2002 Fall Chinook Salmon Run Size in the Scott and Salmon Rivers and Miscellaneous Tributary Streams in the Mid Klamath Basin

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ABSTRACT

Cooperative spawning ground surveys were conducted on the Scott River, Salmon River, and in miscellaneous tributary streams to the Klamath River during the 2002 fall Chinook salmon spawning season. The fall Chinook salmon run size estimate for the Scott and Salmon Rivers was calculated using mark recapture estimators. The run size estimate for miscellaneous tributary streams was derived from redd surveys assuming that each redd supports two adult salmon. The California Department of Fish and Game (Department) estimates that approximately 4,308 fall Chinook salmon returned to the Scott River in the fall of 2002. Of these, 4,261 were adults and 47 were grilse. Fall Chinook salmon ranged in fork length from 44 cm to 111 cm. Grilse were determined to be ≤ 60 cm in fork length. Approximately 2,747 fall Chinook salmon were estimated to have returned to the Salmon River in 2002. Of these, 2,692 were adults and 55 were grilse. Fork lengths ranged from 32 cm to 110 cm and grilse were estimated to be ≤ 55 cm. A minimum of 1,316 fall Chinook salmon were estimated to have returned to the smaller tributary streams located with in the basin upstream of the confluence of the Trinity River. Dry year water conditions limited the distribution of most of the fall Chinook salmon to the lower 7 miles of the Scott River.

INTRODUCTION

The primary objective of the Klamath River Project (KRP) is to determine the size, composition, distribution and timing of runs of fall-run Chinook salmon in the Klamath River basin, excluding the Trinity River basin, annually. The California Department of Fish and Game (Department) has been monitoring fall Chinook salmon spawning escapement levels in the Klamath basin since 1978. To achieve this task the KRP employs several techniques which include a creel survey of sport fishing efforts, recovery of fish returning to Iron Gate Hatchery (IGH), completion of cooperative spawning ground surveys in major tributary streams and rivers, operation of a video fish counting weir on the Shasta River, and operation of a fish marking weir on Bogus Creek.

The methods used to develop fall Chinook salmon run size estimates for the Salmon River have evolved through time since the late 1970's. From 1979 through 1984 the estimate was derived from a limited number of spawning ground surveys that were generally completed by either the Department or the U.S. Forest Service (USFS). In 1985 the number of surveys and area covered by the survey was increased to improve the estimate. The area surveyed expanded to include twelve miles of the main stem, the South Fork from Hotelling Gulch to Forks of Salmon, and the North Fork from Sawyers Bar to Forks of Salmon. A temporary weir and fish marking facility was operated near the mouth of the Salmon River at Oak Bottom from 1986 to 1991. Spawning ground surveys were conducted to recover marked fish and document spawning distribution. The operation of the temporary weir was discontinued in 1992 in favor of conducting more intensive cooperative spawning ground surveys twice weekly. Elimination of the weir was deemed desirable to eliminate unnecessary handling stress on adult salmon during their migration upstream. The weir was also vulnerable to high flow and required a large investment of money and staff time to operate effectively. Over the years, participation in the cooperative spawning ground survey has grown substantially, and in

recent years has included staff from the Department, USFS, the Yurok and Karuk Tribe, the Salmon River Restoration Council, County schools, and local volunteers.

Similar efforts also have occurred on the Scott River since 1979. In the early years of the KRP, spawning ground surveys were conducted in the major spawning areas of the river which included about 5.5 miles of the Scott River near Etna and 4.75 miles of river downstream of the State Highway 3 Bridge crossing near Fort Jones. From 1989 through 1991 spawning ground surveys were limited to the lower river because high flows hampered the migration of fall Chinook salmon to spawning areas upstream. In 1982 a temporary fish marking weir was installed on the lower river at river mile 1.6 and was operated during each spawning season until 1991. Operation of the weir was often affected by high flows, and beginning in 1992 operation of the weir was dropped in favor in conducting more intensive mark recapture spawning ground surveys in cooperation with USFS fisheries staff.

In 1994 the California State Legislature passed the Leslie Amendment (SB 779). The passage of SB 779 requires Departmental staff to obtain landowner permission prior to accessing private lands to conduct biological investigations. The entire length of the Scott River within the Scott Valley passes through privately owned agricultural lands. Although the Scott River likely meets the standards that have been established for navigable easements, the Northern California-North Coast Region of the Department began requesting landowners permission to access the Scott River as it passes through private lands prior to conducting spawning ground surveys along the river. As a result, since 1994, spawning ground surveys have been limited to those areas of the river on private land where landowner permission was granted each year. The level of cooperation from local landowners has varied over the years. However, during the 2001 and 2002 spawning seasons, the number of landowners that have denied permission for access has increased dramatically. Controversies associated with the recent proposed listing of coho salmon under the California Endangered Species Act (CESA) substantially reduced the amount of cooperation provided by local landowners to the extent that the Department has been denied permission to survey nearly all of the Chinook salmon spawning reaches present in the Scott Valley.

Spawning ground surveys have also been conducted in several other miscellaneous tributary streams over the history of the KRP. All of the surveys are conducted with the assistance of the USFS, Yurok Tribe, Karuk Tribe, Salmon River Restoration Council and local volunteers. Although the number and location of tributary streams surveyed each year varies based on run size and availability of staff, most of the major streams have been surveyed on a fairly consistent basis each year. These have generally included Aikens Creek, Beaver Creek, Bluff Creek, Boise Creek, Camp Creek, China Creek, Clear Creek, Dillon Creek, Elk Creek, Grider Creek, Horse Creek, Independence Creek, Indian Creek, Irving Creek, Perch Creek, Red Cap Creek, Rock Creek, Swillup Creek, Slate Creek, Thompson Creek, Ti Creek, and Walker Creek.

METHODS

The annual Chinook salmon run-size estimate for the Salmon and Scott Rivers is derived from mark recapture data obtained from salmon carcasses observed during the cooperative spawning ground survey. The run-size estimate for other tributary streams is developed from redd counts extrapolated by an assumed number of two fish per redd plus the number of live fish observed on the last day of the survey. The Salmon and Scott Rivers were surveyed twice each week during the spawning run. The Salmon River survey was conducted on every Monday and Thursday and the Scott River survey was conducted on every Tuesday and Friday. Miscellaneous tributary streams were surveyed every Wednesday. Surveys began during the second week of October and continued into early December.

On the morning of each survey, crews of at least two people were given daily instructions, data sheets, field equipment, vehicle assignments, and were assigned a survey reach. Crews walked or kayaked their assigned reach in a downstream direction looking for salmon carcasses and spawning redds. All new redds were flagged along the river bank at a location perpendicular to the upstream limit of the redd pit. These locations were then recorded on USGS topographic maps once each week. When a carcass was located crew members identified each to species and gender, checked for marks or tags, obtained a fork length (FL) measurement, collected a scale sample for age composition analysis, and examined females for spawning success.

For purposes of the mark recapture estimate, each carcass was categorized into one of four pathways (Paths). Fresh carcasses, those with clear eyes and/or firm flesh were designated as Path 1. Individually numbered jaw tags were attached to the lower right jaw of all Path 1 carcasses and returned to the river for potential recapture during later surveys. Older carcasses, those with cloudy eyes and/or mushy flesh, were categorized as Path 2. All Path 2 carcasses were cut in half and returned to the river after all biological data was collected. Path 3 carcasses included all of the Path 1 carcasses (with jaw tag) that were recaptured during subsequent surveys. Any carcasses that could be observed by a survey crew but could not be retrieved for data collection, because they were located in inaccessible or unsafe locations, were designated as Path 4. Path 4 designations were rarely encountered during the survey.

