Root River Steelhead Facility Fall 1996 - Spring 1997 Report

Bradley T. Eggold
Fisheries Management
Plymouth, Wisconsin 53073

Summary: A total of 5,589 chinook salmon, 4,406 coho salmon, 3,398 steelhead, 316 brown trout and 5 brook trout were examined at the Root River Steelhead Facility (RRSF) in fall 1996 and spring 1997.

Of the 5,589 chinook salmon examined at the RRSF in the fall of 1996, the majority of them (5,440 or 97%) were passed upstream. Only 149 chinook had to be sacrificed for either disease or contaminant analysis or were too weak to pass upstream.

Four consecutive years of stocking either Lake Ontario Strain (LOS) or Lake Michigan Strain (LMS) chinook salmon produced runs of 4+ LOS and 1+, 2+ or 3+ LMS chinook salmon. The LOS age 4+ fish returned poorly at 0.01% (only 17 fish). Lake Michigan strain chinook salmon returned as 1+ fish at 0.19% (189 fish) from the 1995 year class. Age 2+ fish from the 1994 year class returned at 0.58% (440 fish) and age 3+ fish from the 1993 year class returned at 0.85% (840 fish) which was 9 times higher then the return rate of similarly aged LOS chinook salmon. Age 3+ LOS chinook salmon were considerably smaller than age 3+ LMS chinook salmon in both length and weight for both males and females.

The number of coho salmon returning to RRSF rose dramatically from 813 fish in 1994 to 3,321 fish in 1995 and then 4,406 fish in 1996. A total of 3,940 coho salmon were passed upstream, 305 were saved for contaminant or fish health analysis and 161 died in the facility.

In the fall of 1996, we saw the first adult return of coho salmon from the fall fingerling versus spring yearling stocking study fish. Age 2+ adult coho salmon stocked as yearlings returned at almost twice the rate as those stocked as fingerlings (2.6% vs. 1.5%). Age 1+ coho salmon from the 1995 year class returned differently based on the type of rearing method. Spring yearling raised coho salmon return at 2.09% (847 fish) compared to 0.69% (381 fish) for those stocked as fingerlings. This contrasts with the previous year's data that showed age 1+ returning coho salmon were twice as likely to return from the fall fingerling plant compared to the yearling plant.

Steelhead returns were very similar in 96-97 compared to 95-96. Skamania comprised almost all of the fall run fish. Of the 353 steelhead examined at RRSF, 248 were taken to the Kettle Moraine Fish Hatchery for brood stock and 105 were passed upstream. This year's run was comprised of slightly older fish, primarily age 5+. Chambers Creek and Ganaraska comprised the bulk of the spring 97 run with similar ages to the previous year. A total of 3,045 steelhead returned to RRSF in the spring of 1997, with 96% passed upstream and 125 saved for contaminant or fish health analysis.

Based on the high variability of the population estimates in a given year the only significant changes that occurred in the 1996-97 runs were for chinook salmon and Chambers Creek steelhead. The estimated chinook salmon population increased from 4,478 ± 594 in 1995 to 5,587 ± 147 in 1996. The estimated Chambers creek steelhead population also increased from 1,765 ± 206 in 1996 to 5,014 ± 1,606 in 1997. Reasons for the increase may include: 1) a normal yearly fluctuation in the number of fish returning to spawn in the Root River; or 2) one or more good year classes which would normally comprise the majority of the spawning run.

The Root River has historically been a tremendous source of fish for both anglers, who want to catch them and fishery managers, who want to study them. The river has been stocked with large numbers of salmonids. Past efforts by managers to study these fish populations have been very labor intensive. Portable weirs as well as electrofishing efforts have been implemented to sample fish. Both methods were very labor intensive, costly and provided only a fraction of the fisheries data that the Wisconsin Department of Natural Resources needs to manage the Lake Michigan fishery. To combat these problems the Root River Steelhead Facility (RRSF) was constructed in 1994 through a cooperative effort by the WDNR, Salmon Unlimited, City of Racine and the U.S. Fish and Wildlife Service. Its main purpose is to provide brood stock for the steelhead fishery in Lake Michigan but is an excellent backup to the Strawberry Creek Weir for chinook salmon and to the Kewaunee Weir for coho salmon and steelhead brood stock and eggs. It also provides a unique educational tool for school groups and interested people.

In order to fully utilize the RRSF, a project was written in 1993 with the following objectives: develop a long term index of chinook/coho/steelhead populations in the Root River to track the 1) abundance of returning adults; 2) age-specific growth and condition factors; 3) size and age distribution of returning adults; and 4) return to creel of these species stocked in the Root River. This annual report addresses these objectives.

