ADULT STEELHEAD STUDIES IN THE UPPER SUSTUT RIVER 1992

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Prepared by

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SUMMARY

Steelhead studies were conducted in the upper Sustut River during the late summer and fall of 1992. The objectives of the studies were to determine the time of arrival, abundance, and migration behaviour of steelhead and to assess the upper Sustut River's suitability as an index stream for upper Skeena steelhead stocks. As well, potential steelhead enhancement opportunities and the extent of Native fisheries in the upper river were evaluated. Methods used included a combination of snorkel observations, radio telemetry, and a fish counting fence.

A total of 487 steelhead were estimated to have arrived in the upper Sustut in 1992. The first steelhead arrived in the upper river in early August and numbers continued to increase through late August and early September. Most of the steelhead remained in the 1-km section immediately downstream of the confluence of Johanson Creek and the Sustut River through until late September. A small portion of the steelhead population moved up into the lakes and some fish held in downstream areas including a 2-km section of the river below Moosevale Creek.

Heavy rains in late September raised streamflows and initiated fish movements into the lakes. Virtually all of the steelhead had left the Junction Pool area and moved up into Sustut and Johanson lakes by early October. Based on the radio telemetry studies, it was estimated that 75% of the steelhead moved into Sustut Lake and 25% into Johanson Lake. By late October, steelhead were concentrated in the lake outlet areas with all radio fish located at two specific sites.

At least 14 steelhead observed in the upper Sustut River in 1992 had been tagged with orange Floy tags either in the commercial fishery or in the lower Skeena. Information from eight of these tags was recovered and indicated that five steelhead had been tagged in the commercial fishery, two were tagged in the lower Skeena test fishery and one had been tagged in the lower Skeena sportfishery. The tag information indicated that the upper Sustut steelhead move through the main commercial fishing area during July and early August. Of 237 steelhead examined, 24% had evidence of gillnet marks.

Limited observations suggested that between 5% and 10% of the steelhead in the upper river were taken in the Native fishery, primarily by drifting gillnets through the main holding pools. The

ease of access to the main steelhead holding areas and the large number of people from different locations taking part in this unregulated fishery raises additional concerns for the future of the upper Sustut steelhead stock.

The snorkel surveys in combination with tagging fish at the lower end of the study area provided an excellent method of assessing steelhead numbers in the upper Sustut during the clear low-flow conditions that persisted during the late summer of 1992. The presence of the fence added greatly to monitoring fish movements and assessing timing of steelhead movements out of the main study area. It also enabled us to recover tag information and add additional tags to fish for potential future recovery. The study results suggest that aerial observations of steelhead in key locations such as the outlets of Sustut and Johanson lakes are useful indicators of fish presence, but at least in some instances, do not allow for accurate estimates of total numbers of fish.

Recommendations are made to continue to use the upper Sustut River as a steelhead index stream. We recommend that the fence operation be continued to help calibrate observations, and that snorkel observations in conjunction with tagging studies in the vicinity of the Junction Pool during mid-September be undertaken to provide the most effective means of estimating steelhead abundance in the upper Sustut. An aerial survey in the lake outlet areas after the middle of October could provide a second index of steelhead run strength.

A review of potential spawning areas for upper Sustut River steelhead indicated that extensive spawning gravel areas are available in the vicinity of the Junction Pool and downstream. Other potential spawning areas are identified but have not been evaluated and need specific studies during the spawning period to assess their importance.

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ACKNOWLEDGEMENTS

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Mike Lough returned from the saltwater to spearhead the field studies. He was ably assisted by Rob Dams who braved the grizzly bears to conduct the snorkel surveys and man the fence. Their efforts, with help from Sherril Rutherford and Jason Lee were the key to making this study a success.

The assistance of Ron Steffey of Moose Valley Outfitters and Jim Reed of Pacific Western Helicopters is acknowledged. As well, the cooperation of the Department of Fisheries and Oceans staff from the Pacific Biological Station who were conducting salmon studies in the area is greatly appreciated. Dr. Cole Shirvell and Pierre Dubeau were helpful throughout the study and kindly provided water temperature, streamflow and fish information for periods when they were in the area.

Some of the figures in this report were prepared by Evi Coulson and Alec Dease. Bob Hooton reviewed drafts of this report.

1.0 INTRODUCTION

The Sustut River is located in northcentral British Columbia approximately 200 km north of Smithers. The river arises in two high elevation lakes (Sustut Lake at 1301 m and Johanson Lake at 1444 m[1]) and flows in a southwesterly direction for approximately 100 km to its confluence with the Skeena River (Figure 1). The Sustut River watershed drains an area of approximately 20,000 km^2.

The Sustut River is an important summer steelhead system. Studies conducted by the Ministry of Environment (Spence et al. 1990) suggest that fish in the Sustut may be comprised of two stocks - an early run of steelhead that move into the top end of the system and utilize the river section upstream of Moosevale Creek including Sustut and Johanson lakes, and a second more numerous group of fish that move into the lower Sustut and Bear River during September and October. The upper Sustut steelhead became well-known following the publishing of John Fennelly's book **Steelhead Paradise** in 1963. The detailed accounts of steelhead fishing in this book, in conjunction with the construction of the B.C. Rail grade in the lower Sustut and subsequent development of a mining road adjacent the upper river in the early 1970's led to the closure of the upper Sustut River for angling since 1973.

Steelhead angling is primarily centered around two fishing lodges on the lower Sustut and focuses on the later run of steelhead downstream of the Bear River. As well, steelhead bound for the Sustut are taken in the lower Skeena bar fishery.

The Ministry of Environment (MOE) has expressed concern about the status of the Skeena steelhead, particularly the early-run steelhead that enter the Skeena at the peak of the commercial fishery. It is thought that in some systems such as the Sustut, the runs are being decimated by the combination of commercial interceptions and in-river Native fisheries.

In recent years, steelhead utilizing the upper Sustut River have been used as an indicator of the strength of the early-run Skeena steelhead stocks. Mark-recapture studies during 1986 suggested that approximately 3400 steelhead were present in the system during 1986, a year of strong returns (Spence et al. 1990). Approximately 23% of these fish (800) were in the upper river section upstream of Moosevale Creek (Figure 1).

More recently, a combination of aerial observations from a helicopter and snorkel counts in selected sections of the upper

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[1] Data from Ministry of Environment lake survey files, Smithers

river have been used to assess the strength of the upper Sustut steelhead run. Only 30 steelhead were observed during index surveys conducted in late September 1991 (memo dated September 26, 1991, on file, MOE Smithers). These observations, along with the very poor angling results in the lower Sustut and low juvenile steelhead densities throughout the Sustut watershed in 1991 (Bustard 1992) have raised concerns about the status of the Sustut steelhead populations.

Although numerous observations have been conducted in the upper Sustut River since the late 1950's (Appendix Table 1), there has been no systematic evaluation of the numbers of fish in the upper river over time. If the upper river is to be used as an index stream for Skeena steelhead, some understanding of fish holding patterns and the best methods of obtaining reliable estimates of abundance is needed.

With this as background, a study was undertaken in the upper Sustut River with the following objectives:

1.) To determine the time of arrival, abundance and migration behavior of steelhead throughout the upper Sustut River during the late summer and fall periods.

2.) To determine how the system might best be used as an index stream for upper Skeena steelhead stocks.

3.) To assess potential enhancement opportunities for steelhead in the system.

4.) To evaluate the extent and nature of Native fisheries reported to occur in the upper system.

2.0 METHODS

2.1 Timing and Logistics

The main portion of the study was undertaken by a crew of two from August 11 to September 29, 1992. Vehicle access to the area involved an eight hour drive from Fort St. James. Accomodation was set up at a cabin located midway along Johanson Creek between Johanson Lake and the Junction Pool. Additional trips were made into the area in early June, late July and mid-October as part of the water quality and temperature sampling program. Additional radio-tracking and snorkel work was conducted during the period October 10 to 15th.

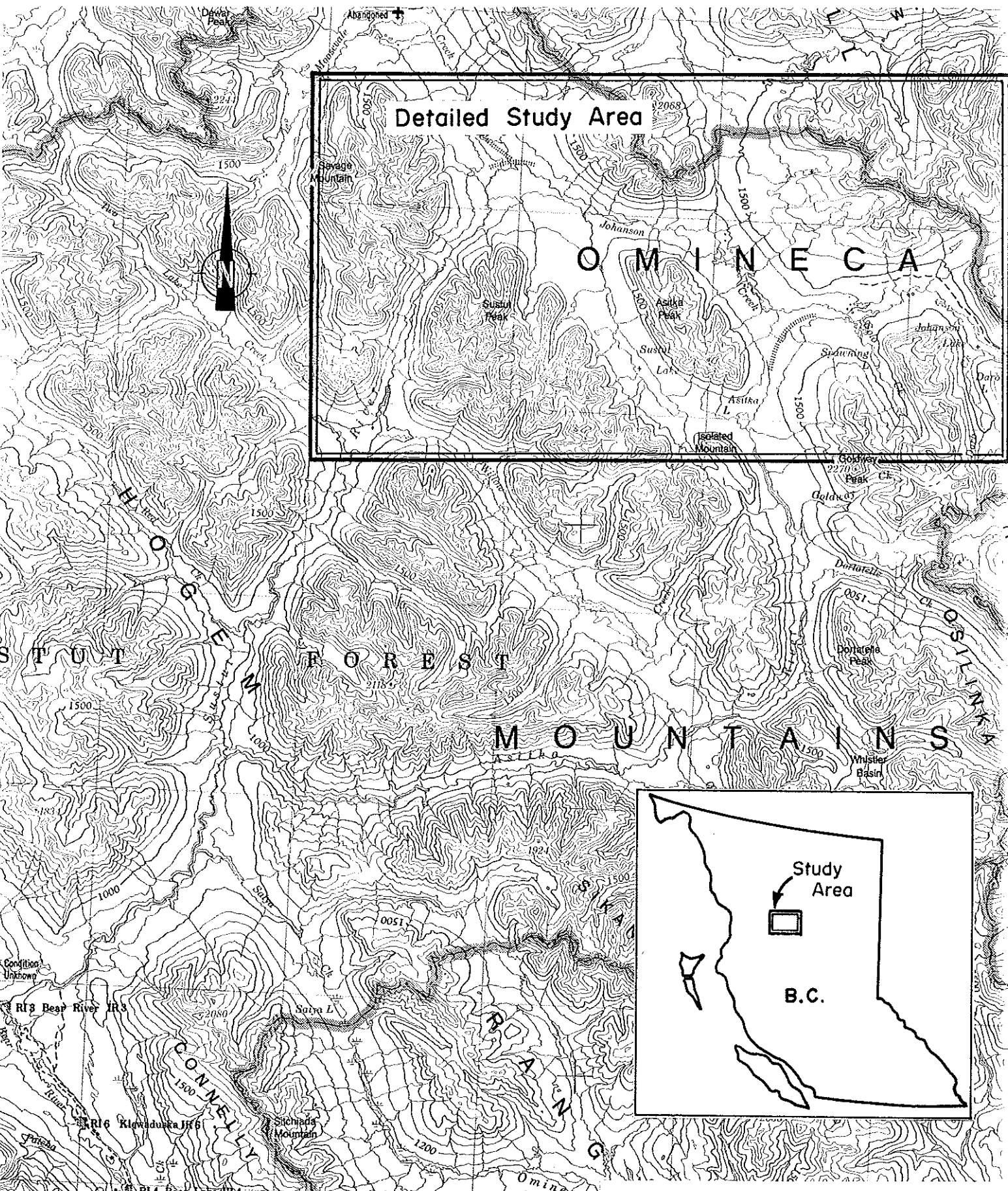

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Figure 1. Sustut River Study Area Location.

All helicopter work in the upper Sustut River was with Pacific Western Helicopters chartered out of a base located at Aiken Lake. A fixed-wing aircraft was used to access the area from Smithers for crew changes and supplies on three occasions during the study.

2.2 Water Temperature and Streamflow

Ryan Model J recording thermographs were installed at three locations in the study area: 1) the Sustut River upstream of Moosevale Creek, 2) the Sustut River 200 m upstream of its confluence with Johanson Creek, and 3) Johanson Creek 100 m downstream from the outlet of Johanson Lake. The thermographs were initially installed on June 9 and changed in late July, and mid-September. The thermographs were removed on October 13 during the final trip into the area. A laboratory thermometer accurate to 0.1 °C was used to calibrate the readings on the thermographs. Maximum, minimum, and mean temperatures were extracted from the charts.

The timing mechanisms failed on two of the thermograph units shortly after installation and temperatures were not available at the two Sustut River sites during the period from mid-June to early July. After this date, temperatures recorded by Department of Fisheries and Oceans (DFO) staff working at the fence were used to fill in the period until the thermographs were repaired. The DFO temperature data was normally taken between 8:00 and 10:00 a.m. and was representative of minimum temperatures. Some mid-afternoon temperatures were recorded and these have been used to estimate the maximums and means for the period July 6 to August 11 in the Sustut upstream of the confluence.

Discharge estimates for the Sustut River above and below the confluence with Johanson Creek and in Johanson Creek upstream of the Sustut were estimated from staff gauge readings taken at these three locations. The readings were conducted by DFO from July 6 through September 9. After this date, the steelhead crew continued to read the gauges until September 28 and again in mid-October. The gauges were calibrated based on discharge estimates made at three flow levels using a "Mini" Current Meter.

2.3 Adult Tagging

Adult steelhead were captured by angling with bait in the Sustut River in the 5-km section of river between the Junction Pool and Moosevale Creek confluence (Figure 2). Most of the marking was done in the lower section of the study area in the vicinity of Moosevale Creek as this section appeared to hold the most newly-arrived fish. Tagging at the lower end of the study area helped reduce the probability of re-capturing fish already radio-tagged.

Fish angled were tagged with a numbered Floy tag inserted on their left side near the dorsal fin, measured, examined for gillnet marks, and separated by sex. This tagging was conducted from August 14 to September 20. Weight and scale information for aging was not collected since this reduced handling of the fish and a substantial amount of this information was already available for upper Sustut steelhead as described in Spence et al. (1990).

The colour of the tags was changed at approximately one-week intervals (Table 1) in an effort to relate arrival timing of fish into the study area to subsequent movement patterns into upstream areas. Orange tags were not used in the main study area, since a program of tagging steelhead with orange Floy tags was conducted in the commercial, sport and Native fisheries in the lower Skeena River during 1992 and we wanted to be able to differentiate these fish during the snorkel observations. Seven orange tags were applied to fish in the outlet of Sustut Lake by MOE staff on October 23 while collecting fish for blood sampling. This was done after the snorkel surveys were completed.

All fish that were passed through the fence on the Sustut just upstream of the Junction Pool were also marked in the same fashion as outlined above until September 22. After this date pink and then yellow tags were applied to fish passing through the fence until fence removal on September 28.

Plans to conduct seining in the upper Sustut to catch fish for tagging were not undertaken since the angling was found to be a very effective means of obtaining fish for marking purposes.

Table 1. Colour Sequence for Steelhead Tagged Downstream of the Sustut Fence.

TAG COLOUR	TIMING
White	Aug 14-Aug 20
Blue	Aug 21-Sept 2
Pink	Sept 2-Sept 9
Yellow	Sept 9-Sept 16
Green	Sept 17-Sept 20

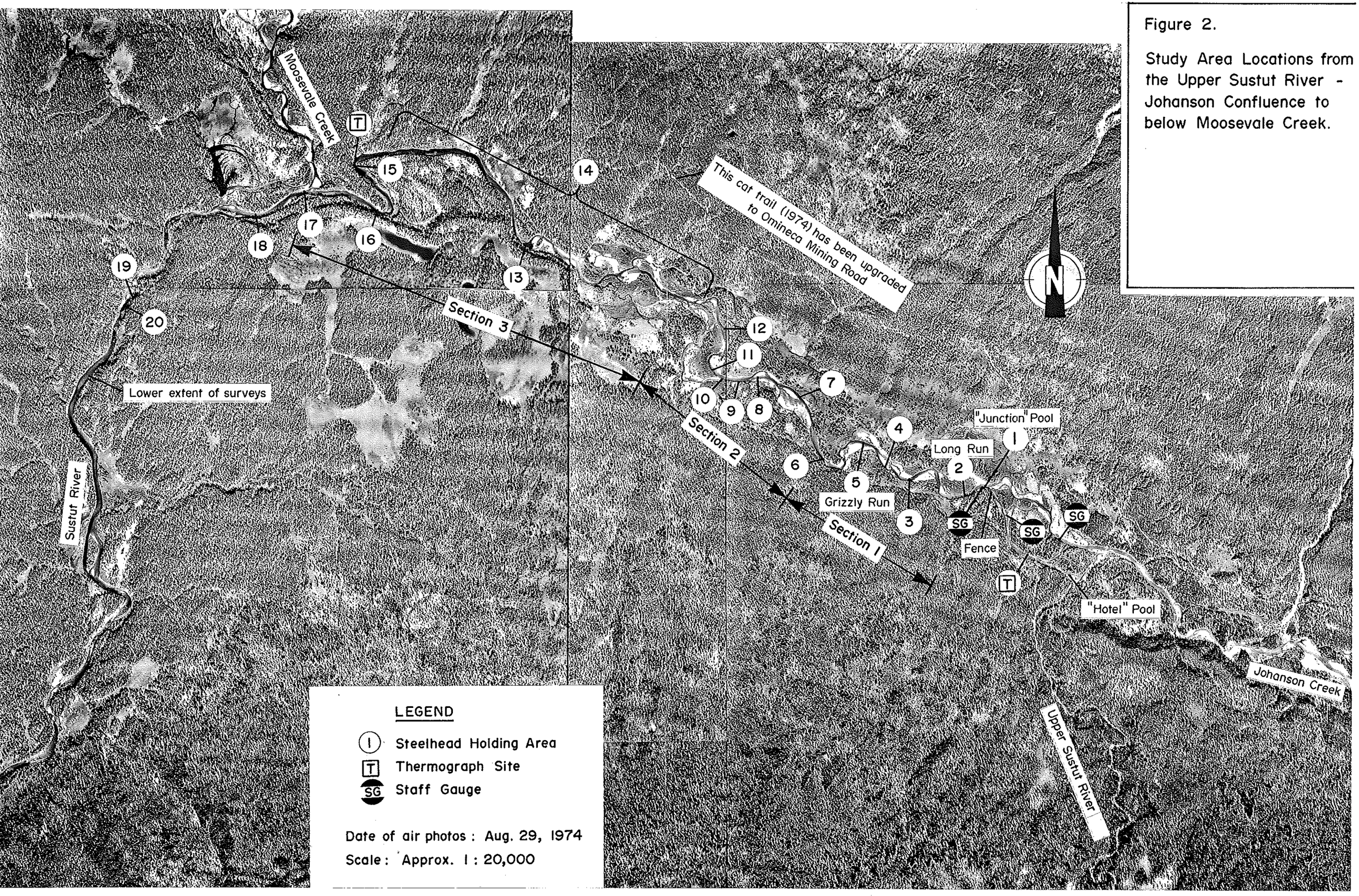

Figure 2.

Study Area Locations from the Upper Sustut River - Johanson Confluence to below Moosevale Creek.

2.4 Snorkel Surveys

Snorkel observations were conducted in the Sustut River from the Junction Pool to the Moosevale Creek confluence at 3-4 day intervals from August 12 to September 28. A final snorkel survey was conducted in this section on October 11. Steelhead were counted and sorted as to tagged and untagged and colour of tags for each pool. In many instances several passes were made through each pool - the first to determine the number of fish and subsequent passes to establish the number of different coloured tags. There was some difficulty distinguishing white and yellow tags, so snorkel observations of different tag colurs after September 10 are not reliable.

All surveys were conducted by a single swimmmer except on August 17 when two swimmers conducted the surveys. It was found that with the low water and good visibility a single swimmer was preferable to avoid confusion of duplicate counts. Visibility was excellent (up to 10 m) until September 18. After this date, visibility decreased with increasing streamflows during late September.

Two of the surveys (September 10 and September 22) were extended downstream an additional 1.5 km to include several holding pools downstream of Moosevale Creek (Location 20 in Figure 2).

Information summarizing fish observations was relayed to a recorder who accompanied the swimmer in a 2.5 m Avon raft. Two of the surveys were aborted before they could be completed due to grizzly bears along the survey route.

2.5 Radio Telemetry

Steelhead to be radio-tagged were firmly held, and with the aid of a small rod, the transmitter was inserted down the esophagus and into the stomach. Two Floy tags were affixed to each fish at the base of the dorsal fin using the same colour scheme as for the single-tagged fish outlined in Table 1. Initially the fish were held in a holding tube for several hours until it was certain that the fish had fully recovered. After predation of a tagged fish in a holding tube by a grizzly on September 1, tubes were no longer used. As well, wool gloves were initially used to hold fish for radio-tagging. However, subsequent observations indicated that several of these fish developed fungus at the point where they had been held, so gloves were not used for most of the tagging.

A total of 17 radio-tags were available for telemetry studies during this program. Six of the tags were re-used in different fish after the tags were recovered due to native gillnetting (3), grizzly predation while in holding tube (1), regurgitation (1), or mortality due to handling (1).

Ten fish were radio-tagged in the first week of the study. The remainder of the tags were applied at 2-3 day intervals, usually at the lower end of the study area (Moosevale Creek). Exceptions to this were two radio-tags applied at the Sustut fence in late August and early September and a single radio-tag applied in the Johanson Lake outlet area in mid-September.

The radio-tags were manufactured by Lotek Engineering Ltd. and consisted of an integrated transmitter-lithium power cell encased in resin. Each transmitter emmitted a different pulsed radio signal at frequencies between 150 and 151 Mhz. The minimum life expectancy of the tags was 150 days, however several of the tags had a 300-day life expectancy. Seven of the tags had been stored for up to ten years and their battery life expectancy is unknown.

SRX-400 programmable scanning receivers, also manufactured by Lotek Engineering were used for both the ground and aerial surveillance. A Telonics programmable receiver was also used for some of the ground tracking. For much of the study, most of the tagged steelhead could be located by ground tracking either on foot, by raft (during snorkel surveys) or by vehicle. Ground tracking was conducted on most days between August 15 and September 29 and again from October 11 to 13. Tracking from a helicopter was undertaken at approximately weekly intervals from September 1 onward including a final aerial tracking conducted by MOE in late October.

Dates for aerial tracking

August 16 (stationary receiver installation)
September 1
September 9
September 14
September 22
September 27
October 23 (conducted by MOE staff)

Four stationary receiver stations were established at the beginning of the study to assist with determining radio-tagged fish movement timing at strategic locations. The four locations were the outlets of Sustut and Johanson lakes, Johanson Creek immediately upstream of the Junction Pool, and the Sustut River just below Moosevale Creek. Receiver problems and computer downloading difficulties made data collection using the stationary receivers ineffective.

2.6 Fence Operation

An adult upstream fence was located 50 m upstream from the Junction Pool on the Sustut River. This fence was installed and operated by DFO staff from the Pacific Biological Station under the direction of Dr. Cole Shirvell, with the objective of counting and tagging

chinook and sockeye in the upper Sustut River. The fence was maintained by DFO staff from early July until September 9 when salmon movements into the Sustut were nearly finished. DFO staff usually left any steelhead at the holding box during this time for the steelhead crew to tag.

After September 9 the fence was maintained as part of the steelhead assessment project until the removal date of September 28. The fence offered the advantage of helping to delineate the timing and proportion of steelhead from the totals observed downstream that entered the upper Sustut River compared to Johanson Creek. As well, it provided us with an opportunity to collect specific information on steelhead that had been tagged in the lower Skeena (orange tags) commercial and sport fisheries and to add more tags to the upper Sustut steelhead for possible recapture in subsequent years to help identify the movement patterns of upper Sustut steelhead.

The fence was 20 m in length and consisted of seven 4'x 8' panels. Five of these panels were covered with 2" mesh wire and two of the panels were built with aluminum conduit spaced at 2" intervals. The upstream live box dimensions were 4'x 8'x 5' with plywood flooring and 5' high aluminum conduit sides.

All steelhead were measured, tagged with a single Floy tag, examined for gillnet marks and sorted by sex. The fish were then passed upstream. Resident rainbow trout, Dolly Varden and mountain whitefish were passed upstream without handling, since it was noted that mortalities were occurring to those fish that had been passed upstream earlier in the study. It wasn't clear whether some of these mortalities resulted from handling at the fence or from stress associated with spawning upstream.

A second holding box was installed in the fence on September 12 to provide an opportunity for fish to move downstream as it was noted that some steelhead and Dolly Varden were holding immediately upstream of the fence apparently trying to move downstream in early September.

The fence remained functional throughout the study period with minimal maintenance until higher flows in late September.