The preliminary Chinook salmon run-size estimate was calculated using the Petersen Method and the Schafer Method was used to calculate the final estimate (Ricker, 1975). The Petersen Method is used to calculate the preliminary estimate because of its simplicity. The calculation is as follows:

$$\text{Escapement} = \frac{(M+1)(C+1)}{(R+1)}$$

Where:
- M = The number of salmon carcasses tagged (Path 1) during the survey.
- C = The total number of salmon carcasses examined during the survey.
- R = The number of tagged salmon carcasses recovered (Path 3) during the survey.

The Schafer equation was used to estimate the final Chinook salmon run size for each river based as follows:

$$\text{Escapement} = \sum((R_{ij})(M_i/R_i)(C_j/R_j))$$

Where:
- M = The total number of fish marked
- M_i = The number of fish marked in period i
- R_i = The total number of marked fish recaptured in period i
- R_j = The total number of marked fish recaptured in period j
- C = The total number of fish recaptured during the season
- C_j = The total number of fish recaptured in period j

The final run size estimate for both the Salmon and Scott rivers was derived by adding the number of live Chinook salmon observed on the last day of the survey to the Schafer estimate. On the Salmon River, the number of spring-run Chinook salmon observed during the USFS spring Chinook surveys, conducted in July, is subtracted from the population estimate in those reaches where spawning of spring and fall Chinook salmon overlap.

SURVEY REACHES

The survey reaches have remained fairly consistent since the beginning of the cooperative spawning ground survey in 1992. During the Chinook salmon spawning season, decisions regarding which reaches should be surveyed was based on the known distribution of the Chinook salmon run each week, the available labor force present during each survey, and on private lands was limited to those areas where permission has been granted by private landowners.

A total of 16 survey reaches, covering approximately 53.6 river miles, have been identified on the Scott River (Table 1). Access to private lands along the Scott River is critically important to the survey in those spawning areas that are present in Scott Valley. The most important Chinook salmon spawning areas within Scott Valley are located downstream of the State Highway 3 Bridge crossing (rm 34.6) to the USGS gauging station located at river mile 21 (Reaches 8, 9, and 10), and in that reach of the river located downstream of Young's Dam (rm 46) to about river mile 42 located upstream of the Eller Lane Bridge crossing (Reaches 12,13, and 14).

A total of 14 survey reaches have been identified for fall Chinook salmon within the Salmon River which includes 6 reaches within the South Fork Salmon River and 4 reaches within the North Fork Salmon River (Table 2). Wooly Creek is also included in the survey and is denoted as reach 13.

Table 1. Description of cooperative spawning ground survey reach locations along the Scott River, CA.

Reach Number	Downstream Limit	RM	Upstream limit	RM	Length (miles)
1	Mouth	0.00	Mid Point	2.60	2.60
2	Mid Point	2.60	Pat Ford Ck	4.90	2.30
3	Pat Ford Ck	4.90	George Allen Gulch	7.80	2.90
4	George Allen Gulch	7.80	Townsend Gulch	10.50	2.70
5	Townsend Gulch	10.50	Bridge Flat	14.20	3.70
6	Bridge Flat	14.20	Jones Beach	18.20	4.00
7	Jones Beach	18.20	USGS Stream Gage	21.00	2.80
8	USGS Stream Gage	21.00	Meamber Bridge	24.40	3.40
9	Meamber Bridge	24.40	Dunlop	29.50	5.10
10	Dunlop	29.50	Highway 3 Bridge	35.60	6.10
11	Highway 3 Bridge	35.60	Eller Lane	41.10	5.50
12	Eller Lane	41.10	Sweezy Bridge	42.10	1.00
13	Sweezy Bridge	42.10	Horn Lane	43.90	1.80
14	Horn Lane	43.90	Young's Dam	46.00	2.10
15	Young's Dam	46.00	Fay Lane	49.60	3.60
16	Fay Lane	49.60	East Fork Confluence	53.60	4.00

Table 2. Description of cooperative spawning ground survey reach locations along the Salmon River, CA.

Reach Number	River	Downstream Limit	RM	Upstream limit	RM	Length (miles)
1	Main Stem	Mouth	0.00	Wooley Ck.	5.00	5.00
2	Main Stem	Wooley Ck.	5.00	Grant Bluffs	9.00	4.00
3	Main Stem	Grant Bluffs	9.00	Nordheimer Ck.	14.80	5.80
4	Main Stem	Nordheimer Ck	14.80	Forks of Salmon	19.50	4.70
5a	South Fork	Forks of Salmon	0.00	Henry Bell Ck.	3.00	3.00
5b	South Fork	Henry Bell Ck.	3.00	O'Farrel Gulch	5.00	2.00
6a	South Fork	O'Farrel Gulch	5.00	Indian Ck.	8.20	3.20
6b	South Fork	Indian Ck.	8.20	Matthews Ck.	10.00	1.80
7	South Fork	Matthews Ck.	10.00	French Ck.	14.10	4.10
8	South Fork	French Ck.	14.10	Cecilville	17.50	3.40
9	North Fork	Forks of Salmon	0.00	Post Mile 4.0	4.00	4.00
10	North Fork	Post Mile 4.0	4.00	Post Mile 8.0	8.00	4.00
11	North Fork	Post Mile 8.0	8.00	Post Mile 12.0	12.00	4.00
12	North Fork	Post Mile 12.0	12.00	Post Mile 16.0	16.00	4.00

RESULTS

Scott River

A total a total of 2,440 carcasses were examined during the survey on the Scott River. Of these, crews tagged 1,026 (Path 1) carcasses and recovered 595 (Path 3) carcasses for a recovery rate of 57.9%. The Petersen model estimated the run size to be 4,222 fish (Appendix A) and the Schafer model estimated a run size of 4,292 fish (Appendix B). A total of 16 live Chinook salmon were observed during the last survey which brings to the total estimate (Schafer estimate + live Chinook) to 4,308 fish.

Chinook salmon males ranged in size from 44 cm to 111 cm in FL (Figure 12) and female Chinook salmon ranged in size from 52 cm to 100 cm in FL (Figure 13). Grilse were determined to be ≤60 cm in FL and comprised approximately 1% of the total run.

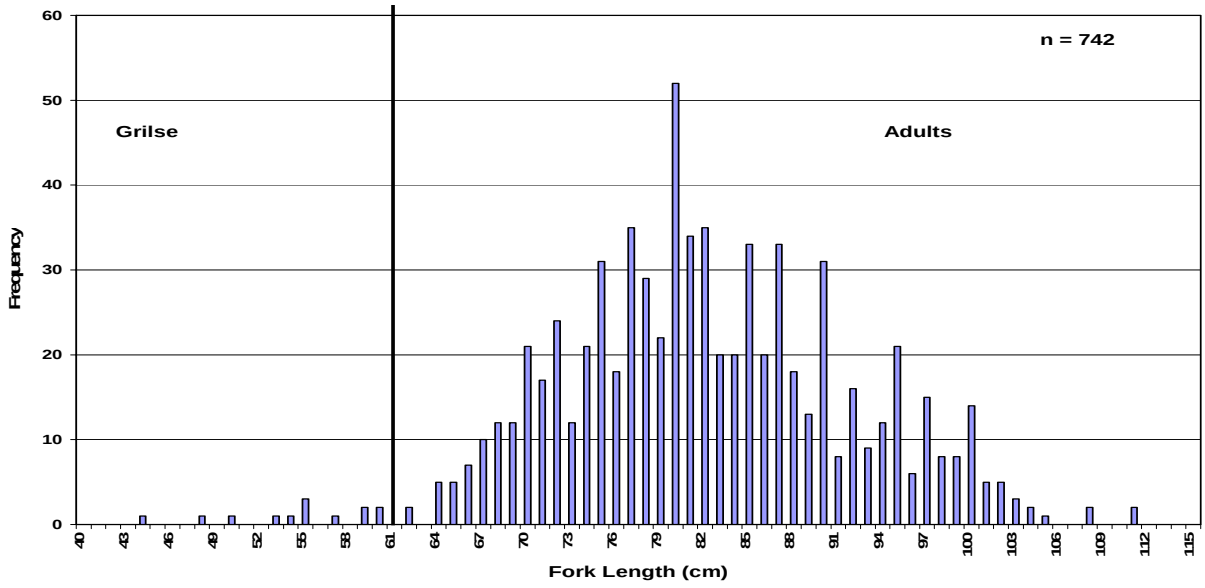

Figure 12. Length frequency distribution of male Chinook salmon observed on the Scott River during spawning ground carcass surveys conducted during the 2002 season.

