Escapement Monitoring of Adult Chinook Salmon in the Secesh River and Lake Creek, Idaho

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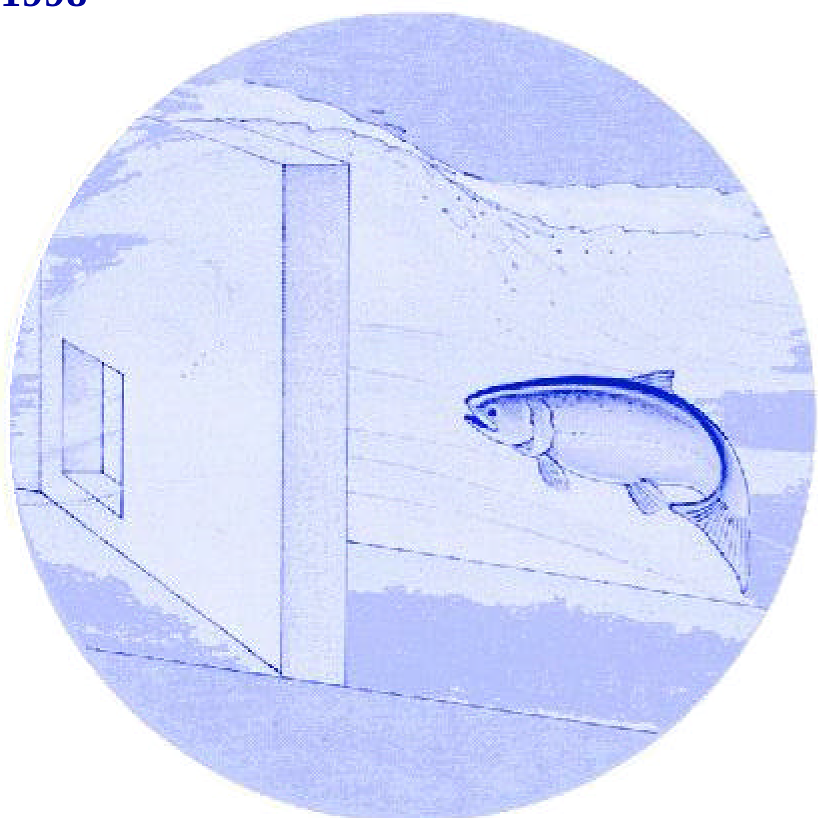
1998



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Bonneville Power Administration
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Portland, Oregon 97208

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Escapement Monitoring of Adult Chinook Salmon in the Secesh River and Lake Creek, Idaho, 1998

Prepared by:

Dave Faurot, Paul A. Kucera and Jay Hesse

Nez Perce Tribe
Department of Fisheries Resources Management
Lapwai, ID 83540

Prepared for:

U.S. Department of Energy
Bonneville Power Administration
Environment, Fish and Wildlife
P.O. Box 3621
Portland, OR 97208-3621

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ABSTRACT

Underwater time-lapse video technology was used to monitor adult spring and summer chinook salmon escapement into spawning areas of the Secesh River and Lake Creek, Idaho, in 1998. This was the second year of testing the remote application of this methodology in the Secesh River drainage. Adult chinook salmon escapement was accurately determined into Lake Creek with the remote time-lapse video application. Underwater time-lapse videography is a passive methodology that does not trap or handle this Endangered Species Act listed species. Secesh River chinook salmon represent a wild spawning aggregate that has not been directly supplemented with hatchery fish. The Secesh River is also a control population under the Idaho Salmon Supplementation study.

Spawner escapement in Lake Creek in 1998 was 52 salmon. An estimated 100 adult chinook salmon migrated upstream past the Secesh River fish counting station to spawning areas in the Secesh River and Summit Creek. Migrating salmon in the Secesh River and Lake Creek exhibited two distinct segments of fish movement, separated by a period of no fish movements. The first segment consisted of male and female upstream movement with very little downstream movement. The second segment followed the period of no fish movements and was primarily males moving upstream and downstream with much less net upstream movement. The first upstream migrating adult chinook salmon passed the Secesh River fish counting station prior to installation on July 10. The first passage on Lake Creek was recorded on July 9, 16 days after installation of the fish counting station. Peak net upstream adult movement at the Secesh River site occurred July 17and 18, and on July 18 at the Lake Creek site. The peak of total movement was August 27 at Secesh River and August 6 at Lake Creek. The last fish passed through the Secesh River fish counting station on September 9 and on August 26 at Lake Creek. Abundance was compared to single and multiple-pass redd count surveys within the drainage. There were differences among the three methodologies. Video methodology provided the lowest estimate of adult spawning abundance. There were no unusual changes in stream temperature or stream discharge during periods of no salmon passage. Salmon movements were not impeded by the fish counting stations, nor was spawning displaced downstream. Fish moved freely upstream and downstream through the fish counting structures. Fish movement was greatest between the period of 10:00 PM and 4:00 AM. There appeared to be a segment of “nomadic” males that moved into and out of the spawning area, apparently seeking other mates to spawn with.

This methodology has the potential to provide more consistent and accurate salmon spawning escapement information than single-pass and multiple-pass spawning ground surveys. Accurate adult escapement information would allow managers to determine if recovery actions were benefiting these salmon spawning aggregates.

ACKNOWLEDGMENTS

Funding for this project was provided by the Bonneville Power Administration. We would like to thank Tom Bumstead for engineering design and structure placement, and Nez Perce Department of Fisheries Resources Management personnel Guy Broncheau, Frank Bear, Ryan Jain, Raphael Johnnie, Jerry Lockhart, Derek McNamara, and Jamie T. Williams for project operations and structure placement. John Hintz of the Nez Perce Tribe furnished the map of the Secesh River drainage. Special thanks to Steve Kammeyer, Gene McPherson, and Joel Patterson from the McCall Fish Hatchery for assistance in determining the sex of adult chinook salmon from video tapes. We thank the U.S. Forest Service for the use of Chinook Campground facilities to station our crew and trailer for the duration of the project. We also appreciate the Nez Perce Tribe for administration of this project.

INTRODUCTION

Accurate determination of adult salmon spawner abundance is important to fisheries management. Spring and summer chinook salmon (*Oncorhynchus tshawytscha*) in the entire Snake River basin are listed as threatened under the Endangered Species Act (NMFS 1992). Spring and summer chinook salmon migrating into the Secesh River system are considered to be a wild spawning aggregate of fish. No supplementation of chinook salmon has occurred in the Secesh River system. Idaho Salmon Supplementation studies (Bowles and Leitzinger 1991) and Pacific Salmon Treaty currently use the Secesh River as a control system.

This investigation began in 1991 with planning and conceptual engineering design of an adult fish counting facility on the lower Secesh River funded through the Pacific Salmon Commission. Preliminary design work followed in 1994 (River Masters Engineering 1994). Listing of the species under the Endangered Species Act in 1992, and concerns with a permanent facility and handling of fish prompted the search for a site where temporary facilities could be used. The Nez Perce Tribe has worked cooperatively with the Idaho Department of Fish and Game (IDFG) and the U.S. Forest Service (USFS) in the planning and developmental stages of this project.

Idaho Department of Fish and Game has conducted single-pass spawning ground surveys of index areas in the Secesh River and Lake Creek since 1957. Traditional chinook salmon redd count surveys in Idaho have relied upon one-time counts at the peak of spawning as an index of relative abundance over time (trend). These counts have assumed that spawning has been completed, that viewing conditions for aerial surveys were acceptable, and/or that spawner distribution has remained constant. These surveys did not account for adult salmon straying, pre-spawning mortalities, late spawning and differences in redd counting techniques. Subsequently the information gained from one-time counts was not sufficient to determine adult spawner abundance in the Secesh River or Lake Creek. Recent surveys on some streams have used multiple ground counts of spawning activities for more accurate assessment of salmon redds (Kucera 1987, Kucera and Cowley 1988, Cowley and Kucera 1989, Kucera and Banach 1991, Kucera and Blenden 1993). The Nez Perce Tribe has conducted annual multiple-pass chinook salmon spawning ground surveys in the Secesh River and Lake Creek since 1987. Time, money, and personnel involved with multiple counts increased as managers desired more accurate estimates. Accurate escapement monitoring of this spawning aggregate is important to fish managers in their evaluation of anadromous salmonid recovery efforts in the Snake River basin.

New technology is available that may improve the accuracy of salmon spawner escapement estimates. The Nez Perce Tribe installed and test operated a temporary fish counting station on private land in the Secesh River, in 1997, to evaluate the use of underwater time-lapse video technology to determine abundance and timing of adult escapement into wild spring and summer chinook salmon production areas. In 1998, the fish counting station on the Secesh River was moved 1,000 meters downstream from the 1997 site to a better location on U. S. Forest Service land to include more spawning area. Lake Creek was the first priority for installation, in 1998, because of smaller size and manageability. A second fish counting station was installed in 1998, on Lake Creek, a headwater tributary of the Secesh River. Lake Creek is a smaller stream, is easier to work in, and is assumed to be a separate spawning aggregate of chinook salmon. As adult salmon migrated upstream through the counting chambers, a photograph of them was taken via the underwater video camera. The structures allowed both upstream and downstream fish movement. Fish were not trapped, handled or held in any manner. Information collected from this project will allow comparison to redd count survey data to assess if redd count information provides reliable indices of adult salmon escapement.

The goal of this project was to accurately assess the spring and summer chinook salmon spawning migration in the Secesh River and Lake Creek drainages.

The objectives of the study were to:

1) Accurately determine adult spring and summer chinook salmon escapement into the Secesh River and Lake Creek drainages on an annual basis.
2) Determine the timing of adult spring and summer chinook salmon spawning migration into the Secesh River and Lake Creek drainages.
3) Determine the accuracy of redd count methodology compared to the underwater video escapement enumeration technique.

DESCRIPTION OF PROJECT AREA

The Secesh River, in west central Idaho, is formed at the junction of Summit and Lake creeks, and traverses 45 km to the southeast where it flows into the South Fork Salmon River (Figure 1). Headwaters of Lake Creek are in the mountains above Burgdorf at an elevation of 2,417 m. Elevation drops to 1,838 m where Lake Creek joins Summit Creek to form the Secesh River. Elevation of the Secesh River then drops to 1,110 m where it flows into the South Fork Salmon River. Average gradient in the vicinity of the projects is 0.5 percent. The Lake Creek project area was located from the mouth of Lake Creek upstream 300 m (Figure 2). The fish counting station was situated with 100 m of the project area downstream of the facility and 200 m of the project area upstream of the facility. The Secesh River project area was located 34 km upstream from the South Fork Salmon River at the U. S. Forest Service's Chinook Campground. The project area, for monitoring and evaluation purposes, was approximately 367 m (Figure 3). The fish counting station was located 233 m upstream of the lower project boundary.

The Secesh River has minimal chinook salmon spawning habitat from the mouth upstream 32 km to the upper end of the canyon area. About 2.5 km of spawning habitat is available from the upper end of the canyon, upstream to the fish counting station. The major chinook salmon spawning area is located upstream of the fish counting station in Secesh Meadows. There is spawning habitat available in lower Grouse and Summit creeks. A mixture of good and scattered spawning habitat exists in Lake Creek from Burgdorf Meadows up to Willow Creek. Additional spawning area exists upstream of Willow Creek. The Nez Perce Tribe has conducted annual chinook salmon multiple ground count surveys in the Secesh River and Lake Creek since 1987.

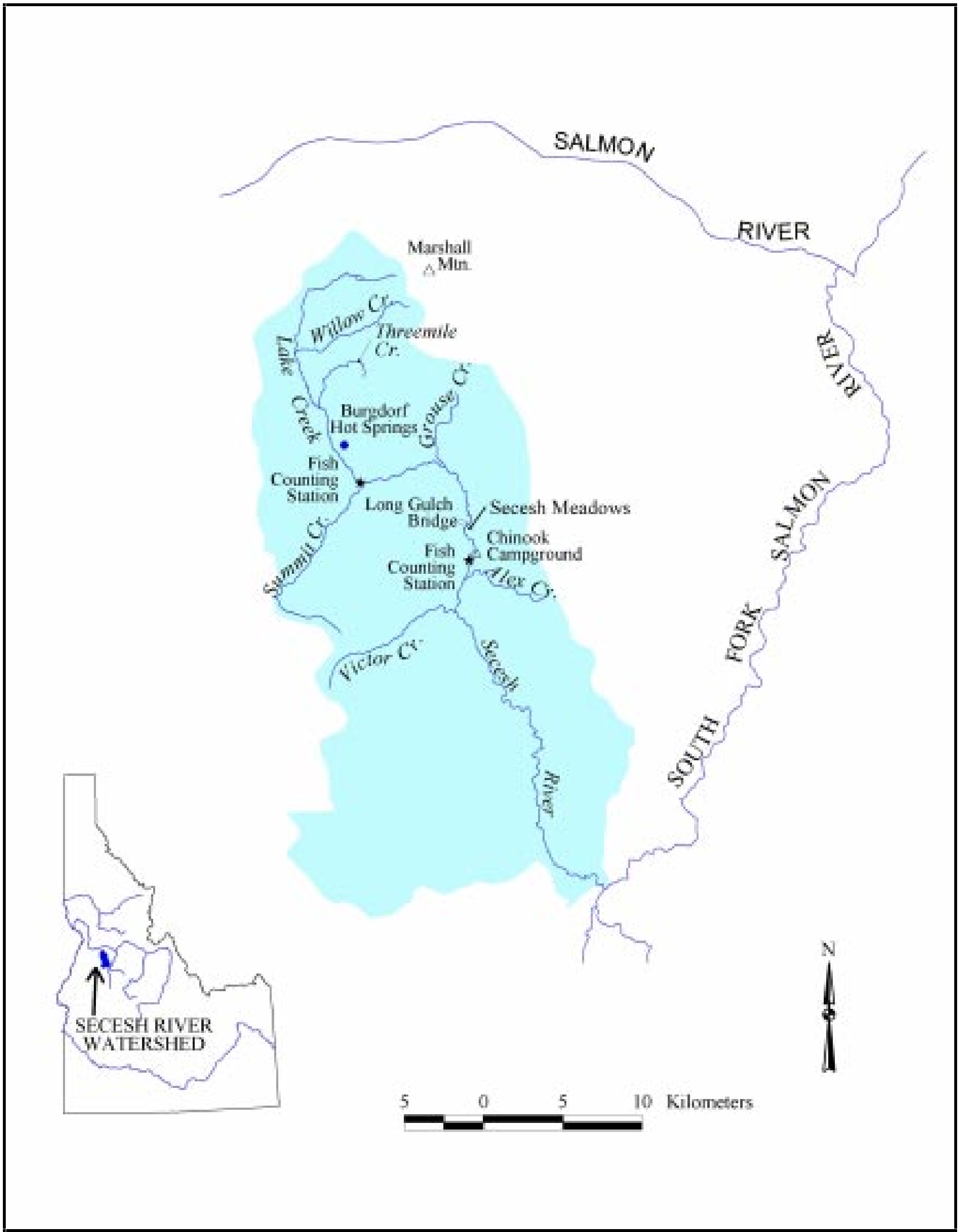

Figure 1. Map of the Secesh River drainage and locations of the fish counting stations (★denotes fish counting station location).

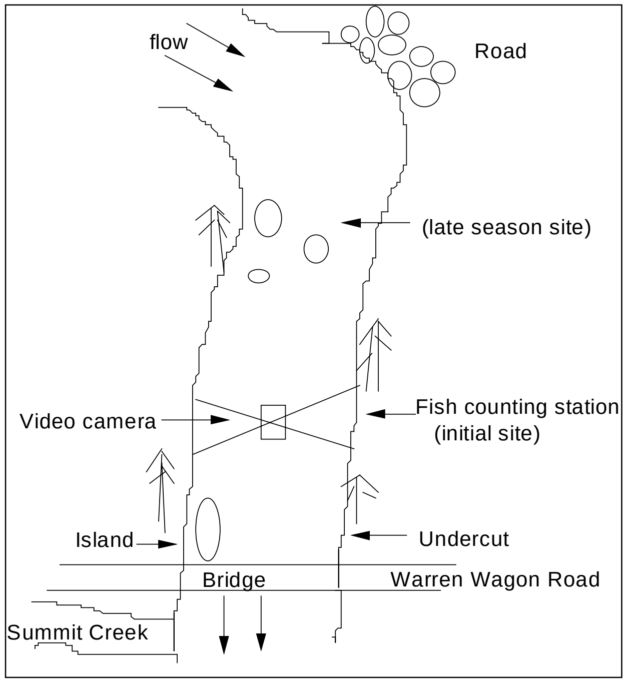

Figure 2. Escapement monitoring project area for snorkel and visual bank observations in Lake Creek in 1998.

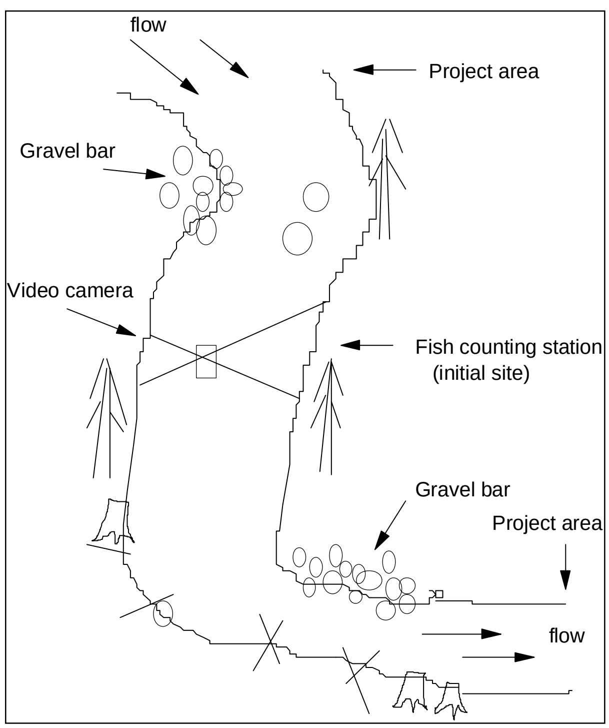

Figure 3. Escapement monitoring project area for snorkel and visual bank observations in the Secesh River in 1998.

