Harvest, Age, and Size at Age of Chinook and Coho Salmon at Strawberry Creek Weir and Besadny Anadromous Fisheries Facility, Including Progress on Special Studies, Fall 2001

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ABSTRACT

A record number of 8,125 chinook salmon *Oncorhynchus tshawytscha*, with an estimated weight of 119,438 pounds, were harvested at Strawberry Creek Weir (SCW), and the entire quota of chinook salmon eggs for use in Wisconsin's hatcheries were collected from SCW in the fall of 2001. For a second consecutive year, a pipeline functioned as designed and delivered enough water to Strawberry Creek to attract chinook salmon and facilitate their movement up Strawberry Creek and into the pond. The estimated age composition of the entire chinook harvest at SCW consisted of 11 percent age 1+, 71 percent age 2+, 16 percent age 3+, and one percent age 4+ salmon.

The average, trophy, and standard weights of chinook salmon returning to SCW in the fall of 2001 were all up from the weights observed in the previous year. Standard weight increased slightly from fall 2000, but remains within 0.3 pound of the lowest standard weight documented since this characteristic was first described for the SCW chinook in 1974. Average and trophy weights have generally declined since the early 1990s. Observations from 2001 would seem to support a reversal of this trend.

A total of 2,566 adipose clipped chinook were recovered at SCW during the fall of 2001. Improved flow (created by the pipeline) and an increased percentage of fingerlings marked with coded wire tags (CWTs) for multiple studies no doubt affected the number of adipose clipped fish returning to SCW.

In the CWT age at maturity study, comparing the maturation schedule of the two experimental lots from the1997 year class through age 4+, the results would seem to support the hypothesis that offspring from older aged parents are more likely to exhibit a later maturation schedule. Offspring from the older, known age 3+ parents were recovered at lower rates at age 1+ and at age 2+, but at higher rates at age 3+ and age 4+ when compared to the offspring from the control group of CWT unaged parents. The recoveries of the two known age experimental lots from the 1998 year class also seem to support the maturation schedule hypothesis. Through age 3+, the progeny of the known age 3+ parents, were recovered at SCW at a slightly lower rate at age 2+ and at more than double the rate at age 3+, than the progeny of the age 3+ males and age 2+ females.

In the marking technique study, after two years of recovery, it is obvious that the initial hope, that photonic tagging can be used as an instant recognition, non-lethal technique of marking and recognizing study fish, is not going to happen. It does appear that the photonic marking technique may have some valid fisheries application for marking fish. At this time it would appear that neither the photonic marking of chinook fingerlings, or the use of a combination ARV or ALV clips were overly detrimental to the subsequent recovery of age 1+ or age 2+ chinook at SCW.

In the spring of 2001 an estimated 205,182 chinook fingerlings were stocked from the SCW pond. Low flow conditions in Strawberry Creek and the low Lake Michigan water level prompted the modification of standard rearing and release techniques. Chinook fingerlings were netted from the SCW pond and trucked the short distance to the Sturgeon Bay Ship Canal. At the time of stocking the chinook fingerlings averaged 91.7 mm and 6.0 g. In 2001 all chinook fingerlings destined for stocking in Lake Michigan by the WDNR and other agencies were to be marked with oxytetracycline (OTC) prior to stocking. Although the chinook fingerlings stocked from Strawberry Creek were treated with OTC it was established through a subsequent evaluation that the fingerlings stocked by WDNR in spring 2001 were poorly marked.

A total of 5,613 chinook salmon were captured at Besadny Anadromous Fisheries Facility (BAFF) in the fall of 2001. This is well above the average number of chinook captured at BAFF since record keeping began in 1990. Of the 5,613 chinook captured, 1,066 (19 %) were released live upriver for the sport fishery. A record number of 2,084 adipose clipped salmon (CWT) were harvested and sacrificed (37 % of the total capture). The entire quota of chinook salmon eggs required for WDNR hatchery production was collected from SCW in the fall of 2001 and as a result no eggs were harvested at BAFF.

In the stocking technique study on the Kewaunee River, although the study is not complete, after three years of recoveries for the 1998 year class and two years of recoveries for the 1999 year class a distinct pattern of recovery rates has emerged. For both the 1998 and 1999 year class, chinook fingerlings stocked at BAFF and Clyde's Hill Road, the intermediate sites, have been recovered at consistently higher rates.

In the current CWT chinook stocking technique study, the 1999 year class of chinook are being recovered at BAFF at a substantially higher rate than chinook from the 1998 year class. In an earlier CWT study of two chinook strains returning to the BAFF, recovery rates also varied widely between year classes. When cumulative recovery rates of the various chinook year classes are plotted against the average monthly flow of the Kewaunee River, as measured at the USGS gauging station, during the month of stocking, it would appear that higher flows are associated with higher recovery rates.

During the fall of 2001, a total of 175 coho salmon *Oncorhynchus kisutch* were captured at BAFF and approximately 0.109 million coho eggs were collected. The coho return to BAFF over the previous decade has ranged from a low of 717 in 1994 to a high of 3,887 in 1990. The coho return in the fall of 2001 was well below the twelve-year average (1990-2001) of 1,859. Mean length and weight were down from the recent record levels of 1999, but were above average for coho captured at BAFF in recent years.

Although salmon less than 800 mm were cleared for sale for human consumption, and a request for bids was announced, no bids were received. On most harvest days, all salmon harvested at SCW and BAFF that were less than 800 mm were iced and shipped to various food pantries in Northeast Wisconsin. During fall 2001 over 22,000 pounds of salmon were given to food pantries. All of the salmon carcasses harvested from SCW and BAFF that were greater than 800 mm, or unsuitable for human consumption, were disposed of through a local contractor who agreed to take all of the salmon carcasses at no cost on the condition that all carcasses would be turned into liquid fish fertilizer. Eggs harvested at SCW and BAFF that were unsuitable for hatchery production were sold under contract to a private company for use in bait production.

INTRODUCTION

STRAWBERRY CREEK

The Wisconsin Department of Natural Resources (WDNR) chinook salmon *Oncorhynchus tshawytscha* program began in the spring of 1969 when approximately 65,000 fingerlings were stocked in Strawberry Creek, Door County. Each year thereafter, an average of 200,000 fingerlings have been released at this Door County site (Figure 1). A fish trap or weir was constructed on Strawberry Creek, and chinook eggs have been collected from sexually mature fish that returned to Strawberry Creek since the fall of 1972. Chinook salmon returning to Strawberry Creek Weir (SCW) have provided eggs for Wisconsin's Great Lakes stocking program and for other state and federal stocking programs. In addition detailed biological information regarding the spawning run has been collected at SCW since the late 1970's. Biological data obtained each fall during the harvest provides important information on chinook age, growth, movement, relative survival, various chinook studies, and comparisons of various disease treatment techniques.

Chinook spawning at the weir begins with the careful examination of each male and female salmon. Only fish with no gross signs of disease are selected for spawning. Compressed air is injected into the body cavity of the female salmon to expel the eggs. The body cavity of each female salmon is then carefully inspected by hatchery personnel for clinical signs of disease. Eggs from female salmon with no clinical signs of disease are then drained of ovarian fluid, fertilized, and water hardened. Since the fall of 1994 chinook eggs have been water hardened in a thiamine enriched solution. Chinook eggs harvested at SCW are transferred to WDNR hatcheries for hatching and rearing. In spring, chinook fingerlings from Wild Rose Fish Hatchery (WRFH) are stocked into SCW pond and held for a period of six to eight weeks. While in the pond they receive two or more daily feedings. During this time, the fish imprint to the stream water flowing through the pond. Upon release the fingerlings, which over the years have averaged approximately 90 mm in length, gradually leave SCW pond. Over the next two week period they make their way down Strawberry Creek (about ½ mile) to the Sturgeon Bay ship canal and eventually into Lake Michigan. During several of the recent years, chinook fingerlings raised at SCW have been captured and trucked to the Sturgeon Bay ship canal because of low flow conditions in Strawberry Creek and low Lake Michigan levels. However, in the spring of 2002, Lake Michigan water level and stream flow were adequate to allow a return to direct release from the pond.

In late August and early September mature chinook begin to return to SCW. The salmon swim up Strawberry Creek, through a weir, and into a pond. Actual harvest and egg collection begins in late September and continues for about four to six weeks. The run usually peaks in mid October.

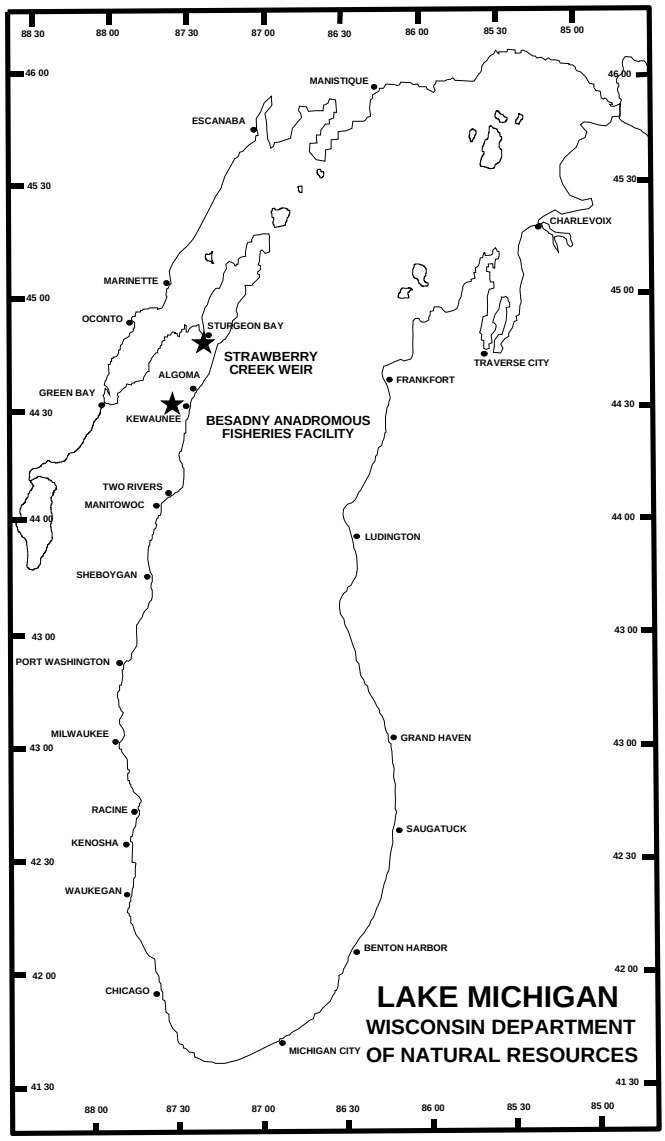

Figure 1.-Location of the Wisconsin Department of Natural Resources Strawberry Creek Weir, Door County, and the Besadny Anadromous Fisheries Facility, Kewaunee County.

SCW was one of four original release sites when coded wire tag (CWT) studies began in 1982. The primary objective of the first CWT study was to determine the movement patterns and growth of CWT chinook. From 1982 to 1984, 20,000 CWT chinook fingerlings were released annually from SCW. The first return of CWT salmon to SCW pond occurred in 1983 and has continued yearly. Since 1985, we have continued to tag a portion of the fingerlings released from SCW pond to monitor the growth of known age salmon and to conduct various treatment experiments. Since 1985, an age length key composed of known aged CWT fish has been used to estimate the age composition of the entire harvest. Prior to this time, a length frequency distribution was used to estimate the age composition of the fall run. Current CWT studies at SCW include: age of maturity study; and a fingerling marking technique study.

KEWAUNEE RIVER

Egg taking operations for chinook and coho salmon *Oncorhynchus kisutch* were conducted for the first time in fall 1990 at a new anadromous fish facility on the Kewaunee River, Kewaunee County (Figure 1). This facility, later named the Besadny Anadromous Fisheries Facility (BAFF), is one of the two WDNR primary egg collection stations for coho and rainbow trout (steelhead) *Oncorhynchus mykiss*. BAFF also functions as a backup for chinook egg collection.

Previously chinook and occasionally coho were imprinted in a rearing pond and released several miles down river from the new facility. The pond has been renovated and is still used for rearing chinook and coho for release to the Kewaunee River. Additionally, some coho and chinook are released directly into the Kewaunee River. Prior to 1990, very little biological information was collected on the fall runs of chinook and coho from the Kewaunee River. Now that BAFF is operational, chinook and coho runs are sampled annually. CWTs have also been used intermittently at BAFF for various chinook and coho salmon studies. Past studies include age, growth, rate of return, comparisons of strain evaluations, comparisons of rearing techniques, and comparisons of disease treatment techniques, on both chinook and coho salmon. Currently a CWT study regarding chinook stocking technique is in progress at BAFF.

The life history of coho is similar to that described above for chinook. Coho are released directly into the lake or stream as yearlings in spring or as young of the year fingerlings in late summer to mid fall. Mature fish home back to the release site to spawn in late fall. Whereas most chinook mature as age 2+ or age 3+, most coho mature and return at age 2+.

METHODS

At the time of stocking or transfer to a rearing pond, and again at the time of release from the rearing pond, subsamples of fingerlings were individually measured to the nearest mm, and weighed to the nearest gram. At the time of harvest, all live chinook at SCW and a sample of chinook and coho at BAFF were measured to the nearest millimeter. Weights on all CWT salmon and approximately half or more of the remaining salmon were measured to the nearest .02 kilogram with an electronic digital scale. Sex was visually determined for all fish and finclips were noted. The heads of all adipose-clipped salmon (probable CWT) were collected, marked with a sequentially numbered jaw tag, and frozen for future examination. In the lab, the presence of a microtag in each head was confirmed with the use of a metal detector. All CWTs were retrieved by dissection and decoded with a compound microscope. The binary code on each CWT identifies year of stocking, the agency that stocked the fish, the location of stocking, and the treatment group of each fish. Known age CWT chinook returning to SCW in 2001 were used to develop a length at age key for aging non-CWT chinook returning in 2001.

Trends in size and condition of chinook salmon harvested at SCW have been examined each year since 1974. Annual sample sizes have ranged from 171 fish to over 6,000 fish. Only fish for which both total length and round weight were recorded were used in calculations. Three measures of estimated weight were calculated and analyzed for each year. They include: 1) average weight; 2) trophy weight (weight of the 95^{th} percentile of the weight distribution); and 3)

standard weight (predicted weight of a 30 inch chinook developed from a length-weight regression model). We used the same standard length of 30 inches for chinook salmon as calculated by Hansen (1986), who conducted a similar study on sport harvested chinook for the years 1969-1984. Statistical procedures were also the same as those used by Hansen.

Although salmon less than 800 mm were cleared for sale for human consumption, and a request for bids was announced, no bids were received. On most harvest days, all salmon harvested at SCW and BAFF that were less than 800 mm were iced and shipped to various food pantries in Northeast Wisconsin. During fall 2001 over 22,000 pounds of salmon were given to food pantries. All of the salmon carcasses harvested from SCW and BAFF that were greater than 800 mm, or unsuitable for human consumption, were disposed of through a local contractor who agreed to take all of the salmon carcasses at no cost on the condition that all carcasses would be turned into liquid fish fertilizer. Eggs harvested at SCW and BAFF that were unsuitable for hatchery production were sold under contract to a private company for use in bait production.

This report also contains information on specific ongoing salmon studies at each facility. Methods for each of these specific studies are detailed in the appropriate section in the text pertaining to the individual study.

RESULTS AND DISCUSSION

STRAWBERRY CREEK CHINOOK

GENERAL HARVEST

The fall of 2001 continued the recent trend of very low Lake Michigan water level and very low stream flow. In September of 1999, Strawberry Creek was warm, the flow was very low, and because of low Lake Michigan levels, Strawberry Creek between the Sturgeon Bay Ship Canal and the Strawberry Creek pond was essentially a ½ mile long mud flat with a trickle of water. As a result of the low water level exacerbated by the low stream flow, harvest of chinook at SCW in the fall of 1999 was substantially below expectations and backup chinook egg collection facilities had to be used to collect eggs and ongoing CWT studies of chinook at SCW were compromised.

Conditions in late summer 2000 were similar to 1999 and the stage was set for another poor harvest at SCW in the fall of 2000. In an attempt to avert another poor season, WDNR operations crew installed a pipeline to carry water from the Sturgeon Bay Ship Canal to Strawberry Creek. The pipeline was designed to carry water approximately 0.7 mile and discharge into Strawberry Creek above the SCW facility to augment the limited natural flow. The pipeline delivered approximately 1,200 gallons of water per minute and was very effective. The harvest of live chinook at the SCW increased from 998 fish in fall 1999 (mostly age 1+ precocious males) to 6,503 (all ages) in fall 2000 and the entire egg harvest was collected at SCW.

Conditions in the fall of 2001 were similar to 1999 and 2000. Low lake level and low flow in Strawberry Creek necessitated the use of the pipeline in fall 2001. For a second consecutive year, the pipeline functioned as designed and delivered enough water to Strawberry Creek to attract chinook salmon and facilitate their movement up Strawberry Creek and into the pond. Chinook harvest began on September 25th and continued through October 24th (Table 1). A record number of 8,125 chinook salmon, with an estimated weight of 119,438 pounds, were harvested at SCW (Appendix A). The entire quota of chinook salmon eggs for use in Wisconsin's hatcheries were collected from SCW in the fall of 2001.

Table 1.-Daily summary of chinook salmon harvest and spawning operations at the Wisconsin Department of Natural Resources spawning facility at Strawberry Creek, Door County, during the fall of 2001.

DATE	LIVE FISH		NUMBER DEAD FISH	TOTAL NUMBER	NUMBER ADIPOSE CLIPPED	POUNDS[1] OF FISH	NUMBER[2] EGGS HARVESTED	WDNR HATCHERY DESTINATION
	MALE	FEMALE						
SEPT 25	223	101	32	356	130	5,233	-	
SEPT 27	695	217	34	946	305	13,906	-	
SEPT 28	-	-	19	19	2	279	-	
OCT 2	451	231	56	738	225	10,849	848,000	BayF WestF
OCT 4	1,067	577	14	1,658	563	24,373	1,019,368	WestF & WR
OCT 5	329	199	-	528	178	7,762	-	
OCT 8	467	241	-	708	237	10,408	691,488	Wild Rose
OCT 11	396	215	-	611	187	8,982	437,670	Wild Rose
OCT 16	761	431	14	1,206	348	17,728	365,256	Wild Rose
OCT 18	498	214	7	719	220	10,569	-	
OCT 24	413	175	7	595	163	8,746	414,200	Wild Rose
SEPT-NOV	-	-	41	41	8	603	-	
TOTALS	5,300	2,601	224	8,125	2,566	119,438	3,775,982	

[1]Weights estimated using the average weight per fish for the entire harvest (2001 average weight was 14.7 pounds).
[2]Number of chinook salmon eggs harvested by WDNR for hatchery production.

The estimated age composition of the entire chinook harvest at SCW consisted of 11 percent age 1+, 71 percent age 2+, 16 percent age 3+, and one percent age 4+ salmon (Table 2). An age at length key developed from known aged CWT chinook captured at SCW in the fall of 2001 was used to divide the length frequency distribution of all chinook measured at SCW in the fall of 2001 (sexes combined) into the four age groups (Figure 2).

Table 2.-Estimated age composition of chinook salmon (sexes combined) harvested at the Strawberry Creek Weir, fall 1985-2001, based on an age at length key developed from known aged CWT chinook salmon returning to Strawberry Creek.

YEAR OF RETURN	PERCENT AGE COMPOSITION					TOTAL NUMBER RETURNED
	AGE 1+	AGE 2+	AGE 3+	AGE 4+	AGE 5+	
1985	7 %	7 %	86 %			5,126
1986	5 %	15 %	47 %	33 %		3,810
1987	9 %	16 %	61 %	14 %	<1 %	6,804
1988	13 %	15 %	64 %	7 %	<1 %	3,031
1989	48 %	18 %	27 %	7 %		1,594
1990	13 %	64 %	21 %	2 %	<1 %	3,016
1991	31 %	25 %	43 %	1 %		1,958
1992	39 %	36 %	24 %	1 %		3,586
1993	16 %	55 %	28 %	1 %		3,964
1994	16 %	53 %	30 %	1 %		3,808
1995	25 %	46 %	29 %			2,292
1996	14 %	47 %	38 %	1 %		6,200
1997	14 %	41 %	42 %	3 %		4,325
1998	7 %	60 %	32 %	1 %		4,943
1999[1]	43 %	37 %	19 %	1 %		842
2000	43%	26%	29%	2%		6,496
2001	11%	71%	16%	1%	<1%	7,893

[1] Age composition of chinook returning to Strawberry Creek in the fall of 1999 was heavily influenced by low flow conditions in Strawberry Creek. Most of the older, larger chinook were unable to negotiate Strawberry Creek and enter the pond.

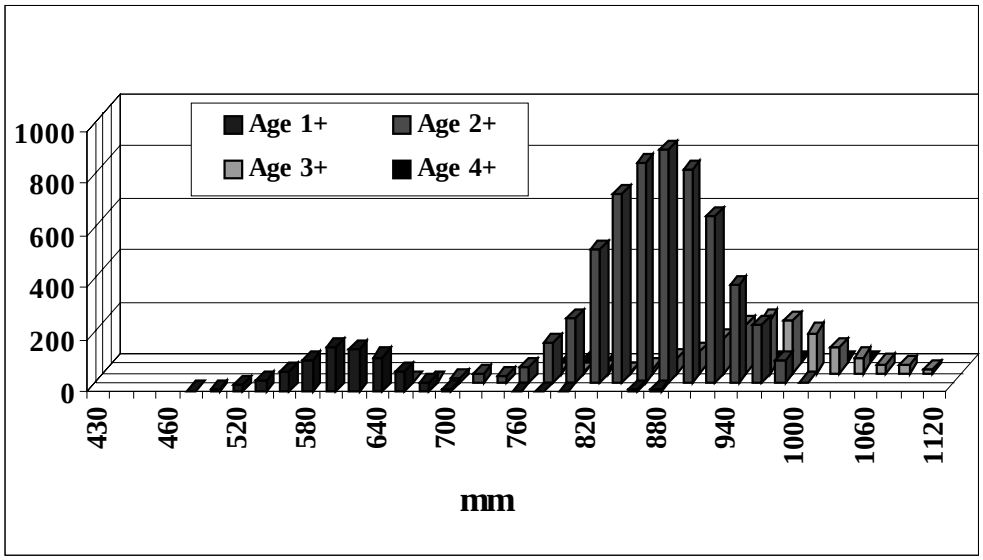

Figure 2.-Length frequency distribution of all chinook salmon measured at SCW in the fall of 2001. Fish were divided into ages with the use of an age at length key developed from known aged CWT chinook salmon captured at SCW in the fall of 2001.

TRENDS IN SIZE AND CONDITION OF CHINOOK SALMON, 1974 - 2001

The average, trophy, and standard weights of chinook salmon returning to SCW in the fall of 2001 were all up from the weights observed in the previous year (Appendix B; Figure 3). The increase in average weight is heavily influenced by the age distribution of chinook returning to SCW. The percent of age 1+ chinook returning to SCW dropped from 43% in 2000 to only 11% in 2001. Standard weight increased slightly from fall 2000, but remains within 0.3 pound of the lowest standard weight documented since this characteristic was first described for the SCW chinook in 1974. Average and trophy weights have generally declined since the early 1990s. Observations from 2001 would seem to support a reversal of this trend.

