U.S. Fish and Wildlife Service
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Fisheries Resource Monitoring Program

Extend Coghill Lake Adult Escapement Operations

Final Report for Study 00-035

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Title: Extend Coghill Lake Adult Escapement Weir Operations

Study Number: 00-035

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Geographic Area: Cook Inlet – Gulf of Alaska (Prince William Sound)

Information Type: Stock Status and Trends

Issues Addressed: The Coghill drainage supports one of the largest coho salmon runs in western Prince William Sound and contributes to commercial drift gillnet, purse seine, sport, and subsistence fisheries. There is limited information on the annual return size or run timing. The new road into Whittier is expected to increase visitor use in Prince William Sound by over 600%. Coghill Lake's proximity to Whittier increases the likelihood that the drainage's salmon resources will experience an increase in harvest pressure.

Study Cost: $75,000

Study Duration: August 2000 to September 2002

Abstract: Operation of the weir at Coghill River was extended into the fall to determine escapement of coho salmon. The estimated escapements from weir counts were 765 in 2000, 1,258 in 2001, and 2,328 in 2002. However, weir operations were hampered by high flow events causing missed counts during high migration periods. In response, a mark recapture experiment was added in 2002 to estimate total escapement (±50%, 95% of the time). Using Chapman's modification of the Peterson model, we estimated the population size at 4,932 fish (SE=945). If monitoring coho salmon is planned in the future, we recommend using a floating type weir. If a less precise estimate is required, a mark recapture experiment could be conducted much more efficiently and cost effectively. Although there were problems with using a picket type weir in the fall, it is apparent that the coho salmon population is relatively small and could be susceptible to overharvest if use increases dramatically. As this population of coho salmon is one of the largest in western Prince William Sound, we recommend further monitoring if use increases substantially.

Key Words: subsistence fishery, coho salmon, Oncorhynchus kisutch, Coghill River, weir, Prince William Sound, Chugach National Forest

Project Data: *Description* - Data for this study consists of daily coho salmon escapement records, sex, age, weight, and length samples, and mark-recapture information. *Format* – Daily salmon escapement counts, sex, age, weight, length, and mark-recapture data is in ASCII format and mark-recapture data is in excel format. Biological samples include scale impressions on

cellulose acetate slides. *Custodian* – Alaska Department of Fish and Game, 401 Railroad Avenue, Cordova, Alaska 99574. Scale cards and data forms. *Availability* – Access to scale cards and data is available upon request to custodian.

Report Availability: Please contact either the authors or Alaska Resource Library and Information Services to obtain a copy of this report.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

INTRODUCTION

Little is known about the escapement and run timing of coho salmon, *Oncorhynchus kisutch*, in the Coghill River located in northwestern Prince William Sound (PWS). Rural residents of Whittier, Chenega, and Tatitlek use the Coghill River and adjacent areas are used for subsistence harvest. The river is more popular as a sportfishing destination for Alaska residents and out-of-state anglers between July 4 and September 9. Approximately 100 individuals visit the Coghill River area during the summer, many staying at the United States Forest Service (USFS) cabin located near Coghill Lake to fish for salmon in the Coghill River (Figure 1). Fishermen and other recreational users often travel to the Coghill River for day trips.

The new road into Whittier is estimated to increase visitation to PWS dramatically (Alaska Department of Transportation and Public Facilities 1995). The Coghill River's proximity to Whittier increases the likelihood of conflicts among users, thus the importance of collecting annual escapement and stock characteristic data before conflicts occur.

The goal of this project was to extend the operation of an existing weir to learn more about the run timing and escapement of coho salmon. Every year, the Commercial Fisheries Division of the Alaska Department of Fish and Game (ADF&G) operates an adult weir on the Coghill River to provide escapement data for inseason management of sockeye, *Oncorhynchus nerka,* and pink salmon, *Oncorhynchus gorbuscha*. Limited historical data indicates that most coho salmon enter the system from mid –August through late September (Appendix A).