METHODS AND MATERIALS

TIMING AND ABUNDANCE

Temporary fish counting stations were installed in the Secesh River and Lake Creek to accurately determine adult escapement into wild spring and summer chinook salmon production areas. The structure included tripod supported upstream and downstream guide fences with a video equipped counting chamber (Figure 4). Fish guiding fences installed between a 30 to 45 degree angle to the bank directed upstream or downstream migrating chinook salmon through a fish counting chamber. The counting chambers were located in the thalweg, which appeared to be the preferred migration route at higher early summer and later low fall flows. Upstream and downstream migrating adults were able to move freely into and through the 0.91 m wide by, 1.22 m long by, 0.76 m high counting chambers. An underwater time-lapse video camera mounted to the side of the fish counting chambers took photographs of the fish as they passed. Fish were not trapped, handled or held at any time.

Figure 4. Artist's rendition of the underwater video escapement monitoring fish counting station.

Equipment

Tripods were constructed of 3.81 cm galvanized steel pipe connected with Kee Klamp® structural pipefittings. Additional weight (gravel bags) was placed on the horizontal braces of some tripods to help anchor tripods in place. Support brackets were attached to a tripod leg to support the picket stringers. Picket stringers were constructed of 0.64 cm aluminum angle with 2.54 cm diameter holes punched 5.08 cm on center. After the tripods, support brackets and stringers were set in their final positions, 2.54 cm aluminum conduit pickets were installed in the stringers. The fish counting chambers were constructed of aluminum angle with dimensions of 0.91 m wide by 1.22 m long by 0.91 m high when viewed from the upstream or downstream end. Aluminum pickets were placed in the counting chamber frames above the passageway to prevent movement through the counting chambers above the viewing area. A transition section was located on both ends of the counting chambers to direct fish into the chambers. These transitions tapered from 0.91 m wide by 1.37 m high at the counting chambers to 2.13 m wide by 1.37 m high at the outer edge. Distance from the counting chambers to the outer edge of the transition was 0.76 m. The guide fences were attached to the counting chambers and transitions with adjustable wing panels located at each outer corner of the transitions. Installation of the guide fences at any angle between 30 and 45 degrees was possible with the hinged wing panels. An adjustable video camera platform was located on the side of the counting chambers. This adjustable platform allowed the camera to be moved up, down, forward, and/or backward as the water level fluctuated to ensure the entire field of view in the counting chambers was recorded on the tape. Photographs of individual salmon were taken through a clear plexiglass window mounted on the lower half of the counting chambers on the near side. On the far side of the counting chambers, an aluminum sheet, painted off-white, was mounted on the lower half of the chamber to create a contrasting background for the photos. The video cameras were ultra-high resolution monochrome CCD cameras. The cameras imaged infrared and visible light and were sealed in a waterproof housing. A cable connected the cameras to a videotape recorder. This cable carried the video signal, power, and camera control conductors. Fish images were recorded in time-lapse (2 frames/sec) on 8mm videotape. Recording occurred continuously while the counting stations were operating. Artificial red light was provided by two arrays of 36 LEDs (Light Emitting Diodes). The LED arrays were mounted beside the cameras. The LEDs illuminated in the red portion of the light spectrum (approximately 690 nm). Red light was used to eliminate possible fish avoidance of white light. White lights would have used excessive current compared to the red LEDs. All electrically powered equipment used 12 volt DC because of the remote location of the sites. All connectors were waterproof O- ring sealed type. Two six-volt golf cart type batteries in series supplied power to the system. Batteries were charged by solar panels at the Secesh River site and by a hydrogenerator at the Lake Creek site. When battery charge levels became low, they were replaced by freshly charged batteries from the McCall Field Office. The Lake Creek fish counting station was installed first and was in place from June 21 through September 15, 1998. Secesh River station was in place from July 10 through September, 18 1998.

Procedure

Personnel replaced video tapes and batteries as necessary to ensure efficient project operation. Video tapes were reviewed at fast forward speed during the season to estimate the progression of the migration and to check equipment operation. About 20 percent of the fish passages were not detected at this replay speed. Video tapes were manually analyzed at the regular playback speed at the end of the season. A master fish passage tape consisting of fish passages through the counting chamber was edited from the original tapes. Each time a fish entered the counting station (Figure 5), the date, time and direction of movement was recorded. Sex and presence/absence of an adipose fin were recorded if it could be determined. The shape of the head, in profile, was the primary characteristic used to determine gender. Fullness of the pelvic area could sometimes aid in female determinations. As the spawning migration progressed, male kypes became more pronounced and differentiation was easier. There was concern that sex could not be determined positively. A panel of four fish biologists reviewed the collapsed video tapes and separately recorded their sex determinations. Because an error rate could not be found, major study results were not always presented by sex. Where results by sex were obvious, such as male upstream and downstream movements during the second segment of the run, findings were presented by sex.

Determination of escapement during the course of the upstream migration was simply a matter of adding to the total as a fish passed upstream, and subtracting as a fish moved downstream. To determine the final number of fish that contributed to production some assumptions had to be made. Males can regenerate sperm. Males that dropped out of the system after the peak of spawning, whether they were dying or attempting to locate another female, were assumed to have contributed to reproduction. The number of females upstream of the fish counting stations varied less than males.

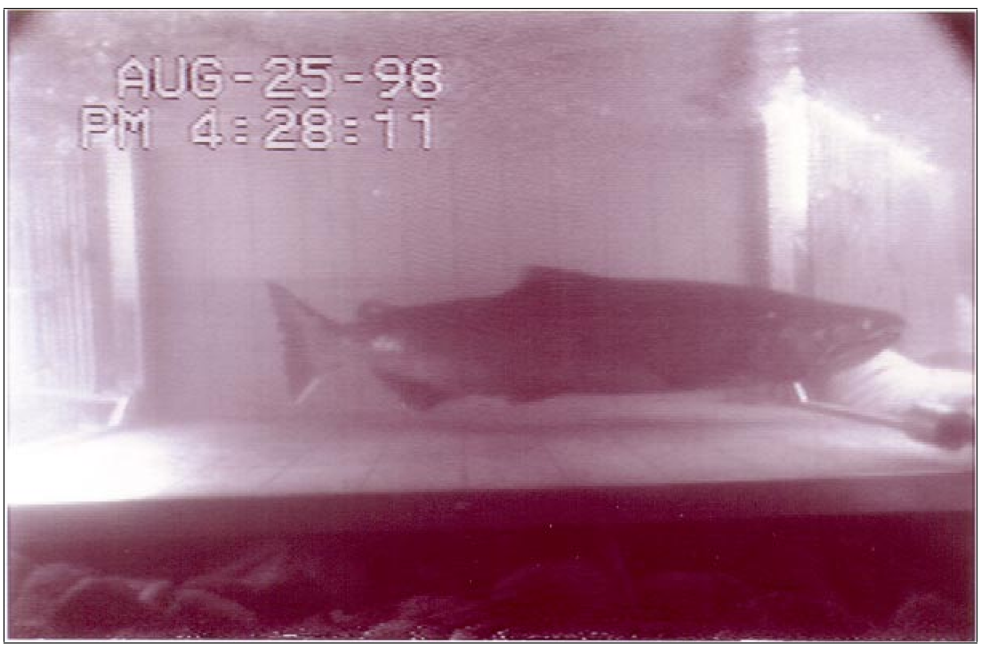

Figure 5. Underwater video photograph of a male chinook salmon migrating through the fish counting chamber.

A temperature-recording site near the Secesh River site was maintained by the National Marine Fisheries Service. Water temperatures were recorded by a thermograph every hour during operation of the fish counting station

MONITORING AND EVALUATION

It was acknowledged that some uncertainty existed in terms of migration impedance and/or spawner displacement due to a fish counting station. A Monitoring and Evaluation (M&E) plan was developed to provide safeguards against any potential migration impedance. The plan contained criteria for determining when facility impacts were significant to salmon, guidelines for corrective actions, and a plan implementation schedule. Snorkel and discrete visual bank observations were used to determine if the fish counting stations were impeding fish movement. Daily observations were conducted both in downstream and upstream locations, after installation of the facility. Particular attention was paid to downstream holding areas. According to M&E plan criteria, if any problems were identified, the pickets or entire counting station could be removed as outlined in the M&E plan. Video tapes were reviewed during the season to follow the progress of the upstream migration, to observe indications of migration impedance, and to check equipment operation. Fish that entered the counting chamber several times within a short time period, but did not continue through would have been an indication that the fish counting chamber was potentially impeding migration.

Visual bank observations were conducted by two people, on opposite banks, walking from the downstream end to the upstream end of the project area. Observers wore polarized sunglasses and hats with brims. They walked quietly and slowly along the bank looking for fish. If a chinook salmon was sighted, they walked back from the bank to avoid disturbing the fish, walked upstream and continued with the survey. The locations where adult salmon were observed were recorded on a drawing of the project areas (Figures 2 and 3).

Underwater observations consisted of two snorkelers, one on each side of the river, drifting downstream looking for fish under banks and around cover. Adult salmon locations were recorded on the project area drawing (Figures 2 and 3). Redds and spawning fish were easily detectable during the visual observations and if present were avoided and not disturbed during the snorkel observations. Locations of non-spawning adult chinook salmon that were seen during visual observations were examined closely during snorkel observations.

DESIGN AND PLACEMENT CRITERIA

Operation of the fish counting station structure was compared to water depth and velocity criteria recommended by Hevlin and Rainey (1993). These criteria were examined relative to safety and structural integrity of the facility given the hydrologic conditions at the site. If the recommended criteria could not be safely met the facility could be removed and installed when the criteria were achievable. More importantly, the structure could determine what the criteria actually should be for the specific installation site. That data will be available for future application. Personnel were stationed on-site to monitor and maintain the fish counting stations on a daily basis. Debris build-up on the guide fences was removed daily or as necessary. Debris loads were small since the facility was installed on the descending limb of the hydrograph. The fish counting stations were installed shortly after conditions were deemed to be safe for personnel to be working in the river.

RESULTS AND DISCUSSION

MIGRATION TIMING AND ABUNDANCE

Time-lapse video has been used before, primarily to enumerate adults at fish counting/viewing windows at hydroelectric projects (Hatch et al. 1994a, 1994b). In some cases, cameras have been submerged in fish ladders. Limited studies have used cameras underwater in a natural setting. Leth and Holubetz (1996) experimentally operated a similar natural stream, remote video recorder system on Running Creek, in the headwaters of the Selway River. Even though a very limited number of adult steelhead and chinook salmon passed through their station, their first and only year operational results were similar to those of our 1997 study. They experienced clogged recorder heads, insufficient power supply, and technical problems with the underwater camera. They concluded that fish were allowed immediate passage through the facility, that video equipment was not labor intensive, and they had the ability to compile a continuous record of fish movement. In 1998, the operation of our fish counting stations was much more efficient. Even though some of the same problems were encountered, backup equipment and experience allowed a quicker response and much less facility down time.

One task within this project was to estimate the number of hatchery strays into the system. A small portion of fish released from McCall Hatchery into the South Fork Salmon River for the Idaho Salmon Supplementation Studies are marked with alternating right or left pelvic fin clips every other year. A fin clip on the side away from the video camera was impossible to detect on tape. Fin clips on the camera side of the fish were difficult to see (none were observed). All chinook salmon smolts released from McCall hatchery have been adipose fin-clipped since 1991 brood year. Adipose fin clips were observed on fish passing through both fish counting stations. However, sometimes "partial" fins were seen. Whether these were poor fin clips, small fins, or naturally damaged fins could not be determined. Partial or poor adipose fin clips were observed on adult fish that returned to South Fork Salmon River weir (Steve Kammeyer, Idaho Department of Fish and Game, personal communication). Therefore any estimate of the hatchery adult straying rate would be inaccurate. This requirement was dropped for 1998 and will not be covered in the future.

Secesh River

Snow pack in the area was below normal during the winter of 1997 to 1998. Runoff was not unusual, however, difficulties with Lake Creek operation delayed installation of the Secesh River fish counting station until the Lake Creek facility was operating smoothly. Water conditions would have allowed earlier installation on the Secesh River. The Secesh River fish counting station was installed on July 10 (Table 1), seven days earlier than installation in 1997. Continuous operation began immediately. There were a total of 578 fish movements past the fish counting station (total of 363 upstream and 215 downstream passages) (Appendix Table A-1).

Table 1. Summary of major chinook salmon escapement dates in Lake Creek and Secesh River, 1998.

Activity	Lake Creek	Secesh River
Start operation	22 June	10 July
Continuous operation	1 July	10 July
First fish	8 July	10 July
Peak of net upstream movement	18 July (6)	17-19 July (15)
Median net upstream passage	18 July	20 July
Period of no fish movement	26, 27 July	3 to 5 August
Peak of activity	6 August (29 total, 1 upstream)	27 August (55 total, 5 upstream
90% net upstream passage	6, 7 August	26, 27 August
Last fish	26 August	9 September
Stop operation	15 September	18 September

Once operation began at the Secesh River fish counting station, operation was continuous except during periods of equipment failure, operator error, and turbidity (7.6 percent of the time).

The upstream migration of adult chinook salmon past the Secesh River fish counting station began prior to July 10. Fish were photographed the first day of operation. This was not the first fish migrating upstream, as fish were recorded upstream at the Lake Creek station on July 8.

There were two distinct segments of adult salmon movement at the Secesh River site (Figure 6, 8). The first segment of salmon movement occurred from July 10 to August 3. Movement progressed rapidly, was upstream and consisted of both sexes. The male upstream spawning migration was basically completed by that time. The peak of net upstream movement was July 17 to 20, when there was an average net upstream movement of nine adult salmon per day (Figure 6) (Appendix Table C). The median net upstream fish passage occurred July 20, ten days after the first recorded fish.

From August 3 to 5, there were no fish passages through the fish counting station. In addition, there were only four fish passages during the four days prior to the period of no movements, and all were upstream. This lull in fish movement activity in the Secesh River was about eight days later than the pause in activity at the Lake Creek site.

During the second segment of the run, after August 6, male movement was upstream and downstream with little net upstream movement. The median fish passage activity occurred on August 19. The height of fish movement activity was from August 14 to 31, when an average of 19 adults moved upstream and downstream per day (range of 1 to 55), with an average net upstream movement of only 1.6 adult salmon per day (Appendix Table C). The one-day peak of movement activity was August 27 when 55 (30 upstream, 25 downstream) fish moved through the fish counting station (Figure 8). This peak of movement activities was mainly males moving upstream and downstream. It did not represent an increase in escapement (Figure 8). This decrease was attributed to downstream drift as males were dying at the end of the season and to nomadic males that moved in and out of the spawning area.

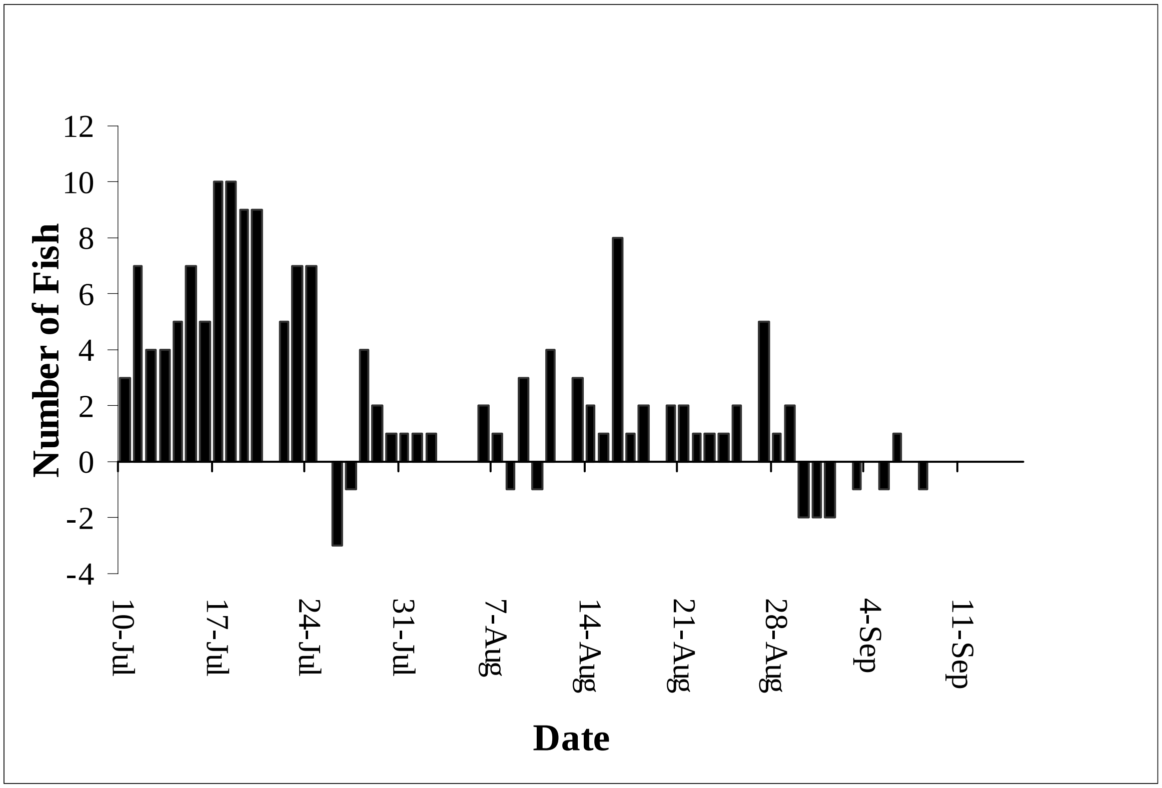

Figure 6. Net upstream spawning migration of adult spring and summer chinook salmon past the Secesh River fish counting station in 1998.

