3A97-35

REGIONAL INFORMATION REPORT 3A97-35

Alaska Department of Fish and Game
Commercial Fisheries Management
and Development Division
333 Raspberry Road
Anchorage, Alaska 99518

October 1997

Salmon Escapement Assessment in the Toklat River, 1994

by

Louis H. Barton

State of Alaska Tony Knowles, Governor

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Regional Information Report[1] No. 3A97-35

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October 1997

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ACKNOWLEDGMENTS

Special thanks are extended to those who participated in this project and who are largely responsible for its success: K. Boeck and O. Wear. Critical review of this report was provided by L. Buklis, J. Bromaghin, and D. Huttunen.

SPONSORSHIP

This project was partially funded by Yukon River Salmon U.S./Canada Negotiation Studies, grant Award No. NA46FP0343 from the U.S. Department of Commerce.

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ABSTRACT

A sonar-estimated escapement of 75,867 salmon was obtained for the Toklat River upstream of Barton Creek for the period 14 August through 4 October 1994. Eighty-nine percent of the estimated passage was along the left bank and 11% along the right bank. The mode and median day of passage both occurred on 21 September. Approximately, 99% of the sonar estimate (75,108) was apportioned to fall-run chum salmon *Oncorhynchus keta* with the remainder considered as coho salmon *O. kisutch.* Apportionment was based upon species composition observed during ground surveys of the major spawning area at Toklat Springs in mid-October. Although this passage estimate is considered conservative due to an unknown number of salmon which passed the sonar counting site prior and subsequent to counting operations, it compares exceptionally well with the total abundance estimate of 76,057 chum salmon made from intensive ground surveys of Toklat Springs during peak of spawning. An additional 39 chum and approximately 2,000 coho salmon passed Barton Creek weir during the same period (mid-August through early October), in addition to three chinook salmon *O. tshawytscha.*

Variations in water levels and velocities, together with migration behavior of upstream migrant Toklat River salmon, affected the ability of the hydroacoustic equipment to accurately estimate salmon passage. However, this factor was addressed by adjusting fish passage estimates as necessary based upon daily calibrations of the hydroacoustic equipment. Sonar counting range was considered adequate for the detection of the majority of fish passing the sonar site as most were oriented nearshore. Daily passage was greatest during periods of darkness, with the greatest movement occurring on the average between 2200 and 2400 hours.

KEY WORDS: Chum salmon, Coho salmon, *Oncorhynchus keta, O. Kisutch*, hydroacoustics, sonar, escapement, Yukon River, Tanana River, Kantishna River, Toklat River

INTRODUCTION

Although five species of Pacific salmon *Oncorhynchus* are found in the Yukon River drainage, chum salmon *O. keta* are the most abundant and occur in genetically distinct summer and fall runs (Wilmot et al. 1992; Seeb et al. 1995). Fall chum salmon are larger, spawn later, and are less abundant than their summer chum counterpart. They primarily spawn in the upper portion of the drainage in streams which are spring fed, usually remaining ice-free during the winter (Buklis and Barton 1984). Major fall chum salmon spawning areas include the Tanana, Chandalar, and Porcupine River systems, as well as selected Canadian portions of the Yukon River (Figure 1).

Fall chum salmon are harvested commercially along the entire mainstem Yukon River in Alaska as well as in the Canadian portion of the river near Dawson, Y.T. Commercial harvest is also permitted in the lower portion of the Tanana River in Alaska, but no commercial fishing is permitted in other tributaries, including the Koyukuk and Porcupine River systems. While the majority of commercially taken fish come from the lower river, downstream of the village of Anvik, fall chum salmon use for subsistence is greatest throughout the upper river drainage, upstream of the village of Koyukuk. In some more recent years estimated drainage-wide subsistence use has rivaled or exceeded the commercial harvest.

The Alaskan commercial fishery for Yukon River fall chum salmon developed in the early 1960's, with annual harvests remaining relatively low through the early to mid-1970's (JTC 1995). Estimated total inriver utilization (U.S. and Canada commercial and subsistence) of Yukon River fall chum salmon was below 300,000 fish per year prior to the mid 1970's (Table 1). The inriver commercial fisheries became more fully developed during the late 1970's and early 1980's, with total utilization averaging 536,000 fish for the 5 year period 1979-1983. Harvest peaked in 1979 at 615,000 and in 1981 at 677,000 fish. Since the mid-1980's management strategies have been implemented to reduce commercial exploitation on fall chum salmon stocks in order to improve upon low escapements observed throughout the drainage during the early 1980's. In 1987 a complete closure of the commercial fall chum salmon fishery occurred in the Alaskan portion of the drainage, while in 1992 commercial fishing in Alaska was restricted to only a portion of the Tanana River during the fall season. In addition to a commercial fishery closure, 1993 marked the first year in State history that a total river closure to subsistence fishing for chum salmon occurred in the Yukon River during the latter portion of the fall season. The closure was in response to an extremely weak fall chum salmon return in that year.

A substantial portion of Yukon River fall chum salmon production originates from the Tanana River. Important spawning stocks in that drainage include those utilizing numerous spring areas of the upper mainstem river itself between approximately Little Delta River and Delta Clearwater River (Barton 1992), the lower Delta River, as well as the Toklat River in the Kantishna River drainage (Figure 2).

Documentation of salmon spawning in the Toklat River dates back to January 1908 when Charles Sheldon reported finding several channels of open water filled with dead salmon at a place known as the "Cutoff--the beginning of an old Indian trail from the Toklat to the Nenana River" (Sheldon 1930). This trail crossing is located approximately 65 river km (rkm) upstream from the mouth of the Toklat River. Gudgel-Holmes (1990) states this native trail from Rex [Kobi(e)] on the Nenana River to the Toklat River, more recently referred to as Rex Trail, was customarily used by members of the Toklat/Nenana band to obtain fish due to the abundance of chum salmon in the fall. Apart from Sheldon's documentation, no information on fall chum spawning abundance or distribution in the Toklat River was available prior to the early 1970s. Throughout the next decade however, observations on Toklat River chum salmon escapement were made by the Alaska Department of Fish and Game (department) and consisted of limited aerial and ground surveys conducted during periods of anticipated peak spawning (Barton 1984a). Beginning in 1980, a special effort was made to conduct a thorough ground survey each year of the major fall chum spawning area at Toklat Springs during periods of peak spawning. It was not until 1985 however, that the first attempt was made to prepare detailed notes on the distribution of spawners throughout the floodplain sloughs.

The existing historic escapement database for Toklat River chum salmon consists of estimates of total spawning abundance dating back to 1974; estimates derived from expanded aerial or ground survey counts of the major spawning area at Toklat Springs, using streamlife and migratory time density data collected from the Delta River fall chum stock (Table 2). The current fall chum salmon biological escapement goal (BEG) for the Toklat River of >33,000 spawners was first established in November 1986. This BEG of total spawning abundance was re-examined in both November 1990 and January 1994 using larger historical databases, but no revision was considered warranted during either of those reviews.

The Toklat River fall chum salmon stock was identified as a conservation concern at the spring 1990 Alaska Board of Fisheries (BOF) meeting because escapements had been less than the BEG since 1979, despite numerous management actions taken by both the department and the BOF during the preceding several years over concern not only for Toklat River fall chum salmon, but for Canadian stocks as well. Such actions ranged from reductions in commercial fishing time throughout the drainage to both commercial and subsistence fishing closures/restrictions. In the spring of 1992 the BOF issued a "charge" to the Yukon River Drainage Fisheries Association (YRDFA) to work with the department in the development of a rebuilding management plan for Toklat River fall chum salmon. Based upon a YRDFA proposal presented to the BOF in the spring of 1993, the BOF adopted the *1993 Toklat River Fall Chum Salmon Rebuilding Management Plan.* A similar rebuilding plan with only slight modifications, was adopted by the BOF prior to the 1994 fishing season. Key elements of these rebuilding management plans included:

- Close Toklat River drainage to sport, personal use, and subsistence fishing,

- Restrict subsistence fishing in the Kantishna River to a maximum of 2,000 chum salmon (via permit system), and

- Require managing commercial harvests in all Yukon River districts to a lower level than the maximum that could otherwise be supported by the return.

Due to the high degree of concern over the Toklat River fall chum salmon stock, the department initiated a feasibility study in 1994 using hydroacoustic techniques to obtain a more comprehensive assessment of fall chum salmon escapement into the river, in addition to maintenance of intensive ground surveys of the Toklat Springs spawning area. This report presents results of that study.

Study Area

Toklat River Basin

The Toklat River heads in the glacial ice fields of the Alaska Range near Mount Pendleton in Denali National Park, draining an area of approximately 3,300 sq. km on the north side of the Alaska Range. Two large branches of the river in its upper basin converge at the base of Divide Mountain to form the main river, the rather flat glacial valley of which exceeds half a kilometer in width at places. The river flows north approximately 140 km to its terminus on the Kantishna River some 90 km upstream of the Tanana River (Figure 3). Excluding the East Fork, all other tributaries are clear water, the largest of which is the Clearwater Fork.

The Toklat River is a typical Alaskan glacial river with turbid, silt-laden water and broad, braided, gravel-bedded channels. Though detailed studies have not been made, discontinuous permafrost is known to underlie much of the basin lowlands (USNPS 1985 as cited in Karle 1989). While most of the surface flow volume is from snow and glacier melt, which gradually diminishes as freezeup approaches, upwelling ground water composes a significant proportion of the river flow volume during the winter months. These up-welling spring areas provide important spawning habitat for fall chum and coho salmon.

Toklat Springs

In 1909 Richard Knight constructed a roadhouse on the Toklat River near the mouth of the Sushana River at the location Sheldon (1930) referred to as "the Cutoff'. It became an important stop along the Nenana to McGrath mail trail during the 1920s (Gudgel-Holmes 1990). Murie (1920) writing about the physiography of the Toklat River region in December 1920, noted that water in the Toklat River practically disappeared underground, only to reappear at Knight's Roadhouse near the mouth of the Sushana River. He reported that water from the Sushana River was warm and icefree, resulting in open water on the Toklat River for "some distance below that point". Sheldon (1930) reported that, "during the whole winter, even in the coldest weather, there is always open water ... from that point (Cutoff) downstream for four or five miles...(and) this place marks the upper end of the salmon run....".

In addition to the springs which surface in channels of the mainriver floodplain in the vicinity of Knight's Roadhouse or "the Cutoff", upwelling spring water also keeps the lower several hundred meters of the Sushana River open in the winter months. Farther upstream the streambed dries up during the late fall to early winter. Geiger Creek, also known as Bear Creek, is a small clearwater tributary entering the Toklat floodplain from the west, across from the mouth of the Sushana River. It too, remains relatively ice-free during the winter months from upwelling spring water. Both of these areas (lower Sushana River and Geiger Creek) are also important fall chum and coho salmon spawning areas. Together, the generalized geographical region encompassing the mainriver floodplain channels in vicinity of Knight's Roadhouse, the lower Sushana River, and Geiger Creek are referred to as Toklat Springs (Figure 4). It is this concentrated area of upwelling spring water, together with time of spawning, which gives rise to some of the most unique salmon spawning habitat in Interior Alaska. However, high-flow summer runoff carrying heavy sediment loads results in scouring and shifting of individual floodplain channels, influencing the amount of available spawning area from year to year. Within the past decade, a channel from the Toklat River breached timber during high flow run-off on the right side of the floodplain approximately 1.5-2 km upstream of the Sushana River mouth. This has resulted in an influx of turbid water into the lower Sushana River in recent years between breakup and late fall, when the influx of turbid water subsides due to falling water levels in the main river.

Barton Creek

Barton Creek is a clearwater tributary of the Toklat River which heads in the foothills south of the old Stampede Trail, paralleling the Sushana River for some distance before entering the Toklat River from the east at approximately rkm 25. Like Toklat Springs, a major source of water flow in this stream originates from upwelling springs located in vicinity of the Rex Trail crossing, likely from the same underground aquifer which gives rise to the open water areas found at Toklat Springs. Barton Creek supports one of the largest chinook salmon runs in the Kantishna River drainage with spawning occurring during late July and August from the mouth upstream to the vicinity of Birch Hill. Later, coho salmon and lesser numbers of fall chum salmon ascend the creek and spawn near the source of the springs, upstream from chinook salmon spawning areas.

Objectives

The main goal of the 1994 study was to determine the feasibility of using hydroacoustic techniques to monitor timing and magnitude of fall chum salmon escapement in the Toklat River. Depending upon project success, a secondary goal was to compare the sonar-estimated escapement to an independent total abundance estimate obtained from intensive ground surveys of Toklat Springs during peak of spawning. Design of the 1994 study was predicated upon two major assumptions. First, while the extent of mainstem spawning is not known with certainty, based upon historic information, it was presumed that little to no chum salmon spawning occurs upstream of Toklat Springs with only limited spawning below that region in most years. Second, it was presumed that species apportionment of mainriver sonar counts upstream of Barton Creek can reasonably be based upon species composition subsequently observed at Toklat Springs during peak of spawning. Given these assumptions, the following specific objectives were identified:

- document timing and magnitude of salmon escapement in the mainstem Toklat River upstream of Barton Creek using hydroacoustic techniques,

- apportion sonar counts to salmon species based upon subsequent ground surveys of Toklat Springs during the period of peak spawning,

- document timing and magnitude of salmon escapement by species in Barton Creek using a counting fence (weir), and

- monitor selected climatological and hydrological parameters daily at the project site for use as baseline data.

METHODS

Hydroacoustic Equipment and Site Selection

The 1994 sonar project site for assessing the salmon run in the Toklat River was located near the terminus of Barton Creek where it debouches onto the Toklat River floodplain (Figures 5 and 6). A bottom profile of the main river channel at this location had been obtained in August 1993 identifying it as potentially favorable for sonar deployment. Camp facilities were established between 4 and 11 August on the eastern side (right bank) of the floodplain between Barton Creek and the main channel of the Toklat River, which allowed a single two-person crew to monitor salmon passage in both the Toklat River and in Barton Creek. Spruce poles were cut, peeled and assembled to frame several canvas wall tents for mess and sleeping quarters as well as to house sonar electronics.

Two sonar fish counters developed by the Hydrodynamics Division of Bendix Corporation were used to monitor salmon passage in the mainstem Toklat River in 1994: a 1978 model counter and a 1979 model counter.[2] Bendix side-scan transducers have co-axil, circular cross-section narrow (2°) and wide (4°) beam widths. Sampling ranges for the narrow and wide beams are variable and maximum at 18.3 and 9.2 m, respectively. Although each counter can be operated on either the narrow or wide beam independently, counters were generally operated by alternating acoustic pulse transmissions between the two beams. In this mode fish passage in the outer half and inner half of the sampling range is monitored by the narrow and wide beam, respectively.

Each counter maintained a record of the spatial distribution of fish counts based upon distance of the acoustic target from the face of the transducer. Fish counts were tallied and stored into memory by 12 electronic range intervals (sectors). Both counters were modified to allow use with a Biosonics Model 115 chart recorder to aid in calibration procedures. Operating characteristics of Bendix counters as well as installation and operational procedures can be found in Bendix Corporation (1978) and Ehrenberg (undated). The modular aluminum substrates designed for use with Bendix counters were not used in this study.

Actual location of sonar transducers in 1994 was based upon the best of several river bottom profiles made of the Toklat River main channel with a recording depth sounder shortly after arrival at the project site. Once the most favorable location had been identified, a detailed profile of the river bottom was obtained by stretching a rope across the river and measuring water depth with a pole every 3 m. The left bank sonar counter, sheltered in a 3 m x 4 m canvas wall tent, was operated from the right bank. This counter was not housed on the left bank point bar due to increased risk of loss from sudden, unexpected high water events. The right bank sonar counter was housed in a separate 4 m x 4.5 m wall tent on the right bank. Wood burning stoves were operated in each sonar tent as required to prevent printer malfunction during periods of dampness and cold weather. Access between river banks was provided by means of a 5 m rubber raft. Personnel pulled themselves across the river in the raft by means of a 1.6 cm rope which had been strung across the river for that purpose. A safety line from the boat was secured to the rope while crossing. A bipod

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[2]Use of company names in this report does not constitute endorsement.

was used to elevate the rope high enough above the river when not in use, so as to avoid floating debris or boat traffic.

The left bank transducer was mounted on a housing made of galvanized steel water pipe (Figure 7). This pod was designed to permit raising and lowering of the sonar beam by using the two riser pipes which extended above the water. Finer adjustments were made with the knurled knobs which attached the transducer plate to the pod. The transducer pod was held in place with sand bags. The left bank transducer cable, supported by a 1.3 cm rope, was elevated across the river to the sonar counter using nylon tie straps spaced about 1 m apart and in such a manner so as to eliminate tension on the cable ends. The rope and transducer cable were suspended high enough above the river to avoid floating debris and boat traffic. The right bank transducer was deployed from the adjacent bank approximately three meters upstream of the left bank transducer. This transducer was mounted on a pod constructed with 2.5 cm PVC pipe, of a design similar to that of Barton (1986a). Aiming was accomplished using the knurled knobs which attached the transducer plate to the pod. Both transducers were deployed in water ranging from approximately 0.5 to 1 m in depth and aimed perpendicular to the current, along the bottom of the river. An attempt was made to maintain deployment at a location with minimum surface water velocity of approximately 30-45 cm/s for each transducer.

The system operator used an artificial acoustic target during deployment to adjust the aim of each transducer, ensuring they were aimed low enough to prevent salmon from passing undetected beneath the acoustic beam. The target, a 250 ml weighted plastic bottle, was allowed to drift downstream along the river bottom and through the acoustic beam. Several drifts were made with the target in an attempt to pass it through each electronic sector of the counting range. When a transducer was properly aimed, the target appeared as a vertical deflection (spike) on an oscilloscope screen as it transected the acoustic beam at any given distance. The target may or may not have simultaneously registered a count (or multiple counts) on the sonar counter, depending upon the length of time it remained in the acoustic beam as it drifted downstream along the river bottom.

A fish lead was constructed shoreward from each transducer to prevent upstream salmon passage inshore of the transducers. Each lead was constructed using 5 cm x 10 cm by 1.2 m high fencing and 2.5 m metal "T" stakes. Leads were constructed so as to include the nearfield "dead range" of each sonar transducer. The inshore lead was shortened or lengthened as appropriate whenever a transducer was relocated because of rising or falling water level, and the artificial target used to ensure proper re-aiming.

Sonar Calibrations and Count Adjustments

Daily comparisons (calibrations) were made between oscilloscope observations and automated counter output to determine if the number of fish registered by the sonar counter equaled the number of fish observed passing through the sonar beam. A minimum of seven 15- to 30-minute calibrations were scheduled daily for the left bank sonar counter within the following time periods: 0000-0030; 0600-0630; 1100-1130; 1600-1630; 1800-1830; 2100-2130; and 2300-2330 hours. Duration of calibrations for the left bank counter was based upon the following criteria: 1) Stop calibration at 15 minutes if less than 10 fish are observed; and, 2) Extend 15-minute calibration to 30 minutes if 10 or more fish are observed in the first 15 minutes. The calibration schedule for the right bank counter included four 15-minute calibrations during the time periods: 0030-0100; 0630-0700; 1830-1900; and 2330-2400 hours. This reduced schedule for the right bank counter was a function of manpower constraints as well as reduced fish passage observed along the right bank.

Bank-specific calibration results were used to adjust passage estimates for each sonar counter on a daily basis. Hourly blocks of a day's count included in an adjustment (adjustment period) were defined by the time between individual bank-specific calibrations. An associated adjustment factor (A), specific to each adjustment period (i) was calculated as follows:

$$A_i = \frac{OC}{SC} \tag{1}$$

where:

OC = oscilloscope count; and,
SC = sonar count.

Adjustment factors were applied to the unadjusted sonar counts for each hour within the associated adjustment period for each bank. The resulting corrected sonar counts for each hour within a day for a given bank were summed, yielding the estimated daily passage (D) of salmon, and is represented by

$$D = \sum (A_i \text{x} SC_i) \tag{2}$$

Counts registered as "debris" were deleted and replaced by interpolated values prior to making adjustments. Interpolated values for a given electronic sector were based upon registered counts for that sector in the preceding and following hour. Daily fish passage was determined by summing the daily bank estimates. Sonar counts caused by fish other than salmon were assumed to be insignificant. Whereas the adjusted (corrected) hourly counts were used to determine temporal distribution of salmon passing the sonar site, spatial distribution was estimated from the unadjusted (raw) sector counts.

Over-counting or under-counting was minimized by adjusting the pulse repetition rate (PRR) or ping rate of each counter as needed. Over- and under-counting primarily results from changes in salmon swimming speeds which may be related to fluctuations in water level and velocity, photoperiod, or fish densities (Barton 1985, 1986a, 1987, 1995). Although a few occasions arose (generally in early season) when the counter's ping rate was subjectively changed based upon a qualitative evaluation of fish passage rates, the ping rate was generally changed at the end of any calibration if the oscilloscope count was in excess of 59 per hour and differed by more than 15% from the sonar count. The new ping rate was calculated as: (sonar count / oscilloscope count) x current PRR setting. If salmon passage rates during calibrations of a given counter, on a given day never exceeded 59 fish per hour, the ping rate of that counter was changed at 2400 hours of that particular day, if the sum of the sonar counts during the day's calibrations exceeded the sum of the oscilloscope counts during the day's calibrations by more than 15%.

A chart recorder was operated with the left bank sonar counter on an experimental basis in 1994. The recorder was programmed to automatically record on-the-hour for a duration of 15 minutes. Early in the season, the chart recorder was only operated at selected times during hours of suppressed light and darkness, approximately 2100 to 0900 hours. However, it was operated 24 h/d during the peak of the run. Tracings on the chart paper were subsequently examined to compare sonar counts to the number of fish estimated passing from the chart recordings. Chart tracings were used to help identify oscilloscope images as fish during calibration periods and to evaluate if over-counting problems were encountered as a result of salmon holding in the acoustic beam.

Barton Creek Weir

A weir was installed in Barton Creek where it debouches onto the Toklat River floodplain approximately 0.5 km upstream from its confluence with the Toklat River (Figures 5 and 6). Barton Creek was approximately 20 m wide at the weir site with water depth about one meter at the deepest location. A 4.5-m span of the weir consisted of six, 75 cm panels butted together and positioned where water was the deepest and current the most swift. Each panel consisted of twenty-five 1.5 cm diameter by 3 m long metal conduit, spaced on 3 cm centers in angle iron supports. These panels were held in place by large tripods constructed from spruce poles and secured with sandbags. Outer wings of the weir were constructed of 5 cm x 10 cm by 1.2 m high fencing and 2.5 m metal "T" stakes. Fencing was secured to "T" stakes with nylon tie straps and sand-bagged along the stream bottom.

A holding pen was constructed in the weir with additional fencing material and provided entry for upstream bound salmon through a fyke opening. The holding pen was checked a minimum of two to four times daily, but frequency of checks increased with increasing numbers of salmon. Adult salmon were dip-netted from the holding pen, counted by species, sexed, and released upstream. Additional daily inspections of the weir were made as needed to remove beaver cuttings and accumulation of autumn foliage to prevent the weir from washing out. Salmon carcasses washed downstream were removed from the weir and the number of salmon retained in the holding pen held to a minimum to help avoid bear problems.

Climatological and Hydrological Observations

A gauge was installed in the main channel of the Toklat River and changes in water level monitored to the nearest centimeter. Surface water temperature was measured with a pocket thermometer to the nearest degree Centigrade (C). Other observations included recording the occurrence of precipitation, estimated wind velocity and direction, and percent cloud cover. All climatological and hydrological observations were recorded twice daily at approximately 1200 and 2200 hours.

Spawning Ground Surveys and Population Estimate

Intensive ground surveys of the spawning area at Toklat Springs were conducted in mid-October. An updated map of floodplain channels and salmon distribution was prepared. Individual channel locations and wetted areas were estimated from several aerial photographs collected in 1994 and the number of live and dead chum and coho salmon recorded by location. The chum salmon ground count was subsequently expanded to an estimate of total abundance based upon the percentage of live chum salmon actually observed, using an estimated streamlife curve (SLC) and migratory time density curve (MTDC) developed for Toklat Springs. These curves were developed as part of the most recent review of the Toklat River BEG in January 1994 and consisted of the following procedures.

The historic escapement database (1974-1993) comprised of spawning ground survey observations at Toklat Springs was examined (Appendices A, B, and C) and the percentage of live fish observed from all *ground* surveys was tabulated (Appendix D). Aerial survey observations were omitted from this exercise since aerial estimates of the percentage of live fish were considered to be less accurate due to carcasses often being concealed by ice, frost, snow, or silt. On occasion, carcass counts obtained during ground surveys have included only the anterior (heads) or posterior (caudal fin) sections of fish left as a result of predation; a situation which cannot be accurately assessed from the air. Next, several point estimates of the average percentage of live fish on a given date were then identified and a Toklat River SLC plotted using these point estimates and interpolating values for days between the point estimates (Table 3). A Toklat Springs MTDC was then estimated using the SLC just described and a Delta River fall chum salmon SLC and MTDC developed in 1985 (Barton 1986b). The Toklat Springs MTDC was estimated using the same relationship between the proportion of the run which had entered the Delta River, given a certain percentage of live fish remaining in the stream. For example, on 14 October, an average of 81.18% of the fish are estimated to be alive at Toklat Springs (from Toklat Springs SLC). Using the Delta River SLC and MTDC, on the average, 83.76% of the Delta River fall chum salmon run is estimated (by interpolation) to be in the river when 81.18% of the fish are alive. Thus, on the average, 83.76% of the Toklat River run is estimated to be at Toklat Springs by 14 October, or when 81.18% of the fish are alive.

