Fishery Data Series No. 13-27

Sonar Estimation of Salmon Passage in the Yukon River Near Pilot Station, 2008

by

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and

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June 2013

Alaska Department of Fish and Game **Divisions of Sport Fish and Commercial Fisheries**

Symbols and Abbreviations

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat. or long.
monetary symbols (U.S.)	\$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	log_2, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

FISHERY DATA SERIES NO. 13-27

SONAR ESTIMATION OF SALMON PASSAGE IN THE YUKON RIVER NEAR PILOT STATION, 2008

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ABSTRACT

The Pilot Station sonar project has provided daily passage estimates for Chinook salmon *Oncorhynchus tshawytscha*, chum salmon *O. keta*, and coho salmon *O. kisutch* for most years since 1986. Fish passage estimates for each species were generated in 2008 through a two-component process: (1) estimation of total fish passage with 120 kHz split-beam sonar and a dual frequency identification sonar (DIDSON), and (2) apportionment to species by sampling with a suite of gillnets of various mesh sizes. An estimated 3,690,360 fish passed through the sonar sampling area between June 1 and September 7; 794,762 along the right bank and 2,895,598 along the left bank. Included were 106,708 ± 14,547 large Chinook salmon (>655 mm mideye tail fork); 23,935 ± 5,951 small Chinook salmon (≤655 mm METF); 1,665,667 ± 136,585 summer chum salmon, 615,127 ± 33,169 fall chum salmon; and 135,570 ± 14,875 coho salmon.

Key words: Chinook salmon *Oncorhynchus tshawytscha*, chum salmon *Oncorhynchus keta*, hydroacoustic, riverine, sonar, run strength, species apportionment, net selectivity, DIDSON, Yukon River

INTRODUCTION

BACKGROUND

Within Alaska, 3 species of Pacific salmon (Chinook salmon *Oncorhynchus tshawytscha,* coho salmon *O. kisutch*, and chum salmon *O. keta*) are managed inseason for harvest by commercial, sport, and subsistence fisheries over 3,185 km of the Yukon River, as well as to meet treaty commitments made under the United States/Canada *Yukon River Salmon Agreement* (Yukon River Panel 2004). The diversity and number of fish stocks, combined with the geographic range of user groups, adds complexity to management decisions. Escapement estimates and run strength indices are generated by various projects along the river, providing stock-specific abundance and timing information, however, much of this information is obtained after the fish have become unavailable to the fisheries. Timely indices of run strength are provided by gillnet test fisheries conducted in the lower Yukon River, but the functional relationship between catch per unit effort (CPUE) and actual abundance is confounded by varying migration patterns through the multichannel environment, gear selectivity, and changes in net site characteristics.

The Pilot Station sonar project has provided daily salmon passage estimates, run timing and biological information to fisheries managers for most years since 1986. The estimates from this project complement information obtained from other sources. Located in a single-channel environment at river km 197 near Pilot Station, the project is far enough upriver to avoid the wide, multiple channels of the Yukon River Delta. Because salmon migrate from the river mouth to the sonar site in 2 to 3 days, the project provides timely abundance information to managers of downstream fisheries (Figure 1). The Andreafsky River is the only major salmon spawning tributary downstream of the sonar site (Figure 2), therefore the majority of migrating salmon in the Yukon River pass the sonar project on their way to the spawning grounds.

Alaska Department of Fish and Game's (ADF&G) primary role is to manage for sustained yield under Article VIII of the Alaska Constitution, but Alaska is also obligated to manage Yukon River salmon stocks according to precautionary, abundance based harvest-sharing principals set forth in the *Yukon River Salmon Agreement* (Yukon River Panel 2004). The goal of bi-national, coordinated management of Chinook salmon and chum salmon stocks is to meet escapement requirements that will ensure sufficient fish availability for sustained harvests in both the United States and Canada in the future. Furthermore, managers follow guidelines specified in state regulations as management plans for Yukon River Chinook, summer chum, fall chum, and coho salmon. Accurate daily salmon abundance estimates not only help managers regulate fishing inseason to meet harvest and escapement objectives, they are also used postseason to determine whether treaty obligations were met and to judge effects of management actions.

Locations in this report are referenced by the proximate bank of the Yukon River, relative to a downstream perspective. At the sonar site the left bank is south of the right bank. Both the City of Pilot Station and the ADF&G sonar camp are located on the right bank.

The Yukon River, at the sonar site, is approximately 1000 m wide between the left and right bank transducers (Figure 3). The left bank substrate, composed of silt and fine sand, drops off gradually at a vertical angle of approximately 2° to 4°. The right bank has a stable, rocky bottom that drops off uniformly to the thalweg at a vertical angle of approximately 10°. The thalweg is approximately 25 m deep and is located approximately 200 m offshore of the right bank. Water velocity, as measured with acoustic Doppler profiling, ranges up to 2 m/sec in offshore portions of the water column. River height, as observed from 2001 to 2007 at the United States Geological Survey (USGS) gage station located downstream of the project, typically ranges from a maximum of 27.4 ft to a minimum of 13.9 ft from June 1 through September 7 (Figure 4).

Prior to 1993, ADF&G used dual-beam sonar equipment that operated at 420 kHz. For the 1993 season, ADF&G changed the existing sonar equipment to operate at a frequency of 120 kHz to allow greater ensonification range by reducing signal loss. The newly configured equipment's performance was verified using standard acoustic targets in the field in 1993. Use of lower frequency equipment improved fish detection at long range.

Up until 1995, ADF&G attempted to identify direction of travel of detected targets by aiming the acoustic beam at an upstream or downstream angle relative to fish travel. This technique was discontinued in 1995 in favor of aiming transducers perpendicular to fish travel maximize fish detection. Because of this and subsequent changes in counting methodology, data collected from 1995 to 2008 are not directly comparable to previous years. In 2001, the equipment was changed from the dual-beam to the current split-beam sonar system configured to operate at 120 kHz (Pfisterer 2002). The split-beam technology allows better testing of assumptions about direction of travel and vertical distribution as the target moves through the acoustic beam most notably by the ability to estimate the three-dimensional position of a target in space (Burwen et al. 1995).

The project uses a combination of fixed-location split-beam sonar and multi-beam dual frequency identification sonar (DIDSON; Belcher et al. 2002) to estimate the daily upstream passage of fish. A series of gillnets with different mesh sizes are drifted through the acoustic sampling areas to apportion the passage estimates to species. In 2004, the selectivity model used in species apportionment was refined through biometric review and analysis of historical catch data from the project test fishery. The model providing the best overall fit to the data was a Pearson model with a tangle parameter. Species proportions and passage estimates reported here were generated with this apportionment model, and are comparable with estimates from 1995 to the present, as historical estimates have been re-generated using the most current model and methodology (Bromaghin 2004).

Early in the 2005 season, the Yukon River experienced high water levels and erosion in the bottom profile that, along with a combination of changes in fish movement and distribution, affected detection of fish with the split beam sonar within 20 m of shore on the left bank. On June 19, 2005, a DIDSON imaging sonar was deployed in this area to verify nearshore fish detection. With its wider beam angle, video like images, and software algorithms which can remove bottom structure from the image, the DIDSON system was able to detect fish passage within 20 m despite high water levels and problematic erosion nearshore, and was operated for the remainder of the season, supplanting split-beam counts in this section of nearshore region. The DIDSON was integrated into the sampling routine on left bank in 2006 and operates side by side with the split-beam sonar. The DIDSON samples the first 20 m of the nearshore stratum; the remainder of the 250 m range is sampled by the split beam.

OBJECTIVES

The primary goal of this project is to accurately estimate daily fish passage, by species, during upstream migration past the sonar site. Project objectives were to:

1. provide managers with timely estimates, and associated confidence intervals, of daily and seasonal passage of adult Chinook, chum and coho salmon;
2. collect biological data from all fish captured in the test fishery, including species, sex, length, and scales as appropriate;
3. assist in the collection of Chinook and chum salmon tissue samples for separate genetic stock identification projects; and
4. collect water temperature data representative of the ensonified areas of the river.

METHODS

Estimates of upstream migration of targeted fish species are produced from a combination of independently generated estimates of fish movements past the sonar site using hydroacoustic equipment, and species proportions based upon the results of drift gillnetting in the same area (Figure 5).

HYDROACOUSTIC DATA ACQUISITION

Equipment

Left bank sonar equipment included:

1. Hydroacoustic Technology Inc.[1] (HTI) Model 244 echosounder configured to transmit and receive at 120 kHz, controlled via Digital Echo Processing (DEP) software installed on a laptop PC;
2. HTI 120 kHz split-beam transducer with a 2.8°x10° nominal beam width;
3. three 250 ft H.T.I. split-beam transducer cables connecting the sounder to the transducer;
4. HTI Model 405 digital chart recorder coupled with a Panasonic KXP 3624 dot matrix printer;
5. Hewlett Packard (HP) Model 54501A digital storage oscilloscope;
6. DIDSON LR (Long Range) unit (14ºx29º approximate beam dimension), configured to transmit and receive at 1.2 MHz, and controlled via software installed on a laptop PC; and
7. one 500 ft DIDSON underwater cable connecting the DIDSON to the “topside breakout box” and laptop PC.

Right bank sonar equipment included:

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[1] Product names used in this report are included for scientific completeness, but do not constitute a product endorsement.

1. HTI Model 244 echosounder configured to operate at 120 kHz, controlled via DEP software installed on a laptop PC;
2. HTI split-beam 120 kHz transducer with a 6°x10° nominal beam width;
3. three 250 ft (228.6 m combined length) HTI split-beam cables connecting the sounder to the transducer; and
4. HTI Model 405 digital chart recorder coupled with Panasonic KXP 3624 dot matrix printer.

Each system configuration of sounder, transducer, and cable was calibrated by the manufacturer prior to the field season. Transducers were mounted on metal tripods and remotely aimed with HTI model 662H dual-axis rotators. Rotator movements were controlled with HTI model 660-2 rotator controllers with position feedback to the nearest 0.1°. Gasoline generators (3000 W) supplied 120 VAC power. The split-beam sonar signal was processed by the digital chart recorders, printed to paper charts, and hand marked. DIDSON data was saved onto the laptops and processed daily via electronic echograms.

Equipment Settings, Thresholds, Data Storage

The split-beam echosounders used a 40 log(R) time-varied gain and 0.4 ms transmit pulse duration during all sampling activities (Table 1). The receiver bandwidth was automatically determined by the equipment based on the transmit pulse duration. Pulse repetition rates were set below the maximum allowed by range to avoid overloading printer buffers. On the left bank, the nearshore stratum pulse repetition rate was set to 5 pings per second (pps), the midshore stratum was set at 4 pps and the offshore stratum was set at 2 pps. The pulse repetition rate for the right bank nearshore was set at 5 pps and the offshore stratum was set at 3.2 pps.

For the split-beam system, echoes were digitized by chart recorders, and then printed on wide carriage, continuous feed paper using dot matrix printers. Four printer thresholds, corresponding to degrees of gray-line, were set for all strata in approximately 3 dB increments. The lowest sampling threshold was set at approximately -40 dB, or about 12 dB lower than the theoretical on-axis target strength of a chum salmon of minimal length (450 mm) calculated using Love's equation (Love 1977). Lowering the threshold by 12 dB allows for detection across the nominal beam width (6 dB) and variability (~6 dB) induced by fish aspect and noise corruption. Transmit power was adjusted as necessary to compensate for environmentally induced signal loss. Threshold levels (in mV) were recorded and converted to target strength, $TS_{dB,}$ as follows:

$$TS_{dB} = 20 \cdot \log\left(\frac{T_{mV}}{1000\,mV}\right) - \left(SL + G_S + G_R\right), \tag{1}$$

where T_{mV} is the chart recorder threshold in mV, SL is the transmitted source level in dB, G_S is the through-system gain, and G_R is the receiver gain.

The DIDSON (Table 2) operated at an average rate of 8 frames/s with a starting range of 0.83 m and an end range of 20.84 m, in high frequency mode (1.2 MHz). Files were recorded onto the laptop and were processed using electronic echograms, where operators could change intensity and threshold to increase visibility of targets on screen.

