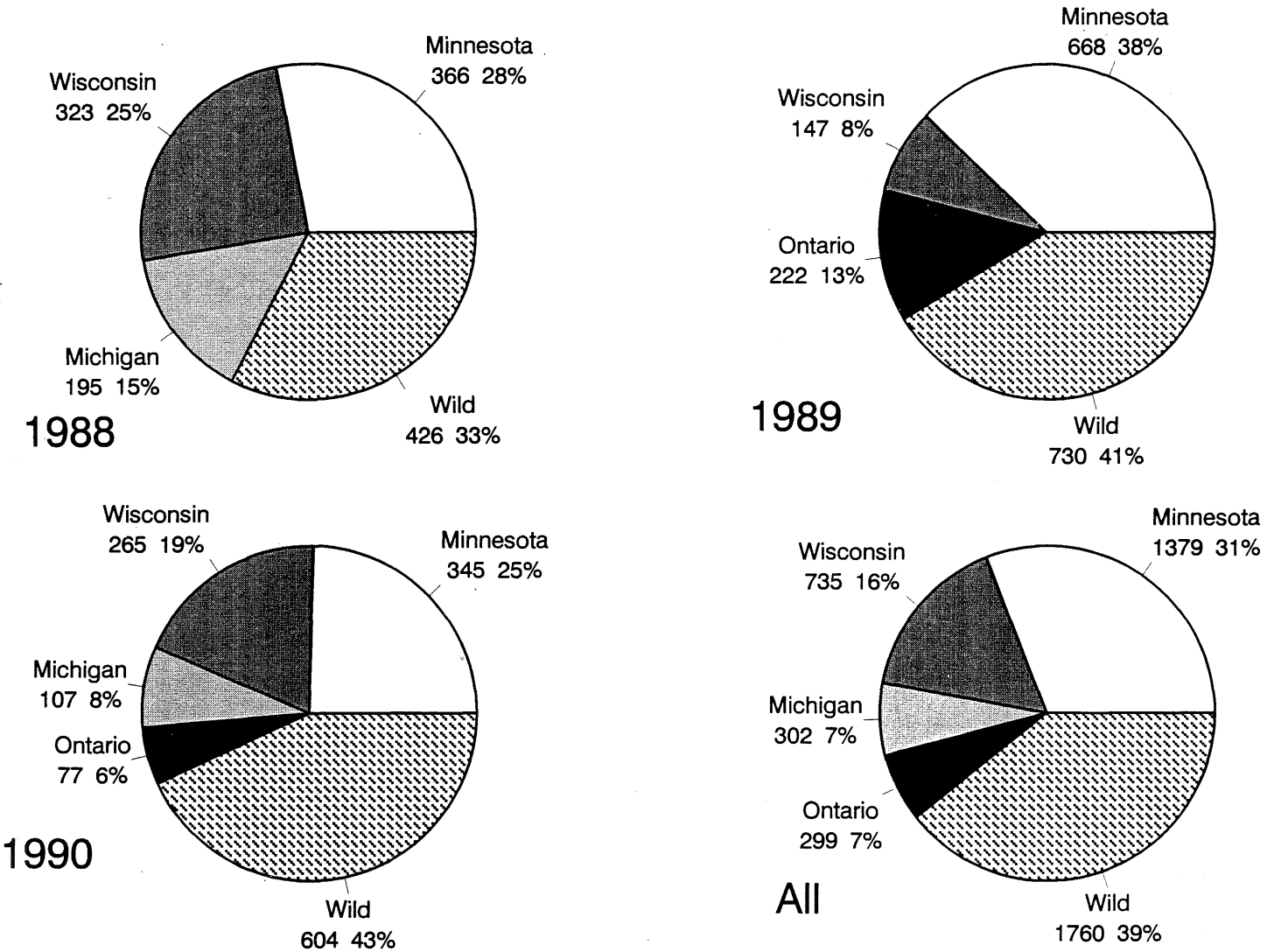


Figure 2. Returns of the 1988-1990 year classes of chinook salmon to the Lake Superior summer creel survey, 1990-1994. Numbers shown are estimated catch and percent of total catch. For sample sizes, see Table 1.