2.7 Aerial Observations

Efforts were made to count steelhead from the air at key locations whenever the helicopter was used for radio-tracking. Particular attention was paid to observations in the outlets of Johanson, Sustut and Mud lakes (Figures 3 and 4). This method has been a key component of past index surveys in the upper Sustut River. Visibility was generally excellent at these locations.

3.0 RESULTS

3.1 Water Temperature and Streamflow Conditions

The summer of 1992 was hot and dry, with virtually no precipitation from early July through mid-September. This was followed by a three-week period of continuous heavy rains until early October.

Ice was still present on most of Johanson Lake on June 9 when the thermographs were first installed. Sustut and Mud lakes were open on this date. Ice was beginning to form on Johanson and Sustut lakes by October 13, while Mud Lake was already iced over.

3.1.1 Water Temperatures

A summary of temperatures recorded in the upper Sustut River just upstream from the Junction Pool and in the outlet of Johanson Lake are shown in Figure 5. More detailed temperature information for these sites and for Johanson Creek upstream of the Junction Pool is summarized in Appendix Table 2.

Mean water temperatures in the Sustut River upstream of the Junction Pool were above 5°C from the time of thermograph installation on June 9 until early October with the exception of a clear cold period in mid-September (Figure 5A). The maximum temperatures recorded during this study were 16.5°C during July and early August. Temperatures did not approach the 19.1°C recorded in the mid-afternoon of August 13, 1991 by Shirvell (1991). Figure 5A shows the wide diurnal fluctuations that occur in this section of the river during July and August. Daily temperature fluctuations of 3-5°C emphasize the importance of time of day when making spot temperature measurements at this site.

The Sustut upstream of the Junction Pool was on average 3°C warmer than Johanson Creek at this location during the period from early July to September 10. The Sustut River has only minor inflows from the lake outlet to the Junction Pool, and it is assumed that the warmer temperatures reflect the warming influence of Sustut Lake and the very shallow Mud Lake.

Temperature profiles taken during mid-September 1986 in Sustut Lake indicate the mean for the top 10 m of Sustut Lake was 14.6°C compared to 9.0°C in Johanson Lake[2]. It is assumed that temperatures at the Sustut Lake outlet are warmer than those recorded just upstream of the Junction Pool. For example, temperatures at the outlet were 5.0°C and 3.2°C on October 12 and

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[2] Data on file, MOE, Smithers

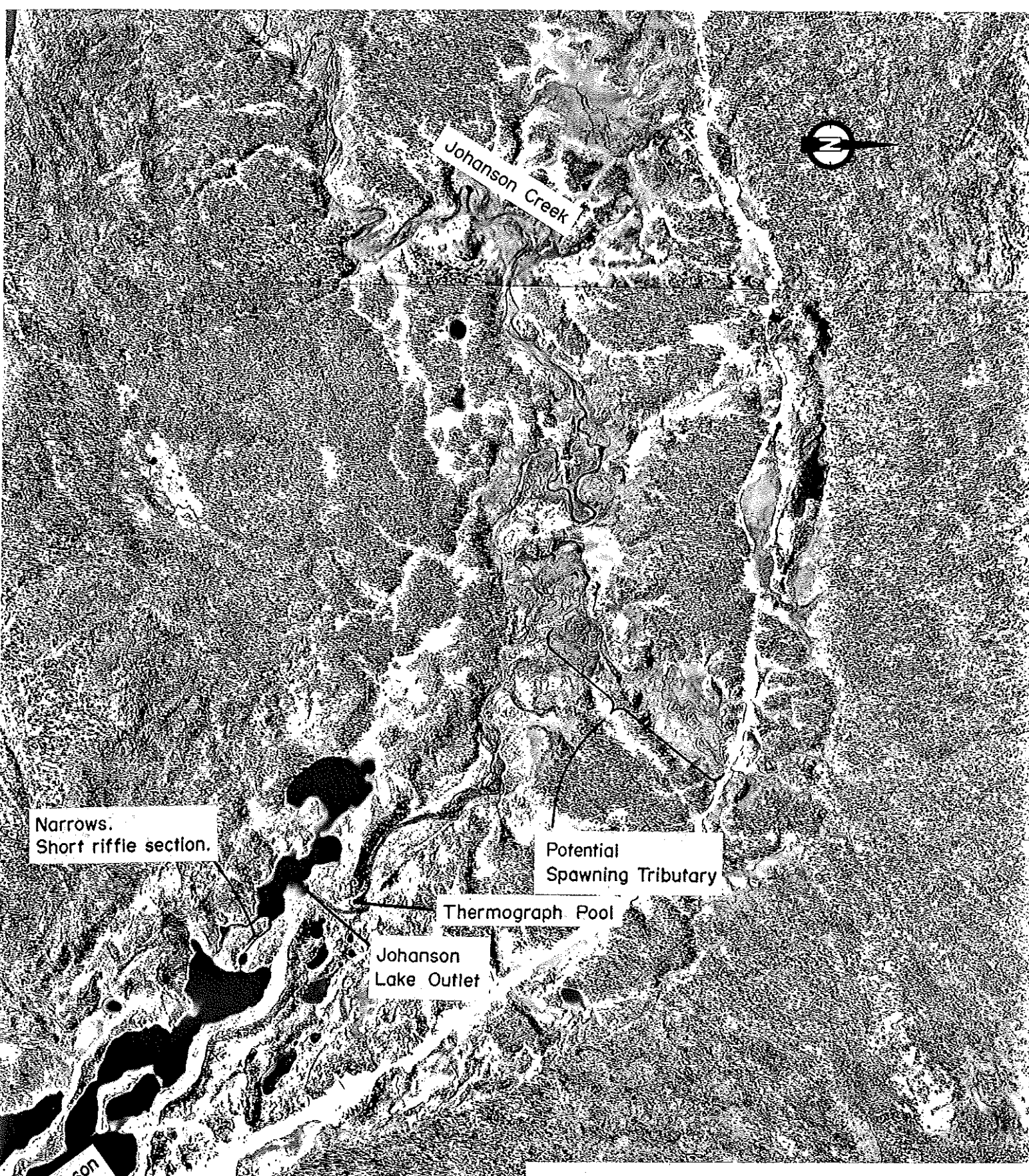

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Figure 3. Study Area Locations in Vicinity of Johanson Lake.

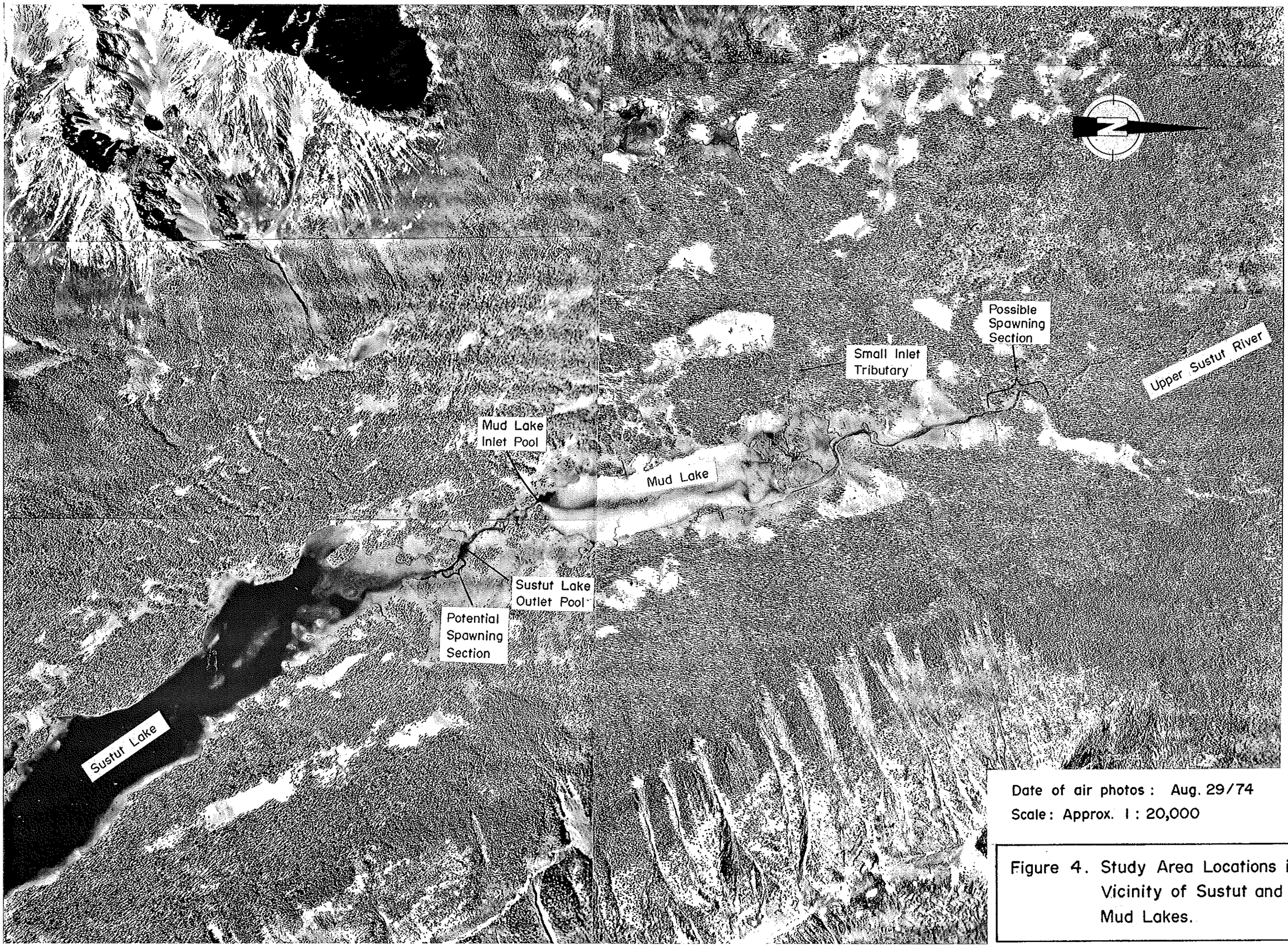

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Figure 4. Study Area Locations in Vicinity of Sustut and Mud Lakes.

Table 2. Mean Monthly Water Temperatures (°C) at Selected Locations in the Upper Sustut System.		
MONTH	JOHANSON LAKE OUTLET	SUSTUT UPSTREAM OF JUNCTION POOL
JUNE (9-30th)	7.9	NA[3]
JULY	13.3	13.3
AUGUST	13.4	12.2
SEPTEMBER	8.0	5.6
OCTOBER (1-12)	5.6	3.4

23 in the Sustut Lake outlet compared to 2.0 and 1.2°C in the Sustut just upstream of the Junction Pool for these dates.

Mean water temperatures at the outlet of Johanson Lake remained above 5°C from early June until October 10 (Figure 5B). After this date temperatures dropped off quickly to 1.5°C by October 23. Maximum daily temperatures rarely exceeded 15°C, and the mean daily temperature at the outlet was just over 13°C in July and August. Diurnal fluctuations were relatively minor (0-2°C) at this location compared to sites lower on the river.

Temperatures at the outlet of Johanson Lake were on average 5°C (range 3-8°C) warmer than in Johanson Creek just upstream of the Junction Pool for the period from July 8 to September 10 (Appendix Table 2). The warming influence of the lake was very obvious by October 12 when ice was forming in Johanson Creek upstream of the Junction Pool while the lake outlet was 4.6°C.

3.1.2 Streamflow

The estimated discharge in the Sustut River and Johanson Creek upstream of the Junction Pool is shown in Figure 6. Streamflows in both systems declined sharply in mid-July and stayed low until late September when heavy rains brought the flows up in both systems. Streamflows in the Sustut River dropped to less than 1 m^3/sec for the period from early August to September 20. Two small freshets exceeding 5 m^3/sec occurred during late September and early October.

Johanson Creek has substantially higher flows than the Sustut at the Junction Pool with minimum flows in the range of 2 m^3/sec during late August and September. Flows stay higher in Johanson Creek

[3] Incomplete records. Thermograph malfunctioned after June 17

during the early summer, presumably fed by snowmelt from more higher elevation areas in this watershed compared to the Sustut Lake system. During the late September freshet, discharge in Johanson Creek was approximately five times that estimated in the Sustut River upstream of the Junction Pool. The Johanson Creek watershed is approximately 2.5 times the size of the Sustut watershed at the Junction Pool (180 km^2 versus 75 km^2). Sustut Lake plays a more important role in moderating streamflows in the upper Sustut than in Johanson Creek, with more of the Johanson Creek inflows entering downstream of the lake system. For example, the Johanson Lake watershed (50 km^2) represents approximately 28% of the Johanson Creek watershed at the Junction Pool. The Sustut Lake watershed (55 km^2) is a similar size, but comprises 73% of the Sustut River watershed upstream of the Junction Pool.

Discharge estimates at the Johanson Lake outlet (1.0 m^3/sec) were approximately 17% of the discharge estimated in Johanson Creek upstream of the Junction Pool (6.0 m^3/sec) when these two locations were metered in mid-October.

3.2 Steelhead Tagging Downstream of Fence

The detailed information for all fish tagged and recaptured in the study is summarized in Appendix Table 3. In summary, 93 steelhead were tagged by angling in the river section downstream of the fence during the period August 14 to September 20. This includes 19 radio fish (distinguished by double tags). Of the 93, 40 were tagged in the 2-km section of river from the Junction Pool downstream, 15 were tagged in the 2-km section upstream of Moosevale Creek, and 38 steelhead were tagged at the Moosevale Creek confluence and immediately downstream. During the tagging, 11 fish were recaptured by angling, including 2 fish that were recaptured twice.

The number of tagged fish present in the section of river downstream from the Junction Pool is summarized in Table 3. Any fish that were either passed through the fence or known to have been removed from the population due to Native netting or hooking mortalities are not included in these estimates. Table 3 represents the maximum estimate of tags in the river. The actual number might have been less due to tag loss, possible tagged fish movement into Johanson Creek, and Native fishing. These estimates become increasingly less accurate after the middle of September as fish became more active in higher flows.

Careful examination of the Johanson Lake outlet area during tracking flights and from the ground, including angling, indicated that steelhead movements into the area were minor until the mid-September period (Appendix Table 10). A single steelhead was

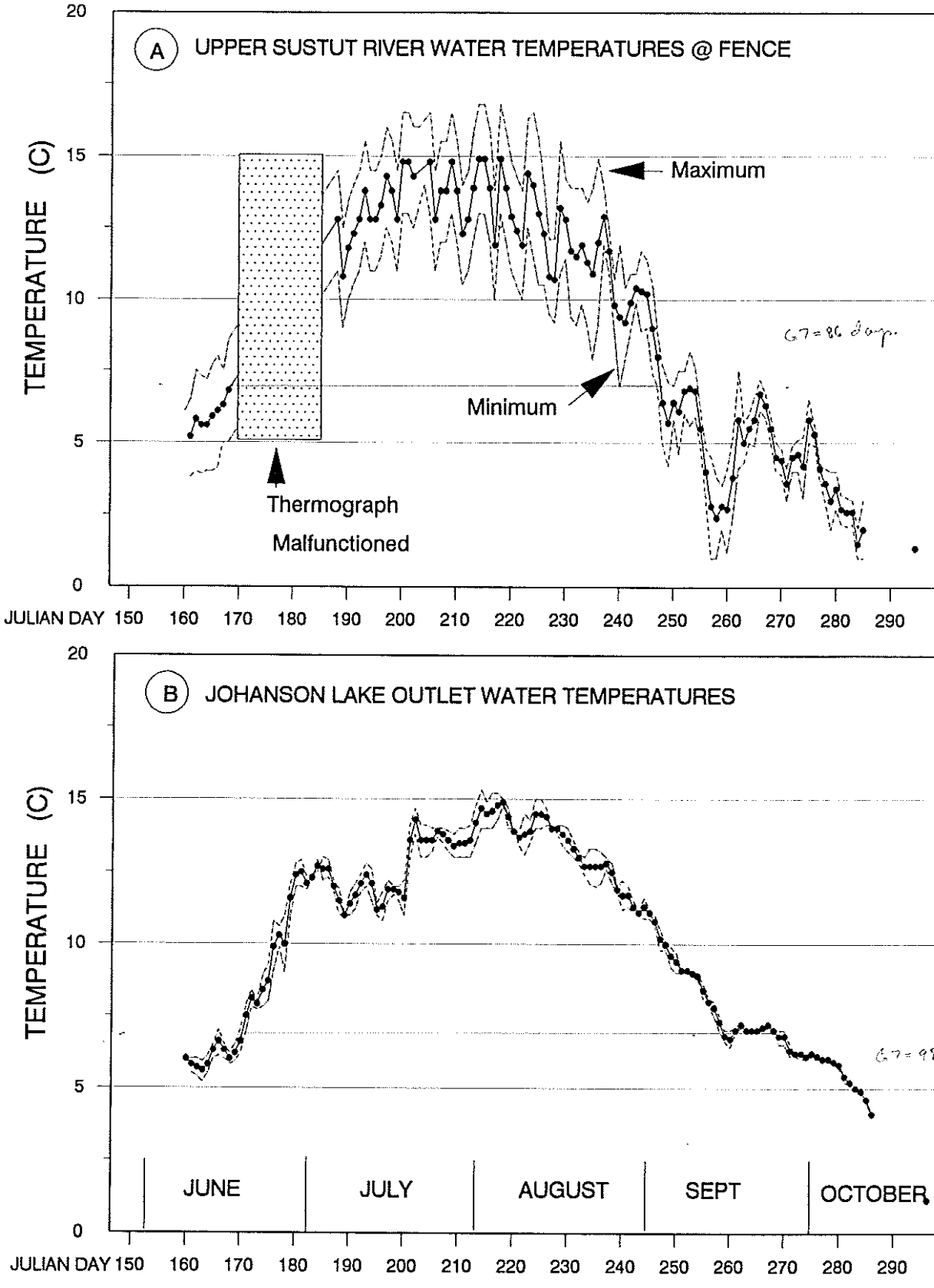

Figure 5. Water Temperatures on the Upper Sustut River and Johanson Lake Outlet

Table 3. Summary of Maximum Number of Tags Available[4] Downstream of the Fence on Snorkel Survey Dates in August and September 1992.

DATE	WHITE	BLUE	PINK	YELLOW	GREEN	TOTAL
Aug 17	10					10
Aug 20	24					24
Aug 24	22	9				31
Aug 28	19	15				34
Sept 2	19	15				34
Sept 6	18	22				40
Sept 10	18	13	10	10		51
Sept 14	17	12	10	15		54
Sept 18[5]	17	12	9	19		57
Sept 22	14	12	7	19	19	71
Sept 28	11	8	5	17	12	53

observed in the lake outlet on August 16, and nine steelhead were observed on September 1.

3.3 Snorkel Observations

A summary of steelhead observations during snorkel surveys conducted from August 12 to October 11 is summarized in Table 4. Visibility during the snorkel surveys was excellent up until September 18. Beyond this date, rising water levels associated with the rains reduced visibility. This made tag observations more difficult, particularly the ability to distinguish tag colours. A detailed summary of the numbers of fish and numbers of tags by location is presented in Appendix Tables 4 and 5.

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[4] Tag numbers have been determined by correcting for those fish that have been passed through the fence or removed from the population for some other reason.

[5] Significant fish movements may have occurred into Johanson Creek after this date making this estimate of number of tags available less accurate.

3.3.1 Timing of Steelhead Arrival into the Upper Sustut

Six steelhead were observed during the first survey conducted from the Junction Pool downstream for 1 km on August 12 indicating that fish had arrived in the river prior to this date. DFO staff indicated that a single steelhead was passed upstream at the fence on August 6 and that four steelhead were observed while snorkelling in the Junction Pool on August 10 (Dr. Cole Shirvell, pers. comm.).

The numbers observed in the section downstream to Moosevale Creek increased over time until September 18 when 329 steelhead were observed (Table 4 and Figure 7). After this date, the numbers observed in this section declined to the point where only 2 fish were observed during the October 11 survey. It should be noted that visibility also declined in these later surveys, and this may partially account for reduced numbers in this section.

Figure 7 indicates that most of the fish arrived in the Sustut/Johanson area during the period August 10 to September 10. There was a large increase in numbers of steelhead observed between surveys on August 24 and September 2. By this date, approximately 70% of the maximum number of steelhead observed had already arrived in the upper river.

The snorkel surveys provided an opportunity to observe the arrival of fish that had been tagged at locations downstream on the lower Skeena River in the sport and commercial fisheries. These fish were marked with orange Floy tags. A single orange-tagged steelhead was observed during surveys on August 24 (Location 11 - Appendix Table 5). The number of orange-tagged fish increased to 8 by the September 2 snorkel survey and up to 11 by September 18 (Figure 7). Since two orange tagged fish were passed through the fence on September 20 and there was one hooking mortality on August 25, it is estimated that at least 14 orange-tagged steelhead were present in the upper Sustut during 1992. Tag numbers were obtained from 8 of these fish (Table 5).

Two of the orange-tagged fish recovered on August 25 at Moosevale Creek had been tagged in the test fishery at Tyee on the lower Skeena on July 18 and July 23. These fish travelled the approximately 460 km distance to Moosevale Creek in 33 and 38 days respectively or at a rate of 12 to 14 km/day. This assumes that they had just arrived in the area shortly before their capture. These fish were not observed during a snorkel survey on the previous day. These estimates are reasonable based on observations by Spence (1989) who estimated that mainstem Skeena steelhead averaged 10 km/day in the lower Skeena and 20 km/day in the Skeena upstream of the Zymoetz.

If we assume that it takes approximately 35 days to reach the upper Sustut from the mouth of the Skeena, and that most steelhead

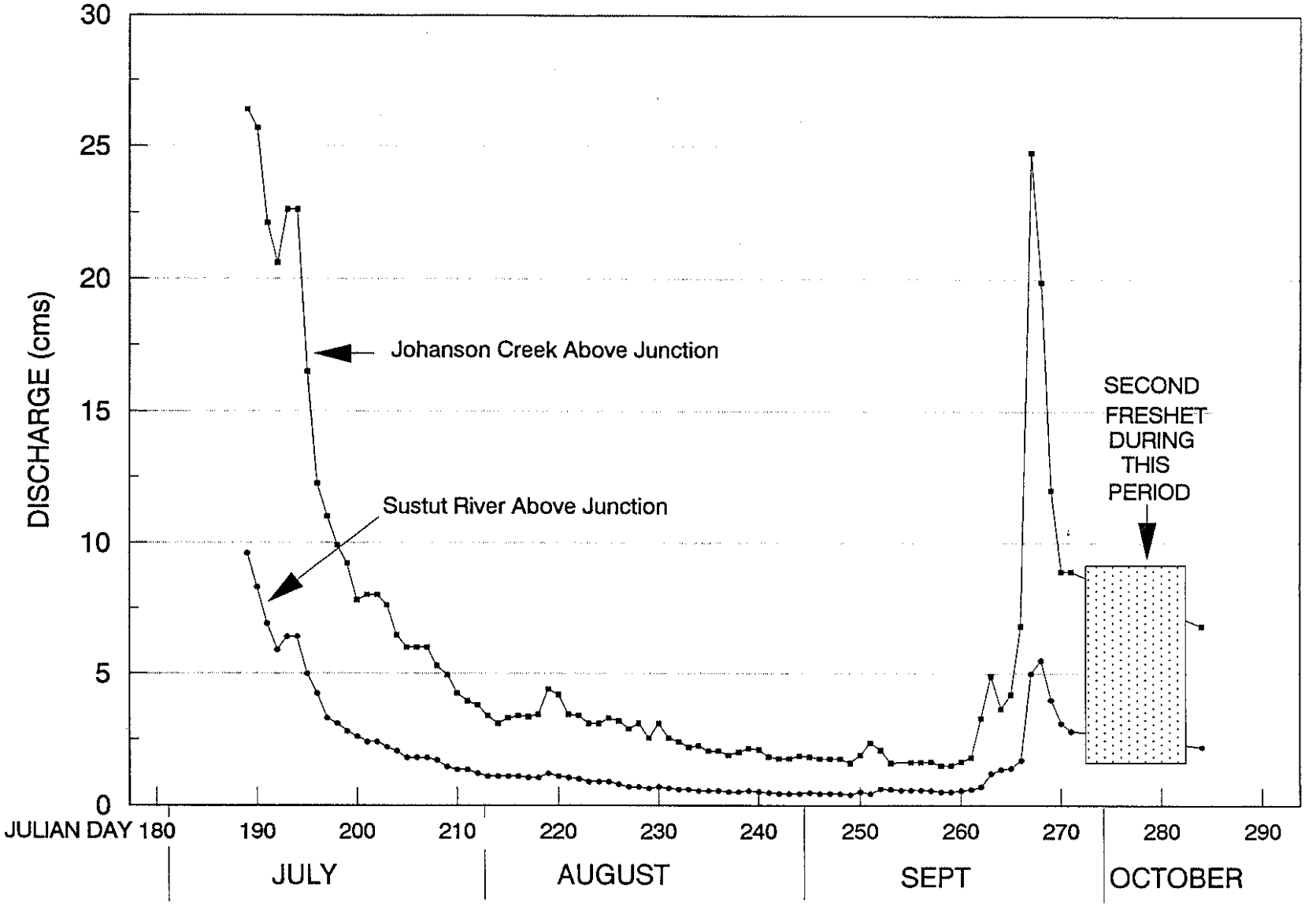

Figure 6. Estimated Discharge in the Upper Sustut River and Johanson Creek , July through October 1992.