METHODS

During the operation of the RRSF, for all targeted species and finclips, a minimum of 100 fish sample per species per finclip was obtained. These fish were measured to the nearest millimeter, weighed to the nearest 0.10 lb, examined for finclips, gender and condition and either held for brood stock, passed upstream or sacrificed (fish health or contaminant analysis). The remaining fish were tallied by species, sex and finclip and passed upstream. All fish that were passed upstream were given an upper caudal clip for population estimates.

All non-targeted species or finclips were tallied by species, finclip and sex, caudally clipped and passed upstream. All coded-wire-tagged (CWT) fish were measured and weighed. Heads were removed from behind the opercular flap and frozen for later examination. Fish needed for other studies such as disease analysis, contaminant analysis or other studies were frozen for later examinations.

Population estimates

Population estimates for each species or strain were derived from one of two equations. For those species with adequate sample sizes, the following Petersen equation for mark and recapture was used

$$N = \frac{M * C}{R} \qquad (1)$$

where

N = size of population in the river
M = number of marked fish
C = number of recaptured fish
R= number of marked fish in recapture sample

with the appropriate sample standard deviation of

For those species with low sample sizes, the

$$S(N) = \sqrt{\frac{M^2 * C * (C - R)}{R}} \quad (2)$$

Bailey's modified equation was used

$$N = \frac{M * (C + 1)}{R + 1} \quad (3)$$

with the appropriate sample standard deviation of

$$S(N) = \sqrt{\frac{M^2 * (C + 1) * (C - R)}{(R + 1)^2 * (R + 2)}} \quad (4)$$

Several studies along with the general objectives and methods outlined above, have been initiated using fish stocked into the Root River.

Chinook salmon strain evaluation

Chinook salmon harvests have been highly variable over the last 6 years. One reason may be the poor performance of the Lake Michigan strain (LMS) chinook salmon that seems to be highly susceptible to Bacterial Kidney Disease (BKD) (Peeters and Royseck, 1996). To address this problem, a Lake Ontario strain (LOS) chinook salmon was stocked in 1992 acquired from New York Department of Environmental Conservation (NYDEC). These fish were not experiencing a BKD outbreak and it was hoped they would survive better than the LMS chinook salmon. In 1993 through 1995, Lake Michigan strain (LMS) chinook salmon were stocked. All lots were marked with a distinctive finclip so that a comparison could be made on the return rates and survival of these two strains.

Accelerated growth fall fingerlings vs spring yearlings

The coho salmon harvest has declined from historical levels which prompted fish managers to closely scrutinize the methods used to raise coho salmon. Prior to 1988, most coho salmon were stocked as yearlings (age 1+) which provided a good harvest averaging 110,000 fish per year. Starting in 1988, coho salmon were stocked as accelerated growth fingerlings (0+). These fish spent less time in the hatchery and were cheaper to raise. Unfortunately, the switch to accelerated growth fingerlings was not properly evaluated and has possibly lead to declines in harvest which averaged 70,000 fish per year. To evaluate the impact of rearing techniques, both accelerated growth fingerling and yearling coho salmon from the same year class, were stocked into the Root River starting in the fall of 1994 and will continue for the next two years. In addition, hyper-accelerated fingerling coho salmon from Illinois DOC were stocked in the spring of 1994 and became an unplanned addition to the study. All three groups were marked with distinctive finclips and will be evaluated during fall spawning runs from 1994-1998.

Steelhead strain evaluation

Since the Root River has been a backup for steelhead brood stock collections and primary source since the RRSF was constructed, approximately 33,000 fish per steelhead strain have been stocked annually. Of continuing importance are the performance of these three strains of steelhead; Skamania, Chambers Creek and Ganaraska. Because each strain must be marked with a distinct finclip for correct brood stock identification, strain evaluations can be conducted including age of returning fish, return rates and population estimates.

RESULTS AND DISCUSSION

The third season of operation for the RRSF started on September 27, 1996 and concluded on April 8, 1997. A total of 5,589 chinook salmon, 4,406 coho salmon, 3,398 steelhead, 316 brown trout and 5 brook trout were examined.

CHINOOK SALMON

A total of 5,589 chinook salmon were examined at the RRSF in the fall of 1996. The majority of them (5,440 or 97%) were passed upstream (Table 1). Some of these were stripped of eggs or sperm but the majority of fish remained healthy enough to pass upstream. Only 149 chinook had to be sacrificed for either disease or contaminant analysis or were too weak to pass upstream. In addition, 644,000 eggs were taken.

In 1996, based on an age-length key from 5,425 known aged finclipped and unclipped chinook salmon (see below), age 1+ fish comprised 31% of the total number examined, age 2+ were 30%, age 3+ were 34% and age 4+ were 5% (Table 3). Because the majority of chinook salmon returning to the RRSF were unclipped, a percentage based on approximated ages of measured clipped chinook salmon had to be applied to all unclipped fish in order to develop an age composition of the run.