Table 3. Return rates (number per 100,000 stocked) of the 1989-1990 year classes of chinook salmon stocked in Lake Superior to the Minnesota summer creel surveys, 1989-1994

Source	1988	1989	1990	1988-1990
MN	94	129	69	98
WI	81	37	66	61
MI	55	0	30	28
ONT	0	50	13	23

Table 4. Returns of the 1988-1990 year classes of chinook salmon in the Lake Superior fall anadromous creel surveys, 1991-1994. Sample sizes in parentheses.

Year and Source	1988	1989	1990	1988-1990
1991	Age 3	Age 2	Age 1	
MN	136 (10)	68 (5)	14 (1)	218
MI	14 (1)	0	0	14
WILD	122 (9)	0	14 (1)	136
1992	Age 4	Age 3	Age 2	
MN	151 (21)	187 (26)	0	338
MI	7 (1)	0	0	7
WILD	43 (9)	65 (9)	0	108
1993	Age 5	Age 4	Age 3	
MN	10 (1)	187 (19)	158 (16)	355
WILD	0	40 (4)	49 (5)	89
1994	Age 6	Age 5	Age 4	
MN	0	0	94 (5)	94
All Years	1988	1989	1990	1988-1990
MN	297 (32)	442 (50)	266 (22)	1005
WI	0	0	0	0
MI	21 (2)	0	0	21
ONT	0	0	0	0
WILD	165 (18)	105 (13)	63 (6)	333
All	483 (52)	547 (63)	329 (28)	1359

Table 5. Return rates (number per 100,000 stocked) of the 1989-1990 year classes of chinook salmon stocked in Lake Superior to theLake Superior fall anadromous creel surveys, 1991-1994.