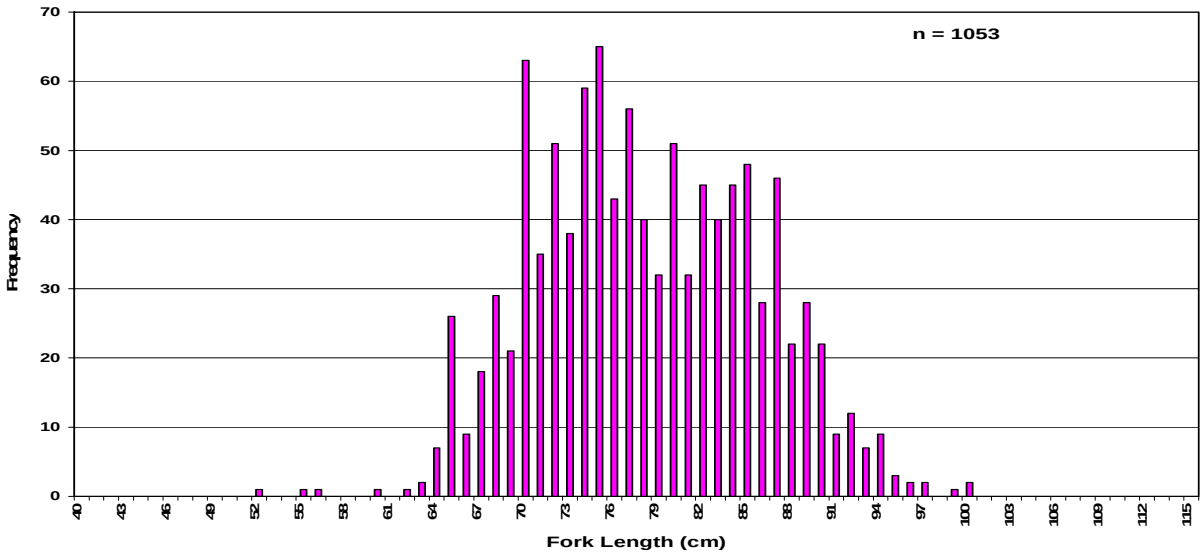

Figure 13. Length frequency distribution of female Chinook salmon observed on the Scott River during spawning ground carcass conducted in 2002.

Low flows persisted in the Scott River throughout the month of October and into the first week of November. Flows during this period ranged from 12 cubic feet per second (cfs) to 35 cfs. Several low flow migration obstacles are formed in the lower 20 miles of the Scott River under these low flow conditions. Although some fish manage to pass over these obstacles, the majority of the run was delayed and these fish elected to spawn in the lower reaches of the river rather than in their historic spawning grounds located upstream in Scott Valley.

On November 8th flows in the Scott River began to rise in response to winter storms that passed through the region. By November 9th the average daily flow in the Scott River peaked at 167 cfs. By November 14th, flows dropped to less than 100 cfs, and by November 18th, flows dropped to about 60 cfs where they remained throughout the remainder of the Chinook salmon spawning season (Figure 14). Several Chinook salmon moved upstream during this brief increase in flow and the vast majority of these fish appear to have spawned in the lower reaches of Scott Valley upstream of the USGS flow gauge located near Fort Jones.

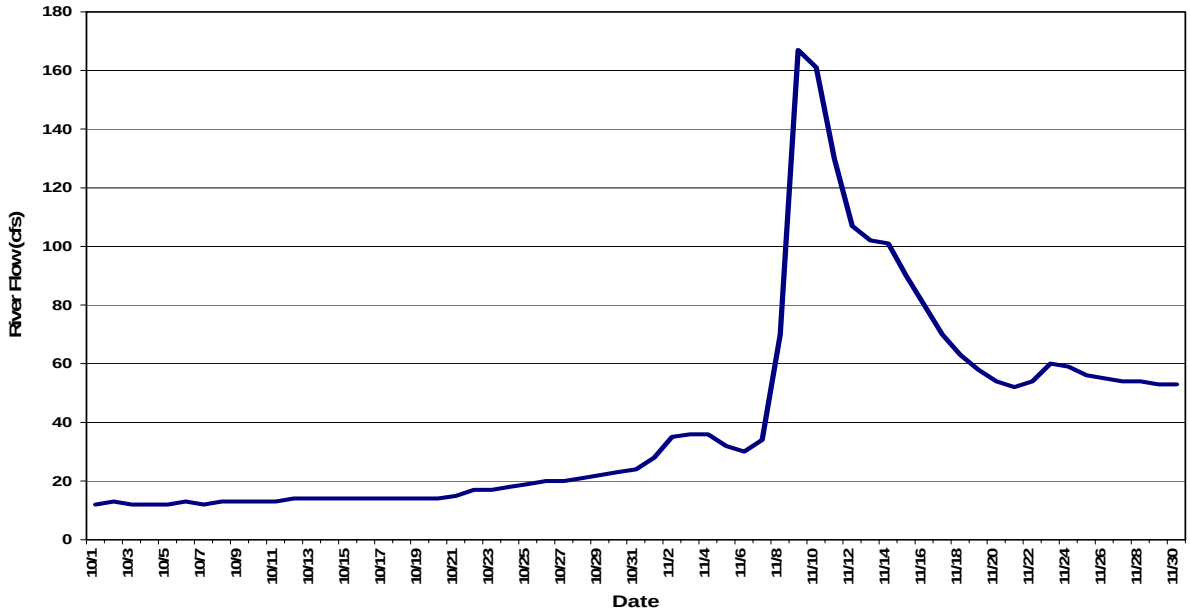

Figure 14. Average daily flows (cfs) observed in the Scott River at the USGS gauge located near Fort Jones.

A summary of fall Chinook salmon survey data collected during the 2002 season is presented in Appendix C. Surveys were conducted in reaches 1 through 5, reach 8, and in the lower portion of reach 9 where landowner permission was granted. Reconnaissance surveys were conducted in reaches 6 and 7 and found only limited use in these two reaches. Based on this information, and the limited amount of survey crews that were available, more intensive spawning ground surveys were not conducted in either of these two reaches during the season. The number of spawning redds observed during the season within each reach was, from greatest to least, 342 in reach 1, 235 in reach 3, 158 in reach 2, 88 in reach 4, 74 in reach 8, 44 in reach 5, and no redds were observed in the lower section of reach 9.

Although the Department had permission to survey most of the river downstream of the Meamber Road Bridge, where most of the spawning in the upper river was observed, Department requests to survey additional areas located throughout the majority of the Scott Valley upstream were denied by private landowners. Based on roadside surveys and discussions with local citizens it does not appear that significant numbers of Chinook salmon spawned in these reaches. Therefore, the Department does not believe that our inability to survey these upstream areas significantly affected the run size estimate for 2002.

A total of eight coho salmon carcasses were observed in the lower river downstream of Townsend Gulch during the survey. Four were males, three of them ranged in FL from 72 cm to 81 cm, and one could not be measured. The other four were females with FLs of 74 cm, 77 cm, 77 cm, and 78 cm. All of the females appeared to have spawned

successfully. None of the coho salmon examined had any fin clips or maxillary clips indicating that they were not of hatchery origin.