OBJECTIVES

1. Count adult coho salmon passing the Coghill River weir
2. Determine age, sex, and length of adult coho salmon
3. Provide a mark recapture estimate of the escapement of coho salmon past the weir +/- 50%, 95% of the time.
4. Provide inseason and postseason reporting of adult coho salmon escapement to the U.S. Forest Service and the U.S. Fish and Wildlife Service, Office of Subsistence Management.

METHODS

Weir: As part of the cooperative agreement with the USFS and with funding from the Federal Subsistence Board, ADF&G continued operation of the Coghill River weir from mid-August through October 1 for the years 2000 to 2002 to enumerate coho salmon in the river. The weir was located approximately 1.6 km upstream of the mouth of the Coghill River and consisted of metal tripods set in the river with aluminum stringer rails and boardwalks between the tripods (Figure 1). The aluminum stringer rails were perforated allowing the insertion of conduit pickets through the stringers close enough together to preclude fish passage. There was also a live box

on one end of the weir to facilitate fish sampling. Personnel pulled several pickets at a time and counted fish as they passed through the weir.

Age, sex, and length data were collected for one out of every six coho salmon counted. Each coho salmon sampled was measured to the nearest millimeter from mid-eye to the fork of the tail, three scales were taken from each fish from two rows above the lateral line on the diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin, and sex was determined using external morphology. Scales were cleaned, moistened and mounted on standard gum cards as described by Bilton (1975). Scale impressions were later made on cellulose acetate. Scale growth patterns were examined to determine the age of each fish by ADF&G technicians in the Cordova office.

Mark-recapture: In 2002, Chapman's modification of the Peterson estimator (Seber, 1982) was used to estimate population size for coho salmon. To determine the sample size for marking fish past the weir, the following equation was used (Robson and Regier, 1964):

$M = C = (\check{N} X)/(1+X) \qquad X = \{(D/N-1)\}0.5$

where, $\check{N}$ = preseason "guestimate" of abundance, M= the proposed number to mark and release during the first sampling event, C = the number captured during the second sampling event, and X = a constant. The estimate of $\check{N}$ = 1012 is an average of the 2000 and 2001 coho salmon estimated returns to Coghill Lake. For 1-% = 0.95, A = 0.50, and D = 24.4 (from Table 2, Robson and Regier, 1964) the sample size needed is 136 fish or an average of one in seven fish to receive a mark. This would require capture of the same number fish to meet for the above confidence limits.

Fish marking: One in six fish were marked keeping a consistent fraction of fish passing the weir. This was slightly more than needed to meet the above confidence limits, but these fish were already being handled to determine age, sex and length. Only healthy fish received a circular punch in the upper lobe of the caudal fin. Additionally, the following information was recorded: the daily number of fish at the weir that passed upstream of the weir marked, unmarked, died at the weir, and the number of "fresh and unspawned" marked and unmarked fish found dead on the face of the weir.

Recapture: Areas known to contain coho salmon were sampled upstream of the weir to obtain repeated estimates of the proportion marked using hook and line and beach seines. Fish caught were examined for a punch in the upper lobe of the caudal fin and given a secondary mark (adipose clip). Fish sampled received a second mark to exclude them from future sampling tallies (sampling w/o replacement). Only whole fish were used for sampling, including carcasses. Carcasses received a knife slash in the left side. The following information was recorded: date, time, set number, location (latitude and longitude coordinates), number of live coho salmon with no mark, mark in upper caudal lobe, and marks in both upper and lower lobes of caudal. The same was recorded for carcasses as well.

Analysis: Two sample Kolmogorov-Smirnov tests were used to determine if capture rates differed due to size for: cumulative length distributions of fish marked in the first event with

those recaptured in the second event, and the cumulative length distributions of all fish marked in the first event with all fish captured in the recapture event (Daniel 1978). The Chapman's modification of the Peterson estimator was used to calculate a population estimate (Seber 1982):

$$\check{N} = \frac{(M+1)(C+1)}{(R+1)} - 1$$

Where: $\check{N}$ = abundance of fish during the first event, M = number of fish marked and released in the first event, R = number of marked fish recaptured in the second event, and C = number of fish examined for marks in the second event.