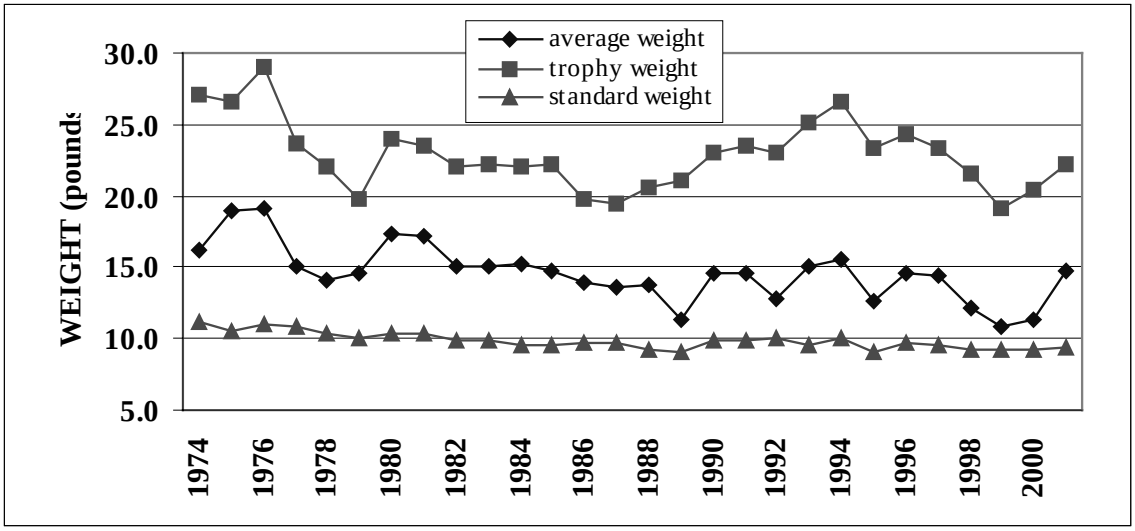

Figure 3.-Average, trophy, and standard weight for chinook salmon harvested at Strawberry Creek, Door County, 1974-2001.

CWT CHINOOK SALMON IN THE HARVEST

A total of 2,566 adipose clipped chinook were recovered at SCW during the fall of 2001 (Table 1). Improved flow (created by the pipeline) and an increased percentage of fingerlings marked with CWTs for multiple studies no doubt affected the number of adipose clipped fish returning to SCW. Of the 2,566 adipose clipped chinook examined, a total of 2,281 CWTs were successfully extracted from the adipose clipped fish (Table 3). Additionally, 38 (1.5%) tags were lost during extraction, 201 (7.8%) of the adipose clipped chinook did not have a CWT and 46 (1.8%) of the heads were not kept for processing because of an advanced stage of decomposition (removed from the pond or stream as dead fish). An unknown portion of the 201 “adipose clipped” chinook without a CWT can be explained by tag loss. However, a certain portion of these “no tag detected” can be attributed to heads from chinook with small or deformed adipose fins kept on the chance that they may have had an adipose fin clip. All but five of the recovered CWTs were from chinook released at SCW. Three CWT chinook were strays from Kewaunee River stockings and two CWT chinook were strays from Lake Huron, stocked by Michigan Department of Natural Resources (MDNR).

Table 3.-Summary of 2,566 adipose clipped chinook salmon harvested at the Strawberry Creek, fall 2001. In addition to the 2,281 CWTs listed below, 38 tags were lost during extraction, 201 of the adipose clipped chinook had no tag detected, and 46 of the heads were not processed because of the advanced stage of decomposition. The chinook released at Strawberry Creek were part of various chinook fingerling studies. The chinook released at all other sites were strays to Strawberry Creek.

YEAR CLASS	LOCATION OF RELEASE	AGE AT CAPTURE	STOCKING AGENCY	NUMBER HARVESTED
2000	Strawberry Creek, WI[1]	1+	WIS DNR	196
	Strawberry Creek, WI[2]		WIS DNR	145
	Strawberry Creek, WI[3]		WIS DNR	174
1999	Strawberry Creek, WI[4]	2+	WIS DNR	481
	Strawberry Creek, WI[5]		WIS DNR	454
	Strawberry Creek, WI[6]		WIS DNR	498
	Kewaunee River (Harbor)[7]		WIS DNR	3
	Lake Huron		MICH DNR	1
	Swan Creek, Lake Huron		MICH DNR	1
1998	Strawberry Creek, WI[8]	3+	WIS DNR	145
	Strawberry Creek, WI[9]		WIS DNR	53
	Strawberry Creek, WI[10]		WIS DNR	113
1997	Strawberry Creek, WI[11]	4+	WIS DNR	11
	Strawberry Creek, WI[12]		WIS DNR	4
1996	Strawberry Creek, WI[13]	5+	WIS DNR	1
	Strawberry Creek, WI[14]		WIS DNR	1

[1] Marking technique study chinook fingerlings stocked at Strawberry Creek A-CWT (regular production).
[2] Marking technique study chinook fingerlings stocked at Strawberry Creek A-CWT and LVclip.
[3] Marking technique study chinook fingerlings stocked at Strawberry Creek CWT and no clip
[4] Marking technique study chinook fingerlings stocked at Strawberry Creek A-CWT and RV clip.
[5] Marking technique study chinook fingerlings stocked at Strawberry Creek A-CWT (regular production).
[6] Marking technique study chinook fingerlings stocked at Strawberry Creek A-CWT and a photonic mark.
[7] Stocking technique study chinook fingerlings stocked in the Harbor near the mouth of the Kewaunee River.
[8] Regular production CWT fingerlings (controls - random mixed ages) stocked at Strawberry Creek.
[9] Fingerlings from known age 3+ males and age 2+ females (age at maturity study stocked at Strawberry Creek).
[10] Fingerlings from known age 3+ males and females (age at maturity study conducted at Strawberry Creek).
[11] Fingerlings from known age 3+ males and females (age at maturity study conducted at Strawberry Creek).
[12] Regular production CWT fingerlings (controls - random mixed ages) stocked at Strawberry Creek.
[13] Fingerlings from eggs which were treated with thiamine (thiamine study conducted at Strawberry Creek).
[14] Fingerlings from eggs which were not treated with thiamine (thiamine study conducted at Strawberry Creek).

AGE COMPOSITION AND SEX RATIO OF SCW CWT CHINOOK SALMON

Four age classes of CWT chinook were recovered at SCW in 2001 (Appendix C, Figure 4). Age 1+ returns (>99% precocious males) accounted for 23 percent of the CWT harvest. Age 2+ chinook, accounted for 63 percent of the harvest (73 % male, 27 % female). The age 3+ CWT chinook made up 14 percent of the return (35% male, 65 % female). Age 4+ salmon accounted for <1 percent of the total CWT harvest (40% male, 60% female).

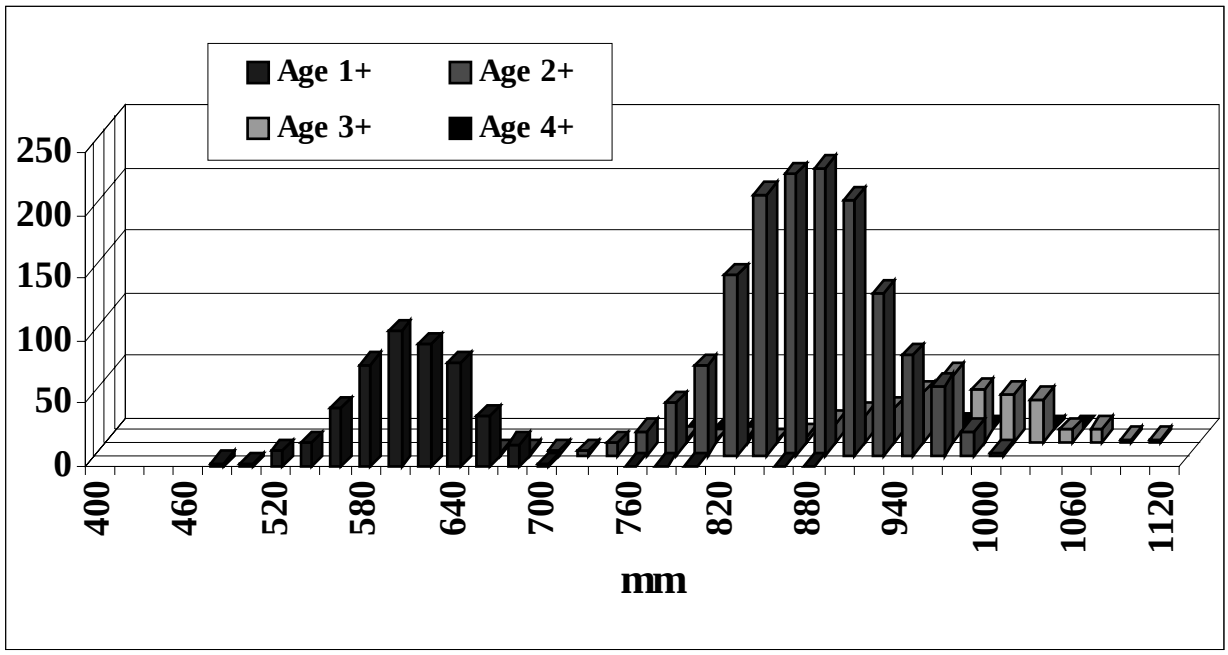

Figure 4.-Length frequency of coded wire tagged, chinook salmon (sexes combined) captured at the Strawberry Creek Weir in the fall of 2001.

SIZE AT AGE OF CWT SALMON

Size at known age (length and weight) of CWT chinook salmon at SCW from 1983 through 2001 is illustrated in Figures 5, 6, 7, and 8, and listed in Appendix D and E. At 616 mm and 2.3 kg, fall 2001 age 1+ chinook (all males) were down from the fall of 2000 and are near the 19-year average of 607 mm and 2.3 kg. There was negligible difference in size between age 1+ study groups. The average size of age 2+ CWT males was 888 mm and 6.7 kg, well above the 18-year average of 843 mm and 5.8 kg. This represents a rather dramatic rebound from the fall of 1998 when age 2+ males (from the 1996 year class) were the smallest since these length and weight statistics have been calculated from known aged fish. Age 2+ females in the fall of 2001, at 853 mm and 6.7 kg, were also above the 18-year average. There was negligible difference in length and weight between the study groups. In the fall of 1999 age 1+ males were the largest since these statistics have been kept and this cohort (1998 year class) age 2+ in the fall of 2000, and age 3+ in the fall of 2001, followed that trend. Age 3+ males (1998 cohort) at 994 mm and 9.0 kg and age 3+ females at 958 mm and 9.1 kg were well above the 17-year average established for this age group. At age 3+ there was negligible size difference between the study groups.

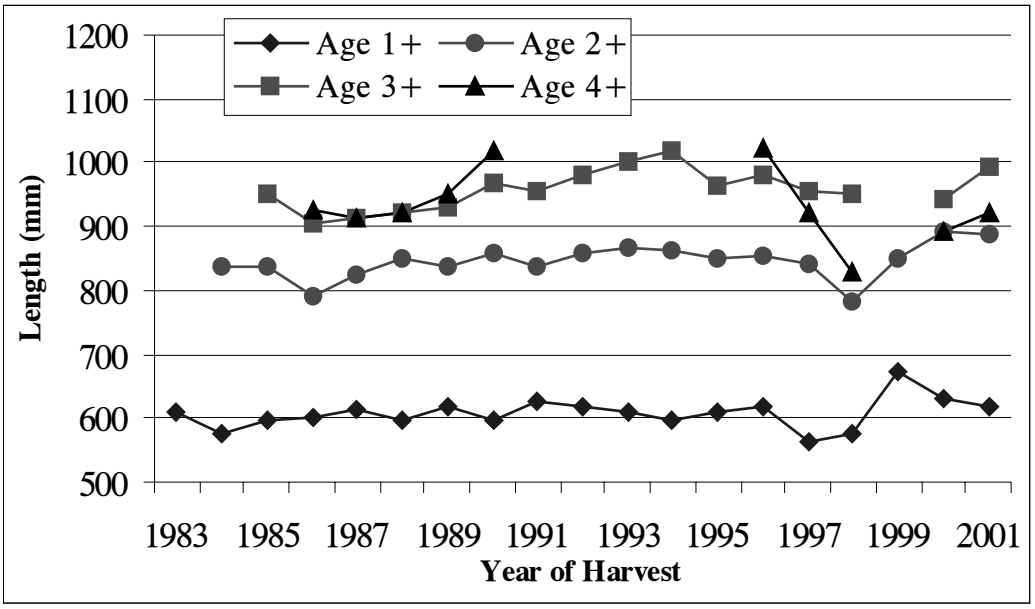

Figure 5.-Mean length of coded wire tagged, male chinook salmon by known age class and year of return to Strawberry Creek Weir, Door County, Wisconsin, 1983-2001.

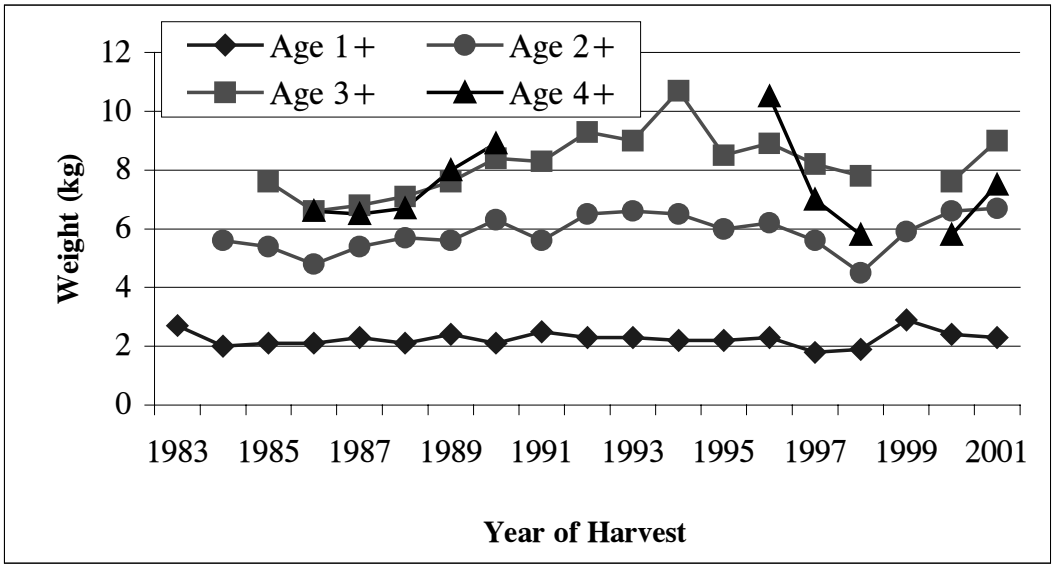

Figure 6.-Mean weight of coded wire tagged, male chinook salmon by known age class and year of return to Strawberry Creek Weir, Door County, Wisconsin, 1983-2001.

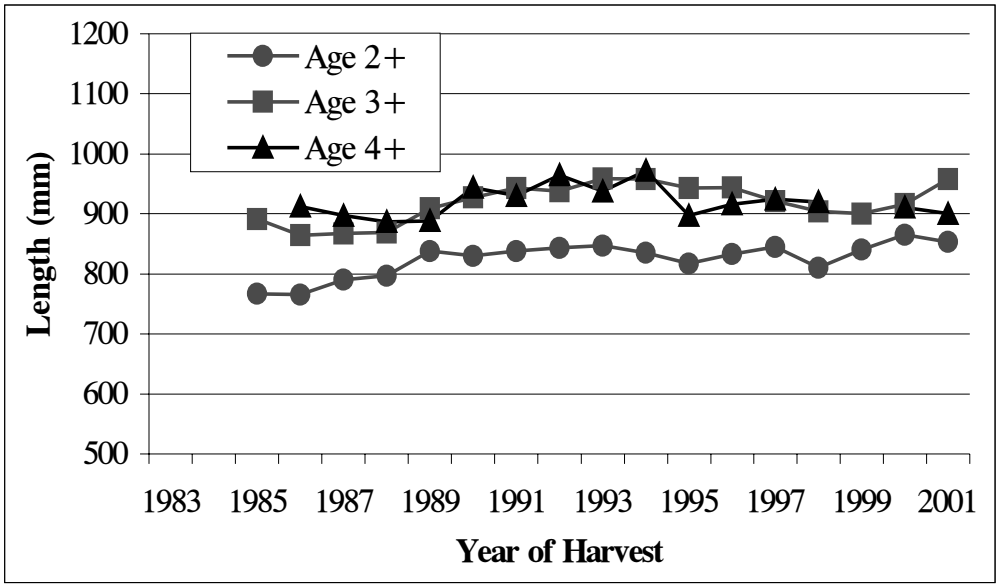

Figure 7.-Mean length of coded wire tagged, female chinook salmon by known age class and year of return to Strawberry Creek Weir, Door County, Wisconsin, 1983-2001.

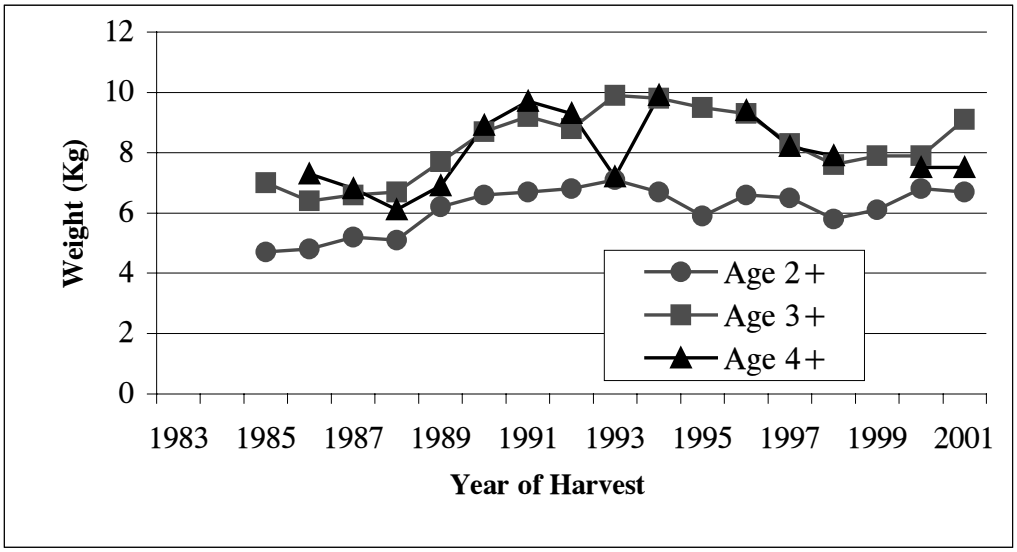

Figure 8.-Mean weight of coded wire tagged, female chinook salmon by known age class and year of return to Strawberry Creek Weir, Door County, Wisconsin, 1983-2001.

RATE OF RETURN, YEAR CLASS STRENGTH, AND SURVIVAL OF CWT SALMON

The rate of return for each of the CWT year classes of chinook salmon stocked at SCW has varied widely from 1982 to present (Appendix F; Figure 9). Cumulative return has varied from a low of 0.75 percent for the 1985 year class to a high of 3.24 percent for the 1994 year class. With a return rate of 2.97 through age 2+, the 1999 year class is poised to exceed the return rate of the 1994 year class. Not only has cumulative year class return rate varied but so has the relative return rate by age within a year class. For the year classes 1982 through 1985, age 3+ chinook were typically 50 percent or more of the cumulative return of that year class. From 1986 through present, with the exception of the 1993 and 1997 year classes, age 3+ chinook have contributed less than 50 percent to the cumulative return rate of any year class. The return of the 1997 year class at age 2+ and 1996 year class at age 3+ (fall of 1999) was heavily influenced by the low water level of Lake Michigan and the low flow of Strawberry Creek. It is likely that the trend of a higher return rate at age 2+ than at age 3+ would have continued for the 1997 year class if water levels and flow conditions had been normal. The change in rate of return at age (maturity schedule) was concurrent with and is likely associated with the Bacterial Kidney Disease (BKD) outbreak of 1988 and 1989.

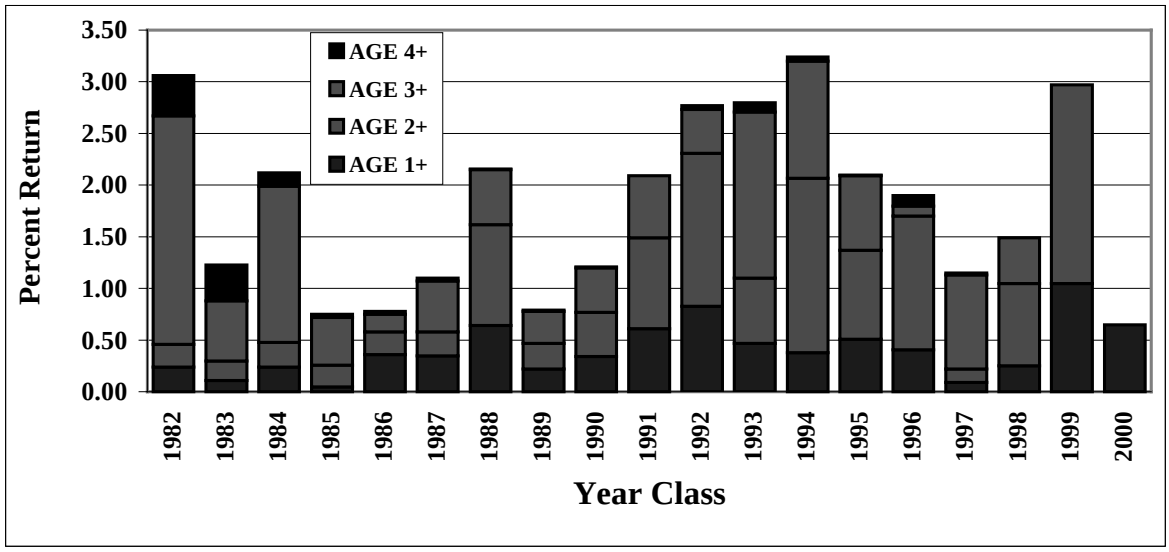

Figure 9.-Cumulative rate of return for the 1982-2000 year classes of coded wire tagged (CWT) chinook salmon stocked at Strawberry Creek, Door County, Wisconsin, by year class, age 1+ through age 4+. For the year classes 1995 through 2000 there were multiple lots of CWT chinook stocked but the return rates have been pooled for this graphic. Comparative rates of return of the various study groups are analyzed later in this report. The return rates of the 1996 year class at age 3+, the 1997 year class at age 2+, and the 1998 year class at age 1+ were heavily influenced by low Lake Michigan water levels and low flow conditions in Strawberry Creek during the fall of 1999.

Numerous CWT studies are in progress at SCW and the poor return in the fall of 1999 will no doubt confound interpretation of some of these studies. During the fall of 1999, the return of all year classes, especially the older, larger cohorts were affected by the low flow of Strawberry Creek and the low level of Lake Michigan. No direct comparisons should be drawn between recovery rates observed at SCW in the fall of 1999 and any other fall. This would include the recovery of the 1996 year class at age 3+, the 1997 year class at age 2+, and the 1998 year class at age 1+. However, comparisons between various same aged cohorts returning in 1999 is likely still valid.

The estimated number of chinook by age (CWT and non-CWT) returning to SCW is detailed in Appendix G. The total percent return is based on the number of chinook fingerlings stocked for each year class. The 1999 SCW harvest was heavily impacted by the water conditions at Strawberry Creek. No direct comparisons should be made between recovery rates in 1999 and other years.

CHINOOK SALMON STUDIES AT SCW

AGE AT MATURITY STUDY

INTRODUCTION

Throughout the 1970's and up to 1988, age 1+ and age 2+ chinook made up less than half of the total salmon harvested at the SCW. Age 3+ fish provided the majority of the returns and supplied most of the eggs needed for production quotas. From 1989 to the present, however, returns have shifted rather dramatically from primarily age 3+ chinook to predominately age 2+ and age 1+ salmon. The shift in age of fish returning to SCW is believed to have been caused by higher mortality rates of larger, older aged chinook during the BKD epizootic. Since 1989 a higher proportion of age 2+ chinook have been used for spawning purposes at SCW. Age of maturity has been demonstrated to be an inheritable trait in chinook salmon (Hankin et al. 1993). By using younger aged salmon for spawning over the past decade at SCW, we may have genetically altered the run of fish to favor an earlier maturation schedule of chinook returning to SCW. It was hypothesized that if older aged chinook were selectively used for gamete production of the fingerling chinook to be stocked at SCW, the maturation schedule could be returned to pre 1989 status.