Salmon River

A total of 1,719 Chinook salmon carcasses were observed on the Salmon River during the 2002 season. Five hundred ninety (590) carcasses were tagged (Path 1) and 329 tagged carcasses were recovered (Path 3) for a recovery rate of 55.7%. The Petersen model estimated the run size to be 2,633 fish (Appendix A) and the Schafer model estimated a total of 2,747 Chinook salmon (Appendix B).

Male Chinook salmon ranged in FL from 33 cm to 110 cm (Figure 15), and females ranged in FL from 32 cm to 103 cm (Figure 16). Based on examination of the length frequency distribution, grilse were determined to be ≤55 cm in FL. Based on this analysis, adult salmon comprised 98% (2,692 fish) of the run and grilse comprised 2% (55 fish) of the run.

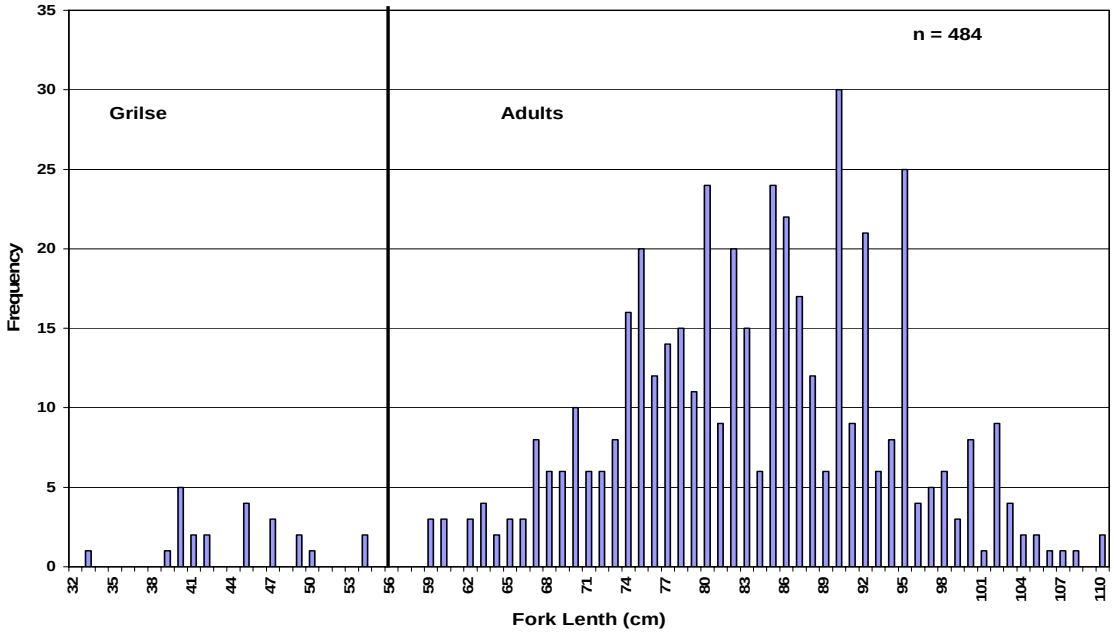

Figure 15. Length frequency distribution of male Chinook salmon observed on the Salmon River during spawning ground surveys conducted during the 2002 season.

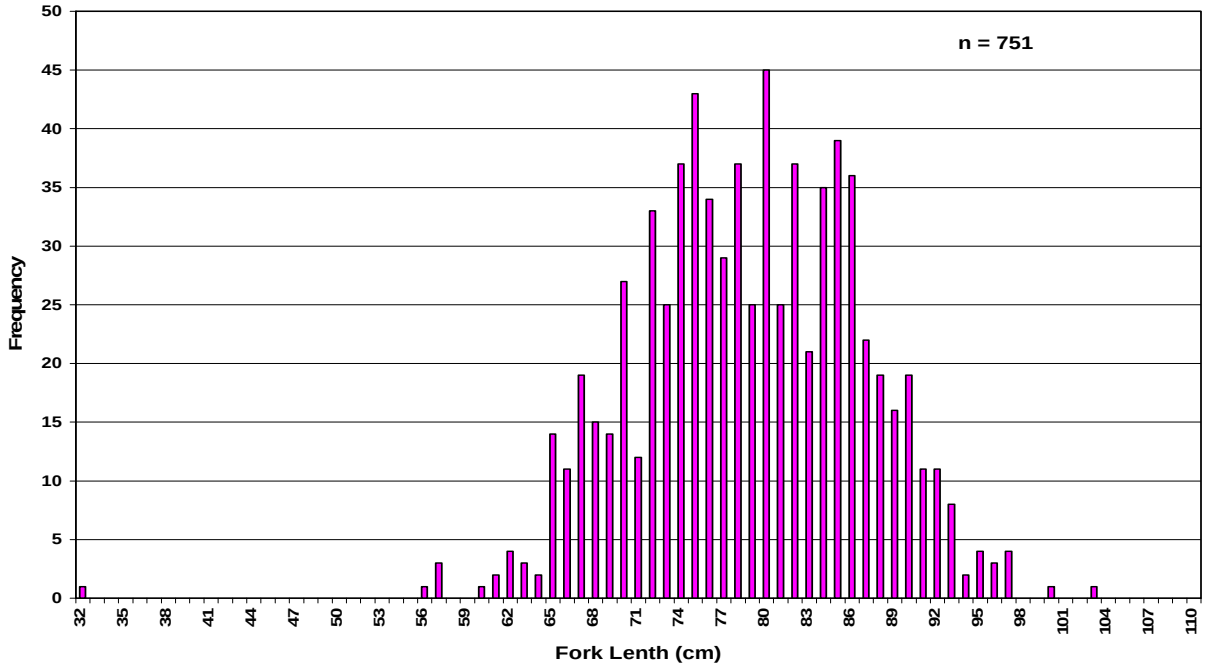

Figure 16. Length frequency distribution of female Chinook salmon observed in the Salmon River during spawning ground carcass surveys conducted during the 2002 season.

Average daily flows in the Salmon River, as measured at USGS Gauge #11522500 located near Somes Bar, ranged from a low of 115 cfs to high of 1,020 cfs during the survey period (Figure 17). From October 14th through November 7th flows remained low ranging from 115 cfs to 197 cfs. Flows began to increase rapidly after November 7th in response to rain and snow accumulations. On November 9th the average daily flow peaked at 1,050 cfs and then began to decline over the next several days until November 14th when the average daily flow was 504 cfs. The survey that was scheduled to occur on November 11th was cancelled because of dangerously high flows and snow accumulations. From November 14th though until December 2nd, when the last survey was conducted, flows in the river ranged between 504cfs to 288cfs. With the exception of the single high flow event, sampling conditions remained favorable throughout the survey period.

A summary of fall Chinook salmon survey data which displays results of the carcass survey and redd survey by reach and survey date, is provided in Appendix D. A total of 1,551 redds were observed during the survey. Although Chinook salmon redds were observed in all reaches, the greatest concentration of spawning occurred in the main stem, upstream of Nordheimer Ck (266 redds), and the lowest reach of the South Fork (188 redds) and North Fork (343 redds).