Table 4. Numbers of Steelhead Observed Over Time in the Sustut River During August to October 1992.

DATE	EXTENT OF SURVEY	STEELHEAD OBSERVED	TAGS OBSERVED	TAGS AVAILABLE	% OBSERVED
Aug 12[6]	Upper 1 km	6	0	0	NA
Aug 14	Moosevale	59	0	0	NA
Aug 17	Moosevale	75	9	10	90.0
Aug 20	Moosevale	107	18	24	75.0
Aug 24	Moosevale	150	23	31	74.2
Aug 28	Upper 1 km	106	15	34	NA
Sep 2	Moosevale	239	24	34	70.6
Sep 6	Moosevale	269	25	40	62.5
Sep 10	Moosevale To Canyon[7] Total	307 40 347	33 8 41	51 51 51	64.7 15.7 80.4
Sep 14[8]	Moosevale	317	37	54	68.5
Sep 18[9]	Moosevale	329	37	57	64.9
Sep 22[10]	Moosevale	270	38	71	NA
Sep 28	Moosevale	131	11	53	NA
Oct 11[11]	Moosevale	2			

NA - % observed not estimated due to incomplete surveys, poor visibility or no fish tagged at the time of the surveys.

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[6] Incomplete due to bears

[7] From Moosevale Creek downstream to Location 20 (1.5 km).

[8] Visibility to this date was excellent - estimated 7-10 m

[9] Slightly reduced visibility

[10] Poor visibility - estimate 3-5 m through main survey section. Observations downstream of Moosevale not included due to very poor visibility in deep canyon pools.

[11] Visibility 3 m

arrived at the top end of the river between August 15 and September 10, then many of the upper Sustut steelhead would have been moving through the commercial fishery at the mouth of the Skeena River between July 10 and August 5.

Other orange tags recovered included fish tagged in the commercial gillnet and seine fishery in the lower Skeena approaches (5 tags) and in the sport fishery on the lower Skeena River (1 tag) from mid-July to early August (Table 5). It should be noted that one of the five tagged fish attributed to the commercial fishery is assumed to have been tagged by a commmercial fisherman since this tag was issued to him. However, records indicating date and location of tagging are not available for this fish. Sport fishing guide returns from the lower Skeena River indicate that very few steelhead are angled during July and the first week of August (Bob Hooton, MOE, pers. comm.). Only one of the eight orange tags originated upstream of the test fishery.

The lack of orange tags on the first group of fish observed in the river (eg., no orange tags on 107 steelhead observed on August 20 - Table 4) suggests that the earliest portion of the upper Sustut River run arriving before August 24 passed through the commercial fishing area prior to any significant tagging efforts in the commercial fishery (approximately July 20).

Among 237 fish examined, 24% had evidence of gillnet marks (symetrical scarring between the operculum and dorsal fin). A higher percentage of the fish examined in the river downstream of the Native fishing had gillnet marks than in the upper river where some gillnetting activity was carried out (27% compared to 23%), suggesting that the marks were the result of netting activity lower in the system. The mean size of steelhead with gillnet marks (73.2 cm fork length) was no different than that of unmarked fish (73.1 cm).

3.3.2 Steelhead Holding Locations Over Time

Most steelhead held in the upper 1 km of the Sustut River downstream from the Junction Pool (Figure 7). During the course of the surveys, 86.3% of the steelhead observations occurred in this upper section compared to 3.8% in the mid-section and 9.9% in the section of the Sustut River from Moosevale Creek upstream for 1.5 km. Nearly all of the steelhead had moved up to the upper section of the river as streamflows increased after September 18 (Figure 7). Five pools located in the upper section of river held most of the fish (Appendix Table 4). Observations at Location 5 (Grizzly Run) accounted for nearly 37% of the steelhead observations during the study. Location 2 (Long Run) accounted for 21% of the steelhead observed.

The observations made during the survey conducted on September 10 were of particular interest (Table 4). This survey was different than the others in that it also included a 1.5 km section of the Sustut River downstream of Moosevale Creek. During this survey, 40 steelhead were observed holding in this lower section, including 8 tagged fish (16% of the total number of tags), indicating that some of the tagged fish were dropping downstream below the main snorkel survey section. These tag observations are significant when estimating the number of tags that were assumed to be in the study area versus those actually observed.

Table 5. Summary of Orange Tag Recoveries in the Upper Sustut River.

RECAPTURE INFORMATION			TAGGING INFORMATION	
DATE	**LOCATION**	**NUMBER**	**DATE**	**LOCATION**
Aug 25	Below Moosevale	5130	July 23	Skeena Test Fishery - Tyee
Aug 25	Moosevale	5171	July 18	Skeena Test Fishery - Tyee
Aug 29	Moosevale	C00570	Aug 2	Commercial gillnet Tugwell - Area 4-9
Sept 19	Moosevale	C02398	Aug 4	Tidal gillnet Near Smith & Kennedy Island Tagged @ barge
Sept 19	White Rock Pool (Loc 3)	S02335	July 31	Skeena @ Old Remo Sportfishery
Sept 20	Fence	C01287	July 16	Tidal Seine near Smith & Kennedy Island
Sept 20	Fence	C00574	Aug 2	Commercial gillnet Tugwell - Area 4-9
Oct 23	Sustut Lake outlet	C02333	?[12]	Commercial gillnet

[12] Tagging date unknown. This tag was issued to a commercial gillnet fisherman but tagging records were not completed and returned.

For this reason, the observations collected on September 10 provide the best estimate of the proportion of fish actually observed during the surveys and of the total number of fish holding in this section of the river. On this date, of the 347 fish counted, approximately 12% were outside of the main survey area. Just over 80% of the maximum number of tagged fish suspected to be in the study area were observed by the swimmer.

3.4 Numbers and Timing of Steelhead Movements Through Fence

A total of 150 steelhead were passed through the fence into the upper Sustut River upstream of the Junction Pool between August 6 and September 28 (Figure 8A and Appendix Table 6). Only 10 of these fish had moved through the fence by the end of August. The largest movement occurred on September 24 when 83 steelhead were passed upstream.

The main movement of steelhead coincided with the heavy rains and rising water levels starting on September 18 (Figure 8B). The day of most significant fish movement occurred during the highest flow of the first freshet during late September. A second peak occurred in late September and early October just after the fence was removed. It is assumed that most of the fish that had been holding in the Junction Pool and downstream moved into the upper Sustut River and Johanson Creek. For example, only one of five radio fish tracked in the Junction Pool on September 27 was still present at this location on September 29.

A total of 31 of the fish that had been tagged downstream were recovered at the fence (Table 6). This was from a maximum number of 86 tags present in the system downstream from the fence (corrected for known mortalities). A higher proportion of those fish tagged earliest in the study area moved through the fence while it was in operation. All of the tagged fish captured at the fence prior to September 19 had either white or blue tags. Many of the green-tagged fish (September 17th onward) were tagged in upper locations of the study area and their time of arrival in the river is not as likely to be reflected in tag colour compared to the earlier tagging.

Visual observations indicated that a number of the fish that were passed through the fence in late August and early September did not move up into Sustut Lake immediately. Instead, these fish held in the Hotel Pool, the only good holding water upstream of the fence located approximately 500 m upstream (Figure 2). For example, on September 6, 18 steelhead were observed in the Hotel Pool. Up to this date, only 25 steelhead had been passed through the fence, indicating that most steelhead were still not venturing through the fast water section between the fence and Sustut Lake.

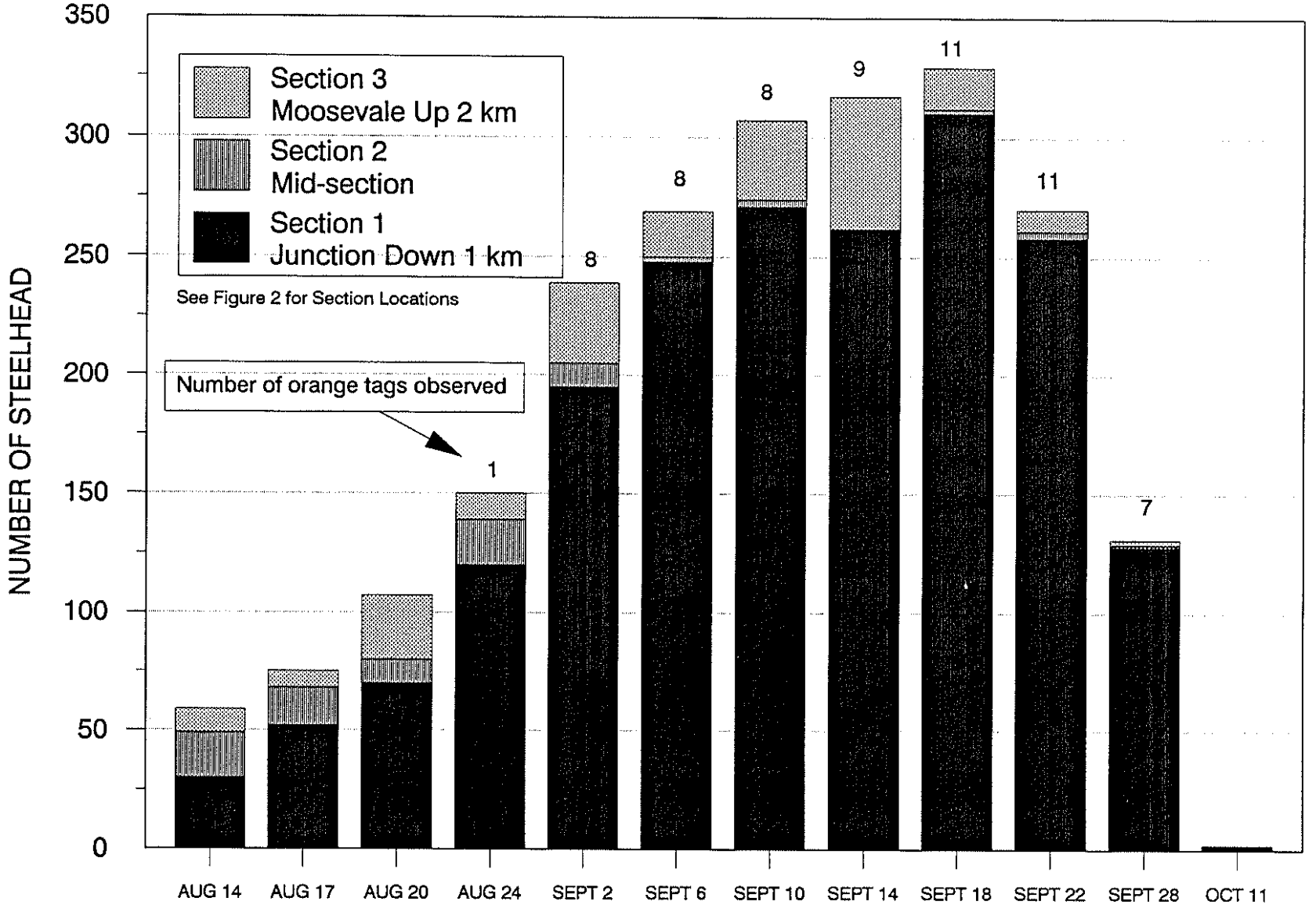

Figure 7. Number of Steelhead Observed During Sustut River Snorkel Surveys.

Table 6. Number and Colours of Tagged Steelhead Passed Through the Fence on the Upper Sustut River.			
TAG COLOUR[13]	TAGS AVAILABLE[14]	TAGS AT FENCE	PERCENTAGE RECOVERED
WHITE	20	10	50.0
BLUE	18	6	33.3
PINK	10	3	30.0
YELLOW	14	2	14.3
GREEN	24	10	41.7
TOTAL	86	32[15]	36.0

In total, 70 Dolly Varden, 5 resident rainbow trout, and 14 mountain whitefish were captured at the fence (Appendix Table 6). The Dolly Varden were mostly mature spawners moving into that section of the Sustut River just upstream of the fence to spawn. Most of the movements occurred from late August through September. Spawning Dolly Varden were observed in the riffle immediately downstream of the Hotel Pool on September 13.

A number of spent fish were found washed down against the fence during mid-September. As well, mortalities to fish moving upstream occurred since some of the fish were small enough to get wedged in between the aluminum conduit on the holding box. Length summaries for Dolly Varden and mountain whitefish captured at the fence and angled in the Sustut River below the Junction Pool are presented in Apendix Table 8.

In total 100 chinook salmon were passed through the fence between July 30 and August 25 with a peak on August 5. Many of the chinook spawned in the Sustut River downstream of the fence to Moosevale Creek and are not included in this total. As well 2590 sockeye salmon were passed upstream of the fence between August 5 and September 22 with a peak on August 9 (Dr. Cole Shirvell, unpublished data on file, Pacific Biological Station, Nanaimo).

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[13] See Table 1 for tagging dates for each colour

[14] Corrected for mortalities

[15] Total includes one fish captured at the fence that was missing a tag. It is assumed that this fish was tagged in the upper river.

A very small number of coho were observed during the surveys in the upper Sustut. The maximum estimate was made during the September 6 snorkel survey when 30 coho (including 27 jacks) were observed (Appendix Table 9). It should be noted that the snorkel surveys focussed on steelhead, and that records after September 10 were limited. However, it was estimated that no more than 10 coho were observed on any of the subsequent surveys. A single jack coho was passed through the fence on August 18.

3.5 Radio Telemetry Studies

Tracking data for each of the 21 steelhead radio-tagged in the study is presented in Appendix Figure 1. The tagging location and final location of each fish is summarized in Table 7.

The radio-tracking data confirmed the snorkel observations that most of the fish remained downstream of the Junction Pool during the period from mid-August to late September. Fish that were tagged in the vicinity of Moosevale Creek at the lower end of the study area, tended to gradually move upstream and hold in a series of pools in the upper 1.5 km of the river immediately downstream of the Junction. Several of these fish did move several kilometers downstream from the Moosevale confluence to hold for periods of time. During periods of heavy Native fishing in the river, some of the radio-fish dropped back downstream from the Junction Pool area short distances to pools that offered better cover.

The tracking data suggests that once fish entered Johanson Creek, they continued a steady movement up the 20 km of creek to the lake. For example Fish 8 moved up Johanson Creek after September 23 and was in Johanson Lake by September 29. Fish 12 also showed a steady daily upstream movement (3-5 km/day) during late September.

Several radio-tagged fish that were passed at the fence in early September remained in the upper Sustut in the Hotel Pool just upstream of the fence for several weeks, confirming the visual observations that most of the fish were not moving through the fast water sections of the upper Sustut until higher flow conditions in late September.

Several interesting movements were noted during the telemetry studies. For example, Fish 7 was tracked over 10 km up Johanson Creek in early September. This fish then moved back downstream below the Junction Pool for most of September and then through the fence on September 24 and into Mud Lake by September 27. Fish 8 moved through the Sustut fence on September 4 and held in a pool just upstream of the fence until September 23. Two days later this fish was located more than 10 km upstream in Johanson Creek and was in Johanson Lake four days later where it remained through to the end of the study. It is assumed that this fish jumped the fence

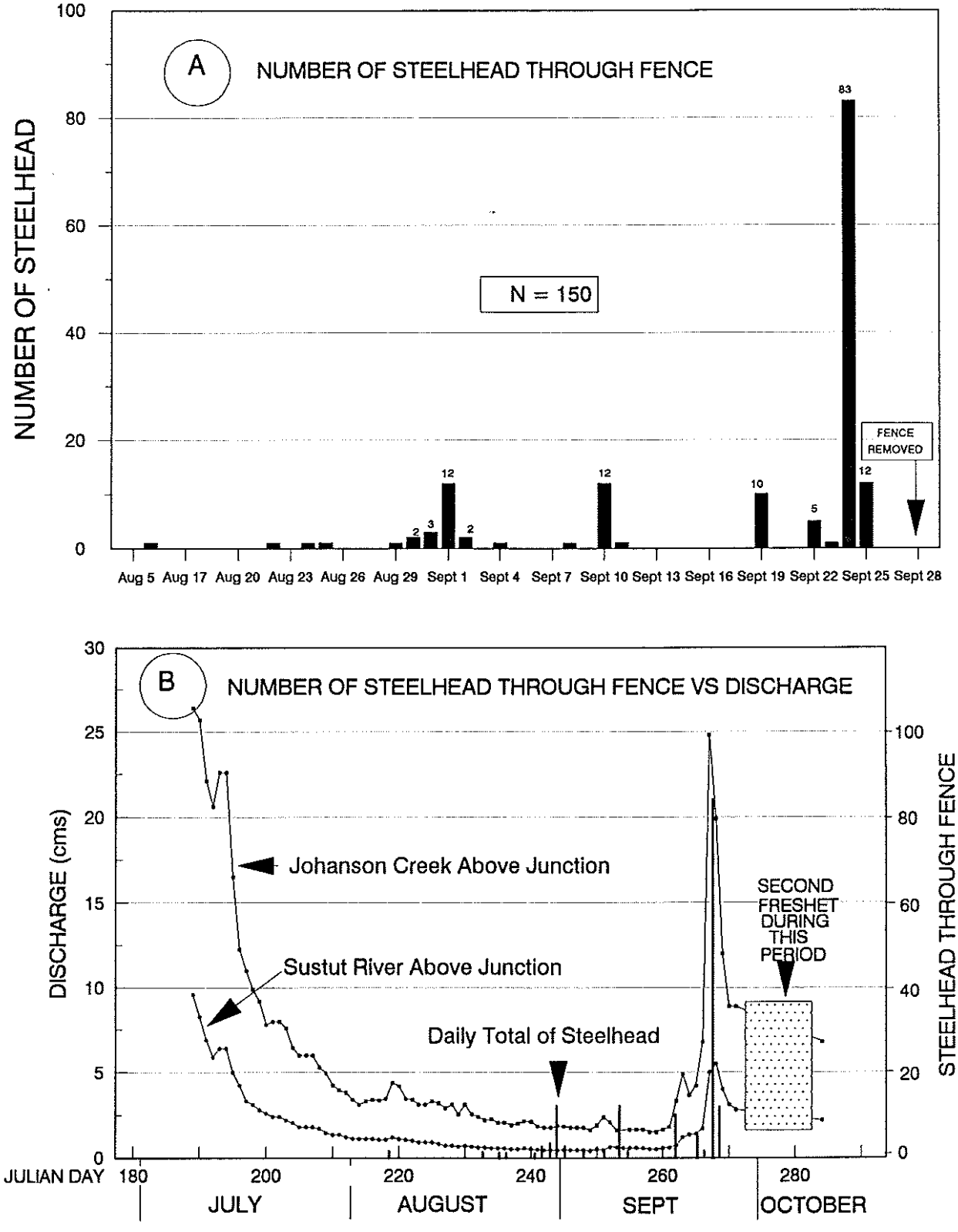

Figure 8. Number of Steelhead Through Counting Fence with Time and Discharge.

during high flow conditions in this period. Observations suggest that this fish is unlikely to have moved through the overflow channel from Johanson Creek that enters the Sustut at the Hotel Pool (Figure 2).

Final locations were determined for 13 of the 17 radio fish that were tracked on October 23. Nine of these fish were located in the outlet of Sustut Lake and four were located near the outlet of Johanson Lake. One of the four fish in Johanson Lake was tagged at the lake. The results indicate that of the 12 radio-tagged fish that were holding below the Junction on the upper Sustut, three moved into Johanson Lake and nine moved into Sustut Lake to overwinter. Using this proportion of radio fish moving into the two lakes suggests that approximately 75% of the steelhead are overwintering in Sustut Lake and 25% in Johanson Lake. It should be emphasized that the sample size is relatively small.

On the final tracking date, (October 23), all of the Sustut Lake fish were found in a single pool located approximately 200 m downstream from the outlet of Sustut Lake (Figure 4). This section is a widening of the river between Sustut and Mud lakes and was described as an important holding area by Fennelly (Appendix Table 1). The dimensions of the pool were estimated to be 150 m long and 80 m wide. It is interesting to note that 11 days earlier (October 12), one of the Sustut radio fish was located in the inlet pool in Mud Lake and a second fish was located in Sustut Lake near the outlet. The other seven fish were in the same location as on October 23. These observations suggest that the fish became more concentrated with the approach of winter.

Similarly, the Johanson Lake fish were concentrated right at the outlet of the small lake into the upper river (Figure 3), although one of the Johanson Lake fish (Fish 20) was detected part way down the lake during late September.

Three of the radio fish tagged during August were taken by Natives using gillnets in the vicinity of the Junction Pool. The tags were recovered in gut piles and in the bushes adjacent the river. A total of 12 radio-tags had been deployed by the date that these fish were taken, including nine fish in the upper river section where nearly all netting occurred.

Table 7. Summary of Tagging Locations and Final Locations of Radio -Tagged Steelhead in the Upper Sustut River.

FISH	TAGGING LOCATION	FINAL LOCATION	COMMENTS
1	Moosevale Ck (Aug 15)	Sustut Lake outlet	Stayed below Moosevale Ck until Sept 10
2	Moosevale (Aug15)	Native Fishery	Netted near Junction - Aug 23
3	Moosevale Ck (Aug 16)	Sustut Lake outlet	Remained in section below Junction Pool until Sept 29
4	Loc 3 (Aug 16)	Unknown	Last observed at Moosevale Ck
5	Loc 2 (Aug 17)	Native Fishery	Netted near Junction - Aug 23
6	Loc 1 (Aug 18)	Native Fishery	Netted near Junction - Aug 23
7	Loc 2 (Aug 17)	Sustut Lake outlet	Tracked in mid-section of Johanson Creek on Sept 1. Put through fence on Sept 24.
8	Loc 2 (Aug 18)	Johanson Lake outlet	Passed through Sustut fence on Sept 4. Jumped fence on Sept 23 and into Johanson Ck.
9	Loc 3 (Aug 18)	Sustut Lake outlet	Last radio fish to leave Junction Pool area
10	Loc 5 (Aug 18)	Sustut Lake outlet	Remained in section below Junction Pool until Sept 29
11	Moosevale Ck (Aug 23)	Unknown	Last tracked in canyon below Moosevale Ck
12	Moosevale Ck (Aug 25)	Johanson Lake outlet	Tracked up Johanson Creek Sept 25-27
13	Moosevale Ck (Aug 28)	Unknown	Last recorded at Loc 5 on Sept 16
14	Fence (Aug 29)	Tagging mort	Fungus growth caused by handling during tagging?
15	Loc 1 Sept 2	Sustut Lake outlet	Passed through Sustut fence on Sept 24
16	Moosevale Ck (Sept 24)	Sustut Lake outlet	Remained in section below Junction Pool until Sept 29
17	Loc 15 (Sept 5)	Sustut Lake outlet	Passed through fence on Sept 19
18	Moosevale Ck (Sept 8)	Unknown	Last tracked at Loc 5 on Sept 22
19	Moosevale Ck (Sept 11)	Johanson Lake outlet	Tracked up Johanson Creek Sept 25-27
20	Johanson Lake (Sept 17)	Johanson Lake outlet	Tracked in mid-lake area on Sept 27
21	Junction (Sept 27)	Sustut Lake outlet	Left Junction Pool on Sept 29

One of the radio-tags was recovered one day after tagging. It had been regurgitated by a 78 cm male steelhead tagged at the fence. A tag from a second fish was recovered in the bushes after a grizzly had eaten the fish that was tagged and being held in a holding tube at the fence. The bear did not eat the tag. A third fish (Fish 14) was radio-tagged at the fence in late August and recovered dead at the fence nearly one month later. This fish had what appeared to be gaff marks on its head when tagged. This fish was observed regularly while holding in the Hotel Pool upstream of the fence. It was noted that fungus growths developed on the head and tail areas of the fish in the vicinity of where it was held during tagging. It is not clear whether the fish died as a result of the handling during tagging or from previous wounds or the combination.