Clearly, the assumption is that fall chum salmon stream residence time is similar in the Toklat and Delta Rivers. Once fish enter the Delta River they are essentially on the spawning grounds, since the spawning area is at the mouth of the Delta River. Observations at Toklat Springs are of fish which are also on the spawning grounds. From this standpoint, "streamlife" as used in this exercise is not total steam residence time. Such would obviously differ between the two rivers as Toklat Springs is some 60+ rkm upstream from the mouth of the Toklat River. "Streamlife" as used here is taken more as the average time fish live once they reach the spawning ground, or "spawner residence time". This is assumed to be similar for these two rivers.

RESULTS

River and Sonar Counting Conditions

Upon arrival of the field crew at the project site on the evening of 3 August, numerous vacant redds and several pair of chinook salmon were observed spawning in lower Barton Creek, and the first chum salmon was observed in the mainstem Toklat River. Water flow in the Toklat River was primarily confined to one channel which traversed the floodplain, leaving exposed a large gravel-bedded point bar on the western side (left bank). A much smaller channel with restricted flow cut behind the point bar. Water flow in this channel fluctuated in response to that of the main river throughout the 1994 season.

Two profiles of the main Toklat River were made on 5 August. The first approximated the same location as the one obtained in August 1993 (Figures 6 and 8). The second was made about 30 m farther downstream where the left bank transducer was eventually deployed on 14 August. River width at the latter location measured 50 m with the bottom sloping gently from the point bar to the thalweg (a distance of 41 m) at a rate of approximately 3.5 to 4.5 cm/m for a bottom slope of approximately 2.0° to 2.5°. River bottom from the thalweg to the right bank was steeper, rising approximately 18 cm/m (~10° bottom slope).

The Toklat River at the project site experienced moderate variations in water level in 1994 (Appendix E). Minimum and maximum water level differed by 75 cm between 5 August and 4 October. With exception of a single high water event which occurred on 26 and 27 August, the overall trend was a decline in water level throughout duration of the project (Figure 9). The high water event, accompanied by an extremely heavy debris load, was responsible for suspending sonar counting operations for nearly 3 days beginning at 1930 hours on 27 August. Although the river crested at approximately 0230 hours on 28 August, counting was not resumed until noon on 30 August. During this high water event, much of the west bank point bar was submersed and the smaller channel behind the bar was of sufficient depth to permit passage of salmon. However, no salmon were observed in this slough based upon ground surveys conducted daily during the period of high water. Apart from the one high water event, water levels in this channel were generally too low to allow salmon passage. A decline in water level was observed throughout September, and by the end of the month it was 33 cm lower than recorded on 5 August. Left bank counting operations were also suspended between 0200 and 1500 hours on 17 August, due to extremely high winds which created a silt storm and reduced visibility to zero. All electronics were powered down and securely sealed to prevent damage from airborne silt particles.

Abundance Estimation

The original strategy was to monitor salmon passage in the mainstem Toklat River with a single transducer deployed from the left bank point bar. Its acoustic beam would extend to the adjacent bank where a diversion weir (fish lead) would direct right-bank oriented salmon offshore through the left bank counter's acoustic beam. Although a left bank transducer was deployed on 14 August, hydrologic conditions prevailing for the remainder of the month prevented a lead from being installed on the right bank of a size sufficient to accomplish this. Only a small lead about 2 m in length could be installed and proved to be of little value. A distance of approximately 8 m, extending from the right bank to the end of the left bank acoustic beam, was uninsonified during this period. However, a 4 m lead was successfully constructed on the right bank on 2 September following a drop in water level from the high water event in late August. A second sonar counter, with its transducer deployed from the right bank, became operational on 6 September to investigate salmon passage along the right bank. Initially, this counter was only operated during hours of suppressed light or darkness; the period of greatest upstream movement observed along the left bank. It was operated 24 h/d subsequent to 19 September.

The sonar-estimated passage in the Toklat River upstream of Barton Creek was 75,867 fish (salmon) for the period 14 August through 4 October 1994 (Table 4). This estimate includes expansions for those days only partially monitored by either counter, as well as two days when counting was suspended during the high water event. For example, only 34 fish were counted on the first day of operations with the left bank counter (14 August) between 1800 and 2400 hours. That count was subsequently expanded to a total of 49 based upon the percentage of counts observed the following day between 1800 and 2400 hours. This same method was used to estimate fish passage on the left bank for 17 August, using data from 18 August. Passage for 27 and 30 August was based upon the average proportion of counts for the missing time blocks on these two days, that were observed during the first three full days of sonar counting after the high water event, i.e., 31 August through 2 September. The 4 October partial-day count obtained with both counters was expanded using temporal passage data collected from the preceding day from respective counters. Daily passage for 28 and 29 August was taken as the average passage estimated from 27 and 30 August. Finally, on days when only the left bank was in operation (14 August through 6 September), daily passage estimates for the right bank were estimated using the average daily proportion that right bank counts comprised of the combined daily total during the period when both sonar counters operated 24 h/d (20 September through 3 October).

The sonar-estimated escapement consists of adjusted daily counts made for each counter based upon oscilloscope calibration data collected throughout the season. A total of 304 calibrations averaging 22.1 min in duration were made to the left bank counter during the period 14 August through 4 October (Appendix F). For the right bank counter, 84 calibrations averaging 15.4 min in duration were made between 6 September and 4 October (Appendix G). Total effort amounted to more than 133 h of calibration time between the two sonar counters. An attempt was made to increase calibration effort during periods of the day when upstream migration was heaviest (Figure 10).

Temporal and Spatial Distribution

The entry pattern of salmon in the Toklat River subsequent to mid-August was protracted for more than 1.5 months in 1994 based upon hydroacoustic fish passage assessment (Figure 11). Although the first chum salmon was observed in the main river near the project site as early as 3 August, relatively few were judged present when sonar operations were initiated on 14 August. Only 54 fish were estimated passing the project site on that day. Passage remained low through the end of August ranging from 54 to 1,209 fish per day. Estimated total passage during that period was 6,424 fish or 8% of the run, with an average passage rate of only 356 fish per day. Daily passage increased to an average of 1,174 fish/d during the first 19 days of September when approximately 29% of the run (22,323 fish) was estimated to have passed the project site. However, during the period 20 September through 4 October, 47,120 fish were estimated passing, representing 62% of the total sonar-estimated escapement. The average passage rate was 3,141 fish/d with the highest daily estimate made on 21 September (5,920 fish). Fish were still passing the project site at a rate of 484 per day when operations terminated on 4 October.

Some 67,454 fish, or 89% of the total sonar-estimated escapement, was estimated to have passed on the left bank, with the remaining 11% (8,413 fish) estimated on the right bank. Spatial distribution of sonar counts by electronic sector indicates that most fish passage occurred nearshore, although some counts were observed in all sectors of each acoustic beam (Figure 12). For example, not only did the majority of fish swim upstream along the left bank point bar, but 92% of *those* passed through the first two nearshore sectors. The average length of each sector was 1.3 m based upon an average counting range of 16.5 m for the left bank counter. This results in more than 62,000 fish passing within 2-2.5 m of the left bank transducer. Similarly, 82% of the right bank passage estimate was confined to the first three nearshore sectors, each of which averaged 0.5 m in length based upon an average counting range of 6.4 m for that counter.

Distribution of sonar counts by hour revealed a distinct diel pattern in passage along both banks (Appendices H and I). Fish passage primarily occurred during periods of darkness or hours of suppressed light (Figure 13). Peak passage along the left bank occurred between 2200 and 2400 hours while peak hourly passage along the right bank was between 2200 and 2300 hours. Night time passage along each bank gradually subsided with the ensuing hours of daylight and remained low until twilight approached.

Weir Passage

A total of 3 chinook , 39 chum (24 male, 15 female) and 295 coho salmon (191 male, 104 female) were passed through the weir in Barton Creek between 17 August and 4 October (Table 5). Thirty-three of the chum salmon (85%) had been passed by 4 September, but the first coho salmon was not passed until 18 September. Although a foot survey of that portion of the stream below the weir on 23 September did not reveal any salmon to be present, a helicopter survey of the same section on 27 September resulted in a count of 7 chum and 699 coho salmon in several large pools 100-150 m downstream of the weir. By late afternoon on 3 October, approximately 1,500-2,000 coho salmon were observed tightly schooled below the weir. These were rapidly-maturing fish as evidenced by their dark-red body color and blackish tails. Within the next 24 hours this large school of fish literally destroyed portions of the weir fencing and passed upstream.

Due to the tremendous load of autumn foliage carried downstream and resulting leaf accumulation on the weir, the fencing portion of the weir had to be removed on 13 September. The weir was once again fish-proof by 1300 hours on 16 September. Although four chum salmon were passed on 16 September, few (if any) salmon are believed to have passed the weir site during the time it was inoperable. For example, no salmon had been passed from 5 through 13 September and only four chum and four coho salmon were passed from 16 to 22 September.

Other fish species observed at the Barton Creek weir in 1994 included longnose sucker (*Catostomus catostomus*), burbot (*Lota lota*), Arctic grayling (*Thymallus arcticus*), and "whitefish". All of these species were of the size that allowed them to pass unharmed through the fencing portion of the weir. Unfortunately no voucher collection was made of the "whitefish" to ascertain the exact species. These fish may have been round whitefish (*Prosopium cylindraceum*) or ciscos (*Coregonus* spp). Although occasionally observed throughout the season, the largest school of "whitefish" was observed at the weir on 30 September.

Spawning Ground Surveys - Toklat Springs

Prior to the ground surveys scheduled to be conducted in mid-October of the main spawning area at Toklat Springs, a helicopter survey was flown of the Toklat River on 27 September upstream of the sonar site. The survey was rated "poor" due to high turbidity levels. The surveyor could only see along the sides of channels in the shallowest water zones. Many floodplain channels were not examined and several bends were omitted during the survey. An estimated 2,640 chum and 3 coho salmon were observed between the sonar site and the vicinity of Mallard Slough (lower end of Toklat Springs). These fish were not observed in large schools but were somewhat scattered, and moving upstream. No spawning was observed. A grizzly sow with three cubs was also observed on the floodplain just downstream of Mallard Slough.

A poor and incomplete examination of the floodplain sloughs at Toklat Springs during this helicopter survey revealed the presence of several thousand chum salmon (Figure 14). Although 6,090 chum salmon (19% carcasses) were actually counted in several shallow-water sloughs where visibility was good, many more fish were observed and judged to be fairly well distributed throughout the central floodplain. For example, 950 live and 255 dead chum salmon were counted in a small slough immediately below Wolf Island. In upper Wolf Slough 1,250 live chum salmon and 435 carcasses were counted. A total of 1,032 live and 437 dead chums were counted in other central floodplain sloughs, while in excess of 1,691 live and 40 dead chums were counted in sloughs on the eastern side of the floodplain. Some degree of spawning was observed to be occurring in most of the areas examined.

The upper extent of the 27 September aerial survey was at a large island in the central floodplain located approximately 1.5-2 km upstream of Knight's Roadhouse and adjacent to where the Toklat River breaches to the Sushana River. A few hundred chum salmon were observed in sloughs at the lower end of this island. Flyovers of both Geiger Creek and the lower portion of the Sushana River also revealed the presence of a few thousand more chum salmon on the 27 September survey.

Intensive *ground* surveys of the Toklat Springs index area were conducted during the period 12-19 October. Foot surveys of Geiger Creek, Sushana River, and clearwater floodplain slough index areas were successfully completed (Table 6). There was little snow cover upon arrival and only 12-15 cm of additional accumulation. Although snow did conceal some carcasses during the latter surveys, all surveys conducted of floodplain sloughs as well as of Sushana River were rated either "good" or "fair". The Geiger Creek survey was rated "good". Chum salmon spawning was judged to be at peak and timing of surveys considered good. Several floodplain sloughs and the Sushana River were surveyed twice. Total count for the Toklat Springs index area was 71,504 chum salmon of which 43.9% were carcasses. A total of 617 coho salmon were also counted, representing less than 1% of the total number of salmon counted at Toklat Springs. Updated maps of floodplain channels and salmon distribution were prepared (Figures 15 and 16). The chum salmon ground count was subsequently expanded to a total abundance estimate of 76,057 fish using the Toklat Springs MTDC previously described. The coho salmon count was not expanded.

DISCUSSION

Overall, the Toklat River project ran smoothly in 1994 with only a few problems encountered. Although it was hoped that salmon passage could be monitored in the main river using a single sonar transducer, two units were necessary, and were successfully deployed and operated to estimate timing and abundance of the salmon run. Future studies at the project site should be specifically designed to monitor the salmon run with two counting units housed and operated from the higher elevation right bank, with transducers deployed from both banks. Thus, it will be important to ensure that ample transducer cable is available to operate in this manner. In 1994 some difficulty associated with length of the left bank transducer cable was encountered, while operating the counter from the right bank. Longer cables will facilitate transducer moves necessitated by fluctuating river water levels and/or increases in debris loads, while at the same time lessen the chance of equipment and/or data loss.

The proportion of the river insonified in 1994 varied throughout the season, depending upon range of the acoustic beams and actual placement of transducers as necessitated by fluctuations in river water level. The uninsonified portion of the river was greatest prior to 6 September when only one unit was operating from the left bank point bar. However, only 17% of the total passage estimate for the season was made during this period, including an estimate for fish passing along the right bank through the uninsonified zone. The right bank estimate during this period was based upon the proportion right bank counts were of the total count on days when both counters were functional. Once both counters became operational 24 h/d in mid-September, an uninsonified area averaging less than two meters in width existed between the outer ends of the two acoustic beams. No attempt was made to estimate fish passage for this small area but it is believed to have been negligible based upon a review of the spatial distribution of counts by electronic sector.

The diel salmon migration pattern observed in the Toklat River has also been observed with fall-run chum salmon in the Sheenjek River (Barton 1983, 1984b, 1985, 1987, and 1995). Although the pattern was very similar along both banks in 1994, increased passage on the left bank during the two hours subsequent to the hour ending at 0800 is somewhat anomalous. It is conjectured that this increase was a function of cleaning the left bank fish lead each morning between 0800 and 0900 hours. Floating/suspended debris such as leaves, beaver cuttings, root wads, small sticks, and cottonwood bark accumulated on the fish lead throughout night-time hours. By morning, accumulated debris had often created a head of 15 cm or more along the upstream side of the lead, allowing salmon to hold in slack water on the downstream side. Once cleaned of debris however, water velocity greatly increased through the lead, perhaps inducing salmon to move upstream.

Debris was always present in the river and its accumulation on fish leads and Barton Creek weir varied throughout the season. However, it was particularly troublesome during the latter part of September from the enormous load of deciduous foliage carried downstream in both the Toklat River and Barton Creek. This increased debris load, together with material selection used for fish leads and part of the weir in Barton Creek, necessitated a high daily vigil and frequent repairs to ensure leads were not breached and salmon allowed to pass upstream undetected. However, excessive accumulation of autumn foliage on Barton Creek weir necessitated its removal for nearly three days in mid-September until the debris load lessened. On the last day of field operations, portions of the weir did collapse from weakened fencing material allowing free salmon passage. Fortunately an estimate was made for the number of coho salmon which passed during that period. The weir and fish lead fencing material used in 1994 must be upgraded to something stronger during future work at this project site.

A preseason fall chum salmon run projection of only 605,000 fish for the Yukon River in 1994 was due largely to an anticipated age-5 shortfall from the 1989 brood year (JTC 1994). Fall chum commercial fishing opportunities were not anticipated in the Alaskan portion of the drainage if the run materialized at that level. In brief, fall chum salmon run strength in 1994 was assessed *inseason* to be much weaker than it in fact was, due to poor performance of the lower Yukon River sonar project at Pilot Station during the fall season. This resulted in closures or restrictions to various fall season fisheries throughout the drainage on a run size much larger than originally believed. In effect, low exploitation on Yukon River fall chum salmon resulted in excellent escapements throughout the drainage in 1994, and the Toklat River was no exception.

The sonar-estimated escapement in the Toklat River was 75,867 salmon. Based upon results of subsequent ground surveys of Toklat Springs, 99% of the estimate, or 75,108 fish, were considered to be fall-run chum salmon. While this estimate is considered conservative due to an unknown number of salmon which passed the sonar counting site prior and subsequent to counting operations, it compares exceptionally well with the subsequent fall chum population estimate made for Toklat Springs. That estimate of 76,057 fall chum salmon revealed the minimum escapement goal (33,000) was exceeded by more than 130% in 1994. This was the largest escapement estimate for this river since 1979.

Results from this first year study indicate that sonar is a feasible means of monitoring salmon escapement in the Toklat River, given the river characteristics and hydrologic conditions that prevailed at the project site in 1994. Further, results also suggest that the assumptions outlined in the objectives section appear to have held true, at least for 1994, and that past estimates of fall chum salmon escapement to the Toklat River, obtained from expanded ground survey observations, are reasonable. Although no other major spawning areas apart from Toklat Springs were manifested in 1994, it is recommended that sonar operations be continued in order to compare the two independent annual abundance estimates (sonar versus expanded ground surveys) over years with differing run sizes.

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Table 1. Alaskan and Canadian total utilization of Yukon River fall chum salmon, 1961–1994 (from JTC 1995).

Year	Canada [a]	Alaska [b,d]	Total
1961	9,076	144,233	153,309
1962	9,436	140,401	149,837
1963	27,696	99,031 [f]	126,727
1964	12,187	128,707	140,894
1965	11,789	135,600	147,389
1966	13,192	122,548	135,740
1967	16,961	107,018	123,979
1968	11,633	97,552	109,185
1969	7,776	183,373	191,149
1970	3,711	265,096	268,807
1971	16,911	246,756	263,667
1972	7,532	188,178	195,710
1973	10,135	285,760	295,895
1974	11,646	383,552	395,198
1975	20,600	361,600	382,200
1976	5,200	228,717	233,917
1977	12,479	340,757	353,236
1978	9,566	331,250	340,816
1979	22,084	593,293	615,377
1980	22,218	466,087	488,305
1981	22,281	654,976	677,257
1982	16,091	357,084	373,175
1983	29,490	495,526	525,016
1984	29,267	383,055	412,322
1985	41,265	474,216	515,481
1986	14,543	303,485	318,028
1987	44,480	361,663 [f]	406,143
1988	33,565	319,677	353,242
1989	23,020	518,157	541,177
1990	33,622	316,478	350,100
1991	35,418	403,678	439,096
1992	20,815	128,031 [h]	148,846
1993	14,090	76,925 [f]	91,015
1994 [g]	38,008	131,217	169,225
Average			
1961–84	14,957	280,840	295,796
1985–89	31,375	395,440	426,814
1990–94	28,391	211,266	239,656

[a] Commercial, Indian Food, and Domestic catches combined.
[b] Catch in number of salmon. Includes estimated number of salmon harvested for commercial production of salmon roe.
[d] Commercial, subsistence, and personal–use catches combined.
[f] Subsistence catch only; commercial fishery did not operate.
[h] Commercial fishery operated only in District 6, the Tanana River.
[g] Data are preliminary.

Table 2. Toklat River fall chum salmon total spawning abundance estimates based upon surveys of the spawning area at Toklat Springs, 1974–1993.

	Toklat Springs			
Year	Floodplain Sloughs	Sushana River	Geiger Creek	Total
1974	34,348	3,622	3,828	41,798
1975	63,088	23,766	5,411	92,265
1976	38,902	9,845	4,144	52,891
1977	24,507 [a]	7,232	3,148 [a]	34,887
1978	21,144	5,286	10,571	37,001
1979	112,890	20,749	24,697	158,336
1980	9,378	13,556	3,412	26,346
1981	3,421	8,500	3,702	15,623
1982	343	2,429	852	3,624
1983	7,753	5,801	8,315	21,869
1984	7,037	6,167	3,554	16,758
1985	15,538	5,360	1,852	22,750
1986	15,615	1,001	1,360	17,976
1987	11,983	2,742	7,392	22,117
1988	11,305	51	2,080	13,436
1989	24,743	3,167	2,511	30,421
1990	17,752	14,415	2,572	34,739
1991	7,616	1,514	4,217	13,347
1992	10,649	1,544	1,877	14,070
1993	18,100	3,571	6,167	27,838

[a] Expanded from observations made under "poor" survey conditions.

Table 3. Estimated stream life curve (SLC) and migratory time density curve (MTDC) for Toklat River fall chum salmon based upon Delta River studies (Barton 1986).

	Delta River [a]		Toklat River		Toklat River	
Date	% Live	Proportion of Run in River	% Live	Proportion of Run in River	SLC [b]	MTDC [d]
17-Sep			100.00%	0.00%	100.00%	0.00%
18-Sep					98.08%	3.96%
19-Sep			96.16%	7.92%	96.16%	7.92%
20-Sep					95.56%	10.95%
21-Sep					94.96%	13.99%
22-Sep					94.36%	17.02%
23-Sep					93.76%	20.05%
24-Sep					93.16%	23.09%
25-Sep	100.00%	0.00%			92.56%	26.12%
26-Sep					91.97%	29.16%
27-Sep					91.37%	32.19%
28-Sep					90.77%	35.22%
29-Sep					90.17%	38.26%
30-Sep					89.57%	41.29%
01-Oct	98.44%	1.77%			88.97%	44.32%
02-Oct					88.37%	47.36%
03-Oct					87.77%	50.39%
04-Oct					87.17%	53.42%
05-Oct	97.37%	3.45%			86.57%	56.46%
06-Oct					85.97%	59.49%
07-Oct					85.37%	62.52%
08-Oct					84.78%	65.56%
09-Oct					84.18%	68.59%
10-Oct	95.94%	9.34%			83.58%	71.63%
11-Oct					82.98%	74.66%
12-Oct					82.38%	77.69%
13-Oct					81.78%	80.73%
14-Oct	94.72%	20.61%	81.18%	83.76%	81.18%	83.76%
15-Oct					80.49%	85.10%
16-Oct					79.81%	86.44%
17-Oct	92.94%	31.58%	79.12%	87.78%	79.12%	87.78%
18-Oct					77.01%	89.73%
19-Oct					74.91%	91.69%
20-Oct	90.96%	43.18%	72.80%	93.64%	72.80%	93.64%
21-Oct					71.63%	94.04%
22-Oct	88.98%	51.79%			70.45%	94.44%
23-Oct	87.73%	56.49%	69.28%	94.84%	69.28%	94.84%
24-Oct					66.40%	95.34%
25-Oct					63.53%	95.83%
26-Oct	83.86%	76.14%	60.65%	96.33%	60.65%	96.33%
27-Oct					59.42%	96.49%
28-Oct					58.18%	96.66%
29-Oct					56.95%	96.82%
30-Oct	76.91%	90.26%	55.71%	96.98%	55.71%	96.98%
31-Oct						
01-Nov						
02-Nov						
03-Nov						
04-Nov						
05-Nov	61.79%	96.14%				

[a] Estimated SLC and MTDC for Delta River (from Barton 1986).

[b] Estimated SLC for Toklat Springs (Sushana River, Geiger Creek, and mainstem floodplain sloughs in vicinity of Knight's Roadhouse). Point estimates (single outlined boxes) are from Appendix A.4.

[d] Estimated MTDC for Toklat Springs (Sushana River, Geiger Creek, and mainstem floodplain sloughs in vicinity vicinity of Knight's Roadhouse). Point estimates (double outlined boxes) are from Delta River SLC and MTDC.

Table 4. Sonar–estimated fish passage in the Toklat River, 1994.

