

**Harvest, Age, and Size at Age of Chinook and Coho Salmon
at Strawberry Creek Weir and Besadny Anadromous Fisheries Facility
Fall 2000**

By Paul Peeters and Ken Royseck



Mature chinook salmon in characteristic spawning colors, collected at the Besadny Anadromous Fisheries Facility, fall 2000. Female 8.90 kg, 907 mm, on top, male, 8.02 kg, 1006 mm, showing the characteristic kype (hooked jaw) that forms with the onset of maturation, on bottom.

ABSTRACT

The fall of 2000 continued the recent trend of very low Lake Michigan water level and very low stream flow. As a result of the low water level exacerbated by the low stream flow, harvest of chinook salmon *Oncorhynchus tshawytscha* at Strawberry Creek Weir (SCW) in the fall of 1999 was essentially a bust and backup chinook egg collection facilities had to be used and ongoing coded wire tag (CWT) studies were compromised. Conditions in late summer 2000 were similar to 1999 and the stage was set for another poor harvest. Wisconsin Department of Natural resources (WDNR) operations crew installed a 0.7 mile pipeline to carry water from the Sturgeon Bay Ship Canal to Strawberry Creek. The pipeline carried approximately 1,200 gallons of water per minute and discharged into Strawberry Creek above the SCW facility to augment

the limited natural flow. 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. Egg harvest increased from 0.6 million in the fall of 1999 to 3.7 million in 2000. Fall 2000 was the third highest live fish harvest since the 1970's when detailed harvest records for Strawberry Creek were first kept. The sex ratio of the 2000 live fish harvest was 70 percent male and 30 percent female. The age composition of the entire chinook harvest at SCW consisted of 43 percent age 1+, 26 percent age 2+, 29 percent age 3+, and two percent age 4+ salmon.

A total of 2,199 adipose clipped chinook were recovered at SCW during the fall of 2000. A total of 2,028 CWTs were successfully extracted from the adipose clipped fish. All but two of the recovered CWTs were from chinook released from SCW. One CWT chinook was a stray from a Keweenaw River stocking and one CWT chinook was a stray from Swan Creek, a Lake Huron tributary stocked by Michigan Department of Natural Resources (MDNR).

Size at known age (length and weight) of CWT chinook salmon has been observed at SCW from 1983 through 2000. The size of age 1+ chinook (all males) was down from the fall of 1999 but remain above the 18-year average. The average size of age 2+ CWT chinook was above the 17-year average. Age 3+ chinook were slightly below the 16-year average established for this age group.

In the CWT thiamine study, chinook treated with thiamine returned to SCW at slightly higher rates than chinook not treated with thiamine. In this study if the thiamine treated chinook were recovered at a higher or even similar rate to the non-treated chinook, thiamine treatment would be considered positive because it had already contributed to a higher percentage of chinook surviving to stocking.

In the CWT age of maturity study, it would appear that in the 1997 year class, the progeny of the age 3+ parental stock may be exhibiting a slightly later maturity schedule than the standard production fish. With the 1998 year class, it is too early to determine if a later maturity schedule will be exhibited.

In the CWT marking technique study, it would appear that, from the recovery of age 1+ fish, the initial hope that photonic tagging could be used as an instant recognition, non-lethal technique of marking and recognizing study fish is probably not going to happen. It does appear that the photonic marking technique may have some valid fisheries application for marking fish. Early in this study, neither the photonic marking, nor the use of a combination ARV clip, on chinook fingerlings, was overly detrimental to the subsequent recovery of age 1+ chinook at SCW. Both, photonic and ARV study groups were recovered at rates higher than the standard CWT control group.

In the spring of 2000 an estimated 198,000 chinook fingerlings were released from the SCW. Low flow conditions in Strawberry Creek and low Lake Michigan water level prompted the modification of rearing techniques and for the first time since chinook fingerlings have been raised and released from SCW, two separate batches of fingerlings were raised. Both batches of chinook fingerlings were harvested by net and trucked to the Sturgeon Bay Ship Canal.

A total of 2,774 chinook were captured at Besadny Anadromous Fisheries Facility (BAFF) in the fall of 2000. This is below average since record keeping began in 1990 and low Keweenaw River flow connected with low Lake Michigan level no doubt played a role. Of the 2,774 chinook

captured, 1,733 (62 percent) were released live upriver with as little handling as possible for the sport fishery. The entire quota of chinook salmon eggs required for hatchery production was collected from SCW in the fall of 2000 and as a result no eggs were harvested at BAFF. Limited biological information is collected from the non-CWT chinook returning to BAFF, as they are believed to have similar biological characteristics to SCW chinook.

A total of 741 adipose clipped chinook were harvested at BAFF. Of these, 625 were from Kewaunee River releases, 43 were strays from SCW, and five were strays from the MDNR Swan Creek stocking on Lake Huron.

In the CWT chinook salmon stocking technique study, on the Kewaunee River, fish from all four of the 1998 and 1999 study lots were recovered at the BAFF in the fall of 2000. Rate of return (number captured/number stocked) for the 1998 and 1999 year classes, now age 2+ and 1+ respectively, was highest for the lots stocked at nine miles and four miles upstream from Lake Michigan.

During the fall of 2000, a total of 1,654 coho *Oncorhynchus kisutch* were captured at BAFF. The coho return was 20 percent below the eleven year average (1990-2000). Approximately 46 percent of the coho captured during the fall of 2000 were utilized for spawning or sacrificed for health testing purposes. Live coho released upriver for the sport fishery, made up 40 percent of the run, and dead coho collected during the season (13 percent), made up the remainder of the run. Mean length and weight for coho were down from the recent record levels of 1999, but were above average for coho captured at BAFF in recent years

Although chinook less than 800 mm and all coho were cleared for sale for human consumption and a request for bids was announced, no bids were received. On most harvest days, all chinook harvested at SCW and BAFF that were less than 800 mm and all coho were iced and shipped to Paul's Pantry in Green Bay. All of the salmon carcasses harvested from SCW and BAFF in the fall of 2000 that were greater than 800 mm, or not suitable for human consumption, usually had to be disposed of at a landfill. In recent years salmon carcasses 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.

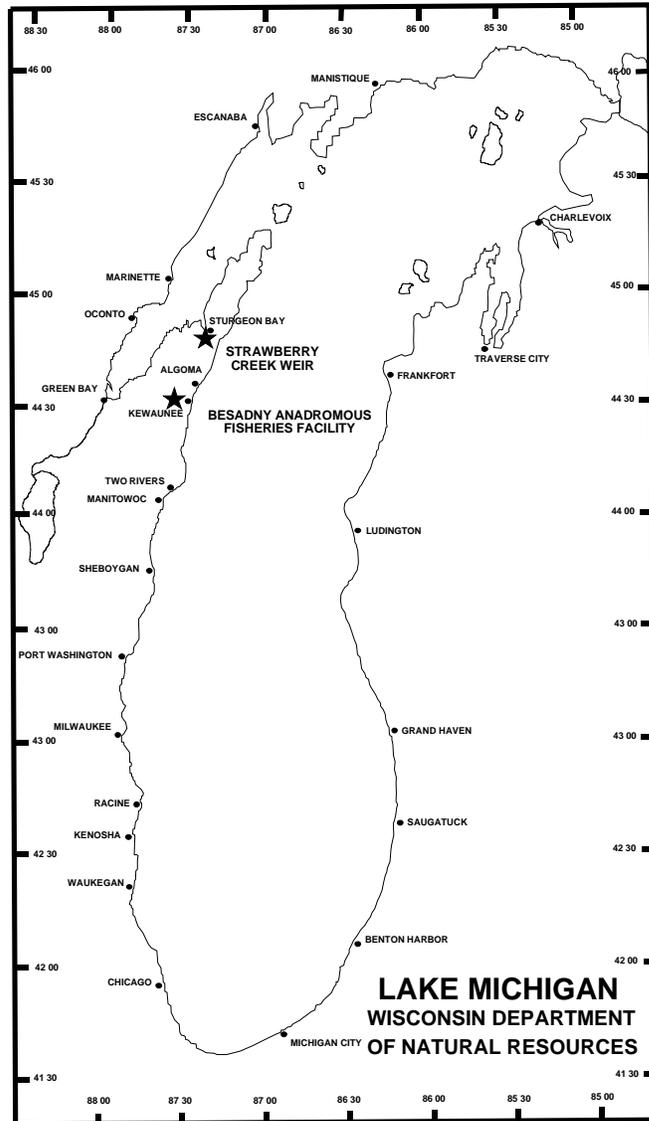


Figure 1.-Location of the Wisconsin Department of Natural Resources Strawberry Creek Weir, Door County, and the Besadny Anadromous Fisheries Facility, Kewaunee County.

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 the last several 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.

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.

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: latent impact of thiamine study; 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 (10 fingerlings at a time) 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 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 2000 were used to develop a length at age key for aging non-CWT chinook returning in 2000.

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 95th 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 Paul's Pantry in Green Bay. All of the salmon carcasses harvested from SCW and BAFF that were greater than 800 mm, or unsuitable for human consumption, usually had to be disposed of at a landfill. In recent years salmon carcasses 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 2000 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. Early in September before the pipeline was operational approximately 1.5 inches of rain temporarily increased Strawberry Creek flow and several hundred chinook made their way up Strawberry Creek and into the pond. Subsequently, Strawberry Creek flow dropped and no additional fish were entering the SCW. On September 27th the pump was turned on and by September 29th almost 600 fish had entered the SCW and egg harvesting began (Table 1). 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. Egg harvest increased from 0.6 million in the fall of 1999 to 3.7 million in 2000 (Table 1). Fall 2000 was the third highest live fish harvest since the 1980's when detailed harvest records for Strawberry Creek were first kept (Appendix A). The sex ratio of the fall 2000 live fish harvest was approximately 70 percent male and 30 percent female.

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 2000.

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 6	25	33	13	71	26	802	-	-
SEPT 15	270	141	1	412	157	4,656	-	-
SEPT 29	393	171	20	584	200	6,599	602,560	Westfield
OCT 2	600	220	7	827	306	9,345	705,760	Wild Rose
OCT 3	547	211	3	761	254	8,599	706,260	West & W R
OCT 6	582	308	-	890	326	10,057	-	
OCT 9	229	83	6	318	105	3,593	348,920	Wild Rose
OCT 11	260	85	5	350	135	3,955	372,835	Wild Rose
OCT 17	837	402	4	1,243	386	14,046	660,436	Wild Rose
OCT 19	512	183	10	705	202	7,967	-	
OCT 26	321	90	54	465	102	5,255	276,000	Wild Rose
SEPT-NOV	-	-	23	23	-	260	-	
TOTALS	4,576	1,927	146	6,649	2,199	75,134	3,672,771	

¹Weights estimated using the average weight per fish for the entire harvest (2000 average weight was 11.3 pounds).