The last recorded upstream fish passage occurred on September 10 and fish counting station observations were concluded on September 18. The peak count for the season occurred on August 29 to 30 when a net upstream migration of 140 chinook salmon had been observed through the Secesh River fish counting station (Appendix Table A-1). That count included an estimated 84 females, 52 males and four of undetermined sex.

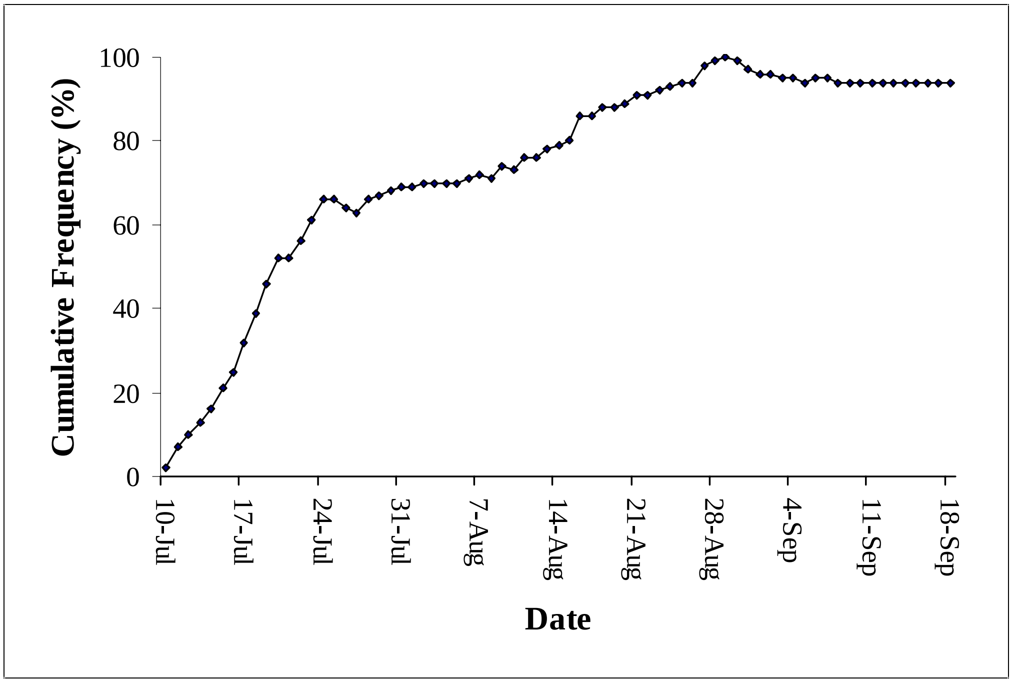

Figure 7. Cumulative adult spring and summer chinook salmon spawner escapement past the Secesh River fish counting station in 1998.

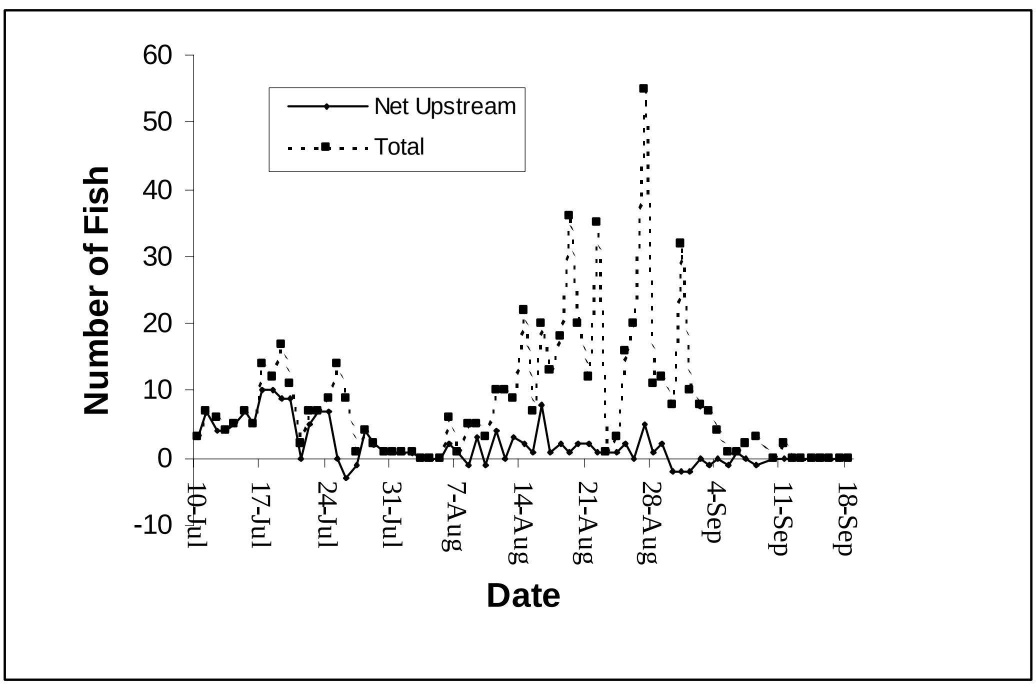

Figure 8. Daily net upstream and total movements of adult spring and summer chinook salmon through the Secesh River fish counting station in 1998.

Video recording did not cover the entire upstream spawning migration on the Secesh River. Estimated corrections were made to account for this (Table 2). Fish were recorded passing the Secesh River fish counting station on the first day of operation, 10 July. The first fish passing through the upstream Lake Creek fish counting station had already been recorded on 8 July. Earlier arriving fish at the Secesh River site probably continued on up to the Lake Creek site as Lake Creek is a colder headwater tributary of the Secesh River and the fish exhibit earlier spawning timing (NPT unpublished data). The distance between the two sites is about 15 km. Fish could have passed both sites the same day or could have taken several days to move up to the Lake Creek site. Bjornn et al. (1991, 1992, 1993) have documented slower average chinook salmon migration rates as fish move closer to spawning areas as compared to migration rates in reservoirs of the Snake River (53.2 km/day through the three lower reservoirs, 42.2 km/day from Lower Granite dam to the Snake River site, 16.6 km/day from Snake River site to lower Salmon River, and 12.4 km/day from lower Salmon River to South Fork Salmon River site). Studies of radio tagged chinook salmon in the Kenai River, Alaska closer to spawning areas, have reported migration rates of 3.2 km/day overall, and 5.8 km/day for migrations greater than 64 km (Hammarstrom et al., 1985), and 2.1 to 3.5 km/day (Burger et al. 1983). If fish swam at five km per day they would reach the Lake Creek site three days after passing Secesh River site. The Lake Creek fish counting station passed six fish during the first three days of operation that could have passed the Secesh River site prior to its start up. With these corrections, an estimated 152 adult chinook migrated upstream past the Secesh River fish counting station to spawning areas above the monitoring site. Of this 152, an estimated 52 migrated on upstream past the Lake Creek fish counting station. This left 100 chinook salmon to spawn in the Secesh River drainage, excluding Lake Creek. These were the numbers of fish used for comparison to redds in the spawning areas.

Table 2. Correction of adult spring and summer chinook salmon spawner escapement abundance estimates at the Secesh River fish counting station in 1998.

Dates	Hours Lost	Cause	Correction	Comments
< 7/10	?	Prior to startup	+3 +3	Equal to three days fish passage at Lake Creek.
8/4-5	19	Operator error	0	During period of no fish passage-two days prior and half day after outage
8/12-13	13	Operator error	+1	Average of activity two days prior and two days after outage
8/23-24	15	Turbidity	+1	Average of activity two days prior and two days after outage
9/5-10	84.5	Turbidity, equipment operator	0	Lost 84 of 168 hours, intermittently. Total numbers were steady and then declining as fish died.

Lake Creek

Below average spring runoff, and a smaller stream system permitted the installation of the temporary Lake Creek fish counting station on June 18. Fish counting station operation began on June 20 (Table 1). Several minor equipment malfunctions were corrected and continuous operations began July 1. Operation was continuous after July 1, except for periods of equipment failure (14.5 hours), operator error (38.5 hours) and 84.5 hours of turbidity (92.5% operational). There were a total of 221 fish movements past the fish counting station (total of 134 upstream and 87 downstream passages) (Appendix B-1). No adult salmon were photographed during the first 16 days of the startup period and continuous operation. This period of no fish passage leads to the conclusion that video coverage of the first fish passage of the adult salmon spawning migration occurred in 1998. Run timing of the salmon spawner migration into Lake Creek followed the same general pattern as the Secesh River site (Figure 9 and 10). The first upstream migrating adult salmon passed the site on July 8 (Figure 9). Both sexes arrived at approximately the same time.

The adult spawner migration into Lake Creek in 1998 was comprised of 52 salmon. The number of adults (52) is an estimate since there was not 100 percent coverage of the run. However, the estimate would appear to be close to the exact figure. A correction was not made to this number for several reasons: fourteen hours of data lost due to turbidity occurred four days prior to the arrival of the first fish; 70 hours lost due to turbidity occurred ten days after the last fish had passed. A correction factor, using the average of three days passage prior to and three days passage after other turbidity-related outages, was zero passage. The remaining lost time occurred in the second segment of the migration (August 1 and after August 14) after most of the upstream migration had occurred. The daily average passage rate for the five-day period, utilizing the usable data on August 1 and the two days before and two days after August 1 was 0.2 fish downstream. The cumulative passage total on August 14 and when operations ceased on September 14 was 46 fish. This indicates movement was equally up and down with negligible net upstream movement during the time of outage.

There were two distinct segments of fish movement in Lake Creek (Figure 9). The first segment of salmon movement occurred from July 8 to 25, and was mostly upstream. Escapement occurred much more rapidly during the first segment of the run as compared to the second segment (Figure 10). The first three fish passing upstream were males, one each on 8, 9, and 10 July, followed by six females on July 10 to 13 (Appendix Table B-1). The peak of net upstream movement occurred on 18 July, ten days after the first fish passage, when six chinook salmon passed upstream through the fish counting station (Figure 9). The peak of upstream passage on Lake Creek and Secesh River occurred at the same time. The median net upstream fish passage occurred July 18, ten days after the first fish passage and two days earlier than the median recorded fish passage at the Secesh River site. There were 72 movements past the fish counting station prior to July 26, with 75 percent of the movements being upstream.

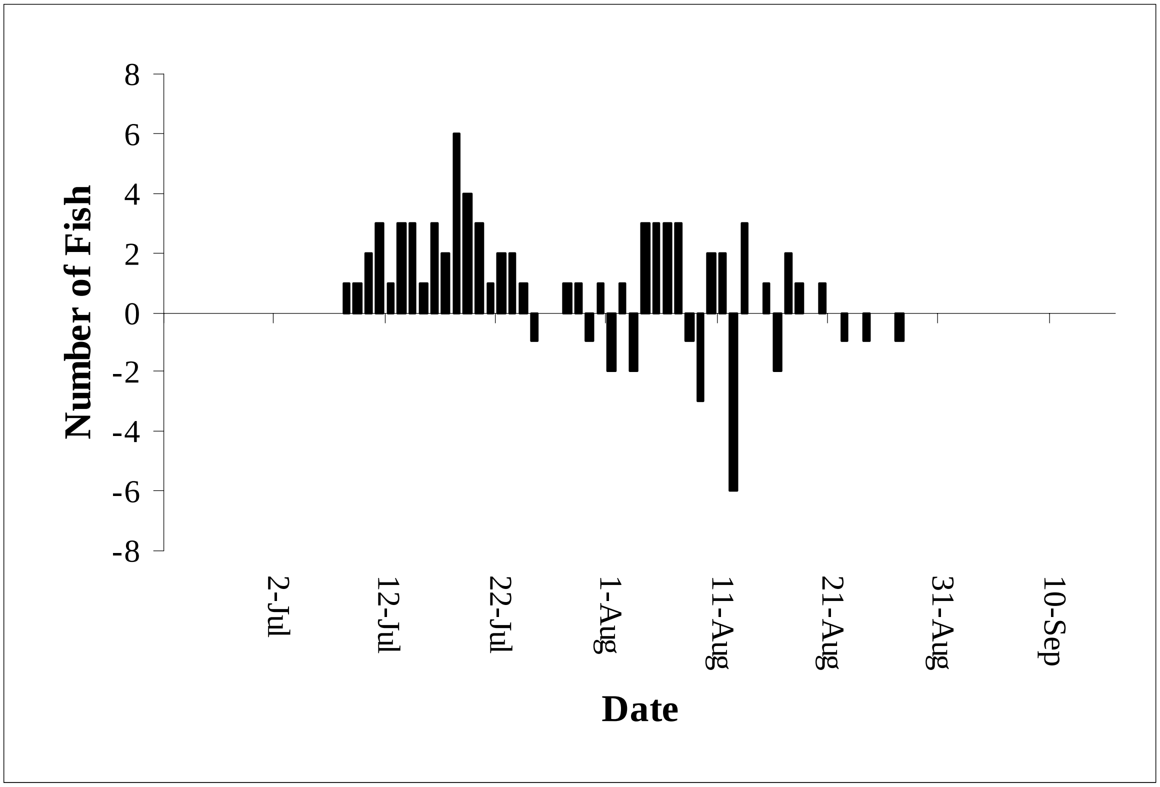

Figure 9. Net upstream spawning migration of adult spring and summer chinook salmon migrating past the Lake Creek fish counting station in 1998.

There were no movements through the fish counting station July 26 to 27 and only one each on July 28 and 29, both upstream. This lull in fish movement activity occurred eight days earlier than the lull in activities at the Secesh River fish counting station. The Lake Creek chinook salmon spawning aggregate is considered to be an earlier spawning aggregate than the Secesh River spawning aggregate.

During the second segment of the run, from July 28 to August 27, fish movement activity increased (Figure 11). There were 149 movements during the second segment of the run, mostly males with back and forth movement and less net upstream movement. The peak of total fish movement activity was August 6, when 15 adults moved upstream and 14 adults moved downstream for a total of 29 movements and a net upstream movement of 1 adult salmon. Peak of total movement activity on Lake Creek was approximately two weeks earlier than peak of total movement activity on the Secesh River. Toward the end of the season, male escapement decreased. This decrease was attributed to downstream drift as males were dying and to nomadic males that moved out of the area into the later Secesh River spawning aggregate. The last upstream moving chinook salmon at Lake Creek fish counting station was recorded on August 24, with the last recorded passage being a downstream passing male on August 28. The fish counting station remained operational until September 15, an additional 18 days after the last fish passage was recorded on August 27.

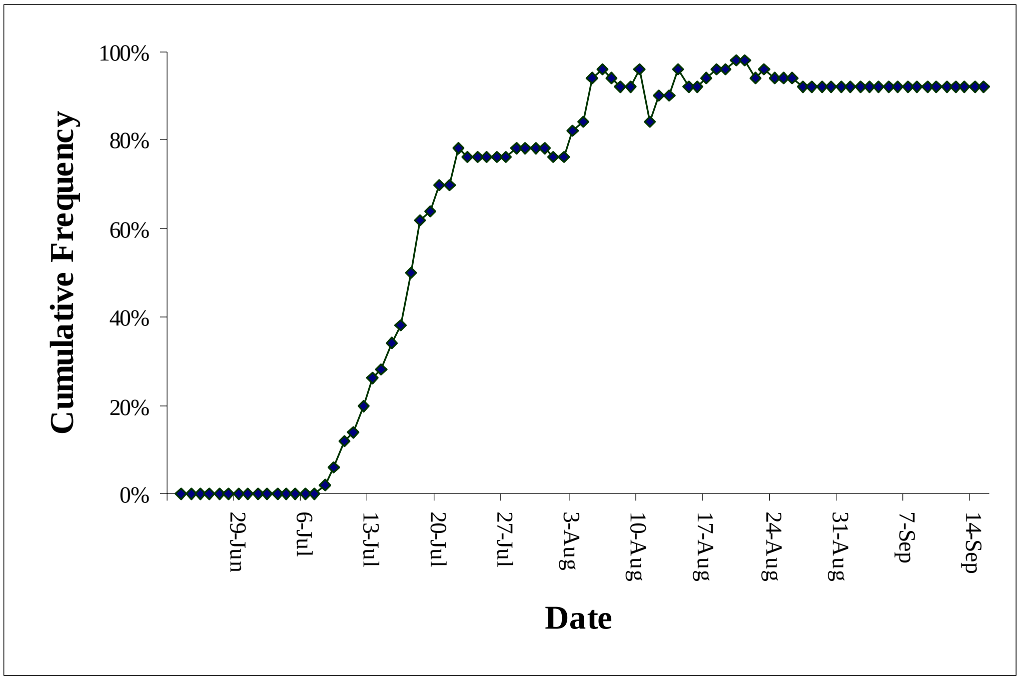

Figure 10. Cumulative adult spring and summer chinook salmon spawner escapement migrating past the Lake Creek fish counting station in 1998.