Aiming

Transducers were deployed on both the left bank and the right bank in an area where the river is approximately 1,000 m wide. The transducers were always positioned and aimed to maximize fish detection. With the transducer located in the area with the best bottom profile, the beam was oriented approximately perpendicular to the current so that migrating fish would present the largest possible reflective surface. Since many fish travel close to the substrate, the maximum response angle of the beam was oriented along the river bottom through as much of the range as possible. The right bank transducer was positioned approximately 3 m from shore, adjusting the aim between 2 strata (S1: 0–50 m and S2: 50–150 m). The left bank split-beam transducer was deployed approximately 5 m from the shoreline and utilized 3 distinct aims to sample a nearshore stratum (S3, 0–50 m), a midshore stratum (S4, 50–150 m), and an offshore stratum (S5, 150–250 m). The DIDSON unit was deployed within 2 m of the split-beam transducer and ensonified the first 2 sectors of the nearshore stratum (0–20 m) (Figure 6). Because the DIDSON sonar's wider beam angle is ideal for the less linear nature of the eroded left bank nearshore, it is assumed that it will detect fish targets better than the split beam which is narrower in the extreme nearshore. Therefore, when aiming the split beam for the nearshore stratum from 0 to 50 m, when necessary for best detection, the aim is optimized for the 20 to 50 m portion of the stratum, which is not ensonified by the DIDSON. In this way, the sonar systems are used in concert to maximize detection for the entire nearshore stratum on left bank. The counts from the 2 systems cannot directly be compared for the 0 to 20 m nearshore, since the aiming strategy optimizes fish detection for DIDSON but not the split beam within this range.

Fluctuating water levels required repositioning of the transducers, and subsequent re-aiming of the beams. To establish an optimal aim, the transducer was panned horizontally upstream and downstream approximately 15º off perpendicular in 2º increments. At each increment, the vertical tilt was adjusted to obtain the best possible bottom picture. The left bank transducers were re-aimed more often to compensate for the dynamic bottom conditions on that side of the river. Once an optimal aim was obtained, the rotator settings were documented and chart printouts of the new aim were posted for visual reference. All operators were trained to first aim to established pan and tilt settings, then to refine that aim to match the substrate pattern on the current chart printout with those of reference chart samples.

Sampling Procedures

Throughout the season strata ranges were adjusted to provide an optimal fit to the bottom profile. The left bank transducers were occasionally relocated either upstream or downstream to compensate for the dynamic bottom profile. Transducers on each bank were repositioned either inshore or offshore as needed to compensate for changing water levels.

Acoustic sampling was conducted simultaneously on both banks during three 3 h periods each day (Table 3). Sample periods were scheduled from 0530 to 0830, 1330 to 1630, and 2130 to 0030 hours, alternating sequentially between strata every 30 minutes. Each sampling stratum was subdivided into 5 equal range sectors, with sonar counts tallied by sector in 15 minute intervals during daily sampling periods. The DIDSON generated sonar counts supplanted those of the split beam for sectors 1 and 2 of the nearshore stratum if they were higher.

Operators counted fish traces on paper echograms for the split-beam system, and on electronic echograms for the DIDSON system. All personnel were trained to distinguish between fish tracings and non-target echoes. Echo traces were counted as a single fish if at least 2 pings in the cluster passed the second printer threshold level (see Equipment Settings, Thresholds and Data Storage sections) and the targets did not resemble inert downstream objects. Groups of fish were distinguishable when the apparent direction of movement of one fish trace differed from that of an adjacent trace.

Fish traces were tallied on field data forms and entered into a Microsoft Access® database. The data were checked daily for data entry or tallying errors, then processed in SAS® using statistical routines developed by the regional biometrician, Toshihide Hamazaki.

Chart printouts and echograms were reviewed daily by either the project leader or crew leader to monitor the accuracy of the marked fish tracings and reduce individual biases. Each chart image was checked for indications of signal loss and changes in bottom reverberation markings, which could indicate either movement of the transducer or a change in bottom structure.

During most seasons, on designated days, the sonar was run continuously on both banks for a 24 h period. Sampling was divided among strata in a sequence consistent with the regular sampling schedule. Estimates obtained from the regular 3 h sampling period were compared with those found when the sonar ran continuously over the same day, as a simple qualitative assessment of the sampling model. Results of these comparisons were not used to adjust estimates, nor did they result in a change of the sampling protocol.

SYSTEM ANALYSES

Performance of the hydroacoustic system was routinely monitored following procedures first established in 1995 (Maxwell et al. 1997). System analyses included equipment performance checks, bottom profiles using down-looking sonar, and hydrologic measurements.

Bottom Profiles

Bottom profiles were recorded along both banks using a Lowrance LCX15MT recording fathometer with GPS capabilities to locate deployment sites with suitable linear bottom profiles. All bottom profiles were recorded and stored electronically. Inseason, the fathometer was used regularly to monitor changing bottom conditions and to watch for the formation of sandbars capable of re-routing fish to unensonified areas.

Hydrological Measurements

Water level was measured using a staff gage located slightly offshore on the right bank, by the field camp. To standardize measurements with observations from previous years, water level measurements were adjusted to the USGS Water Resources Division reference located approximately 500 m downstream of Pilot Station. The information collected from the staff gage was used inseason as a relative water height indicator, and to gather information as a backup for times when the USGS water data was unavailable.

Water temperature was recorded daily using submerged electronic data loggers affixed to the sonar pods on each bank. Temperatures were also collected during the test fishery on each bank, usually within 50 m from shore, using a mercury thermometer submerged approximately 15 cm below the water surface.

SPECIES APPORTIONMENT

Equipment and Procedures

To estimate species composition, gillnets were drifted through 3 zones (right bank, left bank nearshore, and left bank offshore) corresponding to sonar sampling strata (Figure 6). A total of 8 different mesh sizes were fished throughout the season to effectively capture all size classes of fish present and detectable by the hydroacoustic equipment (Table 4). All nets were 25 fathoms (45.7 m) long and approximately 8 m deep. All nets were constructed of Momoi MTC-50 or MT-50, shade 11, double knot multifilament nylon twine and hung "even" at a 2:1 ratio of web to corkline.

Test fishing was conducted twice daily between sonar periods, from 0900 to 1200 hours and 1700 to 2000 hours. During each sampling period, 4 different nets were drifted within each of 3 zones for a total of 24 drifts per day (Table 5). The order of drifts were 1) left bank nearshore zone, 2) right bank zone, and 3) left bank offshore zone, with a minimum of 20 minutes between drifts in the same zone. Each mesh size was fished in all 3 zones before switching to the next mesh size. The shoreward end of the left bank nearshore drift was held approximately 5 to 10 m from shore. The left bank offshore drift was approximately 65 m offshore so as not to overlap with the nearshore drift. Drifts were approximately 8 minutes in duration, but were shortened as necessary to avoid snags or to limit catches during times of high fish passage.

During the 2007 and 2008 seasons, as part of a separate CIP-funded genetic study, an extra period of gillnetting was conducted in order to collect additional Chinook samples. The drifts were located upriver of the area sampled by the sonar, and 3 gillnet mesh sizes (8.5 in, 7.5 in, 6.5 in) were used to target all size classes of Chinook salmon. All other species captured during this extra period were immediately released, and therefore not sampled.

Captured fish were identified to species and measured to the nearest one mm length. Salmon species were measured from mideye to tail fork (METF); non-salmon species were measured from snout to tail fork. Fish species, length, and sex were recorded onto field data sheets. Each drift record included the date, sampling period, drift start and end times, mesh size, length of net, and captain's initials.

The probability of a fish of a given species and length being captured in a net is dependent on mesh size. To remove the effect of net selectivity, the Pearson T net selectivity model was used with coefficients generated for the following species: Chinook salmon; summer and fall chum salmon; coho salmon; pink salmon *O. gorbuscha;* cisco *Coregonus sardinella, C. laurettae;* Humpback whitefish *C. pidschian*; and Broad whitefish *C. nasus*. In addition, coefficients have also been generated for a group of other species containing: sheefish *Stenodus leucichthys;* burbot *Lota lota;* longnose sucker *Catostomus catostomus;* Dolly Varden *Salvelinus malma;* sockeye salmon *O. nerka;* and northern pike *Esox lucius*. A detailed description of the apportionment model and the derivation of net selectivity coefficients used (listed in Appendix A) can be found in Bromaghin 2004.

Scale samples were collected from Chinook salmon, mounted on scale cards, and scale and card numbers were recorded on the test fishing data sheets. Data were transferred from data sheets into a database and processed using SAS software. Age, sex, length data were processed, analyzed and reported by ADF&G staff based in Anchorage (Horne-Brine and DuBois 2010).

Handling mortalities among the captured fish were distributed to the local community, with fish dispersal documented daily.

Genetic tissue samples from both Chinook and chum salmon were also collected for several other projects, in conjunction with the Yukon sonar project test fishing. Age, sex and length data was cross referenced with each tissue sample. The ADF&G Gene Conservation Laboratory (DeCovich et al. 2010) and the USFWS Conservation Genetics Laboratory (Flannery et al. 2010) independently processed and analyzed these samples.

Chinook salmon were classified as either "large" (> 655 mm METF) or "small" (≤ 655 mm METF), with small Chinook salmon serving as a proxy for one-ocean "jacks." Although there is some temporal overlap between the summer and fall runs of chum salmon, for the purposes of estimating passage, all chum salmon encountered through July 18 were designated as summer chum and post July 18 were designated as fall chum salmon.

ANALYTICAL METHODS

Daily estimates were produced from a multi-component process involving:

a) Hydroacoustic estimates of all fish targets passing the site, without regard to species;

b) Species composition derived from test fishing results and applied to the undifferentiated hydroacoustic estimates;

c) Traditional CPUE estimates, used as a separate index by the managers and calculated on a subset of the test fishing data.

Sparse and Missing Data

Test fishing was not conducted during commercial fishery openings and occasionally, during periods of low salmon passage, catches were too sparse to accurately estimate species proportions and associated error bounds. When sufficient gillnet samples were not available for a given day and zone, the data were pooled with data from one or more adjacent days by assigning the same report unit *u*.

Traditional CPUE estimates were calculated on a daily basis irrespective of catch size. In contrast, sonar passage, species composition, and species passage estimates were first calculated on the basis of report units (encompassing one or more full days of sampling in a zone), and then apportioned to daily estimates. For any test fish variable *x* the report unit *u* encompasses day(s) *d*, test fish period(s) *p*, and zone(s) *z* such that:

$$x_u = \sum_{d,p,z}^{u} x_{dpz} \quad (2)$$

The report unit was then also appended to the corresponding days and zones of sonar passage estimates. In effect, any unique combination of day and zone having sufficient test fish catch was also assigned a unique report unit *u*, while combinations not having sufficient catch were pooled by assigning the same report unit either across zones or days.

CPUE

Traditional CPUE measures were calculated for each day *d* and bank *b* using 2 gillnet suites *g* of specific size mesh *m*. Chinook salmon CPUE was calculated on the pooled catch *c* and effort *f* of the large mesh gillnets (7.5- and 8.5-inch); chum and coho salmon CPUE was calculated on the pooled catch and effort of the small mesh gillnets (5.25- 5.75- and 6.5-inch).

The duration of the j^{th} test fish drift in minutes t was calculated as

$$t_j = (SIj - FOj) + \frac{(FOj - SOj)}{2} + \frac{(FIj - SIj)}{2}, \tag{3}$$

where *SO* is the time the net is initially set out, *FO* is the time the net is fully set out, SI is the time the net starts back in, and FI is the time the net is fully retrieved in.

The total fishing effort (in fathom-hours) for each day, bank, and gillnet suite was calculated as

$$f_{dbg} = \sum_g \frac{25 \cdot t_{dbg}}{60}, \tag{4}$$

since all nets were 25 fathoms (45.7 m) in length. CPUE estimates (in catch per fathom-hour) for each species i were made daily for the right and left banks as

$$CPUE_{dbi} = \frac{\sum_g c_{dbig}}{f_{dbg}}. \tag{5}$$

Species Composition

Test fishing drifts were made at stations in each of 3 zones (1, 2, and 3). Zone 1 consisted of the entire counting range on the right bank, zone 2 was approximately 0–50 m from the left bank, and zone 3 was approximately 50–250 m from the left bank. The results of the test fishing were used to generate species proportions for each zone, which were then applied to the corresponding sonar passage estimate in that zone.