²Number of chinook salmon eggs harvested by WDNR for hatchery production.

³Dead chinook from pond or in creek near the pond/road. These fish were picked up and disposed of.

The estimated age composition of the entire chinook harvest at SCW consisted of 43 percent age 1+, 26 percent age 2+, 29 percent age 3+, and two percent age 4+ salmon (Table 2). An age at length key developed from known aged CWT chinook captured at SCW in the fall of 2000 was used to divide the length frequency distribution of all chinook measured at SCW in the fall of 2000 (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 1985-2000, based on a length at age 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

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.

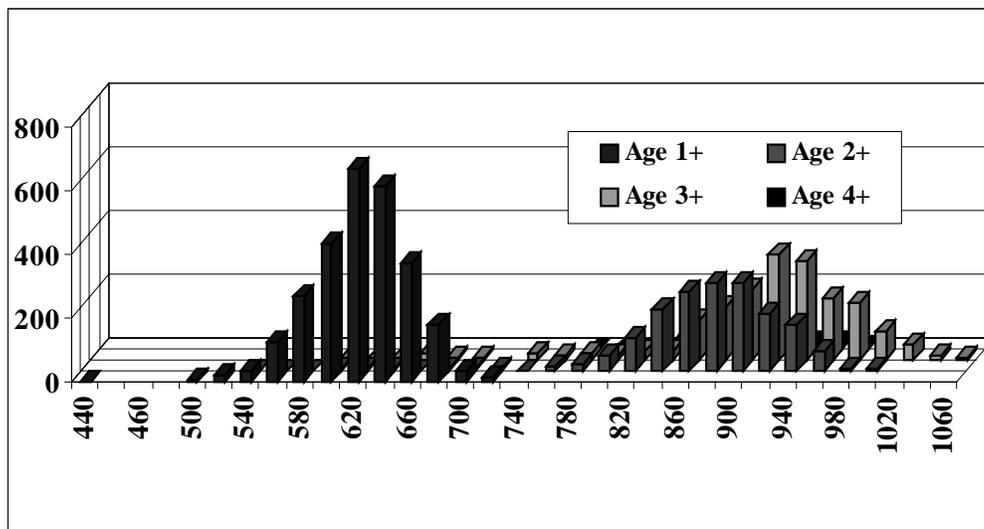


Figure 2.-Length frequency distribution of all chinook salmon measured at SCW in the fall of 2000. Fish were divided into ages with the use of an age at length key developed from known aged CWT chinook salmon captured at SCW in the fall of 2000.

TRENDS IN SIZE AND CONDITION OF CHINOOK SALMON, 1974 - 2000

The average and trophy weights of chinook salmon returning to SCW in the fall of 2000 were up from the weights observed in the previous year (Appendix B; Figure 3). The increase in average weight and trophy weight was to be expected as weights from the fall of 1999 were heavily influenced by the extreme conditions that occurred at Strawberry Creek during the fall of 1999. During 1999, most of the older, larger chinook were unable to reach the SCW and their absence from the harvest skewed the samples to younger, smaller fish. During the fall of 2000, with Strawberry Creek flow augmented by the pipeline, trophy and average weight both recovered slightly. Standard weight was unchanged from 1999 and is within 0.1 pound of the lowest standard weight documented since this characteristic was first described for the SCW chinook in 1974. Average, trophy, and standard weights have all generally declined since the early 1990s. And excluding the extreme data points from 1999, observations from 2000 would seem to continue that trend.

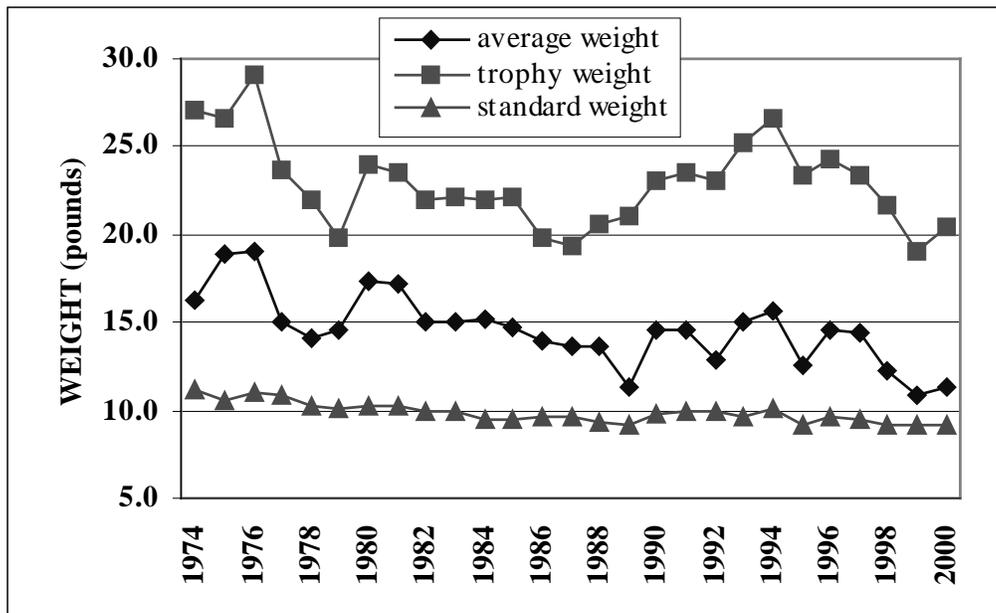


Figure 3.-Average, trophy, and standard weight for chinook salmon harvested at Strawberry Creek, Door County, 1974-2000.

CWT CHINOOK SALMON IN THE HARVEST

A total of 2,199 adipose clipped chinook were recovered at SCW during the fall of 2000 (Table 1). Improved flow (augmented by the pipeline) and increased percentage of fingerlings marked with CWTs for multiple studies no doubt affected the number of adipose clipped fish returning to SCW. A total of 2,028 CWTs were successfully extracted from the adipose clipped fish (Table 3). Additionally, 33 (1.6%) tags were lost during extraction, and 138 (6.3%) of the adipose clipped chinook did not have a CWT. An unknown portion of the 138 “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 been an adipose fin clip. All but two of the recovered CWTs were from chinook released from SCW. One CWT chinook was a stray from a Kewaunee River stocking and one CWT chinook was a stray from Swan Creek, a Lake Huron tributary stocked by Michigan Department of Natural Resources (MDNR).

Table 3.-Summary of 2,199 adipose clipped chinook salmon harvested at the Strawberry Creek, fall 2000. In addition to the 2,028 CWTs listed below, 33 tags were lost during extraction and 138 of the adipose clipped chinook had no tag detected. 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
1999	Strawberry Creek, WI ⁶	1+	WIS DNR	259
	Strawberry Creek, WI ⁷		WIS DNR	228
	Strawberry Creek, WI ⁸		WIS DNR	298
	Kewaunee River (Harbor) ⁹		WIS DNR	1
	Swan Creek, Lake Huron		MICH DNR	2
1998	Strawberry Creek, WI ⁴	2+	WIS DNR	198
	Strawberry Creek, WI ⁵		WIS DNR	185
	Strawberry Creek, WI ³		WIS DNR	181
1997	Strawberry Creek, WI ³	3+	WIS DNR	394
	Strawberry Creek, WI ⁴		WIS DNR	229
1996	Strawberry Creek, WI ¹	4+	WIS DNR	31
	Strawberry Creek, WI ²		WIS DNR	22

¹ Fingerlings from eggs which were treated with thiamine (thiamine study conducted at Strawberry Creek).

² Fingerlings from eggs which were not treated with thiamine (thiamine study conducted at Strawberry Creek).

³ Fingerlings from known age 3+ males and females (age at maturity study conducted at Strawberry Creek).

⁴ Regular production CWT fingerlings (controls) stocked at Strawberry Creek.

⁵ Fingerlings from known age 3+ males and age 2+ females (age at maturity study stocked at Strawberry Creek).

⁶ Marking technique study chinook fingerlings stocked at Strawberry Creek A-CWT and RV clip.

⁷ Marking technique study chinook fingerlings stocked at Strawberry Creek A-CWT (controls).

⁸ Marking technique study chinook fingerlings stocked at Strawberry Creek A-CWT photonic mark.

⁹ Stocking technique study chinook fingerlings stocked in the Harbor near the mouth of the Kewaunee River.

AGE COMPOSITION AND SEX RATIO OF SCW CWT CHINOOK SALMON

Four age classes of CWT chinook were recovered at SCW in 2000 (Appendix C, Figure 4). Age 1+ returns (all precocious males) accounted for 39 percent of the CWT harvest. Age 2+ chinook, accounted for 28 percent of the harvest (57 % male, 43 % female). The age 3+ CWT chinook made up 31 percent of the return (40% male, 60 % female). Age 4+ salmon accounted for two percent of the total CWT harvest (25% male, 75% female).

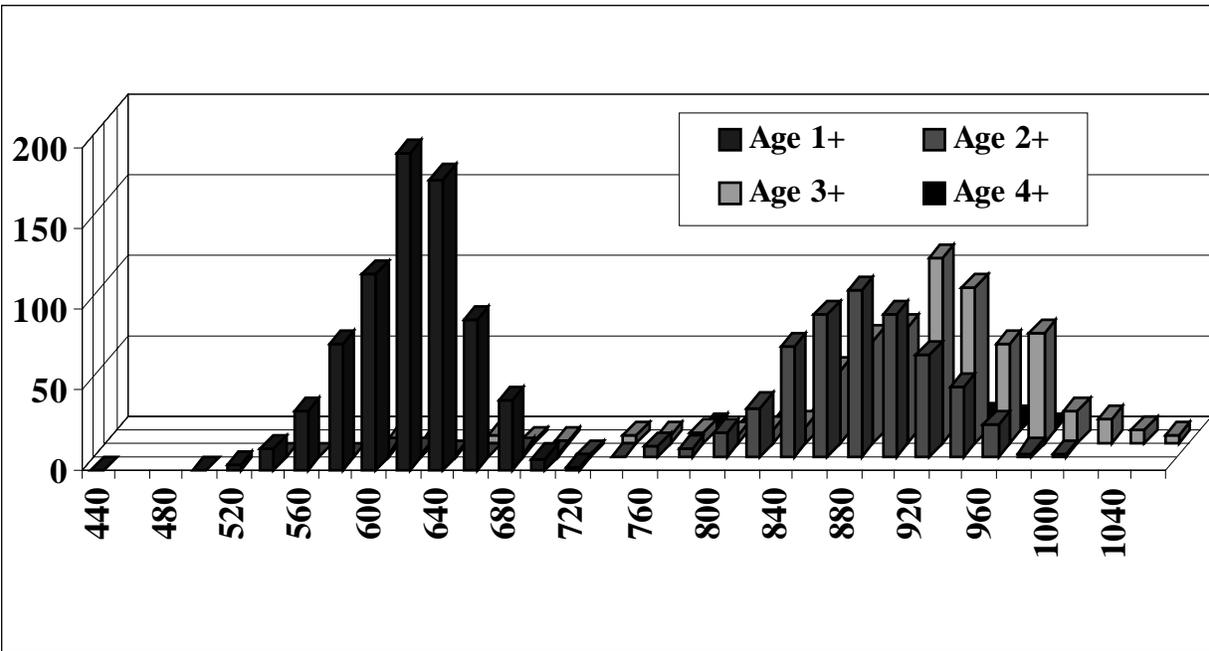


Figure 4.-Length frequency of coded wire tagged, chinook salmon (sexes combined) captured at the Strawberry Creek Weir in the fall of 2000.