The fate of four steelhead (Fish 4, 11, 13 and 18) was unknown at the end of the study. Fish 4 was last recorded moving downstream at Moosevale Creek on August 20. There is a possibility that this fish may have been taken in the Native fishery, but the apparent downstream movements during the main fishery in late August suggests otherwise. Fish 11 was also last tracked below Moosevale Creek in late September. Fish 13 and 18 were in Location 5 (Grizzly Run) until mid-September. It is not known whether the transmitters failed on these fish or whether the fish moved out of the study area. The entire Sustut River from the Bear River confluence upstream was tracked on October 23. Eiler (1990) reports that high-frequency tags such as those used in this study are not easily detected at water depths greater than 6 m, so fish holding in the deeper portions of either lake or even in the deep canyon pools below Moosevale Creek may have been present in the study area but were not detected.

It should be noted that the inability to account for some tagged fish at the end of this study is typical of most steelhead telemetry studies. For example, other steelhead studies in the Skeena (Lough 1980 and 1981; Spence 1989) report that 15-33% of the tagged fish were unaccounted for at the end of the study. Spence (1980) reported 37% of the fish tagged in the Chilcotin River were missing by the following spring. These studies assumed that tag malfunction, regurgitation, predation, and fish movement to other drainages accounts for most of the missing fish. In this study, we were able to recover a regurgitated tag and four tags from predation and Native netting, as well as a tag from a fish that may have died due to handling. These recoveries were possible due to the small size of the system and the intensive monitoring program.

3.6 Steelhead Population Estimates

The most reliable estimates of total steelhead numbers in the upper Sustut River are judged to be those made by direct observation during snorkel surveys. Good visibility along with the small size of the river during low flow conditions allowed for a high proportion of the fish present in the upper river to be observed during surveys. The September 10 snorkel surveys are considered to provide the best estimate of steelhead numbers since this survey included a 1.5 km section downstream of Moosevale Creek that was used by holding steelhead (Table 4).

During the September 10 survey, 347 steelhead were observed. As well 41 of the 51 tagged fish present in this section of the river were accounted for in the survey (80.4%). If we assume that we saw 80.4% of the total number of steelhead present from the Junction Pool downstream on this date, then it could be estimated that 432 fish were present in this river section at this time. We then need to add to this total 57 fish that we know are not in the survey (summarized in Table 8) leading to a total estimated population of 487 steelhead.

It might appear that estimating that we observed 80% of the steelhead present in the study area is optimistic. The high percentage of fish observed during the surveys is supported by the radio-tracking information that was conducted in conjunction with the snorkel surveys. Since all radio-tagged fish had two tags, they were distinguished from the single-tagged fish during the snorkel surveys and recorded separately. Between August 17 and September 14, 62 of the 68 potential sitings of radio-tagged steelhead were made indicating a 91% efficiency of observation. The person conducting the radio-tracking did not indicate how many radio fish were in each pool until after the observations had been made.

There are a number of limitations to the population estimate that should be identified. For example, the estimates assume that we have accounted for all tagged fish taken by Natives. It is probable that additional tags to those we know of were taken - leading to a lower total estimate than in Table 8. Similarly, some single tagged fish may have moved into Johanson Creek and would not have been observed in the surveys. As well, the total number of fish in Johanson on September 10 may have been higher than the 9 fish observed in the vicinity of the lake outlet. The estimates also assume that no fish were holding further downstream than the survey area. Aerial observations suggest that most of the good holding areas were within the survey area, but some fish could have been present downstream.

The estimates do not account for possible tag losses. During the study it was noted that one steelhead taken at the fence had lost

a single tag, and one of the radio-tagged fish was missing a tag, indicating that some tag loss did occur. The effect of tag loss would be to overestimate the actual population.

Despite these limitations, the estimate is not unreasonable based on two supporting alternative methods of estimating numbers. During the September 18 snorkel surveys, 329 steelhead were observed. If we add the 71 fish known to be outside the survey area on this date (Appendix Table 11), then at least 400 steelhead were directly accounted for on this date. This assumes that we observed 100% of the fish in the river and that no fish were holding below Moosevale Creek. At least two of the radio fish were present downstream of Moosevale on this date - so the population of steelhead is definitely over 400 fish.

The second check on the estimate can be obtained by examining the ratio of tagged to untagged steelhead taken at the fence. In total, 93 fish were marked downstream of the fence during this study. Of this total, 7 were removed from the population primarily due to Native fishing leaving a maximum of 86 marked fish in the population. Based on the ratio of radio fish moving into Johanson Lake (25%) versus Sustut Lake (75%), we can assume that 75% or 65 of the 86 marked fish would have moved into the upper Sustut system

Table 8. Summary of Steelhead Population Estimate Based on Snorkel Observations in Upper Sustut River, September 10, 1992.

LOCATION	NUMBER	COMMENTS
Total observed during snorkel survey	347	307 above Moosevale 40 below Moosevale
Corrected total based on tagged to untagged fish observed (80.4%)	430[16]	41 of 51 tagged fish were observed during surveys
Additional fish known to be not in survey area	57	Mortalities[17] 22 Through fence 26 Present in Johanson 9 **Total 57**
Total Estimate	**487**	95% Confidence Intervals: 433-541

[16] See Appendix Table 11 for details of estimate

[17] See Appendix Table 10 for breakdown of these estimates

above the Junction Pool. During the period of fence operation, 31 out of the 150 fish passed through the fence were marked. Using a mark-recapture estimate outlined in Appendix Table 12, leads to an estimate of 436 fish in the system with 95% confidence intervals ranging from 320 fish to 506 fish. We know the lower end of the confidence interval is too low. This estimate is confounded by the possibility that some of the marked fish may have passed through the Sustut fence and subsequently moved downstream and into Johanson Creek similar to radio-tagged Fish 8 (Appendix Figure 1).

A small sample of steelhead was angled in the Sustut Lake outlet pool on October 23 as part of a blood sampling program conducted by MOE. Of the 19 fish angled, 11 had been tagged previously, suggesting that a higher proportion of the total Sustut steelhead population may have been tagged than assumed in the estimates. These observations are based on a small sample size.

3.7 Steelhead Length-Frequency Distribution

The length-frequency of steelhead captured in the upper Sustut River is summarized in Table 9 and Figure 9. In total 247 steelhead were measured during this study - 96 fish during angling for tagging, and 148 fish at the fence.

Female steelhead dominated the population comprising over 80% of the fish examined in 1992. This was up from 65% of the fish sampled in 1986. Over 84% of the fish handled at the fence were female compared to 76% of the fish angled. Nearly all of the female fish (96.0%) were in a very narrow size range from 66-77 cm fork length (Figure 9). These fish were on average 4 cm smaller than the fish sampled in 1986 (Table 9).

Male steelhead comprised just under 20% of the total population of fish (15.5% at the fence and 24.0% of those angled). They were approximately 5.5 cm larger than the female fish handled in this study and were 8 cm smaller on average than the 1986 sample of male steelhead (Table 9). The largest fish handled during this study was a 90.5 cm male tagged at the Moosevale Creek confluence.

The female portion of the steelhead run tends to be dominated more by a single ocean age (in this case age 2+ fish based on data presented in Spence et al. 1990) compared to males which are more characteristically spread over several different ocean ages. Based on the weak system-wide returns of early-run steelhead to the Skeena in 1991, it is possible that the predominance of females observed in the 1992 run is largely a result of variable year class strength between males and females (Bob Hooton, MOE, pers. comm.).

Table 9. Summary of Number, Mean Fork Lengths, and Size Ranges of Steelhead Captured in the Upper Sustut River in 1992 Compared to 1986.

	NUMBER (%)	MEAN FORK LENGTH (CM)	SIZE RANGE (MM)
YEAR	MALES		
1992	49 (19.8)	77.6	69-91
1986[18]	66 (35.7)	84.1	76-98
	FEMALES		
1992	198 (80.2)	72.1	65-82
1986	119 (64.3)	76.3	67-88
	COMBINED		
1992	247	73.2	65-91
1986	185	79.1	67-98

Data collected from two other Skeena steelhead systems also indicated a predominance of females in the 1992 run. Nearly 72% of a sample of 180 steelhead tagged on the Bulkley River at Moricetown and 62% of a sample of 222 fish tagged on the Babine River were females (data on file, MOE, Smithers). Similarly, female steelhead comprised 67% of the 628 steelhead sampled in the Area 4 fishery in 1992 (J.O. Thomas and Assoc., pers. comm.).

3.8 Native Catch of Steelhead in the Upper Sustut

Native fishing in the upper Sustut in 1992 took place from late July through to early September (Appendix Table 13). The early portion of the fishery focussed on chinook salmon with later fishing for sockeye and to a lesser extent steelhead. DFO has issued permits for Takla Band Natives to take up to 50 chinook and 50 sockeye by snagging in the upper Sustut River. Observations during 1992 indicate, that in addition to Natives from the Takla Band, groups from Ft. St. James, Tache, Ingenika and Black Pine were involved in the fishing.

[18] Data from Spence et al. (1990)

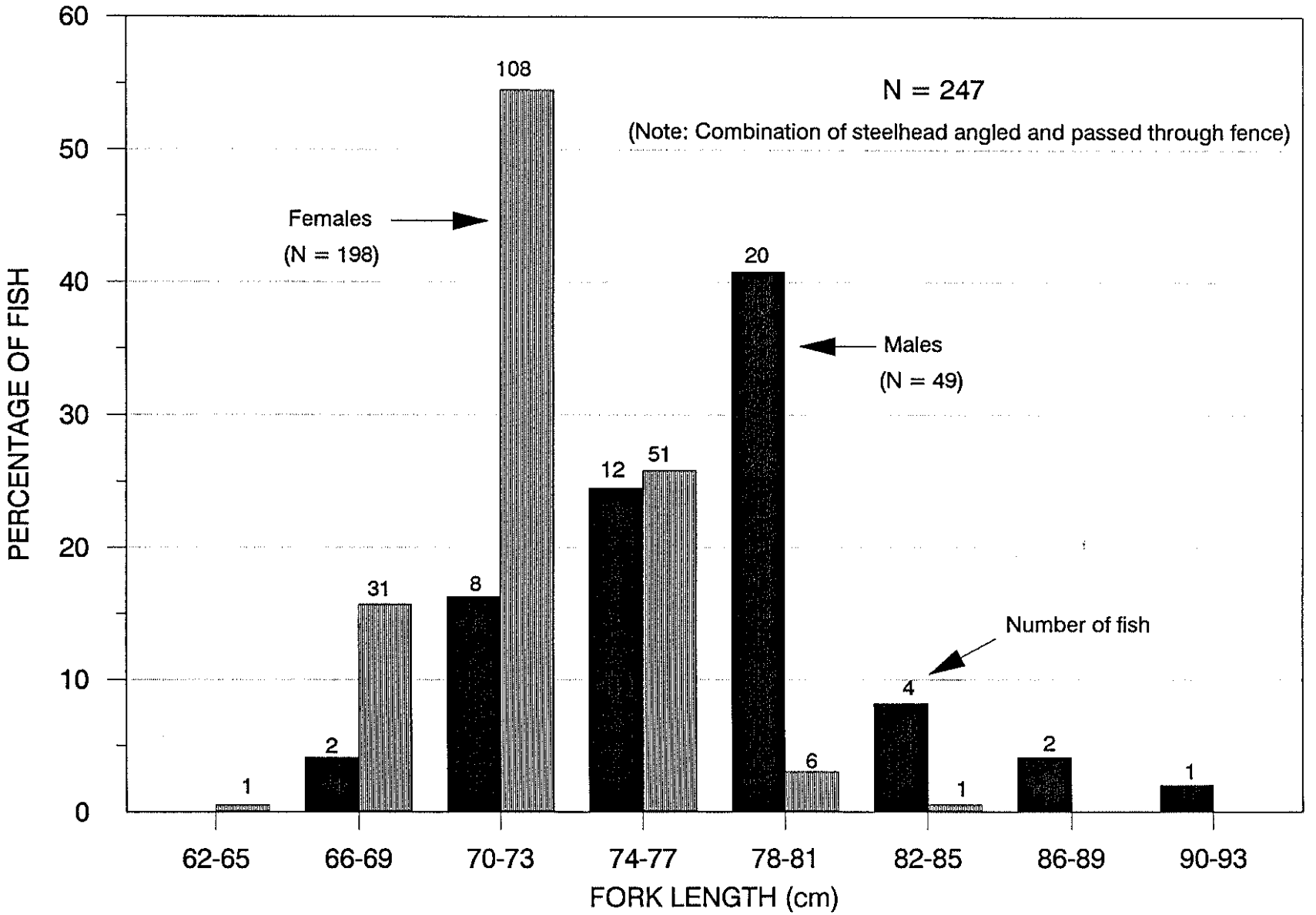

Figure 9. Length-Frequency of Steelhead Captured in the Upper Sustut River in 1992.

Most fish were taken by drifting a monofilament gillnet (3-5" mesh) through runs aided by people throwing rocks to scare the fish into the nets. As well gaffing, and jigging with rods or hand lines and triple hooks were used to catch fish. Fish were removed from the live box at the fence on at least one occasion.

The heaviest activity occurred from August 15 to August 30 in the easily accessible river section located from the Junction Pool downstream for 1 km. There was also evidence of gaffing in the outlet of Johanson Lake. Effort can be extremely heavy at times. For example 10 vehicles and up to 25 people were involved in netting at the Junction Pool on August 23 (Appendix Table 13).

It was very difficult to obtain accurate estimates of fish taken due to the large number of people from different locations who were generally uncooperative in reporting what they had taken and were uncomfortable with anyone observing their activities. With a few exceptions (eg., Peter Abrahams of Takla Landing), tags from steelhead were not returned. Three radio tags were found discarded in the bushes.

During the study, we could directly account for 18 steelhead taken in the Native fishery (Appendix Table 13). Based on the direct observations and some statements from Natives concerning other catches, as well as taking into account the amount of fishing that we were unable to observe, it was estimated that the total catch by Natives probably ranged from a low of 30 to up to 50 steelhead in 1992. These estimates could be low since there was a lot of fishing activity that we were unable to observe.

The radio-telemetry results indicate that native netting accounted for at least three of nine radio-tagged fish present in the upper river (33%) in late August. Snorkel observations between August 20 and August 24 (Appendix Table 4) corrected for visibility (Table 4) suggest between 101 and 167 steelhead were present in the upper 1.5 km section at this time. Assuming a 33% harvest of these steelhead suggests between 33 and 55 steelhead were taken in late August alone.

3.9 Preliminary Assessment of Potential Steelhead Spawning Areas

One of the objectives of this study was to assess potential spawning areas for steelhead in the upper Sustut system and identify whether enhancement opportunities might be available. Since this study was conducted primarily during the fall, direct observations of spawners was limited to a single trip in early June when thermographs were installed. Based on visual observations of suitable bed material in conjunction with the presence of newly-emerged steelhead fry outlined in the juvenile surveys (Bustard 1993), and in some instances spawner observations, several potential areas of steelhead spawning were identified.

The area that appears to be the most significant spawning area in the upper Sustut is located from approximately 800 m upstream of the Junction Pool on the upper Sustut, downstream to the Junction Pool. Spawning steelhead (12) were observed while snorkelling in the section immediately upstream of the Junction Pool on June 9, 1992. This was an area previously identified by Chudyk in 1972 (Appendix Table 1). This was also an area that appeared to be used extensively during early June 1987 (G. Schultze, MOE, pers. comm.). Visibility downstream of the Johanson Creek confluence was too poor to see spawning fish during the June 1992 surveys. It is assumed that spawners would use the gravel sections downstream of this location for a distance of approximately 3.2 km (to Location 13 in Figure 2). Newly-emerged steelhead fry were first observed in the Sustut River upstream of the Junction Pool on July 27 in 1992 and newly-emerged fry observations continued through August.

While conducting studies of spawning chinook salmon, Shirvell (1991) measured over 10,000 m^2 of spawning area in the Sustut above the Junction Pool and estimated another 24,000 m^2 of potential spawning habitat in the 1.2 km section immediately downstream. Additional potential spawning areas exist downstream of this location for at least another 2 km. He also estimated additional spawning areas in Johanson Creek upstream of the Junction Pool. It is expected that many of the areas Shirvell identified as suitable for chinook spawning would also be used by steelhead spawners. A few steelhead spawners were observed in the 0.5 km section of Johanson Creek upstream of the Junction Pool during early June 1987 (G. Schultze, MOE, pers. comm.).

The water temperature measurements conducted in the upper Sustut River during 1992 suggest that Sustut Lake probably plays a major role in determining spawning and subsequent incubation areas for steelhead in this system. For example, water temperatures averaged 3°C warmer in the Sustut River upstream of the Junction Pool compared to Johanson Creek at this location. These warmer temperatures should result in more rapid development of eggs and earlier emergence of fry. This allows some growth prior to winter and presumably better survival.

Past reports have indicated that some scattered steelhead spawning occurs in Johanson Creek (Appendix Table 1 - 1972 and 1986 observations) and the possibility of some spawning in upwelling areas along the northern portion of Sustut Lake.

A second area was identified as a potentially important steelhead spawning location during 1992. Numerous newly-emerged steelhead fry were observed in the lower 800 m of a tributary stream to

Johanson Creek during juvenile surveys in September. It was estimated that approximately 5000 m^2 of excellent spawning gravels were present in this system located approximately 1.5 km downstream from the Johanson Lake outlet (Figure 3).

A number of areas that were thought to provide suitable spawning areas for steelhead may, in fact, be of minor importance. These include the following:

1.) Sustut Lake outlet stream - a short riffle section immediately downstream of the lake. No fish observed during the June flight in 1992 or in 1987 (G. Schultze, MOE, pers. comm.).

2.) Small lake-headed inlet to Sustut River just downstream of Mud Lake (Figure 4) - no fry captured in September. Excellent gravel sections in lower end.

3.) Outlet of Mud Lake - no fry captured in sample area. Poor bed material. An area located 1.5 km downstream from Mud Lake (Figure 4) has suitable bed material and was used by chinook spawners. This section may be used by spawning steelhead. Juvenile surveys in 1992 (Bustard 1993) indicate some steelhead spawning must occur in the upper reach of the Sustut based on steelhead fry captured at a site 1 km downstream.

4.) Johanson Lake outlet - No adults observed in short riffle section between large and small lake during June flight in 1992 or in 1987 (G. Schultze, MOE, pers. comm.). No adults observed in 600 m section downstream of Johanson Lake during snorkelling in June. Possible steelhead fry captured in outlet areas during late August. Several steelhead were observed approximately 1 km below Johanson Lake on the June 6, 1987 flight (G. Schultze, MOE, pers. comm.).

5.) Darb Creek - No adults observed in June flight. No steelhead fry in sample site in September (Bustard 1993).

There is still considerable uncertainty associated with the specific locations used by steelhead spawners in the upper Sustut. It should be emphasized that the lack of spawner and newly-emerged fry observations in some of these sites that appear to offer suitable spawning habitat may reflect incomplete observations during critical periods or depressed spawner numbers rather than lack of suitability of the habitat.

4.0 CONCLUSIONS

4.1 Steelhead Population Estimates

In 1992, it was estimated that 487 steelhead were present in the upper Sustut River (Table 8). Data from two other years can be used to provide some comparison of the strength of the 1992 steelhead run to other years.

For example, Spence et al. (1986) conducted mark-recapture studies in the fall of 1986, a year of unusually strong steelhead escapement throughout the Skeena watershed (Bob Hooton, MOE, pers. comm.). Their estimates indicated approximately 800 steelhead were present in the upper river.

As a second comparison, MOE staff sighted 20 steelhead in the upper Sustut River from the Junction Pool to White Rock (Location 3 in Figure 2) during snorkel surveys on September 25, 1991 (Data on file, MOE, Smithers). The 1991 steelhead run was the second weakest of the 36 year's of test fishery records on the lower Skeena. Very poor guided angler catches verify the dismal returns in 1991 (Data on file, MOE, Smithers). During the 1992 snorkel surveys, between 75 and 78 steelhead were seen in this same section on September 28 and September 22 respectively (Appendix Table 4).

These comparisons suggest that the steehead run in 1992 was relatively strong compared to a year of poor returns such as 1991, but not as good as a very strong year such as 1986. It should be emphasized that the comparisons are limited since the method of estimating steelhead numbers were different in 1986 than 1992. Similarly, the 1991 observations were conducted in a short section of the river where holding patterns may vary considerably from year-to-year. For example, during the 1986 surveys, White Rock Pool provided the best holding water for steelhead (R. Tetreau, MOE, pers. comm.). During the 1992 surveys, many of the steelhead held in the Grizzly Run. It should be recognized that all of these estimates have been conducted in the past decade, and do not necessarily provide a benchmark of historical or potential steelhead use in this river.

The snorkel surveys provided an excellent method of assessing steelhead numbers in the upper Sustut River during the clear low-flow conditions that persisted during the late summer of 1992. The program of marking fish arriving at the lower end of the study area and observing the ratio of marked to unmarked fish in the main holding area provided good estimates of fish abundance. During some snorkel surveys up to 90% of the marked fish were observed. With higher flow conditions and reduced visibility in late September, snorkelling was a less reliable method of obtaining an

accurate estimate of fish numbers, particularly in the deep pools downstream from Moosevale Creek.

The presence of the fence on the Sustut River, in combination with the radio telemetry studies were effective monitors of whether or not the steelhead were leaving the study area. However, the Native fishing within the study area and the lack of Native cooperation in returning catch and tag information, adds some potential error to the estimates, since the number of marked fish in the population may have been less than assumed.

The results of the study suggest that aerial observations of steelhead in key locations such as the outlets of Sustut and Johanson lakes are useful indicators of whether or not fish are present in these areas, but in most instances, probably do not give accurate estimates of total numbers of fish. During this study, these key outlet areas were examined on a number of occasions (Appendix Table 10) including periods in late September when significant steelhead movements had occurred into the top ends of the systems. For example on September 22, 54 steelhead had been passed through the fence, but only 2 steelhead were observed in the lake outlet system. Again, on September 27, 150 steelhead had been passed through the fence and were not present in the Hotel Pool just upstream. However, only 8-10 steelhead were observed at the inlet to Mud Lake despite an extensive aerial search of the key holding areas. Visibility in the lake inlet and outlet areas was considered excellent. On October 23, approximately 50 steelhead were observed in the Sustut Lake outlet pool. Since all of the Sustut Lake radio fish were in this pool at this time, it is assumed that most of the over 300 fish overwintering in Sustut Lake would have been at this location on this date. It should be noted that the October helicopter observations were limited since observers did not want to disturb the area before conducting sampling.

The radio telemetry data also suggests that some steelhead move into the main lakes for a period of time in September and early October before dropping back into the outlet areas by late October.

Spence et al. (1990) report that "groups of up to 250 fish were observed by project staff in pools at the outlets of these lakes (Johanson and Sustut) during the late fall". Their tagging studies were conducted during the first week of October, indicating that during a year of high steelhead escapements (1986), large numbers of steelhead were visible in the lake outlets in early October.

4.2 Steelhead Migration and Holding Patterns

The first steelhead arrived in the upper Sustut River in early August and a small number were already present in the river by the time studies were initiated on August 10. Steelhead numbers continued to increase through late August and into early September. Snorkel survey counts indicated that most fish had arrived in the upper river by September 10 (Figure 7).

The recovery of steelhead that had been tagged in the lower Skeena and adjacent commercial fishing areas (Table 5) in conjunction with back calculating time of arrival of most steelhead in the upper Sustut using travel time estimates from the tagging results (Section 3.3.1) suggests that the majority of Sustut fish are moving through the main portion of the B.C. commercial fishery from early July through early August (Table 5). The lack of orange tags on the first group of fish observed in the river presumably reflects fish moving through the commercial fishery prior to July 20 when most tagging was initiated. It should be stressed that these observations are based on a small number of tag returns.

Since most of the upper Sustut steelhead arrive by early September, the two fishing lodges on the lower Sustut River do not provide a reliable index of the strength of this component of the Sustut steelhead run. Their steelhead fishing starts in early September (Dennis Farnsworth, pers. comm.) after most of the upper river component has passed through. This supports the observations of Spence et al. (1990) who found that only 1 of 387 steelhead tagged in the lower Sustut during September and early October was recaptured in the upper Sustut during early October.

Most of the steelhead observed downstream of the confluence of Johanson Creek held in the 1 km section immediately below the Junction Pool. However, steelhead also held in sections of the Sustut River farther downstream, including areas below Moosevale Creek. For example, on September 10 nearly 12% of the total steelhead observed were located in the river section from Moosevale Creek downstream for 1.5 km (Table 4).

Most steelhead remained in the section of river downstream of Johanson Creek until heavy rains in late September raised streamflow levels substantially. For example, by September 18 approximately 10% of the steelhead that eventually were estimated to enter the Sustut upstream of the Junction, had moved upstream. Only 2 steelhead were observed during the final snorkel survey in mid-October indicating few steelhead remained in the section below the Junction Pool. The greatest movement of fish into the upstream areas occurred during the peak of the first fall freshet when 83 steelhead were passed through the fence on a single day.