Variance was estimated by:

$$\text{Var}(\check{N}) = \frac{(M+1)(C+1)(M-R)(C-R)}{(R+1)^2(R+2)}$$

RESULTS

Weir: *2000*: From July 21 through October 1, 2000, a total of 765 coho salmon were counted (Figure 2). The first coho salmon was observed at the weir on July 21 with seven coho salmon counted during the following week (Appendix A). On July 28 and 29, heavy rainfall caused the river level to rise placing the weir in danger of washing out. Weir pickets were pulled to relieve increasing water pressure on the weir. As a result, no counts were made from July 29 through August 5. By August 6, the water level had dropped allowing safe operation of the weir and normal fish counting operations resumed.

The weir crew began collecting age, sex, and length data on August 21. Since fish passage rates were highly variable the crew established three sampling periods to ensure an adequate sample. Coho averaged 602 mm in length with 57.4% of fish age 1.1, 41.0% age 2.1, and 1.6% age 3.1 (Tables 1 and 2).

2001: From July 10 through September 30, 2001, a total of 1,258 coho salmon were counted. The first coho salmon was observed at the weir on July 10. On July 21 and 22, the area experienced heavy rainfall increasing the river's water level, placing the weir in danger of washing out. The weir crew was forced to pull pickets in order to relieve the increasing water pressure. As a result, no counts were made from July 22 through July 24. By July 25, the water level had dropped sufficiently to allow safe operation of the weir and normal fish counting operations resumed. Coho salmon were not observed again until July 27 (Table 1). On August 19, heavy rainfall again forced the weir crew to pull pickets to alleviate the increasing water pressure. As a result, no counts were made from August 20 through August 22. The weir was in working order and counts resumed on August 23. Heavy rainfall resulted in the weir pickets being pulled on August 28 through September 2 and from September 5 through September 7.

The weir crew began collecting age, sex, and length data on August 21. Since fish passage rates were highly variable the crew established three sampling periods to ensure an adequate sample.

Coho salmon averaged 579 mm in length with 81.4% of fish age 1.1, 17.9% age 2.1, and 0.7% age 3.1 (Tables 1 and 3).

2002: From July 19 though September 12, 2002, a total of 2,328 coho salmon were counted. The first two coho salmon were observed at the weir on July 21 with only ten coho salmon counted during the following week (Appendix A). On August 10, August 20, and September 12, heavy rainfall caused the river's water level to rise. As a result, no counts were made from August 11 through August 14, and from August 21 through August 25. On the morning of September 13, the weir crew reported that five inches of rain had been recorded from the previous evening. The weir crew had pulled a number of pickets earlier in the evening as the water level increased. Due to this rain event, the water level of the river increased so rapidly and with such force that most of the weir tripods, boardwalks, picket stringers, and remaining pickets to be washed downstream. Many of the weir parts were damaged as well. Therefore, the last count for the season was conducted on September 12.

The weir crew began collecting age, sex, and length data on August 8. Since fish passage rates were highly variable the crew established three sampling periods to ensure an adequate sample. Coho salmon averaged 592 mm in length with 86.1% of fish age 1.1, and 13.9% age 2.1 (Tables 1 and 4).

***Mark-recapture 2002*:** When the weir was operational, one fish in six were marked and released for a total of 330. Recapture sampling occurred between September 23 and 26 above the weir site in the Coghill River, outlet of Coghill Lake and in one tributary. All other tributaries were checked for presence of coho salmon, and only one fish was found. Therefore it is reasonable to assume that we sampled where the majority of fish spawned. In all, we sampled 279 fish of which 19 were recaptures.