SIZE AT AGE OF CWT SALMON

Size at known age (length and weight) of CWT chinook salmon at SCW from 1983 through 2000 is illustrated in Figures 5, 6, 7, and 8, and listed in Appendix D and E. At 631 mm and 2.4 kg, fall 2000 age 1+ chinook (all males) were down from the fall of 1999 but remain above the 18-year average of 607 mm and 2.3 kg. There was negligible difference in size between the photonic marked, ventral fin clipped, and standard production age 1+ study groups (Appendix D and E). In the fall of 1999 age 1+ males were the largest since these statistics have been kept and this cohort (1998 year class) now age 2+ in the fall of 2000, followed that trend. The average size of age 2+ CWT males was 893 mm and 6.6 kg, well above the 17-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 2000 were also above the 17-year average. At 865 mm and 6.8 kg they were the largest by length but 0.3 kg smaller than the heaviest age 2+ females (observed in 1993). There was negligible difference between the standard production fish and the single paired family (SPF) study groups. Age 3+ males (1997 cohort) at 942 mm and 7.6 kg and age 3+ females at 916 mm and 7.9 kg were slightly below the 16-year average established for this age group. At age 3+ there was negligible size difference between the standard production CWT chinook and the SPF study groups.

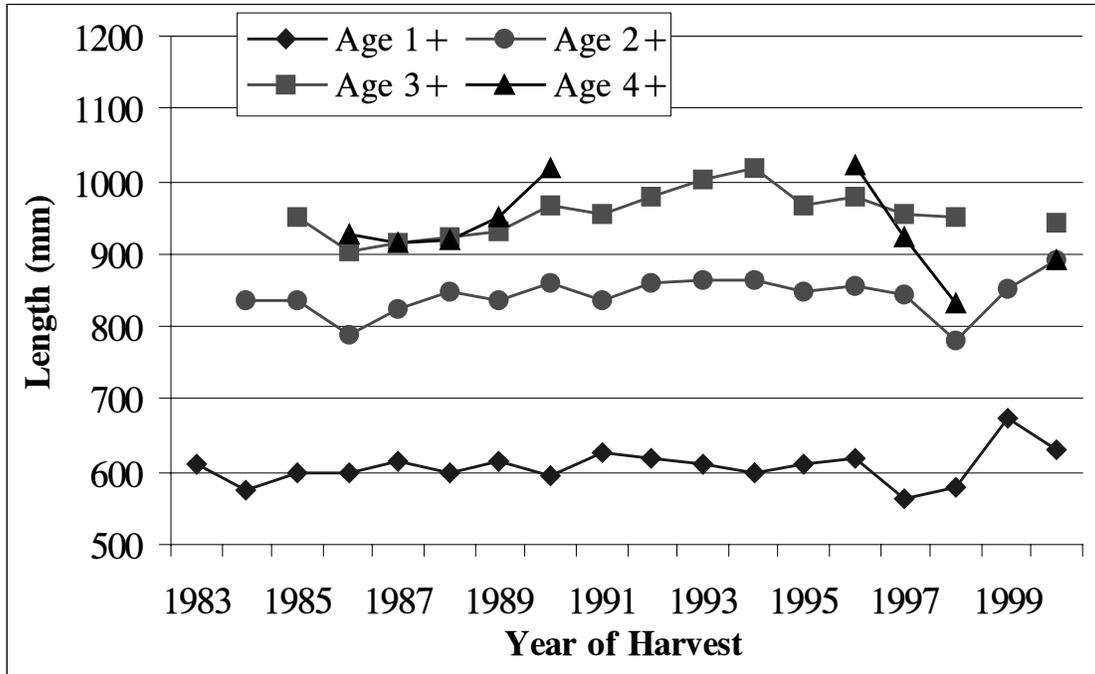


Figure 5.-Mean length of coded wire tagged, male chinook salmon by known age class and year of return to Strawberry Creek Weir, Door County, Wisconsin, 1983-2000.

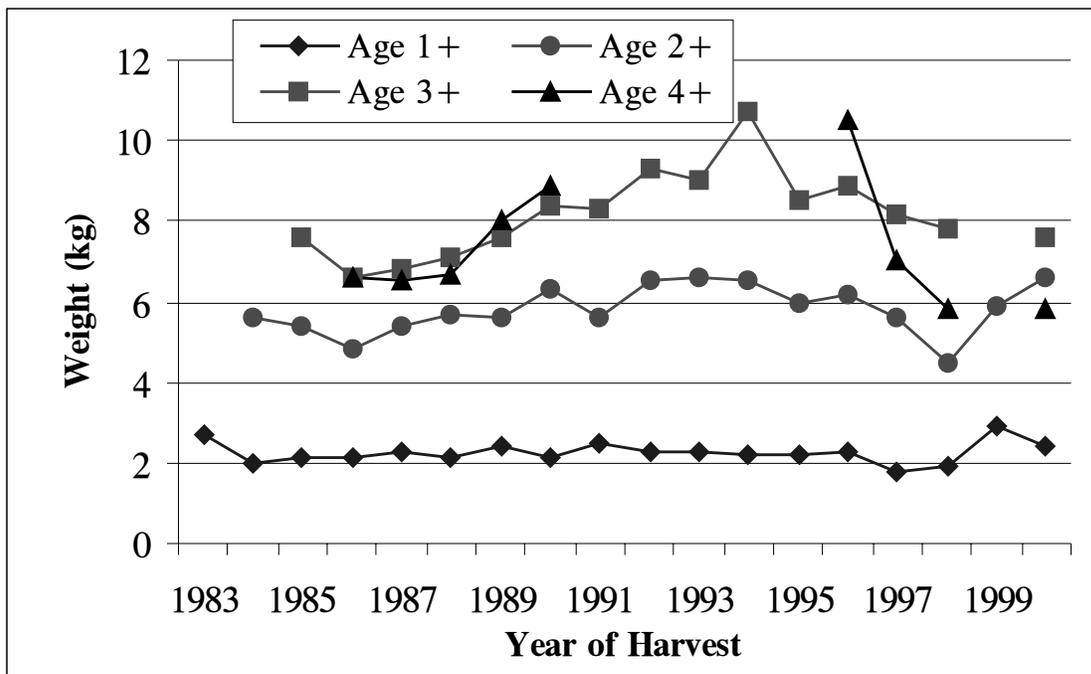


Figure 6.-Mean weight of coded wire tagged, male chinook salmon by known age class and year of return to Strawberry Creek Weir, Door County, Wisconsin, 1983-2000.

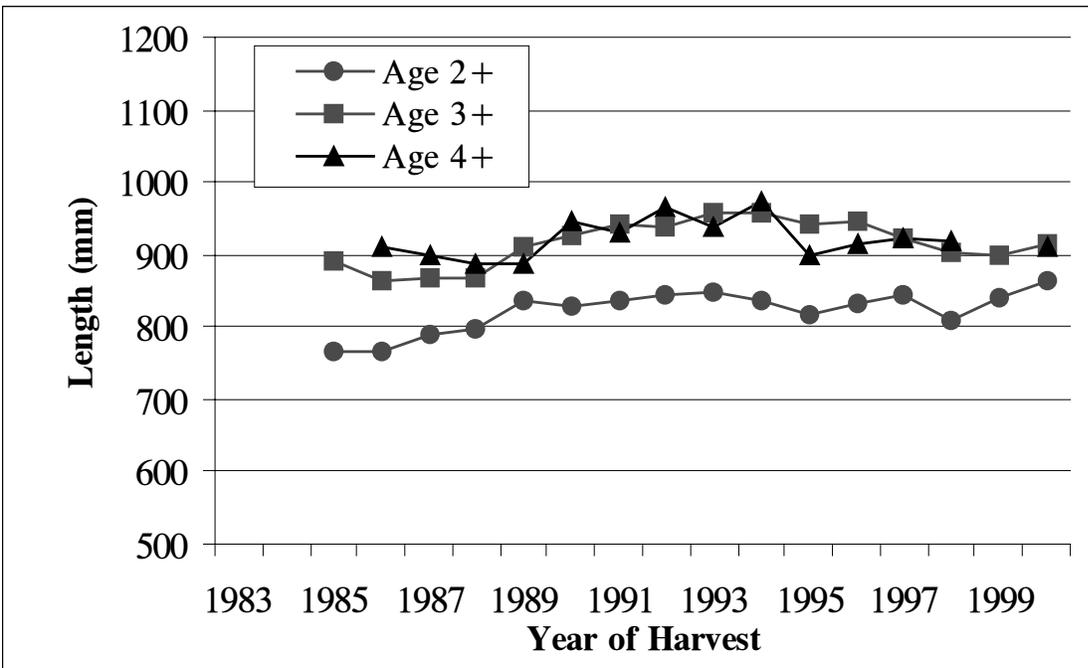


Figure 7.-Mean length of coded wire tagged, female chinook salmon by known age class and year of return to Strawberry Creek Weir, Door County, Wisconsin, 1983-2000.