The 1996 spawning run was comprised of slightly older fish compared to 1995. Thirty-four percent were 3+ chinook salmon compared to only 30% in 1995 (Table 3). The run this year seemed to be evenly spread out among the 1-3 age classes with only 5% of the run comprised of 4+ chinook salmon. This deviates slightly from the first two years of operation at the RRSF as well as the trends noted at the Strawberry Creek Weir for the past 3 years (Peeters and Royseck, 1996).

Chinook salmon strain evaluation

Four consecutive years of stocking either LOS or LMS chinook salmon produced runs of 4+ LOS and 1+, 2+ or 3+ LMS chinook salmon (Table 4). The LOS age 4+ fish returned poorly at 0.01% (17 fish) (Table 5). This return rate is similar to the LOS chinook salmon that returned as 4+ fish to the Besadny Anadromous Fisheries Facility (BAFF) on the Kewaunee River at 0.01% (Peeters and Royseck, 1996). Lake Michigan strain chinook salmon returned as 1+ fish at 0.19% (189 fish) from the 1995 year class. Age 2+ fish from the 1994 year class returned at 0.58% (440 fish). Age 3+ fish from the 1993 year class returned at 0.85% (840 fish) which was 9 times higher then the return rate of similarly aged LOS chinook salmon from the previous year. In all cases, LMS chinook salmon returned at a higher percentage compared to similarly aged LOS chinook salmon.

Average lengths and weights of both strains are shown in Appendix A & B. Since no data were collected on Age 1+ LOS chinook salmon a comparison could not be made to the three years of LMS 1+ data. However by age 2+ and 3+, the LOS chinook salmon were considerably smaller than age 2+ and 3+ LMS chinook salmon in both length and weight for both males and females. It appears that based on return rates and size of returning chinook salmon, the LMS chinook salmon are surviving better and growing bigger than LOS chinook salmon. Similar results were also recorded at BAFF, where both 2+ and 3+ LMS chinook salmon were larger than LOS chinook salmon.

COHO SALMON

A total of 4,406 coho salmon were examined at the RRSF from September 27 through November 11, 1996 (Table 6). The majority of coho salmon were passed upstream (3,940). These fish comprised 89% of all coho salmon processed through the RRSF. A total of 161 fish were sacrificed for eggs or sperm while 305 were saved for contaminant or health analysis. Egg take (2.2 million) and sampling goals were successfully reached.

The number of coho salmon returning to the RRSF increased 30% over the 1995 numbers. In order to properly evaluate the accelerated growth fall fingerling versus spring yearling study, extra man power was added to the staff at RRSF to insure that all possible coho salmon returning to the Root River were captured in the facility. This undoubtedly lead to higher numbers of coho salmon as well as chinook salmon that were captured at the facility.

Percent age composition of returning coho salmon was disproportinately distributed between age 1+ and age 2+ fish. A total of 4,211 fish were used to determine that 32% were age 1+ and 68% were age 2+ (Table 7). This contrasts with 1994 in which the returning coho salmon were evenly distributed between the two ages but are similar to the calculated ages from 1995.

Accelerated growth fall fingerlings vs spring yearlings

Age 1+ jack coho salmon, stocked as fingerlings in 1995, returned at 0.69% (381 fish) while those stocked as spring yearlings (1+) returned at a much higher rate (2.09%) (Table 9). This is in direct opposition to the previous fall when more fall fingerling raised coho salmon returned as jacks compared to spring yearling stocked coho salmon. Age 2+ adult coho salmon, stocked as spring yearlings in 1995, returned at 2.6% (1,700 fish) while those stocked as fall fingerlings in 1994 from the same year class returned at 1.5% (864 fish) (Table 9).

The average lengths and weights of precocious coho salmon (age 1+) from the two different stocking procedures from both the 1995 and 1996 year classes were almost identical for both males and females (Appendix C.). However, the majority of the jack returns were sexually mature males. The average lengths and weights of the 1995 year class of adult coho salmon (age 2+) from the two different stocking procedures were almost identical (26 inches and 6.6 pounds).

STEELHEAD

A total of 3,398 steelhead were examined at the RRSF from September 27, 1996 to April 8, 1997. The majority of all fish (3,023 or 89%) were passed upstream (Table 10). Those steelhead harvested in late summer were Skamania strain (248) to be used for brood stock and those in spring were Chambers Creek and Ganaraska (2). A total of 125 fish were used for contaminant or disease analysis. The majority of fish returning in the spring were comprised of both Chambers Creek and Ganaraska strain steelhead while the fall run was mainly Skamania strain. Additionally, a total of 382,000 Chambers Creek eggs and 395,000 Ganaraska eggs were collected from fish returning to RRSF.