To estimate species proportions, first the total effort f (in fathom-hours) of drift j with mesh size m during report unit u was calculated by multiplying the drift time t (calculated as in equation 3) for each mesh, drift, and reporting unit by 25 fathoms and dividing by 60 minutes per hour,

$$f_{umj} = \frac{25 \cdot t_{umj}}{60}. \tag{6}$$

Total effort for each mesh size fished was then summed over each report unit,

$$f_{um} = \sum_j f_{umj}, \tag{7}$$

and the catch of species i of length l in each report period was summed across all mesh sizes,

$$c_{uil} = \sum_m c_{uilm}. \tag{8}$$

For the catch of each species i of length l, the associated effort was adjusted by applying a length-based selectivity parameter S derived from the Pearson T net selectivity model:

$$f'_{uil} = \sum_{m} \left(S_{ilm} \cdot f_{um} \right), \tag{9}$$

and the CPUE of the catch of each species i of length l was calculated as:

$$CPUE'_{uil} = \frac{c_{uil}}{f'_{uil}}. \tag{10}$$

The proportion p of species i during report unit u was estimated as the ratio of the CPUE for species i to the CPUE of all species combined,

$$\hat{p}_{ui} = \frac{\sum_{l} CPUE'_{uil}}{\sum_{i,l} CPUE'_{uil}}. \tag{11}$$

The variance was estimated from the squared differences between the proportion for each test fish period x for each day (d) within the report unit ($\hat{p}_{udxi}$), and the proportion for the report unit as a whole ($\hat{p}_{ui}$),

$$\hat{Var}(\hat{p}_{ui}) = \frac{\sum \left(\hat{p}_{ui} - \hat{p}_{udxi} \right)^2}{n_u \cdot \left(n_u - 1 \right)}, \tag{12}$$

where n_u = number of test fish sampling periods within the report unit.

Sonar Passage Estimates

Total fish passage was estimated separately for each of the same 3 zones used in the test fish species apportionment. Zone 1 consisted of the entire counting range on the right bank, corresponding to strata 1 and 2 (approximately 0–150 m). Zone 2 consisted of the counting range corresponding to stratum 3 (approximately 0–50 m on the left bank). Zone 3 consisted of the counting range corresponding to stratum 4 and stratum 5 (approximately 50–150 m and 150–250 m on the left bank, respectively).

Within zone 2, passage was simultaneously estimated in sectors 1 and 2 (representing approximately the first 20 m of stratum 3) using both the DIDSON and the HTI sonar. Although the DIDSON was the primary system used to generate estimates in those 2 sectors, the HTI system was also tallied since operating it in sectors 3, 4, and 5 also entailed operating in sectors 1 and 2. The counts generated by the HTI in those 2 sectors essentially served as a backup to the DIDSON in the event of a system failure or a loss of data. Since the ranges of the 2 systems did not always precisely overlap, a passage rate for the DIDSON (targets per meter-hour) was first calculated then expanded by the sector width and count time of the corresponding HTI sample to provide consistent width and count time for all sectors 1 through 5. This was done primarily as a matter of calculation convenience.

First, for sectors 1 and 2 of stratum 3, the sector widths w in meters were calculated for all samples q on day d, period p for both the DIDSON and HTI data. The DIDSON unit ensonifies over a single continuous range while the HTI subdivides this range into equal width sectors (k) 1 and 2 of stratum (s) 3. Sector widths for both systems are based on the start and end points of the range in meters referenced from the face of the transducer, such that,

$$w_{dpskq} = End_{dpskq} - Start_{dpskq}. \tag{13}$$

The mean width of sectors (k) 1 and 2 of the HTI

$$w_{HTI} = \frac{\sum_{s=3} \sum_{q} w_{dpksq}}{n}, \tag{14}$$

and the width of the DIDSON:

$$w_{DID} = \frac{\sum_{q} w_{dpq}}{n}, \tag{15}$$

samples were calculated, where n is the number of samples. The total hours h sampled with the HTI system,

$$h_{HTI} = \sum_{q} h_{dpkq}, \tag{16}$$

and the DIDSON,

$$h_{DID} = \sum_{q} h_{dpq}, \tag{17}$$

were summed, as were the total upstream counts y,

$$y_{HTI} = \sum_{q} y_{dpkq}, \tag{18}$$

$$y_{DID} = \sum_{q} y_{dpq}. \tag{19}$$

Passage rates (r) in fish per hour per meter were then calculated for both the DIDSON and the HTI systems, as

$$r_{DID} = \frac{y_{DID}}{w_{DID} \cdot h_{DID}} \text{ and}; \tag{20}$$

$$r_{HTI} = \frac{y_{HTI}}{w_{HTI} \cdot h_{HTI}} . \quad (21)$$

Due to better detection capabilities at close range, and the aiming protocol described above, it was typical that the DIDSON passage rate would exceed the HTI passage rate in both sectors 1 and 2. In this case a passage estimate was generated for the time sampled by expanding the DIDSON using the HTI sector width and hours:

$$y_{dpk} = r_{DID} \cdot w_{HTI} \cdot h_{HTI} . \quad (22)$$

However, in the event of a system failure or data loss using the DIDSON, the HTI estimate for those 2 sectors would be retained and used in subsequent calculations. In this case, the estimates for this time period would be considered conservative.

Total upstream fish passage y on day d during sonar period p in zone z and stratum s was then calculated by summing net upstream targets over all sectors k and samples q,

$$y_{dpzs} = \sum_{q} \sum_{k} y_{dpzsqk} , \quad (23)$$

and the duration, in hours h, of the time sampled as,

$$h_{dpzs} = \sum_{q} \sum_{k} h_{dpzsqk} , \quad (24)$$

The hourly passage rate r for day d, sonar period p, and zone z was computed as ratio of the sum of the estimated upstream passage in strata s to the duration (in hours) of the sample,

$$r_{dpz} = \frac{\sum_{s} y_{dpzs}}{\sum_{s} h_{dpzs}} . \quad (25)$$

Total passage of fish in report unit u was estimated as the product of the average hourly passage rate and the total hours encompassed by the report unit,

$$\hat{y}_u = \left(d_2 - d_1 + 1\right)_u \cdot 24 \cdot \left(\frac{\sum_{d,p,z \in u} r_{dpz}}{n_u} \right) . \quad (26)$$

where d_1 is the first day, d_2 is the last day, and n_u is the number of sonar sampling periods in report unit u.

Sonar sampling periods, each 3 hours in duration, were spaced at regular (systematic) intervals of 8 hours. Treating the systematically sampled sonar counts as a simple random sample would yield an overestimate of the variance of the total, since sonar counts are highly auto correlated (Wolter 1985). To accommodate these data characteristics, a variance estimator based on the squared differences of successive observations, recommended by Brannian (1986) and modified from Wolter (1985) was employed;

$$\hat{V}ar(\hat{y}_u) = \left[(d_2 - d_1 + 1)_u \cdot 24\right]^2 \cdot \left[1 - \frac{h_u}{(d_2 - d_1 + 1)_u \cdot 24}\right] \cdot \frac{\sum_{p=2}^{n_u} (\hat{r}_{up} - \hat{r}_{u,p-1})^2}{2n_u(n_u - 1)}, \tag{27}$$

where $\hat{r}_{up}$ is the estimated passage rate in reporting unit (u) for period (p), and

$$1 - \frac{h_u}{(d_2 - d_1 + 1)_u \cdot 24}, \tag{28}$$

is the finite population correction factor.

Fish Passage by Species

The passage of species *i* was first estimated for each report unit *u* as the product of the species proportion *p* (Equation 11) and sonar passage *y* (Equation 26), as

$$\hat{y}_{ui} = \hat{y}_u \cdot \hat{p}_{ui}. \tag{29}$$

Except for the timing of sonar and gillnet sampling periods, sonar-derived estimates of total fish passage were independent of gillnet-derived estimates of species proportions. Therefore the variance of their product (daily species passage estimates y_{idz}) was estimated as the variance of the product of 2 independent random variables (Goodman 1960),

$$\hat{V}ar(\hat{y}_{ui}) = \hat{y}_u^2 \cdot \hat{V}ar(\hat{p}_{ui}) + \hat{p}_{ui}^2 \cdot \hat{V}ar(\hat{y}_u) - \hat{V}ar(\hat{y}_u) \cdot \hat{V}ar(\hat{p}_{ui}). \tag{30}$$

Passage estimates were assumed independent between reporting units, so the variance of their sum was estimated by the sum of their variances,

$$\hat{V}ar(\hat{y}_i) = \sum_u \hat{V}ar(\hat{y}_{ui}). \tag{31}$$

Because most users of this data are interested in daily passage by species rather than passage for reporting units, the daily species passage by zone was estimated by calculating the proportion of the hourly passage rate for the day and zone to the hourly passage rate for the report unit,

$$\hat{p}_{dz} = \frac{r_{udz}}{r_u}. \tag{32}$$

and then applying the passage proportion *p* to the report unit estimate *y*,

$$\hat{y}_{dzi} = \hat{y}_{ui} \cdot \hat{p}_{dz}. \tag{33}$$

Total daily passage by species was estimated by summing over all zones,

$$\hat{y}_{di} = \sum_{z} \hat{y}_{dzi} \quad (34)$$

At this stage, there are two potential ways of reporting total season passage, summing the estimates across days and summing across reporting units. Each can produce slightly different totals due to small rounding errors. To prevent confusion, passage estimates were summed over all zones and all days to obtain a seasonal estimate for species y_i, (since this is how the estimates are reported),

$$\hat{y}_i = \sum_{d} \sum_{z} \hat{y}_{dzi} \quad (35)$$

Assuming normally distributed errors, 90% confidence intervals were calculated as,

$$\hat{y}_i \pm 1.645 \sqrt{\hat{V}ar(\hat{y}_i)} \, . \quad (36)$$

SAS® program code (Toshihide Hamazaki, Commercial Fisheries Biometrician, ADF&G, Anchorage, personal communication) was used to calculate CPUE, passage estimates, and estimates of variance.

RESULTS

The right bank split-beam transducer was deployed May 29, and test fishing began on June 1. Split-beam and DIDSON sonars were deployed on the left bank on June 1. The first full day of sampling on both banks was June 5, and the project was fully operational through September 7. Passage estimates were transmitted to fishery managers in Emmonak daily.

ENVIRONMENTAL AND HYDROLOGICAL CONDITIONS

Ice break-up on the Yukon River was sufficiently early to allow for camp set up before June 1. The water levels in 2008 were above average at Pilot Station in early June, and then average to above average in fall based on historical water levels from 2001 to 2007 (Figure 4).

Electronic data loggers were deployed on both banks on June 5. Both loggers remained submerged until September 7, with the exception of the period from August 19 to August 20, when the left bank logger was removed from the water. Temperatures on the left and right banks recorded on the data loggers ranged from 11.32°C in mid-June to 20.07°C on July 7, with the right bank displaying a greater daily range (diel change) of temperatures (Figure 7).

TEST FISHING

Drift gillnetting resulted in the capture of 9,620 fish, including 728 Chinook salmon, 3,166 summer chum salmon, 2,406 fall chum salmon, 844 coho salmon, and 2,476 fish of other species. Of the captured fish, 34.2% were retained as mortalities and delivered to local users to help meet subsistence needs within the nearby community (Table 6).

Daily CPUE data was reported daily (Appendices B1 and B2). The relationship between daily passage estimates and test fishery CPUE for Chinook, summer and fall chum salmon, and coho salmon were all significant (Figure 8). The correlation coefficient for Chinook salmon was

$r = 0.850$ ($P < 0.001$); for summer chum salmon was $r = 0.935$ ($P < 0.001$); for fall chum salmon was $r = 0.934$ ($P < 0.001$), and for coho salmon was $r = 0.823$ ($P < 0.001$).

HYDROACOUSTIC ESTIMATES

An estimated 3,690,360 fish passed through the sonar sampling areas between June 2 and Sept 7; 794,762 (21.5%) along the right bank; 2,090,645 (56.7%) along the left bank nearshore; and 804,953 (21.8%) along the left bank offshore (Table 7). Total fish passage estimates, by species and zone with their associated errors, were calculated daily (Appendix C).

On the left bank 94.5% of fish passage occurred within 100 m from the transducer in the summer season, similarly the fall distribution was 89.9% within 100 m. On the right bank the majority of fish were distributed in the nearshore stratum with approximately 91.8% of total fish passage occurring within 50 m in summer and 96.4% during the fall season (Figure 9).