Analysis: Cumulative distribution functions of fish lengths were plotted and tested with Kolmogorov-Smirnov two sample tests. No significant differences were found when comparisons were made between the lengths of marked fish and total captures ($p>0.09$) or between lengths of marked and recaptured fish ($p>0.52$). Therefore, we concluded that there was no size selectivity during either sampling event. There were also no differences between the mark ratios of the two-recapture sites and the mark ratio at the weir (1.4) was much higher than the second sample (0.6). Therefore, we calculated one un-stratified abundance estimate. Additionally, fish had begun spawning activity just a few days prior to the second sampling period. It is reasonable to assume that we had minimal loss due to death after spawning. Approximately five carcasses were seen on the banks left by bears, but we were unable to ascertain whether or not they had a mark. The sample sizes of marked fish (n=330) and captured fish (n=229) were large enough to ensure minimal bias (<2%) when using the Chapman's modification of the Peterson estimator. We estimated the population size at 4,932 fish (SE=945).

DISCUSSION

The results of this study confirm that the coho salmon population in the Coghill River is relatively small. As this coho salmon population is considered to be one of the largest in western PWS and is located near Whittier (2.5 hrs by boat), it could be vulnerable to overexploitation if use increases substantially. Although no creel census was conducted, ADF&G personnel reported a relatively low level of use during the coho salmon run. At the current use level, this population does not appear to be threatened. However, given the small size of the population and likelihood of increased use, we recommend the USFS and ADF&G coordinate to develop a monitoring strategy to ensure the health of this population.

From the three years of weir operation in the fall, it is evident that picket style weirs are inadequate to withstand the increase in water discharge as a result of large rain events There were repeated occasions when pickets had to be removed to alleviate water pressure and there was one precipitation event that destroyed the entire weir. These weir failures often coincide with peak salmon migration. If a weir is used in the future, it should be designed with the highly variable flows in mind.

The mark recapture experiment worked well and may be worth considering a different variation of this method in the future for estimating population size if less precise information is desired. We found where most of the coho salmon were spawning and they were readily caught with beach seines or by hook and line. During the second sampling event, there was evidence of some degradation of the caudal punch. We were unable to determine whether or not a fish had a mark on only two occasions. However, if we had arrived just one week later after more spawning activity had occurred this problem would have increased. Therefore, we recommend that some other mark, such as an adipose or ventral fin clip be used in the future.

CONCLUSIONS

1. The coho salmon population is relatively small and could be vulnerable to overexploitation if use increases substantially
2. Picket type weirs in western PWS for larger drainages are not adequate for enumerating coho salmon during the fall.

RECOMMENDATIONS

1. Develop a monitoring plan for Coghill River coho salmon because of the likelihood of increased fishing pressure.
2. If further weir operations are planned to enumerate coho salmon, a floating type weir that is more resistant to large fluctuations in flows is advised.

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Table 1. Sample size, mean, standard deviation, minimum, and maximum length of coho salmon from the Coghill River, Prince William Sound, 2000 - 2002.

		Mid-eye to Fork Length (mm)				
Year	Sex	*n*	mean	SD	min	max
2000	Male	71	602	67	440	703
	Female	49	601	48	487	684
	Total	120	602	60	440	703
2001	Male	85	577	88	285	712
	Female	95	580	72	393	713
	Total	180	579	79	285	713
2002	Male	152	578	75	309	750
	Female	178	603	49	428	689
	Total	330	592	63	309	750

Table 2. Age, sex, and length data for coho salmon from the Coghill River weir, 2000.

	Age Class		
	1.1	2.1	3.1
Male			
n	23	13	1
Mean Length	592	617	680
Minimum Length	450	446	
Maximum Length	703	656	
Percentage of sample	37.7%	21.3%	1.6%
Female			
n	12	12	
Mean Length	604	578	
Minimum Length	515	487	
Maximum Length	661	669	
Percentage of sample	19.7%	0.2%	
Sexes Combined			
n	35	25	1
Mean Length	601	591	680
Minimum Length	446	487	
Maximum Length	703	669	
Percentage of sample	57.4%	41.0%	1.6%

Table 3. Age, sex, and length data for coho salmon from the Coghill River weir, 2001.