METHODS

To evaluate the effect of age of the parents on the maturation schedule of their progeny, a CWT study utilizing single paired families (SPF) of known aged chinook was initiated in 1996. For this experiment eggs were obtained from paired spawnings of known age 3+ males and females in the fall of 1996. Age was verified by CWT when possible, or from vertebrae aging of non-CWT fish. The fry from known age 3+ parents were raised to fingerling size and marked with CWTs (lot 31/17/25) prior to being stocked at SCW. One lot of standard production fish from unaged parents was also marked with CWTs (lot 31/17/19) and released from SCW. At stocking, (Appendix H) the two lots of fingerlings were similar in mean length and weight, 93.4 mm, 9.2 g (age 3+ parents) and 93.0 mm, 9.2 g (unaged parents). An estimated 25,800 standard production A-CWT and 42,400 SPF from age 3+ parents were successfully released from SCW. SPF eggs were also collected in the fall of 1997. During fall 1997 spawning operations at SCW, known aged 3+ males were paired with known aged 3+ females and known aged 2+ females. The 3+ male, 3+ female eggs were held separate from the 3+ male, 2+ female eggs through the

fingerling stage. Then before stocking at SCW in the spring of 1998 both of these lots were marked with unique CWTs. A third lot of standard production fingerlings from unaged parental stock was also marked with a different CWT and stocked at SCW in the spring of 1998. At stocking the three lots of CWT fingerlings were all similar in length and weight (Appendix H). The standard production CWT fingerlings (lot 31/17/20) averaged 83.7 mm and 4.7 g. The CWT fingerlings from age 3+ males and age 2+ females (lot 31/17/28) averaged 83.3 mm and weighed 4.7 g. The CWT fingerlings from age 3+ males and age 3+ females (lot 31/17/29) averaged 85.5 mm and weighed 5.1 g. All three groups of CWT chinook fingerlings were raised in the SCW pond along with approximately 140,000 standard production chinook until May 13, 1998 when the SCW pond screens were removed, and they were released from the pond. At release the CWT fingerlings averaged 91.8 mm and 5.8 g, and the standard production fingerlings averaged 89.1 mm and 5.5 g. An estimated 25,500 standard production A-CWT, 22,500 SPF from age 3+ parents, and 22,500 SPF from age 3+ males and 2+ female parents were successfully released from SCW.

RESULTS AND DISCUSSION

Comparing the maturation schedule of the two experimental lots from the1997 year class through age 4+, the results support the hypothesis that offspring from older aged parents are more likely to exhibit a later maturation schedule (Table 4, Figure 10). Offspring from the older, known age 3+ parents were recovered at lower rates at age 1+ and at age 2+, but at higher rates at age 3+ and age 4+ when compared to the offspring from the control group of CWT unaged parents.

Table 4.- Return rate of CWT chinook salmon at age and by year class to the Strawberry Creek Weir, Door County, for year classes 1997 through 1998 in the age of maturity study. In fall 1999, return of the 1997 year class at age 2+, and 1998 year class at age 1+, (highlighted in light blue) were heavily influenced by low flow in Strawberry Creek and low Lake Michigan levels. Although, within year comparisons of affected study groups should still be valid, between year comparisons of affected study groups are not valid.

YEAR CLASS	TREATMENT GROUP	AGE AT RETURN					CUMULATIVE RETURN BY YEAR CLASS
		AGE 1+	AGE 2+	AGE 3+	AGE 4+	AGE 5+	
1997	Age 3+ males, 3+ females	0.06	0.08	0.93	0.03		1.10
	Standard production	0.14	0.20	0.88	0.02		1.24
1998	Age 3+ males, 3+ females	0.31	0.80	0.50			1.61
	Standard production	0.25	0.78	0.57			1.60
	Age 3+ males, 2+ females	0.19	0.82	0.24			1.25

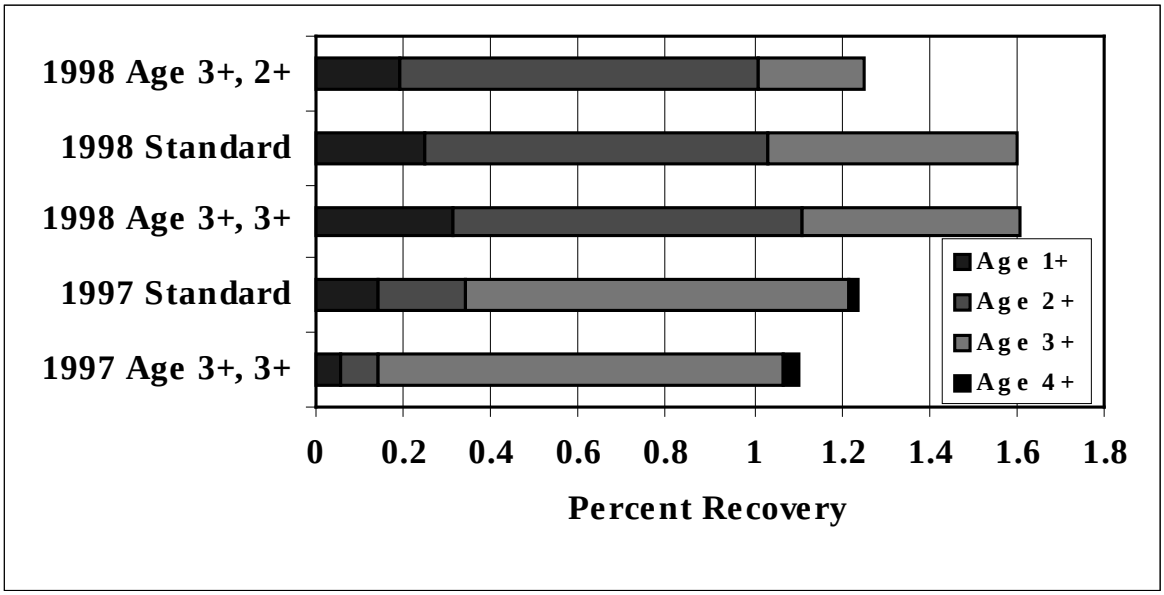

Figure 10.-Percent recovery of chinook salmon at age, at Strawberry Creek Weir, from the age at maturity study CWT treatment lots, from the 1997 and 1998 year classes. Standard lots were made up of fingerlings randomly selected from all spawning dates. Age 3+, 3+ lots were fingerlings from known age 3+ male and female parents and the Age 3+, 2+ lot were fingerlings from known age 3+ male and age 2+ female parents.

Offspring from the 1998 year class, which has three CWT experimental groups (known age 3+ parents, known age 3+ males and age 2+ females, and unaged standard production), has been recovered at SCW through age 3+. The recoveries of the two known age experimental lots also support the maturation schedule hypothesis. Through age 3+, the progeny of the known age 3+ parents, were recovered at SCW at a slightly lower rate at age 2+ (0.80 Vs 0.82) and at more than double the rate at age 3+ (0.50 Vs 0.24), than the progeny of the age 3+ males and age 2+ females. On the contrary, the progeny of the age 3+ parents were also recovered at a higher rate at age 1+ (0.31 Vs 0.19). However, progeny from the standard production, unaged parents are also exhibiting a delayed maturation schedule and when compared to the progeny from the known age 3+ parents were recovered at lower rates at age 1+ (0.25 Vs 0.31) and age 2+ (0.78 Vs 0.80), but higher rates at age 3+ (0.57 Vs 0.50).

As a year class, fingerlings from the 1997 year class were recovered at SCW at relatively low rates at age 1+ and relatively high rates at age 3+. As previously discussed, recovery of the 1997 year class at age 2+ was heavily influenced by the low water conditions in the fall of 1999. Conversely, the 1998 year class was recovered at SCW at relatively high rates as age 1+ and age 2+, but lower rates at age 3+. This despite the fact that the recovery of the 1998 year class at age 1+ was in 1999, the low water year.

Differences between experimental groups within a year class appear to support the maturation schedule hypothesis. However, interpretation of the differences in the maturation schedule between year classes requires other explanations. Three between year class differences that may help explain the observations are noted.

Size at stocking and length of pond residency were different for the two cohorts. The 1997 year class of CWT fingerlings were transferred to SCW on 23 April, 1997 at 5.6-6.2 g and released from SCW on 30 May, 1997 at 9.2 g (Appendix H). Whereas, the 1998 year class of CWT fingerlings were transferred to SCW on 20 April, 1998 at 4.7-5.1 g and released from SCW on 13 May, 1998 at 5.8 g (Appendix H).

Growth as described by length and weight at age was different for the two cohorts. The 1997 year class was substantially smaller (length and weight) at age than the 1998 year class (Figure 5, 6, 7, and 8, Appendixes D and E). Fish from the 1998 CWT cohort were actually the largest (length and weight) ever recovered at SCW at age 1+ and well above average at age 2+. Perhaps faster growing chinook mature at younger ages.

In the fall of 1996 when the gametes were collected for production of the 1997 year class of chinook, the estimated age of the Strawberry Creek run was 14 percent age 1+, 47 percent age 2+, 38 percent age 3+, and less than one percent age 4+ (Peeters and Royseck 1997). Age 1+ fish are not used for gamete production. Therefore, in the fall of 1996 standard production eggs were produced from 55 percent age 2+ fish and 45 percent older fish. In the fall of 1997 when the gametes were collected for production of the 1998 year class of chinook, the estimated age of the Strawberry Creek run was 14 percent age 1+, 41 percent age 2+, 42 percent age 3+, and three percent age 4+ (Peeters and Royseck 1998). In the fall of 1997 standard production eggs were produced from 48 percent age 2+ fish and 52 percent older fish. Gametes for production of the 1997 year class of standard production fingerlings were from a slightly younger parental stock.

CHINOOK SALMON MARKING TECHNIQUE STUDY

INTRODUCTION

The WDNR began using CWTs as a technique of marking chinook salmon back in 1982. Since that time the WDNR has marked and released in excess of one million CWT chinook salmon. The various CWT studies have added much to our knowledge of chinook salmon in Lake Michigan and has allowed the WDNR to improve our chinook rearing and management techniques. Although the CWT technique of marking chinook fingerlings has been reliable and effective, it is also expensive and labor intensive. The CWTs and the necessary equipment to apply and detect CWTs are currently purchased from a sole vendor who has kept the price of utilizing CWTs high. Other drawbacks to the CWT technique is the lethal technique required to retrieve the CWT for decoding and the high expense associated with the necessary manpower to collect salmon heads, extract the CWTs from the fish heads, and then finally decode the extracted CWTs. Additionally, large scale projects such as those conducted by the WDNR in recent years also require the maintenance of large freezer capacities for the storage of salmon heads for processing. This project was set up to evaluate alternate ways of marking chinook fingerlings for future studies that would be both effective and more reasonably priced.

Standard fin clipping is much less expensive and provides instant recognition. With instant recognition, the costs associated with head collection, storage, extraction, and decoding could be eliminated. However, fin clips have the disadvantage of possible fin regeneration and a limited number of clips available which must be coordinated and shared with other Great Lakes states conducting chinook salmon research. Additionally, there have been studies conducted on Pacific

salmon by the state of Washington (personal communication, Thompson, Washington Department of Fish and Wildlife) which indicated reduced survival of salmonid fingerlings marked with fin clips, especially when any of the paired fins were removed.

Recently, a rather promising technique of fish marking was developed by NEWWEST Technologies. The technique known as photonic tagging involves the use of compressed air to dispense a precisely measured amount of "tag" under pressure. The tag is actually a liquid suspension of microscopic fluorescent microspheres, which can be supplied in a wide variety of colors (wavelengths). Additionally, the fluorescent microspheres can be injected into whatever fin the researcher decides. In theory, fish marked by this technique can be identified by simply passing a marked fish under an UV light source of the appropriate wavelength (365) and the tag is fluoresced and visible. By using a combination of different colored tags and various marking locations (different fins) a large number of uniquely marked fish seemed possible. The "tags" for the photonic tagging technique were comparable in price to current CWT costs. However, the equipment to mark the fish photonically was much less expensive. Similar to fin clipping, the concept of photonic tagging had the advantage of instant, non-lethal recognition. This meant that no fish heads would need to be collected, and stored, no tags would need to be extracted and decoded, and no large freezer capacity would need to be maintained. Manpower and cost savings could be substantial. A study to evaluate the photonic marking technique and paired fin clipping on chinook salmon in Lake Michigan was designed.

METHODS

In the spring of 1999 and again in the spring of 2000 three separate lots of CWT chinook salmon fingerlings were marked and released from Strawberry Creek along with the standard production fish (Appendix H). In 1999 one lot was marked with the conventional adipose fin clip and CWT (A-CWT), a second lot was marked with an adipose, right ventral fin clip, and CWT (ARV-CWT), and the third lot was marked with an adipose fin clip, CWT, and a photonic mark (A-CWT photonic). In 1999 there were three different photonic colors utilized (orange, pink, and green), in approximately equal proportion, but they all received the same CWT code (Figure 11). The study plan for the 2000 study was to repeat the same three study groups except that the one lot would be marked with an adipose, left ventral fin clip (ALV-CWT), and the photonic lot would be subdivided into three separate color lots each with their own unique CWT code. Days before photonic marking was to begin, in the spring of 2000, the company cooperating in this study was unable to follow through on their plans, and the three lots of CWT chinook fingerlings destined for photonic tagging were marked and stocked out as a single lot with CWT only (no adipose fin clip) as a last minute modification to the study.

Figure 11.-Photonic marked chinook salmon fingerlings stocked at Strawberry Creek in the spring of 1999. These fingerlings were part of a marking technique study and in addition to the photonic mark they were also marked with an adipose fin clip and CWT. Three colors, (orange, pink, and green) of photonic tags were utilized in approximately equal proportions but all three colors carried the same CWT code.

In the spring of 1999 all three study lots of CWT chinook fingerlings were stocked into the SCW pond on May 3rd, and reared with the standard production fingerlings. At the time of stocking into the SCW pond, the various groups of CWT study fingerlings were similar in size and ranged from 82.6mm to 86.6mm and 4.3g to 5.0g (Appendix H). The chinook fingerlings were released from the SCW pond on May 17th. Before release, underwater video of the CWT fingerlings mixed in with the standard production fingerlings was filmed in the SCW pond. In this video, the photonic tagged fingerlings can easily be seen mixed in with the non-marked fingerlings. At the time of release from SCW pond the photonic mark was very visible to the unaided eye without the use of an UV light source. It is estimated that the following numbers of chinook marking technique study fingerlings were successfully released from SCW: 24,900 A-CWT (31/17/26); 25,000 ARV-CWT (31/17/27); and 24,800 A-CWT/photonic (31/17/34) split into approximate thirds and marked with one of three different photonic colors, (8,300 pink, 8,300 green, and 8,200 orange).

In the spring of 2000 all three study lots of CWT chinook fingerlings were stocked into the SCW pond on May 10th, and reared with the standard production fingerlings. At the time of stocking into the SCW pond, the various groups of CWT study fingerlings were similar in size and ranged from 85.4mm to 86.7mm and 5.1g to 5.7g (Appendix H). The chinook fingerlings were released

from the SCW pond on June 5th. It is estimated that the following numbers of chinook marking technique study fingerlings were successfully released from SCW: 26,000 A-CWT (31/17/35); 26,000 ALV-CWT (31/17/28); and 27,000 CWT without an adipose clip (31/17/36).

RESULTS AND DISCUSSON

In the fall of 2000 the 1999 year class was recovered at SCW at the age of 1+ (Table 5, Figure 12). The A-CWT photonic tagged chinook were recovered at a rate of 1.20 percent, the ARV-CWT treatment group was recovered at a rate of 1.04 percent, and the standard production A-CWT treatment group was recovered at a rate of 0.92 percent.

In the fall of 2001 the 1999 year class was recovered at SCW at the age of 2+ and the 2000 year class was recovered at the age of 1+ (Table 5, Figure 12). Within the 1999 year class, the A-CWT photonic tagged chinook were recovered at a rate of 2.00 percent, the ARV-CWT treatment group was recovered at a rate of 1.92 percent, and the standard production A-CWT treatment group was recovered at a rate of 1.82 percent (Table 5, Figure 12). Within the 2000 year class, the CWT only chinook were recovered at a rate of 0.64 percent, the ALV-CWT treatment group was recovered at a rate of 0.56 percent, and the standard production A-CWT treatment group was recovered at a rate of 0.75 percent.

Table 5.- Return rate of CWT chinook salmon at age and by year class to the Strawberry Creek Weir, Door County, for year classes 1999 through 2000 for the marking technique study.

YEAR CLASS	TREATMENT GROUP	AGE AT RETURN					CUMULATIVE RETURN BY YEAR CLASS
		AGE 1+	AGE 2+	AGE 3+	AGE 4+	AGE 5+	
1999	A-CWT (std production)	0.92	1.82				2.74
	ARV-CWT	1.04	1.92				2.96
	A-CWT + Photonic	1.20	2.00				3.20
2000	A-CWT (std production)	0.75					0.75
	ALV-CWT	0.56					0.56
	CWT without A clip	0.64					0.64

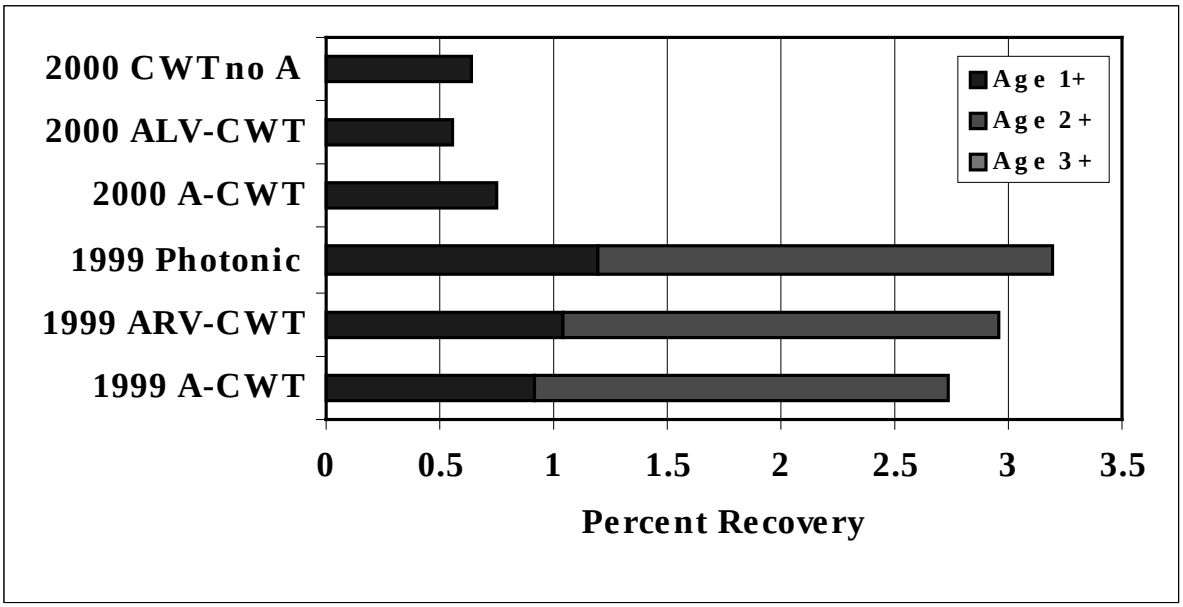

Figure 12.-Percent recovery of chinook salmon at age, at Strawberry Creek Weir, from the marking technique study CWT treatment lots, from the 1999 and 2000 year classes.

In the fall of 2000, all chinook likely to be age 1+ (by preliminary size evaluation) and adipose clipped were visually inspected for the presence of a photonic mark. In normal daylight conditions, no photonic marks were detected. All of these same fish were then taken to a darkened room and viewed under 365 wavelength UV light. Still no photonic marks were detected by this technique. As a final step, the anal fins of all of these chinook salmon were severed near the base of the fin and the fin was viewed in cross section under the UV light in a darkened room. Viewed under these conditions, many of the chinook had detectable sometimes even bright colored photonic marks. In all, a total of 636 chinook were checked with these techniques. During subsequent extraction and decoding of the CWTs in the chinook sampled, it was determined that 68 of the fish did not have a CWT or the CWT was lost during extraction. Another 35 of these fish were from other studies. These other fish were age 1+ strays from other locations, or were small, slow growing age 2+ or older chinook, that were not part of this study group. Seven of these fish were ARV-CWTs that were inadvertently tested, improperly clipped (missing the RV), or had RV fin regeneration. A total of 526 of the fish tested by these techniques were actually part of this study. Of these 296 (56 percent) were A-CWT (31/17/34) which was the group marked with photonic tags and 230 (44 percent) were A-CWT (31/17/26) which was the group stocked at SCW as a control for the ARV-CWT and A-CWT photonic groups.

Detection of the presence or absence of a photonic mark was not an absolute technique. At best, mark detection was time consuming and difficult. About a third of all of the 636 chinook salmon anal fins observed under UV light in a darkened room exhibited some light yellow/green color fluorescence, typically around the edges of the fin cross section. This false/positive reading was common among all of the study groups whether they had been marked with photonic tag or not. Another confounding factor was an apparent color shift in the photonic tag that had been used.

When applied, the photonic colors used were pink, orange, and green. At the time of tagging, there seemed to be good color separation between color groups. Yet many of the viewers of the chinook anal fins under UV light described the observed colors as red, orange, yellow, or green. This was especially confusing when different viewers would describe the colors they saw as red, orange, and green and the next days observer described the colors as orange, yellow, and green. Some viewers on other days used all four colors in their interpretation (red, orange, yellow, and green). In retrospect, when compared to preserved specimens collected at stocking, it would appear that the pink photonic tag exhibited a color shift to something intermediate to red/orange and the orange photonic tag exhibited a shift to a color intermediate to orange/yellow. The green color was still interpreted as green. For the purpose of this analysis of the photonic mark, the pink and orange groups were combined and represented approximately two thirds of the photonic marked fingerlings stocked.

Of the 296 chinook, identified by CWT lot number as the photonic study group, 213 (72 %) were interpreted to have a recognizable photonic mark when cross sections of the anal fin were viewed under UV light in a darkened room. The red/orange/yellow marks accounted for 173 (81 %) of visible marks (at stocking, pink and orange photonic marks accounted for 66.5 percent of study fish) and green accounted for 40 (19 %) of the visible marks (green marks accounted for 33.5 percent at stocking). Additionally, 77 percent of the red/orange/yellow marks were interpreted to be good or strong and 23 percent were called weak. Whereas, only 45 percent of the green marks were interpreted as good or strong and 55 percent were described as weak. Also, 30 of the 68 (44 %) no tag/lost tag group were interpreted to have a photonic mark. Four (2 %) of the 230 A-CWT control group were interpreted to have a weak orange photonic mark. Whether this was a misinterpretation of the false/positive light yellow/green color fluorescence, typically around the edges of the fin cross section, inadvertent mixing of the CWT lots after tagging but before photonic marking, or cross contamination from the shears used to cut the anal fins is unknown.

In the fall of 2001, all adipose clipped chinook likely to be older than age 1+ (by preliminary size evaluation) were visually inspected for the presence of a photonic mark. In normal daylight conditions, no photonic marks were detected. As time and man power permitted, the anal fins of adipose clipped chinook salmon older than age 1+, were severed near the base of the fin and the fin was viewed in cross section under the UV light in a darkened room. Viewed under these conditions, some of the chinook had detectable sometimes even bright colored photonic marks.

In all, a total of 1,119 chinook were checked with these techniques. During subsequent extraction and decoding of the CWTs in the chinook sampled, it was determined that a total of 365 of the fish viewed under UV light were actually from lot 31/17/34, the study group that was experimentally, marked with the photonic tag. The remainder of these fish were actually from other studies, had no tag detected, or the tag was lost during extraction. Of the 365 photonically marked fish that were inspected, 210 (58 %) were interpreted to have a photonic mark, with no mark detected in the others (42 %). Additionally, 39 chinook with no tag or that had a CWT lost during extraction, were also interpreted to have a photonic mark. Of the 210 fish with a photonic mark, 169 (80 %) were interpreted to have a red/orange/yellow mark (at stocking, pink and orange photonic marks accounted for 66.5 percent of study fish) and 41 (20 %) were interpreted to have a green/blue mark (green marks accounted for 33.5 percent at stocking).

In the fall of 2000, at age 1+, photonically marked fish had a detection rate of 72 percent. In the fall of 2001, at age 2+, the detection rate of photonically marked fish dropped to 58 percent. In

both years green was detected at a lower rate than the pink/orange mark. Whereas 33.5 percent of the fish marked with a photonic tag, only 19 percent of the marks detected in 2000 and 20 percent of the marks detected in 2001 were green.