Date	Estimated Fish Passage [a]						Proportion (Both Banks)	
	Left Bank		Right Bank		Both Banks			
	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum [h]
14–Aug	49 [b]	49	5 [d]	5	54	54	0.00	0.00
15–Aug	76	125	7	12	83	137	0.00	0.00
16–Aug	57	182	5	17	62	199	0.00	0.00
17–Aug	91 [b]	273	8	25	99	298	0.00	0.00
18–Aug	91	364	8	34	99	398	0.00	0.01
19–Aug	164	528	15	49	179	577	0.00	0.01
20–Aug	292	820	27	76	319	896	0.00	0.01
21–Aug	179	999	17	93	196	1,092	0.00	0.01
22–Aug	155	1,154	14	107	169	1,261	0.00	0.02
23–Aug	101	1,255	9	117	110	1,372	0.00	0.02
24–Aug	210	1,465	20	136	230	1,601	0.00	0.02
25–Aug	265	1,730	25	161	290	1,891	0.00	0.02
26–Aug	908	2,638	84	245	992	2,883	0.01	0.04
27–Aug	545 [b]	3,183	51	296	596	3,479	0.01	0.05
28–Aug [f]	534 [f]	3,717	50	345	583	4,062	0.01	0.05
29–Aug [f]	534 [f]	4,250	50	395	583	4,645	0.01	0.06
30–Aug	522 [b]	4,772	48	443	570	5,215	0.01	0.07
31–Aug	1,106	5,878	103	546	1,209	6,424	0.02	0.08
01–Sep	1,258	7,136	117	663	1,375	7,799	0.02	0.10
02–Sep	1,289	8,425	120	783	1,409	9,208	0.02	0.12
03–Sep	808	9,233	75	858	883	10,091	0.01	0.13
04–Sep	815	10,048	76	933	891	10,981	0.01	0.14
05–Sep	1,004	11,052	93	1,027	1,097	12,079	0.01	0.16
06–Sep	830	11,882	77	1,104	907	12,986	0.01	0.17
07–Sep	438	12,320	46 [g]	1,150	484	13,470	0.01	0.18
08–Sep	254	12,574	88	1,238	342	13,812	0.00	0.18
09–Sep	912	13,486	163	1,401	1,075	14,887	0.01	0.20
10–Sep	899	14,385	106	1,507	1,005	15,892	0.01	0.21
11–Sep	1,158	15,543	40	1,547	1,198	17,090	0.02	0.23
12–Sep	1,786	17,329	76	1,623	1,862	18,952	0.02	0.25
13–Sep	1,746	19,075	71	1,694	1,817	20,769	0.02	0.27
14–Sep	873	19,948	44	1,738	917	21,686	0.01	0.29
15–Sep	811	20,759	629	2,367	1,440	23,126	0.02	0.30
16–Sep	665	21,424	489	2,856	1,154	24,280	0.02	0.32
17–Sep	904	22,328	660	3,516	1,564	25,844	0.02	0.34
18–Sep	772	23,100	430	3,946	1,202	27,046	0.02	0.36
19–Sep	1,445	24,545	256	4,202	1,701	28,747	0.02	0.38
20–Sep	3,932	28,477	119	4,321	4,051	32,798	0.05	0.43
21–Sep	5,794	34,271	126	4,447	5,920	38,718	0.08	0.51
22–Sep	4,905	39,176	168	4,615	5,073	43,791	0.07	0.58
23–Sep	4,298	43,474	168	4,783	4,466	48,257	0.06	0.64
24–Sep	2,759	46,233	178	4,961	2,937	51,194	0.04	0.67
25–Sep	4,217	50,450	225	5,186	4,442	55,636	0.06	0.73
26–Sep	3,848	54,298	348	5,534	4,196	59,832	0.06	0.79
27–Sep	4,094	58,392	303	5,837	4,397	64,229	0.06	0.85
28–Sep	2,427	60,819	401	6,238	2,828	67,057	0.04	0.88
29–Sep	2,360	63,179	427	6,665	2,787	69,844	0.04	0.92
30–Sep	1,570	64,749	483	7,148	2,053	71,897	0.03	0.95
01–Oct	1,275	66,024	361	7,509	1,636	73,533	0.02	0.97
02–Oct	690	66,714	318	7,827	1,008	74,541	0.01	0.98
03–Oct	526	67,240	316	8,143	842	75,383	0.01	0.99
04–Oct	214 [b]	67,454	270 [b]	8,413	484	75,867	0.01	1.00
Totals	67,454		8,413		75,867		1.00	

[a] No species apportionment has been made.
[b] Expanded or interpolated value.
[d] Daily right bank passage estimates for 14 August to 6 September were taken as the average proportion (0.085) right bank counts were of both banks when both units operated 24 h/d (20 September through 3 Ocotber).
[f] Did not operate due to high water and excessive debris loads in river. Daily estimates taken as average of estimated passage on 27 and 30 August.
[g] Daily right bank passage estimates for period 7–19 September were derived from daily temporal distribution (on respective days) observed among left bank counts
[h] First and third quartiles are shown as well as median day of passage.

Table 5. Daily chum and coho salmon passage at Barton Creek weir (Toklat River drainage), 1994.

Date	Chum Salmon Male	Chum Salmon Female	Chum Salmon Total	Chum Salmon Cum	Coho Salmon Male	Coho Salmon Female	Coho Salmon Total	Remarks (other fish passed)
17–Aug			0	0			0	Two jack chinook caught/released
18–Aug	1	1	2	2			0	
19–Aug	1	1	2	4			0	
20–Aug	1	1	2	6			0	
21–Aug	1	1	2	8			0	
22–Aug	2		2	10			0	
23–Aug			0	10			0	
24–Aug		1	1	11			0	
25–Aug			0	11			0	
26–Aug			0	11			0	Passable hole (approximately 10 h)
27–Aug	6	1	7	18			0	One male chinook caught/released
28–Aug	2	1	3	21			0	One whitefish caught/released
29–Aug			0	21			0	
30–Aug	1	2	3	24			0	
31–Aug	1	2	3	27			0	
01–Sep			0	27			0	
02–Sep	1		1	28			0	
03–Sep	1		1	29			0	
04–Sep	3	1	4	33			0	
05–Sep			0	33			0	
06–Sep			0	33			0	Passable hole (approximately 2 h). One sucker caught/released.
07–Sep			0	33			0	
08–Sep			0	33			0	
09–Sep			0	33			0	Put new fencing on outer ends of weir. Lots of leaves.
10–Sep			0	33			0	Tons of leaves accumulating on weir, must clean often.
11–Sep			0	33			0	Weir choked with leaves.
12–Sep			0	33			0	Fence undercutting from heavy folage accumulation; repaired.
13–Sep			0	33			0	Extremely heavy folage accumulation in weir. Pull outer lead at 1645 h.
14–Sep			0	33			0	Weir out
15–Sep			0	33			0	Weir still out
16–Sep	2	2	4	37			0	Weir operable at 1245 h.
17–Sep			0	37			0	One dead male coho caught in fencing
18–Sep			0	37		1	1	
19–Sep			0	37			0	One male coho spotted downstream of weir
20–Sep			0	37	2		2	Heavy folage accumulation continues.
21–Sep			0	37			0	
22–Sep			0	37	1		1	
23–Sep	1	1	2	39	4		4	
24–Sep			0	39			0	
25–Sep			0	39	3	3	6	
26–Sep			0	39	8	5	13	
27–Sep			0	39	18	8	26	
28–Sep			0	39	17	8	25	
29–Sep			0	39	10	8	18	One whitefish caught/released.
30–Sep			0	39	6	6	12	Large school of whitefish observed on upstream side of weir.
01–Oct			0	39	9	4	13	
02–Oct			0	39	8	2	10	
03–Oct			0	39	30	11	41	
04–Oct [a]			0	39	75	48	123	Repaired holes @ 1510 h. Huge holes in fence by 1750 h; unrepairable
05–Oct [a]			0	39				Removed what was left of weir.
Total	24	15	39		191	104	295	

[a] By 1200 hours on 4 October, the large schools of coho salmon that had been holding in several pools well downstream of weir had moved up behind weir. The coho salmon were all moving upsteam at once and literally tore the weir fencing apart, creating huge holes. By 1750 hours the damage was unrepairable and coho salmon were flooding through. It was estimated that an additional 1,500–2,000 coho salmon passed the weir site in a 24–hour period subsequent to approximately 1700 hours on 4 October.

Table 6. Abundance and distribution of chum and coho salmon at Toklat Springs based upon ground surveys conducted in mid-October 1994.

	Survey Date	Chum Salmon Live	(%)	Dead	(%)	Coho Salmon Live	Dead	Survey Rating
SUSHANA RIVER								
Lower section, downstream of cabin	12-Oct	4,881	72.9%	1,814	27.1%	32	3 *	Fair
Upper section, upstream of cabin	12-Oct	3,954	62.2%	2,402	37.8%	23	2 *	Fair
		8,835	67.7%	4,216	32.3%	55	5 *	
Lower section, downstream of cabin	18-Oct *	6,020	67.5%	2,903	32.5%	37 *	0	Fair-Good
Upper section, upstream of cabin	18-Oct *	7,056	59.8%	4,741	40.2%	44 *	0	Fair-Good
		13,076	63.1%	7,644	36.9%	81 *	0	Fair-Good
Extreme upper section, aerial	20-Oct *	450	60.0%	300	40.0%	0	0	Good
Total Sushana River		13,526	63.0%	7,944	37.0%	81	5	
EASTERN FLOODPLAIN SLOUGHS								
Roadhouse Slough	14-Oct	859	88.1%	116	11.9%	0	0	Good
Roadhouse Slough, upper (section flowing in timber)	19-Oct *	728	86.6%	113	13.4%	0	0	Good
Roadhouse Slough, lower (downstream of Roadhouse)	19-Oct *	1,175	92.8%	91	7.2%	6	0	Good
Total Roadhouse Sl*		1,903	90.3%	204	9.7%	6	0	
Slough flowing immediately behind (west) two small islands downsteam of Sushana River mouth – (Roadhouse Slough extension)	14-Oct	2,217	74.0%	777	26.0%	0	0	Good
(Roadhouse Slough extension)	19-Oct *	1,297	43.1%	1,714	56.9%	0	0	Good
Slough parallels timber below mouth of Sushana Ri to its terminus at lower Mallard Slough	13-Oct *	4,395	62.6%	2,621	37.4%	11	0	Good
Lollipop Slough	13-Oct *	740	26.8%	2,025	73.2%	0	0	Good
Total Eastern Floodplain Sloughs		8,335	55.9%	6,564	44.1%	17	0	
MIDDLE FLOODPLAIN								
Middle Floodplain Slough	13-Oct *	2,505	52.8%	2,239	47.2%	0	0	Fair-Good
Middle Floodplain Slough	16-Oct	1,983	45.0%	2,420	55.0%	0	0	Poor-Fair
Upper Middle Floodplain Sl and upper Wolf Sl extension	13-Oct *	1,299	38.7%	2,059	61.3%	3	0	Good
Sushana River mouth across floodplain to Wolf Slough	14-Oct	6,442	56.4%	4,981	43.6%	25	0	Fair
Sushana River mouth across floodplain to Wolf Slough	18-Oct *	5,800	48.3%	6,218	51.7%	22	1	Fair
Total Middle Floodplain Sloughs		9,604	47.7%	10,516	52.3%	25	1	
WESTERN FLOODPLAIN								
Wolf Island Creek	14-Oct	--	--	1,011	--	--	--	Incomplete
Wolf Island Creek	17-Oct *	1,473	53.4%	1,288	46.6%	23	0	Good
Wolf Slough and Mallard Slough		Part of Main Channel Flow						
Upper Western Floodplain Slough	15-Oct *	1,720	39.2%	2,663	60.8%	54	1	Good
Eagle Slough (downstream Mallard Slough)	13-Oct *	90	26.6%	248	73.4%	0	0	Good
Total Western Floodplain Sloughs		3,283	43.9%	4,199	56.1%	77	1	
GEIGER CREEK								
Mouth to beaver dam	17-Oct *	3,991	65.5%	2,105	34.5%	338	0	Good
Upstream of beaver dam	17-Oct *	304	85.2%	53	14.8%	72	0	Good
Total Geiger Creek		4,295	66.6%	2,158	33.4%	410	0	Good
MAIN TOKLAT RIVER CHANNEL (aerial) Includes Mallard Slough, Wolf Slough, continuing upstream to where Toklat River channel breaches timber into Sushana River.	20-Oct *	1,080	100.0%	0	0.0%	0	0	Fair

SUMMARY:

	Chum Live	(%)	Dead	(%)	Coho Live	Dead
Sushana River	13,526	63.0%	7,944	37.0%	81	5
Geiger Creek	4,295	66.6%	2,158	33.4%	410	0
Toklat Floodplain	22,302	51.2%	21,279	48.8%	119	2
Toklat River Index Area Totals	40,123	56.1%	31,381	43.9%	610	7

Total = 71,504 chum salmon 617 coho salmon

* Survey observations included in totals.

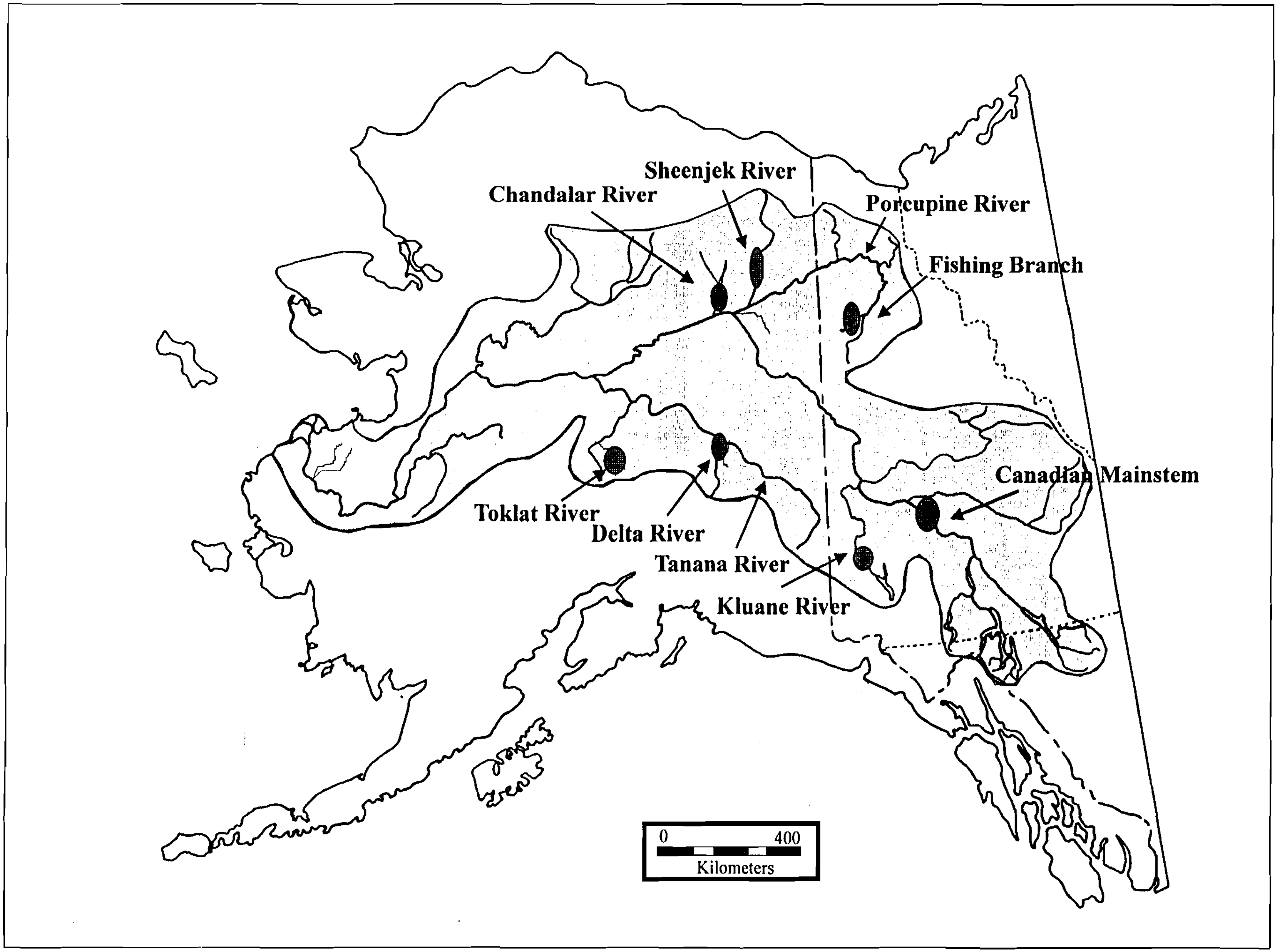


Figure 1. Important Yukon River fall chum salmon spawning areas.

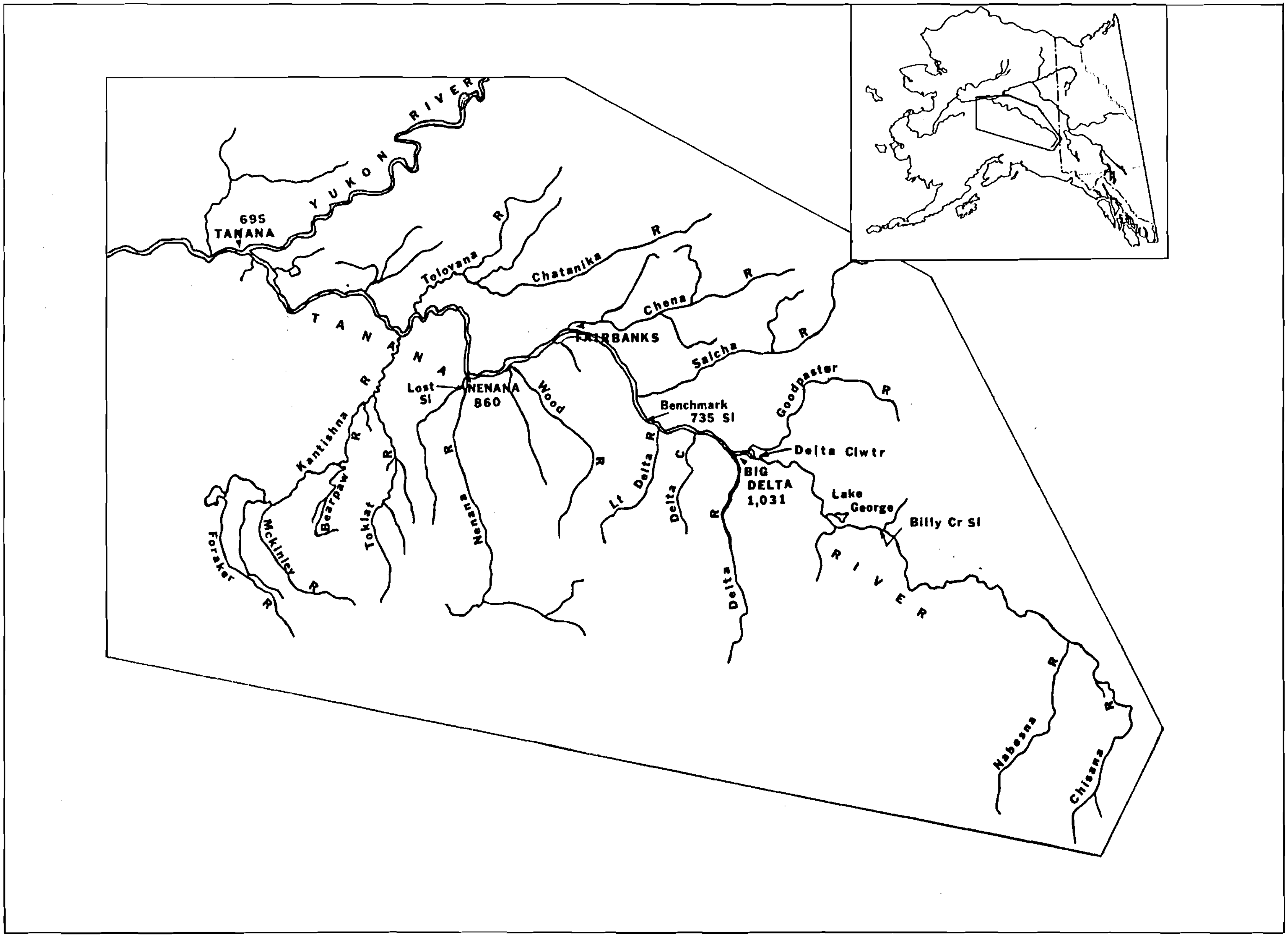


Figure 2. The Tanana River drainage.

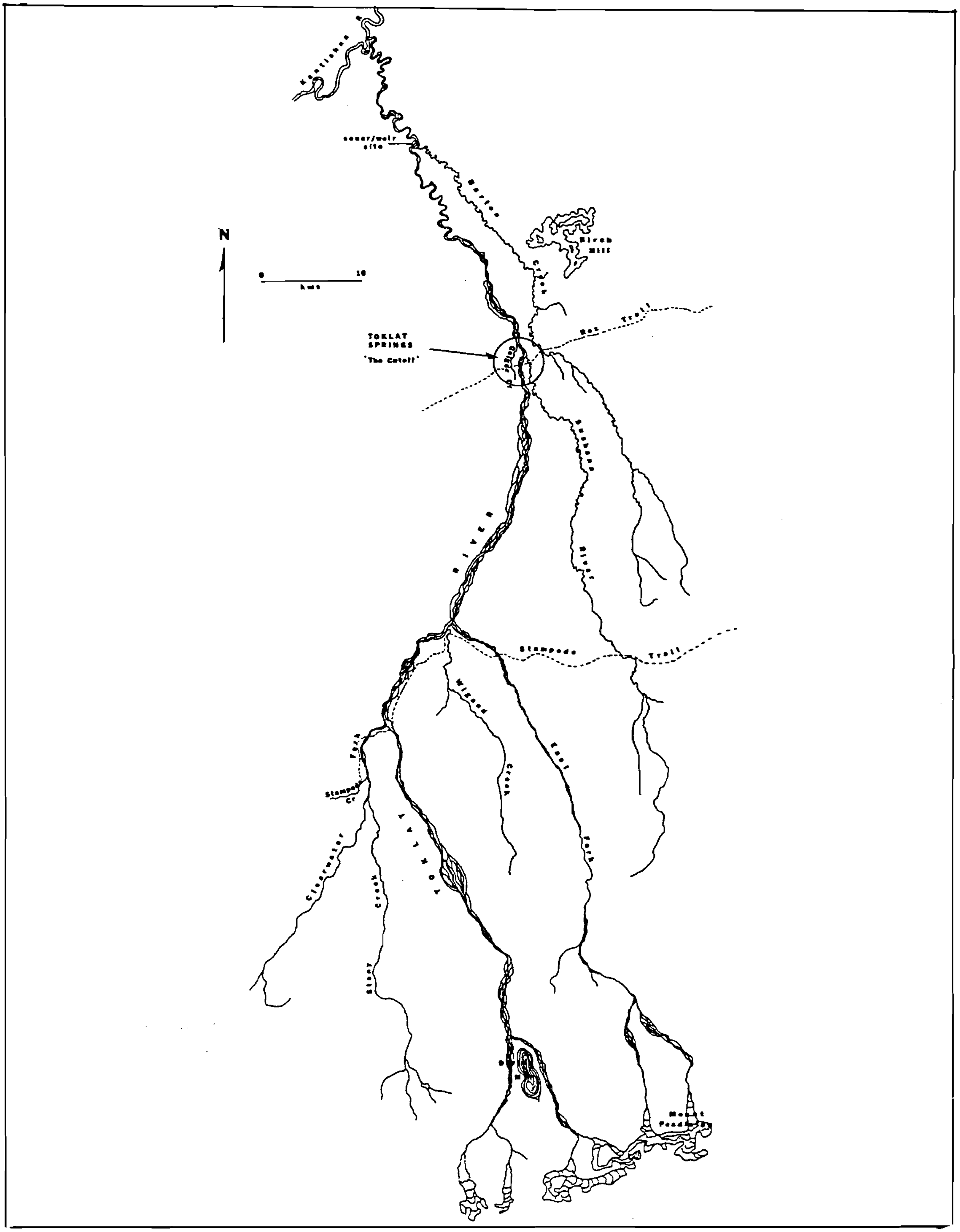


Figure 3. The Toklat River drainage.

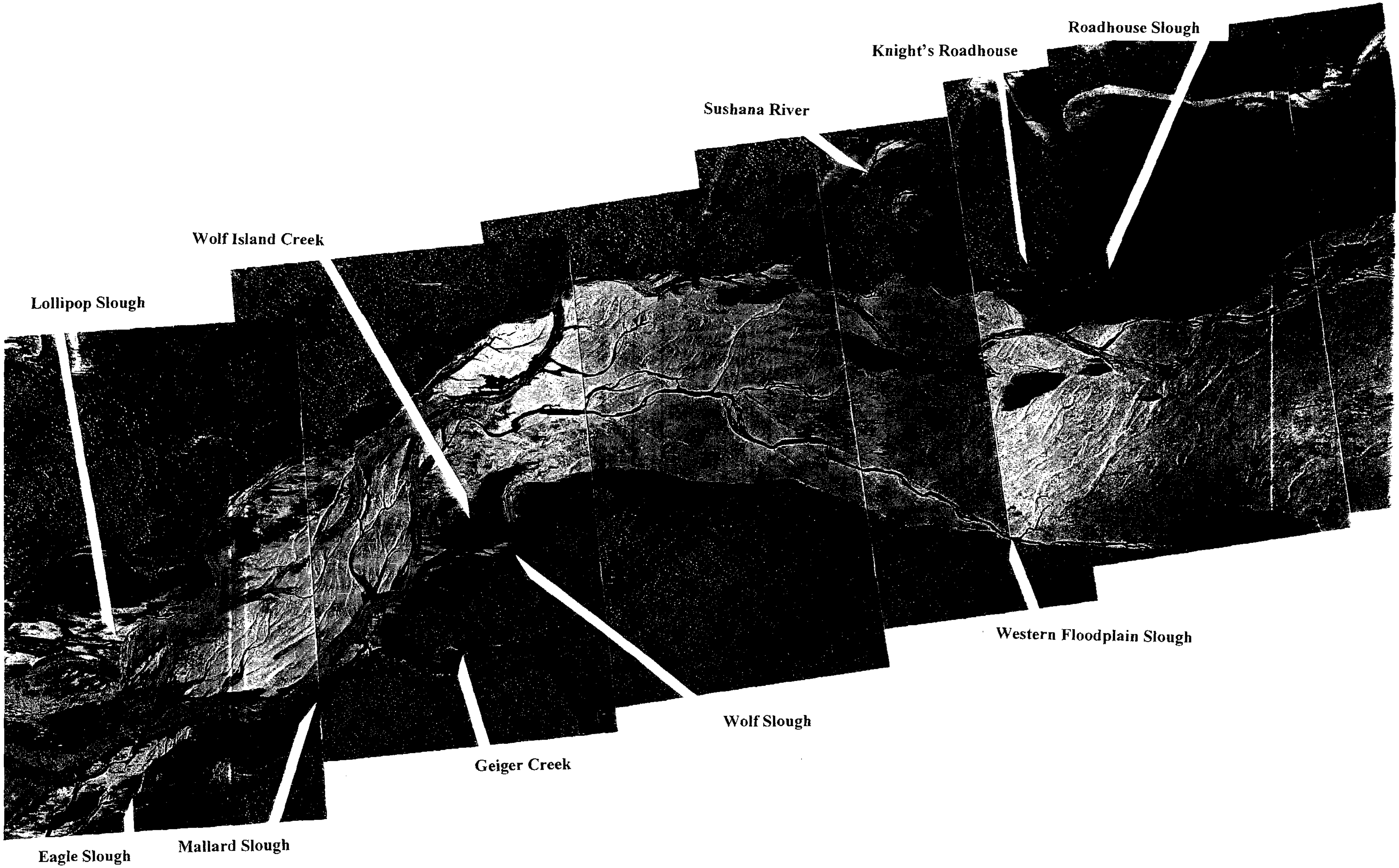


Figure 4. That portion of the Toklat River known as Toklat Springs. Photo by L. Barton, 27 October 1989.