During the study there was some concern that the fence was inhibiting steelhead movements into the upper Sustut and that fish might be holding in the downstream section because they didn't want to enter the holding box. While this was a concern and some fish were observed holding below the fence apparently not wanting to enter the holding box, two observations suggested that the fence was probably not the main factor inhibiting fish movements into upstream areas. Firstly, most of those fish that did pass through the fence in late August and early September tended to stay in the river section a short distance upstream of the fence (Hotel Pool) instead of moving upstream to Sustut Lake. Secondly, there was no significant movement of fish into Johanson Creek and Lake at this time based on aerial observations, angling, and lack of radio-tagged fish moving into the system.

The 1992 surveys indicated that during the late September period, steelhead were actively moving upstream, and no one location would have provided a reliable estimate of steelhead numbers in the system. Many of the fish that were in the vicinity of the lakes, were not visible.

The radio-telemetry portion of the studies provides the best information on overwintering areas for upper Sustut steelhead. At the end of the study, nine of the 12 fish that had been tracked from below the Junction Pool were in the upper Sustut and the other three were in Johanson Lake (Table 7). This information confirms that the lake outlet areas are used by overwintering steelhead in the two systems, with an estimated 75% of the upper Sustut steelhead using Sustut Lake and 25% using Johanson Lake. By late October, the fish were very concentrated in the outlet areas with 100% of the radio fish located at two sites.

These observations are very important in that they also indicate where steelhead were not holding. For example, in the past when fish have been observed in the lake outlets, we were left with the nagging question of "how many fish are out in the deeper sections of the lake?". Based on the radio telemetry data collected in 1992 it can be assumed that if the observations are made in late September and early October, then not all of the steelhead will be in the lake outlet areas. For example, in 1992, most of the movements to the lakes from the holding areas below the Junction Pool occurred after September 20. As well, some of the fish moving into the lakes may be out in the deeper sections of the lake where they are not visible. For example, one of four steelhead tracked in Johanson Lake was tracked part way down the lake on September 17, and one of the nine steelhead tracked in Sustut Lake was in the main body of the lake on October 12. But observations during late October suggest that most steelhead are in the lake outlet areas at this time since this is where 100% of the radio-tagged steelhead were located.

Ice was forming on both lakes by the October 12 visit. Water temperatures at the two lake outlets were considerably warmer than downstream locations by the middle of October. For example, the outlet of Johanson Lake was nearly 5°C warmer than 20 km downstream at the confluence of the Sustut, where ice was forming throughout the river. Similarly, the outlet temperatures on Sustut Lake were 5°C compared to 2°C in the Sustut River 5 km downstream (just above Junction Pool) during this period. It is assumed that the lake outlets provide the most moderate overwintering environment for steelhead at this time of year. The river sections below the lakes probably experience extreme ice conditions during cold winters making the lake outlets an attractive overwintering environment for steelhead in high elevation northern interior rivers such as the Sustut.

Spence et al. (1990) identified the outlets of Sustut and Johanson lakes as the primary overwintering habitat for upper Sustut steelhead. They also indicate that steelhead overwinter in Bear Lake farther downstream on the Sustut (Figure 1). Lough (1980 and 1981) found steelhead overwintering in McDonell (upper Zymoetz) and Kluayaz (Kluatantan) lakes, indicating the importance of lakes to steelhead overwintering in other Skeena River tributaries.

The summer of 1992 was very dry and streamflows in the upper Sustut were unusually low through August and early September. This leaves the question of whether steelhead would have overwintered in the Sustut River downstream of the Junction if a fall freshet did not occur, or whether fish would have entered the lake earlier in September if flows had been higher earlier. Historical information in Appendix Table 1 suggests that steelhead have moved into the outlet section of Sustut Lake in mid-September during some years (eg., Fennelly observations 1959 & 1963 and Spence et al. (1990)) but are also present in the section of the Sustut River below the Junction Pool in others (eg., observation of 75 steelhead 0.5 km below the Junction Pool on October 22, 1990). Peter Abrahams of Takla Landing indicated that he had netted steelhead in the vicinity of the Junction Pool during the winter.

4.3 Native Fishery

Observations during 1992 indicate that Native fishing in the upper Sustut occurs throughout the month of August. Although accurate counts were not possible, it was estimated that between 30 and 50 steelhead were taken in this fishery. The main holding section of the Sustut River is easily accessible from the Omineca Mining Road that passes within 150 m of the Junction Pool. Natives were targetting on steelhead during some of their fishing and the large numbers of people from a number of different locations suggests that steelhead holding in the upper Sustut are very vulnerable to serious exploitation by what amounts to an unregulated and illegal

fishery using drifting gillnets. Discussions with locals at Germansen Landing indicate that the amount of traffic heading to fish in the upper Sustut increased substantially in 1992 over past years.

Our observations suggest that between 5 and 10% of the steelhead in the river were taken in the Native fishery. While this represents a relatively small proportion of the fish present in 1992, it could be a serious conservation concern during years of low escapement or when sockeye and chinook numbers are low and greater effort is directed towards steelhead. It is probable that fishing effort and catch would have been higher in the absence of the fisheries agencies' presence during 1992.

4.4 Steelhead Spawning Areas and Habitat Protection Considerations

A review of potential spawning areas for the upper Sustut River steelhead indicated that extensive gravel areas are available in what may be the main spawning area in the vicinity of the Junction Pool and downstream. Other potential spawning areas in the upper system have not been well evaluated and need specific studies during the spawning period to identify whether or not they are used. A small tributary downstream of the Johanson Lake outlet may be an important spawning area in the Johanson system, based on newly-emerged steelhead fry observed in September.

Identification of specific spawning locations is necessary for effective habitat protection related to road construction in the upper Sustut. For example, during the spring of 1992, a bridge located on the Johanson Creek tributary identified as possibly the main spawning creek was replaced with two metal culverts. It is expected, that with time, these culverts will pose passage difficulties for fish moving upstream in this tributary, and may affect gravel recruitment to downstream areas. As well, a new access corridor downstream of Moosevale Creek associated with a mine development in the area could create access to important steelhead holding areas located in the 2 km section of river immediately downstream of Moosevale Creek.

The existing location of the Omineca Mining Road in the vicinity of the Junction Pool is a classic example of the problems associated with the development of road access close to a critical holding and spawning area for steelhead and salmon in a remote location. In addition to uncontrolled fishing in a "closed area" that has been created by this easy access, it is estimated that a population of more than 10 grizzly bears was present on this 5 km of river adjacent the road from mid-August to mid-September. These bears are very vulnerable to poaching and interaction problems associated with heavy human fishing activity at the same locations as the bears use traditionally.

5.0 RECOMMENDATIONS

1.) It is recommended that the upper Sustut River continue to be used as an index system for early-run upper Skeena summer steelhead stocks. The system is well-suited to serve as an index stream because of its relatively small size, stability and excellent water clarity in a section of the river where fish tend to hold during September. It should be expected that there is annual variability in the migration behavior of upper Sustut steelhead, and that there is no simple methodolgy of determining fish numbers in the system by conducting a "snapshot" survey.

Our studies suggest that a combination of snorkel surveys and fence counts should provide a reliable means of estimating numbers in the upper river system. The snorkel surveys should be conducted in conjunction with marking studies to calibrate the estimates. Timing and location of the surveys is important. Based on the 1992 observations, an effective method of assessing steelhead run strength in the upper Sustut would be to conduct a snorkel survey around September 10 from just upstream of the Junction Pool (Hotel Pool) on the Sustut to 2 km downstream of the Moosevale confluence. After this date there is a higher risk of fish moving out of the main holding area depending upon streamflows. At the same time as the snorkel surveys, the outlets of Sustut and Johanson lakes should be examined for the presence of fish.

Maintaining a fish counting fence on the upper Sustut River complements the snorkel surveys in providing an effective means of determining steelhead numbers. The system is small enough that a fence can be maintained under most streamflow conditions in the fall.

Several disadvantages of using the upper Sustut include the relative remoteness of the area and safety concerns for any crews conducting surveys due to high numbers of grizzly bears feeding on salmon spawners in the index area during the best time for surveys.

2.) The extent and nature of the Native fishery that occurred in the upper Sustut in 1992 is cause for alarm. Steelhead are being taken in this fishery, and during low escapement years or if the trend of increasing effort continues, the upper Sustut steelhead run along with salmon stocks is threatened. It is recommended that discussions with Native groups involved in this fishery be initiated as quickly as possible to educate the parties concerned re the risk to these fish from uncontrolled harvest and to come up with a management plan for

this area. An enforcement presence combining salmon and steelhead concerns, should be undertaken during the month of August and early September.

3.) It is recommended that a follow-up evaluation of steelhead spawning areas be conducted during the spring of 1993. The presence of radio-tagged steelhead and a known escapement of steelhead to the upper system provides an excellent opportunity to identify spawning locations in the Sustut River and Johanson Creek. These studies may identify critical habitats for steelhead in the system, potential enhancement opportunities and habitat protection needs. As well, conducting juvenile surveys at steelhead index sites in the fall of 1993 would help to calibrate fry densities related to a known number of steelhead spawners.

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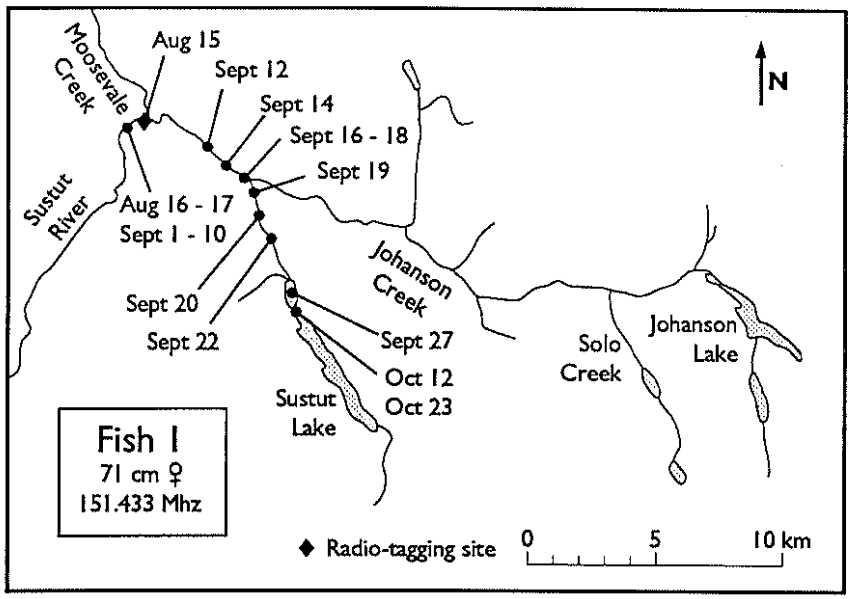
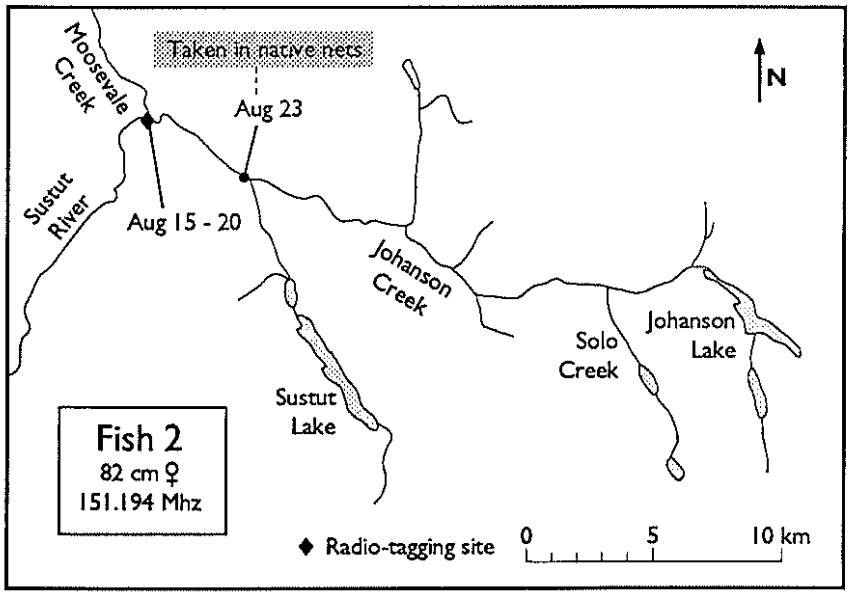
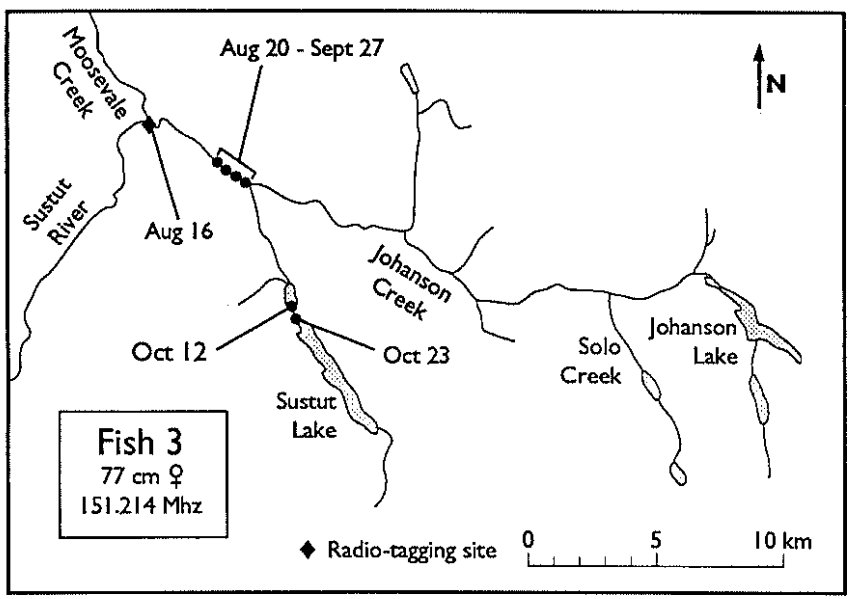
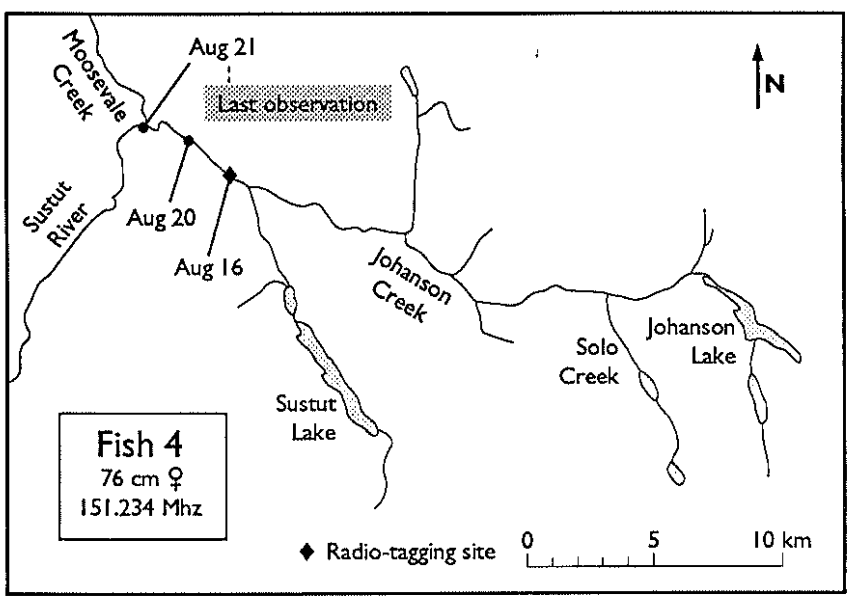
Appendix Figure 1. Steelhead Tagging Data for Upper Sustut River, 1992.

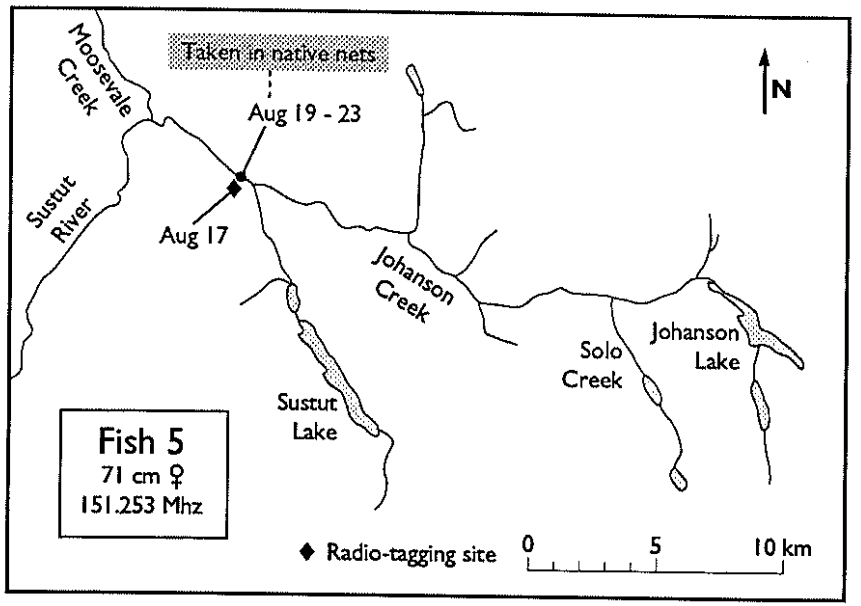


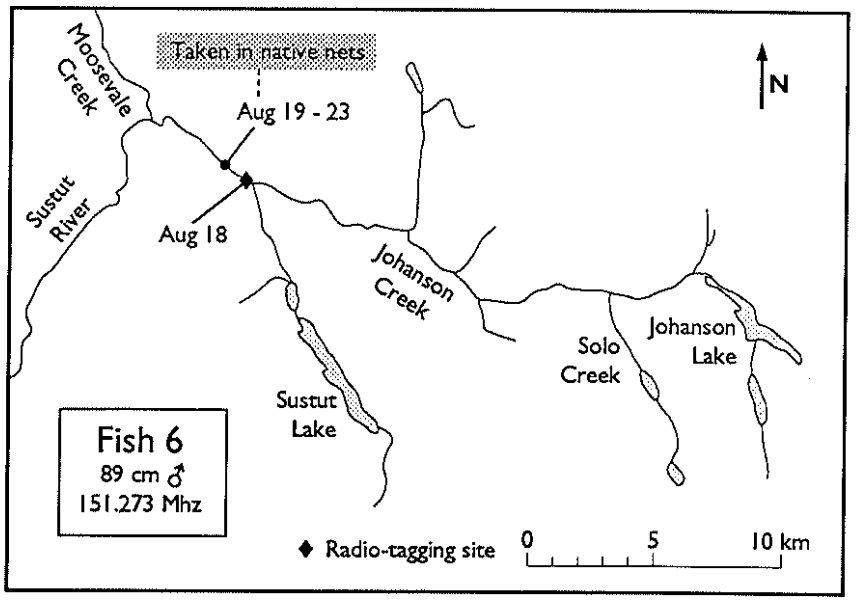


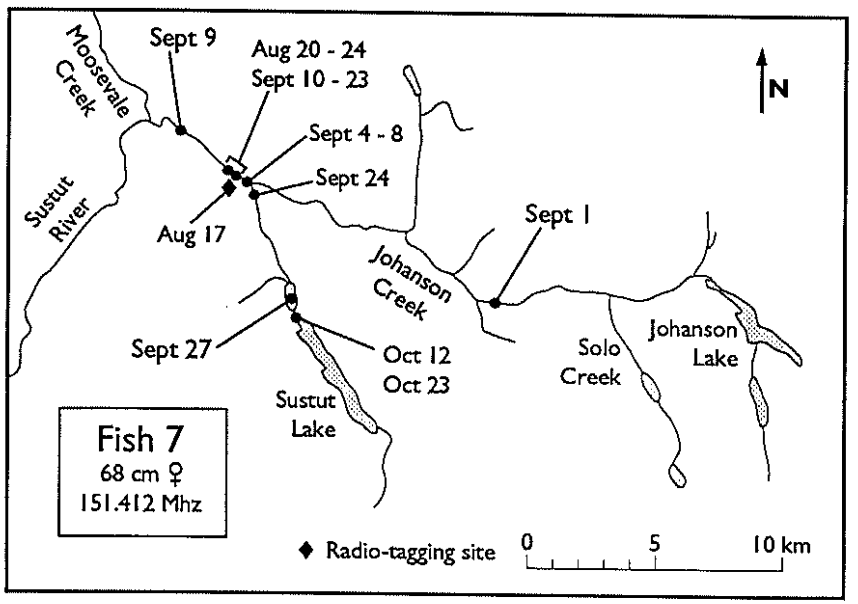


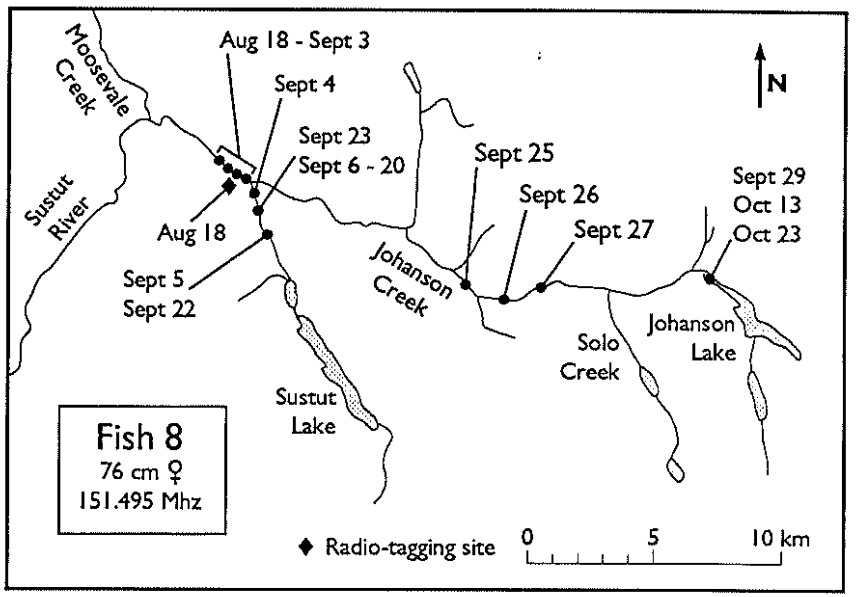


Appendix Figure 1. Steelhead Tracking Data for Upper Sustut River, 1992.