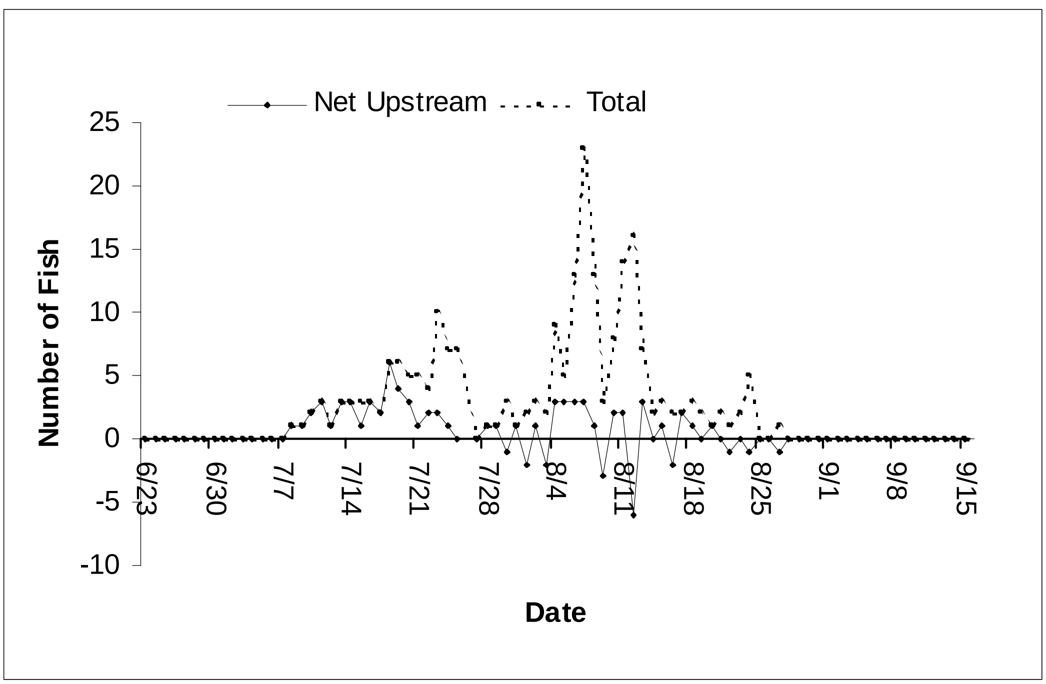

Figure 11. Daily upstream and total movements of adult spring and summer chinook salmon through the Lake Creek fish counting station in 1998.

An estimated 31 females and 20 males were considered to have contributed to spawning. The final number of adult chinook salmon considered contributing to production in Lake Creek in 1998 was 52. This number was used for comparisons to redd counts and included 20 males, 31 females and 1 of undetermined sex.

COMPARISON TO REDD COUNTS

During the 1998 migration three methods were used to describe chinook salmon spawner abundance in Lake Creek (Table 3) and Secesh River. The Nez Perce Tribe Department of Fisheries Resources Management conducted a multiple-pass survey of redds to obtain spawner information for year to year trends, and for correlation with juvenile chinook salmon emigration from Lake Creek and the Secesh River. Idaho Department of Fish and Game (IDFG) conducted a one-pass count of redds in index areas, at the peak of spawning activities. This information is used for trends and relative abundance of spawner success from year to year. Video technology provided the third method of obtaining spawner escapement.

Nez Perce Tribe fisheries personnel conducted three ground count spawning ground surveys on Lake Creek from the mouth upstream, and its tributaries between August 6 and September 4. Two surveys were conducted on the Secesh River from the canyon area upstream to the Long Gulch Bridge, and Grouse and Summit creeks between August 18 and September 16. Only one survey was made through Secesh Meadows area due to lack of access. On each pass they recorded test redds, partial redds, redds in progress, and recorded fish observed at spawning sites. Nez Perce Tribe (Jon Hansen, unpublished data) counted 46 redds in Lake Creek and 68 more redds in the Secesh River drainage, excluding Lake Creek. Idaho Department of Fish and Game personnel (unpublished data) identified a total of 54 redds in two transects within Lake Creek using a one-pass method. IDFG (unpublished data) conducted single pass helicopter and ground counts of two index sites on the mainstem Secesh River. There is a difference between agency counts. In the two transect areas in Lake Creek, IDFG identified 29% more redds (54 versus 42). Roger and Schwartzberg (1986) commented on the need for standardization of timing and number of redd counts and establishment of uniform field methods and reporting techniques. Schwartzberg and Roger (1986) discussed sources of errors in redd counts (e.g. variation in water clarity, redd superimposition, and survey personnel training. These differences in the number of redds makes it difficult to compare fish per redd, and redds per female from other agency reports.

The Secesh River video fish counting station estimated a net upstream movement of 152 adult chinook salmon. The Lake Creek video fish counting station, estimated a net upstream movement of 52 adult chinook salmon. Subtracting the fish that migrated up Lake Creek, left 100 adult chinook salmon to spawn in the Secesh River. Based on the number of salmon that migrated into each stream and subsequent redd counts in each stream, the number of fish per redds in spawning areas upstream of the fish counting stations was calculated. The estimated number of fish per redds in Lake Creek was 1.13 fish per redd. In the Secesh River drainage, above the Secesh River fish counting station and excluding Lake Creek, there were 1.47 adults per redd. Within the entire spawning area above the Secesh River fish counting station there were 1.33 adults per redd. Oregon Department of Fish and Wildlife (unpublished data) gathered fish per redd information in the Imnaha River from 1990 to 1994 and 1996 to 1999. The calculated number of adult fish per redd ranged from 1.64 to 4.02. The average for the entire period was 2.78 fish per redd, adults only, and 3.42 fish per redd including jacks. There were no jacks recorded migrating through either Lake Creek or the Secesh River fish counting stations. Fish per redd information on Lookingglass Creek averaged 2.54 adults per redd (range 2.09-3.01) from 1967 to 1971 (Oregon Department of Fish and Wildlife, unpublished data).

Table 3. Secesh River multiple ground count spawning surveys, excluding Lake Creek in 1998

Location	Number of Redds	Number of Adults (Video)
Loon Creek to Long Gulch	13	
Long Gulch to USFS boundary	31	
USFS boundary to Grouse Creek	9	
Grouse Creek to Lake Creek	2	
Grouse Creek	5	
Summit Creek	8	
Total	68 redds	100 fish

Table 4. Lake Creek multiple ground count spawning surveys in 1998.

Location	Number of Redds	Number of Adults (Video)
Mouth to 3 Mile Creek	26	
3 Mile Creek to Willow Creek	15	
Willow Creek to FS# 318 bridge	5	
FS # 318 bridge to Corduroy Creek	0	
Total	46 redds	52 fish

The 1998 Lake Creek and Secesh River fish per redd numbers were low compared to Imnaha River and Lookinggglass Creek data. One reason may have been the relatively low number of males observed in the Secesh River drainage in 1998. South Fork Salmon River weir reported lower than normal male:female sex ratio (45M:55F) in 1998 (Gene McPherson, McCall Hatchery, personal communication). Johnson Creek weir reported lower numbers of males compared to females (39M:61F) (John Gebhard, Nez Perce Tribe, personal communication).

Potential sources of errors in determination of spawner abundance by the underwater video methodology are listed in Table 5. All potential sources of errors affect the ability to accurately determine salmon spawner escapement and are discussed below.

Table 5. Potential sources of error in video abundance estimate methodology.

Concern	Potential Effect	
	Lake Creek	Secesh River
Fish passed before installation	Minimal	Moderate
Fish escaped under the pickets or counting station	Minimal	Minimal
Fish escaped around the ends of the fish guiding fences	Minimal	Minimal
Fish passed during high turbidity	Minimal	Moderate
Fish passed during down periods	Minimal	Moderate
Tape observers missed fish passages	Minimal	Minimal

Fish passage before fish counting station installation is a definite potential source of error. It is felt this did not occur at Lake Creek, as the fish counting station was in place -16 days prior to the first fish arriving on July 8. An earlier segment of the spawner migration would have to exist prior to June 22 for salmon to have been missed. Salmon did migrate up the Secesh River fish prior to installation of the fish counting station. To try to rule out this possibility, an effort will be made in 1999 to install both fish counting stations prior to spring runoff. This type of error in the data would make the spawner abundance determination conservative. If fish had passed unnoticed, the actual fish count would have been higher and the number of fish per redd would increase.

The potential existed for escapement around the ends of the fish guiding fences. The ends of the fish guiding fences were blocked with gravel bags to prevent escapement. Fish that escaped around the end of one fish guiding fence would become trapped in the area between the upstream and downstream fish guiding fences (Figure 4). No fish were seen in these areas in 1998. The probability of this occurrence going undetected is low.

Fish escapement under the pickets of fish guiding fences is another source of error. If pickets were not in contact with the stream bottom substrate, fish could escape under the fish guiding fence. Pickets were checked daily for contact with bottom substrate. Salmon that escaped under pickets of one fish guiding fence would become trapped in the area between the upstream and downstream fish guiding fences. No fish were seen in these areas in 1998. The potential of salmon escaping underneath pickets of both fish guide fences at the same time is low.

Salmon passage during periods of high turbidity was another source of potential error. This could have happened, but was believed to have been minimal. On Lake Creek the lost data time due to turbidity was analyzed and no adjustment was made. Most of the lost data time was either before the first fish of the season had arrived or after the last fish of the season had passed. For the period within the active portion of the season, a three-day average of upstream and downstream movement before the outage and three-day average after the outage was calculated. It was 0.2 fish per day downstream. No adjustment was made for this. At the Secesh River site the circumstances were different and an adjustment was made. A blowout in upper Summit Creek created turbidity that affected the Secesh River site, only, for four consecutive days. The method just described was used for the correction. Turbidity is beyond the control of the project and will have to be accounted for each year. This type of potential error in the data could occur at any time during the spawner migration Since the overall movement during the spawner migration was upstream, periods of down time would be more likely to miss fish moving upstream, making our estimates conservative.

Error to abundance determination could also occur if fish passed during equipment down periods. Using the method described above, corrections were made for lost data caused by operator error or equipment failure. This should become less each year. Equipment operational time was 92.5% in 1998. Coverage was 94.8% during fish passage periods on Lake Creek. The goal of zero lost time due to operator error or equipment failure should be obtainable.

Tape observers missed fish passages. Tapes were processed after the season at slow speed for final spawner escapement determination. In-season review of tapes at fast speed did indeed miss fish passages. The record of in-season review was not provided to the post-season reviewer and was used as a check of post-season accuracy. No fish passage events recorded in-season were missed by post-season review. Only one observer watched the tapes and accuracy depended on the alertness and conscientiousness of the observer. Data errors of this type could occur equally in both directions. Hatch et al. (1994a) found among-observer variability of time-lapse videotapes to be highly insignificant (P> 1.000). The potential for error of this type is minimal. A computerized editing system (Hatch et al. 1998) was initially to be used for analyzing tapes. This would have been another check for accuracy. However, technical difficulties with the editing system precluded this option. It is not likely to be available in the future.

To draw a conclusion concerning the accuracy of spawner escapement determination via the underwater video technology after one season of successful data collection would be premature. However, for the betterment of this project, and methodologies of escapement monitoring, a discussion of possible inaccuracies and shortcomings is warranted. After reviewing the operation of the fish counting stations and the data collected, and the above discussion of potential sources of error, it is felt the salmon escapement number for Lake Creek is accurate. Video methodology was the most accurate and conservative. A relationship of fish per redds may be developed as the project continues. Numbers of fish per redd in Lake Creek (1.18) were lower than reported in other streams and are of some concern.

The more conservative results of spawner abundance and fish per redd information obtained by the video methodology should be of interest to fish managers. Reliable spawner abundance estimates from unsupplemented salmon spawning aggregates would be a valuable tool upon which to base decisions. Spawning ground survey trend information is subject to a variety of potential sources of error. Each method should be scrutinized for the differences, so managers better understand what they base decisions on. This project will continue to make an effort, in future years, to weed out sources of inaccuracies in salmon spawner abundance determination. Redd count surveys should try to minimize any sources of errors as well.

MOVEMENT

Fish counters at mainstem Columbia River and lower Snake River dams have typically discontinued counting anadromous adults at night between 9:00 PM and 5:00 AM because of low passage rates. Hatch et al. (1994a) monitored the migration of adult sockeye (*O. nerka*) and chinook salmon at the fish-viewing window at Tumwater Dam on the Wenatchee River in Washington using a time-lapse video recorder system. They found nighttime upstream migration past the dam (between 10:00 PM and 4:00 AM) to be from 6.7 to 16.2 percent of the daily passage. At Lower Granite Dam on the mainstem Snake River, Hatch et al. (1994b) counted 6.4 percent of the fish migrating upstream at nighttime. Calvin (1975) also found low rates of nighttime upstream migration movement at mainstem Columbia River dams. The diel timing of spring and summer chinook salmon in this spawning tributary system is quite different than those observed above. During this study 40% of the total movement activity at both fish counting stations, and 79% and 64% of the total net upstream passage at the Secesh River and Lake Creek fish counting stations, respectively, occurred between 10:00 PM and 4:00 AM (Appendix A-2, B-2). It appears that in smaller rivers and streams, that upstream migration occurs more during periods of darkness.

Diel Movement

Diel movement information was obtained from the videotapes. Movements of adults through both fish counting stations occurred day and night, with higher rates of activity during hours of darkness (Figure 12).

Upstream (only) movements of adult salmon passing through both fish counting stations occurred day and night, with a definite higher rate of activity between 10:00 PM and 6:00 AM hours. Downstream passages of spawning chinook salmon through the fish counting station occurred more evenly, with the lowest rates during daylight hours. Downstream movements were dominated by male salmon.

The resulting net upstream diel movement (upstream minus downstream) showed fish moving day and night, but net movement was upstream between 5:00 PM and 6:00 AM, and downstream between 8:00 AM and 3:00 PM (Figure 13).

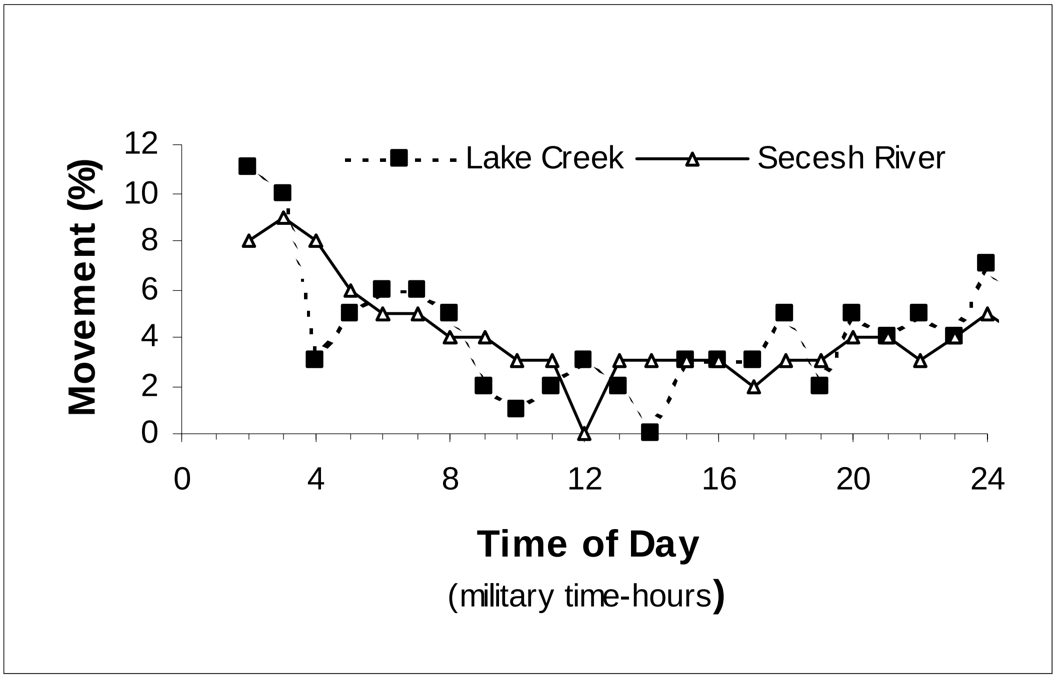

Figure 12. Diel timing of total upstream and downstream movement activity of adult spring and summer chinook salmon through the Lake Creek and Secesh River fish counting stations in 1998.

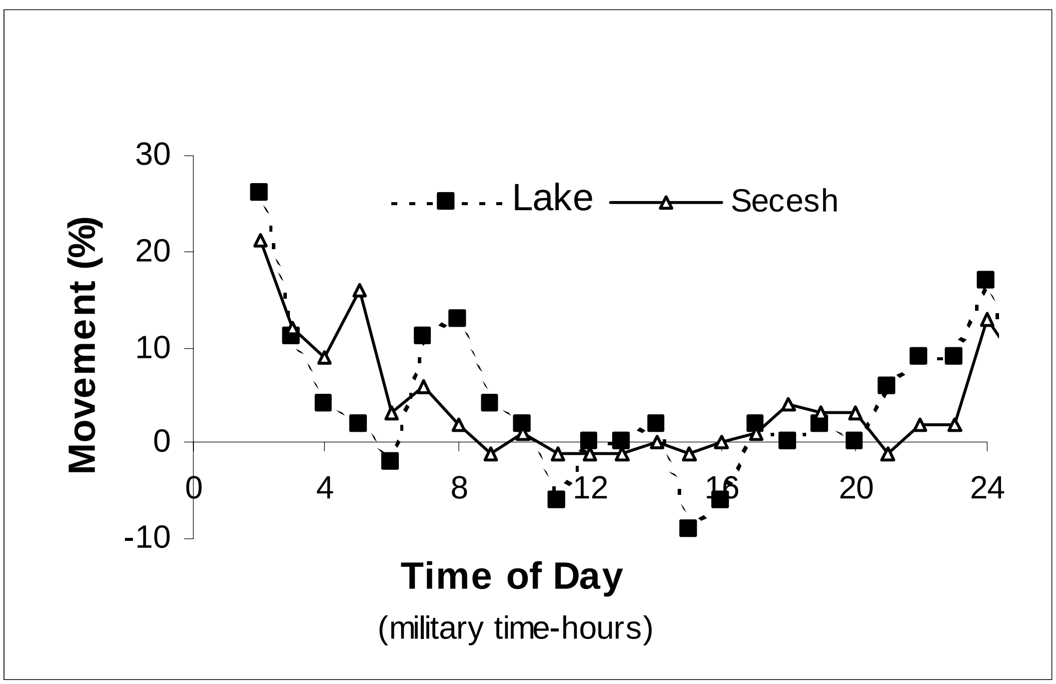

Figure 13. Diel timing of net upstream movements of adult spring and summer chinook salmon through the Lake Creek and Secesh River fish counting stations in 1998.