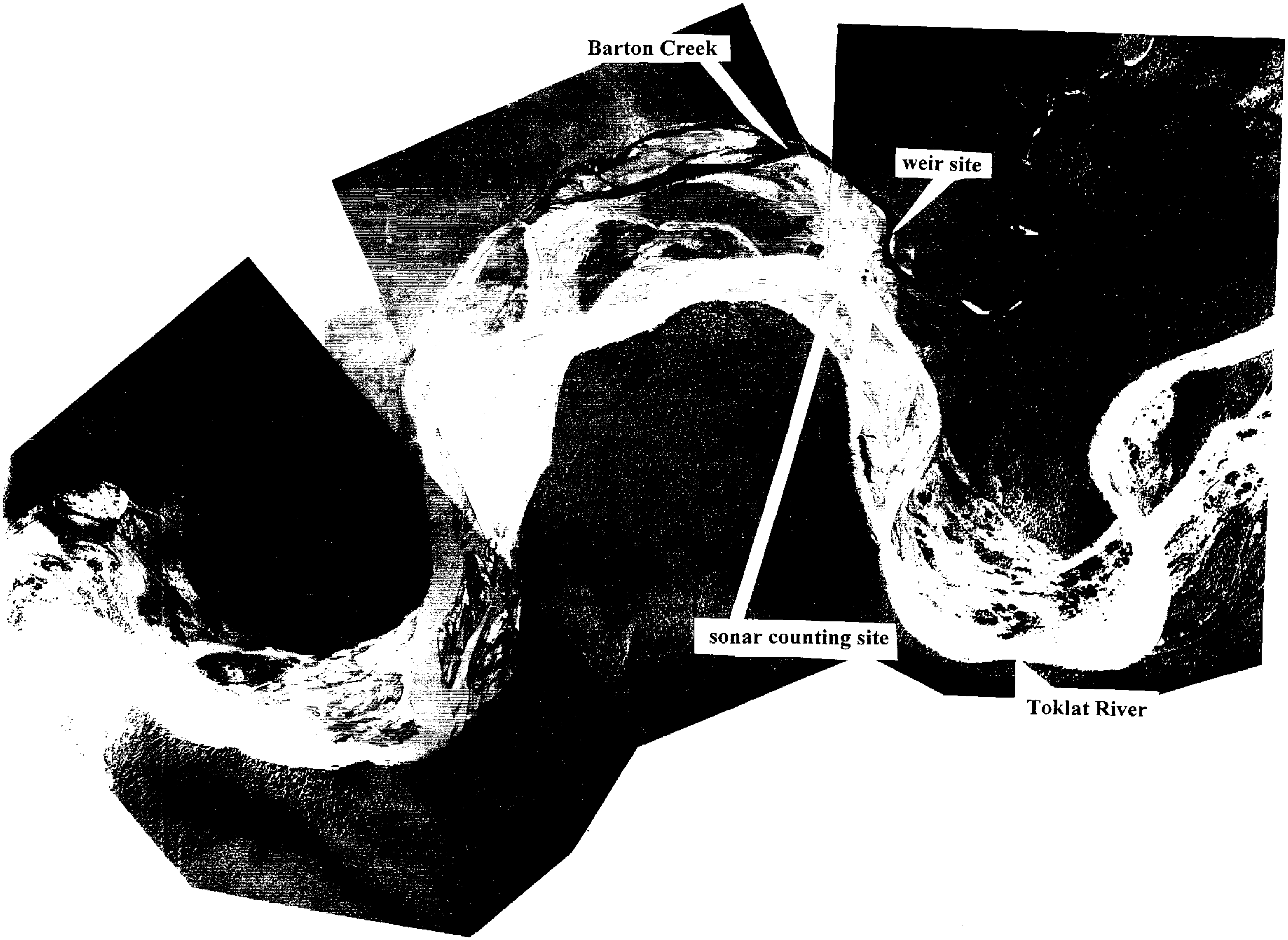
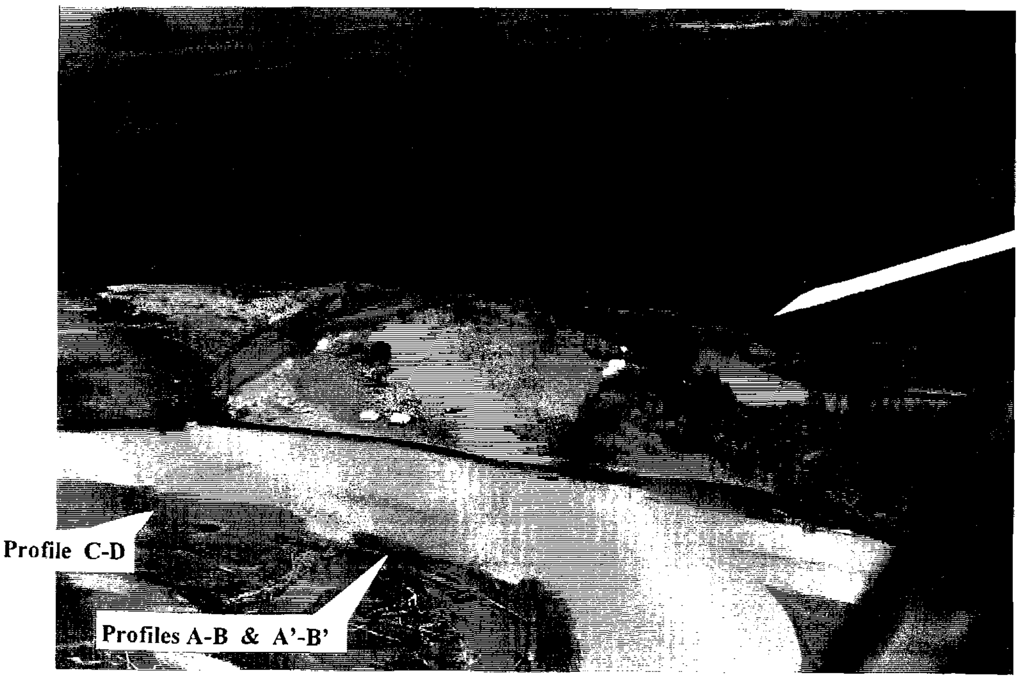


Figure 5. The Toklat River and Barton Creek terminus. (Photo by L. Barton, June1992)

Upstream view showing left (west) bank sonar fish lead in Toklat River main channel.



Downstream view with Barton Creek weir in background.

Figure 6. Toklat River sonar site and Barton Creek weir location, 1994. (Photos by R. Holder)

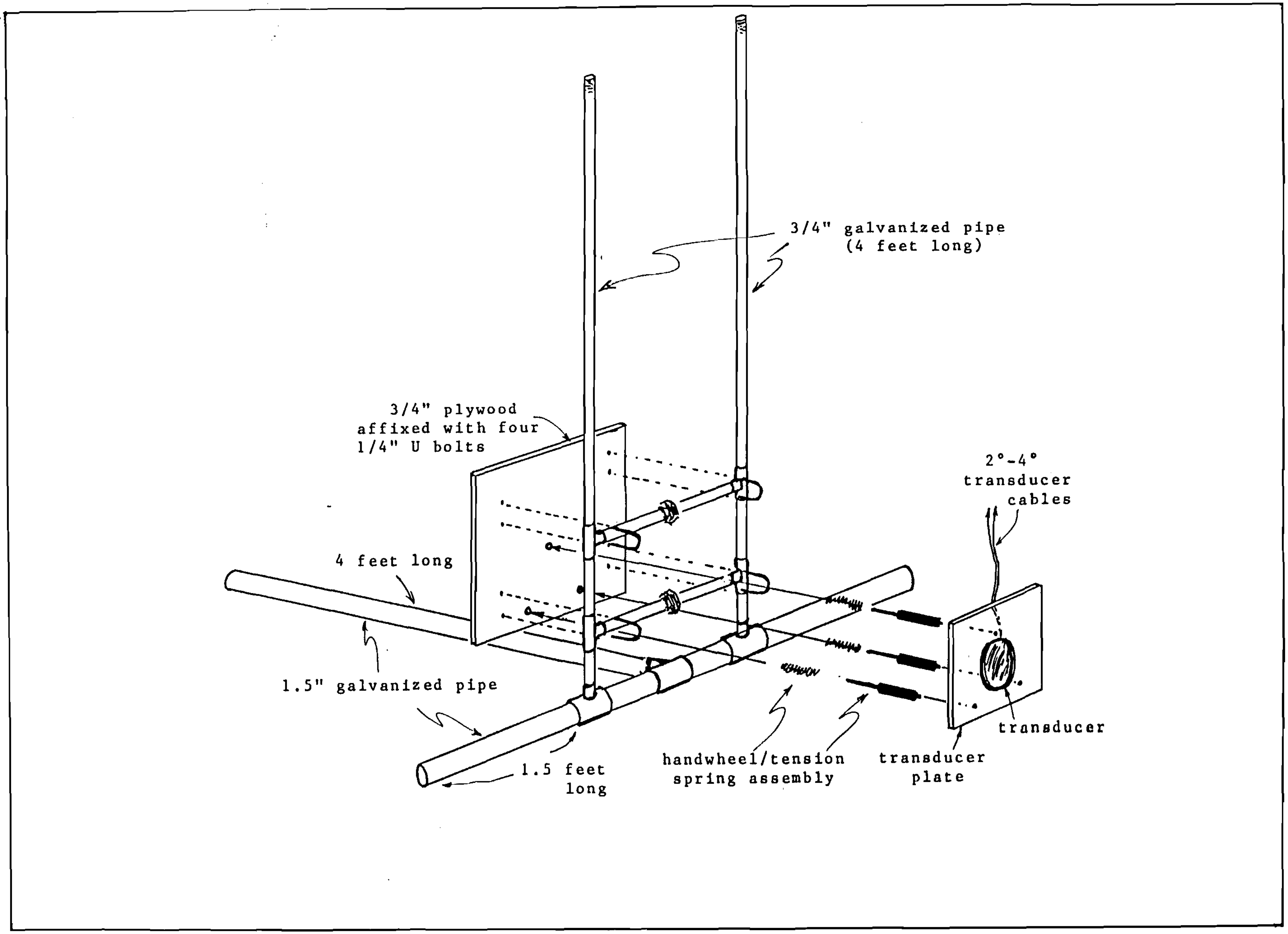


Figure 7. Schematic of prefabricated transducer pod using 1 $^{1}/_{2}$-in (3.8 cm) and $^{3}/_{4}$-in (1.9 cm) galvanized water pipe.

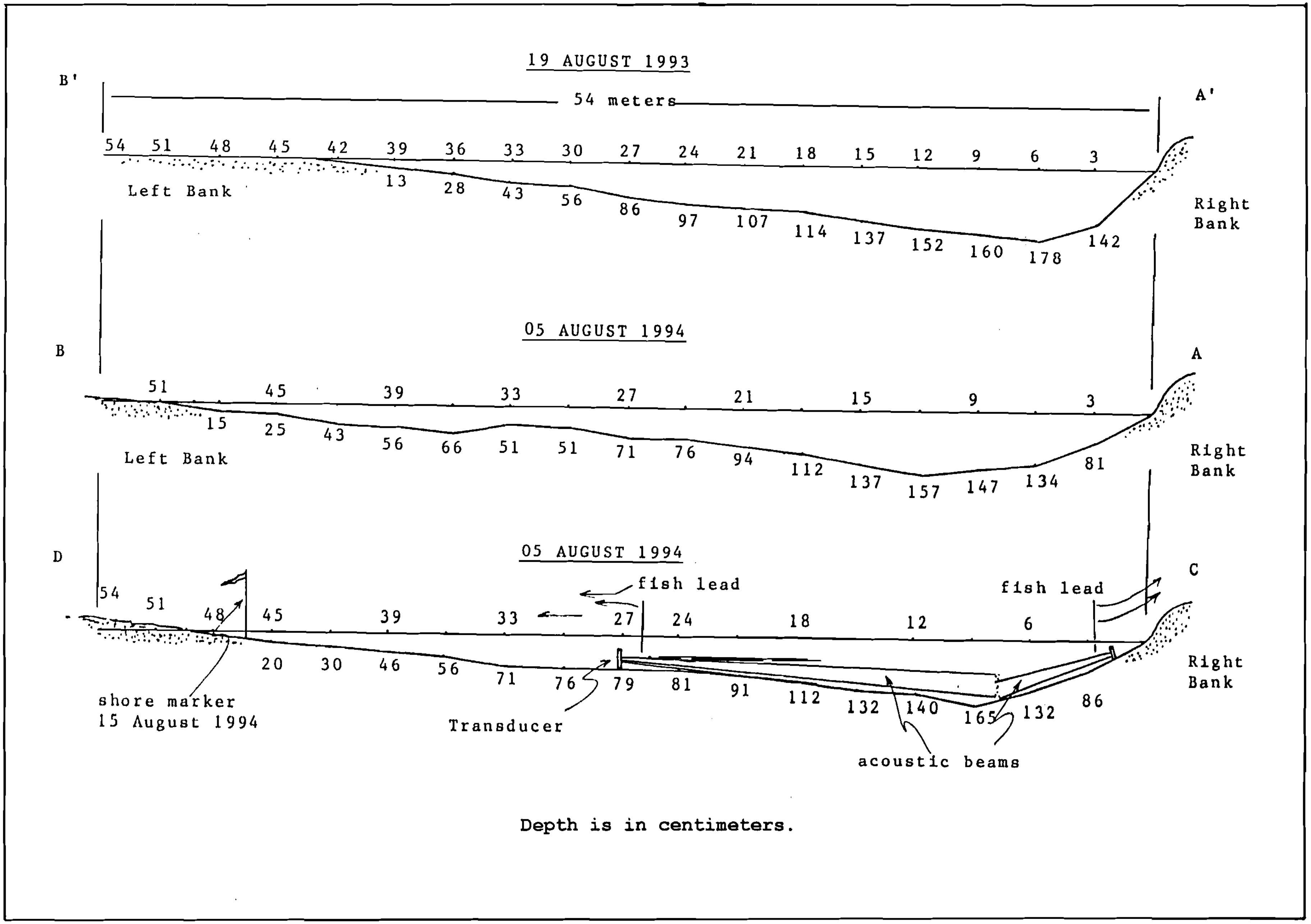


Figure 8. Main channel depth profiles made at the Toklat River sonar project site in August 1993 and 1994.

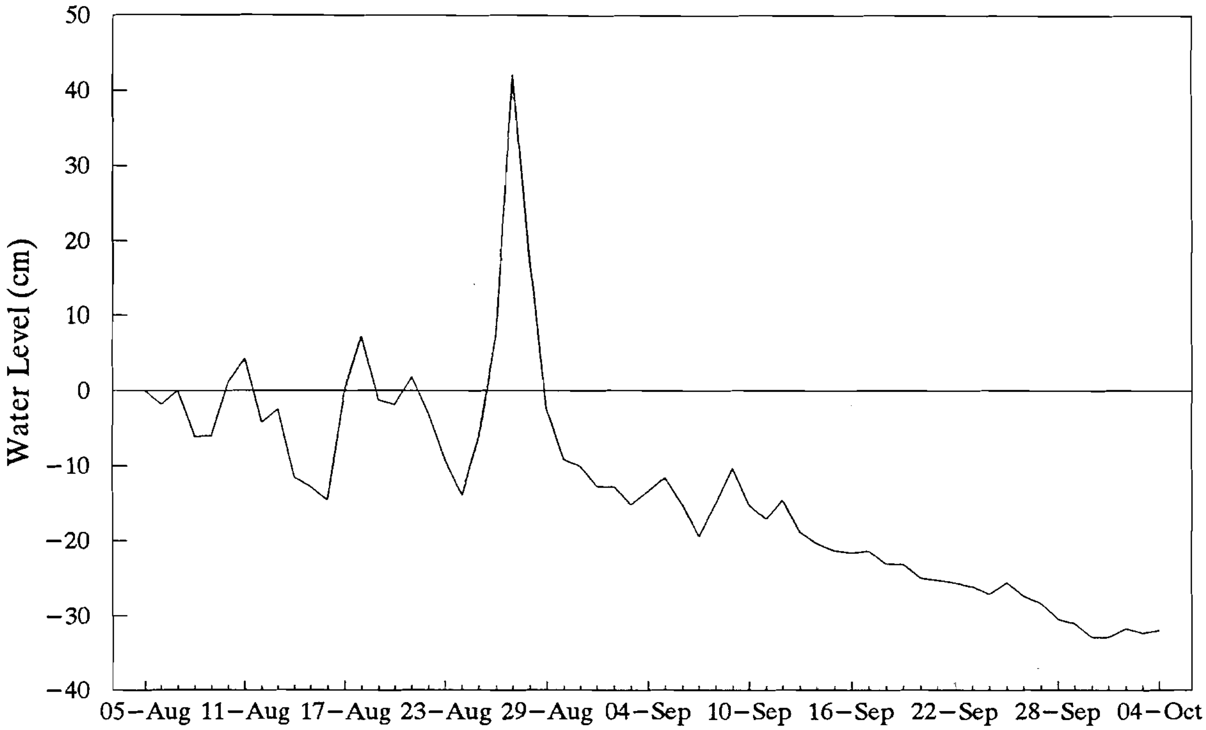


Figure 9. Daily water levels observed in the main channel Toklat River at the sonar project site, 1994.

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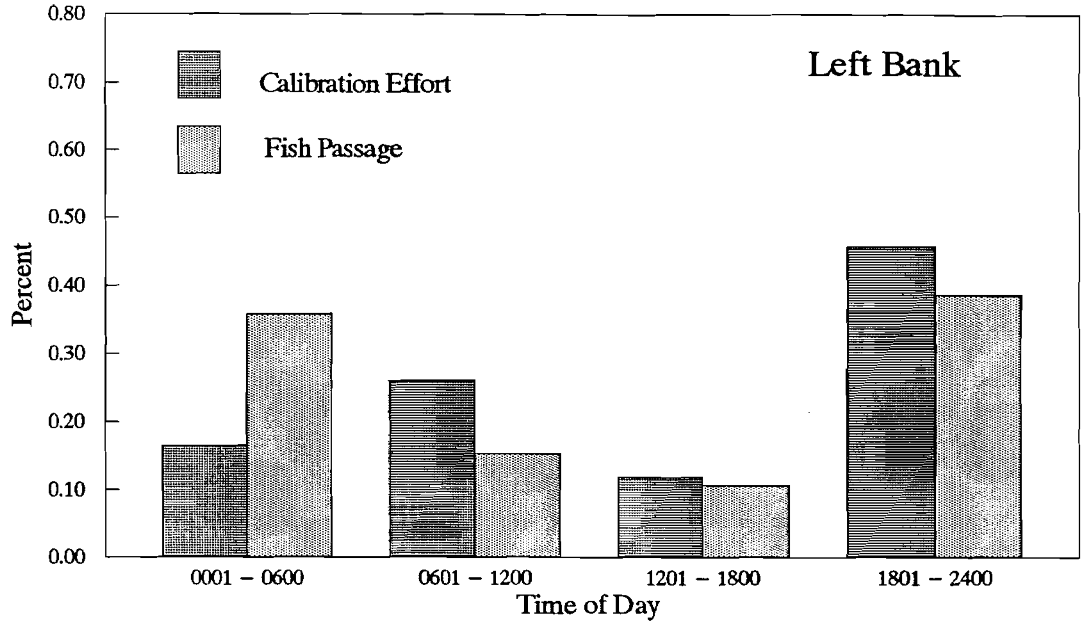

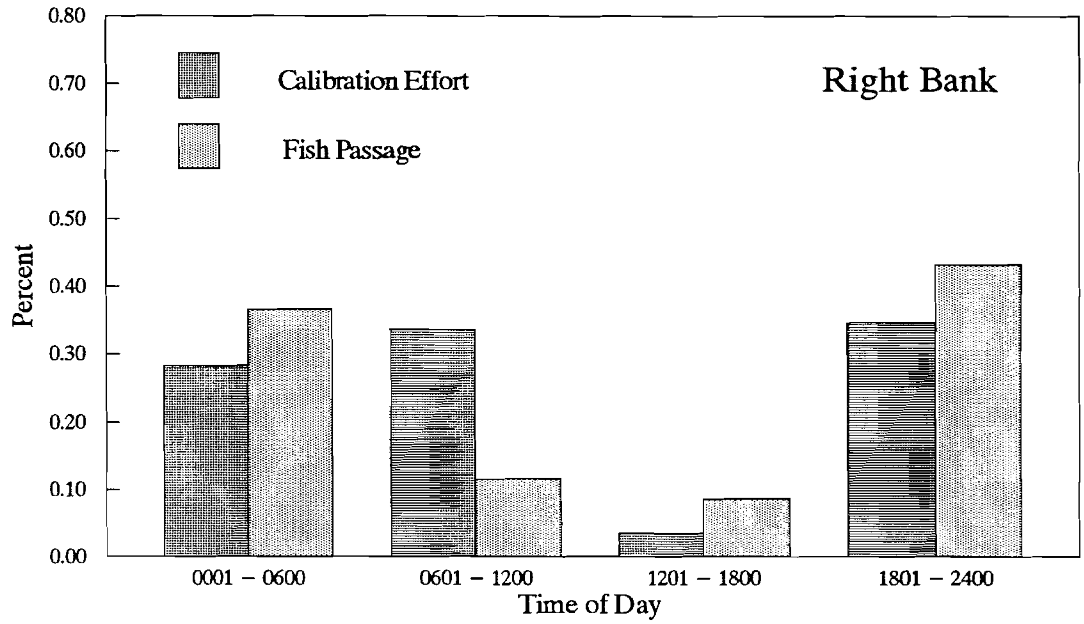

Figure 10. Average daily percent calibration effort versus average daily percent fish passage along the left bank (top) and right bank (bottom) Toklat River, 1994.

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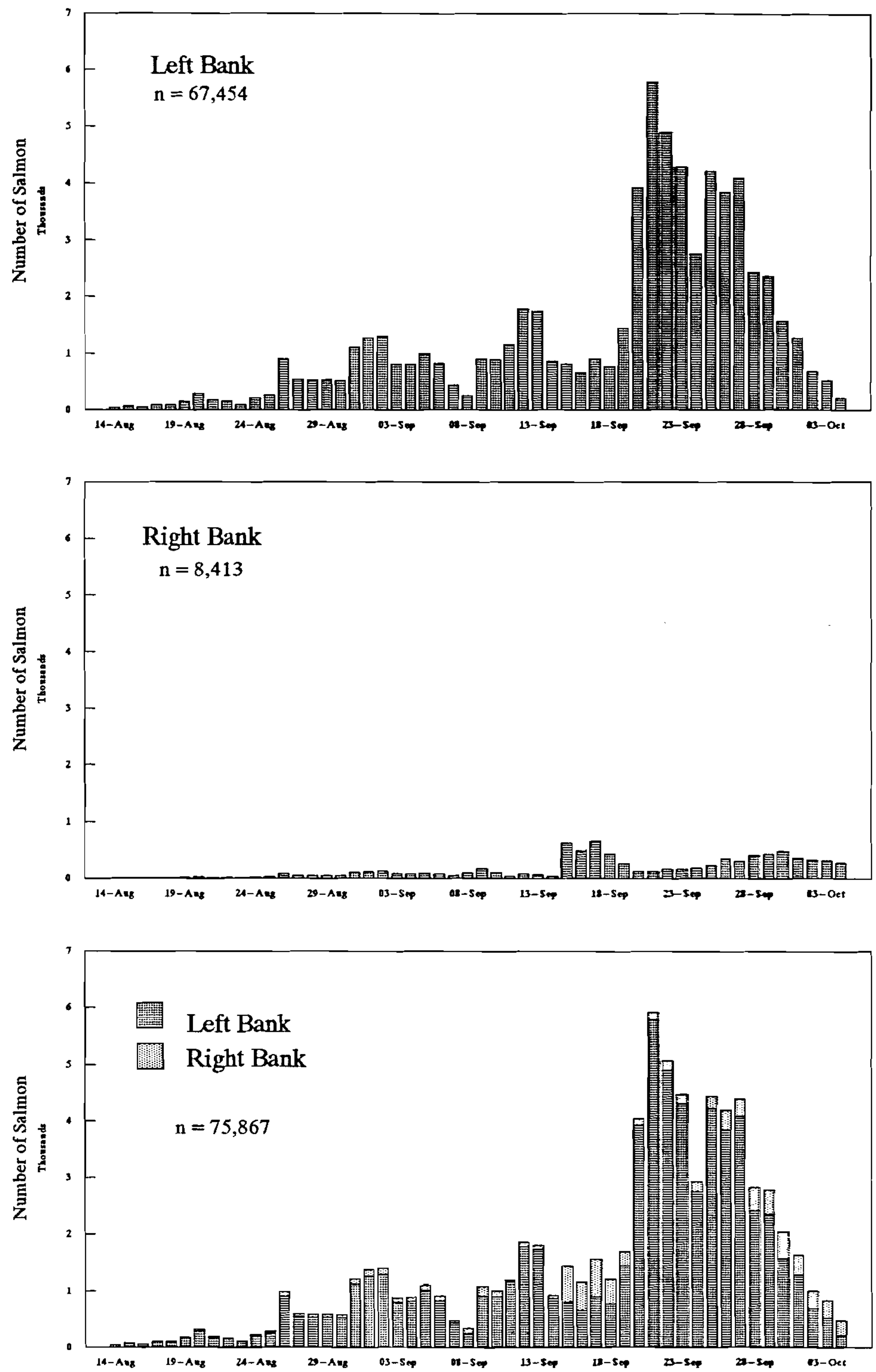

Figure 11. Daily sonar fish passage estimates (by bank) in the Toklat River, 1994.