Source	1988	1989	1990	1988-1990
MN	76	85	54	72
WI	0	0	0	0
MI	6	0	0	2
ONT	0	0	0	0

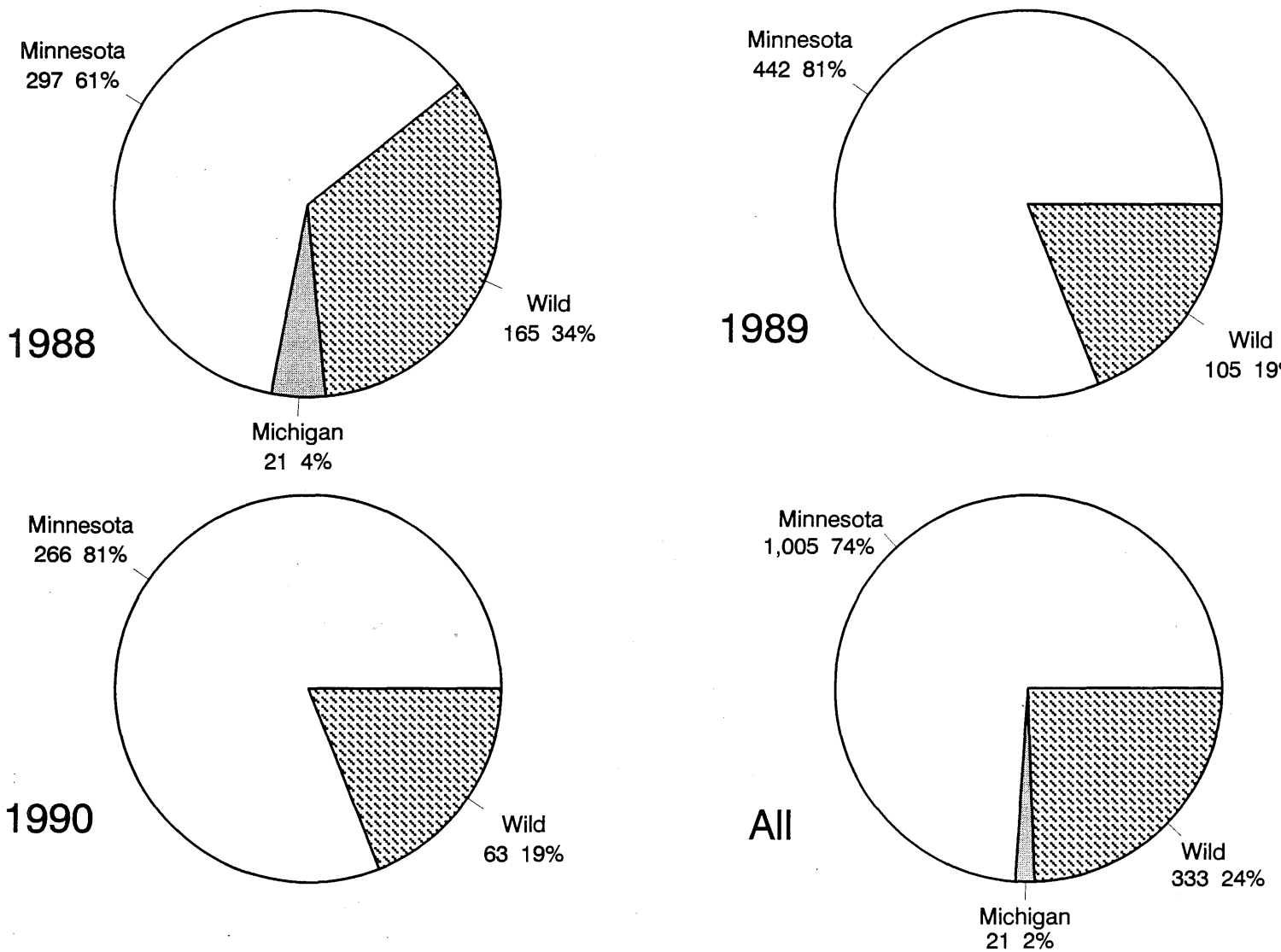


Figure 3. Returns of the 1988-1990 year classes of chinook salmon to the Lake Superior fall anadromous creel survey, 1991-1994. Numbers shown are estimated catch and percent of total catch. For sample sizes, see Table 2.

French River Trap

At the French River trap, approximately 1,200 chinook salmon from the 1988 - 1990 year classes were collected between 1990 and 1995. Chinook salmon stocked in Minnesota were the most abundant, and contributed 89% of all chinook salmon collected from the French River (Table 6). Hatchery fish from other agencies were uncommon, contributing only 2% for all three agencies combined (Figure 4). Dividing the number of Minnesota chinook salmon that returned to the French River by the number of chinook salmon stocked at the French River yielded a return rate of 319 per 100,000. However, this is

Table 6. Returns of the 1988-1990 year classes of chinook salmon in the French River trap, 1990-1995. Sample sizes in parentheses.