Upstream/Downstream Movement

The upstream and downstream movement observed at the Secesh River site in 1997, was observed in 1998 at both Lake Creek and Secesh River sites. There were a total of 578 passages past the Secesh River fish counting station. This averaged to 4.1 passages for each of the 140 photographed adult salmon. Most of this passage was in the second segment of the run (after August 5). During the second segment of the migration there were 427 total movements (upstream and downstream) with a net upstream movement of 31 adult salmon. This averaged to 13.8 passages for each net upstream passage.

It was not possible to differentiate each individual fish passing the fish counting station. However, there were 18 salmon with distinctive marks that could be tracked during a portion of the season. This may not have been a complete history of an individual fish's passings, as marks, scars and fungus could have changed over time. For example, an individual fish could pass multiple times with no distinguishing marks, be called an individual fish with a small fungus patch on the tail, be called another individual fish with an additional fungus mark on the head, etc. Most of these distinctly marked fish were noted two or three times only. There were four fish, all males that passed more than ten times each (46, 15, 13, 12). The 46 movements of the one male were spaced over four days (11.5 passages per day). One female was observed passing the fish counting station eight times over a four-day period. All fish moved upstream, headfirst. Most fish moved downstream, tail first, so that the same side was usually presented to the camera. The progress of fish could be followed upstream and downstream repeatedly. Occasionally fish would move downstream, headfirst. There was only one instance of a fish with multiple passages that did not follow an up/down sequence. Between the up/up passage there was one fish that passed downstream headfirst. Because of the scarceness of distinctive marks, and the behavior that a few fish migrated downstream headfirst (presenting the opposite side to the camera), it was difficult to determine the true size of the upstream/downstream movement.

This large upstream/downstream movement of males, in particular, suggested movement of males between the Lake Creek and Secesh River spawning aggregates. Female salmon appeared to have more fidelity to their natal stream.

The upstream and downstream movement observed at the Secesh River fish counting station in 1997 (Faurot and Kucera 1998) and 1998, was observed at Lake Creek in 1998. There were a total of 221 passages past the fish counting station. This averaged to 4.3 passages for each of the 52 adult salmon Most of this passage was in the second segment of the run (after July 27). During the second segment of the migration there were 151 total movements (upstream and downstream) with a net upstream movement of 14 adult salmon. This averaged 10.8 passages for each net upstream passage.

A few distinctively marked salmon were observed on multiple occasions at the Lake Creek fish counting station. One female chinook salmon was observed 11 times on August 7.

DESIGN AND PLACEMENT CRITERIA

The rate of upstream and downstream salmon movement documented in this report points out the importance of properly designed and placed structures in anadromous fish streams. Structures that allow only upstream passage prevent downstream movement, which appears to be much larger than previously thought. This freedom of movement is important when dealing with ESA listed species because it may affect reproductive success. Freedom of movement is especially critical when dealing with small populations at risk of extirpation. Studies have documented that improperly placed or designed structures can impede upstream fish passage and displace spawning downstream (Hevlin and Rainey 1993). This study also shows the potential for preventing freedom of downstream movement. A potential result may be causing adults to spawn with other spawning aggregates by not allowing them access into and out of these areas. Conventional hatchery collection facility weirs that allow only upstream passage are a classic example. A more subtle change could be, instead of displacing spawning downstream, displacing spawning upstream of a weir.

Equally important as structures that pass fish freely in both directions would be the proper placement of structures in a stream. The recommended criteria from Hevlin and Rainey (1993) did not appear to be realistic for the Secesh River and Lake Creek fish counting station sites. The general design guidelines, rather than specific water depths and velocities appeared to be the most beneficial even though they were meant for small dams and diversions on migration routes and mainstem rivers. These were small streams that had very few areas that could provide attraction flows as high as 8 f/s (2.44 m/s). In this situation, the structure was placed in the river so that it led the fish, with a “V” configuration, to the apex which was in the thalweg. This was probably more beneficial than trying to find areas with 8 f/s (2.44 m/s), with nearby resting areas of less than 2 f/s (0.61 m/s). There was no place in the project areas that 8 f/s (2.44 m/s) could have been provided. A general guideline of using the thalweg with angled guide fences would appear to be better for smaller streams.

The recommended current velocity of less than 2 f/s (0.61 m/s) at the structure to prevent jumping (Hevlin and Rainey 1993) did not appear to be relevant to the Lake Creek site. Water velocities dropped throughout the migration season. Early in the season, velocities were above 2 f/s (0.61 m/s), and late in the season they were below the recommended 2 f/s (0.61 m/s). Fish were never observed jumping at the structure, nor were they heard contacting the structure.

By following basic concepts it was felt the best available fish counting station sites were selected. Priorities in selection of the site were that it be downstream of as much spawning area as possible, in a straight stretch of river with a low gradient and a fairly constant cross section bottom. The counting chamber was placed in the thalweg which is believed to be the preferred migration corridor. Upstream and downstream fish guiding fences were installed to orient and guide fish into the opening for passage.

MONITORING AND EVALUATION

The Monitoring and Evaluation plan was put in place to detect if passage upstream was impeded by the fish counting structure, or if spawning was displaced downstream.

During 66 visual bank observations and 49 snorkel observations in Lake Creek, no adult chinook salmon were seen. There were 221 movements and a net upstream movement of 52 adult spring and summer chinook salmon through the Lake Creek fish counting station in 1998. No adult chinook salmon were observed in the project area the entire season, and no spawning took place in Lake Creek downstream of the fish counting station. It appeared that the Lake Creek fish counting station neither impeded upstream migration nor displaced spawning downstream.

During 57 visual bank observations at Secesh River, seven adult chinook salmon were seen, two downstream and five upstream of the fish counting chamber. During 44 snorkel observations, 12 adult chinook salmon were seen, one downstream and 11 upstream. Most of these (sighted during visual and snorkel observations) were about 100 meters upstream of the fish counting station at the upper end of the project area (Figure 3). There was no spawning activity in the project area.

During all the monitoring and evaluation observations in the Secesh River project area, three adult spring and summer chinook salmon were observed downstream of the fish counting station and 16 upstream. There was no correlation between visual bank observations and snorkel observations of adult salmon. Even though the visual survey occurred first and snorkelers soon afterwards searched for fish in the observed location, non-spawning chinook salmon were not observed at the same location by snorkelers. Fish observed by snorkelers usually were holding very tight under banks and had not been observed by the visual bank observers. No fish could be identified as being in any location for more than one day at a time.

Multiple passages of individually recognizable fish (Appendix Table B-2), up to 46 times for one individual (Figure 5), indicated that upstream and downstream passage was not hampered by the structure. The counting chamber itself did not appear to bother fish either, as evidenced by the fish that entered the counting chamber on August 28 and held there for two hours and 36 minutes. In view of the large number of fish passages, upstream and downstream, and at all times of the day and night, it was felt the counting station was well designed and positioned. Fish were allowed to move freely upstream or downstream. The Monitoring and Evaluation Plan criteria to determine if the fish counting station was impacting salmon migration, was the observation of three to ten or more adult salmon holding below the count station for more than three consecutive days, while no salmon were observed passing the counting station. Fish were never seen or heard bumping into or jumping at the fish guiding pickets, holding directly downstream of the fish guiding fences, or moving back and forth behind the pickets. Never were three to ten or more adult salmon observed holding below the fish counting station for three consecutive days. Fish did not migrate past the fish counting station from August 3 to 5, however, no fish were observed upstream or downstream of the fish counting station on those dates. The lack of movement appeared to be a change in the upstream movement pattern between the active upstream migration and searching for spawning habitat and mates within the spawning area. Because of the above conditions, it was concluded there was no impedance to fish movement, and corrective actions were not necessary in 1998.

There were two redds observed below the Secesh River project area and no redds located within the project area. All redds below the fish counting station were located in sites that appeared to have the desired spawning characteristics for a redd and most of the sites had been used in previous years (Jay Hesse, Nez Perce Tribe, unpublished data). Between 1992 and 1996, with no fish counting facility in place, the percentage of chinook redds observed downstream of the fish counting site ranged from 0 to 8.2%. In 1998, with the fish counting station in place, two redds (1.8 % of the total) were observed downstream of the fish counting station. The number and percent of redds observed spawning below the fish counting station in 1998 was within the range observed since 1992 (Table 6). It appeared that the fish counting station did not displace chinook salmon spawning activity from upstream of the fish counting station to downstream sites.

Table 6. Spring and summer chinook salmon redd counts in the Secesh River and Lake Creek index areas, and in the Secesh River from the fish counting station downstream to the canyon, 1992 to 1998.

	Number of Redds			
	Index Area			
Year	Lake Creek	Secesh River	Secesh Counting Station to Canyon	Percent of Redds Below fish counting station
1998*	44	68	2	1.8
1997*	46	78	5	4.0
1996	31	43	1	1.4
1995	12	18	0	0.0
1994	12	17	0	0.0
1993	44	94	7	5.1
1992	43	66	10	8.2

*- Adjusted for change in fish counting station location.

TEMPERATURE

This was the first year data was collected at Secesh River for individual fish passages and will be used as a baseline to compare future year’s movements. Water temperatures at the Secesh River fish counting station ranged from a low of 4.7 C on June 16, to a high of 19.5 C on August 13, 1998 (Table 7) (Figure 14). Between the passage of the first fish and last fish, temperatures ranged from a low of 8.1 C on August 25 to a high of 19.5 C. Water temperatures were recorded hourly and extrapolated for the exact time of passage for each fish at the fish counting station. The water temperatures recorded for each fish as they passed through the fish counting station ranged from a low of 8.2 C to 19.4 C.

The height of the adult chinook salmon spawner migration through Secesh River fish counting station, July 17 to 19, with temperatures between 11.7 and 19 C. Most fish passage occurred between 11 and 16 degrees C. The three-day period when no salmon moved through the Secesh River fish counting station included temperatures well within this range, and does not appear to have affected fish movement through the fish counting station. Water temperature was highest around 5:00 to 6:00 PM each day. Fish movement through the fish counting station was lowest from 10:00 AMto 4:00 PM.

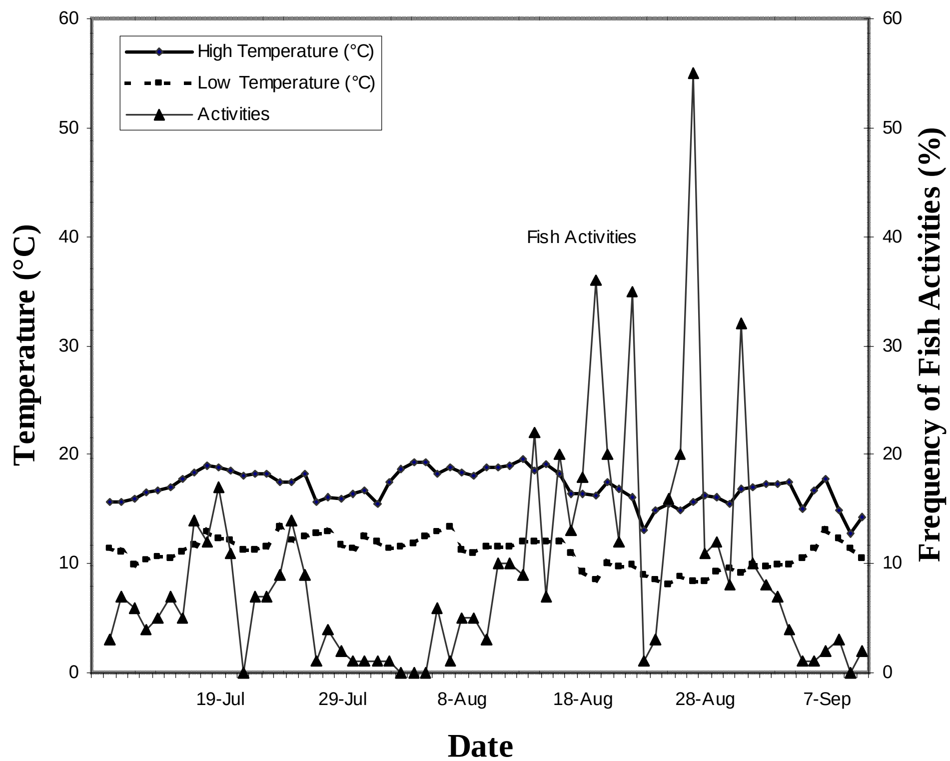

Figure 14. Daily maximum and minimum temperatures, and chinook salmon activity through the Secesh River fish counting station in 1998.

Table 7. Water temperatures during periods of high movement and no movement of adult spring and summer chinook salmon through the Secesh River fish counting station in 1998.

Movement	Dates	Temperature Range (C)
Peak upstream	July 17-19	11.7 to 19.0
High movement	August 13-14	12.3 to 19.4
High movement	August 16	12.1 to 16.8
High movement	August 18-21	8.5 to 16.5
High movement	August 25-27	8.8 to 15.7
High movement	August 30-31	11.4 to 16.9
No movement	August 2-6	11.5 to 19.4

FORK LENGTHS

Fish returning to the South Fork Salmon River weir were assigned to age groupings according to fork length. Fish less than 67 mm were called three year olds (jacks); 68-89 mm were four year olds, and greater than 90 mm were five year olds. Visual fork lengths of fish were taken using the 10 cm grid system painted on the back and bottom plates of the fish counting chamber. Position and orientation of the adult salmon in the counting chamber affected estimated fish length. Lengths were not accurate to +/- 5 cm and were rounded to the nearest 10 cm. This was not satisfactory to develop distinct age groups. Length assignments appeared to vary by different video observer. The run appeared to be predominately larger fish (age five). No jack chinook salmon were detected visually. Visual determination of lengths from videotapes was not satisfactory. Laser technology will be studied for possible application in determining fish lengths in 1999.

RECOMMENDATIONS

- Install the fish counting stations early enough to record the first fish passage at both sites. Fish counting stations will be operated in the Secesh River and Lake Creek in 1999. Exact locations may be changed slightly to accommodate installation prior to spring runoff and opening of road access. Structure material was stored within a mile of both sites. Snowmobiles are available to transport equipment. If weather and water conditions permit, both fish counting station basic structures would be installed during low winter flows, prior to runoff. The structures would be kept in place and cleared of debris through high water. As water levels and velocities recede, video equipment would be installed and recording begun. If the basic structures can be held in place through high water, there is greater potential to positively photograph the first upstream migrating adult salmon.

- Manually edit videotapes. Computerized editing of videotapes has not been satisfactory. Until the computerized editing system is workable, manual editing is the only option. This would eliminate the first, fast–forward tape review which did not provide any useable data. Fish passages would be directly edited/collapsed (at slow speed) onto another tape as time permits. Spot checks would be made of tapes to ensure equipment was operating properly.

- Provide extensive training to personnel. Early operation of the fish counting station would allow additional training of personnel before fish start actively migrating.
  This should reduce down time due to operator error and, with the additional experience, operators would be able to quickly identify and trouble shoot equipment malfunctions.

- Improve the lighting conditions in the fish counting chambers. Computerized editing of videotapes has not been satisfactory due to unstable light conditions. In bright sunlight, surface water movements cause bright light streaks which trigger the editing system. At night, turbulence reflects the nightlights, triggering the computer system.

- Evaluate the use of laser technology to provide accurate length determination.

- Investigate methods for better sex determinations. The proper sex identification of adult chinook salmon from video tapes, especially early in the season, is an important factor relating redds to escapement, and production. Methods of determining sex of adult chinook salmon by multiple reviewers will be investigated.

LITERATURE CITED

Bjornn, T. C., R. R. Ringe, K. R. Tolotti, P. J. Keniry, J. P. Hunt, C. J. Knutsen, and S. M. Knapp. 1992. Migration of adult chinook salmon and steelhead past dams and through reservoirs in the lower Snake River and into tributaries – 1991. U. S. Corps of Engineers Technical Report 92-2. Walla Walla District, WA.

Bjornn, T. C., J. P. Hunt, K. R. Tolotti, P. J. Keniry, R. R. Ringe, S. M. Knapp, and C. J. Knutsen. 1994. Migration of adult chinook salmon and steelhead past dams and through reservoirs in the lower Snake River and into tributaries – 1992. U. S. Corps of Engineers Technical Report 94-1. Walla Walla District, WA.

Bjornn, T. C., J. P. Hunt, K. R. Tolotti, P. J. Keniry, and R. R. Ringe. 1995. Migration of adult chinook salmon and steelhead past dams and through reservoirs in the lower Snake River and into tributaries – 1993. U. S. Corps of Engineers Technical Report 95-1. Walla Walla District, WA.

Bowles, E. and E. Leitzinger. 1991. Salmon supplementation studies in Idaho rivers (ISS). Experimental design. Idaho Department of Fish and Game. Prepared for Bonneville Power Administration. Portland, OR.

Brown, B. 1982. Mountain in the Clouds; a search for the wild salmon. Simon and Schuster. New York.

Burger, C.V., D.B. Wangaard, R.L. Wilmot, and A.N. Palmisano. 1983. Salmon investigations in the Kenai River, Alaska. U.S. Fish and Wildlife Service, National Fishery Research Center, Seattle; Alaska Field Station, Anchorage, AK.

Calvin, L.D. 1975. Estimating Night Fish Passage over Bonneville, The Dalles and John Day Dams. U.S. Corps of Engineers Report, Portland District, OR.

Cowley, K. and P. Kucera. 1989. Chinook salmon spawning ground survey in Big Creek, Johnson Creek, Secesh River and Lake Creek, Salmon River subbasin, Idaho 1989. Nez Perce Tribe Department of Fisheries Management. Lapwai, Idaho.