	Age Class		
	1.1	2.1	3.1
Male			
n	53	8	1
Mean Length	572	607	646
Minimum Length	392	469	
Maximum Length	709	671	
Percentage of sample	37.9%	5.7%	0.7%
Female			
n	61	17	
Mean Length	577	598	
Minimum Length	393	469	
Maximum Length	687	713	
Percentage of sample	43.6%	12.1%	
Sexes Combined			
n	114	25	1
Mean Length	575	601	646
Minimum Length	392	469	
Maximum Length	709	713	
Percentage of sample	81.4%	17.9%	0.7%

Table 4. Age, sex, and length data for coho salmon from the Coghill River weir, 2002.

	Age Class	
	1.1	2.1
Male		
n	109	22
Mean Length	582	575
Minimum Length	420	432
Maximum Length	750	722
Percentage of sample	38.8%	7.8%
Female		
n	133	17
Mean Length	607	600
Minimum Length	440	474
Maximum Length	689	682
Percentage of sample	47.3%	6.0%
Sexes Combined		
n	242	39
Mean Length	596	586
Minimum Length	420	432
Maximum Length	750	722
Percentage of sample	86.1%	13.9%

1. Age, sex, and length of coho salmon from the Coghill River weir, 2002.

1. Coghill Lake and River with locations of Alaska Department of Fish and Game Weir Camp and USFS Recreation Camp.

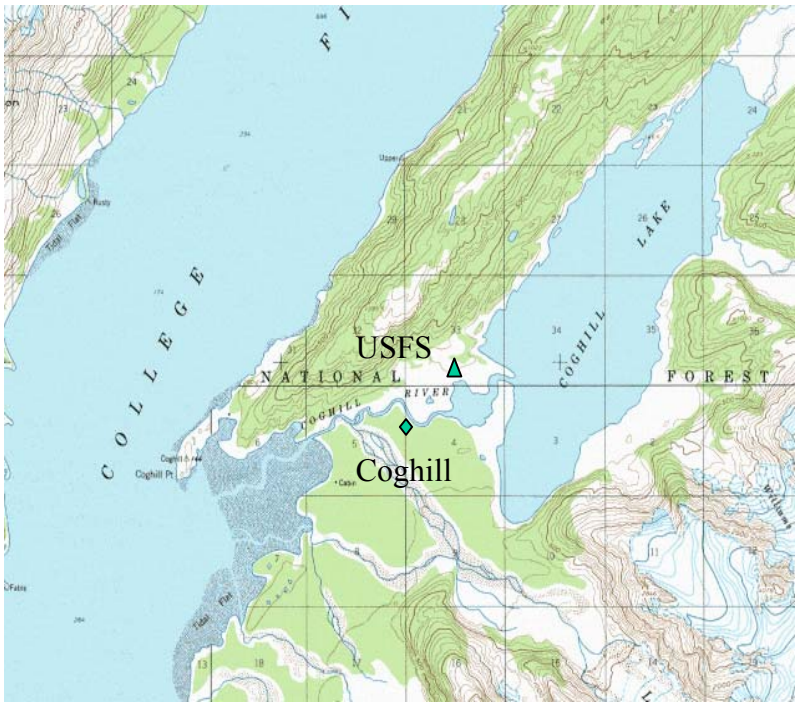
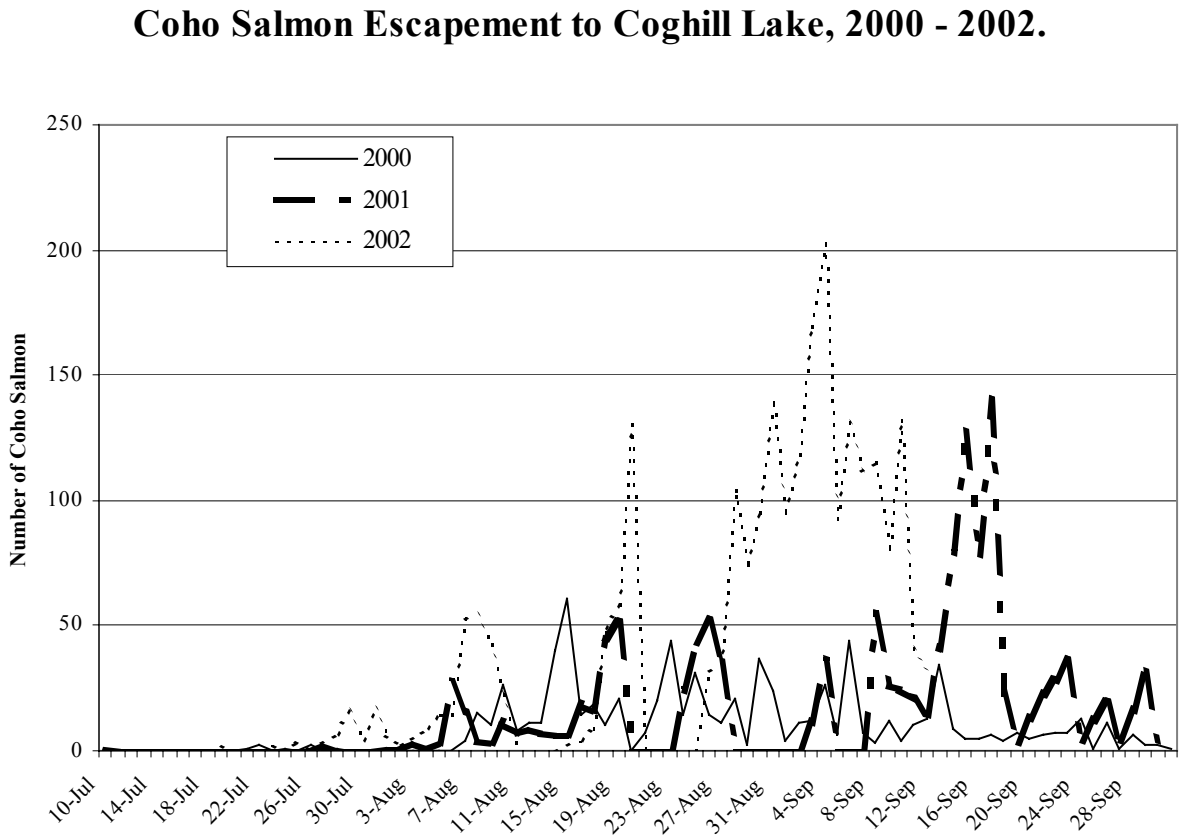