Year and Source	1988	1989	1990	1988 - 1990
1990	Age 2	Age 1	Age 0	
MN	2 (2)	6 (6)	0	8
MI	1 (1)	0	0	1
ONT	1 (1)	0	0	1
WILD	0	1 (1)	0	1
1991	Age 3	Age 2	Age 1	
MN	124 (61)	16 (7)	2 (1)	142
WI	7 (2)	0	0	7
ONT	1 (1)	0	0	1
WILD	43 (26)	10 (5)	0	53
1992	Age 4	Age 3	Age 2	
MN	216 (208)	166 (161)	4 (4)	386
WI	2 (2)	5 (5)	0	7
MI	0	3 (3)	0	3
ONT	0	1 (1)	0	1
WILD	13 (13)	6 (6)	0	19
1993	Age 5	Age 4	Age 3	
MN	15 (9)	195 (166)	219 (204)	429
WI	0	1 (1)	4 (4)	5
WILD	0	8 (6)	14 (11)	22
1994	Age 6	Age 5	Age 4	
MN	0	8 (7)	100 (86)	108
ONT	0	1 (1)	0	1
WILD	0	0	9 (8)	9
1995	Age 7	Age 6	Age 5	
MN	0	0	1 (1)	1
WILD	0	0	1 (1)	1
All Years	1988	1989	1990	1988-1990
MN	357 (280)	391 (347)	326 (296)	1074
WI	9 (4)	6 (6)	4 (4)	19
MI	1 (1)	3 (3)	0	4
ONT	2 (2)	2 (2)	0	4
WILD	56 (39)	25 (18)	24 (20)	105
Total	425 (326)	427 (376)	354 (320)	1206