File - A:DAILY94

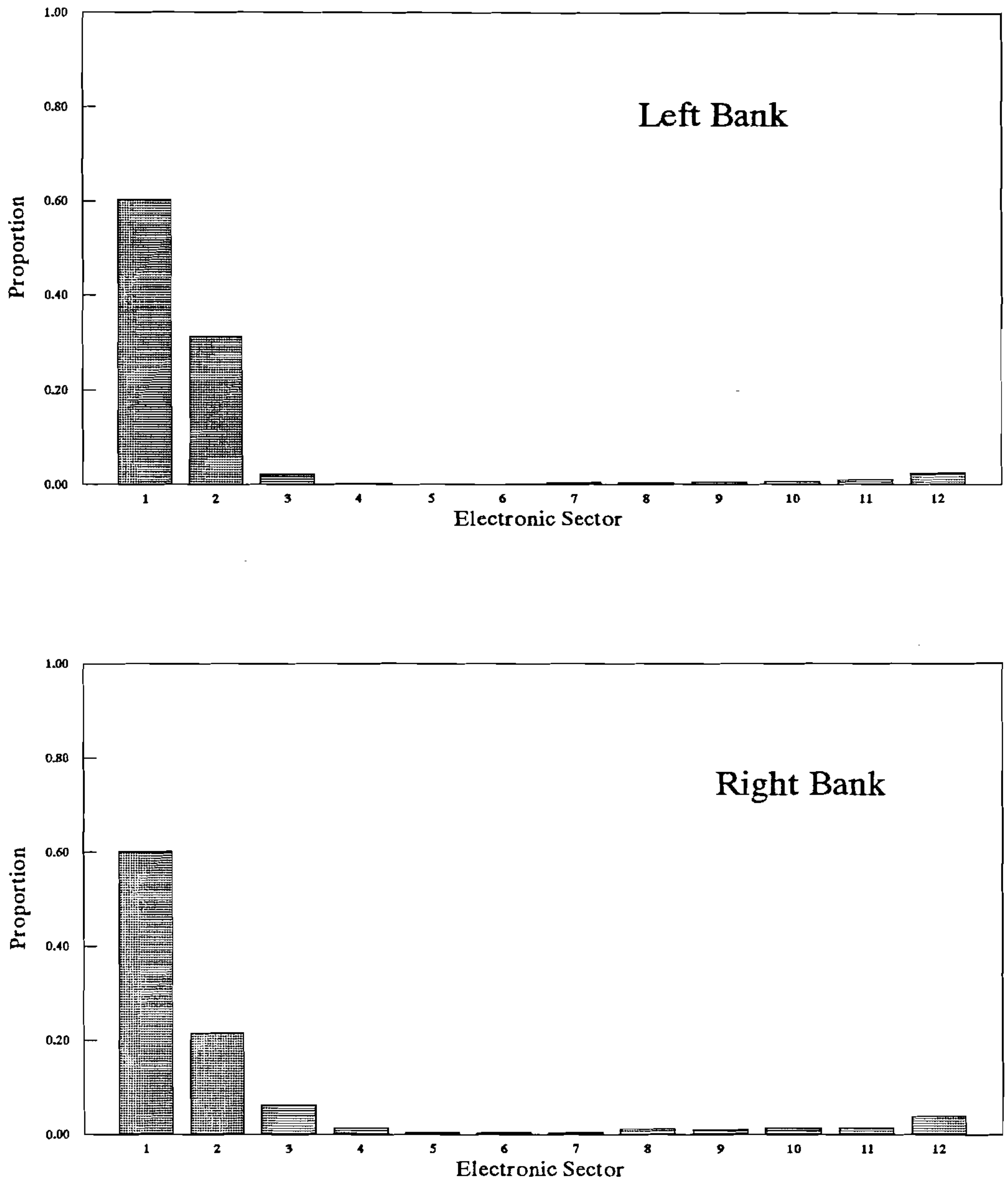

Figure 12. Estimated average proportion of fish passing the Toklat River sonar project site by electronic sector, 1994.

File: A:SECTOR94

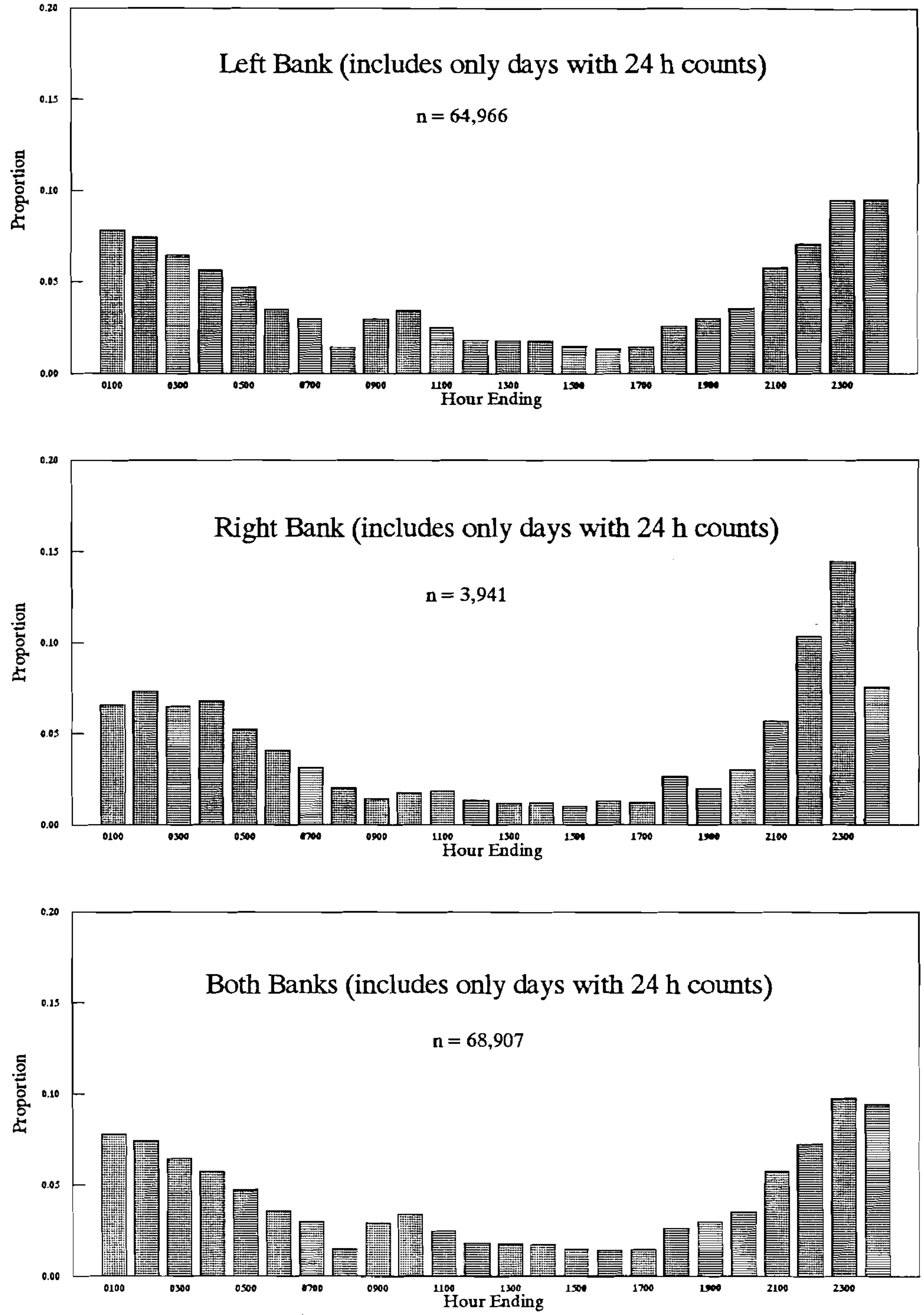

Figure 13. Average temporal migration pattern of fish passing the Toklat River sonar project site, 1994.

File: A:DIEL94

Figure 14. Downstream view(s) of Toklat Springs, 27 September 1994. Photo by L. Barton.

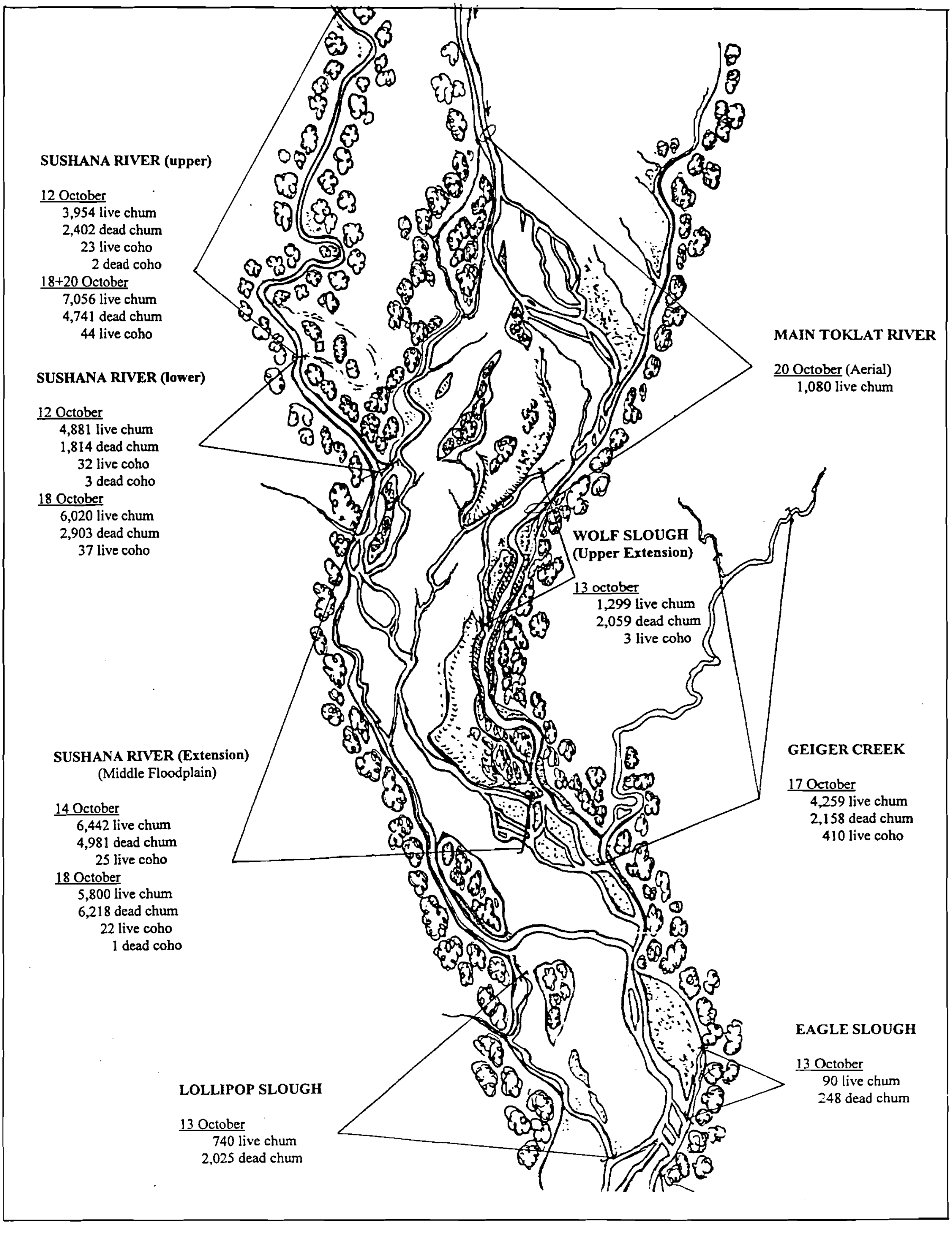

Figure 15. Salmon counts made during ground surveys of Sushana River, Geiger Creek, and selected floodplain sloughs of Toklat Springs, October 1994.

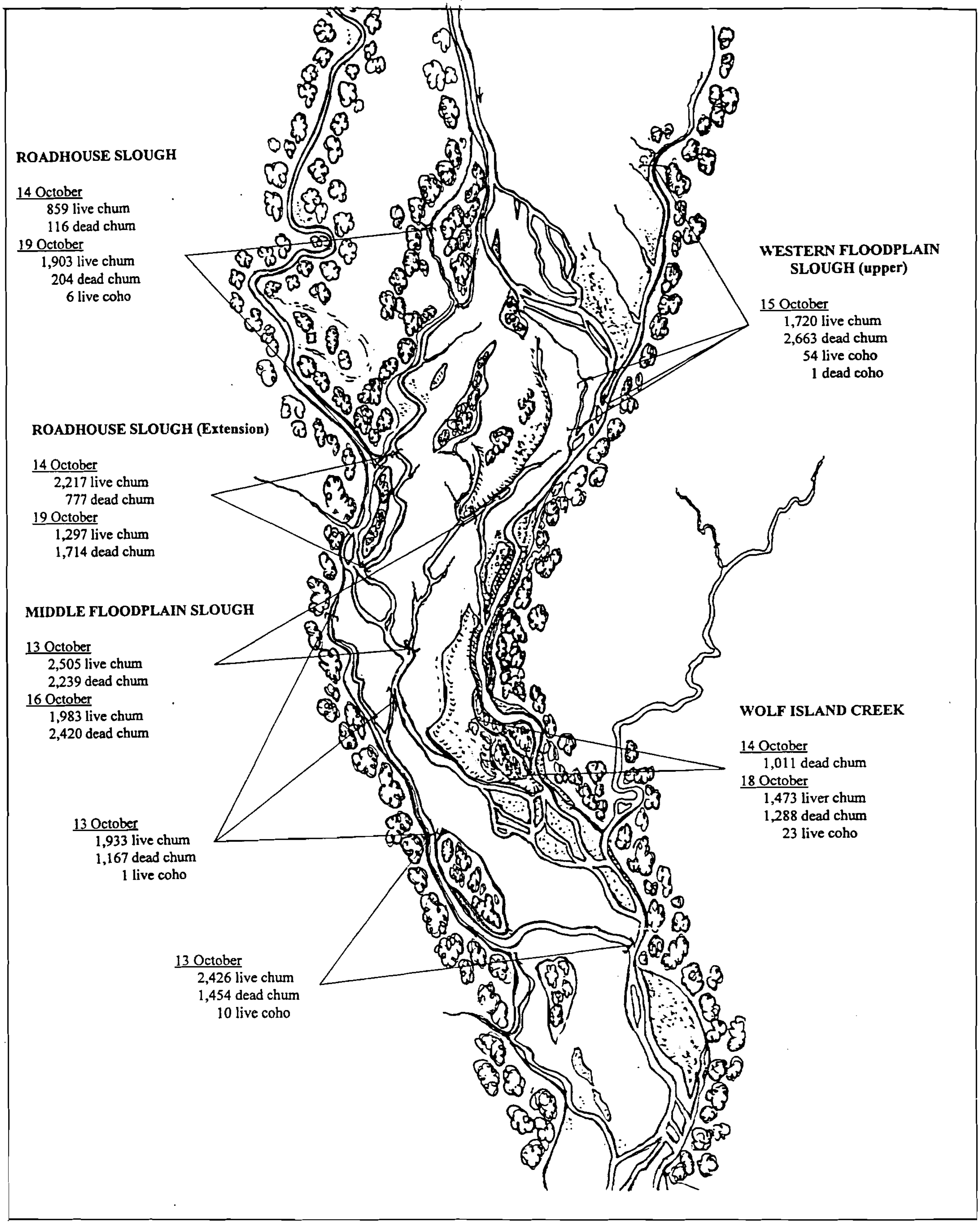

Figure 16. Salmon counts made during ground surveys of selected floodplain sloughs of Toklat Springs, October 1994.

APPENDIX A

TOKLAT RIVER HISTORIC CHUM SALMON GROUND SURVEY DATA

APPENDIX A: TOKLAT RIVER HISTORIC CHUM SALMON GROUND SURVEY DATA

Appendix A.1 Fall chum salmon survey observations and expanded escapement estimates for Toklat River floodplain sloughs within the index area known as Toklat Springs, 1974–1993. The portion of the floodplain included extends from approximately 0.5 km upstream to 2.0 km downstream of Knight's Roadhouse.

Year	Date	Survey Type [a]	Survey Rating	Live Fish Count	Dead Fish Count	Total Number Counted	Percent Live [b]	Percent Dead	Using 20–year database (1974–1993): Proportion of Run [c]	Cumulative Estimate	Proportion of Run [d]	Cumulative Estimate	Total Abundance Estimate
1974	17–Sep	A	Poor	1,250	0	1,250	100.00%	0.00%	– –	– –	– –	– –	
1974	11–Oct	A	Fair	21,367	6,768	28,135	75.94%	24.06%	90.72%	31,013	74.66%	37,684	34,349
1974	20–Oct	A	Fair				10.00%	90.00%		– –		– –	
1975	29–Sep	A	Fair	20,620	?	22,644	91.06% [g]	8.94%	38.26% [d]	59,186	38.26%	59,186	
1975	06–Oct	A	Poor	34,867	– –	39,853	87.49% [g]	12.51%	59.49% [d]	66,990	59.49%	66,990	63,088
1976	05–Oct	A	Good	28,490	?	32,375	88.00% [g]	12.00%	56.46% [d]	57,341	56.46%	57,341	
1976	21–Oct	A	Good	13,807	?	19,243	71.75% [g]	28.25%	94.04% [d]	20,463	94.04%	20,463	38,902
1977	10–Oct	A	Poor	15,000	?	17,554	85.45% [g]	14.55%	71.63% [d]	24,507	71.63%	24,507	24,507
1977	27–Oct	F	Poor	2,000	1,000	3,000	66.67%	33.33%	95.29%	3,148	96.49%	3,109	
1978	06–Oct	A	Good	7,262	?	8,300	87.49% [g]	12.51%	59.49% [d]	13,953	59.49%	13,953	
1978	13–Oct	A	Fair	4,032	1,008	5,040	80.00%	20.00%	86.06%	5,856	80.73%	6,243	
1978	24–Oct	F	Fair	14,000	6,000	20,000	70.00%	30.00%	94.59%	21,144	95.34%	20,978	21,144
1978	25–Oct	A	Good	6,020	2,579	8,599	70.01%	29.99%	94.59%	9,091	95.83%	8,973	
1979	25–Sep	A	Poor	14,115	?	15,161	93.10% [g]	6.90%	26.12% [d]	58,044	26.12%	58,044	
1979	04–Oct	A	Fair	61,550	?	69,540	88.51% [g]	11.49%	53.42% [d]	130,176	53.42%	130,176	
1979	10–Oct	A	Good	58,518	?	68,482	85.45% [g]	14.55%	71.63% [d]	95,605	71.63%	95,605	112,891
1980	16–Oct	F	Good	3,930	2,630	6,560	59.91%	40.09%	96.42%	6,804	86.44%	7,589	
1980	24–Oct	A	Fair	5,730	5,729	11,459	50.00%	50.00%	97.61% [h]	11,740	95.34%	12,019	
1980	30–Oct	F	Good	3,814	5,360	9,174	41.57%	58.43%	98.66% [h]	9,297	96.98%	9,460	9,378
1981	20–Oct	A	Good	2,372	800	3,172	74.78%	25.22%	91.81%	3,455	93.64%	3,387	3,421
1982	21–Oct	F [j]	Good	132	16	148	89.19%	10.81%	43.20%	343	94.04%	157	343
1983	19–Sep	F+A	Gd–Pr	187	5	192	97.40%	2.60%	5.36%	3,582	7.92%	2,424	
1983	18–Oct	F	?	4,647	2,797	7,444	62.43%	37.57%	96.02%	7,753	89.73%	8,296	7,753
1984	13–Sep	A	Fair	250	0	250	100.00%	0.00%	– –	– –	– –	– –	
1984	17–Oct	A	Good	4,026	447	4,473	90.01%	9.99%	39.06%	11,452	87.76%	5,096	
1984	27–Oct	F	?	2,044	4,857	6,901	29.62%	70.38%	99.70% [h]	6,922	96.49%	7,152	7,037
1985	26–Oct	F	Good	8,359	6,660	15,019	55.66%	44.34%	96.99% [h]	15,485	96.33%	15,591	15,538
1986	29–Sep	A	Good	10,395	315	10,710	97.06%	2.94%	6.06%	176,733	68.59% [k]	15,615	15,615
1986	[15–Oct]	F [i]	Fair	2,788	5,289	8,077	34.52%	65.48%	– –	– –	– –	– –	
1986	[29–Oct]	A [i]	Poor	785	80	865	90.75%	9.25%	– –	– –	– –	– –	
	15/29–Oct	F+A [j]	Fr–Po	3,573	5,369	8,942	39.96%	60.04%	98.87% [h]	9,044	86.44%	10,345	

– continued –

Appendix A.1 (page 2 of 2)

Year	Date	Survey Type [a]	Survey Rating	Live Fish Count	Dead Fish Count	Total Number Counted	Percent Live [b]	Percent Dead	Using 20-year database (1974-1993) Proportion of Run [c]	Cumulative Estimate	Proportion of Run [d]	Cumulative Estimate	Total Abundance Estimate
1987	06-Oct	A	Good	3,090	19	3,109	99.39%	0.61%	1.26%	246,746	59.49%	5,226	
	[21-Oct]	F	Good	7,727	2,775	10,502	73.58%	26.42%	--	--	--	--	
	[24-Oct]	A	Fair	500	0	500	100.00%	0.00%	--	--	--	--	
	21/24-Oct	F+A	Go-Fr	8,227	2,775	11,002	74.78%	25.22%	91.81%	11,983	94.04%	11,699	11,983
1988	07-Sep	A	Fair	120	0	120	100.00%	0.00%	--	--	--	--	
	11-Oct	A	Fair	12,091	2,134	14,225	85.00%	15.00%	64.42%	22,082	74.66%	19,053	
	19-Oct	F	Good	3,781	7,005	10,786	35.05%	64.95%	99.44% [h]	10,847	91.69%	11,764	11,305
1989	[23/24 Oct]	F	Good	9,281	14,054	23,335	39.77%	60.23%	--	--	--	--	
	[26-Oct]	A	Good	200	500	700	28.57%	71.43%	--	--	--	--	
	24-26 Oct	F+A	Good	9,481	14,554	24,035	39.45%	60.55%	98.93% [h]	24,295	95.41%	25,191	24,743
1990	16-19 Oct	F	Gd-Fr	10,467	6,614	17,081	61.28%	38.72%	96.22%	17,752	88.75%	19,246	17,752
1991	[17-19 Oct]	F [j]	Gd-Pr	5,077	1,606	6,683	75.97%	24.03%	--	--	--	--	
	[21-Oct]	A [j]	Poor	180	0	180	100.00%	0.00%	--	--	--	--	
	17-21 Oct	F+A [j]	Gd-Pr	5,257	1,606	6,863	76.60%	23.40%	90.11%	7,616	89.73%	7,649	7,616
1992	16-Oct	F	Good	5,738	751	6,489	88.43%	11.57%	47.05%	13,792 [m]	86.44%	7,507 [m]	10,649 [m]
1993	20-24 Oct	F	Fr-Gd	11,325	3,426	14,751	76.77%	23.23%	89.95%	16,399	94.44%	15,619	
	12-Nov	F+A	Pr	97	625	722	--	--	--	1,701 [n]	--	--	18,100 [n]

[a] Aerial (A) and foot (F) surveys.
[b] Percent live fish actually observed unless otherwise indicated.
[c] Proportion of run estimated from Toklat River MTDC; based upon the percentage of live fish actually observed and not date of the observation (i.e., not average proportion of run on date of survey).
[d] Proportion of run estimated from Toklat River MTDC; based upon the proportion of the run observed on date of the observation.
[g] Average percentage of live fish on date of observation, estimated from the Toklat River spawner stream-life curve (1974-87 database).
[h] Proportion of run estimated from Delta River MTDC; based upon the percentage of live fish actually observed.
[k] Porportion of run estimated from the Toklat River MTDC but subjectively shifted 10 days [from 29 September (36.20%) to October 9 (68.59%)] to account for early timing in 1986. Estimate made from a single aerial survey.
[j] Partial or incomplete survey of index area(s).
[m] The average of these estimates was used based upon the following assumption: Percent dead is greater in floodplain sloughs than in Sushana or Geiger Cr, i.e., earlier spawning in floodplain and no more fish were believed moving into Geiger or Sushana subsequent to ground surveys. Since it was unknown whether more fish moved into floodplain sloughs, the average was used.
[n] Based upon results of the 12 November survey of portions of Wolf and Mallard Sloughs, an expanded estimate of 1,701 chum salmon was made for these areas and is included in the total estimate (16,399 + 1,701 = 18,100).