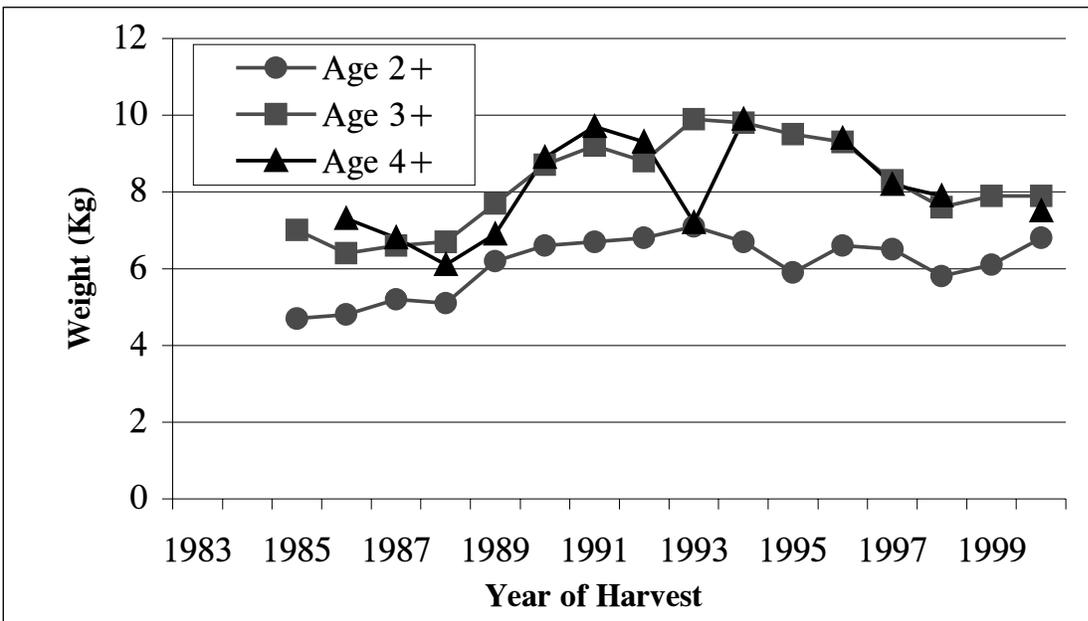


Figure 8.-Mean weight of coded wire tagged, female chinook salmon by known age class and year of return to Strawberry Creek Weir, Door County, Wisconsin, 1983-2000.

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. 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+ (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 BKD outbreak of 1988 and 1989.

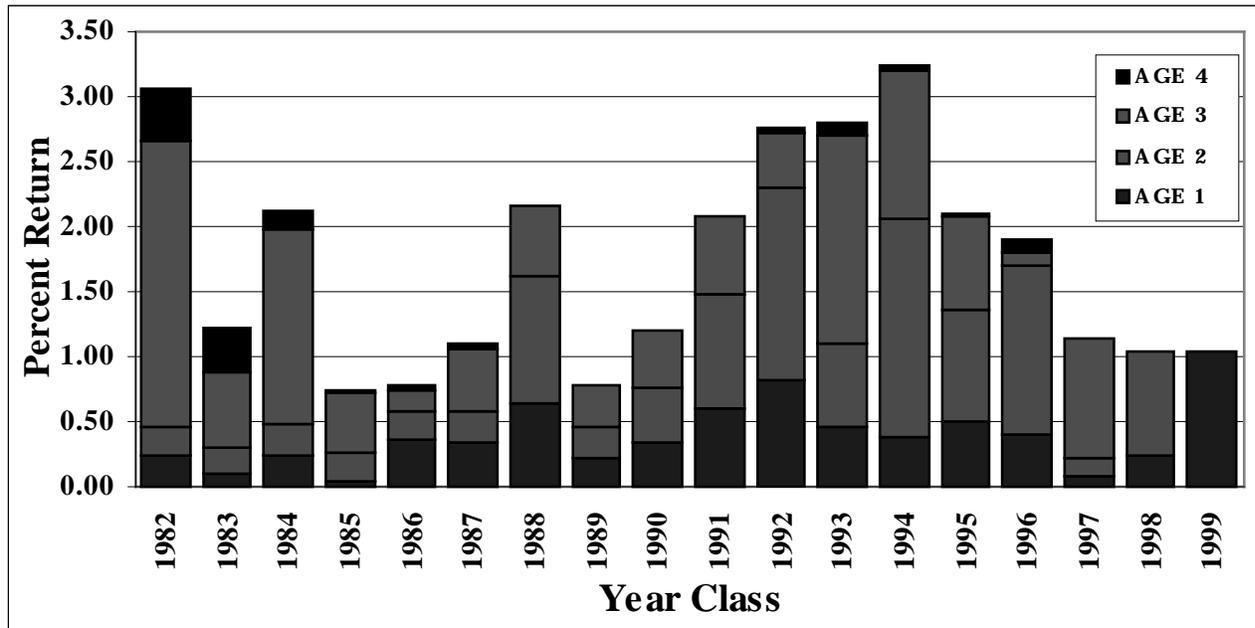


Figure 9.-Cumulative rate of return for the 1982-1999 year classes of coded wire tagged (CWT) chinook salmon stocked at Strawberry Creek, Door County, Wisconsin, by year class, age 1+ through age 4+. For the year classes 1995 through 1999 there were multiple lots of CWT chinook stocked but the return 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

THIAMINE STUDY

Wisconsin and other Great Lakes States have been experiencing problems with a condition known as Early Mortality Syndrome (EMS), especially during the past decade. Researchers believe EMS may be related to the level of thiamine available to developing salmonid eggs. Thiamine treatments during salmon egg water hardening have been shown to reduce EMS in the early life stages, at least until the fish are stocked. A WDNR study was designed to evaluate the possible latent impact of thiamine egg treatment on chinook salmon, post stocking. As part of this chinook study an estimated 25,500 CWT (lot 31/17/11) thiamine treated fingerlings and 22,500 CWT (lot 31/17/12) non-treated fingerlings from the 1995 year class were stocked at SCW in the spring of 1995 (Appendix H). Additionally, an estimated 24,500 CWT (lot 31/17/16) thiamine treated fingerlings and 26,000 CWT (lot 31/17/15) non-treated fingerlings from the 1996 year class were stocked in the spring of 1996 (Appendix H).

The 1995 year class was recovered at SCW as age 1+ in the fall of 1996, as age 2+ in the fall of 1997, as age 3+ in the fall of 1998, as age 4+ in the fall of 1999, and at age 5+ in the fall of 2000. The 1996 year class was recovered at SCW as age 1+ in the fall of 1997, as age 2+ in the fall of 1998, as age 3+ in the fall of 1999, and at age 4+ in the fall of 2000.

Through the fall of 2000 with returns from the 1995 year class as age 1+, 2+, 3+, 4+, and 5+ there appears to be very little difference in the recovery rates of chinook that were treated with thiamine versus chinook that were not treated (Table 4, Figure 10). Cumulative return rates for the 1995 year class through age 5+ were 2.12 percent for thiamine treated chinook versus 2.00 percent for chinook not treated with thiamine. Similarly, there is very little difference between returns of treated and non-treated chinook from the 1996 year class through the fall of 2000, as age 1+, 2+, 3+, and 4+. Treated chinook from the 1996 year class returned at a cumulative rate of 1.89 percent and non-treated chinook returned at a cumulative rate of 1.88 percent.

Table 4.-Thiamine study return rate of CWT chinook salmon at age and by year class to the Strawberry Creek Weir, Door County, for year classes 1995 through 1996. In fall 1999, return of the 1995 year class at age 4+ and 1996 year class at age 3+, (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+	
1995	Not treated with Thiamine	0.40	0.84	0.76	0.00	0.00	2.00
	Treated with Thiamine	0.58	0.85	0.68	0.01	0.00	2.12
1996	Not treated with Thiamine	0.38	1.30	0.12	0.08		1.88
	Treated with Thiamine	0.43	1.27	0.06	0.13		1.89

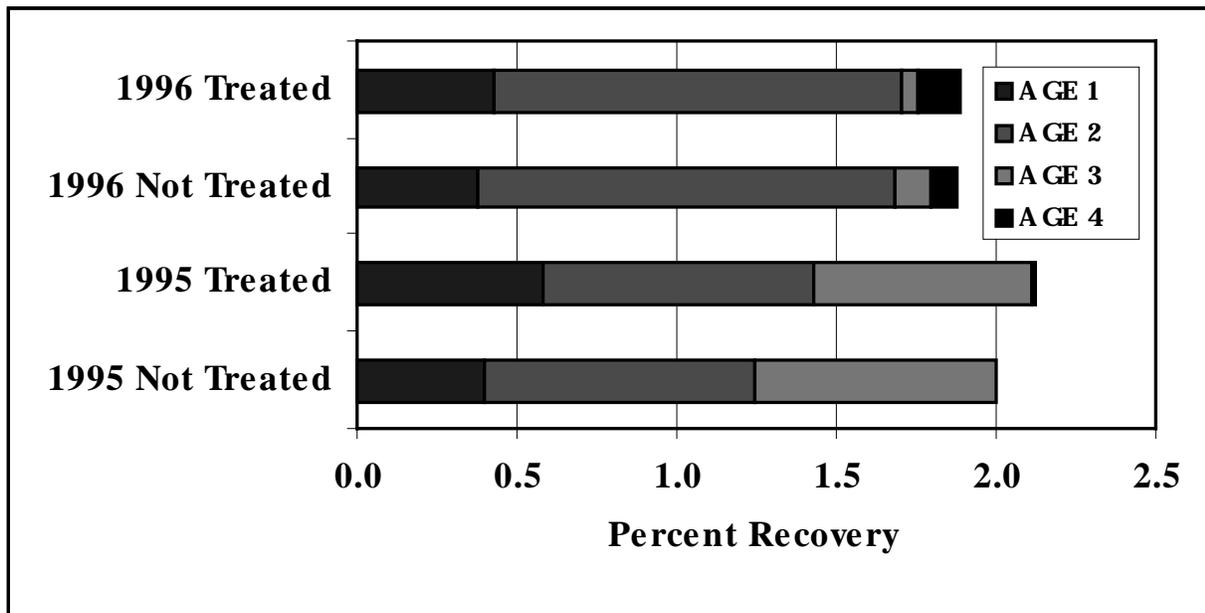


Figure 10.-Percent recovery of chinook salmon at age, at Strawberry Creek Weir, from the thiamine study CWT treatment lots, from the 1995 and 1996 year classes. “Treated” study groups were from fertilized eggs which had been water hardened in thiamine enriched water. “Not Treated” groups were from fertilized eggs which had been water hardened in water not enriched with thiamine.

As discussed above, the treatment of salmonid eggs with thiamine during the water hardening stage has been documented to improve survival of young salmonids through hatching and yolk sac absorption (Hornung et al. 1995) resulting in improved survival to stocking. This study was designed to evaluate if there was any possible latent impact of the thiamine treatment post stocking. In this study if the thiamine treated chinook were recovered at a higher or even similar rate to the non-treated chinook, thiamine treatment would be considered positive because it had

already contributed to a higher percentage of chinook surviving to stocking. No additional substantive returns are expected. Chinook treated with thiamine returned to SCW at slightly higher rates as chinook that had not been treated with thiamine. Although non-treated chinook were generally slightly larger (length and weight) at age than treated chinook, the size difference was negligible (Appendix D and E). A companion study to this was conducted with coho salmon on the Kewaunee River, and because of the shorter life cycle of coho this study has already been completed with a similar conclusion (Peeters and Royseck 1998).

AGE AT MATURITY STUDY

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 few years at SCW, we may have genetically altered the run of fish to favor an earlier maturation schedule of chinook returning to SCW.

To evaluate the effect of age of the parent on the age of sexual maturity of their offspring, a separate single paired family (SPF) CWT study 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 eggs 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 CWTs. A third lot of standard production fingerlings from unaged parental stock was also marked with CWTs 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.