SPECIES ESTIMATES

Fish passage estimates by species were generated and reported daily to fishery managers (Appendix D). Chinook salmon were first encountered at the sonar site on June 7, and summer chum salmon were present on June 9. Chum salmon were the most abundant species during both summer and fall seasons. Cumulative passage estimates[2] for the season totaled 3,690,360 fish (Table 7), composed of 1,665,667 ± 136,585 summer chum salmon and 615,127 ± 33,169 fall chum salmon. Chinook salmon passage estimates composed of 106,708 ± 14,547 fish >655 mm METF and 23,935 ± 5,951 fish ≤655 mm METF. Coho salmon passage estimates were 135,570 ± 14,875 fish as of September 7, with the project ceasing operations before the conclusion of the run. The estimate of pink salmon was 558,050 ± 108,388 fish. Other species, totaling 585,303 ± 91,332 fish, include whitefish, cisco, sheefish, burbot, longnose sucker, Dolly Varden, sockeye salmon, and northern pike (Appendix E).

Of the total passage, 36.0% of Chinook salmon, 30.4% of summer chum salmon, 18.1% of fall chum salmon, and 18.9% of coho salmon passed in the 0 to 20 m region of the left bank nearshore (sectors 1 and 2 of stratum 3), where the DIDSON is the primary sonar used for generating passage estimates. Daily DIDSON estimates of fish passing through this region of left bank and the associated proportion also referred to as the DIDSON contribution (Appendices F1 and F2), were monitored daily to evaluate the performance of the split-beam. DIDSON passage contributions for Chinook, summer chum, fall chum, and coho salmon during the 2008 season were the highest since the DIDSON was implemented into the program in 2005 (Figure 10).

The first major pulse of Chinook and summer chum salmon began approximately June 15 (Figure 11). The midpoints of the runs occurred on June 29 for Chinook salmon and June 30 for summer chum salmon, with average overall run timing for both species (Figure 12; Appendices F1 and F2).

The first major pulse of fall chum salmon occurred on approximately July 28 (Figure 13), with the midpoint of the run falling on August 12 (Figure 14; and Appendices G1 and G2). Coho salmon were first detected July 19, but were not consistent in the test fish catch until July 30 (Figure 13). The midpoint of the coho salmon run fell on August 12 (Figure 14; Appendices G1 and G2).

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2 Cumulative estimates for all fish species include 90% confidence intervals.

MISSING DATA

In 2008, no data periods were lost due to heavy wind or wave action. However, the left bank substrate continued to be unstable, and problems with a reverberation band were encountered from June 1 through June 21. As has been observed in prior years (Maxwell and Huttunen 1998; Maxwell 2000), the reverberation band was wide enough to obscure detection of fish. For brief periods during the spring season, bank erosion upstream caused large plumes of silt to pass through the sonar sampling area, undermining optimal detection of targets. On the charts, the effect of the band was a dark region with very low signal to noise ratio in which fish targets were hard to discern, and those targets offshore of the band seemed to have lower intensity and fewer returns per target than they would in the absence of the band

During the 2008 summer season, no direct Chinook salmon commercial fishing periods occurred in District 2, but 5 commercial summer chum salmon commercial periods occurred, with 4 of the periods taking place during a scheduled test fishing period. During the fall season, 8 commercial periods occurred during a scheduled test fishing period. These commercial fishing periods resulted in the cancellation of the normally scheduled test fishing periods. Additionally, there were 5 days when insufficient numbers of fish were captured within one or more zones during a test fishing period. In order to estimate variance accurately, days with missing test fishing periods were pooled with adjacent days that had 2 complete test fishing periods, and zones with insufficient catches were pooled with zones with sufficient catches on adjacent days (Table 8).

DISCUSSION

During the 2008 season, the Yukon River broke up on May 19 at Pilot Station 3 days later than the historical 2001–2007 average. As in most seasons, the sonar was operational early enough to fully assess both the summer chum and Chinook salmon runs. Fall sampling operations were extended and concluded on September 7 rather than August 31 and contributed an additional 187 Chinook, 12,684 fall chum, and 16,091 coho salmon to the total passage estimate. Because the project still finished before the end of the fall chum and coho salmon runs, estimates should be considered conservative.

There was some uncertainty concerning the apportionment of sonar passage in the early portion of the 2008 season due to exceptionally high pink salmon abundance. For the period of approximately June 30 through July 3, we believe a significant number of pink salmon were initially misapportioned as either summer chum or Chinook salmon. The problem was confined to the left bank nearshore (zone 2) and was due to a nearshore deflection weir used to direct fish into the counting range of the DIDSON. This increased detection of fish relatively close to shore but it was not possible to effectively sample this area with test fish gear. Unfortunately, this is also the zone where a very significant proportion of the summer chum and Chinook salmon estimates were generated. Because of the difficulty in obtaining representative test fish samples extremely close to shore, it was decided that the best approach would be remove the weir and let pink salmon pass inshore of the sonar, effectively excluding a significant portion from being counted.

To correct the estimates for the period prior to removal of the weir, several approaches were considered. It was decided that the most efficient and defensible method was to pool adjacent days when a determined effort was made to fish in this zone and obtain representative samples. In total, the period June 30 through July 6 was combined into a single report period for this zone only, and the resulting species proportions were then applied to daily sonar estimates made in this zone (Table 8). Although it is recognized that this dilutes all the day's catches, it seems to be a reasonable correction when examined against the test fish CPUE for both summer chum salmon and Chinook salmon (Figures 15 and 16). The results of this approach were to decrease the cumulative summer chum salmon estimate by 192,443 and the Chinook salmon estimate by 3,795 (Table 9). The additional fish this decrease represents were distributed primarily as pink salmon.

In comparison to previous years, the DIDSON contribution to the passage estimate in 2008 was high. Despite below average water levels during the summer season, DIDSON estimates were ≥30% for both Chinook and summer chum salmon indicating an increase in passage for these species within 20 m of shore. Low water levels are generally assumed to produce a more offshore oriented passage distribution. Considering the low water conditions during the 2008 season, other factors such as bottom profile, velocity, temperature, and turbidity may additionally need to be explored in the future to help understand passage distributions at the site. Water levels during the fall season remained at average levels. Historically, fall passage distribution is more offshore oriented but again the DIDSON estimates suggest a larger percent of nearshore passage for fall chum and coho salmon (Figure 10).

Estimating fish passage in the Yukon River continues to present major technical and logistic challenges. The sampling environment is often demanding due to the extremely dynamic nature of the water level, turbidity, bottom substrate, and range-dependent signal loss. The hydroacoustic system that we employ in the Yukon River appears to work well for the purpose of detecting passing salmon. We were able to compensate for identified signal loss throughout the field season by modifying equipment parameters in response to the frequent environmental changes. At this point, the system changes are largely subjective and thus hard to objectively quantify as to absolute detectability. Successful estimation of fish passage depends upon constant attention to the frequent changes and diligent re-checking of every part of the acoustic and environmental system.

In 2008, all project goals were met, with passage estimates given to fisheries managers daily during the season. Information generated at the Pilot Station sonar project was also disseminated weekly through multi-agency international teleconferences and data sharing with stakeholders in areas from the lower Yukon River all the way to the spawning grounds in Canada.

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TABLES AND FIGURES

Table 1.–Initial split-beam sonar settings at the Pilot Station sonar project, on the Yukon River, 2008.

			Bank	
Component	Setting	Stratum	Left	Right
Transducer	Beam size (h x w)		2.8º x 10.0º	6.0º x 10.0º
Echosounder	Transmit power (dB)		24	27
	Receiver gain (dB)		-20	-20
	Source Level (dB)		220.54	218.04
	Through-system gain (dB)		-168.46	-162.32
	Absorption coefficient (dB)		0	0
	Calculated threshold (dB)		-43	-43
	Pulse width (ms)		0.4	0.4
	Blanking range (m)		2	2
	Ping rate (pps)	S1		5
		S2		3.2
		S3	5	
		S4	4	
		S5	2	
	Range (m)	S1		50
		S2		150
		S3	50	
		S4	150	
		S5	250	
Chart recorder	Gray 1 (mV)		1.321	0.413
	Gray 2 (mV)		1.866	0.583
	Gray 3 (mV)		2.636	0.824
	Gray 4 (mV)		3.724	1.104

Table 2.–Technical specifications for the dual frequency identification sonar at the Pilot Station sonar project on the Yukon River, 2008.

Identification Mode	Operating Frequency	1.2 MHz
	Beam width (two-way)	0.4° H by 14 ° V
	Number of beams	48
Range Settings	Start range	0.83 m
	Window length	20.01 m
Range bin size		39 mm
Pulse Length		46 µs
Frame rate		8 frames/s
Field of view		29°

Table 3.–Daily sampling schedule for sonar and test fish at the Pilot Station sonar project on the Yukon River, 2008.

	Sonar		
Time	Right Bank	Left Bank	Test fish
	Period 1		
0530	S1	S3	
0600	S2	S4	
0630	S1	S5	
0700	S2	S3	
0730	S1	S4	
0800	S2	S5	
0830			
0900			Period 1
0930			
1000			
1030			
1100			
1130			
1200			
1230			
1300	Period 2		
1330	S1	S3	
1400	S2	S4	
1430	S1	S5	
1500	S2	S3	
1530	S1	S4	
1600	S2	S5	
1630			
1700			Period 2
1730			
1800			
1830			
1900			
1930			
2000			
2030			
2100	Period 3		
2130	S1	S3	
2200	S2	S4	
2230	S1	S5	
2300	S2	S3	
2330	S1	S4	
0000	S2	S5	

Note: S1= stratum 1, S2= stratum 2, etc.

Table 4.–Specifications for drift gillnets used for test fishing by season at the Pilot Station sonar project on the Yukon River, 2008.

Season	Stretch mesh size (in)	Stretch mesh size (mm)	Mesh Diameter (mm)	Meshes Deep (MD)	Depth (m)
Summer	2.75	70	44	131	8.0
(pre 7/19)	4.00	102	65	90	8.0
	5.25	133	85	69	8.0
	6.50	165	105	55	7.9
	7.50	191	121	48	8.0
	8.50	216	137	43	8.1
Fall	2.75	70	44	131	8.0
(post 7/18)	4.00	102	65	90	8.0
	5.00	127	81	72	8.0
	5.75	146	93	63	8.0
	6.50	165	105	55	7.9
	7.50	191	121	48	8.0

Table 5.–Schedule for drift gillnets used for test fishing by season at the Pilot Station sonar project on the Yukon River, 2008.

Season	Test fish Period	Calendar Day: Odd		Even	
		Mesh size (in)		Mesh size (in)	
Summer	1	2.75	5.25	8.50	4.00
(6/01–7/18)		7.50	6.50	7.50	6.50
	2	7.50	6.50	7.50	6.50
		8.50	4.00	2.75	5.25
Fall	1	4.00	5.75	2.75	7.50
(7/19–9/07)		5.00	6.50	5.00	6.50
	2	5.00	6.50	5.00	6.50
		2.75	7.50	4.00	5.75

Table 6.–Number of fish caught and retained in the Pilot Station sonar test fishery on the Yukon River, 2008.

Total Catch											
	Chinook [a]	S Chum	F Chum	Sockeye	Coho	Pink	Whitefish	Cisco	Burbot	Sheefish	Total
May	0	0	0	0	0	0	1	0	0	20	21
June	517	1,786	0	1	0	69	37	55	8	156	2,629
July	208	1,380	550	7	9	1,348	109	109	1	28	3,749
August	2	0	1,809	6	745	75	226	112	9	7	2,991
September	1	0	47	2	90	1	43	37	6	3	230
Total	728	3,166	2,406	16	844	1,493	416	313	24	214	9,620

Fish Retained											
	Chinook	S Chum	F Chum	Sockeye	Coho	Pink	Whitefish	Cisco	Burbot	Sheefish	Total
May	0	0	0	0	0	0	1	0	0	20	21
June	315	1,038	0	0	0	2	20	19	1	147	1,542
July	72	300	213	1	4	81	93	21	0	15	800
August	1	0	526	0	100	0	205	17	1	4	854
September	1	0	17	0	12	0	37	3	1	2	73
Total	389	1,338	756	1	116	83	356	60	3	188	3,290

Proportion Retained											
	Chinook	S Chum	F Chum	Sockeye	Coho	Pink	Whitefish	Cisco	Burbot	Sheefish	Total
May	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	1.000	1.000
June	0.609	0.581	0.000	0.000	0.000	0.029	0.541	0.345	0.125	0.942	0.587
July	0.346	0.217	0.387	0.143	0.444	0.060	0.853	0.193	0.000	0.536	0.213
August	0.500	0.000	0.291	0.000	0.134	0.000	0.907	0.152	0.111	0.571	0.286
September	1.000	0.000	0.000	0.000	0.133	0.000	0.860	0.081	0.167	0.667	0.317
Total	0.534	0.423	0.314	0.063	0.137	0.056	0.856	0.192	0.125	0.879	0.342

[a] Includes 154 Chinook salmon caught in the "Period 0" sampling test fish period. All other species captured during Period 0 were immediately released.