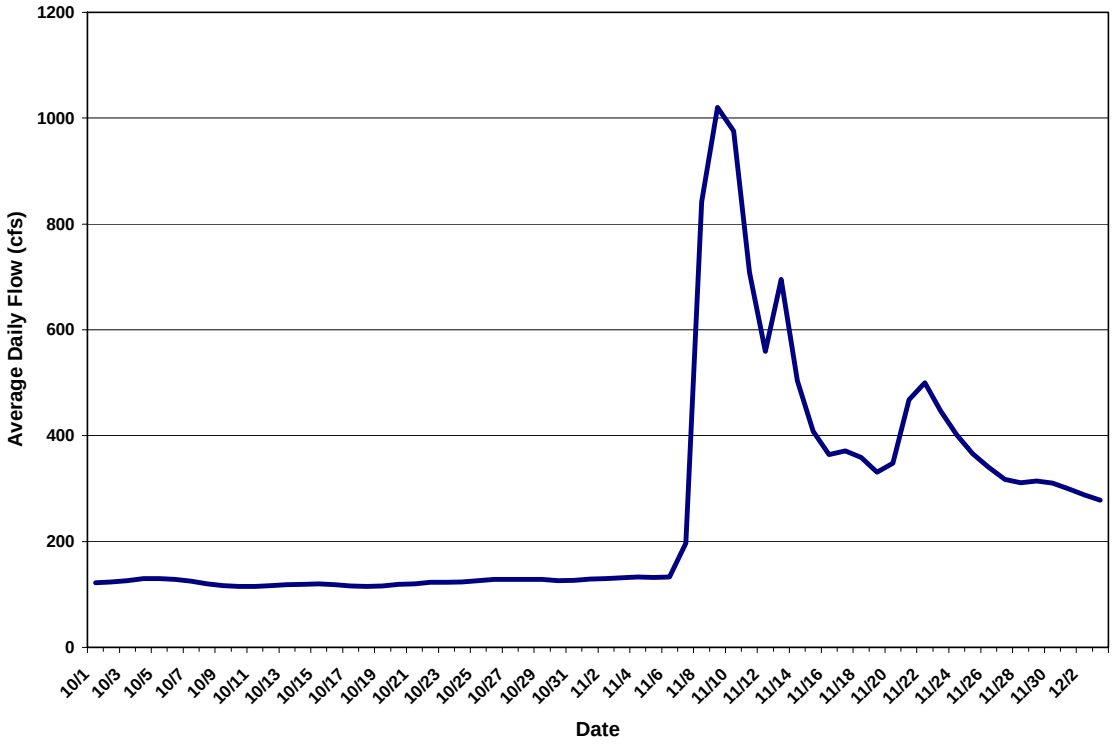

Figure 17. Average daily flows recorded for the Salmon River at the USGS gauging station (# 11522500) located near Somes Bar from October 1 to December 3, 2002. Data are provisional at this time.

Miscellaneous Klamath Tributary Streams

Fall-run Chinook salmon spawner surveys on the smaller tributary streams began on October 8 and ended on December 4, 2002. Crews handled a total of 141 Chinook salmon carcasses and were able to measure 102 of these carcasses. The sizes of those Chinook salmon carcasses ranged from 48 cm to 108 cm in FL and with an average FL of 78.4 cm.

The population estimates for the smaller tributary streams is derived by multiplying the number or redds observed by a factor of 2 and adding the number of live fish observed on the last day of the survey for each tributary stream. Based on these assumptions, the Department conservatively estimates that approximately 1,316 fall-run Chinook salmon spawned in these smaller tributary streams to the Klamath River above the confluence with the Trinity River (Table 6). Since these tributaries are only surveyed periodically, the estimates presented in Table 6 are considered to be minimum estimates.

Table 6. Summary of the Chinook salmon redd surveys for the smaller Klamath River streams in the 2002 season.

Stream	Total Redds	Lives Last survey[a/]	2002 Population Estimate	2001 Population Estimate
Aiken Creek	7	0	14	0
Beaver Creek	34	30	98	426
Bluff Creek	16	4	36	33
Boise Creek	6	0	12	0
Camp Creek	87	6	180	224
China Creek	b/		0	0
Clear Creek	149	0	298	246
Dillon Creek	16	1	33	140
Elk Creek	115	2	232	200
Grider Creek	112	0	224	449
Horse Creek	11	7	29	0
Independence	0	0	0	16
Indian Creek	1	2	4	149
Irving Creek	0	0	0	0
Perch Creek	0	0	0	0
Red Cap Creek	53	2	108	139
Rock Creek	0	0	0	0
Slate Creek	0	0	0	0
Swillup	0	0	0	0
Thompson Creek	24	0	48	218
Ti Creek	0	0	0	0
Walker Creek	0	0	0	0
Totals	631	54	1,316	2,240

a/ The number of live Chinook salmon observed on the last day of the redd surveys.

b/ Data not available at this time.

DISCUSSION

The Department's Klamath River Project has been conducting run size estimates for the Klamath basin since 1978. As discussed in the Introduction of this report, the methods used to conduct these estimates for the Scott and Salmon Rivers have changed over the years as better survey techniques and cooperation with other stakeholders has matured through time. The cooperative spawning surveys began in 1992 and since that time have remained as the most reliable method to estimate Chinook salmon escapement levels in the Scott and Salmon Rivers. Cooperators in the 2002 survey included staff from the U.S. Forest Service, the Yurok Tribal Fisheries Department, the Karuk Natural Resources Department, the Salmon River Restoration Council, the Siskiyou Resource Conservation District, local schools, and volunteers.

Scott River

During the 2002 season the Department estimates that 4,308 Chinook salmon entered the Scott River to spawn. Since 1978 the number of Chinook salmon in the Scott River has ranged from a low of 1,615 fish in 1990 to a high of 14,477 fish in 1995. The average run size estimate for the last 25 years is 5,579 fish. The 2002 Chinook salmon run ranks as the 14th highest run for the period of record and is 1,271 fish short of the average run size (Table 7).

Table 7. Run size estimates for fall Chinook salmon observed in the Scott River from 1978 through 2002.

Year	Grilse	Adults	Total
1978	1,909	3,423	5,332
1979	428	3,396	3,824
1980	2,245	2,032	4,277
1981	3,409	3,147	6,556
1982	4,350	5,826	10,176
1983	170	3,398	3,568
1984	358	1,443	1,801
1985	1,357	3,051	4,408
1986	4,865	3,176	8,041
1987	797	7,769	8,566
1988	473	4,727	5,200
1989	1,188	3,000	4,188
1990	236	1,379	1,615
1991	146	2,019	2,165
1992	965	1,873	2,838
1993	265	5,035	5,300
1994	505	2,358	2,863
1995	3,279	11,198	14,477
1996	145	11,952	12,097
1997	277	8,284	8,561
1998	266	3,061	3,327
1999	563	3,021	3,584
2000	524	5,729	6,253
2001	744	5,398	6,142
2002	47	4,261	4,308
Average	1,180	4,398	5,579

Dry conditions and low river flows hampered the upstream migration of adult salmon and, as a result, a large portion of the Chinook salmon run spawned in the lower seven miles of the river upstream and downstream of Scott Bar. There are several migration obstacles distributed throughout the lower canyon reaches that hamper upstream migration of Chinook salmon during low flow conditions. The most severe of these obstacles is a large cobble and boulder bar located near the confluence of Big Ferry Ck. Other lesser obstacles that are flow related are also present throughout the canyon reach

and some these include a small bedrock falls and cobble bar located a short distance downstream of George Allen Gulch, the waterfall located adjacent to the Scott River Lodge, a large cobble bar located above Kelsey Ck., and the high gradient boulder reach located near the confluence of Boulder Ck.

Chinook salmon redds that are constructed within the canyon reaches are likely more vulnerable to scour should flood flows occur later in the season when young salmon embryos are still developing within the redd. The high gradient and confined channel characteristics within the canyon increase the likelihood for substantial bed scour during high flows. Should significant channel scour occur during a flood, developing embryos could be washed downstream negatively impacting survival of the brood year. In addition, during low flow periods, Chinook salmon tend to construct redds near or in the thalweg of the channel increasing the potential that these redds could be impacted by a large flow. During the survey we also observed several salmon spawning on gravel tailings created by small suction dredge operations during the previous summer. Although these areas can create good gravel conditions for redd construction, they also tend to be unstable since they generally rise above the natural bed surface, and are thus more vulnerable bed scour during high flows.

As fry Chinook salmon begin to emerge in early spring they distribute in near shore microhabitats with slow water velocities. When the majority of adult spawning occurs in the lower seven miles of the river the amount of rearing habitat available in the same reach may not be adequate to support the large numbers fry produced. To the contrary, if adult Chinook salmon are able to spawn in the upper river, as occurs in normal and wet water years, emerging fry salmon would have access to a much greater length of river and rearing habitat which would likely increase survival and growth of the brood year.