Figure 1. Coghill Lake and River with locations of Alaska

2. Daily counts of coho salmon passed through the Coghill River weir, 2000 - 2002.



A. Coho salmon counts by day through the Coghill River weir, 1991 – 2002.

	Year											
Date	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
10-Jul	0	0	0	0	0	0	0	0	0	0	1	0
11-Jul	0	0	0	0	0	0	0	0	0	0	0	0
12-Jul	0	0	0	0	0	0	0	0	0	0	0	0
13-Jul	0	0	0	0	0	0	0	0	0	0	0	0
14-Jul	0	0	0	0	0	0	0	0	0	0	0	0
15-Jul	0	0	0	0	0	1	0	1	0	0	0	0
16-Jul	0	0	0	0	0	0	0	0	0	0	0	0
17-Jul	0	0	0	0	0	0	0	1	0	0	0	0
18-Jul	0	0	0	0	1	0	0	1	0	0	0	0
19-Jul	0	0	0	0	0	4	0		0	0	0	2
20-Jul	0	0	0	0	0	0	0		0	0	0	0
21-Jul	0	0	0	0	0	1	0	1	0	1	0	0
22-Jul	0	0	0	0	0	2	0	1	0	2	*	0
23-Jul	0	0	0	0	1	3	0	3	0	0	*	2
24-Jul	0	0	0	0	1	0	0	3	0	1	*	0
25-Jul	0	0	1	1	1	0	0	4	0	0	0	4
26-Jul	0	0	0	0	5	1	0	8	0	2	0	1
27-Jul	0	0	0	0	1	1	0	0	0	0	2	3
28-Jul	0	0	0	0	1	1	0	4	0	1	0	6
29-Jul	0	0	0	0	1	3	0	7	0	*	0	16
30-Jul	0	0	0	2	4	11	0	5	0	*	0	4
31-Jul	0	0	1	2	4	8	0	4	0	*	0	17
1-Aug	1	0	3	1	6	7	0	15	0	*	1	6
2-Aug	0	0	4	2	0	7	0	6	0	*	1	2
3-Aug	0		1	1		9	0	1	0	*	3	5
4-Aug	0		3	0			2	1	0	*	1	9
5-Aug	1		3	1				3	0	*	3	14
6-Aug	0		2	1					0	0	27	14
7-Aug	0		0	5					0	4	15	53
8-Aug	0		0	5						15	4	54
9-Aug	1		1	1						10	3	42
10-Aug	1		1	0						26	11	22
11-Aug	0		0	1						8	7	*
12-Aug	0		0	6						11	9	*
13-Aug	0		1	2						11	7	*
14-Aug	4			2						40	6	*
15-Aug	1			5						61	6	2
16-Aug	4			10						14	18	4
17-Aug	15			8						18	16	9
18-Aug	33			4						10	45	49
19-Aug	25			6						21	51	58
20-Aug	8			0						0	*	130
21-Aug	1			28						7	*	*
22-Aug	1			8						20	*	*
23-Aug	1			4						44	*	*
24-Aug	0			0						14	24	*

25-Aug	10		9							31	43	*
26-Aug	8		7							14	52	32
27-Aug	1		157							11	35	34
28-Aug	2		90							21	*	104
29-Aug	1		72							2	*	74
30-Aug	0		63							37	*	95
31-Aug	0		35							24	*	139
1-Sep	0		9							4	*	95
2-Sep	0		13							11	*	118
3-Sep	0		21							12	11	169
4-Sep	2		15							26	36	202
5-Sep	123		0							6	*	93
6-Sep	18									44	*	131
7-Sep	13									7	*	112
8-Sep	219									3	54	115
9-Sep	130									12	26	81
10-Sep	106									4	25	132
11-Sep	65									10	21	41

-continued-

Appendix A. (page 2 of 2)

	Year											
Date	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
12-Sep	17									13	14	33
13-Sep	14									34	41	
14-Sep	19									9	79	
15-Sep	5									5	127	
16-Sep	2									5	78	
17-Sep	7									6	140	
18-Sep	4									4	23	
19-Sep	6									7	3	
20-Sep	6									5	13	
21-Sep	11									6	22	
22-Sep	4									7	28	
23-Sep	14									7	36	
24-Sep	3									13	4	
25-Sep										1	12	
26-Sep										11	19	
27-Sep										1	4	
28-Sep										6	16	
29-Sep										2	31	
30-Sep										2	4	
1-Oct										1		
Total Number Coho Salmon	907	31	21	597	26	59	2	69	0	765	1,258	2,328

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002

Weir in place	8-Jun	14-Jun	4-Jun	10-Jun	11-Jun	6-Jun	5-Jun	5-Jun	5-Jun	14-Jun	5-Jun	10-Jul
Weir pulled	24-Sep	2-Aug	13-Aug	5-Sep	2-Aug	3-Aug	4-Aug	5-Aug	7-Aug	1-Oct	1-Oct	13-Sep

* No counts as pickets pulled due to high water