Steelhead strain evaluation

Based on age-length keys from 21 fall run and 483 spring run known aged finclipped steelhead the percent age composition of both runs could be calculated (Table 11). However, due to overlapping sizes of steelhead having the same finclips some of the ages had to be estimated. Skamania steelhead comprised all 21 of the fall fish with age 1+ comprising 0.0% of the total number, age 2+ were 26.3%, age 3+ were 36.8%, age 4+ were 5.3% and age 5+ were 31.6%. This year's spawning run was comprised of slightly older fish, primarily age 5+, compared to the 1995 run. The number of Skamania steelhead returning to the RRSF has declined every year since 1994, from 848 to only 353 in 1996.

Chambers Creek and Ganaraska steelhead comprised all of the 483 fish used in the spring 97 analysis. The age breakdown was 1.0% for age

1+, 22.1% for age 2+, 42.5% for age 3+, 22.5% for age 4+, 10.5% for age 5+ and 1.4% for age 6+. These ages were very similar to those in the spring 1996 run. The number of fish returning to the RRSF have been very similar in each year, averaging 3,000 fish.

The 1997 spring run had significantly higher percentage of 4+ fish with a much lower percentage of 5+ compared to the fall 1996 Skamania run. These differences are most likely due to specific characteristics of each strain

Stocking densities are shown in Table 12. All three strains have been stocked in nearly equal numbers the past 7 years. Each strain receives a distinct finclip that alternate each year. Because of the overlap in sizes from steelhead with the same finclip, lengths and weights for each year class could not be accurately calculated. However, starting in 1997, we will be adding a third set of distinct finclips which should allow us to more accurately age finclipped steelhead and calculate the age composition of returning steelhead as well as length and weight at age for each year class..

POPULATION ESTIMATES

Each fish that was passed upstream of the RRSF received a caudal clip which can be identified by a creel clerk during the recapture phase of the population estimate. An estimated 5,587 ± 147 chinook salmon were present during the fall run while 3,940 ± 0 coho salmon were calculated to be in the Root River (Table 13). Population estimates for steelhead were highest for Ganaraska in the spring of 1997 at 5,356 ± 1,753 fish, followed by Chambers Creek at 5,014 ± 1,606 and lastly Skamania at 3,150 ± 2,189. Only Chambers Creek steelhead and chinook salmon showed a significant increase in population size from the 1995 spawning season.

REFERENCES

Peeters. P and K. Royseck. 1996. Strawberry Creek Weir and Besadny Anadromous Fisheries Facility Report. Wisconsin Department of Natural Resources, Sturgeon Bay, WI.

Table 1. Number of chinook salmon harvested, passed upstream and sampled at the Root River Steelhead Facility during fall 1996.

Date	Number of fish harvested	Number of fish passed upstream	Number of misc. samples[1]	Total number of fish
Sept 27	1	214	-	215
Sept 30	2	720	-	722
Oct 01	2	214	-	216
Oct 02	1	32	-	33
Oct 03	-	3	-	3
Oct 04	-	3	-	3
Oct 06	1	-	-	1
Oct 07	7	417	9	433
Oct 08	-	187	78	265
Oct 09	1	-	-	1
Oct 10	-	612	-	612
Oct 11	-	315	-	315
Oct 14	-	558	-	558
Oct 15	26	238	-	264
Oct 16	2	136	-	138
Oct 17	-	-	-	-
Oct 18	1	352	-	353
Oct 19	-	-	-	-
Oct 20	-	-	-	-
Oct 21	3	314	-	317
Oct 22	1	195	-	196
Oct 23	2	4	-	6
Oct 24	-	304	-	304
Oct 25	-	70	-	70
Oct 26	2	-	-	2
Oct 28	6	323	-	329
Oct 29	2	20	-	22
Oct 30	-	114	-	114
Oct 31	-	-	-	-
Nov 01	1	74	-	75
Nov 02	1	-	-	1
Nov 03	-	-	-	-
Nov 04	-	-	-	-
Nov 05	-	6	-	6
Nov 06	-	-	-	-
Nov 09	-	-	-	-
Nov 11	-	15	-	15
Totals	62	5,440	87	5,589

1 Fish collected and sacrificed for other studies (i.e. disease, contaminants)

Table 2. Summary of chinook salmon, coho salmon, steelhead, brown and brook trout captured at the Root River Steelhead Facility, 1994-97, including number of fish harvested, passed upstream and sampled.