To improve migration conditions through the canyon reach during critically dry water year's future investigations should be conducted on the major migration obstacles to help determine minimum flow levels that would be necessary to improve fish passage upstream so that Chinook salmon have access to spawning areas located higher in the basin. Any decisions to improve migration conditions, either through increased flow or barrier modifications, should be balanced with full appreciation of the natural channel morphology, historical flow conditions and competing water demands.

Salmon River

The Department estimates that 2,747 fall Chinook salmon entered the Salmon River during the 2002 spawning season. Since 1978 the number of fall Chinook salmon in the Salmon River has ranged from a high of 6,000 fish in 1997, to a low of 780 fish in 1999 (Table 8). The average run size from 1978 through 2002 is 2,836 fish. The 2002 fall Chinook salmon run ranks as the 14th highest run and is just 89 fish short of the average run size that has been observed thus far.

Table 8. Run size estimates for fall Chinook salmon observed in the Salmon River from 1978 through 2002.

Year	Grilse	Adults	Total
1978	1,400	2,600	4,000
1979	150	1,000	1,150
1980	200	800	1,000
1981	450	750	1,200
1982	300	1,000	1,300
1983	75	1,200	1,275
1984	216	1,226	1,442
1985	905	2,259	3,164
1986	949	2,716	3,665
1987	118	3,832	3,950
1988	327	3,273	3,600
1989	695	2,915	3,610
1990	596	4,071	4,667
1991	143	1,337	1,480
1992	547	778	1,325
1993	456	3,077	3,533
1994	277	3,216	3,493
1995	1,335	4,140	5,475
1996	274	5,189	5,463
1997	217	5,783	6,000
1998	116	1,337	1,453
1999	110	670	780
2000	228	1,544	1,772
2001	743	2,607	3,350
2002	55	2,692	2,747
Average	435	2,400	2,836

On November 9th the average daily flow in the Salmon River peaked at 1,050cfs and high flows forced the cancellation of the survey scheduled to occur on November 11th. Many of the carcasses that were present in the river just prior to the high flow were likely washed downstream. Although this probably impacted on our recovery efforts, it does not appear, based on our overall carcass recovery rate (55.7%), to have had a significant impact on the run size estimate calculations.

Implications of the Lower Klamath River Fish Die Off

On September 19th of 2002 the Department received reports of dead and moribund adult salmon in the lower 36 miles of the Klamath River. In response to these reports the Department and the U.S. Fish and Wildlife Service, with assistance from the Yurok Tribal Fisheries Department, Hoopa Valley Tribe, and the Karuk Natural Resources Department, conducted an investigation to determine the extent and probable cause of the fish die off. Two disease pathogens, a protozoan parasite, *Ichthyopthirus multifilis* (Ich), and the bacterial pathogen, *Flavobacterium columnare* (Columnaris), were determined to

be the immediate cause of death (Guillen 2003a). Both pathogens attach to the sides and gills of the host. Heavy infestations of theronts, the intermediate lifecycle stage of Ich, on the gills of the host can cause severe damage to the gill epithelia tissues which eventually result in death of the host by asphyxiation. Columnaris also infects the gill epithelia resulting in necrosis of the gill tissues which impede the host's ability to effectively retrieve and distribute oxygen to the body and also disrupt osmoregulatory functions. Gross symptoms of these two combined pathogens include numerous white spots on the gills and skin, lesions, clubbing and erosion of gill filaments, and pale gill color.

The U.S. Fish and Wildlife Service estimated that a minimum of 34,056 fish died in the lower Klamath of which, 32,533 were estimated to be fall Chinook salmon (Guillen 2003b). Of the 32,533 fall Chinook that perished a little over 7,000 (22%) were of hatchery origin from either Trinity River Hatchery or Iron Gate Hatchery. The remaining 25,533 (78%) fall Chinook salmon were not of hatchery origin and would likely have spawned naturally with in the basin.

It is nearly impossible to determine the origin, and therefore, anticipated destination, of those natural origin fall Chinook salmon that died in the lower Klamath River. Since 1978, the contribution of fall Chinook salmon spawners in the Scott and Salmon Rivers, when compared to the entire population estimate of naturally spawning Chinook salmon with in the Klamath River basin, has averaged approximately 9.2% and 4.7%, respectively. In 2002 the fall Chinook salmon run in the Scott and Salmon Rivers contributed approximately 6.2% and 3.9% of the total naturally spawning run of fall Chinook salmon in the basin. Both the contribution Scott and Salmon River fall Chinook salmon runs were low when compared to the average contribution rate that has been observed since 1978. However, the average run size of fall Chinook salmon with in the Scott River in 2002 was 1,271 fish less than the average run size that has been observed over the last 24 years, and in the Salmon River was only 89 fish less the average observed in the same period.

During the cooperative spawning ground survey on the Scott River the Department did observe some fresh mortalities of Chinook salmon that exhibited signs of disease, gill erosion and clubbing of gill filaments (Figure 18). Although these observations were rare and anecdotal in nature, it does appears that some adult salmon that survived the initial disease epizootic in the lower river and were able to survive long enough to continue their migration upstream to the lower Scott River were they eventually died.

The long term ramifications of the 2002 fish die off in the lower Klamath River on natural fall Chinook salmon populations in the Scott and Salmon Rivers is uncertain at this time and will depend largely on the survival of those progeny that were produced in 2002. Additional insights on the actual impacts of the lower river fish die off upon the 2002 fall Chinook salmon run in the Salmon and Scott Rivers may become discernable after the 2007 season when progeny from the 2002 cohort have completed their life-cycle. Fortunately, the 2002 fall Chinook salmon run was relatively large and thus, the impacts of the fish die off on natural populations may have been alleviated.

Figure 18. Adult fall Chinook salmon that was observed on the lower Scott River during the 2002 spawning season that exhibits symptoms of severe gill erosion and clubbing likely caused by the disease outbreak that occurred in the lower Klamath River in September of 2002. Photos are courtesy of Mr. Jim Morris, Etna High School.

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APPENDIX A

Petersen Mark and Recapture Estimate for the Scott River in 2002

$$\text{Petersen Estimate} = \frac{(M+1)(C+1)}{(R+1)}$$

Where: M = The number of salmon carcasses tagged (Path 1) during the survey.
C = The total number of salmon carcasses examined during the survey.
R = The number of tagged salmon carcasses recovered (Path 3) during the survey.

M = 1026
C = 2440
R = 595

Petersen Estimate = ((1026+1)(2440+1))/(595+1)
= 4,206

Total Run Size Estimate = 4,206 + 16 (live Chinook observed on last survey)
= 4,222 Fish

Petersen Mark and Recapture Estimate for the Salmon River in 2002

$$\text{Petersen Estimate} = \frac{(M+1)(C+1)}{(R+1)}$$

Where: M = The number of salmon carcasses tagged (Path 1) during the survey.
C = The total number of salmon carcasses examined during the survey.
R = The number of tagged salmon carcasses recovered (Path 3) during the survey.

M = 590
C = 1595
R = 329

Petersen Estimate = ((590+1) (1595+1))/(329+1)
= 2,858

Total Estimate = 2858 – 481 (Spring Run) +15 (live Chinook) +241 (Wooly Creek Est.)
= 2,633 Fish

APPENDIX B

Schafer Mark and Recapture Estimate for the Scott and Salmon Rivers in 2002

The Schafer equation was used to estimate the final Chinook salmon run size as follows:

$$\text{Escapement} = \sum((R_{ij})(M_i/R_i)(C_j/R_j))$$

Where:
- M = The total number of fish marked.
- M_i = The number of fish marked in period i.
- R_i = The total number of marked fish recaptured in period i.
- R_j = The total number of marked fish recaptured in period j.
- C = The total number of fish recaptured during the season.
- C_j = The total number of fish recaptured in period j.