In the fall of 1998, rate of return for both the standard production CWT fingerlings and the SPF (age 3+ parents) CWT fingerlings, from the 1997 year class, was low when compared to recent years (Table 5, Figure 11). At age 1+ (all precocious males) chinook that were the product of standard production techniques returned to SCW at a rate of 0.14 percent and chinook that were the progeny of known age 3+ parents returned at a rate of 0.06 percent.

Table 5.-Age of maturity study 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 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			1.07
	Standard production	0.14	0.20	0.88			1.22
1998	Age 3+ males, 3+ females	0.31	0.80				1.11
	Standard production	0.25	0.78				1.03
	Age 3+ males, 2+ females	0.19	0.82				1.01

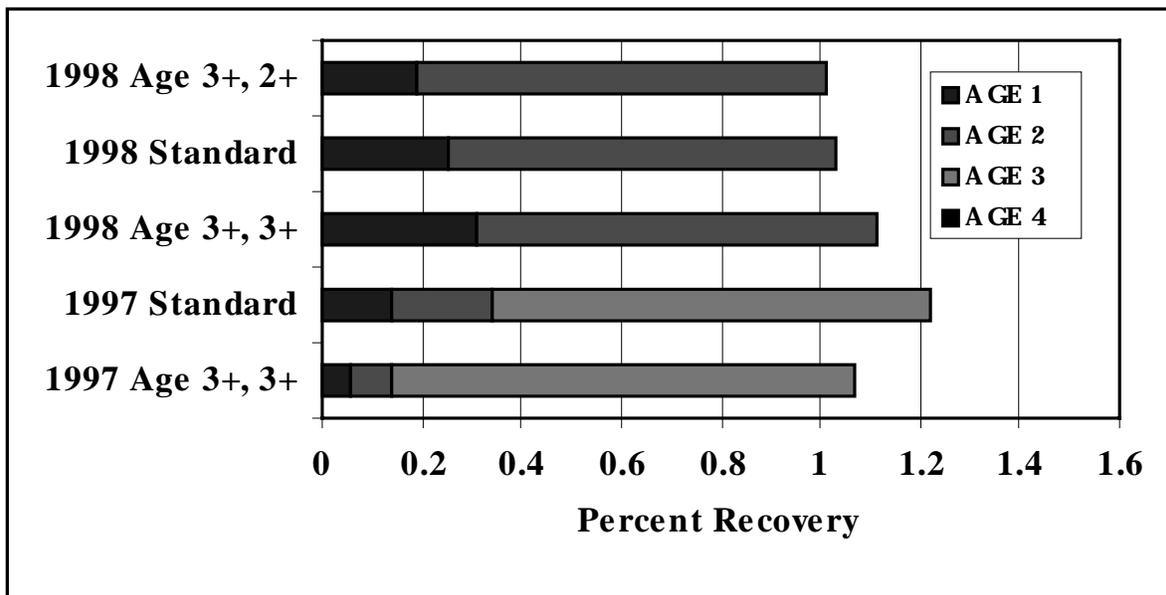


Figure 11.-Percent recovery of chinook salmon at age, at Strawberry Creek Weir, from the age at maturity study CWT treatment lots, from the 1997 and 1998 year classes. Standard lots were made up of fingerlings randomly selected from all spawning dates. Age 3+, 3+ lots were fingerlings from known age 3+ male and female parents and the Age 3+, 2+ lot were fingerlings from known age 3+ male and age 2+ female parents.

In the fall of 1999 two CWT lots from the 1997 year class returned at age 2+ and three CWT lots from the 1998 year class returned at age 1+ (all precocious males). In 1999, the low stream flow and low lake level dramatically influenced the return of chinook to SCW. However, there is no reason to believe that any of the treatment groups within a year class were better suited to deal with these harsh conditions. The 1997 year class (SPF and standard production) returned at a much lower rate than anticipated (Table 5, Figure 11). Whereas in recent years (1993-1998) age 2+ CWT fish have been returning at a rate ranging from 0.6 to 1.3, in 1999, age 2+ CWT fish were recovered at a rate ranging from 0.08 (SPF from age 3+ parents) to 0.20 (standard production). At age 2+ standard production fish from the 1997 year class returned at a higher rate than the SPF fish from age 3+ parents. The 1998 year class of CWT fish returned at a relatively normal rate in the fall of 1999. Apparently the younger, smaller chinook were able to better negotiate the low flow, low water level than the older larger fish. The 1998 year class SPF chinook from age 3+ parents returned at a higher rate (0.31) than the Standard production fish (0.25), and the SPF fish from age 3+ males and age 2+ females (0.19).

In the fall of 2000 the 1997 year class was recovered at age 3+ at SCW and the 1998 year class was recovered at age 2+. After having been recovered at lower rates at age 1+ and age 2+, the 1997 year class SPF fish from age 3+ parents were recovered at a higher rate (0.93 percent) than the age 3+ fish from standard production parents (0.88 percent). The poor return conditions in the fall of 1999 have unavoidably confounded the age at maturity study. However, it would appear that with regard to the experimental lots from the 1997 year class, the progeny of the age 3+ parental stock may be exhibiting a slightly later maturity schedule than the standard production fish. With the 1998 year class, it is too early to determine if a later maturity schedule will be exhibited.

CHINOOK SALMON MARKING TECHNIQUE STUDY

The WDNR began using the 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. Another drawback to the CWT technique is the lethal technique required to retrieve the CWT for decoding. Another drawback to CWTs is 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. 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). 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 photonicly 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. 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 12). 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 lot of CWT chinook fingerlings destined for photonic tagging was marked and stocked out as a CWT only (no adipose fin clip) as a last minute modification to the study.



Figure 12.-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).

In the fall of 2000 the 1999 year class was recovered at SCW at the age of 1+ (Table 6, Figure 13). 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.

Table 6.-Marking technique study 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.

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					0.92
	ARV-CWT	1.04					1.04
	A-CWT + Photonic	1.20					1.20
2000	A-CWT (std production)						
	ALV-CWT						
	CWT without A clip						

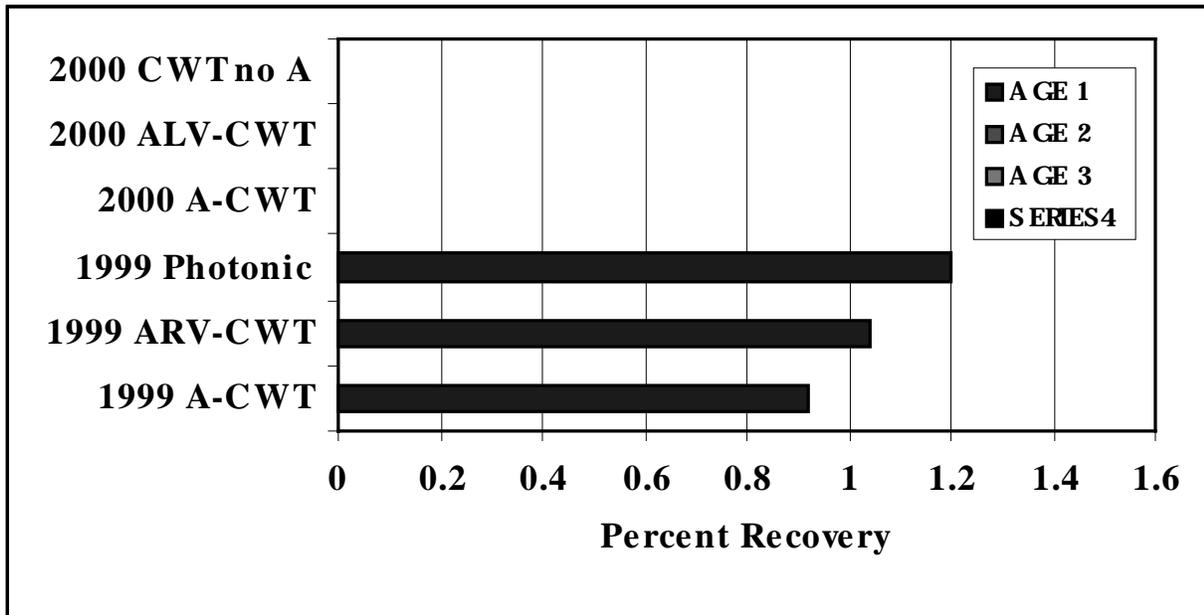


Figure 13.-Percent recovery of chinook salmon at age, at Strawberry Creek Weir, from the marking technique study CWT treatment lots, from the 1999 and 2000 year classes.

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.

Interpretation of the presence or absence of a photonic mark was not an absolute technique. 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 study group that had been marked with one of the three photonic colored tags, 213 (72 percent) 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 percent) of visible marks and green accounted for 40 (19 percent) of the visible marks. 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 percent) no tag/lost tag group were interpreted to have a photonic mark. Four (2 percent) 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.

With the techniques used, looking for the photonic marks, was quite labor intensive. 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. After only one year of chinook recovery at SCW the chinook salmon marking technique study is not ready for final interpretation. However, it is obvious from the recovery of age 1+ fish, that the initial hope that photonic tagging could be used as an instant recognition, non-lethal technique of marking and recognizing study fish is probably not going to happen. It does appear that the photonic marking technique may have some valid fisheries application for marking fish, and study fish will continue to be checked in subsequent years for mark retention. At this time it would appear that neither the photonic marking of chinook fingerlings, or the use of a combination ARV clip was overly detrimental to the subsequent recovery of age 1+ chinook at SCW.

REARING OF CHINOOK FINGERLINGS

In the spring of 2000 an estimated 198,000 chinook fingerlings were released from the SCW (Appendix H). Low flow conditions in Strawberry Creek and low Lake Michigan water level prompted the modification of rearing techniques in the spring of 2000 at SCW. For the first time since chinook fingerlings have been raised and released from SCW, there was concern that low flow conditions in Strawberry Creek would not adequately support approximately 200,000 fingerlings. Therefore, two separate batches of fingerlings were raised. The first batch of standard production chinook fingerlings, stocked in the SCW pond on April 6th and May 2nd. The first batch was subsequently harvested by net and trucked to the Sturgeon Bay Ship Canal on May 9th. At the time of stocking they (approximately 119,000 fingerlings) averaged 86.7mm and 4.8g. The SCW pond was refilled and a second batch of fingerlings was stocked into the pond on May 10th. This second batch of chinook fingerlings was all CWT fingerlings. They were reared in SCW pond until June 5th when they were also harvested by net and trucked to the Sturgeon Bay Ship Canal. An estimated 26,000 A-CWT (31/17/35), 26,000 ALV-CWT (31/17/28), and 27,000 CWT (31/17/36) with no clip on were successfully released at which time they averaged 107.1mm and 9.8g.