After two years of recovery (through age 2+), we have concluded that it is not feasible to use photonic tagging as an instant recognition, non-lethal technique of marking and recognizing anadromous salmonids. The techniques we found necessary to look for and verify the photonic marks in mature chinook returning to the weir were quite labor intensive, and then, only 58 percent of the fish were interpreted to have a mark. Only a single cut of the anal fin (near the base) was made. It is not known if multiple cuts of the anal fin at various distances from the base would have improved detection rates of photonic marks. The photonic marking technique may have some valid fisheries application for marking fish. However, instant recognition, non-lethal detection in anadromous salmonids, is not one of those applications. Unless time and manpower permit, study fish will probably not be checked in subsequent years for photonic mark retention. We also conclude that neither the photonic marking of chinook fingerlings, or the use of a combination ARV or ALV clips (as applied by the WDNR crew at WRFH) were overly detrimental to the subsequent recovery of age 1+ or age 2+ chinook at SCW. If recovery the rate of the ARV and ALV marked study lots continue to equal that of A-CWT study lots, it may be time to consider abandoning CWT use and reconsider fin clipping for chinook studies in the future.

INCIDENTAL FISH CAUGHT AT SCW

Over the 30 years of chinook collection at SCW a few incidental salmonids have been captured intermixed with the chinook salmon. Since the fall of 2000 when the pipeline was first utilized to supplement flow at SCW, the number of incidental salmonids has risen sharply. In 2000, 92 coho salmon, two brown trout, and one brook trout were captured at SCW. In 2001, ten coho and five brown trout were captured.

REARING OF CHINOOK FINGERLINGS

In the spring of 2001 an estimated 205,182 chinook fingerlings (estimated by weight count at stocking) were stocked from the SCW pond (Appendix H). From April 18th, through April 26th an estimated 179,135 standard production and 24,696 A-CWT (31/17/40) chinook fingerlings were transferred from the WRFH to the SCW pond. These fingerlings were reared until May 21st, at which time they were netted and trucked to the Sturgeon Bay Ship Canal for stocking. Low flow conditions in Strawberry Creek and the low Lake Michigan water level prompted the modification of standard rearing and release techniques in the spring of 2001 at SCW. This was the second consecutive year that chinook fingerlings were netted from the SCW pond and trucked the short distance to the Sturgeon Bay Ship Canal. At the time of stocking the chinook fingerlings averaged 91.7 mm and 6.0 g (CWT and non CWT comingled).

In 2001 all chinook fingerlings destined for stocking in Lake Michigan by the WDNR and other agencies were to be marked with oxytetracycline (OTC) prior to stocking. Although the chinook fingerlings stocked from Strawberry Creek were treated with OTC it was established through a subsequent evaluation that the fingerlings stocked by WDNR in spring 2001 were poorly marked.

BESADNY ANADROMOUS FISHERIES FACILITY

CHINOOK

GENERAL HARVEST

A total of 5,613 chinook salmon were captured at BAFF in the fall of 2001 (Table 6). This is well above the average number of chinook captured at BAFF since record keeping began in 1990 (Table 7). Of the 5,613 chinook captured, 1,066 (19 %) were released live upriver for the sport fishery. A record number of 2,084 adipose clipped salmon (CWT) were harvested and sacrificed (37 % of the total capture). An additional 224 (4 % of the total capture) dead chinook were removed from BAFF during the 2001 fall run. The entire quota of chinook salmon eggs required for WDNR hatchery production was collected from SCW in the fall of 2001 and as a result no production eggs were harvested at BAFF. Eggs from the adipose clipped chinook and dead fish were sold, along with the surplus eggs from SCW, under contract to a bait company.

Table 6.-Daily summary of chinook salmon harvest at the Wisconsin Department of Natural Resources Besadny Anadromous Fisheries Facility on the Kewaunee River, Kewaunee County, during the fall of 2001.

DATE	FISH HARVESTED		NUMBER DEAD FISH	FISH PASSED UPSTREAM	TOTAL NUMBER FISH	NUMBER ADIPOSE CLIPPED	EGGS HARVESTED
	MALE	FEMALE					
AUG 31	1	-	-	-	1	1	
SEPT 21	446	90	-	84	620	471	
SEPT 26	338	117	-	33	488	227	
OCT 1	390	148	-	51	589	288	
OCT 4	188	50	-	131	369	167	
OCT 9	327	81	-	243	651	176	
OCT 15	631	320	-	306	1,257	377	
OCT 17	262	191	-	97	550	191	
OCT 24	328	119	-	121	568	105	
NOV 5	252	44	48	-	344	61	
SEPT/NOV	-	-	176	-	176	20[1]	
TOTALS	3,163	1,160	224	1,066	5,613	2,084	

[1]Dead adipose clipped chinook collected throughout the season were not kept for tag extraction because of the advanced stage of decay.

A total of 2,084 adipose clipped chinook were harvested at BAFF in 2001 (Appendix I). Of these, 1,874 (age 2+ and age 3+, males and females) were from Kewaunee River releases, 83 were strays from SCW, and eight were strays from various Michigan Department of Natural Resources stocking locations on Lake Huron and Lake Michigan. Additionally, 29 CWTs were lost during extraction, 70 of the chinook with an apparent adipose fin clip did not have a CWT, and 20 of the salmon heads collected from dead fish at BAFF were too decomposed to work on. The 83 CWT strays from SCW was down from 179 in 1999 and was probably associated with the improved flow at SCW in 2001 due to use of the pipeline.

Table 7.-Yearly summary of chinook salmon harvest and spawning operations at the Wisconsin Department of Natural Resources Besadny Anadromous Fisheries Facility on the Kewaunee River, Kewaunee County, 1990-2001.

HARVEST YEAR	CHINOOK HARVESTED	PASSED UPRIVER	DEAD FISH	TOTAL CHINOOK	ADIPOSE CLIPPED	EGGS HARVESTED
1990	1,307	1,797		3,104	214	1,081,000
1991	2,390	966		3,356	21	1,880,000
1992	2,254	995	625	3,874	120	2,148,000
1993	2,180	726	354	3,260	241	880,000
1994	813	847	62	1,722	452	471,000
1995	1,182	1,362	77	2,621	738	1,360,000
1996	952	2,029	212	3,193	633	616,080
1997	144	1,139	235	1,518	148	-
1998	695	2,858	452	4,005	67	1,155,080
1999	1,803	3,189	806	5,798	496	3,291,346
2000	720	1,733	321	2,774	741	-
2001	4,323	1,066	224	5,613	2,084	-
AVERAGE	1,564	1,559	337	3,403	496	1,431,389

At BAFF many of the chinook, not sacrificed for CWT extraction, or saved for distribution to food pantries, are passed live upstream with as little handling as possible for the sport fishery. Other than detailed information collected on all adipose clipped (CWTs) chinook captured, limited biological information is collected from the unclipped chinook returning to BAFF. Detailed biological information is collected from chinook returning to SCW each fall and chinook returning to BAFF are believed to have similar biological characteristics.

CHINOOK SALMON STUDIES AT BAFF

STOCKING TECHNIQUE STUDY

INTRODUCTION

The WDNR has been stocking chinook salmon as part of the Lake Michigan anadromous fisheries management program since 1969. Over the last two decades, the WDNR has completed several studies that have helped us improve the efficiency with which chinook fingerlings are reared and stocked. The studies have included hatching, rearing, sterilization, and stocking techniques.

One of the previous studies (Peeters and Toneys, 1995) compared recovery rates of chinook fingerlings stocked by three different techniques. This study demonstrated that chinook fingerlings stocked in a river or in a rearing pond with subsequent release to a river were recovered at higher rates than chinook fingerlings stocked directly into Lake Michigan. In the chinook fingerling stocking technique study, rearing pond fingerlings were recovered at a rate of 0.356 as compared to a rate of 0.303 for river stocked fingerlings, and a rate of 0.149 for lake stocked fingerlings. Harbor stocked fingerlings became an unplanned, non-replicated part of this study when fisheries technicians decided, that because of a pounding Lake Michigan surf on the

day of stocking, to put one of the chinook lots destined for the lake, in the harbor. This group of harbor stocked fingerlings was subsequently recovered at a higher rate (0.460 percent) than fingerlings stocked by any of the other techniques.

Researchers on the Pacific Coast (Tabor et al. 1993) demonstrated that in spring and early summer, in the Columbia River, Washington, juvenile salmonids (mostly subyearling chinook salmon) were 59 percent of smallmouth bass *Micropterus dolomieui* diets and 28.8 percent of northern squawfish *Ptychocheilus oregonensis* diets, by weight. If in fact the rivers in which chinook fingerlings are stocked become a predator lined gauntlet that they must run, stocking further upstream may increase the risk of predator encounter. The stocking of chinook fingerlings in a river has been shown to be more effective than stocking directly into the lake, however, stocking of chinook too far upstream may be counterproductive. This study is an attempt to further refine chinook fingerling river stocking techniques by stocking four lots of CWT chinook fingerlings in the Kewaunee River at various distances upstream from Lake Michigan. The Kewaunee River was used for this study because of the Besadny Anadromous Fisheries Facility (BAFF) on the Kewaunee River, which would facilitate collection of mature chinook with CWTs.

METHODS

For two consecutive years (1998 and 1999), four lots of approximately 25,000 chinook salmon fingerlings raised at the WDNR WRFH were marked with CWTs and an adipose fin clip (Appendix J). Chinook fingerlings were stocked in the Kewaunee River Harbor, near BAFF approximately four miles upstream from Lake Michigan, at Clydes Hill Road approximately nine miles upstream from Lake Michigan, and at U.S. Highway 54 approximately 15 miles upstream from Lake Michigan. The lots were as similar as possible except for the difference in distance of stocking site from Lake Michigan.

During April of 1998, study fingerlings were divided into four lots and marked with an adipose fin clip and CWTs (Table 8). Fingerlings for this study were held at the WRFH in central Wisconsin until stocking. On May 1, 1998, the four lots of CWT chinook fingerlings were transported to the Kewaunee River and stocked. Each lot contained between 25,000 and 26,000 fingerlings and average fingerling weights within the four lots ranged from 4.17g to 4.37g. Average length of the CWT chinook fingerlings was 79.5mm. CWT retention rates as estimated by the WRFH staff ranged from 96.6 percent to 99.7 percent and averaged 98.5 percent.

Table 8.-Number of fingerlings, average size, and coded wire tag retention of the four study lots stocked in the spring of 1998.

CWT LOT NUMBER	NUMBER OF FINGERLINGS	AVERAGE WEIGHT	PERCENT TAG RETENTION	STOCKING SITE
31/17/21	25,443	4.32g	99.2	Kewaunee Harbor
31/17/22	25,533	4.28g	96.6	Besadny Anadromous Facility
31/17/23	25,529	4.17g	98.6	Clyde Hill Road crossing
31/17/24	25,586	4.37g	99.7	US Hwy 54 crossing
TOTAL	102,091	4.28g	98.5	Kewaunee River

A small sample (50 from each lot) of the CWT chinook fingerlings were sacrificed at the time of stocking as a quality check of CWT retention, CWT number accuracy, and lot fidelity (Table 9). Two of the 200 chinook fingerlings sampled did not have a tag, for an overall tag retention rate of 99 percent, and all 198 of the tagged fingerlings had the correct lot number.

Table 9.-Coded wire tag verification of four chinook salmon fingerling study lots stocked in the Kewaunee River in the spring of 1998.

CWT LOT NUMBER	SAMPLE SIZE	NUMBER WITH CORRECT TAG #	NUMBER WITH WRONG TAG #	NUMBER WITH NO TAG	PERCENT CORRECT TAG RETENTION
31/17/21	50	50	0	0	100.0
31/17/22	50	49	0	1	98.0
31/17/23	50	49	0	1	98.0
31/17/24	50	50	0	0	100.0
TOTAL	200	198	0	2	99.0

The four lots of CWT chinook fingerlings were stocked at the preselected stocking locations on the Kewaunee River, in Kewaunee County, Wisconsin. Lot 31/17/21 was stocked in the Kewaunee Harbor near the mouth of the Kewaunee River. Lot 31/17/22 was stocked at the Besadny Anadromous Fisheries Facility (BAFF), approximately four miles upstream from Lake Michigan. Lot 31/17/23 was stocked at the Clydes Hill Road crossing of the Kewaunee River, approximately nine miles upstream from Lake Michigan. Lot 31/17/24 was stocked at the U. S. Highway 54 crossing of the Kewaunee River, approximately 15 miles upstream from Lake Michigan. All four lots were stocked on May 1, 1998 within a two-hour time period.

During April of 1999, study fingerlings were divided into four lots and marked with an adipose fin clip and CWTs (Table 10). Fingerlings for this study were held at the WRFH in central Wisconsin until stocking. On May 17, 1999, the four lots of CWT chinook fingerlings were transported to the Kewaunee River and stocked. Each lot was between 22,000 and 25,000 fingerlings and average fingerling weights within the four lots ranged from 5.47g to 5.90g. Average length of the CWT chinook fingerlings was 87.8mm. CWT retention rates as estimated by the WRFH staff ranged from 96.8 percent to 100.0 percent and averaged 99.1 percent.

Table 10.- Number of fingerlings, average size, and coded wire tag retention of the four study lots stocked in the spring of 1999.

CWT LOT NUMBER	NUMBER OF FINGERLINGS	AVERAGE WEIGHT	PERCENT TAG RETENTION	STOCKING SITE
31/17/31	22,037	5.47g	100	Kewaunee Harbor
31/17/32	24,473	5.68g	100	Besadny Anadromous Facility
31/17/33	24,515	5.82g	99.4	Clyde Hill Road crossing
31/17/30	24,354	5.90g	96.8	US Hwy 54 crossing
TOTAL	95,379	5.72g	99.1	Kewaunee River

A small sample (approximately 50 from each lot) of the CWT chinook fingerlings were sacrificed at the time of stocking as a quality check of CWT retention, CWT number accuracy, and lot fidelity (Table 11). One of the tagged fingerlings was mixed in with the wrong lot, and four of the fingerlings sampled did not have a tag, for an overall correct tag retention rate of 97.5 percent.

Table 11.-Coded wire tag verification of four chinook salmon fingerling study lots stocked in the Kewaunee River in the spring of 1999.

CWT LOT NUMBER	SAMPLE SIZE	NUMBER WITH CORRECT TAG #	NUMBER WITH WRONG TAG #	NUMBER WITH NO TAG	PERCENT CORRECT TAG RETENTION
31/17/31	52	52	0	0	100.0
31/17/32	51	50	0	1	98.0
31/17/33	50	48	1	1	96.0
31/17/30	48	46	0	2	95.8
TOTAL	201	196	1	4	97.5

The four lots of CWT chinook fingerlings were stocked at the preselected stocking locations on the Kewaunee River. Lot 31/17/31 was stocked in the Kewaunee Harbor near the mouth of the Kewaunee River. Lot 31/17/32 was stocked at a boat landing just downstream of the BAFF, approximately four miles upstream from Lake Michigan. Lot 31/17/33 was stocked at the Clydes Hill Road crossing of the Kewaunee River, approximately nine miles upstream from Lake Michigan. Lot 31/17/30 was stocked at the U. S. Highway 54 crossing of the Kewaunee River, approximately 15 miles upstream from Lake Michigan. All four lots were stocked on May 17, 1999 within a two-hour time period.

RESULTS AND DISCUSSION

During operations at the BAFF in the fall of 2001 over 5,600 chinook salmon were processed (Appendix F). A total of 2,084 chinook salmon with an adipose fin clipped were measured, weighed, and sexed. During fall 2001 chinook from the 1998 year class were collected at age 3+ and the 1999 year class was collected at age 2+. Fall 2001 should represent the peak of CWT collection for this study.

Of the 2,084 heads collected at BAFF in the fall of 2001 (Appendix I), 20 of the heads were disposed of because of the advanced stage of decomposition (collected as dead fish), no tag was detected in 70 of the heads, and an additional 29 of the heads did have a CWT which was lost during extraction. Of the 1,965 adipose clipped chinook collected at BAFF in the fall of 2001, from which a CWT was successfully extracted and decoded, 1,874 were part of the ongoing Kewaunee River study, and 91 were strays from other locations. Of the 1,874 Kewaunee River study fish, 1,513 were age 2+ (from the 1999 stocking) and 361 were age 3+ fish (from the 1998 stocking). Of the 91 strays collected at BAFF in the fall of 2001, 83 were from Strawberry Creek and eight had been stocked by MDNR.

CWT chinook salmon from all four of the 1998 study lots and all four of the 1999 study lots were recovered at the BAFF in the fall of 2001 (Table 12). Rate of return (number captured/number stocked) for the 1998 year class in the fall of 2001, ranged from a low of 0.19 percent for the lot stocked in the Kewaunee Harbor to a high of 0.60 percent for the lot stocked at Clyde's Hill Road. Rate of return for the 1999 year class in the fall of 2001, ranged from a low of 1.05 percent for the lot stocked at Hwy 54 to a high of 1.88 percent for the lot stocked at BAFF.

Although the study is not complete, a distinct pattern of recovery rates has emerged, after three years of recoveries for the 1998 year class and two years of recoveries for the 1999 year class (Figure 13). For both the 1998 and 1999 year class, chinook fingerlings stocked at BAFF and Clyde's Hill Road, the intermediate sites, have been recovered at consistently higher rates.

In 2001, there was nearly no difference in length and weight at age between the four study groups within a year class (Appendix K and L). Age 2+ male chinook (1999 year class caught in fall 2001) from this study averaged from 860 to 865 mm and 6.2 to 6.4 kg. Age 2+ female chinook (1999 year class caught in fall 2001) from this study averaged from 835 to 845 mm and 6.5 to 6.8 kg. Age 3+ male chinook (1998 year class caught in fall 2001) from this study averaged from 993 to 996 mm and 9.1 to 9.4 kg. Age 3+ female chinook (1999 year class caught in fall 2001) from this study averaged from 939 to 943 mm and 8.8 to 9.1 kg.

Table 12.-Chinook salmon stocking technique study rate of return, at age, to the Besadny Anadromous Fisheries Facility. Rate of return expressed as a percent of the number of chinook stocked in the Kewaunee River that were actually recovered at the Besadny Anadromous Fisheries Facility through the fall of 2001. The percent return is followed by the actual number of fish recovered in parentheses.

Year Class	STOCKING LOCATION	AGE AT RETURN				CUMULATIVE Rate of Return
		1+	2+	3+	4+	
1998	HARBOR	0.14 (35)	0.13 (34)	0.19 (48)		0.46 (117)
	BAFF	0.37 (94)	0.22 (57)	0.33 (85)		0.92 (236)
	CLYDE'S	0.41 (105)	0.31 (78)	0.60 (153)		1.32 (336)
	HWY 54	0.22 (57)	0.22 (56)	0.29 (75)		0.73 (188)
1999	HARBOR	0.32 (70)	1.55 (341)			1.87 (411)
	BAFF	0.53 (129)	1.88 (460)			2.41 (589)
	CLYDE'S	0.53 (129)	1.86 (457)			2.39 (586)
	HWY 54	0.30 (72)	1.05 (255)			1.35 (327)

In the current CWT chinook stocking technique study, the 1999 year class of chinook is being recovered at BAFF at a substantially higher rate than chinook from the 1998 year class. In an earlier CWT study of two chinook strains returning to the BAFF, recovery rates also varied widely between year classes (Peeters and Royseck 1998). When cumulative recovery rates of the various chinook year classes are plotted against the average monthly flow of the Kewaunee River, (as measured at the USGS gauging station, during the month of stocking), higher flows are associated with higher recovery rates (Figure 14).

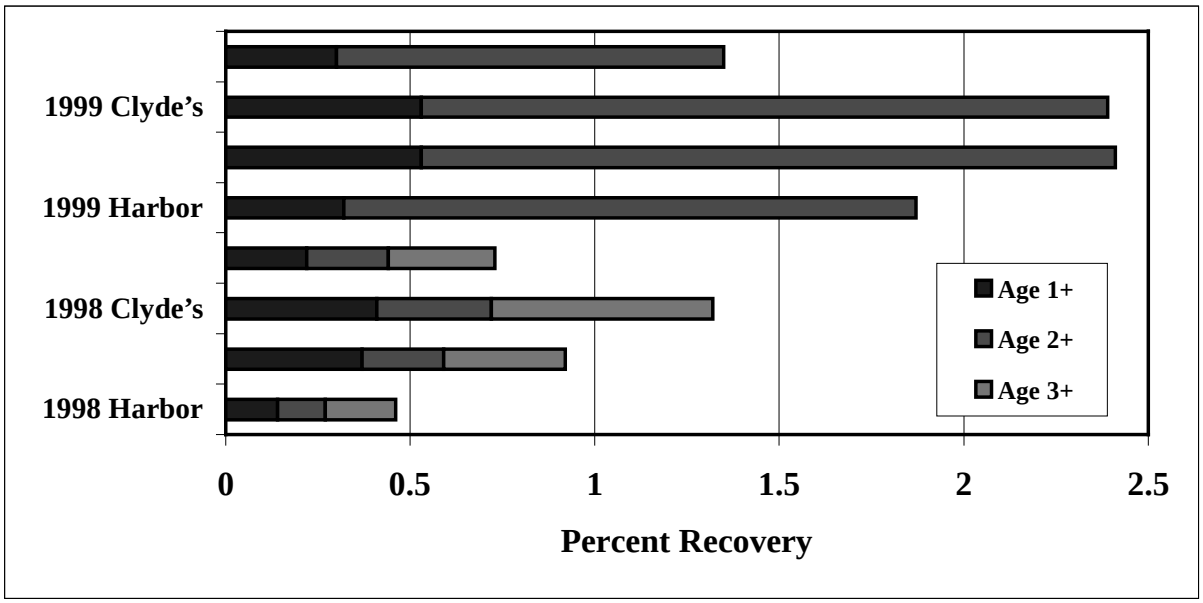

Figure 13.-Percent recovery of CWT chinook salmon, from the 1998 and 1999 year classes, at age, at the Besadny Anadromous Fisheries Facility, from the stocking technique study, through fall 2001.

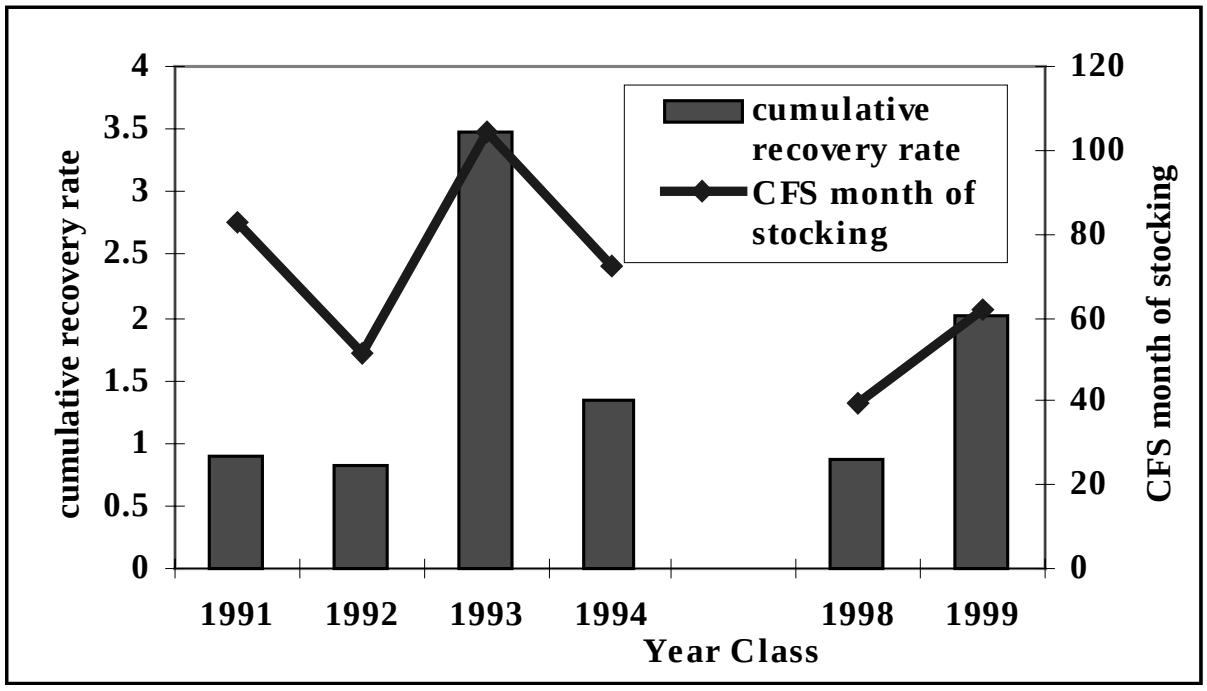

Figure 14.-Cummulative recovery rate of various year classes of CWT study chinook at the Besadny Anadromous Fisheries Facility and the average flow, in cubic feet per second (CFS) during the month of stocking, as measured at the USGS gauging station on the Kewaunee River. The 1991-94 year classes were from a chinook strain experiment and the 1998-99 year classes were from a chinook stocking technique study. The recovery rate of the 1991-94 year classes are through age 4+, the 1998 year class is through age 3+, and the 1999 year class is through age 2+.