CHINOOK SALMON

Harvest Year	Number of fish harvested	Number passed upstream	Number of misc. samples	Total number
Fall - 94	129	1,726	3	1,858
Fall - 95	300	2,663	16	2,979
Fall - 96	62	5,440	87	5,589

COHO SALMON

Harvest Year	Number of fish harvested	Number passed upstream	Number of misc. samples	Total number
Fall - 94	285	513	15	813
Fall - 95	1,191	2,115	15	3,321
Fall - 96	161	3,940	305	4,406

STEELHEAD

Harvest Year	Number of fish harvested	Number passed upstream	Number of misc. samples	Total number
Fall - 94	218	583	47	848
Spring - 95	120	2,582	18	2,720
Fall - 95	330	208	0	538
Spring - 96	150	2,970	49	3,169
Fall - 96	248	105	0	353
Spring - 97	2	2,918	125	3,045

BROWN TROUT

Harvest Year	Number of fish harvested	Number passed upstream	Number of misc. samples	Total number
Fall - 94	0	259	0	259
Fall - 95	46	645	0	691
Spring - 96	0	4	0	4
Fall - 96	70	244	0	314
Spring - 97	0	2	0	2

BROOK TROUT

Harvest Year	Number of fish harvested	Number passed upstream	Number of misc. samples	Total number
Fall - 94	0	160	0	160
Spring - 95	0	1	0	1
Fall - 95	0	6	0	6
Fall - 96	0	5	0	5

Table 3. Estimated age composition of chinook salmon (sexes combined) examined at the Root River Steelhead Facility, 1994-1996. Age is based on age-length key developed from known aged finclipped chinook salmon. Total number represents the number of chinook salmon used in the analysis.

Year of Return	Percent Age Composition 1+	2+	3+	4+	Total Number
1994	39	45	16	-	1,809
1995	25	45	30	-	2,874
1996	31	30	34	5	5,425

Table 4. Summary of chinook salmon stocking numbers by strain and finclip stocked into the Root River 1991-1996.

Year Stocked	Total Number	Strain	Finclip
1991	174,933	L. Michigan	none
1992	166,989	L. Ontario	RMLV
1993	99,345	L. Michigan	LMRV
	70,000	L. Ontario	none
1994	75,533	L. Michigan	LP
	60,000	L. Michigan	none
1995	99,000	L. Michigan	RP
	69,250	L. Michigan	none
1996	158,000	L. Michigan	none

Table 5. Return rate of chinook salmon at age and strain to the Root River Steelhead Facility in the fall of 1994-1996. Return rate expressed as a percent of the number of chinook salmon stocked in the Root River that were actually recovered at RRSF. Number of actual chinook salmon returning to the facility are in parentheses.

	AGE AT RETURN (Percent)				
	1+	2+	3+	4+	Total Return
1992 YEAR CLASS					
[1]L. Ontario (RMLV)	-	0.15 (245)	0.09 (152)	0.01 (17)	0.13 (631)
1993 YEAR CLASS					
L. Michigan (LMRV)	0.33 (323)	0.78 (775)	0.85 (840)		
1994 YEAR CLASS					
L. Michigan (LP)	0.10 (73)	0.58 (440)			
1995 YEAR CLASS					
L. Michigan (RP)	0.19 (189)				

[1] Total return for the L. Ontario strain chinook salmon from the 1992 year class was calculated by using the return rate of 0.13% of LOS chinook salmon from the Besadny Anadromous Fisheries Facility

Table 6. Number of coho salmon harvested, passed upstream and sampled at the Root River Steelhead Facility during fall 1996.

Date	Number of fish harvested	Number of fish passed upstream	Number of misc. samples[1]	Total number of fish
Sept 27	1	89	-	90
Sept 30	1	320	-	321
Oct 01	1	75	-	76
Oct 02	-	18	-	18
Oct 03	1	35	-	36
Oct 04	-	2	-	2
Oct 06	1	-	-	1
Oct 07	-	94	-	94
Oct 08	1	97	14	112
Oct 09	1	-	-	1
Oct 10	-	87	1	88
Oct 11	-	49	-	49
Oct 14	-	145	-	145
Oct 15	26	640	18	684
Oct 16	3	71	-	74
Oct 17	5	-	-	5
Oct 18	7	489	-	496
Oct 19	10	-	-	10
Oct 20	2	-	-	2
Oct 21	13	254	10	277
Oct 22	10	159	-	169
Oct 23	48	509	262	819
Oct 24	-	54	-	54
Oct 25	-	160	-	160
Oct 26	6	-	-	6
Oct 28	3	77	-	80
Oct 29	6	304	-	310
Oct 30	4	31	-	35
Oct 31	3	-	-	3
Nov 01	1	38	-	39
Nov 02	-	-	-	-
Nov 03	1	-	-	1
Nov 04	3	-	-	3
Nov 05	-	90	-	90
Nov 06	1	-	-	1
Nov 09	2	-	-	2
Nov 11	-	53	-	53
Totals	161	3,940	305	4,406

1 Fish collected and sacrificed for other studies (i.e. disease, contaminants)

Table 7. Estimated age composition of coho salmon (sexes combined) examined at the Root River Steelhead Facility, fall 1994-96. Age is based on age-length key developed from known aged finclipped coho salmon. Total number represents the number of coho salmon used in the analysis.

Year of Return	Percent Age Composition 1+	2+	Total Number
1994	53	47	780
1995	24	76	3,049
1996	32	68	4,211

Table 8. Summary of coho salmon stocking numbers by strain and finclip stocked into the Root River 1993-1996. REL = red elastomer mark in adipose tissue of left eye.