Faurot, D. and P. A. Kucera. 1998. Escapement Monitoring of Adult Chinook Salmon in the Secesh River, Idaho, 1997. Annual Report to the U. S. Department of Energy, Bonneville Power Administration by the Nez Perce Tribe Department of Fisheries. Contract No. 97AM30423, Project No. 97-030.

Hammarstrom, S.L., L. Larson, M. Wenger, and J. Carlon. 1985. Kenai Peninsula Chinook and coho salmon studies. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance 1984-1985, Project F-9-17. 148 pp.

Hatch, D.R., M. Schwartzberg, and P.R. Mundy. 1994a. Estimation of Pacific Salmon Escapement with a Time-Lapse Video Recording Technique. North American Journal of Fisheries Management 14:626-635.

Hatch, D.R., D.R. Pederson, J.K. Fryer, M. Schwartzberg, and A. Wand. 1994b. The Feasibility of Documenting and Estimating Adult Fish Passage at Large Hydroelectric Facilities in the Snake River Using Video Technology. Columbia River Inter-Tribal Fish Commission, Annual Report to Bonneville Power Administration, Contract DE-BI79-92BP61404.

Hatch, D. R., J.K. Fryer, M. Schwartzberg, D.R. Pederson, and A. Wand. 1998. A Computerized Editing System for Video Monitoring of Fish Passage. North American Journal of Fisheries Management 18(3) 694-699.

Hevlin, W. and S. Rainey. 1993. Considerations in the Use of Adult Fish Barriers and Traps in Tributaries to Achieve Management Objectives. Paper presented at the National American Fisheries Society Annual Meeting, 1993, Portland, OR.

Holubetz, T. B., and B.D. Leth. 1996. Evaluation and Monitoring of Wild/Natural Steelhead Trout Production. Annual Progress Report to BPA, 1995. Idaho Department of Fish and Game. Boise, ID.

Kucera, P.A. 1986. Big Creek chinook salmon spawning ground survey. Nez Perce Tribe Department of Fisheries Management. Lapwai, Idaho.

Kucera, P.A. 1987. Chinook salmon spawning ground survey in Big Creek, Johnson Creek, Secesh River and Lake Creek, Salmon River subbasin, Idaho 1987. Nez Perce Tribe Department of Fisheries Management. Lapwai, Idaho.

Kucera P. A. and M. J. Banach. 1991. Chinook salmon spawning ground survey in Big Creek, Johnson Creek, Secesh River and Lake Creek, Salmon River subbasin, Idaho - 1990. Nez Perce Tribe Department of Fisheries Management. Lapwai, Idaho.

Kucera P. A. and M.L. Blenden. 1993. Chinook salmon spawning ground survey in Big Creek, and tributary streams of the South Fork Salmon River, Idaho - 1991. In LSRCP Evaluation Studies Annual Report – 1991. AFF1/LSR-94-12. Nez Perce Tribe Department of Fisheries Management. Lapwai, Idaho.

Ortman, D. W. 1968. Salmon and Steelhead Investigations. South Fork of the Salmon River, salmon and steelhead harvest and escapement studies, 1960 – 1967. Annual Progress Report. F 49-R-6, Job 1, 1967-1968. Idaho Department of Fish and Game, Boise, ID.

River Masters Engineering. 1994. Preliminary design of a non-impeding fish counting facility in the Secesh River for adult summer chinook. Prepared for Nez Perce Tribe Fisheries Resources Management. Pullman, WA.

Roger, P. B. and M. Schwartzberg. 1986. An annotated compendium of spawning ground surveys in the Columbia River Basin above Bonneville Dam, 1960-1984. Columbia River Inter-Tribal Fish Commission Technical Report 86-1. Portland, OR.

Schwartzberg, M. and P. B. Roger. 1986. Observations on the accuracy of redd counting techniques used in the Columbia basin. Columbia River Inter-Tribal Fish Commission Technical Report 86-2.

APPENDIX A

Table A-1 Run timing and direction of adult spring and summer chinook salmon passing the escapement monitoring fish counting station in the Secesh River in 1998.

Date (1998)	Time (Hours)	Length (cm)	Estimated Sex (M/F)	Direction	Net Upstream
10-Jul	18:14	90	F	Up	1
10-Jul	22:39	90	F	Up	2
10-Jul	22:44	80	F	Up	3
11-Jul	0:42	70	M	Up	4
11-Jul	9:11	90	F	Up	5
11-Jul	9:32	100	F	Up	6
11-Jul	22:23	100	M	Up	7
11-Jul	22:23	80	M	Up	8
11-Jul	22:43	90	F	Up	9
11-Jul	23:02	100	M	Up	10
12-Jul	14:12	90	M	Up	11
12-Jul	19:27	80	F	Down	10
12-Jul	21:07	80	F	Up	11
12-Jul	21:45	90	F	Up	12
12-Jul	21:45	80	M	Up	13
12-Jul	23:04	80	M	Up	14
13-Jul	0:09	70	M	Up	15
13-Jul	1:47	90	M	Up	16
13-Jul	4:22	80	F	Up	17
13-Jul	21:27	90	F	Up	18
14-Jul	0:44	80	M	Up	19
14-Jul	18:42	90	F	Up	20
14-Jul	19:04	100	M	Up	21
14-Jul	19:05	90	M	Up	22
14-Jul	19:05	80	F	Up	23
15-Jul	4:23	90	F	Up	24
15-Jul	6:25	80	M	Up	25
15-Jul	8:30	90	M	Up	26
15-Jul	16:06	80	F	Up	27
15-Jul	16:06	90	M	Up	28

Table A-1 (continued).

Date (1998)	Time (Hours)	Length (cm)	Estimated Sex (M/F)	Direction	Net Upstream
15-Jul	22:20	80	F	Up	29
15-Jul	22:33	90	F	Up	30
16-Jul	0:31	80	M	Up	31
16-Jul	1:57	80	F	Up	32
16-Jul	4:15	80	F	Up	33
16-Jul	4:44	90	F	Up	34
16-Jul	5:07	80	M	Up	35
17-Jul	0:12	90	M	Up	36
17-Jul	0:35	70	F	Up	37
17-Jul	0:45	80	F	Up	38
17-Jul	1:23	80	F	Up	39
17-Jul	2:52	80	F	Up	40
17-Jul	5:52	85	M	Up	41
17-Jul	9:45	90	M	Up	42
17-Jul	14:15	90	F	Up	43
17-Jul	14:16	80	M	Up	44
17-Jul	14:16	80	F	Up	45
17-Jul	14:48	70	M	Down	44
17-Jul	15:31	100	M	Up	45
17-Jul	15:53	70	M	Down	44
17-Jul	22:54	70	F	Up	45
18-Jul	0:16	70	M	Up	46
18-Jul	0:17	80	F	Up	47
18-Jul	0:56	80	F	Up	48
18-Jul	1:17	80	M	Up	49
18-Jul	1:31	100	M	Up	50
18-Jul	1:31	100	M	Up	51
18-Jul	1:42	60	M	Up	52
18-Jul	3:29	100	M	Up	53
18-Jul	5:30	80	M	Down	52
18-Jul	6:57	100	M	Up	53
18-Jul	22:15	90	M	Up	54
18-Jul	23:23	80	F	Up	55
19-Jul	0:04	80	M	Up	56
19-Jul	0:46	80	M	Up	57

Table A-1 (continued).

Date (1998)	Time (Hours)	Length (cm)	Estimated Sex (M/F)	Direction	Net Upstream
19-Jul	1:01	80	M	Up	58
19-Jul	1:13	70	M	Up	59
19-Jul	1:01	80	M	Up	58
19-Jul	1:13	70	M	Up	59
19-Jul	2:06	80	F	Up	60
19-Jul	2:26	80	F	Up	61
19-Jul	2:51	80	M	Down	60
19-Jul	2:51	?	F	Up	61
19-Jul	3:01	80	F	Down	60
19-Jul	3:08	80	F	Up	61
19-Jul	3:34	80	F	Up	62
19-Jul	6:45	90	F	Down	61
19-Jul	22:03	90	M	Up	62
19-Jul	22:06	70	M	Up	63
19-Jul	22:07	80	F	Down	62
19-Jul	22:49	70	M	Up	63
19-Jul	22:56	80	F	Up	64
20-Jul	0:13	80	F	Up	65
20-Jul	1:03	90	F	Up	66
20-Jul	2:01	80	M	Up	67
20-Jul	3:14	80	M	Up	68
20-Jul	3:41	90	F	Up	69
20-Jul	3:42	90	M	Down	68
20-Jul	5:16	80	F	Up	69
20-Jul	8:33	80	M	Up	70
20-Jul	8:43	80	F	Up	71
20-Jul	22:57	90	F	Up	72
20-Jul	22:59	70	M	Up	73
21-Jul	2:01	80	F	Up	74
21-Jul	18:28	80	F	Down	73
22-Jul	2:29	90	M	Up	74
22-Jul	3:53	80	M	Up	75
22-Jul	4:12	80	M	Down	74
22-Jul	4:43	80	M	Up	75

Table A-1 (continued).

Date (1998)	Time (Hours)	Length (cm)	Estimated Sex (M/F)	Direction	Net Upstream
22-Jul	5:46	90	F	Up	76
22-Jul	5:57	90	M	Up	77
22-Jul	23:22	80	F	Up	78
23-Jul	1:05	80	F	Up	79
23-Jul	1:41	80	F	Up	80
23-Jul	2:23	90	F	Up	81
23-Jul	2:48	80	F	Up	82
23-Jul	3:13	80	M	Up	83
23-Jul	6:22	70	M	Up	84
23-Jul	11:08	80	F	Up	85
24-Jul	0:49	50	M	Up	86
24-Jul	1:02	90	M	Down	85
24-Jul	2:28	80	F	Up	86
24-Jul	3:34	80	F	Up	87
24-Jul	3:41	80	F	Up	88
24-Jul	4:28	80	M	Up	89
24-Jul	4:29	90	F	Up	90
24-Jul	9:55	80	F	Up	91
24-Jul	13:03	90	F	Up	92
25-Jul	0:22	80	F	Down	91
25-Jul	1:08	70	F	Up	92
25-Jul	1:22	80	M	Up	93
25-Jul	1:23	80	?	Up	94
25-Jul	1:35	80	F	Up	95
25-Jul	1:53	80	M	Up	96
25-Jul	5:15	70	M	Up	97
25-Jul	11:06	80	F	Down	96
25-Jul	16:54	90	M	Up	97
25-Jul	21:08	70	?	Down	96
25-Jul	22:23	80	F	Down	95
25-Jul	22:53	80	F	Down	94
25-Jul	23:18	70	F	Down	93
25-Jul	23:31	80	M	Down	92

Table A-1 (continued).

Date (1998)	Time (Hours)	Length (cm)	Estimated Sex (M/F)	Direction	Net Upstream
26-Jul	1:05	70	F	Down	91
26-Jul	1:16	80	M	Up	92
26-Jul	4:17	80	M	Down	91
26-Jul	4:23	90	F	Down	90
26-Jul	5:04	70	M	Down	89
26-Jul	5:39	70	M	Down	88
26-Jul	5:48	90	F	Up	89
26-Jul	18:39	90	F	Up	90
26-Jul	23:19	70	F	Down	89
27-Jul	5:36	80	M	Down	88
28-Jul	0:23	80	M	Up	89
28-Jul	0:28	70	M	Up	90
28-Jul	6:15	80	M	Up	91
28-Jul	11:39	80	M	Up	92
29-Jul	5:56	80	F	Up	93
29-Jul	23:58	80	F	Up	94
30-Jul	3:01	70	?	Up	95
31-Jul	22:00	70	?	Up	96
1-Aug	0:03	70	F	Up	97
2-Aug	23:42	80	M	Up	98
3-Aug	-	-	-	-	98
4-Aug	-	-	-	-	98
5-Aug	-	-	-	-	98
6-Aug	0:27	70	M	Up	99
6-Aug	2:21	70	F	Up	100
6-Aug	5:36	80	M	Up	101
6-Aug	5:55	60	M	Down	100
6-Aug	6:05	80	F	Down	99
6-Aug	23:42	90	M	Up	100
7-Aug	4:40	70	M	Up	101
8-Aug	5:47	?	M	Down	100
8-Aug	6:40	80	F	Up	101
8-Aug	8:52	90	M	Down	100

Table A-1 (continued).

Date (1998)	Time (Hours)	Length (cm)	Estimated Sex (M/F)	Direction	Net Upstream
8-Aug	9:57	90	M	Up	101
8-Aug	20:45	80	M	Down	100
9-Aug	5:51	80	F	Up	101
9-Aug	5:56	70	M	Up	102
9-Aug	8:01	80	M	Down	101
9-Aug	15:14	80	F	Up	102
9-Aug	22:31	80	F	Up	103
10-Aug	0:48	80	M	Down	102
10-Aug	2:12	70	M	Up	103
10-Aug	9:36	80	M	Down	102
11-Aug	0:00	70	F	Up	103
11-Aug	0:10	80	M	Up	104
11-Aug	0:44	80	M	Up	105
11-Aug	2:21	70	M	Up	106
11-Aug	6:06	90	M	Down	105
11-Aug	11:09	90	M	Down	104
11-Aug	11:28	90	M	Up	105
11-Aug	12:54	80	M	Down	104
11-Aug	13:24	80	M	Up	105
11-Aug	14:01	80	F	Up	106
12-Aug	0:09	70	M	Down	105
12-Aug	0:09	90	M	Down	104
12-Aug	0:16	90	M	Up	105
12-Aug	0:50	70	M	Up	106
12-Aug	1:13	80	M	Down	105
12-Aug	1:19	80	M	Up	106
12-Aug	3:49	70	F	Up	107
12-Aug	6:35	70	F	Down	106
12-Aug	16:26	90	M	Down	105
12-Aug	17:57	90	M	Up	106
13-Aug	12:14	80	M	Up	107
13-Aug	16:30	80	M	Down	106
13-Aug	17:31	70	F	Up	107
13-Aug	21:00	70	M	Down	106

Table A-1 (continued).

Date (1998)	Time (Hours)	Length (cm)	Estimated Sex (M/F)	Direction	Net Upstream
13-Aug	23:17	70	M	Down	105
13-Aug	23:35	80	F	Up	106
13-Aug	23:39	80	F	Up	107
13-Aug	23:39	90	M	Up	108
13-Aug	23:47	80	M	Up	109
14-Aug	0:12	70	F	Up	110
14-Aug	0:29	80	M	Up	111
14-Aug	0:33	80	M	Down	110
14-Aug	1:11	90	M	Up	111
14-Aug	1:48	80	M	Down	110
14-Aug	1:53	80	M	Down	109
14-Aug	2:27	90	M	Up	110
14-Aug	3:20	90	M	Up	111
14-Aug	3:36	70	M	Up	112
14-Aug	3:59	90	M	Down	111
14-Aug	4:33	70	M	Down	110
14-Aug	6:48	90	M	Down	109
14-Aug	7:43	90	M	Up	110
14-Aug	8:19	80	M	Down	109
14-Aug	9:39	80	M	Up	110
14-Aug	12:56	80	M	Up	111
14-Aug	13:56	80	M	Down	110
14-Aug	20:24	70	M	Down	109
14-Aug	20:33	80	M	Up	110
14-Aug	20:49	80	M	Down	109
14-Aug	21:50	70	M	Up	110
14-Aug	23:41	80	M	Up	111
15-Aug	0:18	90	M	Up	112
15-Aug	1:28	80	F	Up	113
15-Aug	2:15	90	M	Down	112
15-Aug	6:01	70	F	Up	113
15-Aug	7:34	90	M	Up	114
15-Aug	9:36	80	M	Down	113

Table A-1 (continued).

Date (1998)	Time (Hours)	Length (cm)	Estimated Sex (M/F)	Direction	Net Upstream
15-Aug	22:22	?	M	Down	112
16-Aug	0:15	80	M	Up	113
16-Aug	0:18	80	F	Up	114
16-Aug	0:47	90	F	Up	115
16-Aug	0:57	90	M	Down	114
16-Aug	1:24	80	M	Up	115
16-Aug	3:18	90	M	Up	116
16-Aug	3:47	70	F	Up	117
16-Aug	7:00	80	F	Down	116
16-Aug	7:38	80	F	Up	117
16-Aug	18:36	90	M	Down	116
16-Aug	18:55	80	M	Up	117
16-Aug	19:06	70	M	Down	116
16-Aug	19:18	90	M	Up	117
16-Aug	19:34	70	F	Up	118
16-Aug	19:39	70	M	Down	117
16-Aug	21:05	90	M	Down	116
16-Aug	21:06	90	M	Up	117
16-Aug	22:24	80	M	Up	118
16-Aug	22:34	80	M	Up	119
16-Aug	22:55	90	F	Up	120
17-Aug	0:38	80	F	Up	121
17-Aug	2:23	80	M	Down	120
17-Aug	4:13	80	M	Up	121
17-Aug	4:18	70	M	Down	120
17-Aug	4:44	80	M	Down	119
17-Aug	9:51	70	M	Down	118
17-Aug	10:24	70	F	Up	119
17-Aug	14:52	90	M	Down	118
17-Aug	15:34	80	M	Up	119
17-Aug	20:34	80	F	Up	118
17-Aug	21:39	70	M	Down	119
17-Aug	23:16	80	M	Up	120

Table A-1 (continued).