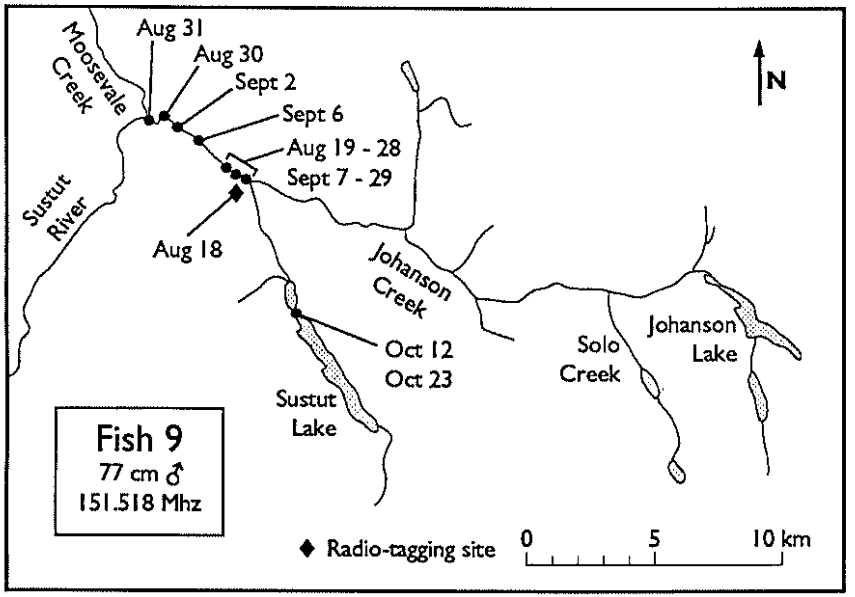


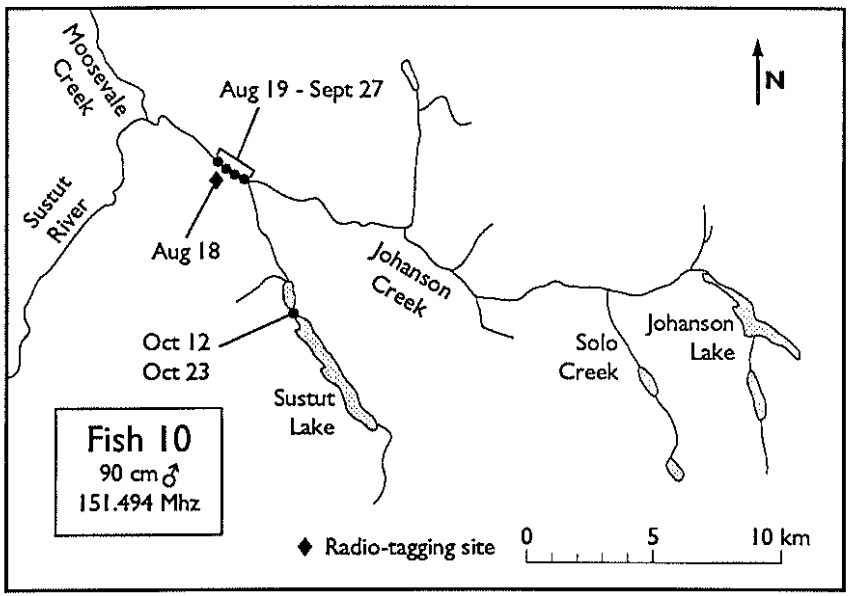


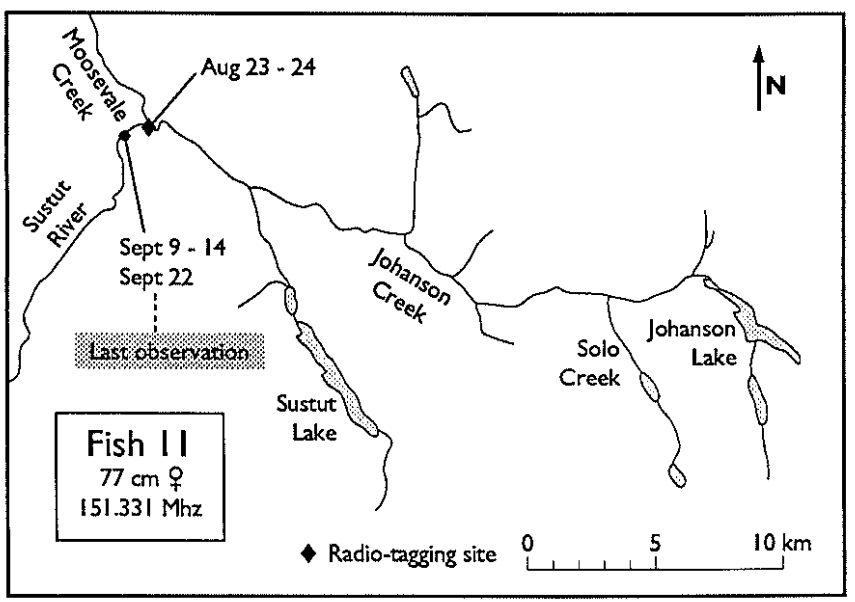


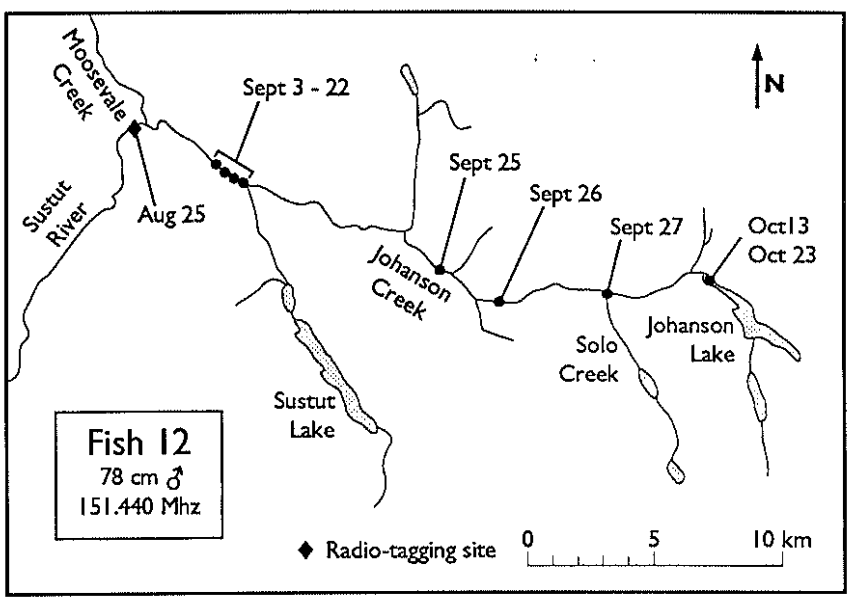


Appendix Figure 1 (continued). Steelhead Tracking Data for Upper Sustut River, 1992.

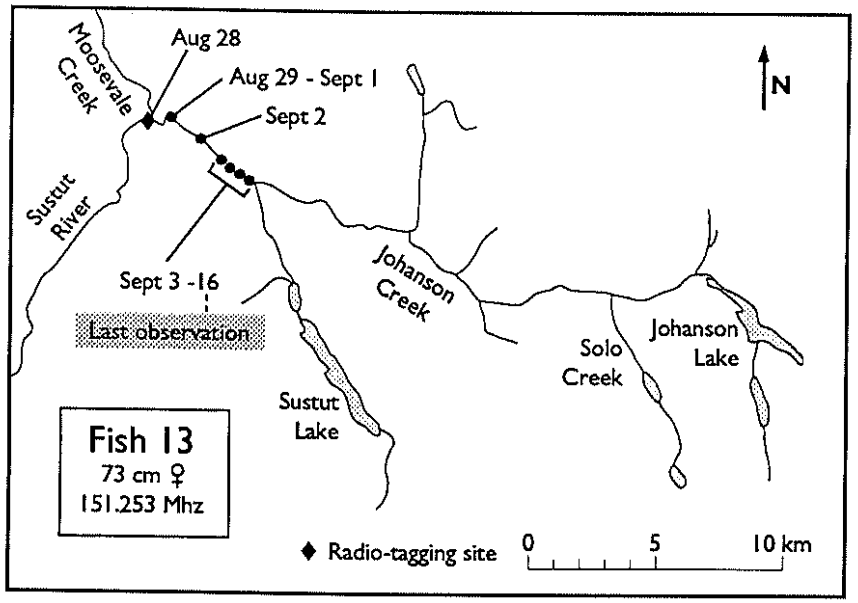


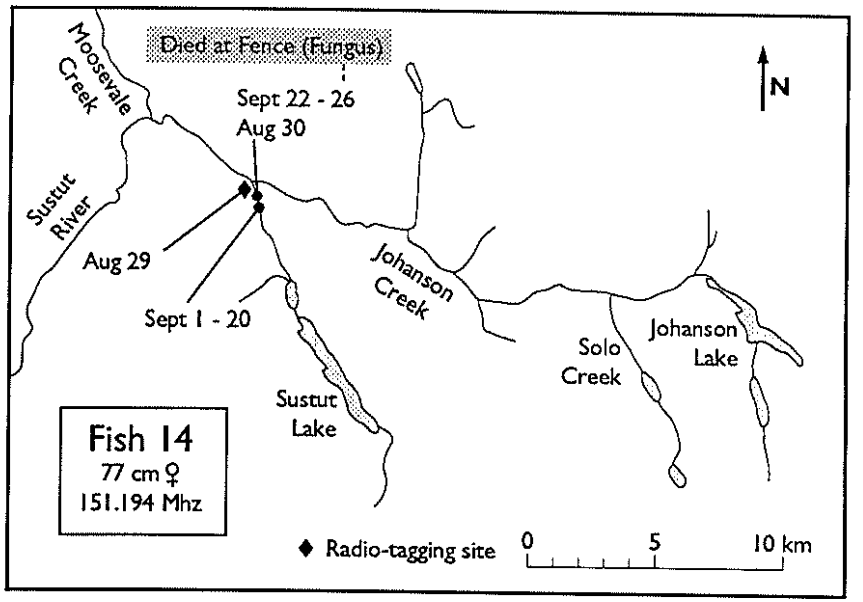


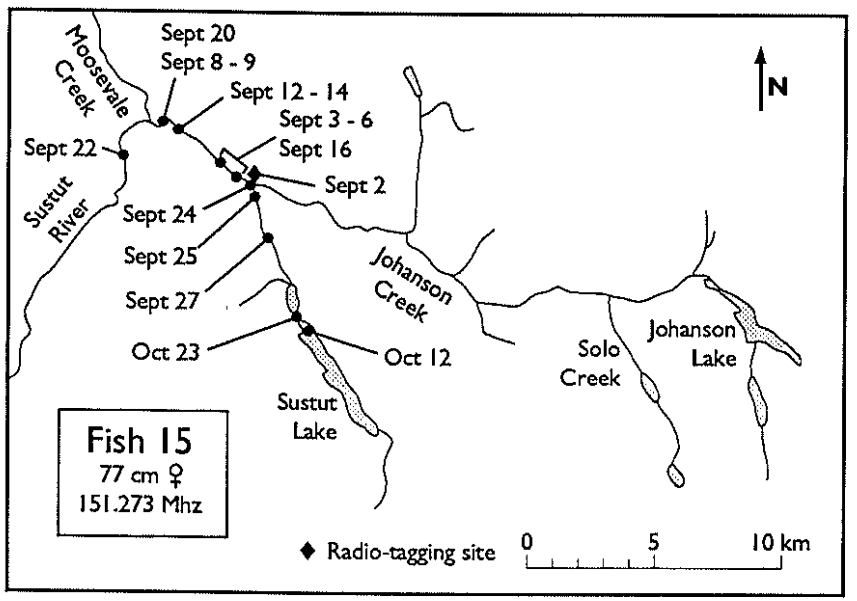


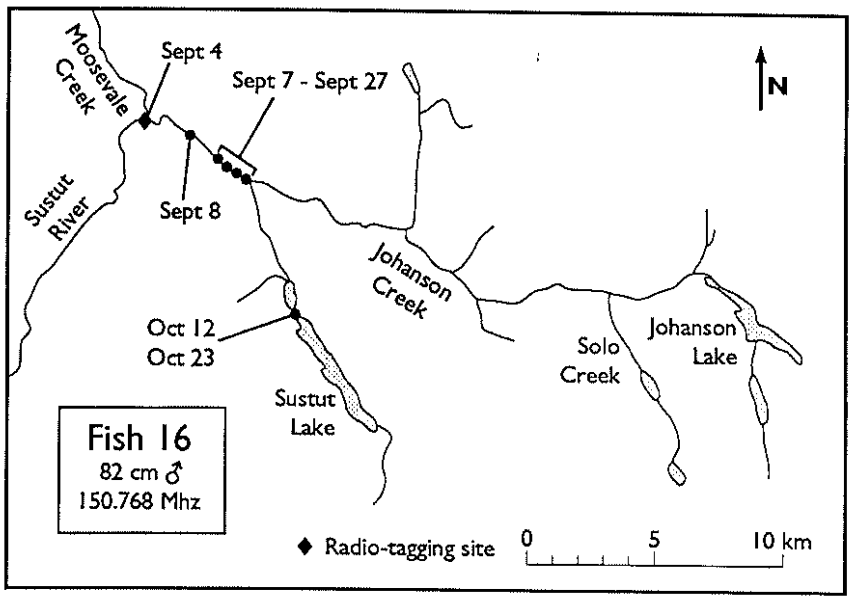


Appendix Figure 1 (continued). Steelhead Tracking Data for Upper Sustut River, 1992.

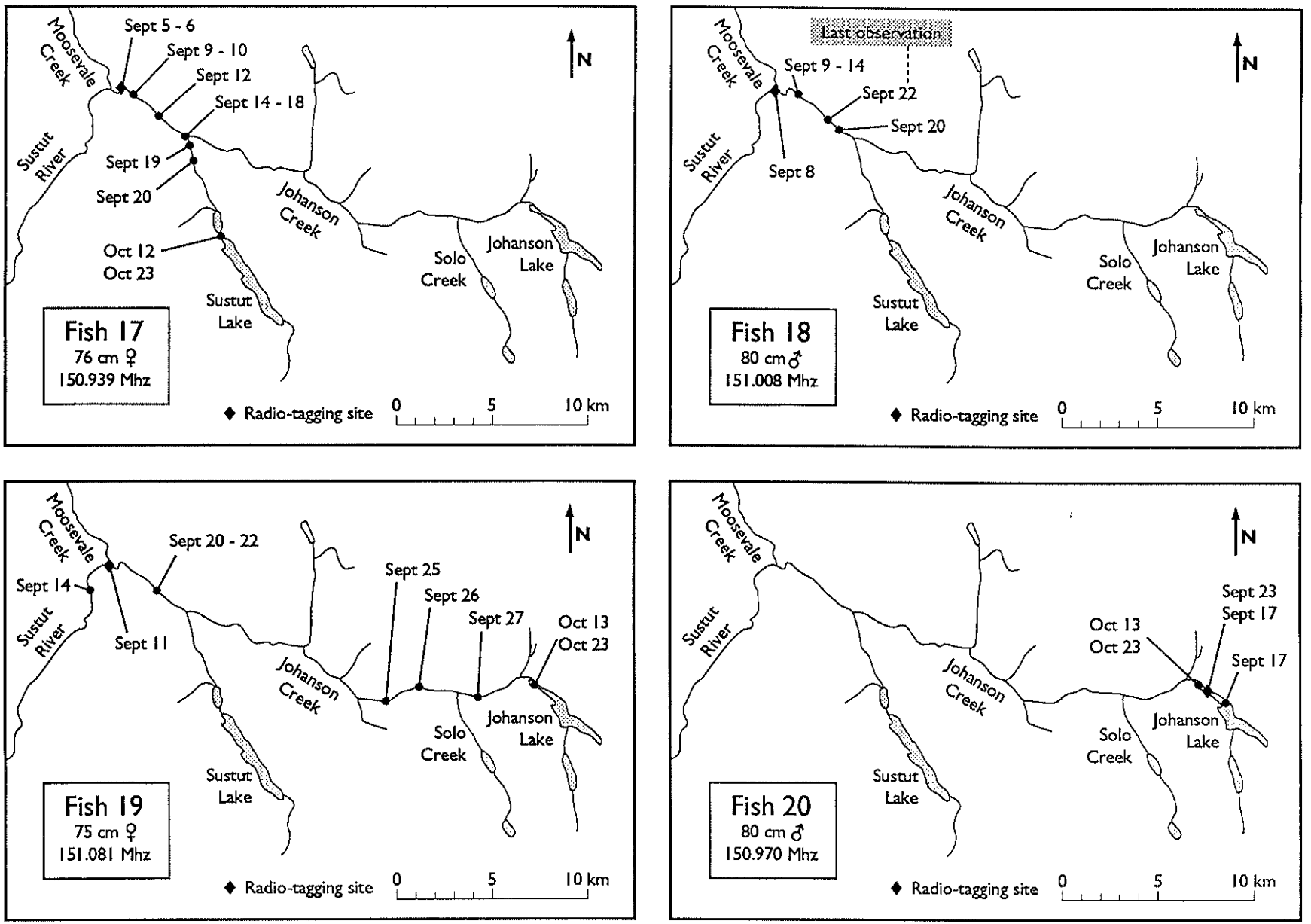




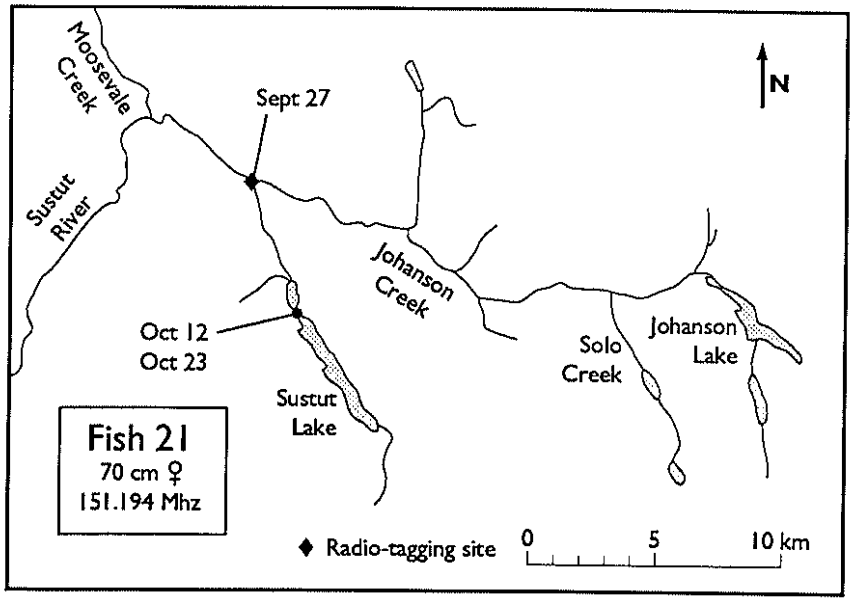




Appendix Figure 1 (continued). Steelhead Tracking Data for Upper Sustut River, 1992.



Appendix Figure 1 (continued). Steelhead Tracking Data for Upper Sustut River, 1992.



Appendix Figure 1 (continued). Steelhead Tracking Data for Upper Sustut River, 1992.

Appendix Table 1. Summary of Miscellaneous Observations of Steelhead in the Upper Sustut River from Past Years.

YEAR	DATE	SOURCE[1]	COMENTS
1959	Sept 12 to Sept 27	Fennelly (1963)[2]	River section above Mud Lake packed with steelhead during entire stay. "Fresh fish moving up daily to replace fish moving into main body of lake". Most fish were congregated in 2 large pools. Lots of fish in Junction Pool and downstream.
	Sept 19		Flew over to Johanson - large numbers of steelhead cruising around the bay. Fishing mainly in bay. 1 fish at thermograph pool. Total catch for stay - 100 steelhead
1963	Sept 5 to 19		Relatively few fish in section below Sustut Lake during early portion of trip
	Sept 8		Junction Pool 25-30 fish Lots of fish down to Big Rock Fish had left Junction Pool by September 14 after four days of rain and fishing.
	Sept 12-15		Dates given by Fiorini for arrival of steelhead to Sustut Lake outlet pools.
			In 1963 large numbers of fish arrived in this section between Sept 8 and 14th
			Total catch for 2 weeks - 64 steelhead for 2 anglers.
1970	Aug 31	Hawthorne	Steelhead (?) observed holding in lower portion of Sustut Lake (widening of the river)
1972	June 19	Chudyk	4 fish observed 4 miles below Johanson Lake and the confluence of Solo Creek 70 steelhead obs. just upstream of Junction Pool in Sustut

[1] Unless noted as reports, all observations are from file notes located at the Ministry of Environment, Smithers.

[2] Mr. Fennelly's detailed observations paying particular attention to timing and location make his book **Steelhead Paradise** an important source of information describing steelhead in the upper Susut River and the Sustut and Johanson lakes area. For that reason, they are included in this summary.

1975	mid-Oct	Whately (letter to Clarke)	30-50 steelhead observed in the upper Sustut (source?).
1976	Oct 14	Chudyk	Large school of fish at cabin area (40-60). Second group in Mud Lake (8). Angled and confirmed steelhead. Angled at Junction Pool - no fish.
1977	Oct 4	Chudyk	Angled 17 steelhead in pools in river section between Sustut Lake outlet and Mud Lake. Observed 6 steelhead in Junction Pool
1979	Sept 17	Whately (letter to Pearce)	Two anglers had landed steelhead in the river section between Sustut and Mud lakes.
1983	Sept 14 to Oct 9	Shultze (1984) report	12 steelhead in Johanson outlet 1 in Johanson Creek 12 below Junction Pool No fish observed in Sustut Lake
1986	Sept 27 to Oct 4	Lough (1986) report	Tagged 187 steelhead in upper river. All fish were tagged in the vicinity of the Junction Pool (to 1 km downstream) or in the lake outlets. Population estimates of approx 800. 250 steelhead observed in vicinity of Junction.
1987	June 6		Active spawning observed in Johanson Creek and the Sustut River above Junction. One radio fish located in Sustut Lake and some spawning may occur in springs along northern portion of lake(?)
1990	Sept 5	Shirvell[3]	63 steelhead observed from Junction Pool to a location 450 m downstream (snorkelling)
	Oct 22	Spence	Johanson Lake outlet obscured by ice. No fish observed from lake to Junction. No steelhead observed in Sustut Lake outlet area. 75 steelhead observed 0.5 km below Junction Pool (snorkel)

[3] Monthly report for September 1990, Pacific Biological Station

1991	Aug 14 to 21	Shirvell[4]	Steelhead began arriving in low numbers at the Junction Pool during August 14-21. 1 to 4 steelhead observed daily during snorkelling in Junction Pool.
	Sept 30 to Oct 7		Observed 20 steelhead in the Junction Pool on Sept. 30 and at least 10 more during the first week of October.
	Sept 25	Jeff Lough	2 steelhead observed at Sustut Lake outlet and 2 steelhead observed in Johanson Lake outlet. 10 fish observed 4 miles below Johanson Lake. 20 steelhead observed from Junction to White Rock Pool while snorkelling plus 2 more seen from the air. 3 observed in pool just upstream from Moosevale
1992	May 21	Spence	Aerial reconnaissance of upper Sustut - 3 steelhead observed just upstream of Moosevale - but too early for spawning in system

[4] Monthly reports for August and September 1991, Pacific Biological Station

Appendix Table 2. Upper Sustut River Water Temperature Measurements (C).

File = APPEND2

JULIAN	DATE	SUSTUT AT FENCE MIN	SUSTUT AT FENCE MAX	SUSTUT AT FENCE MEAN	JOHANSON @ LAKE MIN	JOHANSON @ LAKE MAX	JOHANSON @ LAKE MEAN	JOH @ JUNCTION MIN	SUSTUT @ MOOSEVALE* MIN	SUSTUT @ MOOSEVALE* MAX	SUSTUT @ MOOSEVALE* MEAN
152	JUNE 1										
153	2										
154	3										
155	4										
156	5										
157	6										
158	7										
159	8										
160	JUNE 9		6.1			6.0	6.0				6.4
161	10	3.8	6.5	5.2	5.5	6.0	5.8				
162	11	4.0	7.5	5.8	5.4	6.0	5.7				
163	12	3.9	7.3	5.6	5.2	5.9	5.6				
164	13	4.0	7.2	5.6	5.5	6.1	5.8				
165	14	4.0	7.7	5.9	6.0	6.5	6.3				
166	15	4.1	8.0	6.1	6.1	7.0	6.6				
167	16	5.0	7.5	6.3	6.0	6.5	6.3				
168	17	5.0	8.6	6.8	5.8	6.2	6.0				
169	18				5.9	6.5	6.2				
170	19				6.2	7.0	6.6				
171	20				7.0	7.9	7.5				
172	21				7.8	8.4	8.1				
173	22				7.7	8.0	7.9				
174	23				7.8	8.9	8.4				
175	24				8.0	9.3	8.7				
176	25				9.0	10.8	9.9				
177	26				9.9	10.6	10.3				
178	27				9.0	11.0	10.0				
179	28				11.0	12.1	11.6				
180	29				12.0	12.8	12.4				
181	30				12.0	12.9	12.5				
182	JULY 1				11.9	12.3	12.1				
183	2				12.2	12.4	12.3				
184	3				12.5	12.9	12.7				
185	4				12.2	13.0	12.6				
186	5				12.3	12.9	12.6				
187	6				11.8	12.2	12.0				
188	7	11.0	14.5	12.8	11.0	11.9	11.5	8.0			
189	JULY 8	9.0	12.5	10.8	11.0	11.0	11.0	7.5			
190	9	10.0	13.5	11.8	11.0	11.8	11.4	8.0	9.5		
191	10	10.5	14	12.3	11.2	12.1	11.7	8.0	10.0		
192	11	11.0	14.5	12.8	11.8	12.4	12.1	8.0	10.0		
193	12	12.0	15.5	13.8	12.0	12.8	12.4	9.0	11.0		
194	13	11.0	14.5	12.8	11.5	12.6	12.1	8.0	10.5		
195	14	11.0	14.5	12.8	11.0	11.4	11.2	7.0	9.5		
196	15	11.5	15	13.3	10.8	11.8	11.3	6.5	9.0		
197	16	12.5	16	14.3	11.5	12.2	11.9	8.0	10.0		
198	17	12.0	15.5	13.8	11.7	12.0	11.9	7.0	9.0		
199	18	11.0	14.5	12.8	11.5	12.0	11.8	7.0	9.5		
200	19	13.0	16.5	14.8	11.0	12.2	11.6	8.5	10.0		
201	JULY 20	13.0	16.5	14.8	13.0	14.2	13.6	8.5	10.0		
202	21	12.5	16	14.3	13.8	14.7	14.3	8.5	10.0		
203	22		16		13.0	14.1	13.6	9.5	11.0		
204	23	14.0			13.0	14.1	13.6	9.0	10.5		
205	24	13.0	16.5	14.8	13.2	14.0	13.6	8.0	10.0		
206	25	11.0	14.5	12.8	13.7	14.0	13.9	10.0	9.0		
207	26	12.0	15.5	13.8	13.5	14.0	13.8	9.0	10.0		
208	27	12.0	15.5	13.8	13.2	13.9	13.6	9.0	10.0		
209	28	13.0	16.5	14.8	13.0	13.8	13.4	9.0	10.0		
210	29	12.0	15.5	13.8	13.0	14.0	13.5	8.0	10.0		12.0
211	30	10.5	14	12.3	13.0	14.0	13.5	7.5	8.5		
212	31	11.0	14.5	12.8	13.0	14.1	13.6	7.0	9.0		
213	AUG 1	12.0	15.8	13.9	13.5	14.8	14.2	8.0	10.0		

Appendix Table 2 (cont'd). Upper Sustut River Water Temperature Measurements (C).