Year Stocked	Total Number	Strain	Finclip	Age
1993	-			
1994	66,080	L. Ontario	none	Spring Yearling 1+
	55,954	L. Ontario	RMLP	Fall Fingerling 0+
	50,389	L. Michigan	RP	Spring Fingerling 0+
1995	65,100	L. Michigan	RMRP	Spring Yearling 1+
	54,832	L. Michigan	RMLV	Fall Fingerling 0+
1996	40,590	L. Michigan	RMRV	Spring Yearling 1+
	63,697	L. Michigan	LP	Fall Fingerling 0+
1997	48,107	L. Michigan	RP	Spring Yearling 1+
	10,873	L. Michigan	REL	Spring Yearling 1+

Table 9. Return rate of coho salmon (percent and number) at age and stocking treatment to the Root River Steelhead Facility in the fall 1994-1996 based on year class. Return rate expressed as a percent of the number of coho salmon stocked in the Root River that were actually recovered at RRSF. Number of actual coho salmon returning to the facility are in parentheses.

Year Class	Stocking Treatment	AGE AT RETURN (Percent) 1+	2+
1992	Fall Fingerling (RPLV)	-	0.88 (303)
1993	Spring Yearling (none)	0.71 (472)	3.20 (2,100)
1994	Fall Fingerling (RMLP)	0.88 (495)	1.50 (864)
	Spring Fingerling (RP)	0.59 (297)	0.00 (8)
	Spring Yearling (RMRP)	0.41 (266)	2.60 (1,700)
1995	Fall Fingerling (RMLV)	0.69 (381)	
	Spring Yearling (RMRV)	2.09 (847)	

Table 10. Number of steelhead harvested, passed upstream and sampled at the Root River Steelhead Facility during fall 1996 and Spring 1997.

Date	Number of fish harvested	Number of fish passed upstream	Number of misc. samples[1]	Total number of fish
Sept 27	-	8	-	8
Sept 30	48	69	-	117
Oct 01	-	5	-	5
Oct 02	-	-	-	-
Oct 03	61	1	-	62
Oct 04	-	-	-	-
Oct 06	-	-	-	-

Oct 07	-	-	-	-
Oct 08	-	-	-	-
Oct 09	-	-	-	-
Oct 10	-	-	-	-
Oct 11	-	-	-	-
Oct 14	-	-	-	-
Oct 15	1	-	-	1
Oct 16	-	1	-	1
Oct 17	-	-	-	-
Oct 18	-	2	-	2
Oct 19	-	-	-	-
Oct 20	-	-	-	-
Oct 21	-	2	-	2
Oct 22	-	1	-	1
Oct 23	54	1	-	55
Oct 24	-	2	-	2
Oct 25	-	-	-	-
Oct 26	-	-	-	-
Oct 28	-	-	-	-
Oct 29	39	1	-	40
Oct 30	-	4	-	4
Oct 31	-	-	-	-
Nov 01	-	4	-	4
Nov 02	-	-	-	-
Nov 03	-	-	-	-
Nov 04	-	-	-	-
Nov 05	45	3	-	48
Nov 06	-	-	-	-
Nov 09	-	-	-	-
Nov 11	-	1	-	1
Mar 20	-	54	-	54
Mar 24	-	744	33	777
Mar 27	-	429	-	429
Mar 30	2	-	-	2
Mar 31	-	980	30	1,010
Apr 4	-	217	-	217
Apr 7	-	406	62	468
Apr 8	-	88	-	88
Totals	250	3,023	125	3,398

1 Fish collected and sacrificed for other studies (i.e. disease, contaminants)

Table 11. Estimated age composition of steelhead (sexes combined) examined at the Root River Steelhead Facility, 1994-1997. Age is based on age-length key developed from known aged finclipped steelhead. Total number represents the number of steelhead lengths used in the analysis.

Year of Return	Percent Age Composition 1+	2+	3+	4+	5+	6+	Total Number
Fall - 1994	8.9	7.5	43.2	34.2	6.2		146
Spring - 1995	7.3	31.3	38.0	12.7	10.7		450
Fall - 1995	15.6	12.2	21.8	49.7	0.7		147
Spring - 1996	11.0	36.1	33.1	9.1	10.1	0.6	692
Fall - 1996	-	26.3	36.8	5.3	31.6		21
Spring 1997	1.0	22.1	42.5	22.5	10.5	1.4	483

Table 12. Summary of steelhead stocking densities and strain stocked into the Root River 1990-1996.