COHO

GENERAL HARVEST

During the fall of 2001, a total of 175 coho were captured at BAFF (Table 13). The coho return to the BAFF over the previous decade has ranged from a low of 717 in 1994 to a high of 3,887 in 1990 (Table 14). The coho return in the fall of 2001 was well below the twelve year average (1990-2001) of 1,859. From late September through mid October coho entering BAFF were processed on a regular basis with precocious males being passed upriver as quickly as possible when first handled or sacrificed for food pantry distribution. Adult coho captured through late October were generally not ready for spawning and were sorted back to the holding ponds with as little handling as possible. In early November when coho spawning began all fish that had been sorted back to the ponds and those that had just entered the facility were harvested and spawned. Numbers of coho harvested on specific dates in Table 14 are not indicative of the dates of the coho run because of the practice of sorting adults back to the holding pond. Coho harvested for spawning were sexed, checked for fin clips, measured and most of them were weighed. Approximately 71 percent of the coho captured during the fall of 2001 were utilized for spawning and/or used for health testing purposes. Live coho released upriver for the sport fishery, made up 19 percent of the run, and dead coho collected during the season (10 %), made up the remainder of the run.

Table 13.-Summary of coho salmon harvest at the Wisconsin Department of Natural Resources Besadny Anadromous Fisheries Facility on the Kewaunee River, Kewaunee County, during the fall of 2001.

Harvest Date	Fish Harvested		Number Dead Fish	Fish Passed Upstream	Total Number Fish	Eggs Harvested	Destination Of Eggs
	Male	Female					
Nov 5	37	38	10	-	85	109,000	Kettle Moraine
Sept/Nov[1]	46	3	7	34	90	-	-
Totals	83	41	17	34	175	109,000	Kettle Moraine

[1]Primarily precocious male coho captured during chinook harvest operations; coho not passed upstream were donated to Paul's Pantry.

WDNR personnel collected approximately 0.109 million coho eggs at the BAFF during fall 2001 (Table 13). Coho eggs collected at BAFF in the fall of 2001 were transported to Kettle Moraine Springs Fish Hatchery for hatching and rearing. Coho eggs not suitable for hatchery production were sold under contract to a bait dealer along with surplus chinook eggs. No adipose clipped coho were collected at BAFF in fall 2001. All CWT coho stocked in the Kewaunee River system in recent years have matured and cycled through the fishery. Although CWT coho stocked in the Root River would first be seen in fall 2001 at age 1+, none were captured at BAFF.

Table 14.-Yearly summary of coho salmon harvest and spawning operations at the Wisconsin Department of Natural Resources Besadny Anadromous Fisheries Facility on the Kewaunee River, Kewaunee County, 1990-2001.

YEAR OF HARVEST	COHO[1] HARVESTED	PASSED UPRIVER	DEAD FISH	TOTAL COHO	ADIPOSE CLIPPED	EGGS HARVESTED
1990	2,074	1,813		3,887		1,374,000
1991	853	287		1,140		790,000
1992	362	596		958		163,000
1993	1,215	130	47	1,392		529,000
1994	464	156	97	717		350,000
1995	698	2,744	325	3,767		535,000
1996	632	989	1,762[2]	3,383	55	644,000
1997	773	337	52	1,162	251	524,000
1998	847	1,518	67	2,432	299	607,898
1999	959	536	143	1,638		1,445,423
2000	768	681	205	1,654	-	1,115,000
2001	124	34	17	175	-	109,000
AVERAGE	814	818	-	1,859	-	682,193

[1] Includes fish which were used for egg collection, fish harvested for distribution to food pantries, and those that were collected for disease and contaminant analysis.
[2] In 1996 it was decided that 1,514 coho (BV clip) that had been exposed to Infectious Pancreatic Necrosis as fingerlings should not be used for egg harvest, and that they should not be passed upstream. These fish were captured alive but were sacrificed and disposed of along with the dead fish.

Coho returning to BAFF in the fall of 2001 were age 1+ precocious males from the 2000 year class (stocked as fingerlings in the fall of 2000 or as yearlings in the spring of 2001), or age 2+ fish from the 1999 year class (stocked as fingerlings in the fall of 1999 or as yearlings in the spring of 2000) (Appendix M). Currently, there are no coho studies in the Kewaunee River system and as a result none of the coho from the 1999 or 2000 year classes were marked with an identifying mark. Coho used for spawning and a small sample of age 1+ precocious males were measured and weighed. All other coho processed at BAFF in the fall of 2001 (age 1+ precocious males and age 2+ males and females not used for spawning) were processed as quickly as possible and with a minimum of handling so they could be passed upstream for the sport fishery. The fish passed upstream were only counted as male or female and there was no attempt to determine the numbers of age 1+ versus age 2+ being passed. As a result, coho recovery rate for the 1999 and 2000 year classes (Appendix N, Figure 15) is necessarily based on information collected from spawned fish and an interpretation of information regarding the sex ratio and the dates of coho passed upstream or removed from BAFF as dead fish. Also, because the 1999 and 2000 coho year classes were not identified with any type of mark, the cumulative recovery rate of coho is based on the cumulative numbers of fingerlings and yearlings stocked.

Cumulative recovery rate for the 1999 year class was 0.095 percent (0.055 % at age 1+ and 0.040 % at age 2+). Cumulative (two year) recovery rates of coho has ranged from a high of 4.261 percent, for one lot of coho (1994 year class) stocked in the Kewaunee River as part of an

erythromycin study, to a low of 0.036 percent, for one lot of coho (1994 year class) stocked as hyper accelerated coho fingerlings. Other than the 1994 lot of hyper accelerated coho, the cumulative recovery rate of the 1999 year class was the lowest since these statistics have been kept for coho returning to BAFF. With no identifying fin clips, there is no easy way to differentiate the recovered coho from the 1999 or 2000 year class as attributable to either fingerling or yearling stocked fish. The 2000 year class (all precocious males) was recovered at a rate of 0.044 percent in the fall of 2001.

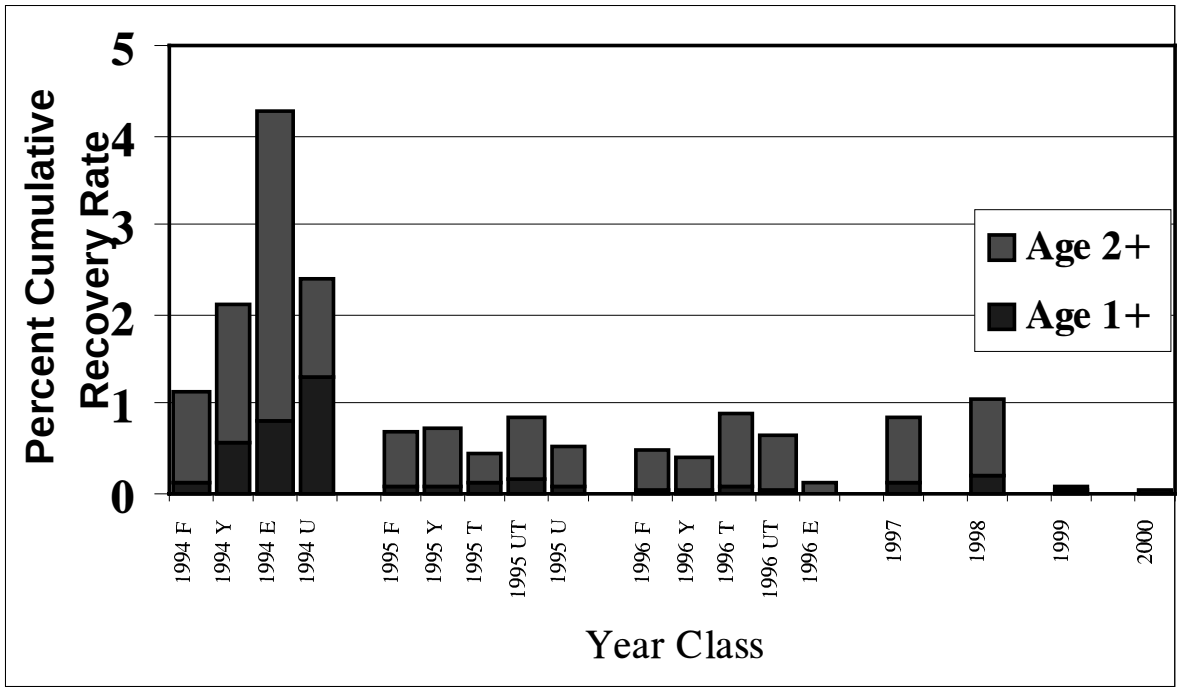

Figure 15.-Coho salmon cumulative recovery rate of return to the Besadny Anadromous Fisheries Facility, Kewaunee County. For year classes 1994, 1995, and 1996, letter designations F (fingerlings), Y (yearlings), E (erythromycin treated), T (thiamine treated), and UT (not treated with thiamine) designate specific marked lots of coho stocked in the Kewaunee for various studies. The 1994U and 1995U lots were unmarked yearlings stocked in the Kewaunee and aged by length frequency. The 1997, 1998, 1999, and 2000 lots were a combination of unmarked fingerlings and yearlings from the respective year classes and were aged by length frequency.

In the fall of 2001 mean length and weight were down from the recent record levels of 1999, but were above average for coho captured at BAFF in recent years (Appendix O, Figure 16 and 17). Age 1+ males averaged 406.8 mm and 0.6 kg, and age 2+ males averaged 691.1 mm and 3.1 kg, while age 2+ females averaged 719.7 mm and 3.7 kg.

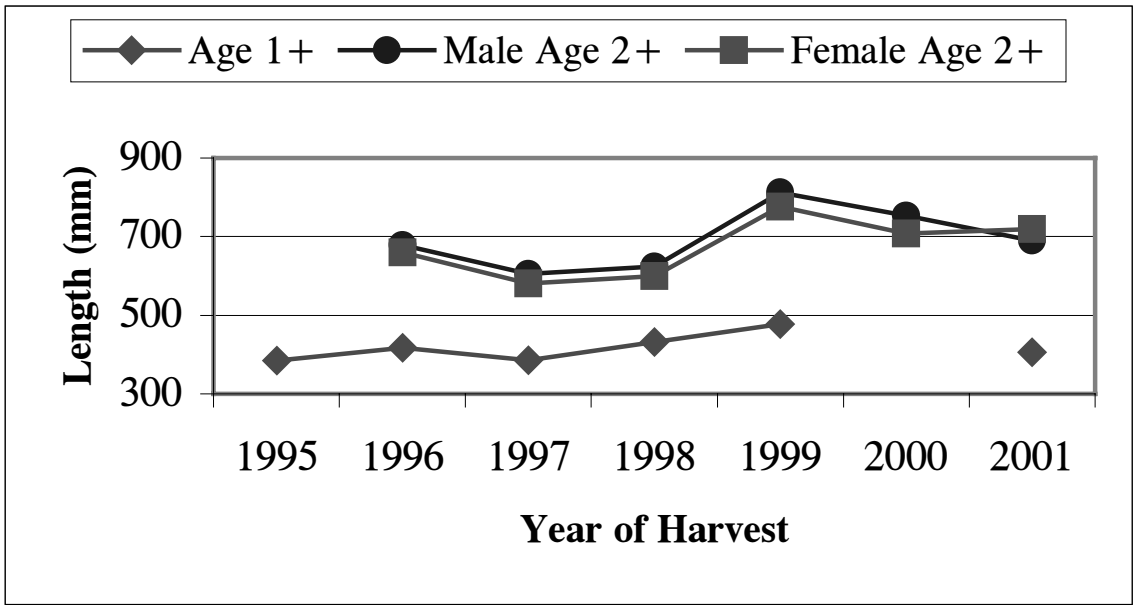

Figure 16.-Mean length of coho salmon by age class and year of return to the Besadny Anadromous Fisheries Facility, 1995-2001. No age 1+ coho were measured at BAFF in the fall of 2000.

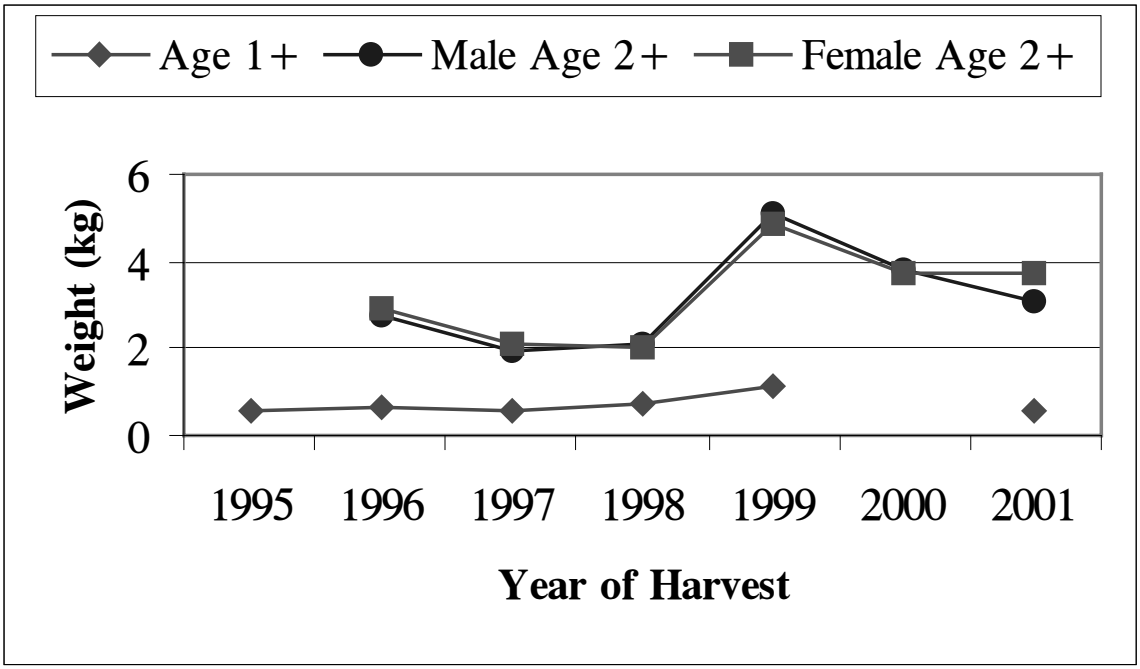

Figure 17.-Mean weight of coho salmon by age class and year of return to the Besadny Anadromous Fisheries Facility, 1995-2001. No age 1+ coho were weighed at BAFF in the fall of 2000.

REFERENCES

Hankin, D. G., J. W. Nicholas, and T. W. Downey. 1993. Evidence for inheritance of age of maturity in chinook salmon. Canadian Journal of Fisheries and Aquatic Sciences. 50:347-358.

Hansen, M. J. 1986. Size and condition of trout and salmon from the Wisconsin waters of Lake Michigan, 1969-84. Wisconsin Department of Natural Resources. Fish Management Report 126. 28 pp.

Peeters, P.J. and K. F. Royseck. 1997. Harvest, age, and size at age of chinook and coho salmon at Strawberry Creek Weir and Besadny Anadromous Fisheries Facility. Wisconsin Department of Natural Resources. 47 p. (mimeo)

Peeters, P.J. and K. F. Royseck. 1998. Harvest, age, and size at age of chinook and coho salmon at Strawberry Creek Weir and Besadny Anadromous Fisheries Facility. Wisconsin Department of Natural Resources. 52 p. (mimeo)

Peeters, P. J. and M. L. Toneys. 1995. Chinook salmon stocking methods study. Wisconsin Department of Natural Resources. 16 p. (mimeo)

Tabor, R. A., R. S. Shively, and T. P. Poe. 1993. Predation on juvenile salmonids by smallmouth bass and northern squawfish in the Columbia River near Richland, Washington. North American Journal of Fisheries Management. 13:831-838.

Appendix A.-Yearly summary of the chinook salmon harvest and spawning operations at the Wisconsin Department of Natural resources spawning facility at Strawberry Creek, Door County, 1981-2001.

HARVEST YEAR	TOTAL NUMBER LIVE & DEAD	NUMBER ADIPOSE CLIPPED	TOTAL[1] WEIGHT (POUNDS)	HATCHERY[2] EGG PRODUCTION
1981	4,314		74,209	9,786,000
1982	3,963		60,206	7,728,000
1983	3,852	48	66,091	6,954,000
1984	5,208	64	76,905	7,652,000
1985	5,601	582	90,860	7,058,000
1986	4,392	322	53,700	5,052,000
1987	7,624	701	99,100	4,929,000
1988	3,477	408	43,645	3,997,000
1989	1,845	301	20,849	1,350,000
1990	3,016	501	47,091	2,378,000
1991	3,009	377	43,630	1,649,000
1992	4,009	382	51,878	1,677,100
1993	4,377	582	66,094	2,156,666
1994	4,051	733	63,195	3,426,026
1995	2,381	408	30,001	2,221,446
1996	6,653	1,187	97,135	4,299,086
1997	4,850	969	69,840	4,060,944
1998	5,035	1,092	61,427	3,489,114
1999	1,934[3]	342[4]	20,646[5]	633,000
2000	6,649	2,199	75,134	3,672,771
2001	8,125	2,566	119,438	3,775,982
AVERAGE	4,494		63,384	4,187,864

[1] Annual average weight per fish used to estimate total weight (2001 average weight was 14.7 pounds,).
[2] Chinook salmon eggs harvested for hatchery production, does not include eggs sold for bait.
[3] Low stream flow and low Lake Michigan conditions limited the ability of salmon to reach the Strawberry Creek Weir. Less than 50% (998) of the chinook accounted for were captured alive.
[4] An additional 193 dead chinook with an adipose fin clip were observed in Strawberry Creek but were not collected because of the advanced stage of decomposition.
[5] Total weight of harvested chinook was heavily influenced by low water flow in Strawberry Creek, which prevented many chinook especially older, larger individuals from reaching the pond.

Appendix B.-Average, trophy, and standard weights, in pounds, of chinook salmon harvested at the Strawberry Creek Weir, Door County, 1974-2000.

Year Of Return	Sample Size	Average Weight[1]	Trophy Weight[2] (95th%)	Standard Weight[3]
1974	171	16.2	27.1	11.1
1975	1,237	18.9	26.6	10.6
1976	344	19.1	29.0	11.0
1977	610	15.0	23.7	10.9
1978	750	14.1	22.0	10.3
1979	865	14.5	19.8	10.1
1980	1,640	17.4	24.0	10.3
1981	2,251	17.2	23.5	10.3
1982	2,725	15.0	22.0	9.9
1983	2,977	15.0	22.2	9.9
1984	4,014	15.2	22.0	9.5
1985	3,341	14.7	22.2	9.5
1986	2,036	13.9	19.8	9.7
1987	2,693	13.6	19.4	9.7
1988	1,326	13.7	20.6	9.3
1989	609	11.3	21.1	9.1
1990	1,194	14.5	23.1	9.8
1991	955	14.5	23.5	9.9
1992	1,546	12.8	23.1	10.0
1993	1,941	15.1	25.2	9.6
1994	3,756	15.6	26.6	10.1
1995	1,946	12.6	23.4	9.1
1996	4,246	14.6	24.3	9.7
1997	4,182	14.4	23.3	9.5
1998	4,032	12.2	21.6	9.2
1999[4]	843	10.9	19.1	9.2
2000	6,443	11.3	20.5	9.2
2001	7,896	14.7	22.2	9.4

[1] Average weight of all chinook salmon weighed in a season during harvest operations at Strawberry Creek.
[2] Trophy weight is defined as the weight of a chinook salmon at the 95th percentile in a distribution of all chinook weights collected during a harvest season at Strawberry Creek.
[3] Standard weight is defined as the predicted weight of a 30 inch chinook salmon using a length/weight regression of all fish weighed during a harvest season at Strawberry Creek.
[4] Average weight, and trophy weight of chinook returning to Strawberry Creek in the fall of 1999 was heavily influenced by low flow conditions in Strawberry Creek. Most of the older, larger chinook were unable to negotiate Strawberry Creek and enter the pond.

Appendix C.-Age composition by sex and year of return of CWT chinook salmon released from and recaptured in Strawberry Creek Weir, Door County, 1983-2000.

YEAR OF RETURN	PERCENT AGE COMPOSITION										TOTAL NUMBER RETURNED
	NUMBER OF MALES					NUMBER OF FEMALES					
	AGE 1+		AGE 2+		AGE 3+		AGE 4+		AGE 5+		
	M	F	M	F	M	F	M	F	M	F	
1983	100%										48
	48	0									
1984	33%		67%								64
	21	0	43	0							
1985	9%		7%		84%						525
	47	0	34	3	229	212					
1986	9%		18%		43%		30%				267
	24	0	37	10	57	59	21	58			
1987	16%		19%		53%		12%		<1%		569
	91	0	84	22	142	160	21	48	0	1	
1988	14%		15%		63%		7%		<1%		368
	51	1	42	14	106	125	12	14	1	2	
1989	64%		14%		17%		5%				249
	159	0	28	6	12	31	6	7			
1990	14%		64%		19%		2%		<1%		381
	54	0	205	40	38	35	5	3	1		
1991	30%		22%		47%		1%				285
	85	0	53	9	39	95		4			
1992	45%		32%		23%		<1%				344
	153	1	75	34	31	47		3			
1993	42%		39%		19%		<1%				572
	240	0	163	59	34	74		2			
1994	18%		60%		21%		1%				709
	127	0	332	96	42	109		3			
1995	25%		43%		31%						389
	98	0	141	28	24	98					
1996	21%		39%		39%		<1%				1,124
	240	0	345	94	148	286	1	10			
1997	22%		44%		32%		2%				931
	205	0	364	44	124		5	18			
1998	6%		61%		32%		1%				1,068
	63	0	621	29	164		3	8			
1999[1]	55%		28%		16%		1%				322
	179	0	74	16	16		1	2			
2000	39%		28%		31%		2%				2,025
	785	0	323	241	247		13	40			
2001	23%		63%		14%		<1%		<1%		2,276
	513	2	1,040	393	109	202	6	9	1	1	

[1] Age composition of chinook returning to Strawberry Creek in the fall of 1999 was heavily influenced by low flow conditions in Strawberry Creek. Most of the older, larger chinook were unable to negotiate Strawberry Creek and enter the pond.

Appendix D.-Average length (mm) by age, sex, and year of return of CWT chinook salmon released from and recaptured at Strawberry Creek, 1983-2000.