Table 7.–Cumulative passage estimates by zone and by species at Pilot Station sonar on the Yukon River, with standard errors (SE) and 90% confidence intervals (CI), 2008.

		Left Bank				90% CI	
Species	Right Bank	Nearshore	Offshore	Total Passage	SE	Lower	Upper
Large Chinook [a]	17,205	56,683	32,820	106,708	8,843	92,161	121,255
Small Chinook	5,024	16,832	2,079	23,935	3,617	17,984	29,886
Summer chum	395,187	843,489	426,991	1,665,667	83,030	1,529,082	1,802,252
Fall chum	97,856	298,196	219,075	615,127	20,164	581,958	648,296
Coho	27,016	58,221	50,333	135,570	9,042	120,695	150,445
Pink	116,165	406,444	35,441	558,050	65,890	449,662	666,438
Other	136,309	410,780	38,214	585,303	55,521	493,971	676,635
Total	794,762	2,090,645	804,953	3,690,360			

[a] Large Chinook salmon are >655 mm METF, small Chinook salmon ≤655 mm METF.

Table 8.–Reporting units of zones pooled at the Pilot Station sonar project on the Yukon River, 2008.

	Right Bank	Left Bank		
Date	(Zone 1)	Nearshore (Zone 2)	Offshore (Zone 3)	Reason for pooling [a]
06/01				
06/02		2	3	IC
06/04				
06/05	10		12	IC
06/30				
07/01				
07/02				IC
07/03				
07/04	96			
07/05				
07/06	102	103	104	CO
07/09				
07/10	114	115	116	CO
07/14				
07/15			131	IC
07/16	132			
07/17		139	140	CO
07/19				
07/20	144			CO
07/21		151	152	
07/22				
07/23	153		155	CO
07/24		160		
07/28				
07/29		172	173	CO
07/30	177			
07/31		181	182	
08/12				
08/13				IC
08/14			218	
08/25				CO
08/26	257	258	259	
08/28				
08/29	266	267	268	CO
08/31				
09/01		273	274	CO
09/02	278			
09/03				
09/04	281	282	283	CO
09/05			286	
09/06				
09/07	287	288	286	CO

[a] CO denotes that a commercial opening prevented test fishing, therefore pooling across days enables the variance estimation of species proportions. IC denotes that zones were pooled when there was insufficient catch in the test fishery for variance estimation.

Table 9.–Final season estimates. "Postseason pooled" represents both pooled a) without adjusting for early July apportionment issues, and b) final estimates after adjusting for apportionment issues, at the Pilot Station sonar project on the Yukon River, 2008.

		Postseason Pooled		Change	
	Inseason estimate	Not Adjusted	Adjusted	Not Adjusted	Adjusted
Lg. Chinook	108,960	109,341	106,708	381	(2,252)
Sm. Chinook	25,478	25,396	23,935	(82)	(1,543)
Total Chinook	134,438	134,737	130,643	299	(3,795)
Summer Chum	1,858,110	1,852,083	1,665,667	(6,027)	(192,443)
Fall Chum	619,371	615,127	615,127	(4,244)	(4,244)
Pink	432,882	436,480	558,050	3,598	125,168
Coho	135,629	135,570	135,570	(59)	(59)
Other	507,416	516,362	585,303	8,946	77,887

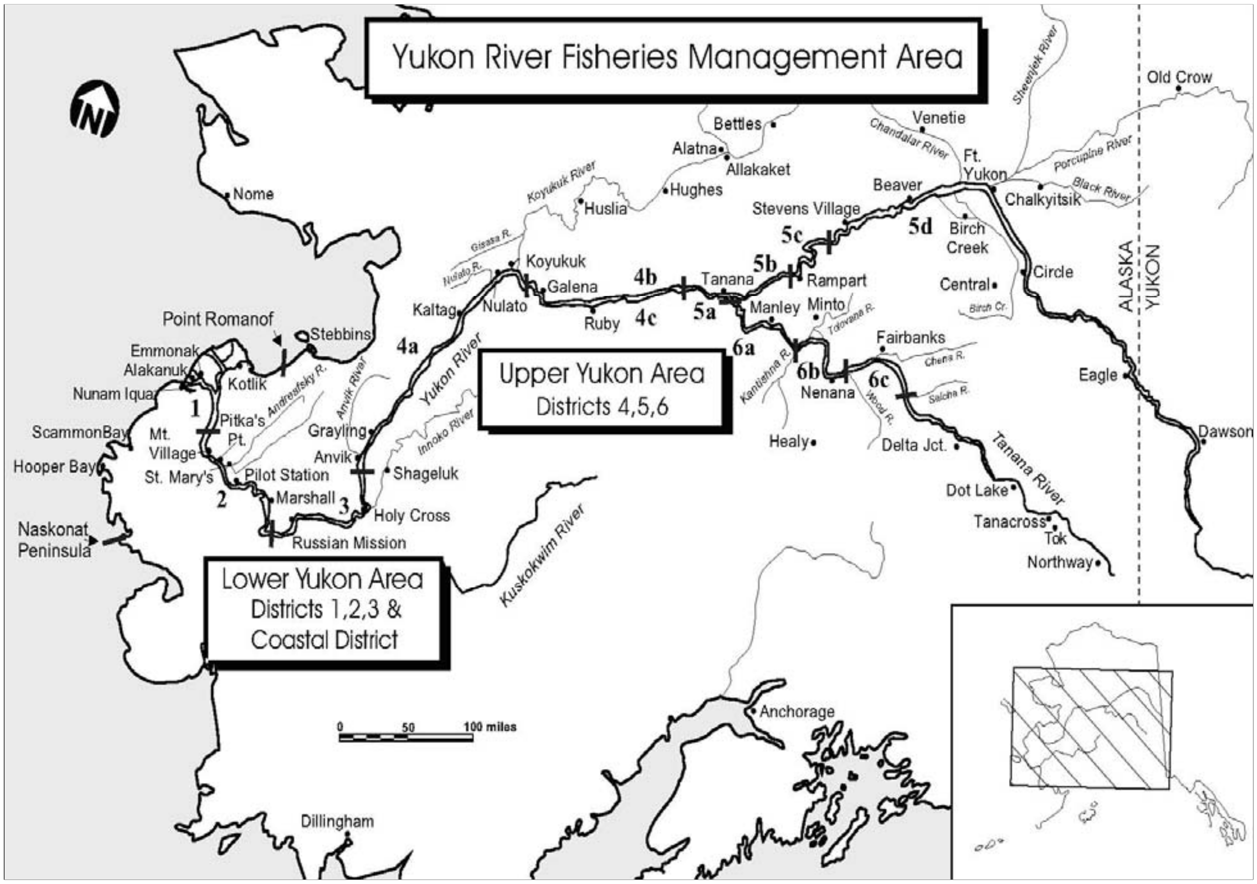


Figure 1.–Fishing districts and communities of the Yukon River watershed.

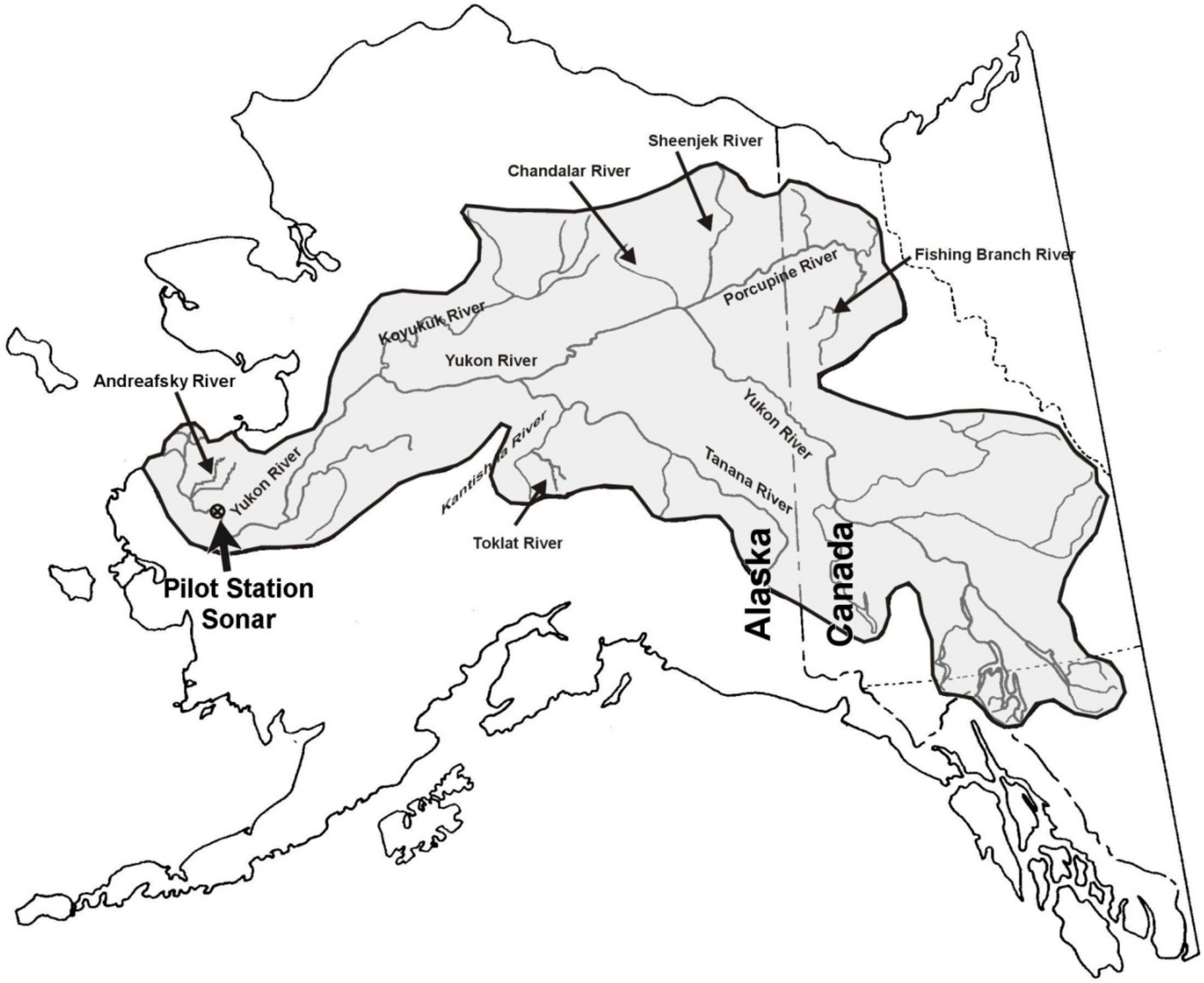


Figure 2.–Extent of Yukon River drainage.