Year Stocked	Total Number	Strain	Finclip
1990	35,370	Skamania	RM
	35,008	Chambers Cr.	LM
	34,761	Ganaraska	ARV
1991	43,622	Skamania	ARM
	35,022	Chambers Cr.	ALM
	37,035	Ganaraska	ALV
1992	39,383	Skamania	RM
	36,600	Chambers Cr.	LM
	34,629	Ganaraska	ARV
1993	35,276	Skamania	ARM
	27,963	Chambers Cr.	ALM
	37,781	Ganaraska	ALV
1994	30,417	Skamania	RM
	35,124	Chambers Cr.	LM
	34,759	Ganaraska	LV
1995	37,347	Skamania	ARM
	37,819	Chambers Cr.	ALM
	34,494	Ganaraska	ALV
1996	34,254	Skamania	RM
	34,579	Chambers Cr.	LM
	35,404	Ganaraska	ARV

Table 13. Population estimates for chinook, coho and steelhead salmon returning to the Root River in 1994 - 1996. No estimates for coho salmon in 1994 could be calculated because of small sample size. s.d. = standard deviation.

Year and species	Number of marked fish	Number of recaptured fish	Number of marked fish in recapture sample	Population size (± 1 s.d.)
Fall - 94				
Chinook	1,720	143	44	5,590 ± 701
Coho	513	2	0	-
Skamania	556	22	6	1,827 ± 539
Spring - 95				
Chambers Cr	1,653	117	45	4,298 ± 503
Ganaraska	453	74	11	2,718 ± 691
Fall - 95				
Chinook	2,663	36	21	4,478 ± 594
Coho	1,354	33	13	3,288 ± 651
Skamania	482	36	6	2,547 ± 811
Spring - 96				
Chambers Cr	1,045	48	28	1,765 ± 206
Ganaraska	1,457	77	31	3,551 ± 475
Fall - 96				
Chinook	5,440	37	36	5,587 ± 147
Coho	3,940	9	9	3,940 ± 0
Skamania	105	29	0	3,150 ± 2,189
Spring - 97				
Chambers Cr	900	38	6	5,014 ± 1,606
Ganaraska	139	23	5	5,356 ± 1,753

Appendix A. Average length (mm) and weight (kg) by age, sex and year of return of Lake Michigan strain chinook salmon examined in the Root River, fall 1994-1996. M=males, F=females, L=length, W=weight, sd=standard deviation and n=sample size.

Year of Return			AVERAGE LENGTH AT AGE 1+	2+	3+	4+	5+
1994	M	$\bar{L}$ (sd)	559.9 (53.4)				
		range	410-661				
		n	95				
	F	$\bar{L}$ (sd)	531.2 (44.3)				
		range	460-588				
		n	9				
1995	M	$\bar{L}$ (sd)	551.8 (74.8)	782.0 (84.9)			
		range	466-754	491-999			
		n	21	108			
	F	$\bar{L}$ (sd)	-	796.0 (39.9)			
		range	-	752-848			
		n	-	8			
1996	M	L (sd)	579.7 (53.3)	761.4 (64.7)	916.1 (74.9)		
		range	490-795	577-880	720-1067		
		n	100	107	58		
	F	$\bar{L}$ (sd)	830.0 (21.2)	774.5 (95.5)	884.4 (52.8)		
		range	815-845	707-842	724-965		
		n	2	2	47		

Year of Return			AVERAGE WEIGHT AT AGE 1+	2+	3+	4+	5+
1994	M	$\bar{W}$ (sd)	1.8 (0.8)				
		range	0.5-6.9				
		n	95				
	F	$\bar{W}$ (sd)	1.6 (0.4)				
		range	1.0-2.2				
		n	9				
1995	M	$\bar{W}$ (sd)	1.8 (0.8)	4.9 (1.5)			
		range	0.9-4.1	1.4-8.6			
		n	21	108			
	F	$\bar{W}$ (sd)	-	6.0 (1.3)			
		range	-	4.5-7.7			
		n	-	8			
1996	M	L (sd)	2.0 (0.7)	4.4 (1.2)	7.7 (2.1)		
		range	1.1-5.6	1.6-7.4	3.7-12.5		
		n	100	107	58		
	F	$\bar{L}$ (sd)	6.0 (0.2)	4.9 (1.8)	7.7 (1.4)		
		range	5.9-6.1	3.6-6.1	4.9-10.8		
		n	2	2	47		

Appendix B. Average length (mm) and weight (kg) by age, sex and year of return of Lake Ontario strain chinook salmon examined in the Root River, fall 1994-1996. M=males, F=females, L=length, W=weight, sd=standard deviation and n=number.