Date (1998)	Time (Hours)	Length (cm)	Estimated Sex (M/F)	Direction	Net Upstream
17-Aug	23:34	80	M	Up	121
18-Aug	0:30	80	M	Up	122
18-Aug	1:33	80	F	Up	123
18-Aug	1:37	80	F	Down	122
18-Aug	3:45	60	M	Up	123
18-Aug	4:13	60	M	Down	122
18-Aug	5:42	60	M	Up	123
18-Aug	6:48	90	F	Up	124
18-Aug	7:18	80	F	Up	125
18-Aug	11:28	70	F	Down	124
18-Aug	13:07	80	F	Down	123
18-Aug	13:11	80	F	Up	124
18-Aug	13:53	70	M	Down	123
18-Aug	15:32	80	M	Down	122
18-Aug	15:58	80	F	Down	121
18-Aug	16:54	80	F	Up	122
18-Aug	16:56	80	M	Up	123
18-Aug	17:56	80	M	Down	122
18-Aug	18:16	80	M	Up	123
19-Aug	1:56	80	M	Down	122
19-Aug	2:10	80	M	Up	123
19-Aug	2:12	80	M	Down	122
19-Aug	2:13	80	M	Up	123
19-Aug	5:43	80	F	Down	122
19-Aug	5:43	70	M	Down	121
19-Aug	6:11	80	F	Up	122
19-Aug	6:46	80	F	Down	121
19-Aug	7:00	70	M	Up	122
19-Aug	7:27	70	M	Down	121
19-Aug	7:29	80	F	Up	122
19-Aug	7:32	70	M	Down	121
19-Aug	7:33	70	M	Up	122
19-Aug	7:36	70	M	Down	121

Table A-1 (continued).

Date (1998)	Time (Hours)	Length (cm)	Estimated Sex (M/F)	Direction	Net Upstream
19-Aug	7:42	80	M	Down	120
19-Aug	7:47	80	M	Up	121
19-Aug	8:09	90	F	Up	122
19-Aug	8:11	90	F	Down	121
19-Aug	8:16	90	F	Up	122
19-Aug	8:16	90	F	Down	121
19-Aug	10:52	80	M	Down	120
19-Aug	11:32	80	M	Up	121
19-Aug	11:37	90	M	Up	122
19-Aug	12:51	80	M	Down	121
19-Aug	13:14	90	M	Up	122
19-Aug	14:25	80	M	Down	121
19-Aug	14:42	80	M	Down	120
19-Aug	14:55	80	M	Up	121
19-Aug	14:56	80	M	Down	120
19-Aug	15:03	90	M	Up	121
19-Aug	18:56	80	M	Down	120
19-Aug	18:58	80	M	Up	121
19-Aug	19:50	80	M	Down	120
19-Aug	19:52	80	M	Up	121
19-Aug	20:34	90	F	Up	122
19-Aug	22:20	80	M	Up	123
20-Aug	1:36	80	M	Down	122
20-Aug	1:43	80	M	Up	123
20-Aug	3:36	70	M	Up	124
20-Aug	4:48	80	M	Down	123
20-Aug	4:51	90	F	Up	124
20-Aug	4:52	80	M	Up	125
20-Aug	4:53	90	M	Down	124
20-Aug	4:56	90	F	Up	125
20-Aug	7:15	80	M	Down	124
20-Aug	7:18	80	M	Up	125
20-Aug	7:59	80	M	Down	124

Table A-1 (continued).

Date (1998)	Time (Hours)	Length (cm)	Estimated Sex (M/F)	Direction	Net Upstream
20-Aug	9:34	80	M	Down	123
20-Aug	9:37	80	M	Down	122
20-Aug	10:09	90	M	Up	123
20-Aug	17:47	80	F	Up	124
20-Aug	19:50	90	M	Down	123
20-Aug	19:59	80	M	Down	122
20-Aug	20:09	90	M	Up	123
20-Aug	20:21	90	M	Up	124
20-Aug	21:23	80	M	Up	125
21-Aug	1:23	80	M	Down	124
21-Aug	1:45	80	M	Up	125
21-Aug	3:04	90	F	Up	126
21-Aug	3:14	80	M	Up	127
21-Aug	7:03	70	M	Down	126
21-Aug	8:27	90	M	Down	125
21-Aug	8:30	80	M	Up	126
21-Aug	10:22	90	M	Down	125
21-Aug	11:56	100	M	Up	126
21-Aug	17:06	80	M	Down	125
21-Aug	17:37	80	M	Up	126
21-Aug	23:17	80	M	Up	127
22-Aug	1:01	80	M	Down	126
22-Aug	1:07	80	M	Up	127
22-Aug	2:02	90	F	Up	128
22-Aug	2:16	80	M	Down	127
22-Aug	2:40	80	M	Down	126
22-Aug	2:41	80	F	Down	125
22-Aug	2:47	80	F	Up	126
22-Aug	2:48	80	M	Up	127
22-Aug	6:13	90	M	Up	128
22-Aug	6:42	80	F	Down	127
22-Aug	6:53	90	F	Up	128
22-Aug	7:06	80	F	Down	127

Table A-1 (continued).

Date (1998)	Time (Hours)	Length (cm)	Estimated Sex (M/F)	Direction	Net Upstream
22-Aug	7:13	90	F	Up	128
22-Aug	7:48	80	M	Down	127
22-Aug	8:06	80	M	Up	128
22-Aug	8:33	80	F	Down	127
22-Aug	8:39	90	M	Down	126
22-Aug	8:41	80	F	Up	127
22-Aug	8:41	90	M	Up	128
22-Aug	9:18	90	F	Down	127
22-Aug	9:25	90	F	Up	128
22-Aug	9:39	90	M	Down	127
22-Aug	9:46	90	M	Up	128
22-Aug	11:01	80	M	Down	127
22-Aug	12:15	90	F	Down	126
22-Aug	12:16	90	F	Up	127
22-Aug	12:20	90	F	Down	128
22-Aug	12:22	80	F	Up	127
22-Aug	12:39	80	M	Up	128
22-Aug	13:27	80	M	Down	127
22-Aug	14:02	80	M	Down	126
22-Aug	14:23	80	M	Up	127
22-Aug	19:25	80	M	Down	126
22-Aug	19:32	80	M	Up	127
22-Aug	22:14	80	M	Up	128
23-Aug	0:57	80	F	Up	129
24-Aug	21:04	80	M	Down	128
24-Aug	21:05	80	M	Up	129
24-Aug	21:33	80	F	Up	130
25-Aug	12:24	80	M	Down	129
25-Aug	12:55	80	M	Up	130
25-Aug	16:27	90	M	Down	129
25-Aug	16:49	90	M	Up	130
25-Aug	17:47	90	M	Down	129
25-Aug	18:03	90	M	Up	130

Table A-1 (continued).

Date (1998)	Time (Hours)	Length (cm)	Estimated Sex (M/F)	Direction	Net Upstream
25-Aug	19:05	90	M	Down	129
25-Aug	21:14	70	F	Up	130
25-Aug	21:14	90	M	Up	131
25-Aug	21:18	90	M	Down	130
25-Aug	21:32	90	M	Up	131
25-Aug	21:56	90	M	Down	130
25-Aug	22:19	90	M	Up	131
25-Aug	22:26	90	M	Up	132
25-Aug	22:38	90	M	Down	131
25-Aug	23:06	90	M	Up	132
26-Aug	0:12	90	M	Down	131
26-Aug	0:28	90	M	Up	132
26-Aug	1:23	90	M	Down	131
26-Aug	1:39	80	F	Up	132
26-Aug	2:02	90	M	Up	132
26-Aug	3:00	80	M	Down	132
26-Aug	3:32	80	M	Up	133
26-Aug	3:41	90	M	Down	132
26-Aug	3:51	90	M	Up	133
26-Aug	4:53	90	M	Down	132
26-Aug	5:50	90	M	Up	133
26-Aug	16:03	90	M	Up	136
26-Aug	7:25	90	M	Up	133
26-Aug	9:50	80	M	Down	132
26-Aug	9:54	80	M	Down	131
26-Aug	16:02	80	M	Up	132
26-Aug	17:35	70	M	Down	131
26-Aug	18:43	90	M	Down	132
26-Aug	18:56	90	M	Up	131
26-Aug	20:53	80	F	Up	132
27-Aug	0:02	70	M	Up	133
27-Aug	1:08	70	M	Down	132
27-Aug	1:26	70	M	Up	133

Table A-1 (continued).

Date (1998)	Time (Hours)	Length (cm)	Estimated Sex (M/F)	Direction	Net Upstream
27-Aug	1:30	70	M	Down	132
27-Aug	1:31	90	M	Down	131
27-Aug	1:34	90	M	Up	132
27-Aug	1:34	70	F	Up	133
27-Aug	1:35	70	M	Up	134
27-Aug	1:36	80	F	Up	135
27-Aug	1:37	70	M	Down	134
27-Aug	1:37	90	M	Up	135
27-Aug	1:37	70	M	Down	134
27-Aug	2:05	70	M	Up	135
27-Aug	2:07	70	M	Down	134
27-Aug	2:17	90	M	Down	133
27-Aug	2:32	90	M	Up	134
27-Aug	2:33	70	M	Up	135
27-Aug	2:41	70	M	Down	134
27-Aug	2:42	80	F	Down	133
27-Aug	2:43	70	M	Up	134
27-Aug	2:44	90	M	Down	133
27-Aug	2:52	80	M	Down	132
27-Aug	2:52	80	?	Up	133
27-Aug	2:58	80	M	Down	132
27-Aug	3:07	90	M	Up	133
27-Aug	3:17	80	M	Up	134
27-Aug	3:20	90	M	Down	133
27-Aug	3:46	90	F	Up	134
27-Aug	4:01	80	M	Up	135
27-Aug	4:04	100	M	Up	136
27-Aug	4:29	80	F	Down	135
27-Aug	4:37	90	M	Up	136
27-Aug	4:55	90	M	Down	135
27-Aug	5:08	70	M	Up	136
27-Aug	5:19	90	M	Up	137
27-Aug	11:32	70	M	Down	136

Table A-1 (continued).

Date (1998)	Time (Hours)	Length (cm)	Estimated Sex (M/F)	Direction	Net Upstream
27-Aug	11:50	80	M	Up	137
27-Aug	13:23	70	M	Down	136
27-Aug	13:24	90	M	Down	135
27-Aug	13:58	90	M	Up	136
27-Aug	16:05	80	F	Down	135
27-Aug	16:57	80	F	Up	136
27-Aug	17:05	70	M	Down	135
27-Aug	17:37	90	M	Down	134
27-Aug	17:42	90	M	Down	133
27-Aug	17:45	100	M	Up	134
27-Aug	17:47	70	M	Up	135
27-Aug	17:47	90	M	Up	136
27-Aug	17:47	?	M	Up	137
27-Aug	18:09	70	M	Down	136
27-Aug	20:04	90	M	Down	135
27-Aug	20:18	80	M	Up	136
27-Aug	20:33	90	M	Down	135
27-Aug	20:47	90	?	Up	136
27-Aug	21:26	80	M	Up	137
28-Aug	0:20	70	M	Down	136
28-Aug	0:50	70	M	Down	135
28-Aug	1:24	80	M	Up	136
28-Aug	3:40	90	M	Up	137
28-Aug	11:45	90	M	Down	136
28-Aug	12:14	80	F	Up	137
28-Aug	14:50	90	M	Up	138
28-Aug	15:56	80	M	Up	139
28-Aug	20:03	90	M	Down	138
28-Aug	20:19	90	M	Up	139
28-Aug	23:12	80	F	Down	138
29-Aug	0:48	80	F	Up	139
29-Aug	2:04	90	M	Down	138
29-Aug	2:15	90	M	Up	139

Table A-1 (continued).

Date (1998)	Time (Hours)	Length (cm)	Estimated Sex (M/F)	Direction	Net Upstream
29-Aug	5:31	80	M	Down	138
29-Aug	6:21	80	F	Up	139
29-Aug	10:11	90	M	Down	138
29-Aug	10:39	90	M	Up	139
29-Aug	12:08	90	M	Down	138
29-Aug	12:35	90	M	Up	139
29-Aug	13:48	80	M	Up	140
29-Aug	21:23	80	M	Down	139
29-Aug	21:43	80	M	Up	140
30-Aug	11:59	90	M	Down	139
30-Aug	12:18	80	M	Down	138
30-Aug	12:24	70	M	Down	137
30-Aug	12:51	90	M	Up	138
30-Aug	13:33	80	M	Up	139
30-Aug	16:50	80	F	Up	140
30-Aug	18:28	80	F	Down	139
30-Aug	19:46	80	M	Down	138
31-Aug	1:50	90	M	Down	137
31-Aug	4:09	80	F	Down	136
31-Aug	4:40	90	M	Up	137
31-Aug	5:42	90	M	Up	138
31-Aug	6:32	90	M	Down	137
31-Aug	8:02	90	M	Down	136
31-Aug	9:53	90	M	Up	137
31-Aug	10:35	90	M	Down	136
31-Aug	14:58	80	F	Down	135
31-Aug	16:03	90	M	Up	136
31-Aug	18:07	90	M	Down	135
31-Aug	18:30	80	F	Up	136
31-Aug	18:30	90	M	Up	137
31-Aug	18:44	80	F	Down	136
31-Aug	18:44	90	M	Down	135
31-Aug	18:58	80	F	Up	136

Table A-1 (continued).

Date (1998)	Time (Hours)	Length (cm)	Estimated Sex (M/F)	Direction	Net Upstream
31-Aug	18:58	90	M	Up	137
31-Aug	19:04	80	F	Down	136
31-Aug	19:05	90	M	Down	135
31-Aug	19:56	80	F	Up	136
31-Aug	19:57	80	F	Up	137
31-Aug	19:57	90	M	Up	138
31-Aug	20:00	90	M	Down	137
31-Aug	20:07	90	M	Up	138
31-Aug	20:10	80	F	Down	137
31-Aug	20:10	90	M	Down	136
31-Aug	20:46	90	M	Up	137
31-Aug	21:22	90	M	Down	136
31-Aug	21:47	90	M	Up	137
31-Aug	22:20	90	F	Down	136
31-Aug	23:06	90	M	Up	137
31-Aug	23:59	90	M	Down	136
1-Sep	1:41	90	M	Down	135
1-Sep	2:49	90	M	Down	134
1-Sep	3:23	90	M	Up	135
1-Sep	4:04	100	M	Up	136
1-Sep	9:12	100	M	Down	135
1-Sep	15:04	90	M	Down	134
1-Sep	17:47	100	M	Up	135
1-Sep	17:49	100	F	Up	136
1-Sep	21:44	90	M	Down	135
1-Sep	22:28	90	M	Down	134
2-Sep	1:40	90	M	Up	135
2-Sep	2:44	90	M	Down	134
2-Sep	2:54	90	M	Up	135
2-Sep	3:55	90	M	Up	136
2-Sep	5:20	90	F	Down	135
2-Sep	8:37	90	F	Up	136
2-Sep	12:59	90	M	Down	135

Table A-1 (continued).

Date (1998)	Time (Hours)	Length (cm)	Estimated Sex (M/F)	Direction	Net Upstream
2-Sep	13:05	90	M	Down	134
3-Sep	0:53	90	M	Up	135
3-Sep	1:04	90	M	Down	134
3-Sep	5:02	90	M	Up	135
3-Sep	6:48	90	M	Down	134
3-Sep	6:50	90	M	Up	135
3-Sep	7:09	90	M	Down	134
3-Sep	23:32	80	F	Down	133
4-Sep	0:21	90	M	Down	132
4-Sep	0:57	80	F	Up	133
4-Sep	14:00	90	M	Down	132
4-Sep	18:13	100	F	Up	133
5-Sep	23:51	90	M	Down	132
6-Sep	5:35	90	M	Up	133
7-Sep	16:35	90	M	Down	132
7-Sep	17:20	90	M	Up	133
8-Sep	12:57	90	M	Down	132
8-Sep	12:59	90	M	Up	133
8-Sep	13:01	90	M	Down	132
9-Sep	-	-	-	-	132
10-Sep	11:06	?	M	Down	131
10-Sep	11:46	?	?	Up	132
11-Sep	-	-	-	-	132
12-Sep	-	-	-	-	132
13-Sep	-	-	-	-	132
14-Sep	-	-	-	-	132
15-Sep	-	-	-	-	132
16-Sep	-	-	-	-	132
17-Sep	-	-	-	-	132
18-Sep	-	-	-	-	132

Table A-2. Diel movements of adult spring and summer chinook salmon through the Secesh River fish counting station, by hour, in 1998.

Time	Total Movements (Up and Down)	Percent (%) Total Movements	Net Upstream Movements	Percent (%) Net Upstream Movement
0000	47	8	27	21
0100	54	9	16	12
0200	44	8	10	9
0300	33	6	21	16
0400	30	5	4	3
0500	28	5	8	6
0600	21	4	3	2
0700	23	4	-1	-1
0800	19	3	1	1
0900	19	3	-1	-1
1000	7	0	-1	-1
1100	16	3	-1	-1
1200	20	3	0	0
1300	15	3	-1	-1
1400	16	3	0	0
1500	9	2	1	1
1600	15	3	5	4
1700	18	3	4	3
1800	22	4	4	3
1900	21	4	-1	-1
2000	20	3	2	2
2100	25	4	3	2
2200	30	5	17	13
2300	25	4	9	8

Time – military time (hours)

Table A-3. Individually recognizable adult spring and summer chinook salmon passing through the Secesh River fish counting station in 1998.

Fish	Sex	Number of Passages	Dates	Time elapsed between first and last passages
a	F	3	August 6(2), 8(1)	50 hours
b	M	2	August15	2 hours
c	F	2	August 16	38 minutes
d	M	3	August16	1 minute
e	F	2	August18	3 hours
f	F	4	August 18	3 ½ hours
g	F	4	August 19	7 minutes
h	M	3	August 20	12 hours
i	M	2	August 20(1), 21(1)	12 hours
j	M	13	August 21(3), 22(10)	35 hours
k	M	2	August 22	7 minutes
l	M	46	August 25(12), 26(12), 27(14), 28(4), 29(4)	4 days
m	F	9	August 27(1), 28(1), 31(7)	4 days
n	M	5	August 30(2), 31(3)	22 hours
o	M	3	August 31(2), September 1(1)	15 hours
p	M	15	August 31(12), September 1(1), 3(2)	3 days
r	M	12	September (4), 2(4), 3(4)	51 hours
s	M	4	September 7(2), 8(3)	21 hours

F – Female
M – Male

APPENDIX B

Table B-1 Run timing and direction of adult spring and summer chinook salmon passing the escapement monitoring fish counting station in Lake Creek in 1998.