YEAR OF RETURN	SEX		AGE				
			1+	2+	3+	4+	5+
1983	M	L (sd)	611 (35.2)	-	-	-	-
		Range	493-866	-	-	-	-
		n	48	-	-	-	-
	F	L (sd)	-	-	-	-	-
		Range	-	-	-	-	-
		n	-	-	-	-	-
1984	M	L (sd)	576 (29.6)	836 (42.1)	-	-	-
		Range	512-586	703-911	-	-	-
		n	21	43	-	-	-
	F	L (sd)	-	-	-	-	-
		Range	-	-	-	-	-
		n	-	-	-	-	-
1985	M	L (sd)	596.8 (32.9)	835.9 (36.9)	950.1 (52.4)	-	-
		Range	535-656	758-910	810-1,119	-	-
		n	47	34	229	-	-
	F	L (sd)	-	766.7 (18.9)	890.7 (46.2)	-	-
		Range	-	745-780	745-1,019	-	-
		n	-	3	212	-	-
1986	M	L (sd)	600.4 (31.9)	788.7 (50.3)	904.8 (45.5)	927 (42.9)	-
		Range	543-680	679-864	792-997	838-1,030	-
		n	24	37	57	21	-
	F	L (sd)	-	764.7 (58.0)	863.6 (40.2)	911.6 (44.7)	-
		Range	-	675-850	753-947	830-1,048	-
		n	-	10	59	58	-
1987	M	L (sd)	612.6 (35.3)	825.4 (45.4)	913.8 (51.0)	915 (106.6)	-
		Range	533-709	654-918	745-1,040	620-1,122	-
		n	91	84	142	21	-
	F	L (sd)	-	790.4 (36.2)	866.5 (41.7)	897 (38.7)	990
		Range	-	734-867	722-963	782-980	-
		n	-	22	160	48	1
1988	M	L (sd)	596.5 (28.4)	849.5 (62.1)	921.8 (61.5)	920.2 (74.3)	862.0
		Range	537-661	643-937	642-1,027	780-1,045	-
		n	51	42	106	12	1
	F	L (sd)	538	796.5 (43.0)	869.0 (44.0)	886.6 (51.2)	862.5 (24.8)
		Range	-	703-851	668-970	786-993	845-880
		n	1	14	125	14	2
1989	M	L (sd)	616.1 (37.1)	837.0 (49.9)	931.4 (74.6)	952.2 (74.9)	-
		Range	542-813	742-932	772-1,032	812-1,018	-
		n	159	28	12	6	-
	F	L (sd)	-	837.5 (40.3)	908.7 (55.2)	888 (114.2)	-
		Range	-	780-902	792-1,015	673-1,011	-
		n	-	6	31	7	-
1990	M	L (sd)	595.9 (31.6)	858.9 (51.9)	965.6 (57.1)	1,020 (56.8)	630
		Range	516-688	702-1,000	814-1,110	953-1,090	-
		n	54	205	38	5	1
	F	L (sd)	-	830.0 (47.8)	926.7 (42.9)	944.0 (12.1)	-
		Range	-	650-947	822-1,050	933-957	-
		n	-	40	35	3	-

Appendix D.-Continued

1991	M	L (sd)	626.6 (29.1)	836.1 (42.1)	954.2 (76.5)	-	-
		Range	560-693	703-930	735-1,070	-	-
		n	85	53	39	-	-
	F	L (sd)	-	838.3 (29.6)	943.0 (46.7)	929.5 (89.0)	-
		Range	-	805-900	800-1,030	825-1,023	-
		n	-	9	95	4	-
1992	M	L (sd)	616.7 (35.6)	860.1 (71.4)	979.1 (71.0)	-	-
		Range	523-711	582-980	793-1,103	-	-
		n	153	75	31	-	-
	F	L (sd)	629.0	842.9 (47.8)	938.0 (49.4)	965.3 (92.8)	-
		Range	-	662-920	800-1,060	877-1,062	-
		n	1	34	47	3	-
1993	M	L (sd)	609.7 (43.0)	864.9 (59.7)	1,001 (60.3)	-	-
		Range	459-745	646-983	841-1,090	-	-
		n	240	163	34	-	-
	F	L (sd)	-	847.0 (40.6)	958.6 (51.6)	937.5 (46)	-
		Range	-	746-936	810-1,054	905-970	-
		n	-	59	74	2	-
1994	M	L (sd)	598.4 (37.1)	861.5(60.0)	1,020 (73.8)	-	-
		Range	501-687	611-1,007	805-1,140	-	-
		n	127	332	42	-	-
	F	L (sd)	-	834.7 (53.2)	958.2 (49.7)	972.3 (63.8)	-
		Range	-	695-1,016	836-1,057	933-1,046	-
		n	-	96	109	3	-
1995	M	L (sd)	609.8 (40.2)	848.1 (67.3)	965.3 (73.6)	-	-
		Range	508-700	614-988	738-1,073	-	-
		n	98	141	24	-	-
	F	L (sd)	-	816.8 (35.5)	943.1 (50.9)	897 (38.7)	-
		Range	-	749-877	810-1,038	782-980	-
		n	-	28	98	48	-
1996	M	L (sd)	616.5 (28.2)	856.2 (56.9)	979.3 (67.6)	1,022.0	-
		Range	553-693	617-972	731-1,120	-	-
		n	91	345	148	1	-
	F	L (sd)	-	833.4 (44.4)	943.8 (49.7)	916 (130.6)	-
		Range	-	700-940	769-1,065	661-1,079	-
		n	-	94	286	10	-
1996[1]	M	L (sd)	607.0 (33.9)	-	-	-	-
		Range	514-691	-	-	-	-
		n	149	-	-	-	-
	F	L (sd)	-	-	-	-	-
		Range	-	-	-	-	-
		n	-	-	-	-	-
1997	M	L (sd)	563.4 (36.8)	842.9 (76.4)	954.4 (68.3)	922 (154.9)	-
		Range	476-666	536-981	653-1,092	757-1,076	-
		n	100	166	124	5	-
	F	L (sd)	-	844.8 (49.5)	920.9 (45.2)	923.8 (79.4)	-
		Range	-	660-899	781-1,040	688-1,042	-
		n	-	24	171	18	-
1997[1]	M	L (sd)	561.2 (36.9)	831.5 (57.2)	-	-	-
		Range	473-661	687-943	-	-	-
		n	105	198	-	-	-
	F	L (sd)	-	808.1 (40.6)	-	-	-
		Range	-	707-856	-	-	-
		n	-	20	-	-	-

1998	M	L (sd) Range n	- - -	780.9 (71.5) 557-943 320	949.5 (87.8) 700-1,107 88	831 (220.5) 627-1,065 3	- - -
	F	L (sd) Range n	- - -	810.4 (40.0) 736-892 18	904.0 (69.2) 625-1,019 83	919.8 (92.2) 713-1,012 8	- - -
1998[1]	M	L (sd) Range n	577.8 (41.5) 510-642 37	766.2 (74.0) 503-930 301	950.1 (73.4) 642-1,090 76	- - -	- - -
	F	L (sd) Range n	- - -	810.3 (25.8) 767-842 11	903.3 (69.0) 662-1,037 97	- - -	- - -
1998[2]	M	L (sd) Range n	574.3 (44.4) 487-674 26	- - -	- - -	- - -	- - -
	F	L (sd) Range n	- - -	- - -	- - -	- - -	- - -
1999	M	L (sd) Range n	- - -	- - -	886.5 (101.2) 666-1,015 13	- - -	- - -
	F	L (sd) Range n	- - -	- - -	870.1 (73.6) 669-965 20	- - -	- - -
1999[1]	M	L (sd) Range n	672.5 (36.2) 575-746 65	844.3(65.9) 696-938 44	820.0(105.8) 719-930 3	855.0 - 1	- - -
	F	L (sd) Range n	- - -	832.4(24.2) 776-860 10	899.9(82.9) 708-1,000 14	989(36.8) 963-1,015 2	- - -
1999[2]	M	L (sd) Range n	672.8(40.0) 536-797 71	857.1(55.3) 717-952 30	- - -	- - -	- - -
	F	L (sd) Range n	- - -	847.5(36.3) 795-897 6	- - -	- - -	- - -
1999[3]	M	L (sd) Range n	676.2 (38.2) 596-760 43	- - -	- - -	- - -	- - -
	F	L (sd) Range n	- - -	- - -	- - -	- - -	- - -

Appendix D.-Continued

2000	M	L (sd)	-	-	-	899.5(64.8)	-
		Range	-	-	-	797-967	-
		n	-	-	-	6	-
	F	L (sd)	-	-	-	919.2(53.3)	-
		Range	-	-	-	818-990	-
		n	-	-	-	16	-
2000[1]	M	L (sd)	634.3(32.0)	900.9(56.4)	949.2(71.8)	883.9(26.7)	-
		Range	554-724	627-1,009	746-1,064	855-929	-
		n	228	102	84	7	-
	F	L (sd)	-	862.6(42.2)	913.4(49.3)	906.2(51.4)	-
		Range	-	590-940	665-1,018	809-996	-
		n	-	96	145	24	-
2000[2]	M	L (sd)	-	887.1(76.9)	938.8(82.8)	-	-
		Range	-	563-993	617-1,075	-	-
		n	-	114	163	-	-
	F	L (sd)	-	872.1(45.7)	918.3(48.7)	-	-
		Range	-	615-950	685-1,032	-	-
		n	-	67	231	-	-
2000[3]	M	L (sd)	-	891.5(72.9)	-	-	-
		Range	-	549-1,008	-	-	-
		n	-	107	-	-	-
	F	L (sd)	-	861.6(41.3)	-	-	-
		Range	-	672-949	-	-	-
		n	-	78	-	-	-
2000[4]	M	L (sd)	628.9(37.7)	-	-	-	-
		Range	454-736	-	-	-	-
		n	259	-	-	-	-
	F	L (sd)	-	-	-	-	-
		Range	-	-	-	-	-
		n	-	-	-	-	-
2000[5]	M	L (sd)	630.4(33.0)	-	-	-	-
		Range	527-718	-	-	-	-
		n	298	-	-	-	-
	F	L (sd)	-	-	-	-	-
		Range	-	-	-	-	-
		n	-	-	-	-	-

Appendix D.-Continued

2001[1]	M	L (sd)	615.0 (37.9)	887.4 (49.8)	994.9 (55.6)	874.0 (99.0)	695
		Range	494 – 700	714 – 998	811 – 1,102	804 – 944	-
		n	196	332	53	2	1
	F	L (sd)	-	856.7 (31.8)	962.3 (49.7)	903.0(117.4)	922
		Range	-	773 – 927	830 – 1,071	820 – 986	-
		n	-	122	92	2	1
2001[2]	M	L (sd)	-	-	989.2 (65.1)	976.3(129.5)	-
		Range	-	-	793 – 1,095	783 – 1,058	-
		n	-	-	40	4	-
	F	L (sd)	-	-	959.5 (46.5)	897.0 (98.6)	-
		Range	-	-	795 – 1,037	714 – 976	-
		n	-	-	73	11	-
2001[3]	M	L (sd)	-	-	997.2 (54.5)	-	-
		Range	-	-	911 – 1,077	-	-
		n	-	-	16	-	-
	F	L (sd)	-	-	952.4 (41.0)	-	-
		Range	-	-	861 – 1,027	-	-
		n	-	-	37	-	-
2001[4]	M	L (sd)	-	881.8 (50.1)	-	-	-
		Range	-	683 – 1,004	-	-	-
		n	-	367	-	-	-
	F	L (sd)	-	842.4 (36.0)	-	-	-
		Range	-	740 – 914	-	-	-
		n	-	114	-	-	-
2001[5]	M	L (sd)	-	893.9 (49.7)	-	-	-
		Range	-	677 – 995	-	-	-
		n	-	341	-	-	-
	F	L (sd)	-	858.4 (35.0)	-	-	-
		Range	-	763 – 957	-	-	-
		n	-	157	-	-	-
2001[6]	M	L (sd)	615.9 (46.7)	-	-	-	-
		Range	520 – 875	-	-	-	-
		n	144	-	-	-	-
	F	L (sd)	892	-	-	-	-
		Range	-	-	-	-	-
		n	1	-	-	-	-
2001[7]	M	L (sd)	616.7 (40.6)	-	-	-	-
		Range	488 – 707	-	-	-	-
		n	173	-	-	-	-
	F	L (sd)	778	-	-	-	-
		Range	-	-	-	-	-
		n	1	-	-	-	-

[1] Thiamine treated salmon (standard production as of 1996)
[2] Single paired family age 3+ male and age 3+ female
[3] Single paired family age 3+ male and age 2+ female
[4] Marking study ARV clip with CWT
[5] Marking study A-CWT with photonic mark
[6] Marking study ALV clip with CWT
[7] Marking study CWT with no clip

Appendix E.-Average weight (kg) by age, sex, and year of return of CWT chinook salmon released from and recaptured at Strawberry Creek, 1983-2000.

YEAR OF RETURN	SEX		AGE				
			1+	2+	3+	4+	5+
1983	M	W (sd)	2.7 (0.5)	-	-	-	-
		Range	1.5-3.6	-	-	-	-
		n	48	-	-	-	-
	F	W (sd)	-	-	-	-	-
		Range	-	-	-	-	-
		n	-	-	-	-	-
1984	M	W (sd)	2.0 (0.3)	5.6 (1.1)	-	-	-
		Range	1.3-2.5	2.4-7.8	-	-	-
		n	20	43	-	-	-
	F	W (sd)	-	-	-	-	-
		Range	-	-	-	-	-
		n	-	-	-	-	-
1985	M	W (sd)	2.1 (0.5)	5.4 (1.0)	7.6 (1.7)	-	-
		Range	1.1-3.6	4.4-6.2	3.1-12.2	-	-
		n	46	29	205	-	-
	F	W (sd)	-	4.7 (0.8)	7.0 (1.5)	-	-
		Range	-	4.1-5.3	2.9-11.5	-	-
		n	-	2	180	-	-
1986	M	W (sd)	2.1 (0.3)	4.8 (1.0)	6.6 (1.1)	6.6 (1.2)	-
		Range	1.4-2.7	3.0-6.5	4.0-9.3	5.1-10.1	-
		n	24	37	57	21	-
	F	W (sd)	-	4.8 (1.0)	6.4 (1.1)	7.3 (1.4)	-
		Range	-	3.5-6.3	3.7-8.9	4.9-11.5	-
		n	-	10	59	58	-
1987	M	W (sd)	2.3 (0.4)	5.4 (1.0)	6.8 (1.3)	6.5 (2.3)	-
		Range	1.6-3.5	2.5-7.3	3.4-10.2	2.7-12.5	-
		n	90	82	142	21	-
	F	W (sd)	-	5.2 (0.9)	6.6 (1.1)	6.8 (1.1)	5.1
		range	-	3.6-7.2	3.7-9.6	4.3-9.2	-
		n	-	22	160	48	1
1988	M	W (sd)	2.1 (0.3)	5.7 (1.3)	7.1 (1.4)	6.7 (1.5)	5.5
		Range	1.3-3.1	2.5-8.3	2.9-9.7	4.9-9.5	-
		n	50	41	94	10	1
	F	W (sd)	1.8	5.1 (1.0)	6.7 (1.3)	6.1 (1.3)	5.4 (0.1)
		Range	-	3.4-6.4	3.4-11.3	3.9-8.9	5.4-5.5
		n	1	13	111	12	2
1989	M	W (sd)	2.4 (0.5)	5.6 (1.1)	7.6 (1.9)	8.0 (1.7)	-
		range	1.5-5.7	3.9-8.1	4.1-10.5	4.9-9.6	-
		n	153	28	10	6	-
	F	W (sd)	-	6.2 (1.0)	7.7 (1.6)	6.9 (2.6)	-
		Range	-	5.5-8.0	4.5-11.4	3.4-10.0	-
		n	-	6	27	5	-
1990	M	W (sd)	2.1 (0.3)	6.3 (1.2)	8.4 (1.8)	8.9 (1.9)	2.6
		range	1.4-2.8	3.1-10.4	4.4-14.7	7.5-11.6	-
		n	54	199	35	4	1
	F	W (sd)	-	6.6 (1.0)	8.7 (1.4)	8.9 (1.8)	-
		range	-	4.2-9.6	5.8-11.9	6.9-10.3	-
		n	-	39	31	3	-

Appendix E.-Continued

1991	M	W (sd)	2.5 (0.4)	5.6 (1.1)	8.3 (1.9)	-	-
		range	1.9-3.5	3.2-8.6	3.6-10.6	-	-
		n	49	40	22	-	-
	F	W (sd)	-	6.7 (1.0)	9.2 (1.6)	9.7 (1.9)	-
		range	-	5.4-8.5	5.6-11.9	7.6-11.4	-
		n	-	9	64	3	-
1992	M	W (sd)	2.3 (0.5)	6.5 (1.4)	9.3 (2.7)	-	-
		range	1.1-3.9	3.0-9.9	4.7-16.7	-	-
		n	112	50	20	-	-
	F	W (sd)	2.4	6.8 (1.2)	8.8 (1.8)	9.3 (2.6)	-
		range	-	3.1-8.4	5.4-13.6	6.7-11.8	-
		n	1	27	34	3	-
1993	M	W (sd)	2.3 (0.6)	6.6 (1.6)	9.0 (2.1)	-	-
		range	0.7-4.5	2.0-10.3	5.4-13.0	-	-
		n	198	85	18	-	-
	F	W (sd)	-	7.1 (1.2)	9.9 (1.4)	7.2	-
		range	-	4.5-9.9	6.2-12.9	-	-
		n	-	31	61	1	-
1994	M	W (sd)	2.2 (0.5)	6.5 (1.5)	10.7 (2.3)	-	-
		range	1.2-3.3	2.1-10.3	5.4-14.9	-	-
		n	123	323	34	-	-
	F	W (sd)	-	6.7 (1.3)	9.8 (1.7)	9.9 (2.0)	-
		range	-	3.9-10.9	6.2-13.2	8.3-12.2	-
		n	-	92	98	3	-
1995	M	W (sd)	2.2 (0.5)	6.0 (1.5)	8.5 (2.1)	-	-
		range	1.2-3.8	2.2-9.4	3.5-11.9	-	-
		n	95	115	23	-	-
	F	W (sd)	-	5.9 (1.0)	9.5 (1.8)	-	-
		range	-	4.1-8.0	5.6-13.1	-	-
		n	-	23	79	-	-
1996	M	W (sd)	2.3 (0.4)	6.2 (1.3)	8.9 (2.2)	10.5	-
		range	1.6-3.3	2.3-9.4	3.3-15.9	-	-
		n	84	288	109	1	-
	F	W (sd)	-	6.6 (1.1)	9.3 (1.7)	9.4 (3.2)	-
		range	-	4.0-9.5	5.1-14.3	4.1-13.7	-
		n	-	77	226	6	-
1996[1]	M	W (sd)	2.2 (0.5)	-	-	-	-
		range	1.2-3.3	-	-	-	-
		n	123	-	-	-	-
	F	W (sd)	-	-	-	-	-
		range	-	-	-	-	-
		n	-	-	-	-	-
1997	M	W (sd)	1.8 (0.4)	5.7 (1.6)	8.2 (1.9)	7.0 (3.7)	-
		range	1.1-3.1	2.4-10.2	2.8-12.7	3.5-10.5	-
		n	93	162	111	4	-
	F	W (sd)	-	6.5 (1.1)	8.3 (1.5)	8.2 (2.0)	-
		range	-	3.2-8.6	5.1-14.1	3.4-13.1	-
		n	-	24	167	18	-
1997[1]	M	W (sd)	1.8 (0.4)	5.5 (1.3)	-	-	-
		range	0.9-3.1	2.5-9.1	-	-	-
		n	99	191	-	-	-
	F	W (sd)	-	5.8 (1.0)	-	-	-
		range	-	3.7-7.4	-	-	-
		n	-	19	-	-	-

1998	M	W (sd)	-	4.6 (1.3)	7.7 (2.1)	5.8 (3.9)	-
		range	-	1.3-8.4	3.3-12.1	2.6-10.2	-
		n	-	320	86	3	-
	F	W (sd)	-	5.8 (0.9)	7.6 (1.6)	7.9 (2.5)	-
		range	-	4.1-7.4	2.7-10.6	3.4-11.5	-
		n	-	18	82	8	-
1998[1]	M	W (sd)	1.9 (0.5)	4.4 (1.3)	7.9 (1.9)	-	-
		range	1.1-2.7	1.2-8.2	2.6-12.3	-	-
		n	37	301	74	-	-
	F	W (sd)	-	5.9 (0.6)	7.7 (1.7)	-	-
		range	-	5.2-7.1	2.8-10.9	-	-
		n	-	11	97	-	-
1998[2]	M	W (sd)	1.9 (0.5)	-	-	-	-
		range	1.2-3.3	-	-	-	-
		n	26	-	-	-	-
	F	W (sd)	-	-	-	-	-
		range	-	-	-	-	-
		n	-	-	-	-	-
1999	M	W (sd)	-	-	6.0 (1.8)	-	-
		range	-	-	2.6-12.3	-	-
		n	-	-	12	-	-
	F	W (sd)	-	-	7.0 (1.5)	-	-
		range	-	-	4.0-10.0	-	-
		n	-	-	19	-	-
1999[1]	M	W (sd)	2.9 (0.6)	5.8 (1.5)	4.6 (2.0)	4.4	-
		range	1.7-4.9	2.9-8.6	2.8-6.9	-	-
		n	65	41	3	1	-
	F	W (sd)	-	6.2 (0.6)	7.9 (2.1)	9.3	-
		range	-	5.0-6.9	3.8-10.7	-	-
		n	-	10	13	1	-
1999[2]	M	W (sd)	2.9 (0.6)	6.0 (1.5)	-	-	-
		range	1.7-4.7	2.9-8.9	-	-	-
		n	71	27	-	-	-
	F	W (sd)	-	5.9 (0.8)	-	-	-
		range	-	4.9-6.7	-	-	-
		n	-	4	-	-	-
1999[3]	M	W (sd)	2.8 (0.5)	-	-	-	-
		range	1.8-4.0	-	-	-	-
		n	43	-	-	-	-
	F	W (sd)	-	-	-	-	-
		range	-	-	-	-	-
		n	-	-	-	-	-

Appendix E.-Continued

2000	M	W (sd)	-	-	-	6.0 (1.0)	-
		range	-	-	-	4.1-7.1	-
		n	-	-	-	6	-
	F	W (sd)	-	-	-	7.7 (1.5)	-
		range	-	-	-	5.0-9.7	-
		n	-	-	-	16	-
2000[1]	M	W (sd)	2.5 (0.5)	6.8 (1.4)	7.7 (1.8)	5.6 (1.1)	-
		range	1.2-4.1	2.1-10.8	3.8-11.7	3.6-7.0	-
		n	227	100	82	7	-
	F	W (sd)	-	6.7 (1.1)	7.9 (1.3)	7.4 (1.2)	-
		range	-	1.9-9.4	3.0-10.8	4.9-9.9	-
		n	-	96	140	24	-
2000[2]	M	W (sd)	-	6.5 (1.4)	7.6 (1.8)	-	-
		range	-	2.0-9.4	2.0-11.1	-	-
		n	-	113	162	-	-
	F	W (sd)	-	7.0 (1.3)	7.9 (1.4)	-	-
		range	-	2.2-11.2	2.9-11.7	-	-
		n	-	66	224	-	-
2000[3]	M	W (sd)	-	6.5 (1.5)	-	-	-
		range	-	1.5-9.5	-	-	-
		n	-	104	-	-	-
	F	W (sd)	-	6.7 (1.1)	-	-	-
		range	-	4.2-10.4	-	-	-
		n	-	78	-	-	-
2000[4]	M	W (sd)	2.4 (0.5)	-	-	-	-
		range	0.8-3.7	-	-	-	-
		n	258	-	-	-	-
	F	W (sd)	-	-	-	-	-
		range	-	-	-	-	-
		n	-	-	-	-	-
2000[5]	M	W (sd)	2.4 (0.5)	-	-	-	-
		range	1.2-4.1	-	-	-	-
		n	296	-	-	-	-
	F	W (sd)	-	-	-	-	-
		range	-	-	-	-	-
		n	-	-	-	-	-

Appendix E.-Continued

2001[1]	M	W (sd)	2.3 (0.5)	6.7 (1.3)	8.9 (1.7)	6.2 (0.2)	8.0
		Range	1.2 – 3.7	2.6 – 10.2	5.1 – 12.9	6.0 – 6.3	-
		n	196	332	53	2	1
	F	W (sd)	-	6.8 (0.9)	9.1 (1.7)	7.6 (4.2)	2.6
		Range	-	4.5 – 9.2	4.5 – 13.4	4.6 – 10.6	-
		n	-	122	92	2	1
2001[2]	M	W (sd)	-	-	9.0 (2.1)	8.8 (2.8)	-
		Range	-	-	3.7 – 12.5	4.7 – 11.0	-
		n	-	-	40	4	-
	F	W (sd)	-	-	9.3 (1.6)	7.4 (2.3)	-
		Range	-	-	5.3 – 13.1	3.4 – 9.8	-
		n	-	-	73	7	-
2001[3]	M	W (sd)	-	-	9.0 (1.4)	-	-
		Range	-	-	7.1 – 11.0	-	-
		n	-	-	16	-	-
	F	W (sd)	-	-	8.9 (1.4)	-	-
		Range	-	-	5.65 – 11.7	-	-
		n	-	-	37	-	-
2001[4]	M	W (sd)	-	6.6 (1.2)	-	-	-
		Range	-	2.8 – 11.1	-	-	-
		n	-	367	-	-	-
	F	W (sd)	-	6.5 (0.9)	-	-	-
		Range	-	3.9 – 8.8	-	-	-
		n	-	114	-	-	-
2001[5]	M	W (sd)	-	6.9 (1.3)	-	-	-
		Range	-	2.4 – 11.1	-	-	-
		n	-	341	-	-	-
	F	W (sd)	-	6.9 (1.1)	-	-	-
		Range	-	3.8 – 9.9	-	-	-
		n	-	157	-	-	-
2001[6]	M	W (sd)	2.3 (0.6)	-	-	-	-
		Range	1.3 – 5.8	-	-	-	-
		n	144	-	-	-	-
	F	W (sd)	7.5	-	-	-	-
		Range	-	-	-	-	-
		n	1	-	-	-	-
2001[7]	M	W (sd)	2.3 (0.5)	-	-	-	-
		Range	1.0 – 3.7	-	-	-	-
		n	173	-	-	-	-
	F	W (sd)	4.7	-	-	-	-
		Range	-	-	-	-	-
		n	1	-	-	-	-

[1] Thiamine treated salmon (standard production as of 1996)
[2] Single paired family age 3+ male and age 3+ female
[3] Single paired family age 3+ male and age 2+ female
[4] Marking study ARV clip with CWT
[5] Marking study A-CWT with photonic mark
[6] Marking study ALV clip with CWT
[7] Marking study CWT with no clip

Appendix F.-Return rate of CWT chinook salmon at age and by year class to the Strawberry Creek Weir, Door County, for year classes 1982 through 2000. In fall 1999, return of the 1994 year class at age 5+, 1995 year class at age 4+, 1996 year class at age 3+, 1997 year class at age 2+, and 1998 year class at age 1+, (highlighted in light blue for the reader's convenience) were heavily influenced by low flow in Strawberry Creek and low Lake Michigan levels. No comparisons should be made between the return rates of the various year classes captured in the fall of 1999 and other years. Return rates for the fall of 2000 and 2001, were not influenced by the low flow and are more typical of normal return rates. Return rates for the 1995 through 2000 year classes are pooled rates of multiple study lots of CWT fingerlings released from Strawberry Creek. Return rates of the individual lots (1995-2000) will be discussed as they relate to the various ongoing CWT studies. Return rates for 2001 are shaded yellow for the reader's convenience.