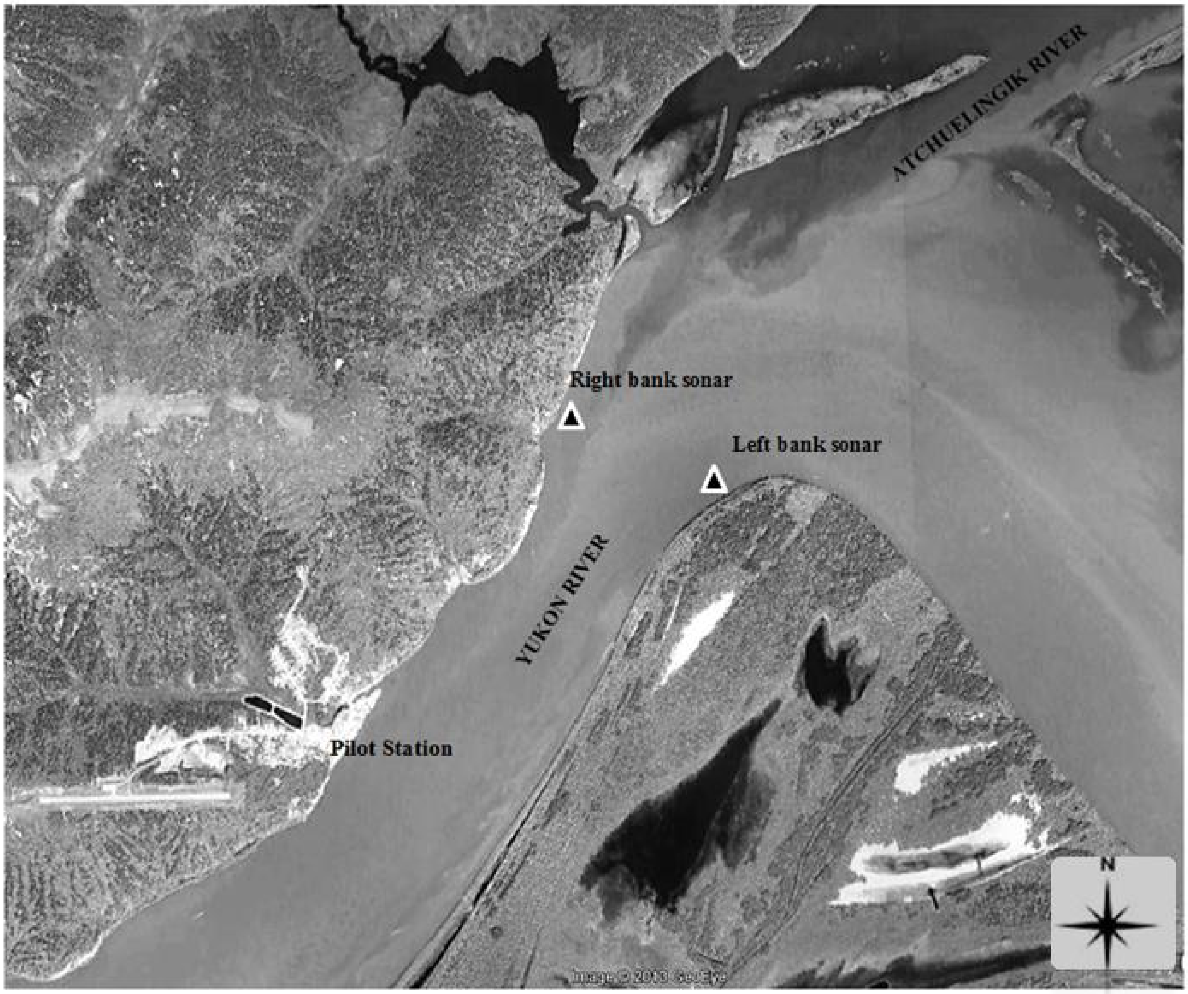
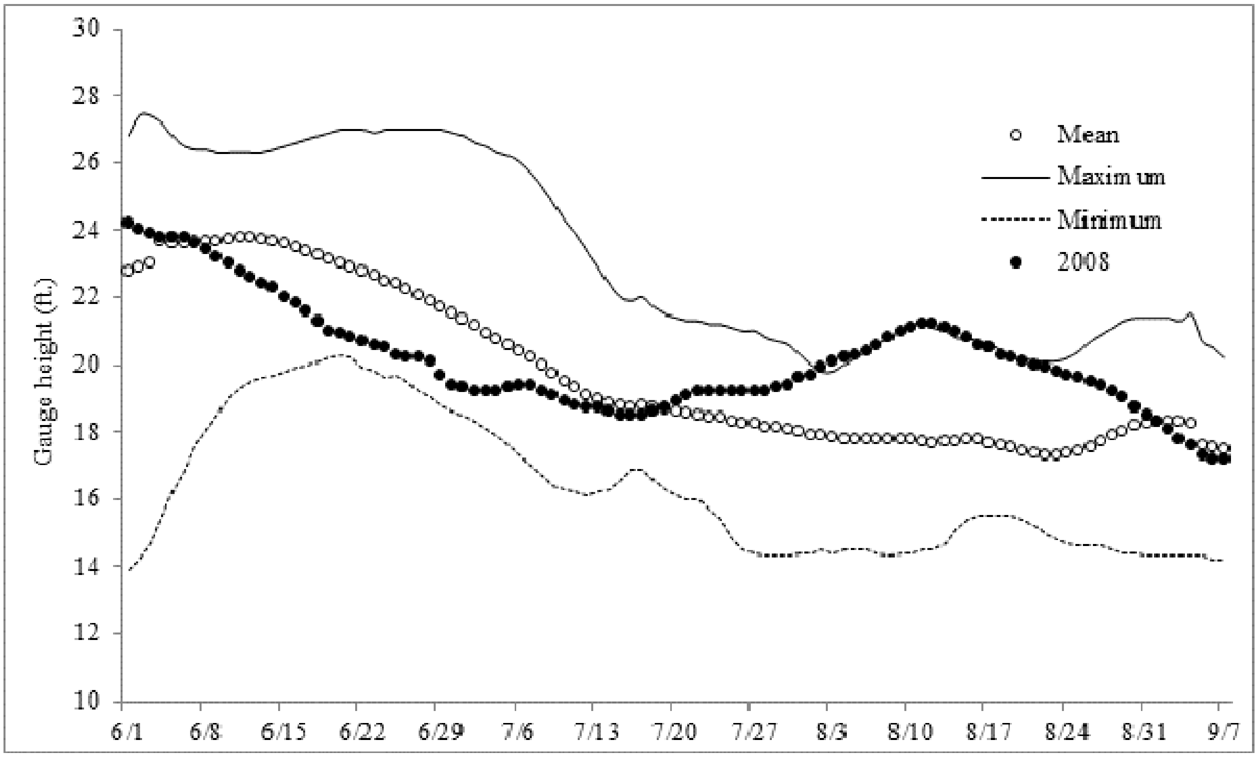


Figure 3.–Location of Pilot Station sonar project showing general transducer sites.



Source: United States Geological Service.
Note: *Missing values were estimated using linear interpolation.*

Figure 4.–Yukon River daily water level during the 2008 season at Pilot Station water gage compared to minimum, maximum, and mean gage height 2001 to 2007.

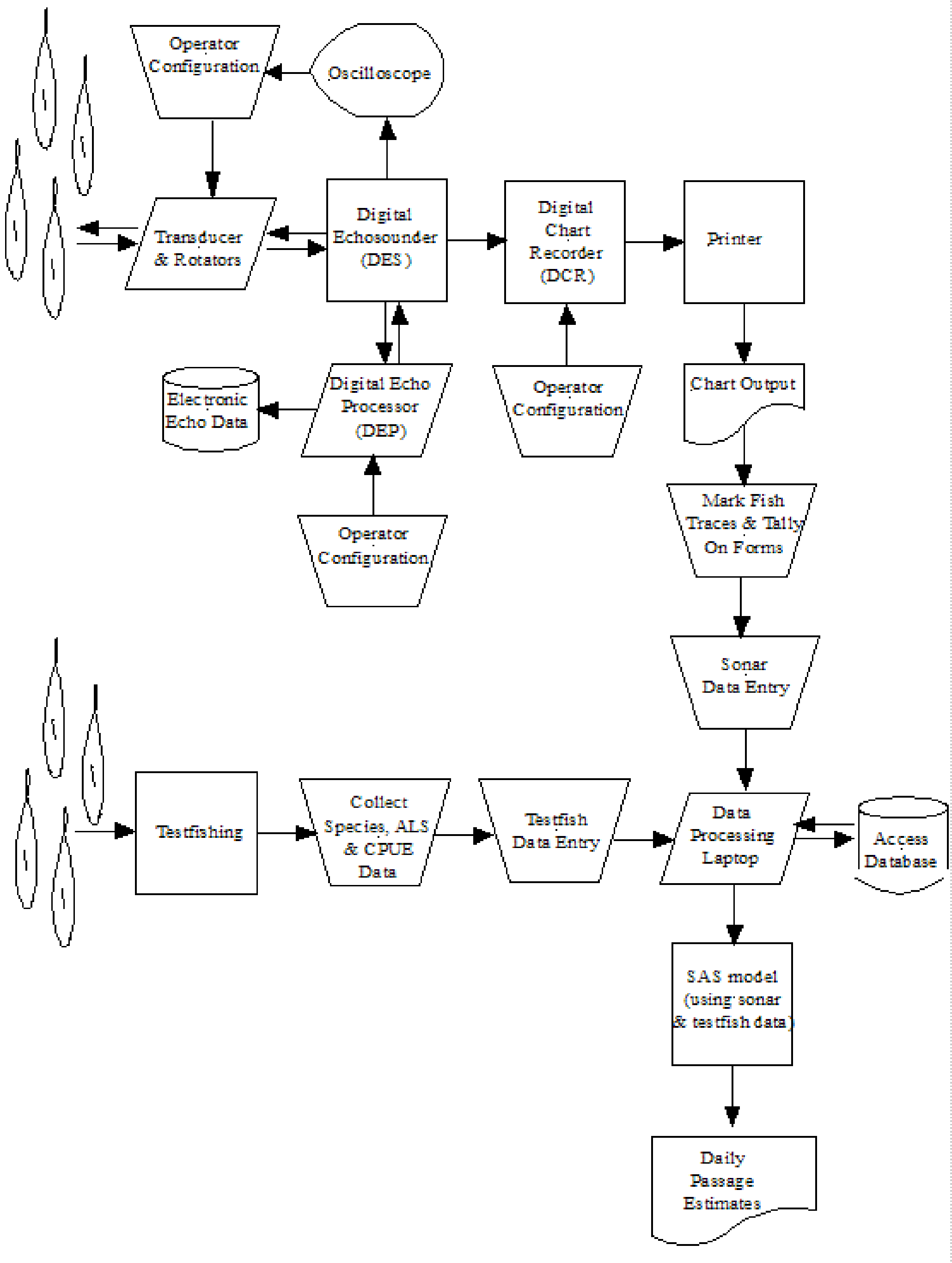


Figure 5.–Flow diagram of data collection and processing at the Pilot Station sonar project on the Yukon River, 2008.

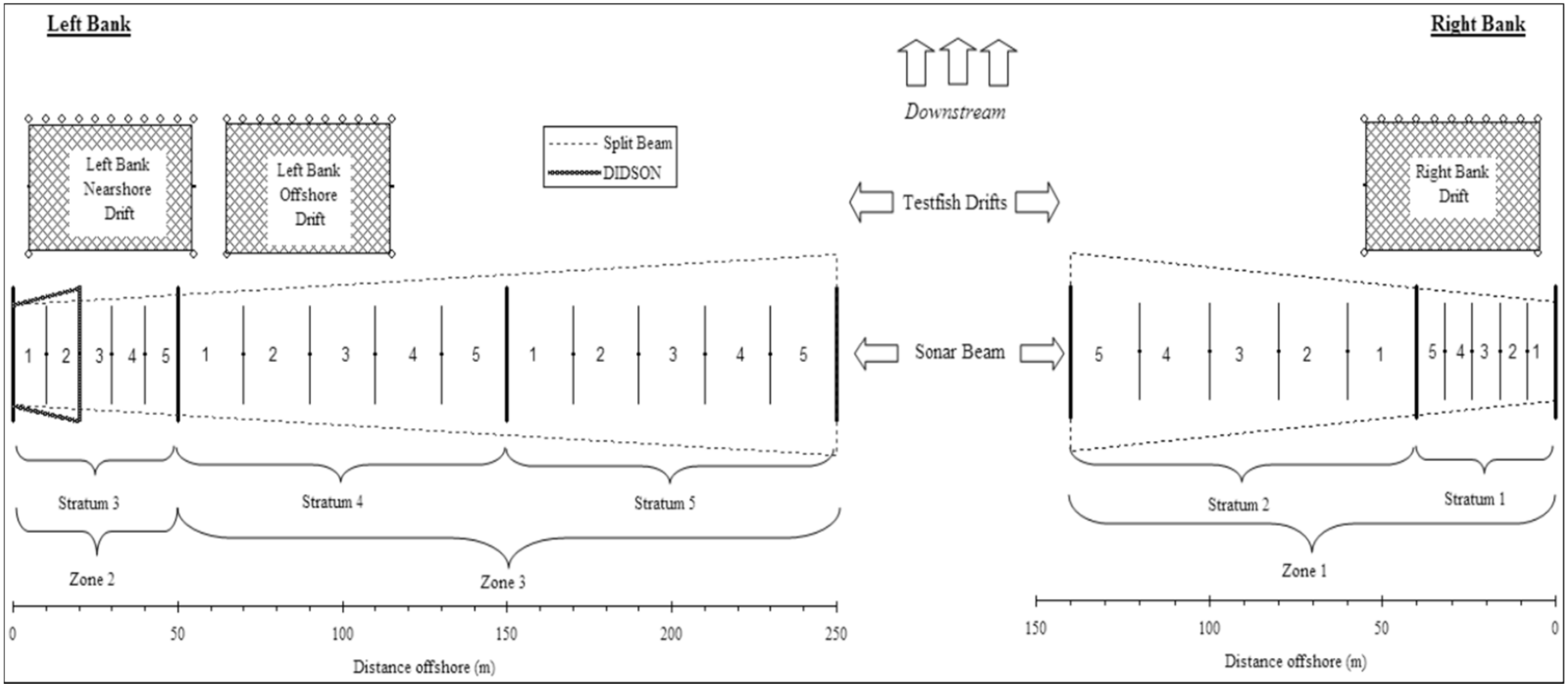


Figure 6.–Illustration of relationships between strata, sectors, zones, test fish drifts, and approximate sonar ranges (not to scale) at the Pilot Station sonar project, on the Yukon River 2008.