Date (1998)	Time (Hours)	Length (cm)	Estimated Sex (M/F)	Direction	Net Upstream
22-Jun	-	-	-	-	-
23-Jun	-	-	-	-	-
24-Jun	-	-	-	-	-
25-Jun	-	-	-	-	-
26-Jun	-	-	-	-	-
27-Jun	-	-	-	-	-
28-Jun	-	-	-	-	-
29-Jun	-	-	-	-	-
30-Jun	-	-	-	-	-
1-Jul	-	-	-	-	-
2-Jul	-	-	-	-	-
3-Jul	-	-	-	-	-
4-Jul	-	-	-	-	-
5-Jul	-	-	-	-	-
6-Jul	-	-	-	-	-
7-Jul	-	-	-	-	-
8-Jul	1:21	60	M	Up	1
9-Jul	15:40	100	M	Up	2
10-Jul	20:37	90	M	Up	3
10-Jul	0:14	90	F	Up	4
11-Jul	7:48	100	F	Up	5
11-Jul	0:20	70	F	Up	6
11-Jul	22:32	80	F	Up	7
12-Jul	17:53	90	F	Up	8
13-Jul	18:48	90	F	Up	9
13-Jul	22:58	70	M	Up	10
13-Jul	1:13	100	F	Up	11
14-Jul	3:32	100	M	Up	12
14-Jul	18:41	90	F	Up	13
14-Jul	0:12	60	F	Up	14
15-Jul	3:58	80	M	Down	13
15-Jul	22:34	100	F	Up	14
15-Jul	6:06	70	M	Up	15

Table B-1 (continued).

Date (1998)	Time (Hours)	Length (cm)	Estimated Sex (M/F)	Direction	Net Upstream
16-Jul	7:39	90	F	Up	16
16-Jul	22:25	90	M	Up	17
16-Jul	5:23	90	F	Up	18
17-Jul	19:17	90	M	Up	19
17-Jul	0:01	100	M	Up	20
18-Jul	0:16	60	M	Up	21
18-Jul	2:27	90	M	Up	22
18-Jul	15:47	100	M	Up	23
18-Jul	22:25	80	F	Up	24
18-Jul	23:26	80	F	Up	25
18-Jul	4:01	100	M	Up	26
19-Jul	6:16	80	F	Up	27
19-Jul	17:21	70	F	Up	28
19-Jul	20:06	80	F	Up	29
19-Jul	22:38	80	F	Up	30
19-Jul	22:48	80	F	Up	31
19-Jul	1:19	80	F	Down	30
20-Jul	1:19	60	M	Down	29
20-Jul	3:14	60	F	Up	30
20-Jul	21:53	80	M	Up	31
20-Jul	21:56	80	F	Up	32
20-Jul	1:38	90	F	Up	33
21-Jul	1:49	80	M	Up	34
21-Jul	3:34	90	F	Up	35
21-Jul	17:58	50	M	Up	36
21-Jul	20:28	80	F	Down	35
21-Jul	0:42	80	M	Down	34
22-Jul	6:39	80	M	Down	33
22-Jul	20:18	80	F	Up	34
22-Jul	20:32	90	F	Up	35
22-Jul	0:26	70	M	Up	36
23-Jul	4:07	90	M	Up	37
23-Jul	9:14	80	M	Down	36

Table B-1 (continued).

Date (1998)	Time (Hours)	Length (cm)	Estimated Sex (M/F)	Direction	Net Upstream
23-Jul	9:43	90	M	Up	37
23-Jul	10:31	80	M	Down	36
23-Jul	10:36	90	M	Up	37
23-Jul	11:13	90	M	Up	38
23-Jul	22:28	80	M	Down	37
23-Jul	22:30	90	M	Up	38
23-Jul	22:59	90	M	Up	39
23-Jul	0:31	90	F	Down	38
24-Jul	0:34	80	F	Up	39
24-Jul	1:29	80	F	Up	40
24-Jul	5:44	80	F	Down	39
24-Jul	9:03	80	M	Down	38
24-Jul	9:16	90	M	Down	37
24-Jul	21:50	90	F	Up	38
24-Jul	0:58	120	M	Up	39
25-Jul	13:55	100	M	Down	38
25-Jul	13:55	100	M	Up	39
25-Jul	14:11	100	M	Down	38
25-Jul	14:12	90	M	Up	39
25-Jul	14:14	80	M	Down	38
25-Jul	14:14	80	M	Up	39
25-Jul	14:15	80	M	Down	38
26-Jul	-	-	-	-	38
27-Jul	-	-	-	-	38
28-Jul	23:43	?	F	Up	39
29-Jul	0:30	90	M	Up	40
30-Jul	5:46	?	F	Down	39
30-Jul	5:47	?	F	Up	40
30-Jul	5:53	?	M	Down	39
31-Jul	10:01	100	F	Up	40
1-Aug	10:19	90	M	Down	39
1-Aug	23:41	100	F	Down	38
2-Aug	23:42	100	F	Up	39

Table B-1 (continued).

Date (1998)	Time (Hours)	Length (cm)	Estimated Sex (M/F)	Direction	Net Upstream
2-Aug	23:46	?	F	Down	38
2-Aug	5:40	100	F	Up	39
3-Aug	19:11	90	F	Down	38
3-Aug	0:52	90	M	Down	37
4-Aug	0:54	80	M	Up	38
4-Aug	1:57	90	F	Up	39
4-Aug	2:56	90	F	Up	40
4-Aug	3:46	60	M	Down	39
4-Aug	5:22	60	F	Up	40
4-Aug	6:44	90	F	Up	41
4-Aug	6:47	90	F	Down	40
4-Aug	6:49	90	F	Up	41
4-Aug	2:49	70	M	Down	40
5-Aug	5:49	80	M	Up	41
5-Aug	18:47	70	M	Up	42
5-Aug	22:27	60	M	Up	43
5-Aug	22:34	60	M	Down	42
5-Aug	1:36	70	M	Up	43
6-Aug	3:32	70	M	Down	42
6-Aug	3:26	80	M	Up	43
6-Aug	5:26	70	M	Up	44
6-Aug	16:52	110	M	Up	45
6-Aug	18:36	100	F	Up	46
6-Aug	19:32	90	F	Up	47
6-Aug	19:58	100	F	Down	46
6-Aug	20:25	80	F	Down	45
6-Aug	20:29	100	F	Up	46
6-Aug	20:34	?	F	Up	47
6-Aug	20:37	?	F	Down	46
6-Aug	22:45	90	M	Up	47
7-Aug	0:26	90	F	Down	46
7-Aug	0:27	100	F	Up	47
7-Aug	0:32	100	F	Down	46

Table B-1 (continued).

Date (1998)	Time (Hours)	Length (cm)	Estimated Sex (M/F)	Direction	Net Upstream
7-Aug	0:33	100	F	Up	47
7-Aug	0:56	100	F	Down	46
7-Aug	0:58	100	F	Up	47
7-Aug	1:00	100	F	Down	46
7-Aug	1:01	100	F	Up	47
7-Aug	1:03	100	F	Down	46
7-Aug	1:04	100	M	Down	45
7-Aug	1:08	100	F	Up	46
7-Aug	1:17	?	F	Down	45
7-Aug	1:35	90	F	Down	44
7-Aug	1:58	90	F	Up	45
7-Aug	1:58	90	M	Up	46
7-Aug	3:12	100	F	Down	45
7-Aug	3:28	100	F	Up	46
7-Aug	3:34	100	F	Down	45
7-Aug	4:06	100	F	Up	46
7-Aug	5:13	100	F	Down	45
7-Aug	6:44	100	F	Up	46
7-Aug	11:26	100	F	Up	47
7-Aug	21:09	90	M	Up	48
7-Aug	4:21	110	M	Up	49
8-Aug	4:41	100	M	Up	50
8-Aug	4:49	100	F	Down	49
8-Aug	4:51	60	M	Down	48
8-Aug	5:08	60	M	Up	49
8-Aug	7:14	90	M	Down	48
8-Aug	8:42	90	F	Up	49
8-Aug	9:32	80	F	Down	48
8-Aug	13:25	90	F	Down	47
8-Aug	15:02	60	F	Down	46
8-Aug	18:42	80	M	Down	45
8-Aug	19:35	90	F	Up	46
8-Aug	19:52	90	M	Up	47

Table B-1 (continued).

Date (1998)	Time (Hours)	Length (cm)	Estimated Sex (M/F)	Direction	Net Upstream
8-Aug	5:54	80	F	Up	48
9-Aug	15:41	100	M	Down	47
9-Aug	18:36	110	F	Down	46
9-Aug	4:23	90	M	Down	45
10-Aug	6:52	80	M	Up	46
10-Aug	10:15	100	M	Down	45
10-Aug	15:32	80	F	Up	46
10-Aug	16:31	100	M	Up	47
10-Aug	18:39	90	M	Down	46
10-Aug	21:49	90	F	Up	47
10-Aug	22:52	120	M	Down	46
10-Aug	0:34	90	M	Up	47
11-Aug	1:30	100	M	Down	46
11-Aug	2:43	60	M	Down	45
11-Aug	2:48	70	M	Up	46
11-Aug	6:31	100	M	Up	47
11-Aug	6:31	100	M	Up	48
11-Aug	8:04	110	M	Up	49
11-Aug	13:41	90	M	Down	48
11-Aug	16:27	90	F	Down	47
11-Aug	16:30	90	F	Up	48
11-Aug	16:33	70	F	Down	47
11-Aug	19:38	80	M	Up	48
11-Aug	20:54	80	M	Up	49
11-Aug	21:18	70	M	Down	48
11-Aug	5:12	60	M	Up	49
12-Aug	8:13	60	F	Down	48
12-Aug	11:51	90	M	Down	47
12-Aug	12:40	70	M	Up	48
12-Aug	14:01	90	M	Down	47
12-Aug	15:56	80	M	Down	46
12-Aug	16:01	70	M	Down	45
12-Aug	16:20	90	M	Down	44

Table B-1 (continued).

Date (1998)	Time (Hours)	Length (cm)	Estimated Sex (M/F)	Direction	Net Upstream
12-Aug	16:40	100	M	Up	45
12-Aug	16:55	100	M	Down	44
12-Aug	17:05	70	M	Down	43
12-Aug	17:43	100	M	Down	42
12-Aug	18:52	90	M	Down	41
12-Aug	20:27	100	M	Up	42
12-Aug	22:06	90	M	Down	41
12-Aug	23:34	80	F	Up	42
12-Aug	0:09	110	M	Up	43
13-Aug	0:43	80	M	Up	44
13-Aug	4:07	90	M	Down	43
13-Aug	15:21	90	M	Up	44
13-Aug	16:59	120	M	Down	43
13-Aug	18:07	110	M	Up	44
13-Aug	22:24	80	M	Up	45
13-Aug	2:49	80	F	Up	46
14-Aug	11:40	90	M	Down	45
14-Aug	4:41	110	M	Up	46
15-Aug	19:06	90	F	Up	47
15-Aug	21:16	80	M	Up	48
15-Aug	14:53	90	M	Down	47
16-Aug	23:08	90	M	Down	46
16-Aug	4:45	80	M	Down	45
17-Aug	10:07	120	M	Up	46
17-Aug	3:43	80	M	Up	47
18-Aug	4:05	120	M	Down	46
18-Aug	7:05	90	M	Up	47
19-Aug	0:08	80	F	Up	48
19-Aug	23:30	70	M	Up	49
19-Aug	19:45	90	F	Down	48
20-Aug	1:44	90	M	Up	49
21-Aug	1:46	100	M	Down	48
21-Aug	1:47	90	M	Up	49

Table B-1 (continued).

Date (1998)	Time (Hours)	Length (cm)	Estimated Sex (M/F)	Direction	Net Upstream
22-Aug	20:09	90	M	Down	48
23-Aug	21:26	80	M	Down	47
23-Aug	0:20	90	M	Up	48
24-Aug	1:15	80	F	Up	49
24-Aug	4:28	80	M	Down	48
24-Aug	4:33	90	?	Up	49
24-Aug	13:34	80	F	Down	48
24-Aug	13:01	90	M	Down	47
25-Aug	-	-	-	-	47
26-Aug	-	-	-	-	47
27-Aug	18:58	70	M	Down	46
28-Aug	-	-	-	-	46
29-Aug	-	-	-	-	46
30-Aug	-	-	-	-	46
31-Aug	-	-	-	-	46
1-Sep	-	-	-	-	46
2-Sep	-	-	-	-	46
3-Sep	-	-	-	-	46
4-Sep	-	-	-	-	46
5-Sep	-	-	-	-	46
6-Sep	-	-	-	-	46
7-Sep	-	-	-	-	46
8-Sep	-	-	-	-	46
9-Sep	-	-	-	-	46
10-Sep	-	-	-	-	46
11-Sep	-	-	-	-	46
12-Sep	-	-	-	-	46
13-Sep	-	-	-	-	46
14-Sep	-	-	-	-	46

Table B-2. Diel movements of adult spring and summer chinook salmon passing through the Lake Creek fish counting station, by hour in 1998.

Time	Total Movements (Up and Down)	Percent (%) Total Movements	Net Upstream Movements	Percent Net Upstream Movement
0000	24	11	12	26
0100	23	10	5	11
0200	6	3	2	4
0300	11	5	1	2
0400	13	6	-1	-2
0500	13	6	5	11
0600	10	5	6	13
0700	4	2	2	4
0800	3	1	1	2
0900	5	2	-3	-6
1000	6	3	0	0
1100	4	2	0	0
1200	1	0	1	2
1300	6	3	-4	-9
1400	7	3	-3	-6
1500	7	3	1	2
1600	10	5	0	0
1700	5	2	1	2
1800	10	5	0	0
1900	9	4	3	6
2000	12	5	4	9
2100	8	4	4	9
2200	16	7	8	17
2300	8	4	2	4

Time - Military Time (hours)

Table B-3. Individually recognizable adult spring and summer chinook salmon passing through the Lake Creek fish counting station in 1998.

Fish	Sex	Number of Passages	Dates	Time Elapsed Between First and Last Passage
a	M	3	July 23	77 minutes
b	F	2	July 30	1 minute
c	F	8	August 6(2),7(6)	10 hours
d	F	4	August 6	1 hour
e	F	11	August 7	51 minutes
f	M	2	August 7	54 minutes
g	F	3	August 8	11 hours
h	F	3	August 8(1), 9(1), 10(1)	45 hours

F – Female
M – Male

APPENDIX C

Table C-1. Dates of net upstream migration and total movements of adult spring and summer chinook salmon through the Secesh River and Lake Creek fish counting stations in 1998.

	Lake Creek		Secesh River	
Date	Net Upstream	Total Movements	Net Upstream	Total Movements
7/1	0	0		
7/2	0	0		
7/3	0	0		
7/4	0	0		
7/5	0	0		
7/6	0	0		
7/7	0	0		
7/8	1	1		
7/9	1	1	Operation began	Operation began
7/10	2	2	3	3
7/11	3	3	7	7
7/12	1	1	4	6
7/13	3	3	4	4
7/14	3	3	5	5
7/15	1	3	7	7
7/16	3	3	5	5
7/17	2	2	10	14
7/18	6	6	10	12
7/19	4	6	9	17
7/20	1	5	9	11
7/21	2	5	0	2
7/22	2	4	5	7
7/23	1	10	7	7
7/24	-1	7	7	9
7/25	0	7	0	14
7/26	0	0	-3	9
/7/27	1	0	-1	1
7/28	1	1	4	4
7/29	-1	1	2	2
7/30	1	3	1	1
7/31	-2	1	1	12

Table C-1 (continued).

Date	Lake Creek		Secesh River	
	Net Upstream	Total Movements	Net Upstream	Total Movements
8/1	1	2	1	1
8/2	-2	3	1	1
8/3	3	2	0	0
8/4	3	9	0	0
8/5	3	5	0	0
8/6	3	13	2	6
8/7	-1	23	1	1
8/8	-3	13	-1	5
8/9	2	3	3	5
8/10	2	8	-1	3
8/11	-6	14	4	10
8/12	3	16	0	10
8/13	0	7	3	9
8/14	1	2	2	22
8/15	-2	3	1	7
8/16	2	2	8	20
8/17	1	2	1	13
8/18	0	3	2	18
8/19	1	2	1	36
8/20	0	1	2	20
8/21	-1	2	2	12
8/22	0	1	1	35
8/23	-1	2	1	1
8/24	0	5	1	3
8/25	0	0	2	16
8/26	-1	0	0	20
8/27	0	1	5	55
8/28	0	0	1	11
8/29	0	0	2	12
8/30	0	0	-2	8
8/31	0	0	-2	32
9/1	0	0	-2	10
9/2	0	0	0	8
9/3	0	0	-1	7

Table C-1 (continued).

Date	Lake Creek		Secesh River	
	Net Upstream	Total Movements	Net Upstream	Total Movements
9/4	0	0	0	4
9/5	0	0	-1	1
9/6	Operations ceased	Operations ceased	1	1
9/7	-	-	0	2
9/8	-	-	-1	3
9/9	-	-	0	0
9/10	-	-	0	2
9/11	-	-	0	0
9/12	-	-	0	0
9/13	-	-	0	0
9/14	-	-	0	0
9/15	-	-	0	0
9/16	-	-	0	0
9/17	-	-	0	0
9/18	-	-	0	0
			Operations ceased	Operations ceased