YEAR CLASS	AGE AT RETURN					CUMULATIVE RETURN BY YEAR CLASS
	AGE 1+	AGE 2+	AGE 3+	AGE 4+	AGE 5+	
1982	0.24	0.22	2.21	0.39	0.01	3.07
1983	0.11	0.19	0.58	0.35	0.02	1.25
1984	0.24	0.24	1.51	0.13	0.00	2.12
1985	0.05	0.21	0.46	0.03	<0.01	0.75
1986	0.36	0.22	0.17	0.03	0.00	0.78
1987	0.35	0.23	0.49	0.03	0.00	1.10
1988	0.64	0.98	0.53	0.01	0.00	2.16
1989	0.22	0.25	0.31	0.01	0.00	0.79
1990	0.34	0.43	0.43	0.01	0.00	1.21
1991	0.61	0.88	0.60	0.00	0.00	2.09
1992	0.83	1.48	0.42	0.04	0.00	2.77
1993	0.47	0.63	1.61	0.09	0.00	2.80
1994	0.38	1.69	1.13	0.04	0.00	3.24
1995	0.51	0.86	0.72	0.01	0.00	2.10
1996	0.41	1.29	0.10	0.10	0.00	1.90
1997	0.09	0.13	0.91	0.02		1.15
1998	0.25	0.80	0.44			1.49
1999	1.05	1.92				2.97
2000	0.65					0.65

Appendix G.-Estimated number of chinook salmon by age returning to Strawberry Creek, Door County, and percent return by year class for ages 1+ through 4+ for the 1982 – 2000 year classes. For the years 1982 through 1990, rate of return is based on the number of fingerlings stocked into the pond at Strawberry Creek and does not account for subsequent mortalities. For the years 1991 through present the number stocked reflects the number believed to have been successfully released from the pond. This table includes CWT and non-CWT chinook based on a length at age key developed from known aged, CWT chinook returning to Strawberry Creek each harvest year. Return of the 1995, 1996, 1997, and 1998 year classes of chinook in fall 1999 (shaded in light blue for the reader's convenience) was heavily influenced by low flow in Strawberry Creek and low Lake Michigan levels. No comparisons should be made between the return rates of the various year classes captured in the fall of 1999 and other years. Return rates for 2001 are shaded yellow for the reader's convenience.

YEAR CLASS	AGE AT RETURN				TOTAL NUMBER RETURNED	NUMBER STOCKED (1,000'S)	TOTAL PERCENT RETURN
	1+	2+	3+	4+			
1982	362	539	3,281	1,257	5,439	250.0	2.2
1983	490	359	1,791	890	3,530	350.0	1.0
1984	359	572	4,271	212	5,414	350.0	1.5
1985	191	1,027	1,940	112	3,270	339.5	1.0
1986	616	455	430	60	1,561	300.0	0.5
1987	394	287	633	20	1,334	275.0	0.5
1988	765	1,930	842	35	3,572	225.2	1.6
1989	392	490	861	40	1,783	250.2	0.7
1990	607	1,291	1,110	17	3,025	250.0	1.2
1991	1,399	2,180	1,160	0	4,739	220.0[1]	2.2[2]
1992	634	2,032	672	50	3,388	125.0[1]	2.7[2]
1993	599	1,051	2,360	127	4,137	130.0[1]	3.2[2]
1994	569	2,923	1,796	47	5,335	157.0[1]	3.4[2]
1995	867	1,784	1,610	6	4,267	213.0[1]	2.0[2]
1996	618	2,949	162	160	3,889	210.5[1]	1.8[2]
1997	337	313	1,885	70	2,605	211.6[1]	1.2[2]
1998	361	1,664	1,296		3,321	210.5[1]	1.6[2,3]
1999	2,787	5,627			8,414	211.7[1]	4.0[2,4]
2000	892				892	198.0[1]	0.5[2,5]

[1] Corrected for the number of chinook salmon actually believed to have been successfully released from the Strawberry creek pond.
[2] Percent based on the number of chinook fingerlings successfully released, not the number stocked into the Strawberry Creek pond.
[3] Percent return based on age 1+ through age 3+.
[4] Percent return based on age 1+ through age 2+.
[5] Percent return based on age 1+.

Appendix H.-Summary of chinook salmon stocking densities and average size of CWT and non-CWT chinook fingerlings when stocked into and released from the pond at the Strawberry Creek Weir, Door County, 1982-2001. Information for the 2001 year class is shaded yellow for the reader's convenience.

YEAR CLASS	CWT CHINOOK STOCKED AT STRAWBERRY CREEK						NON-CWT CHINOOK STOCKED AT STRAWBERRY CREEK					
	NUMBER CWT'S STOCKED	SAMPLE TIME	AVERAGE LENGTH (mm)	SAMPLE SIZE	AVERAGE WEIGHT (G)	DATE	NUMBER NON-CWT'S STOCKED	SAMPLE TIME	AVERAGE LENGTH (mm)	SAMPLE SIZE	AVERAGE WEIGHT (g)	DATE
1982	20,000											
1983	20,000	Stocking	81.6		6.7	5/02/83						
1984	20,000	Stocking	83.6		4.9	4/30/84	330,000	Stocking	74.7	124		4/20/84
		Release	93.7	20	7.2	6/4/84		Release	89.1	105	5.5	6/4/84
1985	50,000	Stocking	83.7	50	5.5	4/29/85	289,500	Stocking	75.7	50	3.4	4/16/85
		Release	92.4	52	7.2	5/28/85		Release	92.4	155	7.2	5/28/85
1986	25,000	Stocking	79.0	62	4.3	4/23/86	184,000	Stocking	67.9	50	2.5	4/14/86
	15,000[1]	Stocking	79.5	48	3.9	5/1/86	91,000	Stocking	73.5	85	3.9	4/23/86
		Release	95.7[2]	92	7.7	5/28/86		Release	93.9	145	7.3	5/28/86
1987	15,000	Stocking	81.0	60	4.6	4/27/87	260,000	Stocking	65.3	58	2.6	4/9/87
	25,000[1]	Stocking	91.1	80	6.6	5/14/87		Release	84.5	70	5.8	5/22/87
		Release	94.0[2]	61	6.6	5/22/87						
1988	25,150	Stocking	91.7	50	4.4	5/10/88	200,000	Stocking	65.5	110	1.9	4/6-7/88
	25,300[1]	Stocking	85.3	60	5.0	5/3/88		Release	78.5	80	4.7	5/23/88
		Release	87.8[2]	70	5.2	5/23/88						
1989	25,241	Stocking	77.1	80	3.5	4/24/89	115,550	Stocking	67.9	70	2.5	4/6/89
		Release	83.4	50	4.5	5/19/89	109,450	Stocking	71.2	50	2.6	4/24/89
								Release	75.7	50	3.4	5/19/89
1990[3]	25,100	Stocking	69.6	60	2.9	4/18/90	133,497	Stocking	61.2	50	2.1	4/5/90
		Release	95.9	44	8.6	5/29/90	91,403	Stocking	68.7	50	2.8	4/18/90
								Release	91.2	50	7.6	5/29/90
1991[4]	25,200	Stocking	72.8	50	3.0	4/11/91	139,600	Stocking	71.1	50	2.9	4/2/91
		Release	88.4	50	5.6	5/24/91	85,200	Stocking				4/11/91
								Release	91.3	50	6.1	5/24/91
1992[5]	28,850	Stocking	81.7	50	4.6	5/6/92	170,000	Stocking	62.6	50	1.9	3/26/92
		Release	97.4	63	8.5	5/29/92	11,150	Stocking				5/6/92
								Release	85.3	99	5.6	5/29/92
1993[6]	27,024	Stocking	75.3	50	3.3	4/21/93	100,000	Stocking	73.1	50	3.2	4/8/93
		Release	95.8	34	7.1	6/4/93	71,450	Stocking	75.8	50	4.4	4/21/93
								Release	94.0	50	6.9	6/4/93

Appendix H.-Continued

YEAR CLASS	CWT CHINOOK STOCKED AT STRAWBERRY CREEK						NON-CWT CHINOOK STOCKED AT STRAWBERRY CREEK					
	NUMBER CWT'S STOCKED	SAMPLE TIME	AVERAGE LENGTH (mm)	SAMPLE SIZE	AVERAGE WEIGHT (G)	DATE	NUMBER NON-CWT'S STOCKED	SAMPLE TIME	AVERAGE LENGTH (mm)	SAMPLE SIZE	AVERAGE WEIGHT (g)	DATE
1994[7]	26,450	Stocking	80.1	60	4.9	4/22/94	131,432	Stocking	77.8	50	4.3	4/14/94
		Release	85.8	40	6.1	5/17/94		Release	85.5	50	6.3	5/17/94
1995[8,9]	22,646	Stocking	80.9	50	4.7	5/1/95	115,364	Stocking	71.5	50	3.5	4/21/95
		Release	96.3	47	8.1	5/25/95	50,027	Stocking	73.5	60	3.6	5/1/95
	25,697	Stocking	78.6	50	4.5	5/1/95		Release	90.6	50	7.9	5/25/95
		Release	96.2	77	8.3	5/25/95						
1996[10]	26,270	Stocking	87.1	87	5.8	5/13/96	100,460	Stocking	84.8	50	5.8	5/2/96
		Release	91.2	19	7.2	5/31/96	60,000	Stocking	82.6	50	4.8	5/13/96
	24,600	Stocking	88.1	78	6.3	5/17/96		Release	90.0	112	7.3	5/31/96
		Release	92.7	19	7.9	5/31/96						
1997[11,12]	25,850	Stocking	85.1	50	5.6	4/23/97	71,917	Stocking				5/5/97
		Release	93.0	30	9.2	5/30/97	71,534	Stocking	86.4	100	5.3	5/6/97
	42,491	Stocking	88.5	50	6.2	4/23/97		Release	96.6	50	7.7	5/30/97
		Release	93.4	70	9.2	5/30/97						
1998[11,13]	25,619	Stocking	83.7	50	4.7	4/20/98	70,780	Stocking	75.5	50	3.1	4/21/98
	22,785	Stocking	83.3	50	4.7	4/20/98	70,000	Stocking				4/22/98
	22,697	Stocking	85.5	50	5.1	4/20/98		Release	89.1	100	5.5	5/13/98
		Release	91.8	30	5.8	5/13/98						
1999[14]	8,313[15]	Stocking	85.4	18	4.8	5/3/99	80,090	Stocking	81.8	50	5.3	4/30/99
	8,317[16]	Stocking	86.6	14	4.8	5/3/99	57,073	Stocking	81.6	50	4.3	5/4/99
	8,233[17]	Stocking	85.5	17	4.8	5/3/99		Release				5/17/99
	25,051[18]	Stocking	85.9	50	5.0	5/3/99						
	24,943[19]	Stocking	82.6	50	4.3	5/3/99						
		Release				5/17/99						
2000[20]	26,306[21]	Stocking	86.7	58	5.7	5/10/00	92,976	Stocking	71.1	50	2.8	4/6/00
	26,241[22]	Stocking	86.2	56	5.4	5/10/00	27,000	Stocking	84.3	50	4.9	5/2/00
	27,301[23]	Stocking	85.4	56	5.1	5/10/00		Release	86.7	50	4.8	5/9/00
		Release	107.1	100	9.8	6/5/00						
2001[24,25]	24,696	Stocking	85.1	100	4.7	4/25/01	140,291	Stocking	76.8	100	3.5	4/18&19
		Release[26]	91.7	100	6.0	5/21/01	38,844	Stocking				4/25&26
								Release[26]	91.7	100	6.0	5/21/01

Appendix H.-Continued.

[1] Fingerlings treated with methyltestosterone in an attempt to sterilize them (stocked in 1986-88).
[2] Includes regular and sterile A CWT chinook salmon.
[3] First year that a moist pellet diet was fed to chinook fingerlings while in the pond.
[4] In 1991 an estimated 220,000 chinook were released from the Strawberry Creek pond (includes A CWT and non-CWT combined).
[5] In 1992 an estimated 125,000 chinook were released from the Strawberry Creek pond (includes A CWT and non-CWT combined) losses due to escapement and bird predation.
[6] In 1993 an estimated 130,000 chinook were released from the Strawberry Creek pond (includes A CWT and non-CWT combined) losses due to escapement and gill disease.
[7] In 1994 an estimated 157,000 chinook (131,000 standard production and 26,000 A CWT) were released from the Strawberry Creek pond.
[8] Beginning in the fall of 1994 all chinook eggs (other than thiamine study control eggs) were water hardened in thiamine to reduce EMS
[9] In 1995 an estimated 213,000 chinook (165,000 standard production, 25,000 A CWT treated and 22,500 A CWT non treated) were released from the Strawberry Creek pond.
[10] In 1996 an estimated 210,000 chinook (160,000 standard production, 24,500 A CWT treated and 26,000 A CWT non treated) were released from the Strawberry Creek pond.
[11] In the fall of 1996 and 1997 a limited number of known age chinook were spawned as single paired families (SPF) to produce fingerlings from known aged parents.
[12] In 1997 an estimated 211,600 chinook (143,000 standard production, 25,800 regular A CWT and 42,400 SPF A CWT) were released from the Strawberry Creek pond.
[13] In 1998 an estimated 210,500 chinook (140,000 standard production, 25,500 regular A CWT and 45,000 SPF A CWT) were released from the Strawberry Creek pond.
[14] In 1999 an estimated 211,700 chinook (137,000 standard production, 24,900 regular A-CWT, 25,000 RV A-CWT, 8,300 A-CWT pink photonic, 8,300 A-CWT green photonic, and 8,200 A-CWT orange photonic) were released from the SCW pond.
[15] Fingerlings with a CWT (and an adipose fin clip as per standard procedure) and a pink photonic mark in the anal fin.
[16] Fingerlings with a CWT (and an adipose fin clip as per standard procedure) and a green photonic mark in the anal fin.
[17] Fingerlings with a CWT (and an adipose fin clip as per standard procedure) and an orange photonic mark in the anal fin.
[18] Fingerlings with a CWT (and an adipose fin clip as per standard procedure) and a RV fin clip.
[19] Fingerlings with a CWT (and an adipose fin clip as per standard procedure).
[20] In 2000 an estimated 198,000 chinook (119,000 standard production, 26,000 regular A CWT, 26,000 ALV CWT and 27,000 no clip CWT) were netted from the Strawberry Creek pond and trucked for release in the Sturgeon Bay Ship Canal.
[21] Fingerlings with a CWT (and an adipose fin clip as per standard procedure).
[22] Fingerlings with a CWT (and an adipose fin clip as per standard procedure) and a LV fin clip.
[23] Fingerlings with a CWT only (no adipose fin clip as per standard procedure).
[24] In 2001 an estimated 205,182 chinook (180,582 standard production, 24,600 regular A CWT) were netted from the Strawberry Creek pond and trucked for release in the Sturgeon Bay Ship Canal.
[25] In 2001 all chinook fingerlings stocked into Lake Michigan by the WDNR and other agencies were to be marked with OTC. Subsequent evaluation indicated that chinook fingerlings treated with OTC by WDNR hatcheries were poorly marked.
[26] Mean length and weight at release was from a comingled sample of CWT and non-CWT fingerlings.

Appendix I.-Summary of 2,084 adipose clipped chinook salmon harvested at the Besadny Anadromous Fisheries Facility, fall 2001. In addition to the 1,965 CWTs listed below, 29 tags were lost during extraction, 70 of the adipose clipped chinook had no tag detected, and 20 of the salmon heads were too decomposed to work on. The chinook released in the Kewaunee River were part of a chinook fingerling stocking evaluation. The chinook released at all other sites were strays to the Kewaunee River.

YEAR CLASS	LOCATION OF RELEASE	AGE AT CAPTURE	STOCKING AGENCY	NUMBER HARVESTED
2000	Strawberry Creek, WI[1]	1+	WIS DNR	9
	Strawberry Creek, WI[2]		WIS DNR	4
	Port Austin, Lake Huron		MICH DNR	1
	Au Gres River, Lake Huron		MICH DNR	1
	Swan Creek, Lake Huron		MICH DNR	1
	Medusa Creek, Lake Mich		MICH DNR	4
1999	Kewaunee River (Harbor)[3]	2+	WIS DNR	341
	Kewaunee River (BAFF)[4]		WIS DNR	460
	Kewaunee River (Clyde's)[5]		WIS DNR	457
	Kewaunee River (Hwy. 54)[6]		WIS DNR	255
	Strawberry Creek, WI[1]		WIS DNR	14
	Strawberry Creek, WI[7]		WIS DNR	21
	Strawberry Creek, WI[8]		WIS DNR	28
	Port Austin, Lake Huron		MICH DNR	1
1998	Kewaunee River (Harbor)[3]	3+	WIS DNR	48
	Kewaunee River (BAFF)[4]		WIS DNR	85
	Kewaunee River (Clyde's)[5]		WIS DNR	153
	Kewaunee River (Hwy. 54)[6]		WIS DNR	75
	Strawberry Creek, WI[1]		WIS DNR	4
	Strawberry Creek, WI[9]		WIS DNR	2
	Strawberry Creek, WI[10]		WIS DNR	1

[1] Regular production CWT fingerlings (controls) stocked at Strawberry Creek.
[2] Fingerlings from a marking technique study conducted at Strawberry Creek (A-CWT and LV clip).
[3] Stocking technique study chinook fingerlings stocked in the Kewaunee Harbor near the mouth of the Kewaunee River.
[4] Stocking technique study chinook fingerlings stocked in the Kewaunee River near the BAFF approximately four miles upstream from Lake Michigan.
[5] Stocking technique study chinook fingerlings stocked in the Kewaunee River at Clyde's Hill Road crossing approximately nine miles upstream from Lake Michigan.
[6] Stocking technique study chinook fingerlings stocked in the Kewaunee River at Hwy. 54 crossing approximately 15 miles upstream from Lake Michigan.
[7] Fingerlings from a marking technique study conducted at Strawberry Creek (A-CWT and RV clip).
[8] Fingerlings from a marking technique study conducted at Strawberry Creek (A-CWT and photonic mark).
[9] Fingerlings from age at maturity study conducted at Strawberry Creek (known age 3+ males and age 2+ females).
[10] Fingerlings from age at maturity study conducted at Strawberry Creek (known age 3+ males and age 3+ females).

Appendix J.-Summary of chinook salmon stocking densities, strain, and average size of CWT and non-CWT salmon fingerlings at stocking into the Kewaunee River 1984-2001. All fish sampled at release.

YEAR CLASS	CWT CHINOOK STOCKED IN KEWAUNEE RIVER						NON-CWT CHINOOK STOCKED IN KEWAUNEE RIVER					
	NUMBER CWT'S STOCKED	STRAIN	AVERAGE LENGTH (mm)	SAMPLE SIZE	AVERAGE WEIGHT (G)	DATE	NUMBER NON-CWT'S STOCKED	STRAIN	AVERAGE LENGTH (mm)	SAMPLE SIZE	AVERAGE WEIGHT (g)	DATE
1984							250,000	L. Mich.				
1985							311,500	L. Mich.				
1986	20,000[1]	L. Mich.	78.5	50	4.5	4/22/86	190,000	L. Mich.	79.0		4.5	5/28/86
	20,000[2]	L. Mich.	78.7	50	4.7	4/22/86						
	20,000[3]	L. Mich.	83.3	50	4.8	4/22/86						
1987	20,000[1]	L. Mich.	77.3	50	4.2	4/29/87	190,000	L. Mich.	63.8		2.5	5/21/87
	20,000[2]	L. Mich.	78.1	50	4.4	4/29/87						
	20,000[3]	L. Mich.	79.3	50	4.5	4/29/87						
1988							200,000	L. Mich.	90.7		7.4	5/23/88
1989							180,000	L. Mich.				5/23/89
1990							133,497	L. Mich.				5/1&9/90
1991	20,255	L. Mich.	75.1	100	3.3	5/9/91	120,852	L. Ont.	83.3	100	5.0	5/9/91
	20,306	L. Ont.	84.2	100	4.6	5/9/91						
1992	22,345	L. Mich.	83.6	50	5.3	5/4/92	70,748	L. Ont.			4.9[8]	5/11/92
	21,920	L. Ont.	86.6	50	5.9	5/4/92						
1993	21,643	L. Mich.	80.4	50	4.6	5/5/93	50,000	L. Ont.			3.8[8]	5/14/93
	21,898	L. Ont.	81.5	50	4.9	5/5/93						
1994	16,905	L. Mich.	77.7	50	4.5	5/2/94	70,118	L. Ont.			4.9[8]	5/9/94
	22,875	L. Ont.	75.4	60	3.5	5/2/94						
1995							97,867	L. Mich.			6.7[8]	5/16/95
1996							105,468	L. Mich.			4.5[8]	5/22/96
1997							108,606	L. Mich.			5.8[8]	5/15/97
1998	25,443[4]	L. Mich.	80.4	50	4.7	5/1/98	20,000	L. Mich.			4.3[8]	4/12/98
	25,533[5]	L. Mich.	79.2	50	4.2	5/1/98						
	25,529[6]	L. Mich.	77.8	50	4.0	5/1/98						
	25,586[7]	L. Mich.	80.6	50	4.2	5/1/98						
1999	22,037[4]	L. Mich.	86.4	52	5.0	5/17/99	15,300	L. Mich.			5.9[8]	5/7/99
	24,473[5]	L. Mich.	89.8	52	5.8	5/17/99						
	24,515[6]	L. Mich.	86.6	50	5.2	5/17/99						
	24,354[7]	L. Mich.	88.6	50	5.4	5/17/99						
2000							107,635	L. Mich.	83.8[8]		5.1[8]	5/4/00
2001							21,374 61,009	L. Mich. L. Mich.				5/18/01 5/24/01

Appendix J. Continued

[1] Chinook fingerlings stocked as part of a stocking technique study (stocked into and released from a rearing pond approximately three miles upstream from Lake Michigan).
[2] Chinook fingerlings stocked as part of a stocking technique study (stocked directly into the Kewaunee River approximately nine miles upstream from Lake Michigan).
[3] Chinook fingerlings stocked as part of a stocking technique study (stocked directly into Lake Michigan near the mouth of the Kewaunee River).
[4] Chinook fingerlings stocked as part of a stocking technique study (stocked into the Kewaunee Harbor near Lake Michigan).
[5] Chinook fingerlings stocked as part of a stocking technique study (stocked into the Kewaunee River near BAFF approximately four miles upstream from Lake Michigan).
[6] Chinook fingerlings stocked as part of a stocking technique study (stocked into the Kewaunee River at Clyde's Hill Road crossing approximately nine miles upstream from Lake Michigan).
[7] Chinook fingerlings stocked as part of a stocking technique study (stocked into the Kewaunee River at Hwy. 54 crossing approximately 15 miles upstream from Lake Michigan).
[8] Estimated from hatchery weight count at stocking.