BESADNY ANADROMOUS FISHERIES FACILITY

CHINOOK

GENERAL HARVEST

A total of 2,774 chinook salmon were captured at BAFF in the fall of 2000 (Table 7). This is below the average number chinook captured at BAFF since record keeping began in 1990 (Table 8) and low Kewaunee River flow connected with low Lake Michigan level no doubt played a role. Of the 2,774 chinook captured, 1,733 (62 percent) were released live upriver. The entire quota of chinook salmon eggs required for hatchery production was collected from SCW in the fall of 2000 and as a result no eggs were harvested at BAFF. Adipose clipped salmon (CWT) were harvested and sacrificed. An additional 321 dead chinook were removed from BAFF during the 2000 fall run. 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 7.-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 2000.

DATE	FISH HARVESTED		NUMBER DEAD FISH	FISH PASSED UPSTREAM	TOTAL NUMBER FISH	NUMBER ADIPOSE CLIPPED	EGGS HARVESTED
	MALE	FEMALE					
SEPT 19	7	-	-	1	8	7	
SEPT 26	55	1	-	81	137	56	
OCT 4	180	23	21	340	564	203	
OCT 9	86	14	3	234	337	100	
OCT 16	146	24	-	520	690	170	
OCT 18	58	3	-	103	164	61	
OCT 25	64	9	8	278	359	73	
NOV 1	35	3	33	101	172	38	
NOV 7	9	-	11	55	75	9	
NOV 14	3	-	7	20	30	3	
SEPT/NOV	-	-	238	-	238	21	
TOTALS	643	77	321	1,733	2,774	741	

A total of 741 adipose clipped chinook were harvested at BAFF in 2000 (Appendix I). Of these, 625 (age 1+ precocious males, and age 2+ males and females) were from Kewaunee River releases, 43 were strays from SCW, and five were strays from the Michigan Department of Natural Resources Swan Creek stocking on Lake Huron. Additionally, 11 CWTs were lost during extraction, 46 of the chinook with an apparent adipose fin clip did not have a CWT, and 11 of the salmon heads collected from dead fish at BAFF were too decomposed to work on. The 43 CWT strays from SCW was down from 179 in 1999 and was probably associated with the improved flow at SCW in 2000 due to the pipeline and increased flow at SCW.

Table 8.-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, 1990-2000.

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	-
AVERAGE	1,313	1,604	349	3,202	352	1,171,137

At BAFF as many of the chinook as possible, not sacrificed for CWT extraction, are passed live upstream with as little handling as possible for the sport fishery. Other than detailed information collected on all CWT chinook captured, limited biological information is collected from the non-CWT 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

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.

Meanwhile, 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 dolomieu* 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.

For two consecutive years (1998 and 1999), four lots of approximately 25,000 chinook salmon fingerlings raised at the WDNR Wild Rose Fish Hatchery 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 9). Fingerlings for this study were held at the Wild Rose Fish Hatchery 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 hatchery staff at Wild Rose ranged from 96.6 percent to 99.7 percent and averaged 98.5 percent.

Table 9.-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 10). 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 10.-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 11. Fingerlings for this study were held at the Wild Rose Fish Hatchery 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 hatchery staff at Wild Rose ranged from 96.8 percent to 100.0 percent and averaged 99.1 percent.

Table 11.- 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 12). 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 12.-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.

Of the 673 adipose clipped chinook collected at BAFF in the fall of 2000, from which a CWT was successfully extracted and decoded, 625 were part of the ongoing Kewaunee River study, and 48 were strays from other locations. Of the 625 Kewaunee River study fish, 400 were age 1+ (from the 1999 stocking) and 225 were age 2+ fish (from the 1998 stocking). Of the 48 strays collected at BAFF in the fall of 2000, 43 were from Strawberry Creek and 5 had been stocked by MDNR in Lake Huron.

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 2000 (Table 13). Rate of return (number captured/number stocked) for the 1998 year class in the fall of 2000, ranged from a low of 0.13 percent for the lot stocked in the Kewaunee Harbor to high of 0.31 percent for the lot stocked at Clyde's Hill Road. Rate of return for the 1999 year class in the fall of 2000, ranged from a low of 0.32 percent for the lot stocked in the Kewaunee Harbor to high of 0.53 percent for the lot stocked at Clyde's Hill Road and the lot stocked at BAFF.

Table 13.-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 2000. 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)			0.27
	BAFF	0.37 (94)	0.22 (57)			0.59
	CLYDE'S	0.41 (105)	0.31 (78)			0.72
	HWY 54	0.22 (57)	0.22 (56)			0.44
1999	HARBOR	0.32 (70)				0.32
	BAFF	0.53 (129)				0.53
	CLYDE'S	0.53 (129)				0.53
	HWY 54	0.30 (72)				0.30

In 2000, there was nearly no difference in length and weight at age between the four study groups within a year class (Appendix K and L). Individually, age 1+ chinook (1999 year class caught in fall 2000) from this study ranged from 492 to 707 mm and 1.0 to 3.6 kg (all males). As study groups the average length ranged from 588 to 609 mm and the average weight ranged from 2.0 to 2.3 kg. There was however, a substantial difference between the length and weight at age between the age 1+ fish collected in the fall of 1999 and the age 1+ fish collected in the fall of 2000. In the fall of 1999, age 1+ male chinook averaged 67 mm and 0.7 kg larger than age 1+ male chinook in the fall of 2000. In the fall of 2000, both males and females were caught at age 2+. Similar to the age 1+ fish, there was little difference between the average length and weight at age of the study groups.

COHO

GENERAL HARVEST

During the fall of 2000, a total of 1,654 coho were captured at BAFF (Table 14). The coho return to the BAFF over the last ten years has ranged from a low of 717 in 1994 to a high of 3,887 in 1990 (Table 15). The coho return in the fall of 2000 was 20 percent below the eleven year average (1990-2000). 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. 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 15 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 46 percent of the coho

captured during the fall of 2000 were utilized for spawning or sacrificed for health testing purposes. Live coho released upriver for the sport fishery, made up 40 percent of the run, and dead coho collected during the season (13 percent), made up the remainder of the run.

Table 14.-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 2000.

Harvest Date	Fish Harvested		Number Dead Fish	Fish Passed Upstream	Total Number Fish	Eggs Harvested	Destination Of Eggs
	Male	Female					
Nov 1	123	281	39	19	462	669,000	Kettle Moraine
Nov 7	95	166	1	111	373	352,000	Kettle Moraine
Nov 14	50	53	-	526	629	94,000	Kettle Moraine
Sept/Nov	-	-	165	25	190	-	
Totals	268	500	205	681	1,654	1,115,000	Kettle Moraine

Table 15.-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, 1990-2000.

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
AVERAGE	877	887	-	2,019	-	734,302

¹ Includes fish which were used for egg collection 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.

WDNR personnel collected approximately 1.115 million coho eggs at the BAFF over a two week period during fall 2000 (Table 14). Coho eggs collected at BAFF in the fall of 2000 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 2000. All CWT coho stocked in the Kewaunee River system in recent years have matured and cycled through the fishery, and CWT coho stocked in the Root River would first be seen in fall 2001 at age 1+.

Coho returning to BAFF in the fall of 2000 were age 1+ precocious males from the 1999 year class (stocked as fingerlings in the fall of 1999 or as yearlings in the spring of 2000), or age 2+ fish from the 1998 year class (stocked as fingerlings in the fall of 1998 or as yearlings in the spring of 1999) (Appendix M). Currently, there are no coho studies in the Kewaunee River system and as a result none of the coho from the 1998 or 1999 year classes were marked with an identifying mark. Only age 2+ coho harvested for spawning were weighed and measured. All other coho processed at BAFF in the fall of 2000 (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. Early in the spawning process most age 2+ coho (male and female) were utilized for spawning. However, as the spawning season progressed and hatchery staff filled the coho egg quota, age 2+ (male and female) as well as age 1+ precocious male coho were passed upstream. 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 1998 and 1999 year classes (Appendix N, Figure 14) 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 1998 and 1999 coho year classes were not identified with any type of marking, the cumulative recovery rate of coho is based on the cumulative numbers of fingerlings and yearlings stocked. Cumulative recovery rate for the 1998 year class was 1.060 percent (0.186 percent at age 1+ and 0.874 percent 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. With no identifying fin clips, there is no easy way to differentiate the recovered coho from the 1998 or 1999 year class as attributable to either fingerling or yearling stocked fish. The 1999 year class (all precocious males) was recovered at a rate of 0.055 percent in the fall of 2000.

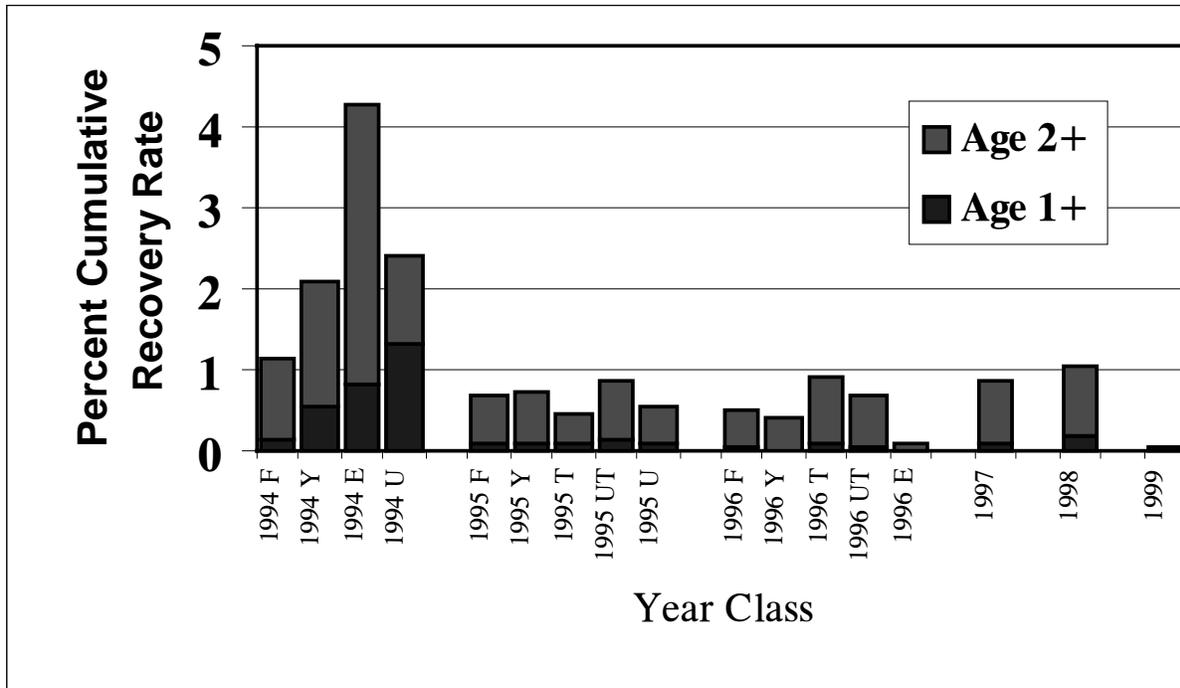


Figure 14.-Coho salmon cumulative recovery rate of return to the Besadny Anadromous Fisheries Facility, Kewaunee County. For year classes 1994, 1995, and 1996, letter designations F (fingerlings), Y (yearlings), E (erythromycin treated), T (thiamine treated), and UT (not treated with thiamine) designate 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, and 1999 lots were a combination of unmarked fingerlings and yearlings from the respective year classes and were aged by length frequency.