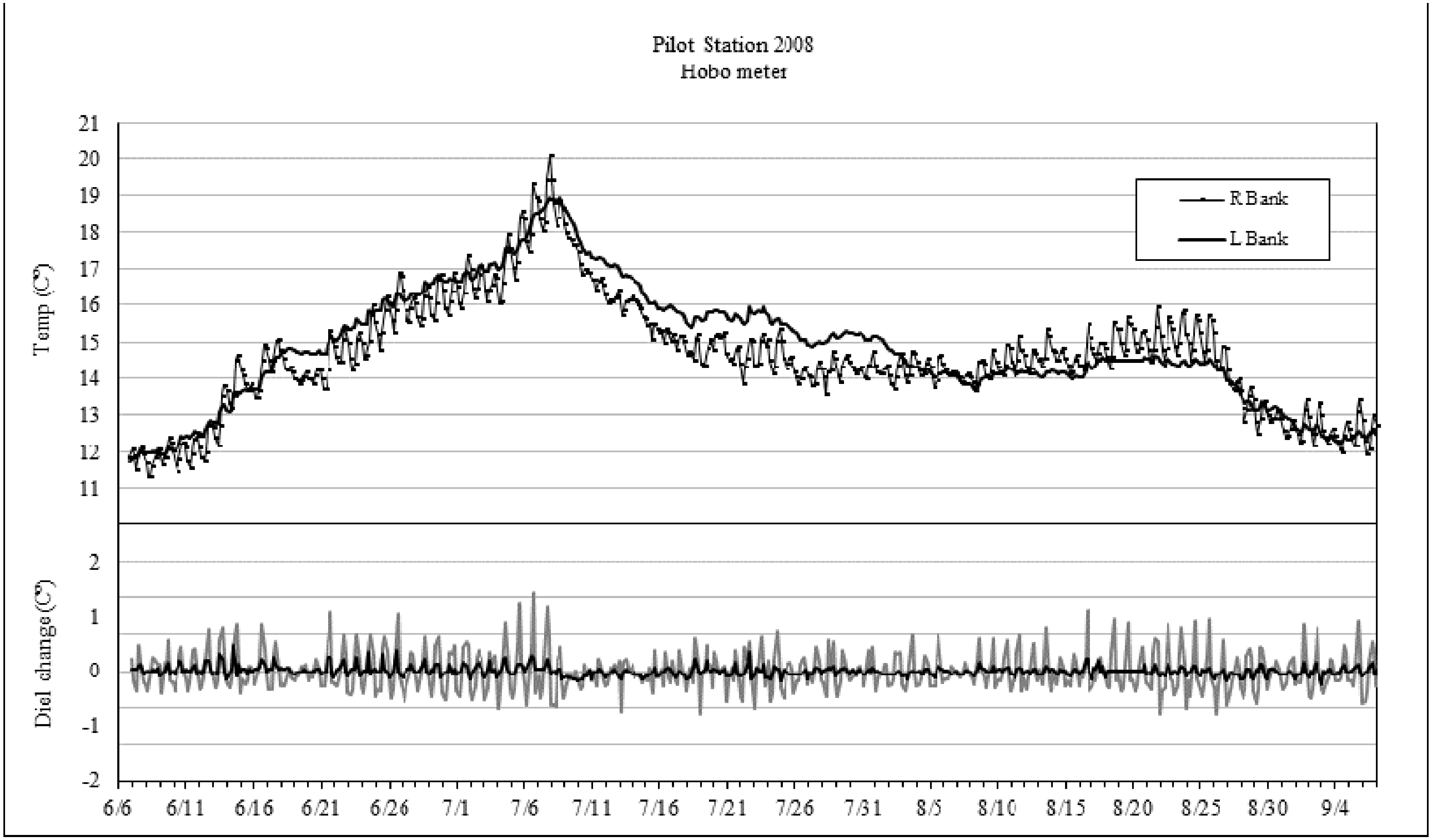


Figure 7.–Mean water temperatures recorded at the Pilot Station sonar project on the Yukon River with electronic data loggers, by bank with diel change.

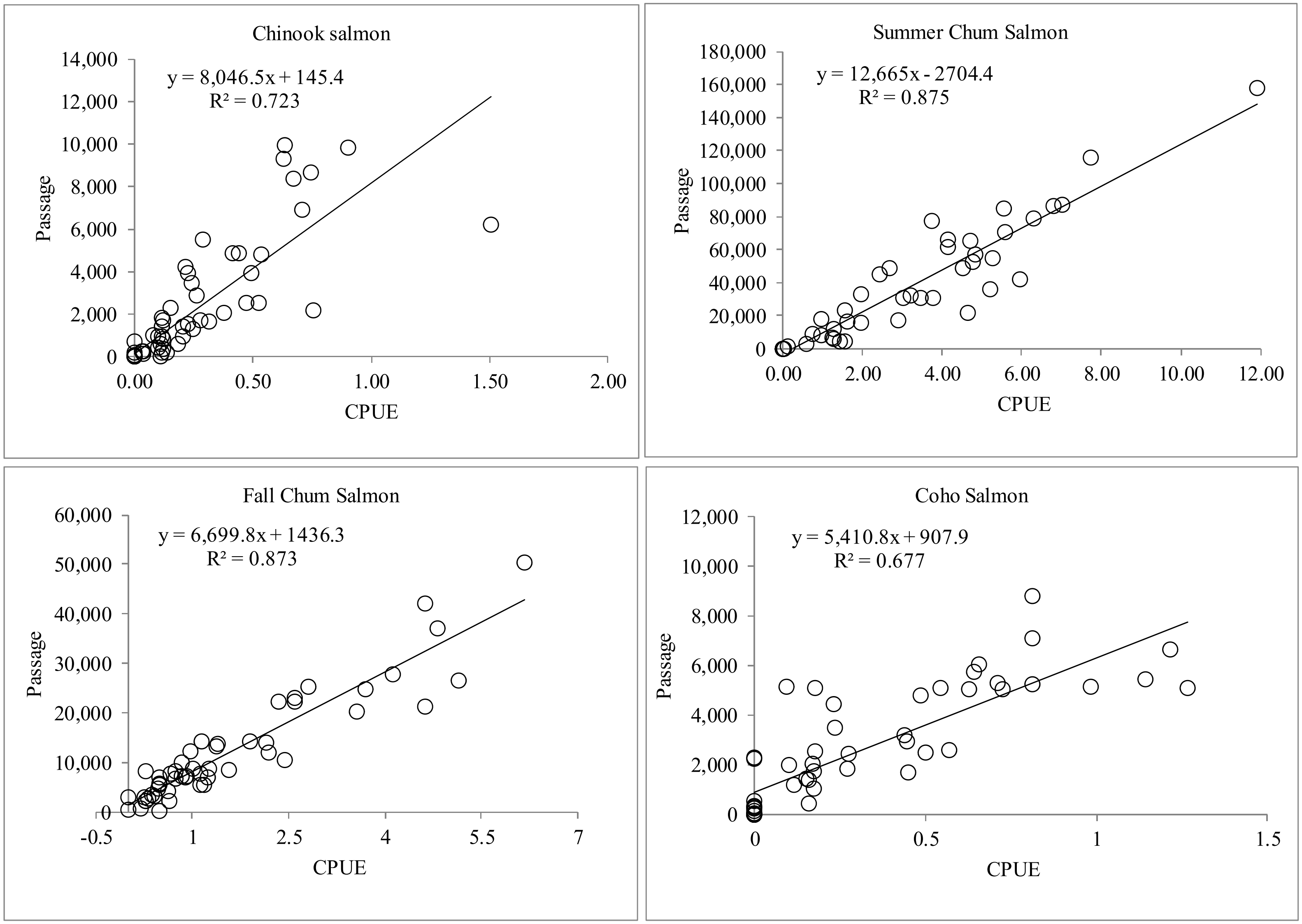


Figure 8.–Scatter plots of daily passage vs. CPUE for Chinook, summer chum, fall chum, and coho salmon, at the Pilot Station sonar project on the Yukon River, 2008.

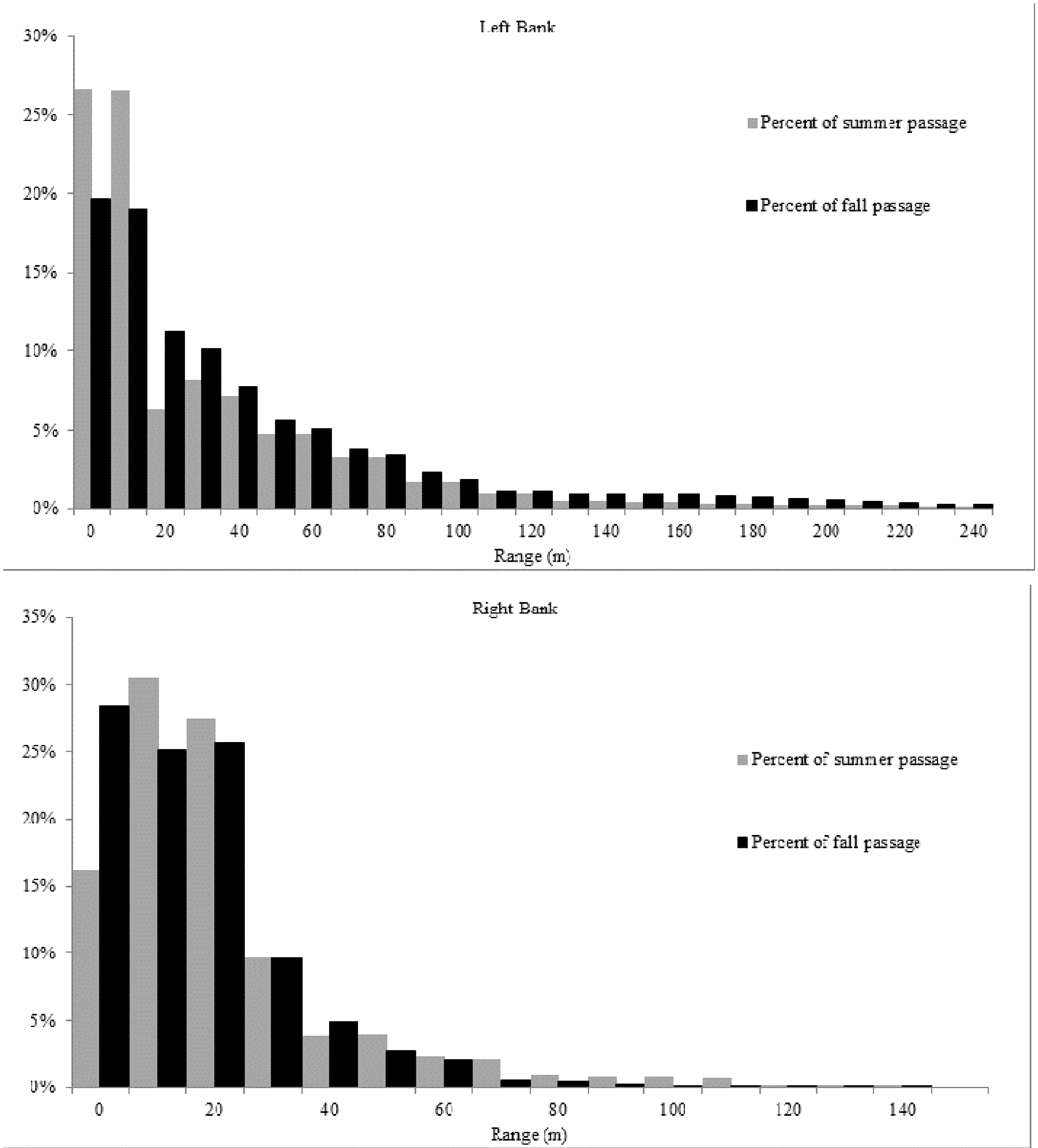


Figure 9.–Horizontal fish distribution (distance from transducer) by bank and season, at the Pilot Station sonar project on the Yukon River, 2008.