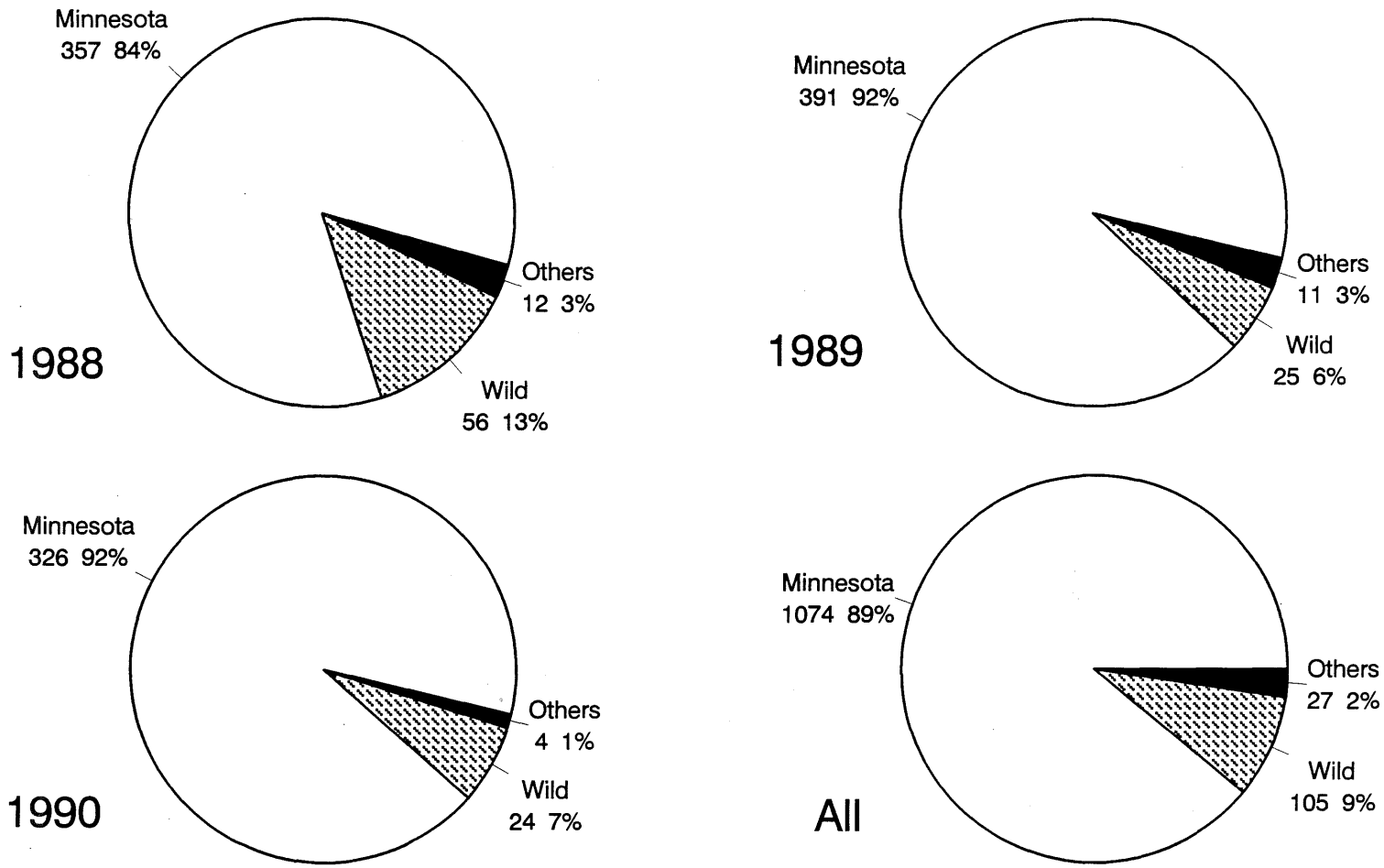


Figure 4. Returns of the 1988-1990 year classes of chinook salmon to the French River trap, 1990-1995. Numbers shown are estimated return and percent of total return. For sample sizes, see Table 3.

certainly an overestimate since all chinook salmon stocked in Minnesota were reared on French River water. Based on returns from the 1991 and 1992 year classes of chinook salmon, in which only salmon stocked in the French River were marked, approximately two-thirds of the chinook salmon that returned to French River were stocked somewhere else in Minnesota (Duluth Fisheries records). Therefore, the best estimate of survival to maturity for chinook salmon stocked in the French River is about one-third of the observed return rate, or approximately 100 per 100,000 stocked. The return rate to French River of all chinook salmon stocked in Minnesota was 76 per 100,000. From other agencies, the capture rate at the French River trap was 2 per 100,000 stocked in Wisconsin, 0.4 per 100,000 stocked in Michigan, and 0.3 per 100,000 stocked in Ontario (Table 7). Wild salmon contributed from 6% to 13% to each of the year classes and averaged 9% (Figure 4). The French River trap sampled only spawning chinook salmon, hence 99% of the fish sampled were age 3 or older (Table 6).

Discussion

Stocked chinook salmon were an important component of chinook salmon populations in Minnesota waters of Lake Superior. Stocked chinook salmon from outside of Minnesota contributed more to the summer fishery than to the fall fishery. This was expected since the summer fishery caught mostly young, immature chinook salmon that were relatively well mixed throughout the lake, while the fall chinook salmon were spawners that were homing to their place of origin. In contrast, stocked chinook salmon from Minnesota contributed more to the catches in the fall creel surveys and at the French River trap than both stocked salmon from other agencies and wild chinook salmon. The low percentage of wild salmon in the fall was also expected because of the low potential for natural reproduction in Minnesota tributaries. Most tributaries are short with erratic flows and limited gravel areas. Redds are likely to be damaged by a succession of flooding, low water, and winter ice. Poor recruitment potential limits the possibility of establishing large runs of naturalized chinook salmon in Minnesota streams. Because natural reproduction in Minnesota is low, and stocked chinook return to their water of origin, fall runs in Minnesota are dependent on chinook salmon stocked in Minnesota. However, the percent return of stocked chinook salmon year classes to the French River trap declined from 1981-1992 (Figure 5), although stocking levels at the French River have been constant. If the survival of stocked chinook salmon does not improve, the chinook salmon management program in Minnesota will need to be reevaluated (Schreiner 1995).

There were only minor differences in the contribution of stocked chinook salmon observed between the year classes included in this study. The 1988 year class of chinook salmon appeared to have a lower proportion of hatchery fish in the fall creel survey and at the French River trap. The opposite was observed in the summer creel survey, where the contribution of hatchery fish was the highest in the 1988 year class. The small sample sizes from the creel surveys, the small catch of wild salmon in the French River run, and the short time period of this study limited the ability to

Table 7. Return rates (Number per 100,000 stocked) of the 1989-1990 year classes of chinook salmon stocked in Lake Superior to the French River trap, 1990-1995.