As previously stated, only coho processed for spawning at BAFF were weighed and measured in the fall of 2000. In the fall of 2000 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 12 and 13). Age 2+ males averaged 735.3 mm and 3.8 kg while age 2+ females averaged 707.0 mm and 3.7 kg.

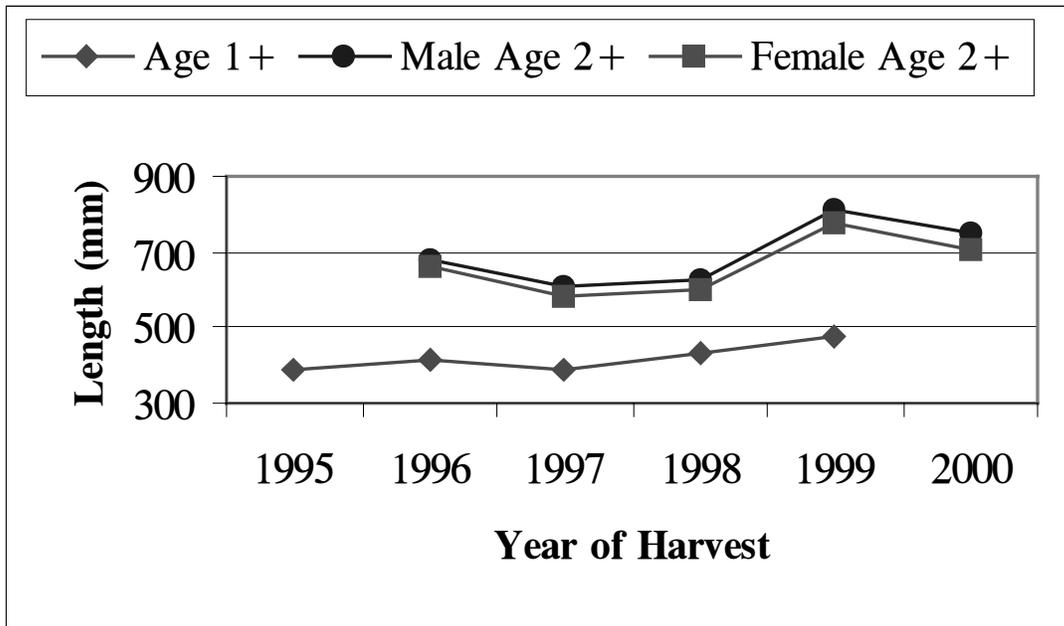


Figure 15.-Mean length of coho salmon by age class and year of return to the Besadny Anadromous Fisheries Facility, 1995-2000. No age 1+ coho were measured at BAFF in the fall of 2000.

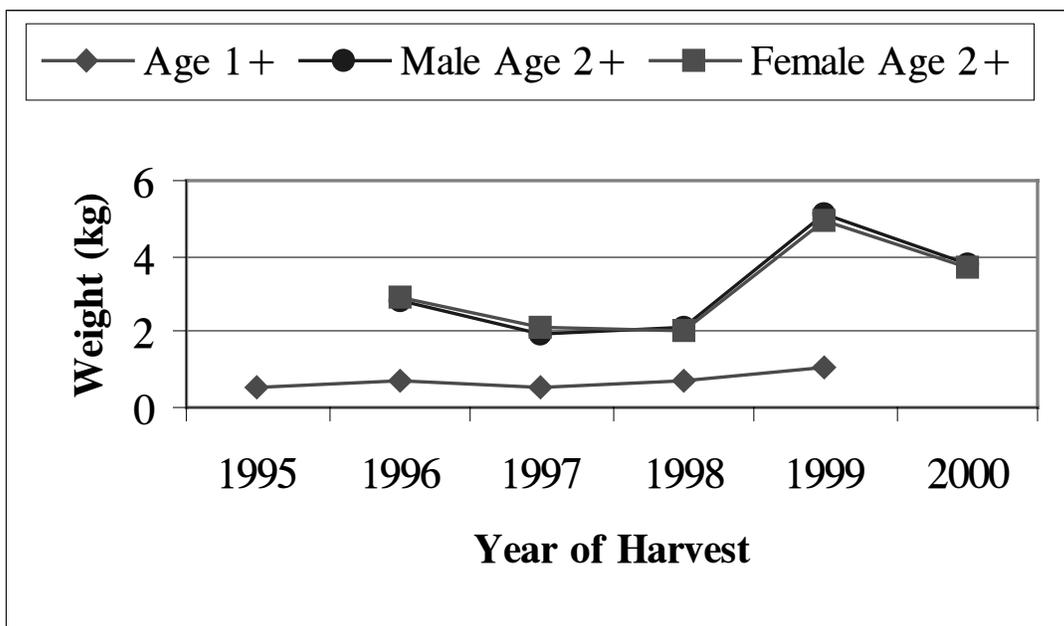


Figure 16.-Mean weight of coho salmon by age class and year of return to the Besadny Anadromous Fisheries Facility, 1995-2000. No age 1+ coho were weighed at BAFF in the fall of 2000.

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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, 1981-2000.

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
AVERAGE	4,312		60,582	4,208,458

¹ Annual average weight per fish used to estimate total weight (2000 average weight was 11.3 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

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	34	1	2			
2000	39%		28%		31%		2%				2,025
	785	0	323	241	247	376	13	40			

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

Appendix D.-Continued

1991	M	L (sd) Range n	626.6 (29.1) 560-693 85	836.1 (42.1) 703-930 53	954.2 (76.5) 735-1,070 39	- - -	- - -
	F	L (sd) Range n	- - -	838.3 (29.6) 805-900 9	943.0 (46.7) 800-1,030 95	929.5 (89.0) 825-1,023 4	- - -
1992	M	L (sd) Range n	616.7 (35.6) 523-711 153	860.1 (71.4) 582-980 75	979.1 (71.0) 793-1,103 31	- - -	- - -
	F	L (sd) Range n	629.0 - 1	842.9 (47.8) 662-920 34	938.0 (49.4) 800-1,060 47	965.3 (92.8) 877-1,062 3	- - -
1993	M	L (sd) Range n	609.7 (43.0) 459-745 240	864.9 (59.7) 646-983 163	1,001 (60.3) 841-1,090 34	- - -	- - -
	F	L (sd) Range n	- - -	847.0 (40.6) 746-936 59	958.6 (51.6) 810-1,054 74	937.5 (46) 905-970 2	- - -
1994	M	L (sd) Range n	598.4 (37.1) 501-687 127	861.5(60.0) 611-1,007 332	1,020 (73.8) 805-1,140 42	- - -	- - -
	F	L (sd) Range n	- - -	834.7 (53.2) 695-1,016 96	958.2 (49.7) 836-1,057 109	972.3 (63.8) 933-1,046 3	- - -
1995	M	L (sd) Range n	609.8 (40.2) 508-700 98	848.1 (67.3) 614-988 141	965.3 (73.6) 738-1,073 24	- - -	- - -
	F	L (sd) Range n	- - -	816.8 (35.5) 749-877 28	943.1 (50.9) 810-1,038 98	897 (38.7) 782-980 48	- - -
1996	M	L (sd) Range n	616.5 (28.2) 553-693 91	856.2 (56.9) 617-972 345	979.3 (67.6) 731-1,120 148	1,022.0 - 1	- - -
	F	L (sd) Range n	- - -	833.4 (44.4) 700-940 94	943.8 (49.7) 769-1,065 286	916 (130.6) 661-1,079 10	- - -
1996 ¹	M	L (sd) Range n	607.0 (33.9) 514-691 149	- - -	- - -	- - -	- - -
	F	L (sd) Range n	- - -	- - -	- - -	- - -	- - -
1997	M	L (sd) Range n	563.4 (36.8) 476-666 100	842.9 (76.4) 536-981 166	954.4 (68.3) 653-1,092 124	922 (154.9) 757-1,076 5	- - -
	F	L (sd) Range n	- - -	844.8 (49.5) 660-899 24	920.9 (45.2) 781-1,040 171	923.8 (79.4) 688-1,042 18	- - -
1997 ¹	M	L (sd) Range n	561.2 (36.9) 473-661 105	831.5 (57.2) 687-943 198	- - -	- - -	- - -
	F	L (sd) Range n	- - -	808.1 (40.6) 707-856 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) Range n	- - -	- - -	- - -	899.5(64.8) 797-967 6	- - -
	F	L (sd) Range n	- - -	- - -	- - -	919.2(53.3) 818-990 16	- - -
2000 ¹	M	L (sd) Range n	634.3(32.0) 554-724 228	900.9(56.4) 627-1,009 102	949.2(71.8) 746-1,064 84	883.9(26.7) 855-929 7	- - -
	F	L (sd) Range n	- - -	862.6(42.2) 590-940 96	913.4(49.3) 665-1,018 145	906.2(51.4) 809-996 24	- - -
2000 ²	M	L (sd) Range n	- - -	887.1(76.9) 563-993 114	938.8(82.8) 617-1,075 163	- - -	- - -
	F	L (sd) Range n	- - -	872.1(45.7) 615-950 67	918.3(48.7) 685-1,032 231	- - -	- - -
2000 ³	M	L (sd) Range n	- - -	891.5(72.9) 549-1,008 107	- - -	- - -	- - -
	F	L (sd) Range n	- - -	861.6(41.3) 672-949 78	- - -	- - -	- - -
2000 ⁴	M	L (sd) Range n	628.9(37.7) 454-736 259	- - -	- - -	- - -	- - -
	F	L (sd) Range n	- - -	- - -	- - -	- - -	- - -
2000 ⁵	M	L (sd) Range n	630.4(33.0) 527-718 298	- - -	- - -	- - -	- - -
	F	L (sd) Range n	- - -	- - -	- - -	- - -	- - -

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

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

Appendix E.-Continued

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

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

Appendix E.-Continued

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

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

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 1999. 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) 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, (highlighted in yellow) were not influenced by the low flow and are more typical of normal return rates. Return rates for the 1995 through 1999 year classes are pooled rates of multiple study lots of CWT fingerlings released from Strawberry Creek. Return rates of the individual lots (1995-1999) will be discussed as they relate to the various ongoing CWT studies.