Appendix A.2. Fall chum salmon survey observations and expanded escapement estimates for Geiger Creek, 1974–1993.

Year	Date	Survey Type [a]	Survey Rating	Live Fish Count	Dead Fish Count	Total Number Counted	Percent Live [b]	Percent Dead	Using 20-year database (1974–1993).				Total Abundance Estimate
									Proportion of Run [c]	Cumulative Estimate	Proportion of Run [d]	Cumulative Estimate	
1974	17-Sep	A	Poor	350	0	350	100.00%	0.00%	--	--	--	--	
1974	11-Oct	A	Fair	2,362	788	3,150	74.98%	25.02%	91.62%	3,438	74.66%	4,219	3,828
1975	29-Sep	A	Fair	1,885	?	2,070	91.06% [e]	8.94%	38.26% [d]	5,411	38.26%	5,411	5,411
1976	05-Oct	A	Good	1,100	?	1,250	88.00% [e]	12.00%	56.46% [d]	2,214	56.46%	2,214	
1976	13-Oct	F	Fair	1,300	130	1,430	90.91%	9.09%	34.51%	4,144	80.73%	1,771	4,144
1976	21-Oct	A	Good	790	0	790	100.00%	0.00%	--	--	94.04%	840	
1977	10-Oct	A	Poor	1,100	200	1,300	84.62%	15.38%	66.37%	1,959	71.63%	1,815	
1977	27-Oct	F	Poor	2,000	1,000	3,000	66.67%	33.33%	95.29%	3,148	96.49%	3,109	3,148
1978	06-Oct	A	Good	1,993	?	2,278	87.49% [e]	12.51%	59.49% [d]	3,829	59.49%	3,829	
1978	13-Oct	A	Fair	1,204	301	1,505	80.00%	20.00%	86.06%	1,749	80.73%	1,864	
1978	24-Oct	F	Fair	7,000	3,000	10,000	70.00%	30.00%	94.60%	10,571	95.34%	10,489	10,571
1978	25-Oct	A	Good	2,184	936	3,120	70.00%	30.00%	94.60%	3,298	95.83%	3,256	
1979	25-Sep	A	Poor	3,300	?	3,545	93.10% [e]	6.90%	26.12% [d]	13,570	26.12%	13,570	
1979	04-Oct	A	Fair	15,000	?	16,947	88.51% [e]	11.49%	53.42% [d]	31,725	53.42%	31,725	
1979	10-Oct	A	Good	10,815	?	12,657	85.45% [e]	14.55%	71.63% [d]	17,669	71.63%	17,669	24,697
1980	09-Oct	A	Poor	1,200	300	1,500	80.00%	20.00%	86.06%	1,743	68.59%	2,187	
1980	14-Oct	F	Good	2,000	700	2,700	74.07%	25.93%	92.46%	2,920	83.76%	3,223	
1980	24-Oct	A	Fair	995	995	1,990	50.00%	50.00%	97.61% [h]	2,039	95.34%	2,087	
1980	30-Oct	F	Good	1,900	1,400	3,300	57.58%	42.42%	96.73%	3,412	96.98%	3,403	3,412
1981	20-Oct	A	Good	2,585	550	3,135	82.46%	17.54%	77.28%	4,057	93.64%	3,348	3,702
1982	21-Oct	F	Good	563	244	807	69.76%	30.24%	94.67%	852	94.04%	858	852
1983	19-Sep	F+A	Good	112	6	118	94.92%	5.08%	14.19%	832	7.92%	1,490	
1983	18-Oct	F	?	3,700	519	4,219	87.70%	12.30%	50.74%	8,315	89.73%	4,702	8,315
1984	17-Oct	A	Good	1,251	139	1,390	90.00%	10.00%	39.11%	3,554	87.78%	1,584	3,554
1984	28-Oct	A	Poor	2,250	750	3,000	75.00%	25.00%	91.60%	3,275	96.66%	3,104	
1985	28-Oct	A	Fair	1,350	337	1,687	80.02%	19.98%	86.06%	1,960	96.66%	1,745	1,852
1986	29-Sep	A	Good	235	0	235	100.00%	0.00%	--	--	38.26%	614	
1986	16-Oct	F	Fair	900	387	1,287	69.93%	30.07%	94.61%	1,360	86.44%	1,489	1,360

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Appendix A.2. (page 2 of 2)

									Using 20-year database (1974-1993).				
Year	Date	Survey Type [a]	Survey Rating	Live Fish Count	Dead Fish Count	Total Number Counted	Percent Live [b]	Percent Dead	Proportion of Run [c]	Cumulative Estimate	Proportion of Run [d]	Cumulative Estimate	Total Abundance Estimate
1987	22-Oct	F	Good	5,114	1,536	6,650	76.90%	23.10%	89.96%	7,392	94.44%	7,042	7,392
1988	07-Sep	A	Fair	25	0	25	100.00%	0.00%	--	--	--	--	
	20-Oct	F	Good	1,410	542	1,952	72.23%	27.77%	93.83%	2,080	93.64%	2,085	2,080
1989	24-Oct	F	Good	1,394	1,036	2,430	57.37%	42.63%	96.76%	2,511	95.34%	2,549	2,511
1990	17-Oct	F	Good	1,741	673	2,414	72.12%	27.88%	93.87%	2,572	87.78%	2,750	2,572
1991	18-Oct	F	Fair	1,896	269	2,165	87.58%	12.42%	51.34%	4,217	89.73%	2,413	4,217
1992	17-Oct	F	Good	1,552	96	1,648	94.17%	5.83%	17.97%	9,171	87.78%	1,877 [k]	1,877
1993	21-Oct	F	Good	4,264	1,094	5,358	79.58%	20.42%	86.88%	6,167	94.04%	5,698	6,167

[a] Aerial (A) and foot (F) surveys.
[b] Percent live fish actually observed unless otherwise indicated.
[c] Proportion of run estimated from Toklat River MTDC; based upon the percentage of live fish actually observed and not date of the observation (i.e., not average proportion of run on date of survey).
[d] Proportion of run estimated from Toklat River MTDC, based upon the average proportion of the run observed on date of the observation.
[g] Average percentage of live fish on date of observation, estimated from the Toklat River spawner stream-life curve (1974-87 database).
[h] Proportion of run estimated from Delta River MTDC, based upon the average percentage of live fish actually observed.
[k] This estimate was used as it was judged that no more fish were entering the river subsequent to the ground survey.

Appendix A.3. Fall chum salmon survey observations and expanded escapement estimates for Sushana River, 1974–1993.

Year	Date	Survey Type [a]	Survey Rating	Live Fish Count	Dead Fish Count	Total Number Counted	Percent Live [b]	Percent Dead	Using 20-year database (1974–1993) Proportion of Run [c]	Cumulative Estimate	Proportion of Run [d]	Cumulative Estimate	Total Abundance Estimate
1974	11-Oct	A	Fair	2,100	925	3,025	69.42%	30.58%	94.76%	3,192	74.66%	4,052	3,622
1975	29-Sep	A	Fair	8,280	--	9,093	91.06% [e]	8.94%	38.26% [d]	23,766	38.26%	23,766	23,766
1975	06-Oct	A	Poor	6,325	225	6,550	96.56%	3.44%	7.09%	92,384	59.49%	11,010	
1976	05-Oct	A	Good	3,600	?	4,091	88.00% [e]	12.00%	56.46% [d]	7,246	56.46%	7,246	
1976	13-Oct	F	Fair	3,350	1,005	4,355	76.92%	23.08%	89.81%	4,849	80.73%	5,395	
1976	21-Oct	A	Good	4,891	543	5,434	90.01%	9.99%	39.06%	13,912	94.04%	5,778	9,845
1977	10-Oct	A	Poor	4,500	1,000	5,500	81.82%	18.18%	80.52%	6,831	71.63%	7,678	
1977	19-Oct	A	Poor	3,720	2,480	6,200	60.00%	40.00%	96.41%	6,431	91.69%	6,762	
1977	26-Oct	F	Good	4,000	3,000	7,000	57.14%	42.86%	96.79%	7,232	96.33%	7,267	7,232
1978	06-Oct	A	Good	1,645	?	1,880	87.49% [e]	12.51%	59.49% [d]	3,161	59.49%	3,161	
1978	13-Oct	A	Fair	1,112	278	1,390	80.00%	20.00%	86.06%	1,615	80.73%	1,722	
1978	24-Oct	F	Fair	3,500	1,500	5,000	70.00%	30.00%	94.59%	5,286	95.34%	5,244	5,286
1978	25-Oct	A	Good	2,075	889	2,964	70.01%	29.99%	94.59%	3,134	95.83%	3,093	
1979	25-Sep	A	Poor	5,905	?	6,343	93.10% [e]	6.90%	26.12% [d]	24,283	26.12%	24,283	
1979	04-Oct	A	Fair	20,000	?	22,596	88.51% [e]	11.49%	53.42% [d]	42,299	53.42% early	42,299	
1979	10-Oct	A	Good	12,700	?	14,862	85.45% [e]	14.55%	71.63% [d]	20,749	71.63%	20,749	20,749
1980	09-Oct	A	Poor	7,638	1,910	9,548	80.00%	20.00%	86.06%	11,095	68.59%	13,920	
1980	14-Oct	F	Good	8,758	2,778	11,536	75.92%	24.08%	90.74%	12,713	83.76%	13,773	
1980	24-Oct	A	Fair	4,803	4,802	9,605	50.01%	49.99%	97.61% [h]	9,840	95.34%	10,074	
1980	30-Oct	F	Good	8,758	4,128	12,886	67.97%	32.03%	95.06%	13,556	96.98%	13,287	13,556
1981	20-Oct	A	Good	6,100	1,500	7,600	80.26%	19.74%	85.55%	8,884	93.64%	8,116	8,500
1982	21-Oct	F	Good	1,325	1,029	2,354	56.29%	43.71%	96.90%	2,429	94.04%	2,503	2,429
1983	19-Sep	A	Good	38	0	38	100.00%	0.00%	--	--	7.92%	480	
1983	18-Oct	F	?	2,960	482	3,442	86.00%	14.00%	59.33%	5,801	89.73%	3,836	5,801
1984	13-Sep	A	Fair	350	0	350	100.00%	0.00%	--	--	--	--	
1984	17-Oct	A	Good	2,991	332	3,323	90.01%	9.99%	39.06%	8,507	87.78%	3,786	
1984	27-Oct	F	?	3,469	2,491	5,960	58.20%	41.80%	96.65%	6,167	96.49%	6,177	6,167
1985	25-Oct	F	Good	3,356	1,762	5,118	65.57%	34.43%	95.46%	5,360	95.83%	5,341	5,360
1986	29-Sep	A	Good	39	0	39	100.00%	0.00%	--	--	38.26%	102	
1986	17-Oct	A	Good	611	100	711	85.94%	14.06%	59.64%	1,192	87.78%	810	1,001
1987	20-Oct	F	Good	647	51	698	92.69%	7.31%	25.46%	2,742	93.64%	745	2,742

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Appendix A.3. (page 2 of 2)

									Using 20-year database (1974-1993)				
Year	Date	Survey Type [a]	Survey Rating	Live Fish Count	Dead Fish Count	Total Number Counted	Percent Live [b]	Percent Dead	Proportion of Run [c]	Cumulative Estimate	Proportion of Run [d]	Cumulative Estimate	Total Abundance Estimate
1988	07-Sep	A	Good	0	0	0	--	--	--	--	--	--	
	10-Oct	A	Fair	0	0	0	--	--	--	--	--	--	
	21-Oct	F	Good	22	3	25	88.00%	12.00%	49.22%	51	94.04%	27	51
1989	21-Oct	F	Good	2,124	858	2,982	71.23%	28.77%	94.17%	3,167	94.04%	3,171	3,167
1990	15/16 Oct	F	Good	6,210	842	7,052	88.06%	11.94%	48.92%	14,415	86.44%	8,158	14,415
1991	19/21 Oct	F+A	Fair	1,002	224	1,226	81.73%	18.27%	80.98%	1,514	94.04%	1,304	1,514
1992	16/19 Oct	F+A	Good	1,176	240	1,416	83.05%	16.95%	74.30%	1,906	91.69%	1,544 [k]	1,544
1993	23-Oct	F	F-G	1,554	213	1,767	87.95%	12.05%	49.46%	3,571	94.84%	1,863	3,571

[a] Aerial (A) and foot (F) surveys.
[b] Percent live fish actually observed unless otherwise indicated.
[c] Proportion of run estimated from Toklat River MTDC; based upon the percentage of live fish actually observed and not date of the observation (i.e., not average proportion of run on date of survey).
[d] Proportion of run estimated from Toklat River MTDC; based upon the average proportion of the run observed on date of the observation.
[g] Average percentage of live fish on date of observation, estimated from the Toklat River spawner stream-life curve (1974-87 database).
[h] Proportion of run estimated from Delta River MTDC; based upon the average percentage of live fish actually observed.
[k] This estimate was used as it was judged that no more fish were entering the river subsequent to the ground survey.

Appendix A.4. Percent live chum salmon observed from ground surveys conducted at Toklat Springs, 1976–1993. Numbers in parentheses represent year of survey.

Day	Date	Floodplain Sloughs	Sushana River	Geiger Creek	Average	Point Estimate	
1	19–Sep	97.40% (83)		94.92% (83)	96.16%	96.16%	19–Sep
2	20–Sep						20–Sep
17	05–Oct						05–Oct
18	06–Oct						06–Oct
19	07–Oct						07–Oct
20	08–Oct						08–Oct
21	09–Oct						09–Oct
22	10–Oct						10–Oct
23	11–Oct						11–Oct
24	12–Oct						12–Oct
25	13–Oct		76.92% (76)	90.91% (76)	83.92%		13–Oct
26	14–Oct		75.92% (80)	74.07% (80)	75.00%	81.18%	14–Oct
27	15–Oct	[34.5% (86) omit–early]	88.06% (90)		88.06%		15–Oct
28	16–Oct	59.91% (80)	83.05% (92)	[69.9% (86)omit–early]	71.48%		16–Oct
29	17–Oct			72.12% (90) 94.17% (92)	83.15%	79.12%	17–Oct
30	18–Oct	62.43% (83)	86.00% (83)	87.70% (83) 87.58% (91)	80.93%		18–Oct
31	19–Oct	35.05% (88) 61.28% (90) 76.60% (91)	81.73% (91)		63.67%		19–Oct
32	20–Oct		92.69% (87)	72.23% (88)	82.46%	72.80%	20–Oct
33	21–Oct	89.19% (82)	56.29% (82) 88.00% (88) 71.23% (89)	69.76% (82) 79.58% (93)	75.68%		21–Oct
34	22–Oct	74.78% (87)		76.90% (87)	75.84%		22–Oct
35	23–Oct		87.95% (93)		87.95%	69.28%	23–Oct
36	24–Oct	70.00% (78) 76.77% (93) 39.77% (89)	70.00% (78)	70.00% (78) 57.37% (89)	63.99%		24–Oct
37	25–Oct		65.57% (85)		65.57%		25–Oct
38	26–Oct	55.66% (85)	57.14% (77)		56.40%	60.65%	26–Oct
39	27–Oct	[29.6%(84)omit–outlier)	58.20% (84)	66.67% (77)	62.44%		27–Oct
40	28–Oct						28–Oct
41	29–Oct						29–Oct
42	30–Oct	41.57% (80)	67.97% (80)	57.58% (80)	55.71%	55.7%	30–Oct
43	31–Oct						31–Oct

APPENDIX B

TOKLAT RIVER CLIMATOLOGICAL AND HYDROLOGIC OBSERVATIONS

APPENDIX B: TOKLAT RIVER CLIMATOLOGICAL AND HYDROLOGIC OBSERVATIONS

Appendix B.1. Climatological and hydrologic observations made at the Toklat River sonar project site, 1994.

					Temperature (C)		Water Level (cm)		Surface Water velocity (floating chip method)			
Date	Time	Precip (code) [a]	Cloud Cover (code) [b]	Wind (Direction and Velocity)	Air	Water Surface	24 h Change	relative to zero datum	Time of day	cm/sec	Water Color (code) [c]	Remarks [d]
04-Aug	100	A	C	Calm		17					D	Water very turbid in Toklat; saw chum salmon surface in main current in from of camp.
	1730	A	C	N 10-15	29	12					A	Barton Creek
	2100	A	C	NW 0-3							D	
05-Aug	1330	A	C	Calm	31						D	Desert like heat; made river profiles.
	2230						0.0	zero datum			D	Sink water depth gauge in Toklat River.
	1200	A	C	SW 5-10	26						D	Hot, deadly day.
	2300	A	B	Calm		18	-1.8	-1.8			D	
01-Jan	1200	B	O	SW 5-10		15					D	
	2200	B	B	Calm		15	1.8	0.0			D	
02-Jan	1200	B	B	N 0-5		13					D	Large pit dug by grizzly bear 100 yrds behind tents.
	1700	B	B	N 5-10		11					A	Barton Creek. No chum observed.
	2200	A	S	Calm		14	-6.1	-6.1			D	
03-Jan	1200	A	S	Calm	19	13					D	
	2200	A	S	Calm		17	0.0	-6.1			D	
04-Jan	1200	A	B	NW 0-5		14					D	Rain late at night.
	2200	B	O	S 5-10	20	17	7.3	1.2			D	
05-Jan	1200	B	B	S 5-10	20	16					D	
	2200	B	C	Calm	13	16	3.1	4.3			D	
06-Jan	1200	A	B	W 5-10	20	12					D	Installed 1978 west bank sonar - 1800 h.
	2300	B	O	Calm	12	13	-8.6	-4.3			D	
07-Jan	915	B	B	S 5-10	18	13					D	Observe first fish finning in shallows on left (west) bank.
	2230	A	C	Calm	11	13	1.8	-2.4			D	
08-Jan	1000	A	C	Calm	21	11					D	Put lead in for west bank sonar. Single wolf tracks in camp from last night.
	2200	A	O	NW 2-3	16	13	-9.2	-11.6			D	
09-Jan	1200	A	S	Calm	19	12					D	Very few fish passing.
	2230	A	C	Calm	12	14	-1.2	-12.8			D	
10-Jan	1300	A	S	Calm	26	14					D	Wolf in camp again last night.
	2300	A	O	S 5-10	16	14	-1.8	-14.6			D	
11-Jan	1300	B	C	S 0-5	23	14					D	Massive wind/silt storm @ 0130 h; visibility 10 ft; winds gusting to 50 mph; sonar off @ 0200 h.
		Weather not taken									D	Wind/silt storm starting again @ 110 h; very nasty.
12-Jan	1300	A	C	S 30-35	21	14					D	Mostly sunny but windy all day.
	2200	A	C	S 0-5	14	15	7.3	7.3			D	
13-Jan	1400	A	C	Calm	21	13					D	Begin normal calibration periods.
	2200	A	B	Calm	13	14	-8.6	-1.2			D	
14-Jan	1200	B	O	S 5-10	14	12					D	Move xducer out 3 ft - water dropping; spotted wolf (big & grey) at brush line by Barton creek.
	2200	B	O	S 0-5	9	12	-0.6	-1.8			D	
15-Jan	1230	B	O	S 30-35+	12	10					D	Wind blowing 30-40 mph; water rising; current getting strong. Connected chart recorder
	2200	B	O	S 10-15	9	9	3.7	1.8			D	to sonar counter @ 2310 h.
16-Jan	1215	B	O	S 15-20	8	7					D	Water starting to drop. Chilly.
	2200	B	S	Calm	5	8	-4.9	-3.0			D	
17-Jan	1230	A	S	S 0-5	14	7					D	Observed 1 chum in shallow water upstream of xducer.
	2200	B	B	Calm	7	9	-6.1	-9.1			D	Northern lights out.
18-Jan	1200	B	O	ESE 5-10	13	8					D	Move left bank xducer out 10 ft and extend weir. Unsuccessful in putting a lead in on adjacent
	2200	C	O	Calm	7	7	-4.9	-14.0			C	bank to move fish offshore, into left bank acoustic beam; water too swift/deep. Raining steady.
19-Jan	1220	C	O	S 5-10	14	9					D	Raining hard - water rising; wolf tracks on east and west banks.
	2200	B	O	S 5-10	14	11	8.0	-6.1			D	
20-Jan	1200	B	O	W 0-5	19	12			1430	156	D	Water still rising move xducer in 10 ft; fish passage increasing. Wolf tracks on front of bar.
	2230	B	O	S 0-5	16	13	13.8	7.6			D	
21-Jan	1200	A	O	S 5-10	9	11			1430	163	D	Lots of debris in weir; observed chum 100 yd upstream of xducer in shallows.
		A	O	S 0-5	7	9	34.6	42.1			D	Power down @ 1939 h; take all hardware out of water; huge trees surging downriver.
22-Jan	1410	A	O	S 5-10	8	6			1600	156	D	River crested @ 0230 h.
	2200	A	O	S 5-10	3	7	******	17.4			D	
23-Jan	1200	A	C	NW 5-10	3	5			1545	188	D	
	2200	A	C	Calm	3	7	******	-2.4			D	
24-Jan	1200	A	C	Calm	7	6					D	Put hardware back in river and begin counting @ 1200 h.
	2200	A	C	Calm	9	8	-6.7	-9.1			D	
25-Jan	1600	A	C	Calm	16	9			1600	144	D	Some milling along xducer face; moved xducer out 8 ft.
	2220	A	C	Calm	8	10	-0.9	-10.1			D	
26-Jan	1200	A	C	Calm	17	9			1200	167	C	Good numbers of fish passing; beautiful sunny day.
	2200	A	B	S 5-10	10	11	-2.8	-12.8			C	

- continued -

Date	Time	Precip (code) [a]	Cloud Cover (code) [b]	Wind (Direction and Velocity)	Temperature (C) Air	Temperature (C) Water Surface	Water Level (cm) 24 h Change	Water Level (cm) relative to zero datum	Surface Water velocity (floating chip method) Time of day	Surface Water velocity (floating chip method) cm/sec	Water Color (code) [c]	Remarks [d]
27–Jan	1210	A	S	Calm	12	10			1230	188	C	Lots of sun today. Wolf on west bank bar – green eyes. Bull 30 yd behind camp.
	2200	A	O	Calm	10	11	0.0	−12.8			C	
28–Jan	1300	A	C	Calm	15	9			1400	184	C	Bright sunny day; successfully install 11 ft lead on right bank, at end of left bank counting
	2200	A	O	WSW 0–5	11	11	−2.4	−15.2			C	range.
29–Jan	1200	B	B	Calm	12	10			1300	176	C	Light rain heavy overcast; water rising slowly.
	2200	B	O	Calm	8	11	1.8	−13.4			C	
30–Jan	1230	A	B	SW 5–10	10	8			1600	194	C	Clearing toward evening.
	2200	A	C	Calm	3	8	1.8	−11.6			C	
31–Jan	1200	A	C	Calm	13	7			1520	144	C	Bright sunny day; low passage in daylight hours, increasing with sundown. Deploy right bank
	2200	A	C	Calm	3	8	−3.7	−15.2			C	sonar xducer 5 ft from shore; operating on 2 degree only; no fish lead installed; xducer is
01–Feb	1300	A	O	Calm	7	6			1300	192	C	about 25 ft upstream of right bank lead which was installed on 3 Sep.
	2200	A	O	Calm	7	6	−4.3	−19.5			C	
02–Feb	1230	A	O	Calm	9	7			1300	138	C	Fish passage low.
	2200	B	O	Calm	6	7	4.3	−15.2			C	
03–Feb	1200	B	S	N 5–10	8	7			1430	180	D	Observed 1 chum just behind weir working fence. passage starting to pick up in evening.
	2200	A	C	N 5–10	4	8	4.9	−10.4			D	
04–Feb	1230		S	N 5–10	4	5			1230	174	C	
	2200	A	C	Calm	7	6	−4.9	−15.2			C	
05–Feb	1200	A	O	NW 5–10	4	6			1300	165	C	Move xducer out 3 ft, in more swift current to move fish along.
	2200	A	B	Calm	4	7	−1.8	−17.1			C	
06–Feb	1200		C	Calm	10	6			1400	170	C	Passage increasing; observed 1 coho jump downstream of lead and 1 about 20 ft off east bank.
	2200	A	C	Calm	2	7	2.4	−14.6			C	
07–Feb	1600		B	N 30–40	8	6			1600	155	C	Strong wind blowing all day.
	2200	A	S	N 30–35	7	6	−4.3	−18.9			C	
08–Feb	1200	A	B	N 20–30/35–40	8	5			1300	171	B	Wind still howling; has not abated in 30 hrs.
	2200	A	B	N 25–30	4	6	−1.5	−20.4			B	
09–Feb	1200	A	S	N 15–20	5	4			1200	174	B	Heavy leaf litter in left bank lead. Moved right bank xducer 10 ft downstream.
	2200	A	S	N 15–20	3	7	−0.9	−21.3			B	
10–Feb	1200	A	S	N 10–15	4	4			1430	188	B	
	2200	A	S	N 0–5	3	4	−0.3	−21.6			B	
11–Feb	1200	A	S	N 10–15	8	4			1430	159	B	Leaves choking lead. During evening cleaning of lead could feel fencing vibrate from salmon
	2200	A	C	N 20–25/30	2	4	0.3	−21.3			B	hitting downstream side; was also hit in leg a couple times. Right bank lead installed by
12–Feb	1230	A	B	N 5–10	2	3			1600	182	B	right bank xducer @ 2030 h.
	2200	A	C	Calm	4	4	−1.8	−23.2			B	Eagle on opposite side of river collecting branches to make a nest.
13–Feb	1200	A	C	Calm	2	3			1400	170	B	Move left bank xducer out 1 ft; Oly slightly hypothermic from holes in chest waders. Passage
	2200	A	C	Calm	4	4	0.0	−23.2			B	increased in evening. Observed 1 chum in shallows above xducer.
14–Feb	1200	A	O	N 25–30	5	3			1300	171	B	Observed 2 coho on downstream side of left bank lead; still good passage; the right bank sonar
	2200	A	O	Calm	4	6	−1.8	−25.0			B	became operational 24 h/d; hit in leg by salmon while cleaning right bank lead.
15–Feb	1230	A	C	N 5–10	10	4			1230	168	B	Leads choked with leaves in morning; fish passage still good. Observed 4 chum working
	2200	A	C	N 0–5	2	5	−0.3	−25.3			B	downstream side of left bank lead.
16–Feb	1300	A	S	N 0–5	6	4			1300	178	B	A lot of leaves in leads.
	2200	A	S	Calm	1	4	−0.3	−25.6			B	Young bull moose in Barton creek.
17–Feb	1200	A	C	Calm	9	4			1400	165	B	Beautiful sunny day. Hit by fish in the legs while cleaning left bank lead.
	2200	A	C	Calm	3	5	−0.6	−26.2			B	
18–Feb	1200	A	C	Calm	2	3			1200	171	B	Observed 4–5 chum above and 4–5 below left bank lead in shallow water.
	2200	A	S	N 0–5	4	4	−0.9	−27.1			B	
19–Feb	1300	A	C	Calm	7	4			1400	176	B	Looks like snow clouds. Passage increased in evening. Spotted large number of chum
	2200	A	C	N 0–5	0	3	1.5	−25.6			B	in shallows above left bank xducer; also 5 on upstream of right bank xducer.
20–Feb	1200	A	C	Calm	−3	2			1200	152	B	Observed 11 chum upstream of right bank xducer and 5 downstream @ 2205 h.
	2200	A	C	Calm	−2	3	−1.8	−27.4			B	
21–Feb											B	Bright sunny day; passage decreased. 50+ bull in Barton creek. Observed 9 chum about 200 ft
	2200	A	C	Calm	−3	3	−0.9	−28.3			B	upstream of right bank xducer and 4 below lead @ 2215 h.
22–Feb	1200	A	C	SSW 5	4	1			1200	183	B	Observed 14 chum and 1 coho upstream of right bank xducer and 8 chum below xducer.
	2200	A	O	Calm	0	4	−2.1	−30.5			B	
23–Feb	1200	A	C	Calm	4	2			1200	143	B	Observed 14 chum and 1 coho above lead in shallows.
	2200	A	C	Calm	−2	2	−0.6	−31.1			B	
24–Feb	1330	A	C	Calm	6	1			1300	167	B	Bright sunny day. Brown bear tracks on west bar. Counted 22 chums along right bank to
	2200	A	C	Calm	−3	2	−1.8	−32.9			B	about 200 ft upstream.