Source	1988	1989	1990	1988-1990
MN	92	75	66	76
WI	2	2	1	2
MI	0.3	0.8	0	0.4
ONT	0.9	0.4	0	0.3

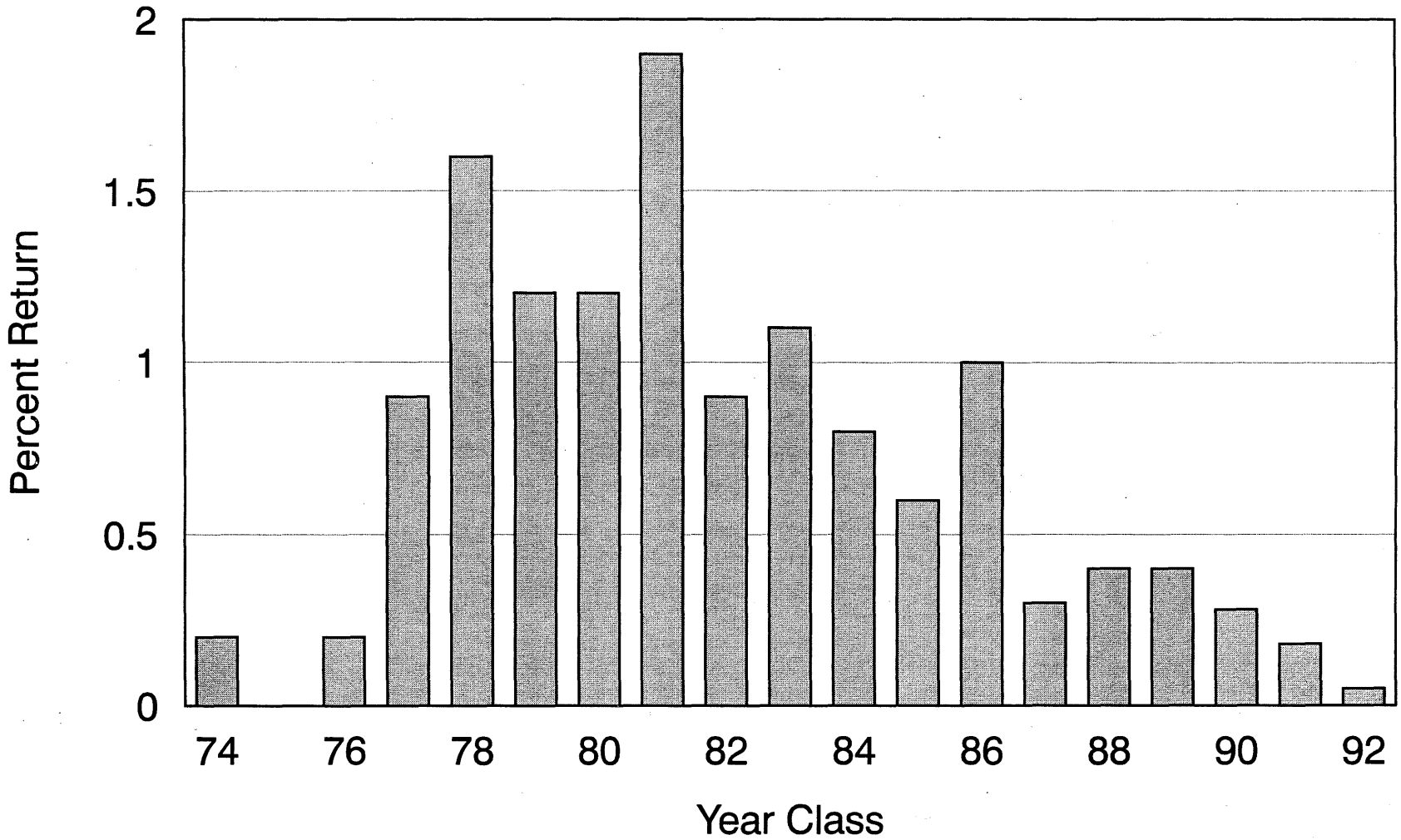


Figure 5. Percent return rate of the 1974 - 1992 year classes of chinook salmon to the French River trap (updated from Schreiner 1995).