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		1.90
1997	0.09	0.13	0.91			1.13
1998	0.25	0.80				1.05
1999	1.05					1.05

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 – 1999 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 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 2000 are shaded 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 ^{2,3}
1997	337	313	1,885		2,535	211.6 ¹	1.2 ^{2,4}
1998	361	1,664			2,025	210.5 ¹	1.0 ^{2,5}
1999	2,787				2,787	211.7	1.3

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, 1982-2000. Information for the 2000 year class is shaded 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						

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.

Appendix H.-Continued.

- 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).

Appendix I.-Summary of 673 adipose clipped chinook salmon harvested at the Besadny Anadromous Fisheries Facility, fall 2000. In addition to the 673 CWTs listed below, 11 tags were lost during extraction, 46 of the adipose clipped chinook had no tag detected, and 11 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
1999	Kewaunee River (Harbor) ⁶	1+	WIS DNR	70
	Kewaunee River (BAFF) ⁷		WIS DNR	129
	Kewaunee River (Clyde's) ⁸		WIS DNR	129
	Kewaunee River (Hwy. 54) ⁹		WIS DNR	72
	Strawberry Creek, WI ⁵		WIS DNR	4
	Strawberry Creek, WI ⁴		WIS DNR	4
	Swan Creek, Lake Huron		MICH DNR	3
1998	Kewaunee River (Harbor) ⁶	2+	WIS DNR	34
	Kewaunee River (BAFF) ⁷		WIS DNR	57
	Kewaunee River (Clyde's) ⁸		WIS DNR	78
	Kewaunee River (Hwy. 54) ⁹		WIS DNR	56
	Strawberry Creek, WI ⁴		WIS DNR	8
	Strawberry Creek, WI ³		WIS DNR	3
	Strawberry Creek, WI ⁵		WIS DNR	4
	Swan Creek, Lake Huron		MICH DNR	2
1997	Strawberry Creek, WI ⁵	3+	WIS DNR	7
	Strawberry Creek, WI ³		WIS DNR	11
1996	Strawberry Creek, WI ¹	4+	WIS DNR	2

¹ Fingerlings from eggs which were treated with thiamine (thiamine study conducted at Strawberry Creek).

² Fingerlings from eggs which were not treated with thiamine (thiamine study conducted at Strawberry Creek).

³ Fingerlings from known age 3+ males and females (age at maturity study conducted at Strawberry Creek).

⁴ Fingerlings from known age 3+ males and age 2+ females (age at maturity study conducted at Strawberry Creek).

⁵ Regular production CWT fingerlings (controls) stocked at Strawberry Creek.

⁶ Stocking technique study chinook fingerlings stocked in the Kewaunee Harbor near the mouth of the Kewaunee River.

⁷ Stocking technique study chinook fingerlings stocked in the Kewaunee River near the BAFF approximately four miles upstream from Lake Michigan.

⁸ Stocking technique study chinook fingerlings stocked in the Kewaunee River at Clyde's Hill Road crossing approximately nine miles upstream from Lake Michigan.

⁹ Stocking technique study chinook fingerlings stocked in the Kewaunee River at Hwy. 54 crossing approximately 15 miles upstream from Lake Michigan.

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 1984-2000. 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	

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

Appendix K.-Continued.

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

Appendix L.-Continued

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 Keweenaw River, Keweenaw County, 1987-2000.

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

Appendix N.-Estimated rate of recovery of coho salmon at the Besadny Anadromous Fisheries Facility, through fall 1999. 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		
					(100)		

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 2000.

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)	526.4 (73.6)	536.0 (47.1)	675.0 (50.9)	654.8 (24.4)
	Range	373-660	479-583	622-754	620-685
	Sample size	24	4	5	8
1994 accelerated fingerlings fingerling/yearling study LMLP	Length mm (SD)	369.1 (24.1)	-	672.7 (58.7)	648.4 (40.1)
	Range	319-439	-	439-788	506-785
	Sample size	56	-	249	365
1994 yearlings fingerling/yearling study LMRP	Weight kg (SD)	0.5 (0.1)	-	2.7 (0.8)	2.7 (0.5)
	Range	0.3-0.8	-	0.9-4.2	1.5-3.8
	Sample size	32	-	87	90
1994 erythromycin study controls not treated BV	Length mm (SD)	360.1 (21.5)	-	658.6 (57.1)	644.4 (40.8)
	Range	285-417	-	416-854	383-759
	Sample size	202	-	363	559
1994 yearlings standard production NC	Weight kg (SD)	0.5 (0.1)	-	2.4 (0.7)	2.6 (0.6)
	Range	0.2-0.7	-	0.6-4.4	1.2-4.6
	Sample size	81	-	138	201
1994 erythromycin study controls not treated BV	Length mm (SD)	381.4 (23.5)	-	683.7 (62.4)	670.0 (39.3)
	Range	325-442	-	449-795	484-792
	Sample size	203	-	427	683
1994 yearlings standard production NC	Weight kg (SD)	0.5 (0.1)	-	2.9 (0.8)	3.1 (0.6)
	Range	0.2-0.9	-	0.7-5.0	0.9-5.1
	Sample size	62	-	185	238
1994 yearlings standard production NC	Length mm (SD)	426.6 (43.7)	482.4 (29.6)	702.3 (62.4)	680.6 (41.6)
	Range	333-518	433-517	527-885	554-770
	Sample size	424	12	155	221
1994 yearlings standard production NC	Weight kg (SD)	0.7 (0.2)	1.0 (0.2)	3.1 (0.9)	3.2 (0.6)
	Range	0.4-1.2	0.8-1.3	1.5-5.7	1.7-4.9
	Sample size	101	7	64	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)	397.1 (33.8)	421.7 (37.6)	591.4 (58.6)	562.3 (47.3)
	Range	321-480	392-464	460-742	461-674
	Sample size	52	3	172	159
	Weight kg (SD)	0.6 (0.2)	0.52	1.84 (0.6)	1.74 (0.5)
	Range	0.3-0.9	-	0.7-3.8	0.9-3.2
	Sample size	36	1	169	151
1995 yearlings fingerling/yearling study LMRV	Length mm (SD)	430.3 (41.3)	443.5 (41.7)	602.3 (57.8)	576.1 (49.8)
	Range	338-516	414-473	480-733	466-698
	Sample size	42	2	139	180
	Weight kg (SD)	0.7 (0.2)	-	1.9 (0.6)	1.9 (0.6)
	Range	0.4-1.0	-	1.0-4.3	0.8-3.8
	Sample size	18	-	133	165
1995 yearlings standard production NC	Length mm (SD)	438.6 (42.6)	510.1 (5.0)	605.8 (69.7)	584.4 (47.7)
	Range	346-508	505-515	466-740	470-673
	Sample size	23	3	60	74
	Weight kg (SD)	0.8 (0.2)	1.2	2.0 (0.8)	3.0 (0.5)
	Range	0.5-1.01	-	0.8-4.0	0.9-3.3
	Sample size	9	1	59	73
1995 yearlings thiamine study treated A/CWT 31-17-13	Length mm (SD)	409.2 (38.1)	-	609.9 (72.7)	597.1 (51.4)
	Range	335-481	-	495-763	474-703
	Sample size	23	-	39	31
	Weight kg (SD)	0.6 (0.2)	-	2.0 (0.8)	2.1 (0.6)
	Range	0.2-0.9	-	0.9-4.2	1.0-3.6
	Sample size	20	-	39	31
1995 yearlings thiamine study not treated A/CWT 31-17-14	Length mm (SD)	413.7 (39.6)	-	618.4 (64.9)	584.5 (54.5)
	Range	302-484	-	479-780	477-711
	Sample size	29	-	68	68
	Weight kg (SD)	0.7 (0.2)	-	2.1 (0.8)	2.0 (0.6)
	Range	0.2-1.1	-	0.7-4.3	0.9-3.3
	Sample size	26	-	66	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)	368.7 (22.7)	-	597.6 (73.3)	581.9 (46.4)
	Range	331-410	-	405-785	487-728
	Sample size	16	-	149	173
	Weight kg (SD)	0.5 (0.1)	-	1.9 (0.8)	1.8 (0.5)
	Range	0.3-0.8	-	0.6-4.7	0.9-3.8
	Sample size	15	-	135	169
1996 yearlings fingerling/yearling study RM	Length mm (SD)	405.2 (26.1)	-	623.4 (86.9)	608.6 (50.4)
	Range	366-440	-	357-777	498-743
	Sample size	13	-	124	116
	Weight kg (SD)	0.6 (0.1)	-	2.2 (0.9)	2.1 (0.6)
	Range	0.4-0.8	-	0.7-4.2	0.9-4.0
	Sample size	13	-	112	114
1996 yearlings thiamine study treated A/CWT 36-17-17	Length mm (SD)	399.9 (19.4)	-	648.9 (72.9)	611.1 (54.8)
	Range	364-430	-	445-772	510-725
	Sample size	10	-	75	76
	Weight kg (SD)	0.6 (0.1)	-	2.4 (0.9)	2.1 (0.6)
	Range	0.4-0.8	-	0.7-4.4	1.0-3.6
	Sample size	10	-	72	75
1996 yearlings thiamine study not treated A/CWT 36-17-18	Length mm (SD)	380.2 (18.2)	-	639.3 (59.9)	617.8 (56.4)
	Range	333-409	-	529-752	480-738
	Sample size	18	-	59	65
	Weight kg (SD)	0.5 (0.1)	-	2.2 (0.7)	2.2 (0.7)
	Range	0.3-0.7	-	1.1-4.0	1.0-4.0
	Sample size	18	-	57	61
1996 erythromycin study not treated BV	Length mm (SD)	380	-	614.6 (64.0)	580.2 (55.1)
	Range	-	-	510-722	509-700
	Sample size	1	-	20	22
	Weight kg (SD)	0.5	-	1.9 (0.6)	1.8 (0.5)
	Range	-	-	0.9-2.9	1.1-2.9
	Sample size	1	-	20	19
1997 fingerlings/ yearlings standard production NC	Length mm (SD)	431.8 (28.2)	468.4 (30.3)	812.5 (59.4)	776.8 (37.7)
	Range	340-506	400-510	570-918	575-857
	Sample size	163	31	236	532
	Weight kg (SD)	0.7 (6.1)	1.0 (0.2)	5.1 (1.2)	4.9 (0.8)
	Range	0.4-1.2	0.6-1.3	1.7-7.9	2.0-6.8
	Sample size	159	30	236	532
1998 fingerlings/ yearlings standard production NC	Length mm (SD)	478.4 (40.6)	-	735.3 (58.9)	707 (40.3)
	Range	345-556	-	556-849	507-805
	Sample size	63	-	266	500
	Weight kg (SD)	1.1 (0.3)	-	3.8 (1.0)	3.7 (0.7)
	Range	0.4-1.8	-	1.5-6.2	1.2-7.7
	Sample size	63	-	266	500