Appendix B cont.

Summary of tagged fish recovery efforts during the 2002 Chinook Salmon Survey on the Scott River

		Tagging Period (i)																
		10/15	10/18	10/22	10/25	10/29	11/1	11/5	11/8	11/12	11/15	11/19	11/22	11/26	12/3			
Survey Date	Recovery Period (j)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	∑ Rj	∑ Cj	Cj/Rj
10/18	1	1	1													2	22	11.00
10/22	2		4													4	64	16.00
10/25	3			22												22	103	4.68
10/29	4			6	33	1										40	204	5.10
11/1	5		1		2	61	4									68	184	2.71
11/5	6				3	4	52	3								62	203	3.27
11/8	7			1			2	19	2							24	121	5.04
11/12	8					2	1	11	22	3						39	226	5.79
11/15	9							4	2	33	3					42	207	4.93
11/19	10						1	1	3	9	50	4				68	326	4.79
11/22	11				2	1		4	2	1	7	43	8			68	196	2.88
11/26	12							3	1	5	2	15	32	4		62	289	4.66
12/3	13		1			2	1	2	2		2	1	10	32	3	56	173	3.09
12/6	14								1	1		7		5	15	29	104	3.59
# Recovered (Ri) =		1	7	29	40	71	61	47	35	52	64	70	50	41	18	586	2422	77.54
# tagged (Mi) =		2	12	45	58	92	88	107	67	114	99	153	75	91	24			
Mi/Ri =		2.00	1.71	1.55	1.45	1.30	1.44	2.28	1.91	2.19	1.55	2.19	1.50	2.22	1.33			

Appendix B cont.

Schafer Estimate Calculation Worksheet for the 2002 Chinook Salmon Survey on the Scott River

		Tagging Period (i)														
		10/15	10/18	10/22	10/25	10/29	11/1	11/5	11/8	11/12	11/15	11/19	11/22	11/26	12/3	
Date	Recovery Period (j)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
10/18	1	22	18.857	0	0	0	0	0	0	0	0	0	0	0	0	40.86
10/22	2	0	109.71	0	0	0	0	0	0	0	0	0	0	0	0	109.71
10/25	3	0	0	159.83	0	0	0	0	0	0	0	0	0	0	0	159.83
10/29	4	0	0	47.483	244.04	6.6085	0	0	0	0	0	0	0	0	0	298.13
11/1	5	0	4.6387	0	7.8471	213.88	15.614	0	0	0	0	0	0	0	0	241.98
11/5	6	0	0	0	14.243	16.97	245.62	22.362	0	0	0	0	0	0	0	299.19
11/8	7	0	0	7.8233	0	0	14.546	218.08	19.302	0	0	0	0	0	0	259.75
11/12	8	0	0	0	0	15.018	8.3598	145.12	244.05	38.112	0	0	0	0	0	450.66
11/15	9	0	0	0	0	0	0	44.881	18.869	356.56	22.872	0	0	0	0	443.19
11/19	10	0	0	0	0	0	6.9161	10.914	27.532	94.592	370.8	41.914	0	0	0	552.66
11/22	11	0	0	0	8.3588	3.7349	0	26.248	11.035	6.319	31.21	270.9	34.588	0	0	392.39
11/26	12	0	0	0	0	0	0	31.836	8.923	51.095	14.421	152.82	223.74	41.383	0	524.22
12/3	13	0	5.2959	0	0	8.006	4.4567	14.066	11.828	0	9.5575	6.7523	46.339	219.41	12.357	338.07
12/6	14	0	0	0	0	0	0	0	6.865	7.8621	0	54.869	0	39.798	71.724	181.12
Total		22.00	138.51	215.13	274.48	264.22	295.51	513.50	341.54	546.68	448.86	472.39	304.67	260.80	12.36	**4,292**

Total Chinook salmon run size estimate including 16 live Chinook salmon observed on the last survey = 4,308

Appendix B cont.

Summary of tagged fish recovery efforts during the 2002 Chinook Salmon Survey on the Salmon River																
		Tagging Period (i)														
		14-Oct	17-Oct	21-Oct	24-Oct	28-Oct	31-Oct	4-Nov	7-Nov	14-Nov	18-Nov	21-Nov	25-Nov			
Survey Date	Recovery Period (j)	1	2	3	4	5	6	7	8	9	10	11	12	∑ Rj	∑ Cj	Cj/Rj
10/17	1	2												2	70	35.00
10/21	2	1	20	1										22	259	11.77
10/24	3			62	1									63	250	3.97
10/28	4			5	51	2								58	224	3.86
10/31	5		1	2	10	37	8							58	164	2.83
11/4	6	1	2	8	6	5	23	5						50	205	4.10
11/7	7				2	4	1	21	1					29	74	2.55
11/14	8					1			2					3	65	21.67
11/18	9						2			6	3			11	100	9.09
11/21	10										13			13	46	3.54
11/25	11						1	1		1		4	1	8	54	6.75
12/2	12					1			1		2		3	7	46	6.57
# Recovered (Ri) =		4	23	78	70	50	35	27	4	7	18	4	4	324	1557	111.7
# Tagged (M_i) =		9	50	138	119	70	54	62	15	19	30	17	7			
Mi/Ri =		2.25	2.17	1.77	1.70	1.40	1.54	2.30	3.75	2.71	1.67	4.25	1.75			

Appendix B cont.

Schafer run size estimate summary for the 2002 fall Chinook salmon run on the Salmon River														
		Tagging Period (i)												
		10/14	10/17	10/21	10/24	10/28	10/31	11/4	11/7	11/14	11/18	11/21	11/25	
Survey Date	Recovery Period (j)	1	2	3	4	5	6	7	8	9	10	11	12	Total
10/17	1	157.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	157.50
10/21	2	26.49	511.86	20.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	559.18
10/24	3	0.00	0.00	435.29	6.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	442.03
10/28	4	0.00	0.00	34.16	334.84	10.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	379.82
10/31	5	0.00	6.15	10.01	48.07	146.47	34.90	0.00	0.00	0.00	0.00	0.00	0.00	245.59
11/4	6	9.23	17.83	58.03	41.82	28.70	145.49	47.07	0.00	0.00	0.00	0.00	0.00	348.17
11/7	7	0.00	0.00	0.00	8.68	14.29	3.94	123.05	9.57	0.00	0.00	0.00	0.00	159.52
11/14	8	0.00	0.00	0.00	0.00	30.33	0.00	0.00	162.50	0.00	0.00	0.00	0.00	192.83
11/18	9	0.00	0.00	0.00	0.00	0.00	28.05	0.00	0.00	148.05	45.45	0.00	0.00	221.56
11/21	10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	76.67	0.00	0.00	76.67
11/25	11	0.00	0.00	0.00	0.00	0.00	10.41	15.50	0.00	18.32	0.00	45.00	11.25	100.49
12/2	12	0.00	0.00	0.00	0.00	9.20	0.00	0.00	24.64	0.00	21.90	0.00	32.86	88.60
	sub total	193.21	535.83	558.32	440.15	239.81	222.80	185.62	196.71	166.37	144.03	45.00	44.11	**2,972**
	Total fall Chinook salmon run size estimate (2,972 - 481 Spring Chinook + 15 lives + 241 Chinook in Wooly Ck.) =													**2,747**

Appendix C. Summary of Chinook salmon data collected on the Scott River, 2002.