detect year class variation. However, an unusually strong year class of wild salmon could affect the relative contributions of hatchery fish by contributing large numbers of wild fish that reduce the proportion of hatchery chinook salmon. Inversely, a very weak wild year class would increase the apparent contribution of hatchery fish.

This study was conducted concurrently with natural resource agencies from Michigan, Wisconsin, and Ontario. Chinook salmon stocked in Minnesota contributed more to the summer sport catches in Wisconsin and Michigan than those stocked in any other jurisdiction. However, wild fish were usually more abundant in summer sport catches than all hatchery fish combined. The contributions of wild fish were 39% in Minnesota, 66% in Wisconsin, 75% in Michigan, and 91% in Ontario (Peck et al., submitted to *North American Journal of Fisheries Management*. In review.). Since Michigan and Ontario collectively encompass 87% of the lake, it is clear that stocked chinook salmon play a minor role in determining the abundance of chinook salmon on a lakewide basis.

Management Implications

In Minnesota, stocked chinook salmon contribute significantly to the sport fishery. If chinook salmon stocking in Minnesota waters were discontinued, summer sport anglers might see a 30% reduction in catch. Fall anglers could experience reductions in catch as high as 75% or more. If all agencies quit stocking, Minnesota summer anglers would probably experience declines in chinook salmon catch of 60%. Hatchery contributions to the summer sport fishery may be reduced in years with strong natural year classes of chinook salmon because there would be so many more wild fish distributed throughout the lake. However, the Minnesota fall fishery would not benefit from this because very few wild chinook salmon spawn in Minnesota tributaries. Alternatively, an increase in stocking quotas would have little impact on lakewide summer fisheries, but might benefit fall shore anglers if survival rates improved. Angler preferences, fish community interactions, trends in return rates of stocked chinook salmon, and the status of wild chinook salmon populations must all be considered before changes in chinook salmon stocking can be recommended (Schreiner 1995). Because only three consecutive year classes were included in this study, it should be repeated periodically to measure changes in relative and absolute contribution of hatchery and wild chinook salmon to Minnesota fisheries, especially if chinook salmon management were altered.

References

Busiahn, T.R., Editor. 1990. Fish community objectives for Lake Superior. Great Lakes Fishery Commission, Special Publication 90-1, Ann Arbor, Michigan

Halpern, T.N., D.R. Schreiner, and S.A. Geving. 1995. Completion report for Minnesota waters of Lake Superior - 1994. Minnesota Department of Natural Resources. Section of Fisheries. Study 2, Job 4, Federal Aid, St. Paul.

Hansen, M.J., Editor. 1994. Lake Superior: the state of the lake in 1992. Great Lakes Fishery Commission, Special Publication 94-1. Ann Arbor, Michigan

Negus, M.T. 1995. Bioenergetics modeling as a salmonine management tool applied to Minnesota waters of Lake Superior. *North American Journal of Fisheries Management* 15:60-78.

Peck, J.W., S.T. Schram, T.S. Jones, and W.R. McCallum. In preparation. Contribution of wild and hatchery fish to chinook salmon populations in Lake Superior.

Schreiner, D.R., Editor. 1995. Fisheries management plan for the Minnesota waters of Lake Superior. Minnesota Department of Natural Resources, Special Publication 149, St. Paul.

ACKNOWLEDGMENTS

Personnel from Duluth and Lake Superior Fisheries Areas collected data on chinook salmon and identified fin clips. James Peck reviewed drafts of the manuscript.

Edited by:
P. J. Wingate, Fisheries Research Manager