Year of Return		AVERAGE LENGTH AT AGE				
		1+	2+	3+	4+	5+
1994	M	$\bar{L}$ (sd)	736.6 (80.1)			
		range	451-883			
		n	83			
	F	$\bar{L}$ (sd)	695.4 (125.9)			
		range	476-770			
		n	5			
1995	M	$\bar{L}$ (sd)		849.3 (129.4)		
		range		569-999		
		n		31		
	F	$\bar{L}$ (sd)		845.6 (59.0)		
		range		630-951		
		n		69		
1996	M	L (sd)			974.0 (0.0)	
		range			974	
		n			1	
	F	$\bar{L}$ (sd)			827.0 (1.7)	
		range			825-828	
		n			3	

Year of Return		AVERAGE WEIGHT AT AGE				
		1+	2+	3+	4+	5+
1994	M	$\bar{W}$ (sd)	4.1 (1.3)			
		range	0.8-7.1			
		n	83			
	F	$\bar{W}$ (sd)	3.7 (1.6)			
		range	1.1-5.1			
		n	5			
1995	M	$\bar{W}$ (sd)		6.6 (2.7)		
		range		1.8-13.2		
		n		31		
	F	$\bar{W}$ (sd)		6.9 (1.5)		
		range		2.3-10.5		
		n		69		
1996	M	L (sd)			10.1 (0.0)	
		range			10.1	
		n			1	
	F	$\bar{L}$ (sd)			6.8 (1.3)	
		range			5.9-8.3	
		n			3	

Appendix C. Average length (mm) and weight (kg) by stocking age, sex, age and year of return of finclipped coho salmon examined in the Root River, fall 1995-96. M=males, F=females, L=length, W=weight, sd=standard deviation and n=number.

			AVERAGE LENGTH AT AGE			
Year of Return			Fingerling Stocked		Yearling Stocked	
			1+	2+	1+	2+
1995	M	$\bar{L}$ (sd)	392.9 (23.6)		388.4 (34.5)	
		range	338-444		315-577	
		n	100		134	
	F	$\bar{L}$ (sd)	426.5 (4.9)		541.0 (0)	
		range	423		541	
		n	2		1	
1996	M	L (sd)	380.8 (24.6)	690.6 (61.6)	418.3 (33.0)	669.3 (60.2)
		range	316-443	422-798	353-506	346-785
		n	99	112	99	259
	F	$\bar{L}$ (sd)	426.5 (4.9)	671.1 (41.6)	486.3 (95.1)	657.1 (38.1)
		range	423	392-769	392-665	530-741
		n	2	200	6	264

			AVERAGE WEIGHT AT AGE			
Year of Return			Fingerling Stocked		Yearling Stocked	
			1+	2+	1+	2+
1995	M	$\bar{W}$ (sd)	0.6 (0.2)		0.6 (0.2)	
		range	0.5-0.9		0.5-1.8	
		n	100		134	
	F	$\bar{W}$ (sd)	0.9 (0)		1.8 (0)	
		range	0.9		1.8	
		n	2		1	
1996	M	L (sd)	0.5 (0.1)	3.0 (0.7)	0.7 (0.2)	2.7 (0.7)
		range	0.3-0.9	0.8-4.8	0.4-1.3	0.4-4.4
		n	99	112	99	259
	F	$\bar{L}$ (sd)	426.5 (4.9)	3.0 (0.6)	1.3 (0.8)	2.8 (0.6)
		range	423	0.6-5.2	0.5-2.8	1.1-4.6
		n	2	200	6	264

Appendix D. Average length (mm) and weight (kg) by stocking age, sex, age and year of return of finclipped and unclipped coho salmon examined in the Root River, fall 1994-1996. M=males, F=females, L=length, W=weight, sd=standard deviation and n=number.

Year of Return			AVERAGE LENGTH AT AGE Hyper-accelerated fingerlings 1+	 2+	 Yearling Stocked 1+	 2+
1994	M	$\bar{L}$ (sd) range n			378.2 (25.5) 336-528 72	
	F	$\bar{L}$ (sd) range n			452.0 (136.6) 368-656 4	
1995	M	$\bar{L}$ (sd) range n	548.8 (58.7) 391-719 55			666.1 (89.1) 492-815 66
	F	$\bar{L}$ (sd) range n	538.7 (44.7) 454-625 45			657.8 (70.2) 476-782 75
1996	M	L (sd) range n		738.0 (0.0) 738 1		
	$\bar{F}$	L (sd) range n				

Year of Return			AVERAGE WEIGHT AT AGE Hyper-accelerated fingerlings 1+	 2+	 Yearling Stocked 1+	 2+
1994	M	$\bar{W}$ (sd) range n			1.1 (0.3) 0.7-3.0 72	
	F	$\bar{W}$ (sd) range n			2.5 (2.5) 1.2-6.3 4	
1995	M	$\bar{L}$ (sd) range n	1.5 (0.6) 0.5-3.2 55			2.9 (0.6) 0.9-5.5 66
	F	$\bar{L}$ (sd) range n	1.6 (0.4) 0.9-2.7 45			2.8 (1.0) 0.9-5.0 75
1996	M	L (sd) range n		3.2 (0.0) 3.2 1		
	F	$\bar{L}$ (sd) range n				