JULIAN	DATE	SUSTUT AT FENCE MIN	SUSTUT AT FENCE MAX	SUSTUT AT FENCE MEAN	JOHANSON @ LAKE MIN	JOHANSON @ LAKE MAX	JOHANSON @ LAKE MEAN	JOH @ JUNCTION MIN	SUSTUT @ MOOSEVALE* MIN	SUSTUT @ MOOSEVALE* MAX	SUSTUT @ MOOSEVALE* MEAN
214	AUG 2	13.0	16.8	14.9	14.0	15.3	14.7	10.0	11.0		
215	3	13.0	16.8	14.9	14.0	14.9	14.5	10.0	11.0		
216	4	12.0	15.8	13.9	14.0	15.2	14.6	9.0	10.0	14.5	
217	5	10.0	13.8	11.9	14.3	15.2	14.8	8.0	9.5	15.0	
218	6	13.0	16.8	14.9	14.8	15.0	14.9	10.5	12.0	12.0	
219	7	12.0	15.8	13.9	14.0	14.7	14.4	9.0	10.0		
220	8	11.0	14.8	12.9	14.0	13.8	13.9	7.5	9.0	11.0	
221	9	10.5	14.3	12.4	13.4	13.9	13.7	8.0	9.0	11.0	
222	10	10.0	13.8	11.9	13.1	14.5	13.8	7.0	9.5	13.0	
223	11	12.5	16.3	14.4	13.5	14.3	13.9	9.0	11.0	14.5	12.2
224	12	11.5	16.5	14.0	14.0	15.0	14.5	10.0	11.0	15.0	
225	13	10.5	15.5	13.0	14.0	15.0	14.5	9.5	10.5		
226	14	10.5	14.0	12.3	14.1	14.7	14.4	9.0	11.0		
227	15	9.5	12.1	10.8	14.1	13.9	14.0	8.0	8.8		
228	16	9.2	12.1	10.7	13.8	14.1	14.0	8.0	8.5		
229	17	10.9	15.5	13.2	13.4	14.1	13.8	8.0	10.0		
230	18	11.4	14.2	12.8	13.2	14.0	13.6	7.5	9.5		
231	19	9.4	13.9	11.7	13.0	13.6	13.3	6.0	7.0		10.0
232	20	9.1	13.9	11.5	12.8	13.2	13.0	6.0	6.0	12.0	9.0
233	21	9.8	13.9	11.9	12.4	13.0	12.7	6.0			
234	22	9.1	13.4	11.3	12.1	13.3	12.7	5.0	5.0	13.0	9.0
235	23	7.9	13.9	10.9	12.0	13.3	12.7	4.0	4.0	14.0	9.0
236	24	9.1	14.9	12.0	12.1	13.2	12.7	5.5			
237	25	11.9	13.9	12.9	12.6	13.0	12.8	7.5			
238	26	10.9	12.4	11.7	12.1	12.8	12.5	7.5			
239	27	8.9	10.7	9.8	11.8	12.0	11.9	5.0	6.0	14.0	10.0
240	28	6.9	11.9	9.4	11.2	12.2	11.7	3.5	4.0	11.0	7.5
241	29	7.9	10.4	9.2	11.3	12.0	11.7	5.0			
242	30	8.9	10.9	9.9	11.1	11.5	11.3	7.0	5.0	11.0	8.0
243	31	9.9	10.9	10.4	11.0	11.2	11.1	7.0	7.0	10.0	8.5
244	SEPT 1	8.9	11.7	10.3	10.9	11.6	11.3	6.5	6.0	12.0	9.0
245	2	9.0	11.4	10.2	10.9	11.2	11.1	7.0	6.0	11.0	8.5
246	3	7.4	10.5	9.0	10.6	11.0	10.8	4.0			
247	4	7.0	8.9	8.0	9.8	10.5	10.2	4.0	4.0	10.0	7.0
248	5	5.0	7.7	6.4	9.8	10.1	10.0	3.5	3.0	8.0	5.5
249	6	4.2	7.1	5.7	9.2	9.9	9.6	3.5	3.0	7.0	5.0
250	7	5.8	7.0	6.4	9.0	9.7	9.4	4.0			
251	SEPT 8	4.6	7.5	6.1	9.0	9.1	9.1	3.5	3.0	8.0	5.5
252	9	6.0	7.5	6.8	9.0	9.2	9.1	5.5			
253	10	5.6	8.2	6.9	8.9	9.0	9.0		4.0	9.0	6.5
254	11	5.9	7.6	6.8	8.8	9.0	8.9				
255	12	4.9	6.1	5.5	8.1	8.6	8.4		3.0	9.0	6.0
256	13	3.1	4.8	4.0	7.9	8.1	8.0		2.0	6.0	4.0
257	14	1.0	4.5	2.8	7.5	8.0	7.8		1.0	5.0	3.0
258	15	1.0	3.8	2.4	7.0	7.5	7.3				
259	16	2.0	3.5	2.8	6.6	7.0	6.8				
260	17	1.2	4.1	2.7	6.4	7.0	6.7				
261	18	2.4	5.2	3.8	6.9	7.1	7.0		0.0	5.0	2.5
262	19	4.1	7.5	5.8	7.1	7.3	7.2		3.0	6.0	4.5
263	20	4.3	5.7	5.0	6.9	7.1	7.0				
264	21	5.0	6.0	5.5	6.9	7.0	7.0				
265	22	4.9	6.6	5.8	7.0	7.0	7.0		2.5	6.0	4.3
266	23	6.1	7.2	6.7	7.0	7.2	7.1		3.0	6.0	4.5
267	24	5.9	6.7	6.3	7.1	7.2	7.2				
268	25	5.0	5.9	5.5	7.0	7.0	7.0				
269	26	4.0	5.0	4.5	6.5	7.0	6.8		2.0	5.0	3.5
270	27	3.9	4.8	4.4	6.5	7.0	6.8				
271	28	3.0	4.1	3.6	6.1	6.5	6.3				
272	29	4.0	4.9	4.5	6.1	6.2	6.2				
273	30	4.0	5.1	4.6	6.0	6.3	6.2				
274	OCT 1	3.1	5.2	4.2	6.0	6.1	6.1				
275	2	5.0	6.5	5.8	6.1	6.3	6.2				
276	3	4.9	5.6	5.3	6.0	6.2	6.1				
277	4	3.8	4.3	4.1	6.0	6.0	6.0				

Appendix Table 2 (cont'd). Upper Sustut River Water Temperature Measurements (C).

JULIAN	DATE	SUSTUT AT FENCE MIN	SUSTUT AT FENCE MAX	SUSTUT AT FENCE MEAN	JOHANSON @ LAKE MIN	JOHANSON @ LAKE MAX	JOHANSON @ LAKE MEAN	JOH @ JUNCTION MIN	SUSTUT @ MOOSEVALE* MIN	SUSTUT @ MOOSEVALE* MAX	SUSTUT @ MOOSEVALE* MEAN
278	OCT 5	3.0	4.1	3.6	5.9	6.0	6.0				
279	6	2.0	4.0	3.0	5.8	5.9	5.9				
280	7	2.7	4.0	3.4	5.7	5.8	5.8				
281	8	2.2	3.2	2.7	5.2	5.5	5.4				
282	9	2.1	3.1	2.6	5.1	5.2	5.2				
283	10	2.2	3.0	2.6	4.9	5.0	5.0				
284	11	1.0	2.0	1.5	4.8	5.0	4.9				
285	12	1.0	3.0	2.0	4.5	4.7	4.6				1.9
286	13				4.1		4.1				
287	14										
288	15										
289	16										
290	17										
291	18										
292	19										
293	20										
294	21										
295	22										
296	23			1.5			1.5	0.5			0.8

* July 8 to August 20th temperatures from DFO measurements at gauge below Junction Pool.

Appendix Table 3. Summary of Steelhead Tagging in the Upper Sustut River in 1992.

TAGGING LOCATION CODES:

100 = FENCE
200 = JOHANSON LAKE
1 = JUNCTION POOL
2 = LONG RUN
3 = WHITEROCK POOL
4 = BLACKBEAR POOL
5 = GRIZZLY RUN
6 = CORNER POOL (BIG ROCK)
7 = INSERT RUN
8 = STEELHEAD HEAVEN
9 = SLOW RUN
10 = LOWER FLAT
300 = NATIVE CATCH FROM LOCATION 1 TO 3.
400 = SUSUT LAKE OUTLET
11 = RUN ABOVE SPLIT
12 = CORNER GLIDE
13 = ESKER CURVE
14 = SUSTUT FLATS
15 = MAXMIN CORNER
16 = LONG SECTION
17 = MOOSEVALE CREEK JUNCTION
18 = MIKES MEAT HOLE
19 = SUSTUT CANYON
20 = LOWER CANYON ROCK
LOCATIONS 18–20 ARE DOWNSTREAM OF MOOSEVALE CREEK

TAG COLOUR CODE: WHITE = 1 BLUE = 2 PINK = 3 YELLOW = 4 GREEN = 5 ORANGE = 6

TAG #	COL	DATE M/D	LOC	RADIO FREQ	SEX M=1/F=2	FORK LENGTH (CM)	NET MARKS Y=1/N=2	RECAPTURE LOC	RECAPTURE DATE (M/DAY)	COMMENTS
7124	1	814	1		2	76		100	924	
7125	1	814	1		2	71.5		100	825	
7101	1	815	1		2	69	2			
7102	1	815	18		2	70	2	100	910	
7103	1	815	18	151.194	2	82	2	300	825	NETTED BELOW JX ALSO TAG # 7104
7120	1	815	1	151.433	2	71	2	100	919	ALSO TAG # 7121
7122	1	815	1		2	76				ALSO TAG 7123 – NO RADIO
7105	1	816	17	151.214	2	77	2			ALSO TAG #7106
7107	1	816	17		2	72	2			
7108	1	816	3	151.234	2	76	1			ALSO TAG # 7109
7110	1	817	2	151.253	2	71	1	300	823	ALSO TAG # 7111
7112	1	818	2	151.495	2	76	2	100	904	TRIPLE BEEP ALSO TAG #7113
7114	1	818	3	151.516	1	77	1			ALSO TAG # 7115
7116	1	818	2	151.412	2	68	1	100	924	1 TAG –ALSO TAG #7117
7118	1	818	1	151.273	1	89	2	300	823	NETTED – ALSO TAG # 7119
7126	1	818	5	151.494	1	89.5	2			DOUBLE BEEP ALSO TAG # 7127
7128	1	818	2		2	74	2	5	919	
7129	1	818	2		2	72.5	1			
7131	1	819	17		2	77	1	100	924	
7132	1	819	17		1	78.5	2			SCAR UNDER LEFT JAW
7133	1	819	6		1	73.5	2	300	826	APPROXIMATE CAPTURE DATE – ABRAHAM
7134	1	819	6		2	75	2	100	822	
7135	1	819	6		2	71	2			
7136	1	819	3		2	74	2	100	920	
7138	1	820	7		2	68.5	2	100	924	
1463	2	821	17		2	76	1			
1577	2	821	17		2	74	2			
1578	2	821	17		1	77.5	2	1	907	
1579	2	821	17		2	75.5	1	100	924	
1580	2	821	17		2	78	2	100	901	SCAR ON TAIL
1582	2	822	17		2	74	1			
1583	2	822	17		2	73	2	100	924	
1481	2	823	17	151.331	2	77	2			ALSO TAG # 1482 SCAR ON HEAD
1483	2	823	17		1	75	2	100	925	
1484	2	825	18	151.437	1	78.5	1			ORANGE TAG 05130 ON RIGHT ALSO TAG # 1485
1486	2	825	100	151.253	1	78	2			TAG REGURGITATED 826 ALSO TAG # 1487
1584	2	825	18		2	71	1	100	910	
1488	2	826	17		2	70	2			
1489	2	826	17		2	71	2			
1585	2	827	17	151.253	2	73	2			ALSO TAG #1586
708	3	829	17		2	66	1			ORANGE TAG C00570
1587	2	829	1		1	79	2	300	830	JX POOL
1588	2	829	100	151.194	2	77	2	100	926	MORT AT FENCE: FRESH SCARS ON HEAD TAG #1589

FILE = TAGLIST

Appendix Table 3. Summary of Steelhead Tagging in the Upper Sustut River in 1992 (Cont'd).

TAG #	COL	DATE M/D	LOC	RADIO FREQ	SEX M=1/F=2	FORK LENGTH (CM)	NET MARKS Y=1/N=2	RECAPTURE LOC	RECAPTURE DATE (M/DAY)	COMMENTS
1591	2	829	2		1	78	2	2	830	
1592	2	830	100		2	71	2			
1593	2	830	100		2	72	2			
1594	2	830	2		2	79	1	100	910	ALSO LOC 4 ON 1023 BY MOE
1595	2	831	100		2	72	2			
1490	2	901	100		1	83	2			
1491	2	901	100		2	71	2			SCAR BELOW DORSAL
1492	2	901	100		2	71	2			
1493	2	901	100		1	73	2			
1494	2	901	100		2	76	2			
1495	2	901	100		1	82	1			WHITE SCAR ON HEAD
1496	2	901	100		2	68	2	400	1023	MOE ANGLING
1497	2	901	100		2	68	2			SCAR ON NOSE
1596	2	901	100	151.273	2	77	2	100	901	EATEN BY GRIZZLY ALSO TAG # 1599
1600	2	901	100		2	69	2			
704	3	902	1		1	81	2	1	918	MORT FROM BEARS
705	3	902	1		2	69	2			
706	3	902	1	151.273	2	77	1	100	925	ALSO RECAP AT LOC 15 ON 920 ALSO TAG #707
1498	2	902	1		2	76	2	1	902	HOOKING MORT
1499	2	902	100		2	71	2			
1500	2	902	100		2	68	2			
701	3	904	17	150.768	1	82	1			ALSO TAG # 702
703	3	904	17		1	70	2	15	913	
964	3	905	15	150.939	2	76	1	100	919	ALSO TAG #965
966	3	905	15		1	80	2	100	925	
968	3	907	1		1	84	2			
969	3	908	100		2	74	2			SHORT TAGS AT FENCE AFTER THIS
970	3	908	17	151.008	1	80	1			ALSO TAG # 971
972	3	908	18		1	78	2			BRIGHT
973	3	909	100		1	76	2			
2801	4	909	17		2	73	2			TEETH MARKS AND GASH ON BELLY – SEAL BITE?
2802	4	909	13		2	76	1			
2803	4	909	13		2	70	2	100	924	
2804	4	909	13		2	79	1			
2805	4	909	13		2	79	2			
2806	4	910	100		2	74	1			
2807	4	910	100		1	73	2			
2810	4	910	100		2	73	2			
2811	4	910	100		2	68	1			
2812	4	910	100		2	69	2			
2813	4	910	100		2	77	2			
2814	4	910	100		2	66	2			
2815	4	910	100		2	74	2			
2816	4	910	100		2	75	2			
2817	4	910	100		2	70	1			
2818	4	910	100		2	70	2			
2819	4	910	100		2	70	1			
2820	4	910	100		2	70	2			
2821	4	910	100		2	73	1			
2808	4	911	100		2	71	2			
2822	4	911	17		2	75	2			WHITE MARK ON NOSE AND HOOK LEFT IN FISH
2823	4	911	17	151.081	2	75	2			ALSO TAG # 2824
2835	4	911	17		2	73	2			
2836	4	911	17		1	90.5	2			
2837	4	912	17		1	79.5	2			
2838	4	914	13		2	75	1			
2839	4	914	13		2	74	2	100	924	
2840	4	914	13		1	79	1			
2841	4	914	13		2	70	2			
2842	4	916	100		2	72	2			
991	5	917	200	150.969	1	80	2			ALSO TAG #X00992
993	5	917	200		2	75	2			NOTE: LONG GREEN TAGS
994	5	917	200		1	78	2			FROM 851–1000 ARE
851	5	918	13		2	72	1	5	919	

Appendix Table 3. Summary of Steelhead Tagging in the Upper Sustut River in 1992 (Cont'd).

TAG #	COL	DATE M/D	LOC	RADIO FREQ	SEX M=1/F=2	FORK LENGTH (CM)	NET MARKS Y=1/N=2	RECAPTURE LOC	RECAPTURE DATE (M/DAY)	COMMENTS
995	5	918	13		1	76	2			PREFIXED WITH X00
996	5	918	13		2	72	2			
997	5	918	13		2	74	1			
998	5	918	13		2	70	2	100	924	
852	5	919	3		2	67	2	400	1023	LOC 3 & 5 ON 919: MOE ANGLING
853	5	919	3		2	70	2	100	925	
884	5	919	3		2	73	2	100	924	
885	5	919	3		2	74	1			
1651	5	919	3		1	77	2			SHORT GREEN TAGS
1652	5	919	4		2	74	2	100	924	
1653	5	919	4		2	72	2	5	919	
1654	5	919	5		1	77	2			
1656	5	919	5		2	73	2	100	920	
1657	5	919	5		2	71	1			
1658	5	919	5		2	76	2			BLEEDING?
1659	5	919	5		2	74	2	100	920	
1660	5	919	17		2	73	2			
1661	5	919	17		2	75	2	100	924	
1662	5	919	17		2	70	2	100	924	
1664	5	919	100		2	69	2			
1665	5	919	100		2	67	1			
1666	5	919	100		2	73	2			
1667	5	919	100		2	72	1			
1668	5	919	100		2	70	2	400	1023	MOE ANGLING
1669	5	919	100		2	73	2			
1699	5	919	100		2	69	2			
1700	5	919	100		2	72	2			
1663	5	920	100		2	73	2			
1671	5	920	100		2	74	1			
1672	5	920	100		2	71	2			
1673	5	920	100		2	72	2			
1674	5	920	100		2	71	2			
1675	5	920	100		2	71	2			
1676	5	920	100		2	73	2			
1677	5	920	100		2	71	2			
1678	5	920	17		2	74	2	100	924	
1679	5	920	17		2	75	2	100	925	
1680	5	920	17		2	71	2			
1681	5	920	18		2	74	2			
1683	5	920	100		2	71	2			
1684	5	920	100		2	72	1	400	1023	MOE ANGLING
1685	5	920	100		2	73	2			
1687	5	920	100		2	72	2			SCAR ON SIDE
1688	5	920	100		2	72	1			
1690	5	920	100		2	68	2			
1691	5	920	100		2	76	2			
1692	5	920	100		2	72	2			
1693	5	920	100		2	72	2			
1694	5	920	100		1	71	2			
1695	5	920	100		2	69	2			
1696	5	920	100		2	72	2			
1697	5	920	100		2	65	2			
853	3	922	100		2	67	2			
854	3	922	100		2	69	2			
855	3	922	100		1	74	2			
857	3	922	100		1	69	2			
858	3	922	100		2	68	2			
859	3	923	100		2	67	1			
454	4	924	100		2	72	1			
455	4	924	100		2	70	2			
456	4	924	100		2	73	2			
458	4	924	100		2	72	2	400	1023	MOE ANGLING
459	4	924	100		2	73	1	400	1023	MOE ANGLING. LOST SPAGHETTI TAG @ FENCE
460	4	924	100		2	70	2			

Appendix Table 3. Summary of Steelhead Tagging in the Upper Sustut River in 1992 (Cont'd).

TAG #	COL	DATE M/D	LOC	RADIO FREQ	SEX M=1/F=2	FORK LENGTH (CM)	NET MARKS Y=1/N=2	RECAPTURE LOC	RECAPTURE DATE (M/DAY)	COMMENTS
461	4	924	100		2	71	2			
462	4	924	100		2	74	2			OPERCULUM DAMAGE
463	4	924	100		1	73	1			
464	4	924	100		2	70	2			
465	4	924	100		1	78	2			
466	4	924	100		2	72	1			
467	4	924	100		2	69	1			
468	4	924	100		2	70	2			SCAR ON SIDE
469	4	924	100		2	73	2			
476	4	924	100		2	73	1			
477	4	924	100		2	72	2			
478	4	924	100		1	75	2			
479	4	924	100		1	74	2			
480	4	924	100		1	80	2			
481	4	924	100		2	76	2			
482	4	924	100		2	70	2			
483	4	924	100		2	70	2			
484	4	924	100		2	79	2			
485	4	924	100		2	72	2			
486	4	924	100		2	71	1			
487	4	924	100		2	73	1			
488	4	924	100		1	72	2			
489	4	924	100		2	69	2			
490	4	924	100		2	73	2			
491	4	924	100		2	70	1			
492	4	924	100		2	69	2			
493	4	924	100		2	71	2			
494	4	924	100		2	70	1			
495	4	924	100		1	73	2			
496	4	924	100		2	73	2			
497	4	924	100		2	71	1			
498	4	924	100		2	71	1			
499	4	924	100		2	70	1	400	1023	MOE ANGLING
500	4	924	100		1	76	2			
856	3	924	100		2	72	2			
860	3	924	100		2	68	1	400	1023	MOE ANGLING
861	3	924	100		2	71	1			
863	3	924	100		1	69	2			
864	3	924	100		2	75	2			
865	3	924	100		2	68	2			
866	3	924	100		2	72	2			
867	3	924	100		2	70	2			
868	3	924	100		2	75	2			
869	3	924	100		2	71	2			
870	3	924	100		2	71	2			
871	3	924	100		2	72	1			
872	3	924	100		2	73	2			
873	3	924	100		2	71	2			OPERCULUM DAMAGE
874	3	924	100		2	69	2			
875	3	924	100		2	72	2			
947	3	924	100		2	75	2			
967	3	924	100		2	71	2			
2825	4	924	100		2	72	2			
2826	4	924	100		2	70	2			
2828	4	924	100		2	71	2			
2829	4	924	100		1	81	1	400	1023	MOE ANGLING
2830	4	924	100		2	68	2			
2831	4	924	100		2	72	1			
2832	4	924	100		2	72	1			
2833	4	924	100		2	67	2	400	1023	MOE ANGLING
2834	4	924	100		2	75	2			

Appendix Table 3. Summary of Steelhead Tagging in the Upper Sustut River in 1992 (Cont'd).

TAG #	COL	DATE M/D	LOC	RADIO FREQ	SEX M=1/F=2	FORK LENGTH (CM)	NET MARKS Y=1/N=2	RECAPTURE LOC	RECAPTURE DATE (M/DAY)	COMMENTS
453	4	925	100		2	71	2			
470	4	925	100		2	73	2			
471	4	925	100		2	71	1			
472	4	925	100		1	72	2			
2809	4	925	100		2	67	2			
2843	4	925	100		2	78	2			
2844	4	925	100		2	74	2			
1698	5	926	1	151.194	2	70	2	..		ALSO TAG # 1655
2377	6	1023	400		2	76				MOE TAGGING
2378	6	1023	400		1	79				
2379	6	1023	400		2	72				
2380	6	1023	400		1	79				
2384	6	1023	400		1	80				
2385	6	1023	400		1	75				
2386	6	1023	400		2	74				

NOTE: ALL TAGS MOE EXCEPT YELLOW TAGS # 450–500.
THESE TAGS ARE LABELLED "REWARD BOX 2792" – BUSTARD & ASSOC.

TAGGING LOCATION CODES:

100 = FENCE
200 = JOHANSON LAKE
1 = JUNCTION POOL
2 = LONG RUN
3 = WHITEROCK POOL
4 = BLACKBEAR POOL
5 = GRIZZLY RUN
6 = CORNER POOL (BIG ROCK)
7 = INSERT RUN
8 = STEELHEAD HEAVEN
9 = SLOW RUN
300 = NATIVE CATCH FROM LOCATION 1 TO 3.
400 = SUSUT LAKE OUTLET
10 = LOWER FLAT
11 = RUN ABOVE SPLIT
12 = CORNER GLIDE
13 = ESKER CURVE
14 = SUSTUT FLATS
15 = MAXMIN CORNER
16 = LONG SECTION
17 = MOOSEVALE CREEK JUNCTION
18 = MIKES MEAT HOLE
19 = SUSTUT CANYON
20 = LOWER CANYON ROCK

TAG COLOUR CODE: WHITE = 1 BLUE = 2 PINK = 3 YELLOW = 4 GREEN = 5 ORANGE = 6

Appendix Table 4. Detailed Summary of Steelhead Observations During Snorkel Surveys in the Sustut River, 1992.