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Appendix B.1. (page 3 of 3)

Date	Time	Precip (code) [a]	Cloud Cover (code) [b]	Wind (Direction and Velocity)	Temperature (C) Air	Temperature (C) Water Surface	Water Level (cm) 24 h Change	Water Level (cm) relative to zero datum	Surface Water velocity (floating chip method) Time of day	Surface Water velocity (floating chip method) cm/sec	Water Color (code) [c]	Remarks [d]
25-Feb	1430	A	S	S 15-20	6	1			1630	163	B	Spotted 19 chum in shallows above left bank xducer; females appear ripe. Also saw 14 chums
	2200	A	O	S 5-10	4	1	0.0	-32.9			B	above and 5 below right bank xducer.
26-Feb	1200	B	O	S 15-20	9	2			1530	173	B	Saw 6 chum above left bank lead and 3 below. Saw 5 chum above and 1 below right bank lead.
	2200	B	C	Calm	-1	3	1.2	-31.7			B	
27-Feb	1200	A	O	N 0-5	6	2					B	Observed 9 chum above left bank xducer and 4 behind lead. Also saw 9 chum above right bank
	2200	A	O	Calm	2	3	-0.6	-32.3			B	xducer and 9 below.
28-Feb	1330	A	S	Calm	11	3					B	Power down both counters @ 1000 h.
	2200	B	O	NW 10-15	3	4	0.3	-32.0			B	
29-Feb	1200	A	S	N 20-25	7	4					B	
Average					9	8						

[a] Precipitation code for the preceding 24-hour period: A = None; B = Intermittent rain; C = Continuous rain; D = Snow and rain mixed; E = Light snowfall; F = Continuous snowfall; G = Thunderstorm w/ or w/o precipitation.
[b] Instantaneous cloud cover code: C = Clear and visibility unlimited (CAVU); S = Scattered (<60%); B = Broken (60-90%); O = Overcast (100%); F = Fog or thick haze or smoke.
[c] Instantaneous water color code: A = Clear; B = Slightly murky or glacial; C = Moderately murky or glacial; D = Heavily murky or glacial; E = Brown, tanic acid stain.
[d] All hydrologic observations refer to the main channel Toklat River unless otherwise specified.

APPENDIX C

TOKLAT RIVER SONAR CALIBRATION DATA

APPENDIX C: TOKLAT RIVER SONAR CALIBRATION DATA

Appendix C.1. Oscilloscope data used to calibrate the left bank sonar counter at the Toklat River project site, 1994.

Date	Time Start	Duration (min)	Scope Count	Sonar Count	Adjustment Factor	PRR	Dead Range	Ctng Range	Total Range	Passage Rate (Fish/hour)
14-Aug	2305	15	3	13	0.231	0.400	4.0	72	76.0	12
15-Aug 16-Aug 17-Aug 18-Aug			No Calibrations							
19-Aug	1337	15	1	10	0.100	0.200	3.0	90	93.0	4
	1605	15	4	6	0.667	0.200	3.0	90	93.0	16
	1840	15	1	6	0.167	0.200	3.5	90	93.5	4
	2105	15	2	4	0.500	0.200	3.5	90	93.5	8
	2325	15	5	8	0.625	0.200	3.5	90	93.5	20
20-Aug	20	15	6	22	0.273	0.200	3.5	90	93.5	24
	735	15	5	54	0.093	0.200	2.5	60	62.5	20
	1505	15	5	16	0.313	0.200	2.5	55	57.5	20
	1816	15	5	22	0.227	0.200	2.5	55	57.5	20
	2101	15	4	12	0.333	0.200	2.5	55	57.5	16
	2305	15	5	14	0.357	0.200	2.5	55	57.5	20
21-Aug	1	15	6	20	0.300	0.200	2.5	55	57.5	24
	601	15	5	30	0.167	0.200	2.5	55	57.5	20
	1125	15	0	0	--	0.200	2.5	55	57.5	0
	1603	15	0	0	--	0.200	2.5	55	57.5	0
	1805	15	2	6	0.333	0.200	2.5	55	57.5	8
	2103	15	4	7	0.571	0.200	2.5	55	57.5	16
	2305	15	0	0	--	0.200	2.5	55	57.5	0
22-Aug	5	15	1	5	0.200	0.200	2.5	55	57.5	4
	605	15	5	22	0.227	0.200	2.5	55	57.5	20
	1102	15	5	13	0.385	0.200	2.5	55	57.5	20
	1601	15	5	9	0.556	0.200	2.5	55	57.5	20
	1801	15	1	1	1.000	0.200	2.5	55	57.5	4
	2120	15	0	0	--	0.200	2.5	55	57.5	0
	2310	15	1	1	1.000	0.200	2.5	55	57.5	4
23-Aug	5	15	1	1	1.000	0.200	2.5	55	57.5	4
	615	15	1	3	0.333	0.200	2.5	55	57.5	4
	1101	15	0	0	--	0.200	2.5	55	57.5	0
	1601	15	1	1	1.000	0.200	2.5	55	57.5	4
	1805	15	3	6	0.500	0.200	2.5	55	57.5	12
	2105	15	3	4	0.750	0.200	2.5	55	57.5	12
	2305	15	4	17	0.235	0.200	2.5	55	57.5	16
24-Aug	1	15	6	7	0.857	0.492	2.5	55	57.5	24
	601	15	1	2	0.500	0.492	2.5	55	57.5	4
	1101	15	2	2	1.000	0.492	2.5	55	57.5	8
	1610	15	1	0	--	0.492	2.5	55	57.5	4
	1805	15	0	0	--	0.492	2.5	55	57.5	0
	2102	15	2	2	1.000	0.492	2.5	47	49.5	8
	2301	30	5	7	0.714	0.492	2.5	47	49.5	10
25-Aug	12	15	3	5	0.600	0.492	2.5	47	49.5	12
	605	10	2	5	0.400	0.492	2.5	47	49.5	12
	1105	15	1	1	1.000	0.492	2.5	47	49.5	4
	1610	15	0	0	--	0.492	2.5	47	49.5	0
	1805	15	3	3	1.000	0.492	2.5	47	49.5	12
	2101	15	2	2	1.000	0.492	3.0	55	58.0	8
	2301	15	7	7	1.000	0.492	3.0	55	58.0	28
26-Aug	1	15	2	1	2.000	0.492	3.0	55	58.0	8
	801	30	21	26	0.808	0.492	3.0	80	83.0	42
	1101	15	8	6	1.333	0.492	3.0	80	83.0	32
	1625	15	3	2	1.500	0.492	3.0	80	83.0	12
	1801	30	25	17	1.471	0.492	3.0	80	83.0	50
	2125	30	73	61	1.197	0.492	3.0	80	83.0	146
	2301	30	62	44	1.409	0.492	3.0	80	83.0	124
27-Aug	1	30	36	21	1.714	0.492	3.0	80	83.0	72
	615	15	5	4	1.250	0.492	3.0	80	83.0	20
	801	30	34	57	0.596	0.492	3.0	80	83.0	68
	1140	15	9	14	0.643	0.492	3.0	80	83.0	36
	1801	15	8	6	1.333	0.492	3.0	80	83.0	32

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Date	Time Start	Duration (min)	Scope Count	Sonar Count	Adjustment Factor	PRR	Dead Range	Ctng Range	Total Range	Passage Rate (Fish/hour)
28-Aug				Sonar Powered Down						
29-Aug				Sonar Powered Down						
30-Aug	1305	15	0	0	--	0.492	3.0	48	51.0	0
	1610	15	0	0	--	0.492	3.0	47	50.0	0
	2010	15	5	2	2.500	0.492	3.0	55	58.0	20
	2101	15	4	1	4.000	0.492	3.0	55	58.0	16
	2301	15	6	2	3.000	0.492	3.0	55	58.0	24
31-Aug	1	15	7	3	2.333	0.492	3.0	50	53.0	28
	615	30	26	18	1.444	0.492	3.0	50	53.0	52
	1420	15	2	1	2.000	0.492	4.0	47	51.0	8
	1601	15	2	0	--	0.492	4.0	47	51.0	8
	1801	15	3	1	3.000	0.492	4.0	47	51.0	12
	2101	30	12	2	6.000	0.492	4.0	47	51.0	24
	2301	40	49	15	3.267	0.492	4.0	42	46.0	74
01-Sep	1	30	40	30	1.333	0.086	4.0	42	46.0	80
	605	30	30	34	0.882	0.086	4.0	42	46.0	60
	1105	15	4	17	0.235	0.086	4.0	42	46.0	16
	1601	15	8	14	0.571	0.086	4.0	46	50.0	32
	1801	15	8	11	0.727	0.086	4.0	46	50.0	32
	2101	40	52	83	0.627	0.086	4.0	46	50.0	78
	2301	30	79	67	1.179	0.155	4.0	46	50.0	158
02-Sep	5	30	52	46	1.130	0.155	4.0	46	50.0	104
	615	30	24	26	0.923	0.155	4.0	46	50.0	48
	1101	15	6	7	0.857	0.155	4.0	46	50.0	24
	1605	15	5	8	0.625	0.155	4.0	46	50.0	20
	1810	15	5	4	1.250	0.155	4.0	46	50.0	20
	2105	30	49	50	0.980	0.155	4.0	46	50.0	98
	2301	30	43	41	1.049	0.155	4.0	46	50.0	86
03-Sep	1	30	38	40	0.950	0.155	4.0	46	50.0	76
	610	15	6	10	0.600	0.155	4.0	46	50.0	24
	1110	15	1	2	0.500	0.155	4.0	46	50.0	4
	1605	15	5	8	0.625	0.155	4.0	48	52.0	20
	1810	15	7	9	0.778	0.155	4.0	48	52.0	28
	2101	30	28	31	0.903	0.155	4.0	48	52.0	56
	2301	30	29	38	0.763	0.155	4.0	48	52.0	58
04-Sep	1	30	36	50	0.720	0.155	4.0	48	52.0	72
	610	15	2	2	1.000	0.155	4.0	48	52.0	8
	1125	15	2	5	0.400	0.155	4.0	48	52.0	8
	1605	15	4	3	1.333	0.155	4.0	48	52.0	16
	1805	15	4	7	0.571	0.155	4.0	48	52.0	16
	2101	15	9	11	0.818	0.155	4.0	48	52.0	36
	2301	30	37	59	0.627	0.155	4.0	44	48.0	74
05-Sep	1	30	45	80	0.563	0.155	4.0	44	48.0	90
	625	30	20	22	0.909	0.155	4.0	44	48.0	40
	1105	15	2	2	1.000	0.155	4.0	46	50.0	8
	1801	15	4	3	1.333	0.155	4.0	46	50.0	16
	2105	15	3	3	1.000	0.155	4.0	46	50.0	12
	2301	30	55	62	0.887	0.155	4.0	46	50.0	110
06-Sep	1	30	42	48	0.875	0.155	4.0	46	50.0	84
	610	15	5	5	1.000	0.155	4.0	46	50.0	20
	1101	15	0	0	--	0.155	4.0	46	50.0	0
	1605	15	5	22	0.227	0.155	4.0	46	50.0	20
	1801	15	0	0	--	0.155	4.0	46	50.0	0
	2105	15	4	7	0.571	0.155	4.0	46	50.0	16
	2305	30	25	38	0.658	0.155	4.0	46	50.0	50
07-Sep	15	30	25	27	0.926	0.155	4.0	46	50.0	50
	615	15	1	2	0.500	0.155	4.0	46	50.0	4
	1102	15	3	5	0.600	0.155	4.0	46	50.0	12
	1601	15	1	1	1.000	0.155	4.0	46	50.0	4
	1801	15	0	0	--	0.155	4.0	46	50.0	0
	2101	15	0	0	--	0.155	4.0	46	50.0	0
	2301	30	4	2	2.000	0.155	4.0	46	50.0	8

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Date	Time Start	Duration (min)	Scope Count	Sonar Count	Adjustment Factor	PRR	Dead Range	Ctng Range	Total Range	Passage Rate (Fish/hour)
08-Sep	10	30	3	1	3.000	0.155	4.0	46	50.0	6
	610	15	2	4	0.500	0.155	4.0	46	50.0	8
	1101	15	0	0	--	0.155	4.0	46	50.0	0
	1601	15	0	0	--	0.155	4.0	46	50.0	0
	1801	15	1	1	1.000	0.155	4.0	46	50.0	4
	2102	15	5	5	1.000	0.155	4.0	46	50.0	20
	2320	30	29	46	0.630	0.155	4.0	46	50.0	58
09-Sep	1	15	8	12	0.667	0.155	4.0	46	50.0	32
	705	15	7	14	0.500	0.155	4.0	46	50.0	28
	1105	15	2	1	2.000	0.155	3.5	46	49.5	8
	1605	30	19	21	0.905	0.155	3.5	46	49.5	38
	1825	15	2	3	0.667	0.155	3.5	46	49.5	8
	2101	30	27	36	0.750	0.155	3.5	46	49.5	54
	2301	30	42	59	0.712	0.155	3.5	46	49.5	84
10-Sep	1	30	48	65	0.738	0.155	3.5	46	49.5	96
	701	30	24	24	1.000	0.155	3.5	46	49.5	48
	1101	15	1	2	0.500	0.155	3.5	46	49.5	4
	1601	15	1	1	1.000	0.155	3.5	46	49.5	4
	1801	15	0	0	--	0.155	3.5	46	49.5	0
	2101	15	2	2	1.000	0.155	3.5	47	50.5	8
	2301	30	24	42	0.571	0.155	3.5	47	50.5	48
11-Sep	1	30	37	52	0.712	0.155	3.5	47	50.5	74
	601	15	5	6	0.833	0.155	3.5	47	50.5	20
	1101	15	4	3	1.333	0.155	3.5	47	50.5	16
	1601	30	17	37	0.459	0.155	3.5	47	50.5	34
	1905	15	0	0	--	0.155	4.5	45	49.5	0
	2101	30	56	58	0.966	0.155	4.5	45	49.5	112
	2301	40	102	141	0.723	0.155	4.5	45	49.5	153
12-Sep	1	30	106	104	1.019	0.231	4.5	45	49.5	212
	601	30	22	25	0.880	0.231	4.5	45	49.5	44
	1101	15	3	2	1.500	0.231	4.5	45	49.5	12
	1601	15	2	2	1.000	0.231	4.5	45	49.5	8
	1801	15	6	5	1.200	0.231	4.5	45	49.5	24
	2101	30	78	53	1.472	0.231	3.0	45	48.0	156
	2301	30	66	68	0.971	0.231	3.0	45	48.0	132
13-Sep	1	30	99	100	0.990	0.231	3.0	45	48.0	198
	605	30	22	20	1.100	0.231	3.0	45	48.0	44
	1240	15	2	3	0.667	0.231	3.0	45	48.0	8
	1601	15	1	0	--	0.231	3.0	45	48.0	4
	1801	15	8	14	0.571	0.231	3.0	45	48.0	32
	2101	30	55	38	1.447	0.231	3.0	45	48.0	110
	2301	30	90	85	1.059	0.231	3.0	45	48.0	180
14-Sep	1	30	75	72	1.042	0.231	3.0	45	48.0	150
	605	15	3	5	0.600	0.231	3.0	45	48.0	12
	1105	15	2	1	2.000	0.231	3.0	45	48.0	8
	1601	15	0	0	--	0.231	3.0	45	48.0	0
	1801	15	0	0	--	0.231	3.0	45	48.0	0
	2101	30	26	25	1.040	0.231	3.0	45	48.0	52
	2301	30	49	47	1.043	0.231	3.0	45	48.0	98
15-Sep	1	30	29	30	0.967	0.231	3.0	45	48.0	58
	601	30	23	20	1.150	0.231	3.0	45	48.0	46
	1101	15	3	2	1.500	0.231	3.0	45	48.0	12
	1601	15	1	2	0.500	0.231	3.0	45	48.0	4
	1801	15	6	9	0.667	0.231	3.0	45	48.0	24
	2101	15	8	9	0.889	0.231	3.0	45	48.0	32
	2301	30	33	35	0.943	0.231	3.0	45	48.0	66
16-Sep	1	30	32	36	0.889	0.231	3.0	45	48.0	64
	601	30	20	16	1.250	0.231	3.0	45	48.0	40
	1101	15	0	0	--	0.231	3.0	45	48.0	0
	1601	15	1	1	1.000	0.231	3.0	45	48.0	4
	1801	15	3	2	1.500	0.231	3.0	45	48.0	12
	2101	15	8	8	1.000	0.231	3.0	45	48.0	32
	2301	30	30	29	1.034	0.231	3.0	45	48.0	60

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Date	Time Start	Duration (min)	Scope Count	Sonar Count	Adjustment Factor	PRR	Dead Range	Ctng Range	Total Range	Passage Rate (Fish/hour)
17-Sep	5	15	9	12	0.750	0.231	3.0	45	48.0	36
	601	30	21	14	1.500	0.231	3.0	45	48.0	42
	1103	15	0	0	--	0.231	3.0	45	48.0	0
	1601	15	0	0	--	0.231	3.0	48	51.0	0
	1801	15	4	5	0.800	0.231	3.0	48	51.0	16
	2101	30	45	23	1.957	0.231	3.0	48	51.0	90
	2301	30	31	35	0.886	0.231	3.0	48	51.0	62
18-Sep	1	30	43	41	1.049	0.231	3.0	48	51.0	86
	601	30	35	30	1.167	0.231	3.0	48	51.0	70
	1101	15	8	12	0.667	0.231	3.0	48	51.0	32
	1601	15	0	0	--	0.231	3.0	48	51.0	0
	1801	15	9	16	0.563	0.231	3.0	48	51.0	36
	2101	15	7	5	1.400	0.231	3.0	48	51.0	28
	2301	15	7	7	1.000	0.231	3.0	48	51.0	28
19-Sep	1	15	5	3	1.667	0.231	3.0	48	51.0	20
	601	30	16	13	1.231	0.231	3.0	48	51.0	32
	1103	15	0	0	--	0.231	3.0	48	51.0	0
	1445	15	8	54	0.148	0.231	3.0	46	49.0	32
	1601	15	4	6	0.667	0.231	3.0	46	49.0	16
	1801	15	8	25	0.320	0.231	3.0	46	49.0	32
	2101	30	145	225	0.644	0.231	3.0	46	49.0	290
	2301	30	171	193	0.886	0.231	3.0	46	49.0	342
20-Sep	1	30	205	256	0.801	0.231	3.0	46	49.0	410
	601	30	76	85	0.894	0.231	3.0	46	49.0	152
	1101	40	90	117	0.769	0.231	3.0	46	49.0	135
	1601	30	25	23	1.087	0.302	5.0	44	49.0	50
	1801	30	27	31	0.871	0.302	5.0	44	49.0	54
	2101	30	49	50	0.980	0.302	5.0	44	49.0	98
	2301	30	69	72	0.958	0.302	5.0	44	49.0	138
21-Sep	1	30	79	85	0.929	0.302	5.0	44	49.0	158
	601	45	94	72	1.306	0.302	5.0	44	49.0	125
	1101	30	86	88	0.977	0.204	5.0	44	49.0	172
	1601	30	66	99	0.667	0.204	5.0	44	49.0	132
	1801	30	160	231	0.693	0.204	5.0	44	49.0	320
	2101	30	213	204	1.044	0.204	5.0	44	49.0	426
	2301	30	244	310	0.787	0.204	5.0	44	49.0	488
22-Sep	1	30	213	236	0.903	0.204	5.0	44	49.0	426
	601	30	52	43	1.209	0.204	5.0	44	49.0	104
	1101	30	60	62	0.968	0.204	5.0	44	49.0	120
	1601	30	51	70	0.729	0.204	5.0	44	49.0	102
	1801	30	121	164	0.738	0.204	5.0	44	49.0	242
	2101	30	183	207	0.884	0.204	5.0	44	49.0	366
	2301	30	309	328	0.942	0.204	5.0	44	49.0	618
23-Sep	1	30	223	248	0.899	0.204	5.0	44	49.0	446
	601	30	95	94	1.011	0.204	5.0	44	49.0	190
	1101	30	93	106	0.877	0.204	5.0	44	49.0	186
	1601	15	3	3	1.000	0.204	5.0	44	49.0	12
	1801	30	54	59	0.915	0.204	5.0	44	49.0	108
	2101	30	120	142	0.845	0.204	5.0	44	49.0	240
	2301	30	142	145	0.979	0.204	5.0	44	49.0	284
24-Sep	1	30	97	109	0.890	0.204	5.0	44	49.0	194
	601	15	4	3	1.333	0.204	5.0	44	49.0	16
	1116	30	47	52	0.904	0.204	5.0	44	49.0	94
	1601	30	50	68	0.735	0.204	5.0	44	49.0	100
	1801	30	64	87	0.736	0.204	5.0	44	49.0	128
	2101	40	194	323	0.601	0.204	5.0	44	49.0	291
	2301	30	96	112	0.857	0.397	5.0	44	49.0	192
25-Sep	1	30	138	172	0.802	0.397	5.0	44	49.0	276
	601	30	41	46	0.891	0.397	5.0	44	49.0	82
	1101	30	53	62	0.855	0.397	5.0	44	49.0	106
	1601	15	6	8	0.750	0.397	5.0	44	49.0	24
	1801	30	88	92	0.957	0.397	5.0	44	49.0	176
	2101	30	223	203	1.099	0.397	5.0	44	49.0	446
	2301	40	251	180	1.394	0.397	5.0	44	49.0	377

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Date	Time Start	Duration (min)	Scope Count	Sonar Count	Adjustment Factor	PRR	Dead Range	Ctng Range	Total Range	Passage Rate (Fish/hour)
26–Sep	1	30	164	179	0.916	0.261	5.0	44	49.0	328
	601	15	5	6	0.833	0.261	5.0	44	49.0	20
	1101	30	44	64	0.688	0.261	5.0	44	49.0	88
	1601	15	4	3	1.333	0.261	5.0	44	49.0	16
	1801	30	46	54	0.852	0.261	5.0	44	49.0	92
	2101	30	141	166	0.849	0.261	5.0	44	49.0	282
	2301	30	379	431	0.879	0.261	5.0	41	46.0	758
27–Sep	1	30	242	272	0.890	0.261	5.0	41	46.0	484
	801	30	23	18	1.278	0.261	5.0	41	46.0	46
	1101	30	19	19	1.000	0.261	5.0	41	46.0	38
	1601	15	3	3	1.000	0.261	5.0	42	47.0	12
	1801	30	30	22	1.364	0.261	5.0	42	47.0	60
	2101	30	149	160	0.931	0.261	5.0	42	47.0	298
	2301	30	277	308	0.899	0.261	5.0	42	47.0	554
28–Sep	1	30	181	212	0.854	0.261	5.0	42	47.0	362
	601	30	34	30	1.133	0.261	5.0	42	47.0	68
	1101	15	6	8	0.750	0.261	5.0	42	47.0	24
	1601	15	4	18	0.222	0.261	5.0	44	49.0	16
	1825	15	8	14	0.571	0.261	5.0	44	49.0	32
	2101	30	43	46	0.935	0.261	5.0	44	49.0	86
	2301	30	108	115	0.939	0.261	5.0	44	49.0	216
29–Sep	1	30	79	82	0.963	0.261	5.0	44	49.0	158
	601	30	42	18	2.333	0.261	5.0	44	49.0	84
	1101	15	3	3	1.000	0.261	5.0	44	49.0	12
	1601	15	2	1	2.000	0.261	5.0	44	49.0	8
	1801	30	32	33	0.970	0.261	5.0	44	49.0	64
	2101	30	121	137	0.883	0.261	5.0	44	49.0	242
	2301	30	137	148	0.926	0.261	5.0	44	49.0	274
30–Sep	1	30	68	76	0.895	0.261	5.0	44	49.0	136
	701	30	19	17	1.118	0.261	5.0	44	49.0	38
	1101	15	3	5	0.600	0.261	5.0	44	49.0	12
	1601	15	0	0	--	0.261	5.0	44	49.0	0
	1801	15	3	4	0.750	0.261	5.0	44	49.0	12
	2101	30	64	64	1.000	0.261	5.0	44	49.0	128
	2301	30	73	86	0.849	0.261	5.0	44	49.0	146
01–Oct	1	40	118	153	0.771	0.261	5.0	44	49.0	177
	601	30	59	63	0.937	0.370	5.0	44	49.0	118
	1101	15	7	7	1.000	0.370	5.0	44	49.0	28
	1601	15	0	0	--	0.370	5.0	44	49.0	0
	1801	15	0	0	--	0.370	5.0	44	49.0	0
	2101	15	5	7	0.714	0.370	5.0	44	49.0	20
	2301	40	51	33	1.545	0.370	5.0	44	49.0	77
02–Oct	1	30	37	35	1.057	0.195	5.0	44	49.0	74
	601	15	0	0	--	0.195	5.0	44	49.0	0
	1101	15	2	2	1.000	0.195	5.0	44	49.0	8
	1601	15	3	3	1.000	0.195	5.0	44	49.0	12
	1801	30	15	22	0.682	0.195	5.0	44	49.0	30
	2101	30	20	26	0.769	0.195	5.0	44	49.0	40
	2301	30	26	36	0.722	0.195	5.0	44	49.0	52
03–Oct	1	15	4	6	0.667	0.195	5.0	44	49.0	16
	601	15	4	4	1.000	0.195	5.0	44	49.0	16
	1101	15	2	4	0.500	0.195	5.0	44	49.0	8
	1601	15	1	2	0.500	0.195	5.0	44	49.0	4
	1801	15	7	11	0.636	0.195	5.0	44	49.0	28
	2101	15	4	6	0.667	0.195	5.0	44	49.0	16
	2301	15	8	14	0.571	0.195	5.0	44	49.0	32
04–Oct	1	15	7	12	0.583	0.195	5.0	44	49.0	28
	601	15	4	6	0.667	0.195	5.0	44	49.0	16
Total	304	6,705	10,838	12,366	0.876					

Appendix C.2. Oscilloscope data used to calibrate the right bank sonar counter at the Toklat River project site, 1994.