Appendix K.-Average length (mm) by age, sex, and year of return of CWT chinook salmon stocked as part of the stocking technique study in the Kewaunee River and recaptured at the BAFF on the Kewaunee River, Kewaunee County, 2000.

YEAR OF RETURN	SEX		AGE LENGTH AT AGE				
			1+	2+	3+	4+	5+
1999[1]	M	L (sd)	660.8(35.9)	-	-	-	-
		range	562-730	-	-	-	-
		n	35	-	-	-	-
	F	L (sd)	-	-	-	-	-
		range	-	-	-	-	-
		n	-	-	-	-	-
1999[2]	M	L (sd)	664.1(31.9)	-	-	-	-
		range	595-740	-	-	-	-
		n	94	-	-	-	-
	F	L (sd)	-	-	-	-	-
		Range	-	-	-	-	-
		n	-	-	-	-	-
1999[3]	M	L (sd)	668.3(36.4)	-	-	-	-
		range	520-782	-	-	-	-
		n	105	-	-	-	-
	F	L (sd)	-	-	-	-	-
		range	-	-	-	-	-
		n	-	-	-	-	-
1999[4]	M	L (sd)	677.9(31.6)	-	-	-	-
		range	604-743	-	-	-	-
		n	57	-	-	-	-
	F	L (sd)	-	-	-	-	-
		range	-	-	-	-	-
		n	-	-	-	-	-
2000[1]	M	L (sd)	587.6(38.4)	901.9(39.1)	-	-	-
		range	512-668	847-1,010	-	-	-
		n	70	26	-	-	-
	F	L (sd)	-	877.6(28.0)	-	-	-
		range	-	840-912	-	-	-
		n	-	8	-	-	-
2000[2]	M	L (sd)	604.6(36.7)	885.2(53.5)	-	-	-
		range	492-680	723-966	-	-	-
		n	129	44	-	-	-
	F	L (sd)	-	855.9(28.1)	-	-	-
		range	-	817-903	-	-	-
		n	-	13	-	-	-
2000[3]	M	L (sd)	608.7(40.2)	900.0(38.2)	-	-	-
		range	493-707	819-1,000	-	-	-
		n	129	56	-	-	-
	F	L (sd)	-	873.2(31.2)	-	-	-
		range	-	804-952	-	-	-
		n	-	22	-	-	-
2000[4]	M	L (sd)	603.4(31.2)	902.0(39.7)	-	-	-
		range	522-664	772-983	-	-	-
		n	72	46	-	-	-
	F	L (sd)	-	855.3(34.7)	-	-	-
		range	-	795-900	-	-	-
		n	-	10	-	-	-

Appendix K.-Continued.

2001[1]	M	L (sd)	-	860.1 (55.1)	995.2 (61.6)	-	-
		range	-	686-999	812-1,103	-	-
		n	-	307	23	-	-
	F	L (sd)	-	837.2 (49.6)	941.9 (49.4)	-	-
		range	-	761-986	801-1,026	-	-
		n	-	34	25	-	-
2001[2]	M	L (sd)	-	865.2 (52.8)	996.4 (56.2)	-	-
		range	-	671-1,005	873-1,070	-	-
		n	-	389	27	-	-
	F	L (sd)	-	844.8 (41.1)	939.0 (52.9)	-	-
		range	-	760-941	740-1,034	-	-
		n	-	71	58	-	-
2001[3]	M	L (sd)	-	863.5 (50.6)	993.2 (67.6)	-	-
		range	-	680-993	700-1,102	-	-
		n	-	400	67	-	-
	F	L (sd)	-	843.1 (45.1)	943.2 (48.4)	-	-
		range	-	703-934	805-1,062	-	-
		n	-	57	86	-	-
2001[4]	M	L (sd)	-	863.1 (54.8)	995.2 (56.9)	-	-
		range	-	695-1,045	810-1,125	-	-
		n	-	220	32	-	-
	F	L (sd)	-	834.7 (36.5)	942.8 (50.8)	-	-
		range	-	758-924	792-1,033	-	-
		n	-	35	43	-	-

[1] Stocking technique study chinook fingerlings stocked in the Kewaunee Harbor near the mouth of the Kewaunee River.
[2] Stocking technique study chinook fingerlings stocked in the Kewaunee River near the BAFF approximately four miles upstream from Lake Michigan.
[3] Stocking technique study chinook fingerlings stocked in the Kewaunee River at Clyde's Hill Road crossing approximately nine miles upstream from Lake Michigan.
[4] Stocking technique study chinook fingerlings stocked in the Kewaunee River at Hwy. 54 crossing approximately 15 miles upstream from Lake Michigan.

Appendix L.-Average weight (kg) by age, sex, and year of return of CWT chinook salmon stocked as part of the stocking technique study in the Kewaunee River and recaptured at the BAFF on the Kewaunee River, Kewaunee County, 1999.

YEAR OF RETURN	SEX		AGE WEIGHT AT AGE				
			1+	2+	3+	4+	5+
1999[1]	M	W (sd)	2.9 (0.5)	-	-	-	-
		range	1.7-3.7	-	-	-	-
		n	33	-	-	-	-
	F	W (sd)	-	-	-	-	-
		range	-	-	-	-	-
		n	-	-	-	-	-
1999[2]	M	W (sd)	2.8 (0.5)	-	-	-	-
		range	1.6-4.1	-	-	-	-
		n	86	-	-	-	-
	F	W (sd)	-	-	-	-	-
		range	-	-	-	-	-
		n	-	-	-	-	-
1999[3]	M	W (sd)	2.9 (0.5)	-	-	-	-
		range	1.3-4.4	-	-	-	-
		n	99	-	-	-	-
	F	W (sd)	-	-	-	-	-
		range	-	-	-	-	-
		n	-	-	-	-	-
1999[4]	M	W (sd)	3.0 (0.5)	-	-	-	-
		range	2.0-4.1	-	-	-	-
		n	53	-	-	-	-
	F	W (sd)	-	-	-	-	-
		range	-	-	-	-	-
		n	-	-	-	-	-
2000[1]	M	W (sd)	2.0 (0.5)	6.7 (0.9)	-	-	-
		range	1.2-3.6	5.2-8.4	-	-	-
		n	68	26	-	-	-
	F	W (sd)	-	7.4 (1.0)	-	-	-
		range	-	6.1-8.7	-	-	-
		n	-	8	-	-	-
2000[2]	M	W (sd)	2.1 (0.4)	6.5 (1.2)	-	-	-
		range	1.0-3.1	3.4-8.4	-	-	-
		n	128	42	-	-	-
	F	W (sd)	-	6.7 (0.9)	-	-	-
		range	-	5.5-8.5	-	-	-
		n	-	13	-	-	-
2000[3]	M	W (sd)	2.3 (0.5)	6.8 (1.0)	-	-	-
		range	1.1-3.6	5.0-9.5	-	-	-
		n	129	54	-	-	-
	F	W (sd)	-	7.1 (0.7)	-	-	-
		range	-	5.8-8.9	-	-	-
		n	-	22	-	-	-
2000[4]	M	W (sd)	2.2 (0.4)	6.7 (1.0)	-	-	-
		range	1.5-3.2	3.7-8.5	-	-	-
		n	71	46	-	-	-
	F	W (sd)	-	6.3 (0.8)	-	-	-
		range	-	4.4-7.3	-	-	-
		n	-	10	-	-	-

Appendix L.-Continued

2001[1]	M	W (sd) range n	- - -	6.2 (1.3) 2.5-10.1 307	9.1 (1.8) 5.1-12.1 23	- - -	
	F	W (sd) range n	- - -	6.6 (1.4) 5.1-12.3 34	8.8 (1.6) 5.1-12.2 25	- - -	
2001[2]	M	W (sd) range n	- - -	6.4 (1.2) 2.7-9.7 389	9.4 (1.6) 5.9-11.7 27	- - -	
	F	W (sd) range n	- - -	6.8 (1.1) 4.5-9.8 71	9.1 (1.4) 4.4-12.1 58	- - -	
2001[3]	M	W (sd) range n	- - -	6.4 (1.2) 3.2-10.1 400	9.2 (1.9) 3.3-12.8 67	- - -	
	F	W (sd) range n	- - -	6.8 (1.1) 4.2-9.8 57	9.1 (1.6) 5.7-12.3 86	- - -	
2001[4]	M	W (sd) range n	- - -	6.4 (1.3) 3.4-10.4 220	9.3 (1.8) 4.9-13.6 32	- - -	
	F	W (sd) range n	- - -	6.5 (0.9) 4.9-8.4 35	9.1 (1.7) 5.1-12.1 43	- - -	

[1] Stocking technique study chinook fingerlings stocked in the Kewaunee Harbor near the mouth of the Kewaunee River.
[2] Stocking technique study chinook fingerlings stocked in the Kewaunee River near the BAFF approximately four miles upstream from Lake Michigan.
[3] Stocking technique study chinook fingerlings stocked in the Kewaunee River at Clyde's Hill Road crossing approximately nine miles upstream from Lake Michigan.
[4] Stocking technique study chinook fingerlings stocked in the Kewaunee River at Hwy. 54 crossing approximately 15 miles upstream from Lake Michigan.

Appendix M.-Coho salmon stocking history of the Kewaunee River, Kewaunee County, 1987-2001.

YEAR STOCKED	NUMBER STOCKED	AGE AT STOCKING (YEAR CLASS)	CLIP	SOURCE OF EGGS	STUDY
1987	126,429	Fingerling (87)	LV	Lake Michigan	Accelerated
	50,400	Yearling (86)	NC		Standard Production
1988	51,040	Yearling (87)	NC		Standard Production
	119,502	Fingerling (88)	ARV	Lake Michigan	Accelerated
	86,700	Fingerling (88)	NC		Standard Production
1989	146,680	Fingerling (89)	LP	Lake Michigan	Age & Growth
	71,000	Fingerling (89)	NC		Standard Production
1990	72,555	Fingerling (90)	ALV	Lake Superior	Strain Evaluation
	875	Fingerling (90)	NC		Standard Production
	94,390	Fingerling (90)	RP	Lake Michigan	Strain Evaluation
1991	59,010	Fingerling (91)	LP	Lake Michigan	Strain Evaluation
	52,608	Fingerling (91)	LV	Lake Ontario	Strain Evaluation
	7,058	Fingerling (91)	NC		Standard Production
	42,550	Fingerling (91)	BV	Lake Michigan	Control/Erythromycin
1992	62,131	Fingerling (92)	RP	Lake Michigan	Strain/Disease Evaluation
	45,000	Fingerling (92)	NC	Lake Michigan	Standard Production
	40,490	Fingerling (92)	BV	Lake Michigan	Control/Erythromycin
	59,975	Fingerling (92)	RV	Lake Ontario	Control/Erythromycin
1993	None stocked (the entire 1993 year class was stocked as yearlings in 1994)				
1994	57,587	Yearling (93)	NC	Lake Michigan	Standard Production
	10,710	Yearling (93)	NC	Lake Ontario	Standard Production
	60,822	Fingerling (94)	LMLP	Lake Michigan	Fingerling/Yearling
	130,516	Fingerling (94)	LP	Lake Michigan	Hyper Accelerated
1995	28,846	Yearling (94)	NC	Lake Michigan	Standard Production
	5,280	Yearling (94)	NC	Lake Ontario	Standard Production
	32,154	Yearling (94)	BV	Lake Michigan	Control/Erythromycin
	59,400	Yearling (94)	LMRP	Lake Michigan	Fingerling/Yearling
	54,808	Fingerling (95)	LMLV	Lake Michigan	Fingerling/Yearling
1996	29,718	Yearling (95)	NC	Lake Michigan	Standard Production
	20,595	Yearling (95)	A	Lake Michigan	Treatment/Thiamine
	19,083	Yearling (95)	A	Lake Michigan	Control/Thiamine
	49,878	Yearling (95)	LMRV	Lake Michigan	Fingerling/Yearling
	66,486	Fingerling (96)	LM	Lake Michigan	Fingerling/Yearling
1997	40,950	Yearling (96)	BV	Lake Michigan	Control/Erythromycin
	18,800	Yearling (96)	A	Lake Michigan	Treatment/Thiamine
	20,220	Yearling (96)	A	Lake Michigan	Control/Thiamine
	62,886	Yearling (96)	RM	Lake Michigan	Fingerling/Yearling
	50,155	Fingerling (97)	NC	Lake Michigan	Standard Production
1998	126,619	Yearling (97)	NC	Lake Michigan	Standard Production
	50,024	Fingerling (98)	NC	Lake Michigan	Standard Production
1999	127,771	Yearling (98)	NC	Lake Michigan	Standard Production
	50,960	Fingerling (99)	NC	Lake Michigan	Standard Production
2000	129,920	Yearling (99)	NC	Lake Michigan	Standard Production
2001	141,130	Yearling (00)	NC	Lake Michigan	Standard Production
	51,468	Fingerling (01)	NC	Lake Michigan	Standard Production

Appendix N.-Estimated rate of recovery of coho salmon at the Besadny Anadromous Fisheries Facility, through fall 2001. Unclipped (NC) fish were aged by length frequency distribution.

Year Class	Year Stocked (season)	Stocking Technique	Number Stocked	Clip	%Recovery Rate (number)		Cumulative Recovery Rate
					1+	2+	
1993	1994 (spring)	Production Yearlings	68,297	NC	0.271	3.480	3.751
					(185)	(2,377)	(2,562)
1994	1994 (spring)	Hyper Accelerated	130,516	LP	0.026	0.010	0.036
					(34)	(13)	(47)
1994	1994 (fall)	F/Y Study Fingerlings	60,822	LMLP	0.120	1.010	1.130
					(73)	(614)	(687)
1994	1995 (spring)	F/Y Study Yearlings	59,400	LMRP	0.557	1.552	2.109
					(331)	(922)	(1,253)
1994	1995 (spring)	Erythromycin Study	32,154	BV	0.809	3.452	4.261
					(260)	(1,110)	(1,370)
1994	1995 (spring)	Production Yearlings	34,126	NC	1.301	1.102	2.403
					(444)	(376)	(820)
1995	1995 (fall)	F/Y Study Fingerlings	54,808	LMLV	0.100	0.604	0.704
					(55)	(331)	(386)
1995	1996 (spring)	Thiamine Study/treated	20,595	A/CWT	0.112	0.340	0.452
					(23)	(70)	(93)
1995	1996 (spring)	Thiamine Study/controls	19,083	A/CWT	0.152	0.713	0.865
					(29)	(136)	(165)
1995	1996 (spring)	F/Y Study Yearlings	49,878	LMRV	0.088	0.640	0.728
					(44)	(319)	(363)
1995	1996 (spring)	Production Yearlings	29,718	NC	0.087	0.451	0.538
					(26)	(134)	(160)
1996	1996 (fall)	F/Y Study Fingerlings	66,486	LM	0.024	0.484	0.508
					(16)	(322)	(338)
1996	1997 (spring)	F/Y Study Yearlings	62,886	RM	0.021	0.382	0.402
					(13)	(240)	(253)
1996	1997 (spring)	Thiamine Study/treated	18,800	A/CWT	0.096	0.803	0.899
					(18)	(151)	(169)
1996	1997 (spring)	Thiamine Study/controls	20,220	A/CWT	0.049	0.613	0.663
					(10)	(124)	(134)
1996	1997 (spring)	Erythromycin Controls	40,950	BV	0.002	0.103	0.105
					(1)	(42)	(43)
1997	1997/fall 1998/spring	Production Fing/year	50,155 126,619	NC	0.110	0.740	0.850
					(194)	(1,308)	(1,502)
1998	1998/fall 1999/spring	Production Fing/year	50,024 127,771	NC	0.186	0.874	1.060
					(330)	(1,554)	(1,884)
1999	1999/fall 2000/spring	Production Fing/year	50,960 129,920	NC	0.055	0.040	0.095
					(100)	(73)	(173)
2000	2000/fall 2001/spring	Production Fing/year	51,468 141,130	NC	0.044		
					(85)		

Appendix O.-Mean length and weight of various groups of coho stocked in the Kewaunee River, Kewaunee County, as fingerlings and yearlings and captured at the Besadny Anadromous Fisheries Facility through fall 2001

Year class Study group Fin clip		Age at return (Year of return)			
		Age 1+		Age 2+	
		Male	Female	Male	Female
1994 hyper accelerated fingerlings fingerling/yearling study LP	Length mm (SD) Range Sample size	526.4 (73.6) 373-660 24	536.0 (47.1) 479-583 4	675.0 (50.9) 622-754 5	654.8 (24.4) 620-685 8
	Weight kg (SD) Range Sample size	1.7 (0.7) 0.9-2.7 9	1.4 (0.5) 1.0-1.9 3	2.0 - 1	2.8 - 1
1994 accelerated fingerlings fingerling/yearling study LMLP	Length mm (SD) Range Sample size	369.1 (24.1) 319-439 56	- - -	672.7 (58.7) 439-788 249	648.4 (40.1) 506-785 365
	Weight kg (SD) Range Sample size	0.5 (0.1) 0.3-0.8 32	- - -	2.7 (0.8) 0.9-4.2 87	2.7 (0.5) 1.5-3.8 90
1994 yearlings fingerling/yearling study LMRP	Length mm (SD) Range Sample size	360.1 (21.5) 285-417 202	- - -	658.6 (57.1) 416-854 363	644.4 (40.8) 383-759 559
	Weight kg (SD) Range Sample size	0.5 (0.1) 0.2-0.7 81	- - -	2.4 (0.7) 0.6-4.4 138	2.6 (0.6) 1.2-4.6 201
1994 erythromycin study controls not treated BV	Length mm (SD) Range Sample size	381.4 (23.5) 325-442 203	- - -	683.7 (62.4) 449-795 427	670.0 (39.3) 484-792 683
	Weight kg (SD) Range Sample size	0.5 (0.1) 0.2-0.9 62	- - -	2.9 (0.8) 0.7-5.0 185	3.1 (0.6) 0.9-5.1 238
1994 yearlings standard production NC	Length mm (SD) Range Sample size	426.6 (43.7) 333-518 424	482.4 (29.6) 433-517 12	702.3 (62.4) 527-885 155	680.6 (41.6) 554-770 221
	Weight kg (SD) Range Sample size	0.7 (0.2) 0.4-1.2 101	1.0 (0.2) 0.8-1.3 7	3.1 (0.9) 1.5-5.7 64	3.2 (0.6) 1.7-4.9 64

Appendix O.-Continued.

Year class Study group Fin clip		Age at return (Year of return)			
		Age 1+		Age 2+	
		Male	Female	Male	Female
1995 accelerated fingerlings fingerling/yearling study LMLV	Length mm (SD) Range Sample size	397.1 (33.8) 321-480 52	421.7 (37.6) 392-464 3	591.4 (58.6) 460-742 172	562.3 (47.3) 461-674 159
	Weight kg (SD) Range Sample size	0.6 (0.2) 0.3-0.9 36	0.52 - 1	1.84 (0.6) 0.7-3.8 169	1.74 (0.5) 0.9-3.2 151
1995 yearlings fingerling/yearling study LMRV	Length mm (SD) Range Sample size	430.3 (41.3) 338-516 42	443.5 (41.7) 414-473 2	602.3 (57.8) 480-733 139	576.1 (49.8) 466-698 180
	Weight kg (SD) Range Sample size	0.7 (0.2) 0.4-1.0 18	- - -	1.9 (0.6) 1.0-4.3 133	1.9 (0.6) 0.8-3.8 165
1995 yearlings standard production NC	Length mm (SD) Range Sample size	438.6 (42.6) 346-508 23	510.1 (5.0) 505-515 3	605.8 (69.7) 466-740 60	584.4 (47.7) 470-673 74
	Weight kg (SD) Range Sample size	0.8 (0.2) 0.5-101 9	1.2 - 1	2.0 (0.8) 0.8-4.0 59	3.0 (0.5) 0.9-3.3 73
1995 yearlings thiamine study treated A/CWT 31-17-13	Length mm (SD) Range Sample size	409.2 (38.1) 335-481 23	- - -	609.9 (72.7) 495-763 39	597.1 (51.4) 474-703 31
	Weight kg (SD) Range Sample size	0.6 (0.2) 0.2-0.9 20	- - -	2.0 (0.8) 0.9-4.2 39	2.1 (0.6) 1.0-3.6 31
1995 yearlings thiamine study not treated A/CWT 31-17-14	Length mm (SD) Range Sample size	413.7 (39.6) 302-484 29	- - -	618.4 (64.9) 479-780 68	584.5 (54.5) 477-711 68
	Weight kg (SD) Range Sample size	0.7 (0.2) 0.2-1.1 26	- - -	2.1 (0.8) 0.7-4.3 66	2.0 (0.6) 0.9-3.3 64

Appendix O.-Continued.

Year class Study group Fin clip		Age at return (Year of return)			
		Age 1+		Age 2+	
		Male	Female	Male	Female
1996 accelerated fingerlings fingerling/yearling study LM	Length mm (SD) Range Sample size	368.7 (22.7) 331-410 16	- - -	597.6 (73.3) 405-785 149	581.9 (46.4) 487-728 173
	Weight kg (SD) Range Sample size	0.5 (0.1) 0.3-0.8 15	- - -	1.9 (0.8) 0.6-4.7 135	1.8 (0.5) 0.9-3.8 169
1996 yearlings fingerling/yearling study RM	Length mm (SD) Range Sample size	405.2 (26.1) 366-440 13	- - -	623.4 (86.9) 357-777 124	608.6 (50.4) 498-743 116
	Weight kg (SD) Range Sample size	0.6 (0.1) 0.4-0.8 13	- - -	2.2 (0.9) 0.7-4.2 112	2.1 (0.6) 0.9-4.0 114
1996 yearlings thiamine study treated A/CWT 36-17-17	Length mm (SD) Range Sample size	399.9 (19.4) 364-430 10	- - -	648.9 (72.9) 445-772 75	611.1 (54.8) 510-725 76
	Weight kg (SD) Range Sample size	0.6 (0.1) 0.4-0.8 10	- - -	2.4 (0.9) 0.7-4.4 72	2.1 (0.6) 1.0-3.6 75
1996 yearlings thiamine study not treated A/CWT 36-17-18	Length mm (SD) Range Sample size	380.2 (18.2) 333-409 18	- - -	639.3 (59.9) 529-752 59	617.8 (56.4) 480-738 65
	Weight kg (SD) Range Sample size	0.5 (0.1) 0.3-0.7 18	- - -	2.2 (0.7) 1.1-4.0 57	2.2 (0.7) 1.0-4.0 61
1996 erythromycin study not treated BV	Length mm (SD) Range Sample size	380 - 1	- - -	614.6 (64.0) 510-722 20	580.2 (55.1) 509-700 22
	Weight kg (SD) Range Sample size	0.5 - 1	- - -	1.9 (0.6) 0.9-2.9 20	1.8 (0.5) 1.1-2.9 19
1997 fingerlings/ yearlings standard production NC	Length mm (SD) Range Sample size	431.8 (28.2) 340-506 163	468.4 (30.3) 400-510 31	812.5 (59.4) 570-918 236	776.8 (37.7) 575-857 532
	Weight kg (SD) Range Sample size	0.7 (6.1) 0.4-1.2 159	1.0 (0.2) 0.6-1.3 30	5.1 (1.2) 1.7-7.9 236	4.9 (0.8) 2.0-6.8 532
1998 fingerlings/ yearlings standard production NC	Length mm (SD) Range Sample size	478.4 (40.6) 345-556 63	- - -	735.3 (58.9) 556-849 266	707 (40.3) 507-805 500
	Weight kg (SD) Range Sample size	1.1 (0.3) 0.4-1.8 63	- - -	3.8 (1.0) 1.5-6.2 266	3.7 (0.7) 1.2-7.7 500

Appendix O.-Continued.

Year class Study group Fin clip		Age at return (Year of return)			
		Age 1+		Age 2+	
		Male	Female	Male	Female
1999 fingerlings/ yearlings standard production NC	Length mm (SD) Range Sample size	- - -	- - -	691.1 (96.8) 486-820 35	719.7 (34.3) 631-781 38
	Weight kg (SD) Range Sample size	- - -	- - -	3.1 (1.2) 1.1–5.2 35	3.7 (0.6) 2.3-5.1 38
2000 fingerlings/ yearlings standard production NC	Length mm (SD) Range Sample size	406.8 (34.2) 349-470 11	- - -	- - -	- - -
	Weight kg (SD) Range Sample size	0.6 (0.2) 0.4-1.0 11	- - -	- - -	- - -