FILE = SNORK2

LOCATION*	AUGUST						SEPTEMBER							OCTOBER	TOTAL	%
	12	14	17	20	24	28	2	6	10	14	18	22	28	11		
1		1	4	2	1	13	53	57	46	36	36	7	9	1	266	11.0
2	2	7	12	19	8	3	33	73	90	74	60	68	63		512	21.3
3	2	1	8	9	35	2	14	27	43	31	38	3	2		215	8.9
4	2	1	2	2	4		1	1	1			3	3		20	0.8
5		6	8	33	54	88	63	71	80	105	168	165	48		889	36.9
6		14	18	5	18		31	19	11	16	8	12	3	1	156	6.5
7				6	4						1				11	0.5
8		7	16				4	1			1				29	1.2
9		1													1	0.0
10		5										3	1		9	0.4
11		4			10		6								20	0.8
12		2		4	5			1	3						15	0.6
13							32	11	29	52	17	9	1		151	6.3
14			3	2	2			2							9	0.4
15		2					1	6		3					12	0.5
16				3	3										6	0.2
17		8	4	20	6		1		4				1		44	1.8
18				2											2	0.1
19									32			2			34	1.4
20									8						8	0.3
															0	0.0
TOTAL	6	59	75	107	150	106	239	269	347	317	329	272	131	2	2409	100.0

SUMMARY BY SECTION

FILE = SNORK2 BOTTOM

SECTION	AUGUST				SEPTEMBER						OCTOBER		TOTAL	%
	14	17	20	24	2	6	10	14	18	22	28	11		
1	30	52	70	120	195	248	271	262	310	258	128	2	1946	86.3
2	19	16	10	19	10	2	3	0	2	3	1	0	85	3.8
3	10	7	27	11	34	19	33	55	17	9	2	0	224	9.9
TOTAL	59	75	107	150	239	269	307	317	329	270	131	2	2255	100

SPLIT INTO APPROXIMATELY 3 SECTIONS
SECTION 1 = JUNCTION POOL TO CORNER (BIG ROCK) POOL
SECTION 2 = LOCATION 7 (INSERT RUN) TO LOCATION 12 (CORNER GLIDE)
SECTION 3 = LOCATION 13 (ESKER CURVE) TO LOCATION 18 (MIKE'S MEAT HOLE)

* SEE FIGURE 2 FOR SPECIFIC LOCATIONS.

Appendix Table 5. Detailed Summary of Tagged Steelhead Observed in Snorkel Surveys in the Upper Sustut River in 1992.

LOC	AUG 17		AUG 20		AUG 24			AUG 28			SEP 2				SEP 6				SEP 10					SEP 14					SEP 15					SEP 22							SEP 28						
	W	O	W	O	W	B	O	W	B	O	W	B	P	O	W	B	P	O	W	B	P	Y	O	W	B	P	Y	O	W	B	P	Y	O	W	B	P	Y	G	UID	O	W	B	P	Y	G	UID	O
1											3	1	2	2	5	2			2	3	1	1	1	3	2	1		1	1	3	2	1		1	1													
2	1		5		1						3	2			1	6		1	3	2	1	1	1	2	2	2	1	2	4	2		1	1	3	1	1		2	10	3	2			2	3	4
3	1		1		6	2						1		1		1		2		2	1		2		1	1		3			3		3						1						
4																							1														1								
5			5		7	1		13	2		5			2	3		1	4	6	3	1	1		7	2			1	8	5	1	3	5	1		1	1		15	3	1		1		1	2
6	2		3			4						3		1	1	2						1			2					1								1	1						
7			1																																										
8	2																1																													
9																																							1						
10																																													
11						1	1																																					
12			1																																										
13											1	2		1							2	2	1			4	5	1		1	1		1			1				1						
14	1										1														1																				
15																	2																													
16																																													
17	2		2		1																																							
18																																													
19																			3	2		1	1																							
20																			1		1																									
TOT	9		18		15	8	1	INCOMPLETE			13	9	2	7	10	11	4	7	15	12	7	7	7	12	9	9	6	8	13	11	8	5	10	5	1	3	1	2	26	10	3	0	0	2	2	4	6
TOTAL NON-ORANGE					23						24				25				41					37					37					38							11						

See Figure 2 for specific locations.

1 orange-tagged fish tagged with blue and listed as blue.

COLOUR CODE: W = WHITE Y = YELLOW UID = UNIDENTIFIED
B = BLUE G = GREEN
P = PINK O = ORANGE

File = Snork1

Appendix Table 6. Summary of Fish Captures at Sustut River Fence from August 6 to September 28, 1992

DATE	STEELHEAD	DOLLY VARDEN	RESIDENT RAINBOW	SOCKEYE	MOUNTAIN WHITEFISH
Aug 6	1	1	0		0
Aug 16		0	0		1
Aug 17		0	0		0
Aug 18		0	0		0
Aug 19		0	0		1
Aug 20		0	0		0
Aug 21		1	0		1
Aug 22	1	0	0		3
Aug 23		0	0		0
Aug 24	1	2	0		2
Aug 25	1	1	0		0
Aug 26		2	0		1
Aug 27		0	0		0
Aug 28		1	0		0
Aug 29	1	1	0		3
Aug 30	2	1	0		0
Aug 31	3	0	0		0
Sept 1	12	1	0		0
Sept 2	2	2	0		0
Sept 3		1	0		0
Sept 4	1	3	0		0
Sept 5		2	0		0
Sept 6		4	3		0
Sept 7		1	0		0
Sept 8	1	3	0		0
Sept 9		1	0	24	0
Sept 10	12	2	0	79	0
Sept 11	1	1	0	37	0
Sept 12		1	0		0
Sept 13		2	0		0
Sept 14		4	1		0
Sept 15		3	0	1	1
Sept 16		2	1		0
Sept 17		4	0	10	1
Sept 18		3	0	7	0
Sept 19	10	4	0	83	0
Sept 20		1	0	23	0
Sept 21		2	0	1	0
Sept 22	5	3	0	15	0
Sept 23	1	5	0	9	0
Sept 24	83	2	0	8	0
Sept 25	12	2	0		0
Sept 26		0	0	1	0
Sept 27		0	0		0
Sept 28		1	0		0
TOTAL	**150**	**70**	**5**	**298**	**14**

Note: Only those salmon passed through the fence from September 9 onward are reported in this table.
Data prior to September 10 provided by DFO
File = FENCE

Appendix Table 7. Steelhead Tag Recaptures at Fence.

TAG #	COLOUR	DATE M/D	LOCATION	RADIO FREQ	SEX M=1/F=2	FORK LENGTH (CM)	NET MARKS Y=1/N=2	RECAPTURE LOCATION	RECAPTURE DATE (M/DAY)
7134	1	819	6		2	75	2	100	822
7125	1	814	1		2	71.5		100	825
7112	1	818	2	151.495	2	76	2	100	904
7102	1	815	18		2	70	2	100	910
7120	1	815	1	151.433	2	71	2	100	919
7136	1	819	3		2	74	2	100	920
7124	1	814	1		2	76		100	924
7116	1	818	2	151.412	2	68	1	100	924
7138	1	820	7		2	68.5	2	100	924
7131	1	819	17		2	77	1	100	924
1580	2	821	17		2	78	2	100	901
1594	2	830	2		2	79	1	100	910
1584	2	825	18		2	71	1	100	910
1579	2	821	17		2	75.5	1	100	924
1583	2	822	17		2	73	2	100	924
1483	2	823	17		1	75	2	100	925
964	3	905	15	150.939	2	76	1	100	919
966	3	905	15		1	80	2	100	925
706	3	902	1	151.273	2	77	1	100	925
2839	4	914	13		2	74	2	100	924
2803	4	909	13		2	70	2	100	924
1659	5	919	5		2	74	2	100	920
1656	5	919	5		2	73	2	100	920
1661	5	919	17		2	75	2	100	924
884	5	919	3		2	73	2	100	924
998	5	918	13		2	70	2	100	924
1662	5	919	17		2	70	2	100	924
1678	5	920	17		2	74	2	100	924
1652	5	919	4		2	74	2	100	924
1679	5	920	17		2	75	2	100	925
853	5	919	3		2	70	2	100	925

TAGGING LOCATION CODES:

100 = FENCE
200 = JOHANSON LAKE
1 = JUNCTION POOL
2 = LONG RUN
3 = WHITEROCK POOL
4 = BLACKBEAR POOL
5 = GRIZZLY RUN
6 = CORNER POOL (BIG ROCK)
7 = INSERT RUN
8 = STEELHEAD HEAVEN
9 = SLOW RUN
300 = NATIVE CATCH FROM LOCATION 1 TO 3.
400 = SUSUT LAKE OUTLET
10 = LOWER FLAT
11 = RUN ABOVE SPLIT
12 = CORNER GLIDE
13 = ESKER CURVE
14 = SUSTUT FLATS
15 = MAXMIN CORNER
16 = LONG SECTION
17 = MOOSEVALE CREEK JUNCTION
18 = MIKES MEAT HOLE
19 = SUSTUT CANYON
20 = LOWER CANYON ROCK

TAG COLOUR CODE: WHITE = 1 BLUE = 2 PINK = 3 YELLOW = 4 GREEN = 5

File = Append7

Appendix Table 8. Dolly Varden and Rocky Mountain Whitefish Length–Frequency Measurements.

DOLLY VARDEN		
FISH #	LENGTH (CM)	COMMENT
1	37.0	ANGLED
2	37.0	FENCE
3	39.5	FENCE
4	40.0	FENCE
5	40.0	ANGLED
6	44.0	ANGLED
7	44.0	FENCE
8	45.0	FENCE
9	45.0	FENCE
10	45.5	ANGLED
11	47.0	ANGLED
12	47.5	FENCE
13	47.5	FENCE
14	49.5	ANGLED
15	49.5	ANGLED
16	50.0	FENCE
17	50.0	FENCE
18	51.0	FENCE
19	51.5	FENCE
20	52.0	ANGLED
21	54.5	FENCE
22	55.0	FENCE
23	56.0	FENCE
24	56.5	FENCE
25	57.0	FENCE
26	57.0	FENCE
27	58.0	FENCE
28	59.5	FENCE
29	59.5	FENCE
30	60.0	ANGLED
31	60.0	FENCE
32	63.0	ANGLED
33	63.0	FENCE
34	75.0	FENCE
35	78.0	FENCE
MEAN	**52.1**	
RANGE	**37–78**	
NUMBER	**35**	

MOUNTAIN WHITEFISH
LENGTH (CM)
270
300
315
320
345
350
360
360
370
380
380
390
MEAN 345
RANGE 270–390
NUMBER 12

All whitefish captured at fence

Based on a mix of fish passed through the fence and angled in the Sustut River during tagging studies.
Fence measurements provided by Dr. Cole Shirvell, Pacific Biological Station, Nanaimo

FILE = DV

Appendix Table 9. Detailed Summary of Upper Sustut River Coho Observations During 1992.

DATE	COHO OBSERVED	LOCATION NUMBER *	COMMENTS
AUG 12	0		Snorkel survey from the Junction Pool downstream for aproximately 1 km.
AUG 14	1 Jk	17	Snorkel survey from the Junction Pool downstream to Moosevale Junction.
AUG 17	2	17	Snorkel survey from the Junction Pool downstream to Moosevale Juntion.
AUG 18	1 Jk		Passed 1 jack coho (52 cm) through the Sustut River fence (commercial shaker).
AUG 20	1 Jk	1	Snorkel survey from the Junction Pool downstream to Moosevale Junction.
	7 Jk	17	The adult coho was estimated to be 8 – 10 lbs.
	1 A	17	**Total coho observed on Aug 20 = 9**
AUG 20	1 Jk	17	Angled 1 coho jack at Moosevale Junction.
AUG 24	2 Jk	1	Snorkel survey from the Junction Pool downstream to Moosevale Junction.
	12 Jk	17	The 3 adult coho were observed between the Junction Pool and Moosevale Junction.
	3 A		**Total coho observed on Aug 24 = 17**
AUG 28	1	1	Snorkel survery was aborted below the White Rock Pool due to the presence of bears.
SEPT 2	2 Jk	1	Snorkel survey from the Junction Pool downstream to Moosevale Junction.
	1 A	1	**Total coho observed on Sept 2 = 12**
	6 Jk	13	
	2 Jk	15	
	1 Jk	17	
SEPT 6	1 Jk	1	Snorkel survey from the Junction Pool downstream to Moosevale Junction.
	2 Jk	3	After this date coho observations were not accurately recorded during
	12 Jk	5	snorkel surveys, due to focus on steelhead.
	1 A	5	**Total coho observed on Sept 6 = 30**
	10 Jk	13	
	2 A	13	
	2 Jk	17	
SEPT 9	1	17	Angled 1 coho (73 cm).
SEPT 10	<20		Snorkel survey from the Junction Pool downstream to Sustut Canyon. Observed a few coho (<10) in the Long Run and Big Rock Pools. Also observed approximately 10 coho including jacks in the Sustut Canyon Pool.
SEPT 14	11		Snorkel survey from the Junction Pool downstream to Moosevale Junction. Observed 11 coho, including jacks, in the White Rock and Grizzly Runs.
SEPT 17	1		1 small coho angled in Johanson Lake outlet.
SEPT 18	<9		Snorkel survey from the Junction Pool downstream to Moosevale Junction. Small number of coho observed (<9) but number was not recorded.
SEPT 22	N/A		Snorkel survey from the Junction Pool downstream to Moosevale Junction. Small number of coho observed but number was not recorded.
SEPT 22	N/A		Snorkel survey from the Junction Pool downstream to Moosevale Junction. Small number of coho observed but number was not recorded.
OCT 11			Snorkel survey from the Junction Pool downstream to Moosevale Junction. Visibility was reduced during this survey. Observed 1 possible coho/steelhead.

(FILE = SUSCOHO)

* Refer to Figure 2.

Appendix Table 10. Summary of Aerial and Ground Observations of Steelhead in Sustut and Johanson Lake Outlets.

DATE	METHOD	JOHANSON LAKE	SUSTUT LAKE
June 9[1]	Hel	No fish observed including look at Darb Creek	No fish observed Excellent visibility
Aug 16	Hel	1 sthd obs in Thermograph Pool	No sthd observed
Aug 22	Ground	No fish observed	
Aug 24	Ground	Hooked 1 sthd in Thermograph Pool	
Aug 26	Ground	No fish observed or angled	
Aug 30	Ground	No fish observed or angled	
Sept 1	Hel	5 sthd in Thermograph Pool & 3-4 in lake outlet	No sthd observed
Sept 7	Ground	4 sthd observed from shore in outlet	
Sept 9	Hel	4 sthd observed off tip of island in lake	
Sept 14	Hel		2 sthd observed in inlet to Mud Lake
Sept 17	Ground	3 sthd angled at inlet to small lake	
Sept 22	Hel	2 sthd observed in outlet	No fish observed
Sept 23	Ground	No fish observed in outlet	
Sept 26	Ground	No fish observed or tracked in lake	
Sept 27	Hel	No fish observed Radio fish in large lake	8-10 fish holding in outlet pool below Sustut
Oct 12	Ground	No fish observed from shore. 4 radio fish tracked at outlet	Fish seen rising at outlet pool but no estimate possible
Oct 23	Hel	Poor visibility at outlet due to ice	50 sthd observed but minimal viewing effort in order to avoid disturbance

[1] Observations conducted during thermograph installation

Appendix Table 11. Summary of Steelhead Not in Snorkel Survey Section Over Time.

DATE	# OF STHD	FENCE CUMULATIVE TOTAL	MORTS	MORTALITIES CUMULATIVE TOTAL	STHD NOT IN SNORK SURVEYS*	COMMENTS
Aug 6	1	1			1	Passed by DFO (ID Correct?)
Aug 16		1			2	1 sthd obs in Johanson outlet
Aug 17		1			2	
Aug 18		1	1	1	3	1 hook mort @ JX
Aug 19		1		1	3	
Aug 20		1		1	3	
Aug 21		1		1	3	
Aug 22	1	2		1	4	
Aug 23		2	8	9	12	Native netting – actually counted
Aug 24	1	3		9	13	White tag #7125
Aug 25	1	4	2	11	16	Orange tag – hooking mort: 1 native capture
Aug 26		4	3	14	19	3 native capture
Aug 27		4	1	15	20	1 native capture
Aug 28		4	1	16	21	2 native captures incl 1 white tag
Aug 29	1	5	2	18	24	2 native captures incl 1 blue tag
Aug 30	2	7		18	26	
Aug 31	3	10	1	19	30	1 fish died in holding tube at fence
Sept 1	12	22		19	50	9 sthd observed in Johanson outlet. 1 grizzly mort.
Sept 2	2	24	2	21	54	1 hooking mort; 1 native capture
Sept 3		24		21	54	
Sept 4	1	25		21	55	
Sept 5		25		21	55	
Sept 6		25	1	22	56	1 native capture based on head in Jx Pool
Sept 7		25		22	56	
Sept 8	1	26		22	57	
Sept 9		26		22	57	Assume responsibility for fence
Sept 10	12	38		22	69	
Sept 11	1	39		22	70	
Sept 12		39		22	70	
Sept 13		39		22	70	
Sept 14		39		22	70	
Sept 15		39		22	70	
Sept 16		39		22	70	
Sept 17		39		22	70	
Sept 18		39	1	23	71	Tag on bar (P0704) – Bears?
Sept 19	10	49		23	81	
Sept 20		49		23	81	
Sept 21		49		23	81	
Sept 22	5	54		23	86	
Sept 23	1	55		23	87	
Sept 24	83	138		23	170	
Sept 25	12	150		23	182	
Sept 26		150		23	182	
Sept 27		150		23	182	
Sept 28		150		23	182	Fence removed

Note – 3 morts occurred at fence or upstream in Sustut – not inlcuded in mort total.
18 morts accounted to natives based on direct observation. This represents a portion of their take.
Note 1 fish passed at fence was later tracked into Johanson system.

* This is a minimum and includes only those steelhead that were actually observed in Johanson Creek. This becomes increasingly inaccurate in September as fish started to move, based on fence observations and fish observed in the vicinity of the lake.

FILE = FENCE

Appendix Table 12. Mark–Recapture Estimates for Steelhead in Snorkel Surveys and at Fence.

MARK–RECAPTURE ESTIMATES FOR STEELHEAD OBSERVED IN SNORKEL SURVEYS

BASED ON SEPT 10 OBSERVATIONS.

# OF STEELHEAD MARKED (M)	51	$N = \frac{(M+1)(C+1)}{R+1}$ (Ricker 1975)
# OF STEELHEAD OBSERVED DURING SURVEYS	347	
# OF MARKS OBSERVED (R)	41	

$N = \frac{18096.00}{42} = 429.8571$

SE =	0.00413612	0.064312	27.6452623	X 1.96 =	54.1847141	95% conf N =	484.04	375.67

SUSTUT ESTIMATES BASED ON MARKED TO UNMARKED STEELHEAD CAPTURED AT THE FENCE

# OF STEELHEAD MARKED (M)	65	$N = \frac{(M+1)(C+1)}{R+1}$
# OF STEELHEAD CAPTURED AT FENCE (C)	150	
# OF MARKS (R)	31	

$N = \frac{9966.00}{32} = 310.4375$

SE =	0.013051765	0.114244	35.4657215	X 1.96 =	69.5128142	95% conf N =	379.95	240.92
						JOH LK =	126	80
						TOTAL =	506	320

ASSUMPTIONS:
93 MARKS OUT BUT 7 REMOVED FROM POP DUE TO MORTS AND CAPTURES
ASSUME 75% SPLIT BETWEEN JOHANSON AND SUSTUT
BASED ON DISTRIBUTION OF RADIO FISH
75% OF 86 = 65 FISH
THIS ASSUMES THAT 31/65 = 47.7% OF POPULATION HAD PASSED THROUGH FENCE AT THE TIME OF FENCE REMOVAL
MOE SAMPLING AT SUSTUT LAKE INDICATED 11 OF 19 FISH WERE TAGGED = 57.9%

BASED ON ESTIMATE – 310 FISH IN SUSTUT LAKE
103 FISH IN JOHANSON LAKE

TOTAL = 413 FISH
OTHERS = 23 FISH (NATIVES AND OTHERS)
TOTAL = 436 FISH

FILE = POPEST1

Appendix Table 13. Summary of Native Fishing Observations in Junction Pool Area.

DATE	STEELHEAD	COMMENTS
July 29 (DFO)		Hook and line. Catch not observed
Aug 1 (DFO)		7 Natives from Ft. St. James. No catch
Aug 4 (DFO)		7 chinook and 2 sockeye taken with gaffs J. Abrahams and sons.
Aug 5 (DFO)		Natives fishing all day. 8 chinook and 2 sockeye.
Aug 6 DFO)		Two groups – 5 chinook and 2 sockeye
Aug 9 (DFO)		1 family – 2 sockeye
Aug 10 (DFO)		J. Abraham and N. George 6 chinook and 1 sockeye
Aug 13		Natives observed gaffing salmon for a minimum of 2 hrs. 2 sockeye From Takla and Ingenika Band
Aug 17 (DFO)		Using gillnet 12 people from Takla incl French and Alexander – 29 sockeye and 1 chinook
Aug 19		Young natives gaffing salmon. No catch reported. From Ft. St. James
Aug 20		2 families of natives observed gaffing and netting. Catch not observed. Fish appeared to be pushed downstream into other holding water.
Aug 21 (DFO)		Using gaffs – at least 5 people With 2 packs, garbage bag and plastic container full Estimated 25 sockeye
Aug 22		One large family group of natives observed netting. Also harvested all fish in DFO fence, no count possible. Used gillnets and fished more later in day.
Aug 23	8	10 vehicles observed. Veh. lic #'s: 870 WG, 970 WG, 8923 WG, 8770, WDL 022, 9778 WG. At 1430 counted 16 Natives fishing in Jx Pool area with more people downstream. At 1830 most people were preparing to leave at the parking area. Most people were from Takla with some from Ft St. James. Observed 2 gillnets fishing bank to bank, with many young natives using hand lines. 6 men made steady trips with heavy packs of fish. 150 Sockeye were counted on the beach after an estimated 50 left in backpacks. This minimum estimate was developed over a one hour period, not including catches from groups fishing downstream of the Long Run. 7 Steelhead were observed including 2 radio tags. One additional radio transmitter was later recovered. Natives fishing the Junction Pool area reported 10–15 Std harvested. No single–tagged fish were observed or reported to be caught. Std were later observed holding in large concentrations downstream. Suspect groups fishing this area likely caught Std.
Aug 24 (DFO)		At least 100 sockeye. Poor count.
Aug 25	1	No fishing observed, although one single tagged Std was reported to be caught.

File = Natvkill

Appendix Table 13. Summary of Native Fishing Observations in Junction Pool Area (Cont'd).

DATE	STEELHEAD	COMMENTS
Aug 26	3	3 vehicles observed. 6423 NC, 2334 VK, 2257 TM. An estimated 25 people with 2 gillnets, 2–4 kids with rods and 2–4 hand lines. Between 1300 and 1600 hrs, observed approx 40 sockeye and 1 Std. Natives also reported 1 single tagged Std that was caught. Natives headed downriver to target Std after we left. Pierre of DFO saw an additional steelhead
Aug 27	1	Peter Abraham and family fishing Jx Pool. 27 Sockeye observed and 1 Std (not tagged). Peter reported having a single tagged Std in his smoke house. (Returned this on Aug 28) Fishery Officer visted Peter's smokehouse and obs. approx. 100 sockeye.
Aug 28	1	3 white and 5 native persons from Germansen Landing (Orig. Takla) observed fishing Jx. Pool. In 10 minutes of gaffing 1 sockeye and 1 Std (no tag) were caught. Fishing continued after we left. Gaffing and jigging.
Aug 29	2	Native capture reported by DFO. T. John and sons from Takla Landing took shot at grizzlies.
Aug 31 (DFO)		7–9 adults using triple hooks and gillnet. 25 sockeye were counted by C.O.
Sept 2	1	12 natives from Takla/Germansen observed jigging. In 15–20 minutes 8 sockeye and 1 Std obs.
Sept 3		Natives from Osilinka fishing. "Watched" by 2–3 whites.
Sept 5		4 natives with 2 vehicles obsevered at Jx Pool trail. 2376 VG. No catch observed.
Sept 6	1	Sthd head found in bottom of Jx. Pool
Sept 7		Evidence of Native fishing in the Thermograph Pool downstream from Johanson Lake outlet.
	TOTAL = 18 Steelhead	

This table represents a combination of observations made during this study and those made by DFO while operating fence.