Date	Time Start	Duration	Scope Count	Sonar Count	Adjustment Factor	PRR	Dead Range	Ctng Range	Total Range	Passage Rate (Fish/hour)
06-Sep	2345	10	2	18	0.111	0.155	1.0	20	21	12
07-Sep	640	15	0	0	--	0.155	1.0	20	21	0
	2340	15	3	6	0.500	0.200	1.0	20	21	12
08-Sep	630	30	0	0	--	0.200	1.0	20	21	0
09-Sep										
10-Sep	40	15	4	61	0.066	0.300	1.0	20	21	16
	645	15	2	8	0.250	0.300	1.0	20	21	8
	2335	15	1	4	0.250	0.300	1.0	20	21	4
11-Sep	635	25	0	0	--	0.300	1.0	20	21	0
12-Sep	45	15	0	0	--	0.300	1.0	20	21	0
	101	15	1	5	0.200	0.300	1.0	20	21	4
	640	15	2	5	0.400	0.300	1.0	20	21	8
13-Sep	40	20	0	0	--	0.300	1.0	20	21	0
	101	10	1	2	0.500	0.300	1.0	20	21	6
	640	15	0	0	--	0.300	1.0	20	21	0
14-Sep	40	20	0	0	--	0.300	1.0	20	21	0
	630	15	3	8	0.375	0.300	1.0	20	21	12
15-Sep										
16-Sep	35	15	5	16	0.313	0.300	1.0	20	21	20
	645	15	9	21	0.429	0.300	1.0	20	21	36
	2335	15	7	12	0.583	0.400	1.0	20	21	28
17-Sep	640	20	3	5	0.600	0.400	1.0	20	21	9
18-Sep	45	15	8	11	0.727	0.400	1.0	19	20	32
	640	15	2	2	1.000	0.400	1.0	19	20	8
19-Sep	45	15	1	1	1.000	0.400	1.0	20	21	4
	645	15	2	3	0.667	0.400	1.0	20	21	8
20-Sep	45	15	2	3	0.667	0.400	1.0	20	21	8
	645	15	3	8	0.375	0.400	1.0	20	21	12
	1501	15	1	1	1.000	0.400	1.0	20	21	4
	1801	15	0	0	--	0.400	1.0	20	21	0
	2335	15	1	3	0.333	0.400	1.0	20	21	4
21-Sep	40	15	2	4	0.500	0.400	1.0	20	21	8
	701	15	1	1	1.000	0.400	1.0	20	21	4
	1145	15	0	0	--	0.400	1.0	20	21	0
	1845	15	2	3	0.667	0.400	1.0	20	21	8
	2335	15	1	3	0.333	0.400	1.0	20	21	4
22-Sep	45	15	0	0	--	0.400	1.0	20	21	0
	645	15	1	1	1.000	0.400	1.0	20	21	4
	1845	15	1	1	1.000	0.400	1.0	20	21	4
	2335	15	3	4	0.750	0.400	1.0	20	21	12
23-Sep	45	15	2	2	1.000	0.400	1.0	20	21	8
	645	15	2	3	0.667	0.400	1.0	20	21	8
	1645	15	0	0	--	0.400	1.0	20	21	0
	2340	15	3	2	1.500	0.400	1.0	20	21	12
24-Sep	45	15	0	0	--	0.400	1.0	20	21	0
	630	15	4	5	0.800	0.400	1.0	20	21	16
	1930	15	0	0	--	0.400	1.0	20	21	0
	2335	15	7	6	1.167	0.400	1.0	20	21	28
25-Sep	45	15	5	6	0.833	0.400	1.0	20	21	20
	630	15	1	1	1.000	0.400	1.0	20	21	4
	1845	15	1	1	1.000	0.400	1.0	20	21	4
	2345	10	0	0	--	0.400	1.0	20	21	0

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Date	Time Start	Duration	Scope Count	Sonar Count	Adjustment Factor	PRR	Dead Range	Ctng Range	Total Range	Passage Rate (Fish/hour)
26–Sep	45	15	1	1	1.000	0.400	1.0	20	21	4
	630	15	2	2	1.000	0.400	1.0	20	21	8
	1845	13	1	0	––	0.400	1.0	20	21	5
	2340	15	3	2	1.500	0.400	1.0	20	21	12
27–Sep	43	15	3	3	1.000	0.400	1.0	20	21	12
	845	15	0	0	––	0.400	1.0	20	21	0
	1843	15	0	0	––	0.400	1.0	20	21	0
	2335	15	2	2	1.000	0.400	1.0	20	21	8
28–Sep	43	15	3	4	0.750	0.400	1.0	20	21	12
	643	15	1	1	1.000	0.400	1.0	20	21	4
	1901	15	2	1	2.000	0.400	1.0	20	21	8
	2340	15	8	7	1.143	0.400	1.0	20	21	32
29–Sep	43	15	7	4	1.750	0.400	1.0	20	21	28
	643	15	0	0	––	0.400	1.0	20	21	0
	1835	15	1	1	1.000	0.400	1.0	20	21	4
	2343	15	10	12	0.833	0.400	1.0	20	21	40
30–Sep	43	15	3	2	1.500	0.400	1.0	20	21	12
	735	15	1	1	1.000	0.400	1.0	20	21	4
	1835	15	0	0	––	0.400	1.0	20	21	0
	2340	15	1	1	1.000	0.400	1.0	20	21	4
01–Oct	101	15	5	9	0.556	0.400	1.0	20	21	20
	640	15	2	3	0.667	0.400	1.0	20	21	8
	1725	15	0	0	––	0.400	1.0	20	21	0
	2345	10	2	5	0.400	0.400	1.0	20	21	12
02–Oct	40	15	3	5	0.600	0.400	1.0	20	21	12
	625	15	7	59	0.119	0.400	1.0	20	21	28
	1910	30	6	39	0.154	0.400	1.0	20	21	12
	2335	15	2	3	0.667	0.400	1.0	20	21	8
03–Oct	101	15	7	9	0.778	0.400	1.0	20	21	28
	635	15	0	0	––	0.400	1.0	20	21	0
	1916	15	1	1	1.000	0.400	1.0	20	21	4
	2325	15	2	4	0.500	0.400	1.0	20	21	8
04–Oct	30	15	5	7	0.714	0.400	1.0	20	21	20
	635	15	2	3	0.667	0.400	1.0	20	21	8
Total	84	1,293	192	437	0.439					

APPENDIX D

TOKLAT RIVER TEMPORAL SONAR COUNT DATA

APPENDIX D: TOKLAT RIVER TEMPORAL SONAR COUNT DATA

Appendix D.1. Temporal distribution of daily sonar counts along the left bank Toklat River, 1994.

Printer Printout Time	14–Aug	15–Aug	16–Aug	17–Aug	18–Aug	19–Aug	20–Aug	21–Aug	22–Aug	23–Aug	24–Aug	25–Aug	26–Aug	27–Aug	28–Aug	29–Aug	30–Aug	31–Aug
0100		5	4	1	1	0	21	23	2	10	11	29	12	68				62
0200		1	2		5	0	4	17	2	4	3	13	7	25				152
0300	A total of 34 fish were estimated for this time period. [a]	2	3		3	0	5	15	1	0	16	7	5	29			A total of 318 fish were estimated for this time period. [f]	32
0400		2	2		1	0	4	16	1	12	15	7	10	23				62
0500		3	1	A total of 77 fish were estimated for this time period. [b]	4	1	6	16	3	0	13	9	8	46				45
0600		5	6		2	0	9	26	1	0	13	23	12	38				21
0700		2	6		2	2	4	13	13	1	2	10	1	19	534 fish estimated passing (average of Aug 27&30)	534 fish estimated passing (average of Aug 27&30)		63
0800		1	9		9	0	12	3	13	4	16	9	5					79
0900		1	8		7	0	13	2	2	1	1	8	40					24
1000		2	2		2	0	8	2	4	2	1	3	25					29
1100		3	1		1	4	18	4	6	1	1	3	14	A total of 297 fish were estimated for this time period. [d,f]				8
1200		2	1		19	4	17	2	9	4	5	15	20					8
1300		3	1		8	8	12	3	3	1	6	12	28				4	7
1400		1	1		5	14	12	3	6	9	6	17	26				0	5
1500		1	1		1	9	12	3	1	5	3	8	72				12	8
1600		1	1		4	8	17	4	2	8	0	3	28				8	28
1700		7	1		1	25	10	1	15	3	2	2	15				4	8
1800	8	0	1		1	20	13	1	12	6	2	4	55				0	5
1900	1	11	1		2	2	22	2	2	3	0	5	62				2	15
2000	2	4	0	1	2	7	14	2	19	3	4	9	41				4	30
2100	1	0	1	1	3	5	7	7	5	6	26	14	72				25	70
2200	0	1	2	3	1	17	29	13	26	9	30	25	102				16	90
2300	0	17	1	3	6	23	11	1	4	3	8	12	136				53	109
2400	3	1	1	5	1	15	12	0	3	8	24	18	112				78	146
Total	49	76	57	91	91	164	292	179	155	101	210	265	908	545	534	534	522	1,106
Percent	0.1%	0.1%	0.1%	0.1%	0.1%	0.3%	0.4%	0.3%	0.2%	0.2%	0.3%	0.4%	1.4%	0.8%	0.8%	0.8%	0.8%	1.7%

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[a] Initial hookup of sonar counter at 1800 hours. Estimated passage based upon proportion observed for this time block on 15 August.
[b] Powered down between 0100–2000 hours due to extremely heavy silt storm. Estimated passage based upon proportion observed for this time block on 18 August.
[d] Powered down due to high water.
[f] Estimated passage based upon average proportion observed during these time blocks for first 3 days after the high water event (31 August – 2 September).
[g] Powered down for season at 1000 hours. Estimated passage based upon the average proportion observed for this time block during 1–3 October.
[h] Totals only include days with 24 hour counts (i.e., excludes 14, 17, 27–30 August, and 4 October)
[i] Total estimated passage, including days with expanded counts.

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Printer Printout Time	01-Sep	02-Sep	03-Sep	04-Sep	05-Sep	06-Sep	07-Sep	08-Sep	09-Sep	10-Sep	11-Sep	12-Sep	13-Sep	14-Sep	15-Sep	16-Sep	17-Sep	18-Sep
0100	103	122	80	85	70	74	63	9	61	105	92	172	215	105	51	43	51	78
0200	83	153	81	47	82	131	60	8	54	128	112	166	242	89	46	63	63	66
0300	78	118	84	15	91	78	42	17	32	114	101	139	170	90	68	68	62	63
0400	49	123	53	55	94	108	43	20	72	117	64	127	126	115	69	51	81	58
0500	57	67	43	42	47	93	64	18	66	61	62	148	163	93	85	38	83	85
0600	93	68	55	32	46	39	41	14	44	54	64	66	63	46	27	47	54	56
0700	63	46	27	53	57	50	3	2	44	40	14	38	52	13	36	28	30	45
0800	41	74	16	14	13	14	15	3	16	18	0	38	18	3	14	2	3	2
0900	89	39	10	17	21	14	4	0	54	28	4	19	18	10	15	17	10	0
1000	55	36	40	13	14	19	5	0	11	14	0	10	20	6	8	9	3	37
1100	34	14	10	14	24	1	3	0	13	26	12	16	20	2	14	1	9	26
1200	16	22	4	13	32	1	5	1	15	8	7	15	8	6	30	1	10	20
1300	24	22	11	33	19	4	3	1	22	5	0	27	4	1	11	2	19	12
1400	6	25	4	26	29	0	3	0	16	6	1	51	3	9	23	16	26	23
1500	4	31	4	21	1	3	3	0	6	11	12	16	5	5	12	5	6	11
1600	8	20	14	23	16	13	4	0	19	13	3	15	9	3	15	0	2	5
1700	11	7	12	29	22	7	18	0	46	3	13	12	3	0	2	12	10	14
1800	12	22	1	30	28	7	3	1	8	7	16	15	11	1	11	15	45	17
1900	47	20	18	24	7	8	6	5	4	6	21	28	26	5	13	37	53	20
2000	32	25	25	20	21	9	3	3	20	11	28	63	35	9	22	4	14	12
2100	31	13	41	41	24	8	3	12	22	3	67	119	41	28	34	1	32	7
2200	86	71	54	52	37	21	8	28	42	35	199	123	128	49	44	55	111	39
2300	111	71	50	62	92	71	24	40	125	41	109	177	184	95	83	64	75	51
2400	125	80	71	54	117	57	12	72	100	45	157	166	182	90	78	86	52	25
Total	1,258	1,289	808	815	1,004	830	438	254	912	899	1,158	1,786	1,746	873	811	665	904	772
Percent	1.9%	2.0%	1.2%	1.3%	1.5%	1.3%	0.7%	0.4%	1.4%	1.4%	1.8%	2.7%	2.7%	1.3%	1.2%	1.0%	1.4%	1.2%

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[a] Initial hookup of sonar counter at 1800 hours. Estimated passage based upon proportion observed for this time block on 15 August.
[b] Powered down between 0100–2000 hours due to extremely heavy silt storm. Estimated passage based upon proportion observed for this time block on 18 August.
[d] Powered down due to high water.
[f] Estimated passage based upon average proportion observed during these time blocks for first 3 days after the high water event (31 August – 2 September).
[g] Powered down for season at 1000 hours. Estimated passage based upon the average proportion observed for this time block during 1–3 October.
[h] Totals only include days with 24 hour counts (i.e., excludes 14, 17, 27–30 August, and 4 October)
[i] Total estimated passage, including days with expanded counts.

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Printer Printout Time	19-Sep	20-Sep	21-Sep	22-Sep	23-Sep	24-Sep	25-Sep	26-Sep	27-Sep	28-Sep	29-Sep	30-Sep	01-Oct	02-Oct	03-Oct	04-Oct	Total [h]	% passage by time
0100	36	316	181	344	460	168	235	278	418	325	164	129	167	78	28	32	5,086	0.078
0200	24	300	152	270	480	140	225	205	435	280	122	103	134	47	46	21	4,846	0.075
0300	10	294	192	165	503	117	213	240	300	215	154	96	134	18	24	17	4,194	0.065
0400	24	216	147	122	299	72	243	158	265	182	150	44	157	25	16	9	3,677	0.057
0500	22	173	137	100	232	46	99	113	259	166	91	65	86	23	24	18	3,060	0.047
0600	28	138	96	101	184	22	108	55	159	95	48	70	118	12	17	8	2,298	0.035
0700	24	143	149	157	160	19	81	30	146	64	83	44	71	6	10	9	1,947	0.030
0800	1	75	57	33	37	1	30	19	41	60	21	29	54	21	3	2	948	0.015
0900	4	252	149	55	22	50	175	154	52	159	179	92	62	29	34	8	1,944	0.030
1000	3	349	220	253	169	101	145	92	116	109	115	99	47	40	16	9	2,254	0.035
1100	1	229	212	223	191	98	66	53	68	48	79	25	22	15	8		1,641	0.025
1200	1	126	161	107	148	74	70	71	41	24	16	7	9	10	6		1,193	0.018
1300	8	214	170	101	57	48	86	85	12	10	42	11	2	6	11	A total of 81	1,175	0.018
1400	8	140	242	190	7	14	61	33	29	11	26	15	3	9	1	fish were	1,161	0.018
1500	9	66	174	152	43	48	27	59	41	5	51	11	2	18	1	estimated	987	0.015
1600	26	56	155	122	21	111	33	30	34	4	17	19	0	6	2	for this time	919	0.014
1700	42	48	104	77	18	103	58	101	27	4	32	13	0	8	11	period. [g]	957	0.015
1800	25	85	452	202	82	123	94	76	56	19	43	17	1	28	24		1,696	0.026
1900	38	76	430	185	125	92	152	101	81	54	66	22	8	34	23		1,962	0.030
2000	162	97	290	257	172	124	261	142	109	35	62	50	5	31	40		2,328	0.036
2100	160	83	344	262	218	374	464	282	242	83	230	134	13	52	64		3,748	0.058
2200	281	96	394	277	173	409	394	257	265	90	185	145	36	37	19		4,585	0.071
2300	160	200	680	550	195	208	531	573	456	193	186	185	81	75	39		6,168	0.095
2400	349	160	506	600	302	197	366	642	442	192	198	145	63	62	58		6,192	0.095
Total	1,445	3,932	5,794	4,905	4,298	2,759	4,217	3,848	4,094	2,427	2,360	1,570	1,275	690	526	214	64,966 [h]	
																	67,454 [k]	
Percent	2.2%	6.1%	8.9%	7.6%	6.6%	4.2%	6.5%	5.9%	6.3%	3.7%	3.6%	2.4%	2.0%	1.1%	0.8%	0.3%	100.0%	

[a] Initial hookup of sonar counter at 1800 hours. Estimated passage based upon proportion observed for this time block on 15 August.
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[g] Powered down for season at 1000 hours. Estimated passage based upon the average proportion observed for this time block during 1–3 October.
[h] Totals only include days with 24 hour counts (i.e., excludes 14, 17, 27–30 August, and 4 October)
[k] Total estimated passage, including days with expanded counts.

Appendix D.2. Temporal distribution of daily sonar counts along the right bank Toklat River, 1994.

Printer Printout Time	01-Sep	02-Sep	03-Sep	04-Sep	05-Sep	06-Sep	07-Sep	08-Sep	09-Sep	10-Sep	11-Sep	12-Sep	13-Sep	14-Sep	15-Sep	16-Sep	17-Sep	18-Sep
0100							1	4		14	1	1	3	0		24	37	38
0200							5	0		14	1	9	6	1		38	41	23
0300							3	9		8	3	4	12	1		40	47	41
0400							1	4		8	6	8	9	6		37	47	38
0500							1	9		12	3	10	7	7		20	35	44
0600							1	5		10	2	2	8	6		34	42	44
0700							1	0		5	1	2	1	6		35	24	35
0800							1	0		3	1	5	0	1		37	20	12
0900							1	0								38	13	
1000							1	1										
1100																		
1200																		
1300							Daily passage estimates for period 7–19 September.[d]											
1400																		
1500							10.7%	64.0%	70.7%	15.6%	33.0%	29.6%	18.9%	36.5%	74.7%	23.7%	37.6%	26.4%
1600																		
1700							total = 5	56	115	16	13	22	13	16	470	116	248	113
1800																		
1900																		
2000																		
2100																		
2200							2		13	10					82			5
2300							9		21	5	6	8	6		35	44	61	10
2400						6	14		14	1	3	5	6		42	26	45	27
Total	0	0	0	0	0	–	46	68	163	106	40	76	71	44	629	489	660	430
Percent																		

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[a] Totals only include days with 24 hours of counts (i.e., September 20 thorugh October 3). Double outlined areas indicate when sonar was not operating.
[b] Estimated passage based upon the average proportion observed for this time block during 1–3 October.
[d] Estimated daily passage during missing time periods on right bank were estimated from the daily temporal distribution (on respective days) observed among left bank counts.

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Printer Printout Time	19-Sep	20-Sep	21-Sep	22-Sep	23-Sep	24-Sep	25-Sep	26-Sep	27-Sep	28-Sep	29-Sep	30-Sep	01-Oct	02-Oct	03-Oct	04-Oct	Total [a]	% Passage by time
0100	3	16	2	1	12	14	14	6	20	10	71	27	15	31	20	15	259	0.066
0200	9	11	7	15	4	4	6	12	17	15	66	66	22	17	28	13	290	0.074
0300	2	8	3	8	6	1	41	9	19	8	27	35	24	26	42	22	257	0.065
0400	11	13	3	2	3	4	12	6	28	20	35	53	35	28	26	14	268	0.068
0500	12	9	5	7	16	6	11	11	7	28	12	33	33	15	14	23	207	0.053
0600	18	7	6	11	11	2	9	9	23	6	12	18	33	7	6	17	160	0.041
0700	7	13	2	4	12	6	2	3	9	10	15	7	15	11	16	15	125	0.032
0800	1	7	8	5	0	3	4	7	2	12	4	5	7	3	13	7	80	0.020
0900	1	1	3	14	1	3	2	3	1	9	5	3	4	4	3	8	56	0.014
1000		1	8	10	5	1	1	10	6	4	4	6	8	2	4	5	70	0.018
1100		0	8	2	3	1	6	12	6	4	3	9	5	2	13		74	0.019
1200		1	5	1	0	1	2	6	7	9	3	5	2	5	6		53	0.013
1300		5	0	3	4	3	2	6	2	1	1	8	1	5	6	A total of 131	47	0.012
1400		1	2	5	0	2	3	4	8	4	1	3	1	6	7	fish were	47	0.012
1500	33.3%	1	1	1	2	5	2	3	2	0	3	8	1	8	4	estimated	41	0.010
1600		1	1	0	1	4	3	3	1	9	11	2	3	8	6	for this time	53	0.013
1700	85	1	1	2	0	0	5	1	2	4	10	10	3	2	8	period. [b]	49	0.012
1800		1	9	3	4	7	5	6	7	12	14	21	1	11	3		104	0.026
1900		1	3	4	1	5	5	13	4	9	4	8	3	12	7		79	0.020
2000		3	8	4	7	7	4	15	15	10	10	2	15	13	7		120	0.030
2100		3	10	20	23	5	7	42	21	27	15	18	12	19	3		225	0.057
2200	46	4	13	13	19	33	35	49	25	38	26	50	36	29	38		408	0.104
2300	38	9	16	21	22	24	31	94	45	101	40	57	54	27	29		570	0.145
2400	23	2	2	12	12	37	13	18	26	51	35	29	28	27	7		299	0.076
Total	256	119	126	168	168	178	225	348	303	401	427	483	361	318	316	270	3,941 [a]	1.000
Percent																		

[a] Totals only include days with 24 hours of counts (i.e., September 20 thorugh October 3). Double outlined areas indicate when sonar was not operating.
[b] Estimated passage based upon the average proportion observed for this time block during 1–3 October.
[d] Estimated daily passage during missing time periods on right bank were estimated from the daily temporal distribution (on respective days) observed among left bank counts.