Reach	15-Oct		18-Oct		22-Oct		25-Oct		29-Oct		1-Nov		5-Nov		8-Nov		12-Nov		15-Nov		19-Nov		22-Nov		26-Nov		3-Dec		6-Dec		Totals by reach	
1	0	0	10	1	41	2	46	23	75	35	61	59	77	50	38	18	31	19	72	18	65	58	32	62	7	8	5	22	0	3	560	378
	2	0	6	0	12	0	20	1	68	0	22	0	21	0	20	0	45	0	52	0	68	0	35	0	4	1	23	0	0	0	398	2
	988	131	920	24	936	101	851	34	773	16	468	6	525	1	169	0	200	3	188	5	69	4	43	3	5	0	3	0	0	14	6138	342
2	1	0	2	1	2	1	10	0	10	5	20	8	26	11	21	6	59	15	11	10	35	5			14	23	4	3	0	4	215	92
	0	0	2	0	3	1	1	3	4	6	4	0	11	0	8	0	19	0	6	0	11	0			60	0	3	0	3	0	135	10
	501	76	550	23	311	12	468	25	288	0	341	17	250	3	41	0	105	0	53	1	56	1			12	0	1	0	0	0	2977	158
3	0	0	0	0	2	0	2	1	1	0	7	1	4	2			14	1	12	3	15	4			9	0	4	6	3	4	73	22
	0	0	0	0	0	0	1	0	0	1	1	0	1	0			1	0	2	0	11	0			13	0	27	0	33	0	90	1
	256	11	175	34	390	52	197	14	219	16	267	12	252	5			83	0	91	91	100	0			14	0	1	0	1	0	2046	235
4	0	0							5	0	0	1					5	0			29	0			13	2			0	7	52	10
	0	0							0	0	1	0					1	0			5	0			22	0			16	0	45	0
	35	22							79	26	13	0					120	0			135	15			19	22			1	3	402	88
5	0	0							1	0					0	0													0	0	1	0
	0	0							0	0					0	0													16	0	16	0
	3	4							106	40					2	0													1	0	112	44
6																																
7																																
8															8	0	5	4	3	3	9	3	43	6	48	30	11	28	0	12	127	86
															2	0	7	1	6	0	8	0	18	0	36	0	37	0	7	1	121	2
															43	5	74	14	76	12	99	23	110	20	60	0	6	0	5	0	473	74
9 1/													0	0	0	0			1	0			0	0			0	0			1	0
													0	0	0	0			0	0			0	0			0	0			0	0
													0	0	0	0			2	0			0	0			0	0			2	0
Totals	1	0	12	2	45	3	58	24	92	40	88	69	107	63	67	24	114	39	99	34	153	70	75	68	91	63	24	59	3	30	1029	588
by	2	0	8	0	15	1	22	4	72	7	28	0	33	0	30	0	73	1	66	0	103	0	53	0	135	1	90	0	75	1	805	15
Day	1783	244	1645	81	1637	165	1516	73	1465	98	1089	35	1027	9	255	5	582	17	410	109	459	43	153	23	110	22	11	0	8	17	12150	941

1/ Surveys in Reach 9 were limited to the Pastures of Heaven property. Permission to access all other private properties upstream of this point were denied.

Key	
Path 1	Path 3
Path 2	Path 4
Live	Redds

Path 1= fresh carcass jaw tag applied.
Path 2= decayed carcass not suitable for tag application.
Path 3= recovery of path 1 carcass with a jaw tag.
Path 4= carcass observed but could not be retrieved during survey.
Live = the number of live chinook salmon observed during the survey for that day and reach.
Redds = the number of fresh redds observed during the survey.

Appendix D. Summary of Chinook salmon data collected on the Salmon River, 2002

Reach	8-Oct		14-Oct		17-Oct		21-Oct		24-Oct		28-Oct		31-Oct		4-Nov		7-Nov		14-Nov		18-Nov		21-Nov		25-Nov		2-Dec		Totals by reach	
1	0	0	0	0			0	0			0	0			0	0					0	0			0	0			0	0
	0	0	2	0			5	0			2	13			5	0					16	0			5	0			35	13
	741	4	741	20			250	22			194	27			130	28					42	12			1	0			2099	113
2	0	0	0	0			0	0			0	0			0	0					0	0					0	0	0	0
	0	0	1	0			17	0			16	0			13	0					1	0					0	6	48	6
	242	6	119	25			124	39			72	11			40	8					32	18					1	0	630	107
3	0	0	0	0			0	0			0	0			0	0					0	0					0	0	0	0
	0	0	7	0			24	0			32	0			33	0					6	0					0	0	102	0
	584	22	542	26			378	51			240	48			209	10					92	11					10	2	2055	170
4			0	0	13	0	38	4	19	11			13	9	27	9	5	11	8	4	6	3	3	1	1	1	0	4	133	57
			1	0	0	2	13	8	21	9			9	9	12	0	10	4	12	1	6	3	6	4	5	3	24	0	119	43
			684	141	326	34	359	70	433	6			244	8	140	5	129	0	22	0	9	0	4	2	2	0	2	0	2354	266
5A			3	0	16	2	45	7	71	33	52	46	23	35	18	25	2	11	7	2	14	7	10	10	2	5	0	1	263	184
			1	0	6	0	18	0	28	14	18	13	27	4	10	7	9	0	12	0	21	0	6	0	16	1	3	1	175	40
			371	41	426	35	441	14	454	26	250	11	46	44	134	4	91	2	34	8	38	1	10	2	3	0	0	0	2298	188
5B			0	0	0	0	1	0	3	1	2	1	0	2	0	0	1	0	3	0	0	0	0	0	1	0	0	0	11	4
			0	0	0	0	0	0	1	0	4	0	1	0	1	0	3	1	3	0	0	0	0	0	4	0	0	0	17	1
			27	11	15	5	61	14	53	4	36	0	8	0	10	3	11	0	64	16	18	0	22	0	4	2	0	0	329	55
6A			0	0	3	0	3	0	3	0	1	1	1	0	1	0			0	0	1	0			1	0	0	0	14	1
			0	0	1	0	4	0	2	1	3	0	2	0	2	0			1	0	1	0			5	0	4	0	25	1
			51	7	48	26	58	0	38	5	26	5	17	6	26	4			24	0	25	1			3	0	1	0	317	54
6B			0	0	0	0	3	0			2	0	2	0					0	0	1	0					0	0	8	0
			0	0	1	0	0	0			1	0	0	0					0	0	3	0					0	0	5	0
			39	38	45	44	25	45			16	0	17	6					1	0	2	1					0	0	145	134
9			6	0	18	0	46	10	20	18	12	7	15	12	16	17	7	7	1	0	8	1	4	3	2	3	0	2	155	80
			4	0	10	0	18	0	15	12	18	0	13	14	16	0	6	0	11	2	5	3	3	0	3	0	8	0	130	31
			351	91	208	72	366	22	357	38	183	9	129	9	154	0	29	0	55	9	47	0	22	0	3	0	2	93	1906	343
10			0	0			0	0	3	0	1	2															0	0	4	2
			0	0			1	0	1	0	3	0															0	0	5	0
			21	25			16	13	22	15	0	0															0	0	59	53
11			0	0			2	0																					2	0
			2	0			0	0																					2	0
			0	0			20	2																					20	2
13																	0	0	0	0									0	0
																	2	0	1	0									3	0
																	70	54	0	12									70	66
Totals by Day	0	0	9	0	50	2	138	21	119	63	70	57	54	58	62	51	15	29	19	6	30	11	17	14	7	9	0	7	590	328
	0	0	18	0	18	2	100	8	68	36	97	26	52	27	92	7	30	5	40	3	59	6	15	4	38	4	39	7	666	135
	1567	32	2946	425	1068	216	2098	292	1357	94	1017	111	461	73	843	62	330	56	200	45	305	44	58	4	16	2	16	95	12282	1551

Key	
Path 1	Path 3
Path 2	Path 4
Live	Redds

Path 1 = Fresh carcasses, jaw tag applied
Path 2 = Decayed carcasses, not suitable for tag application
Path 3 = Recovery of Path 1 carcasses with jaw tag
Path 4 = Carcasses observed but not recovered during survey
Live = Number of live Chinook salmon observed during the survey for that day and reach
Redds = Number of fresh redds observed during the survey for that day and reach