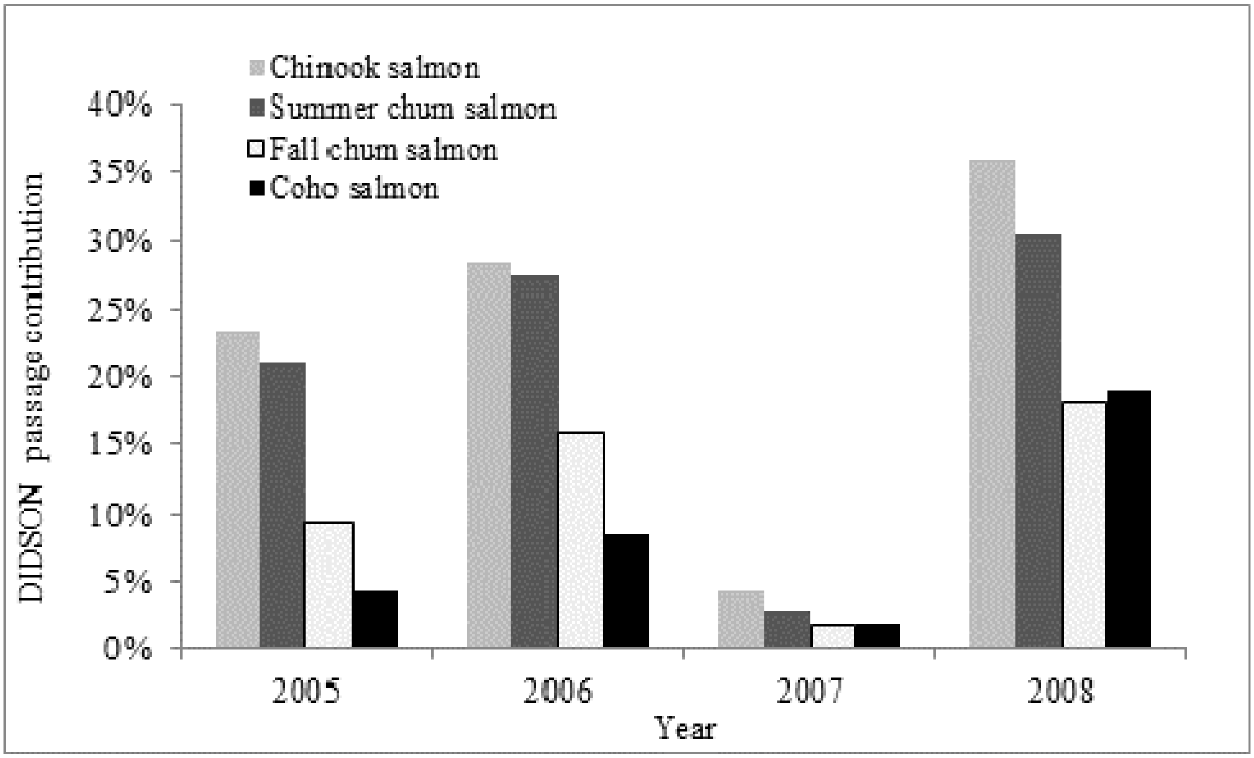
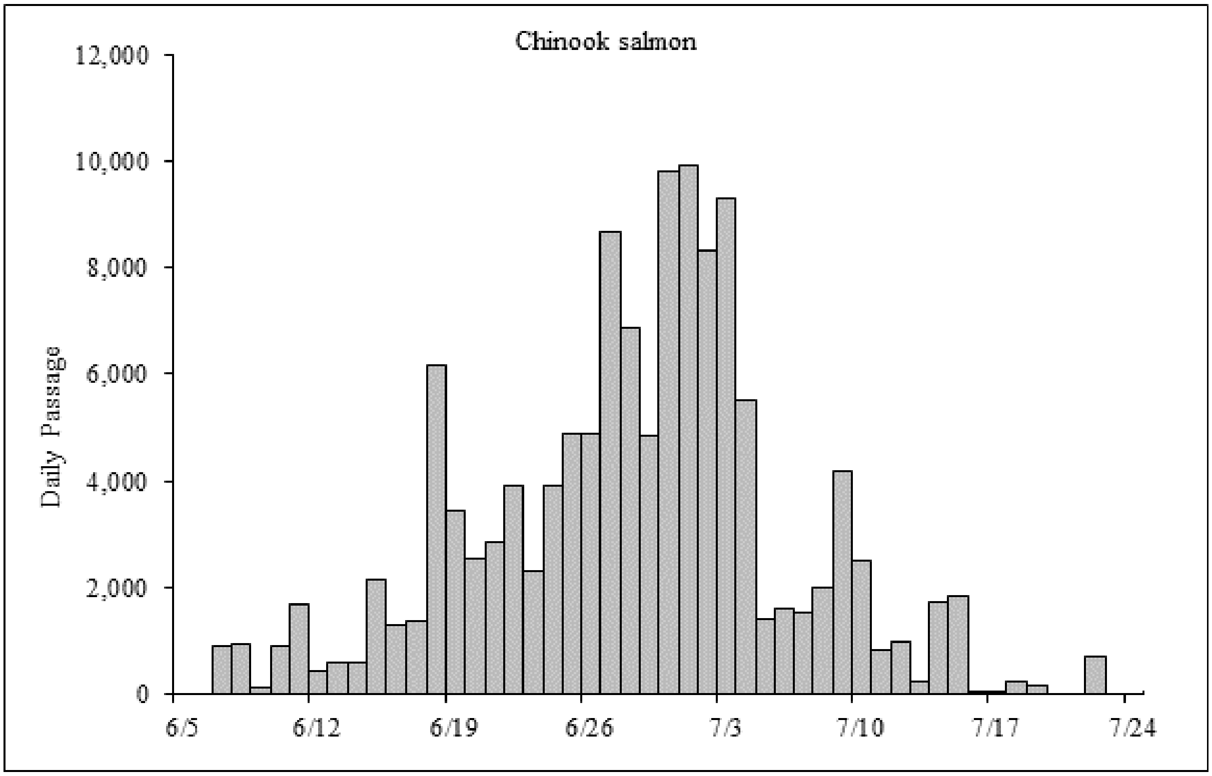


Figure 10.–Percent of additional passage contributed by the DIDSON 2005–2008, at the Pilot Station sonar project on the Yukon River, relative to split-beam in the same area, zone 2, (0–20 m on the left bank).



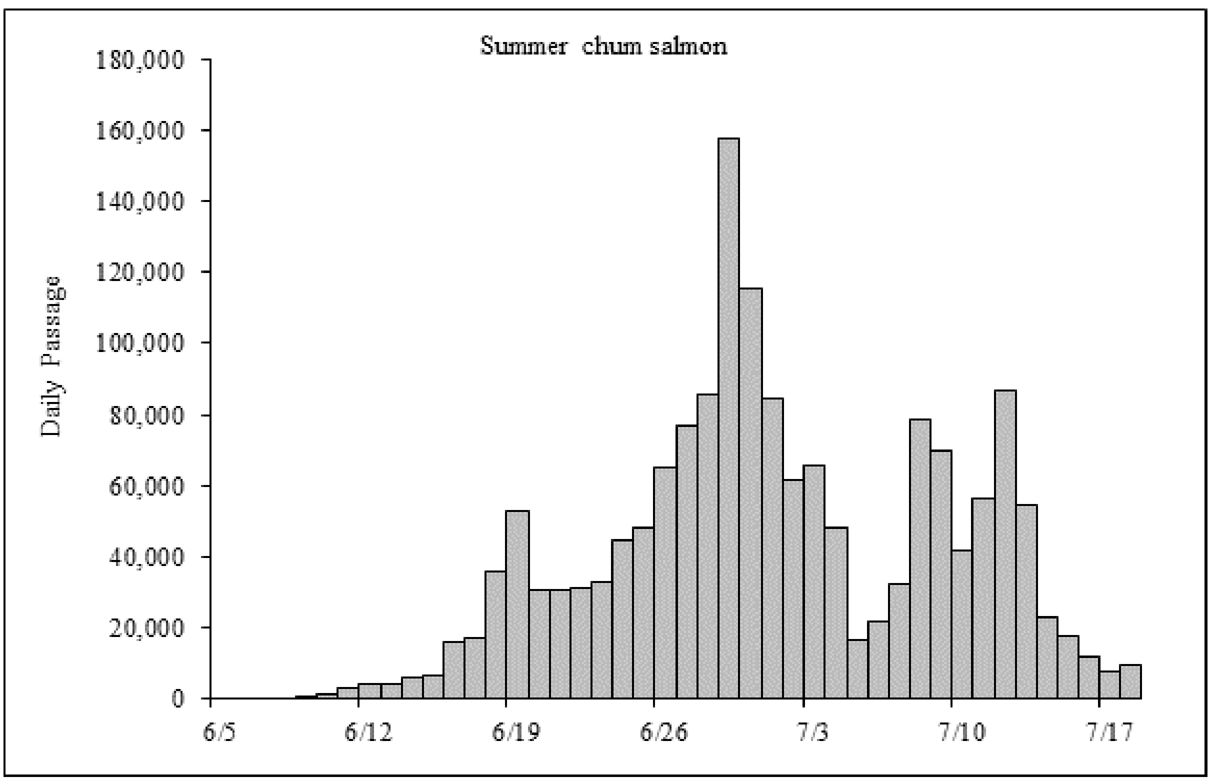
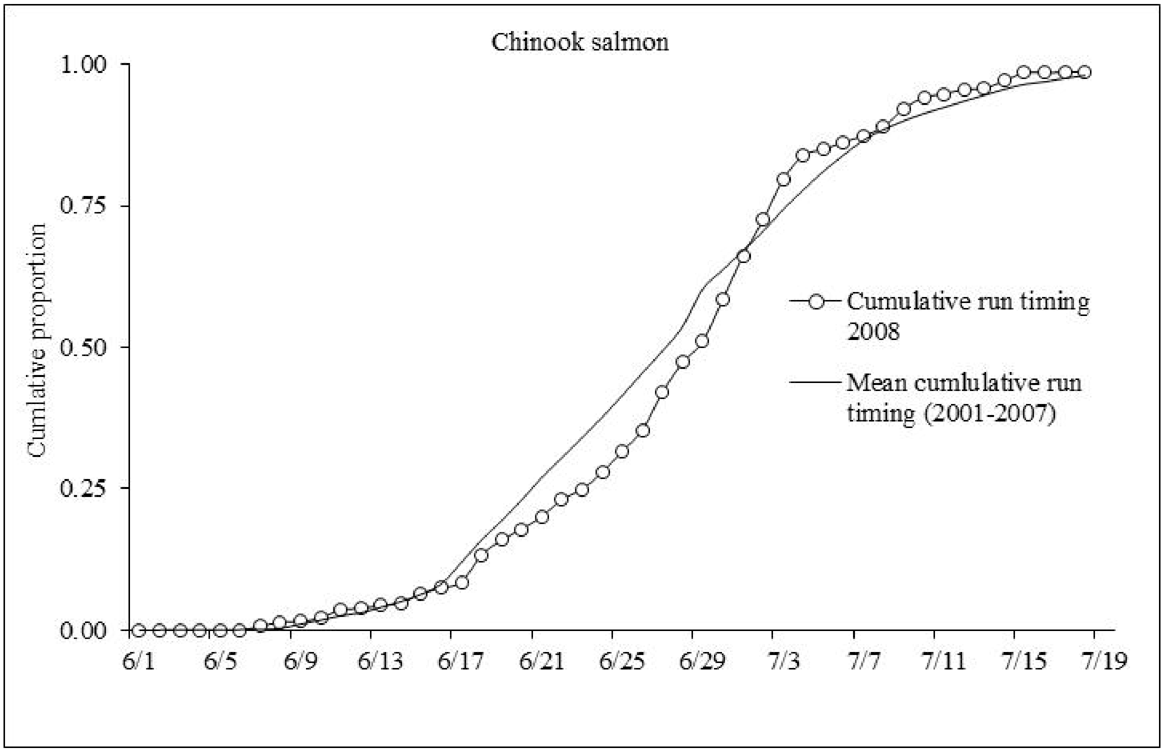


Figure 11.–Chinook and summer chum salmon daily passage estimates, at the Pilot Station sonar project on the Yukon River, 2008.



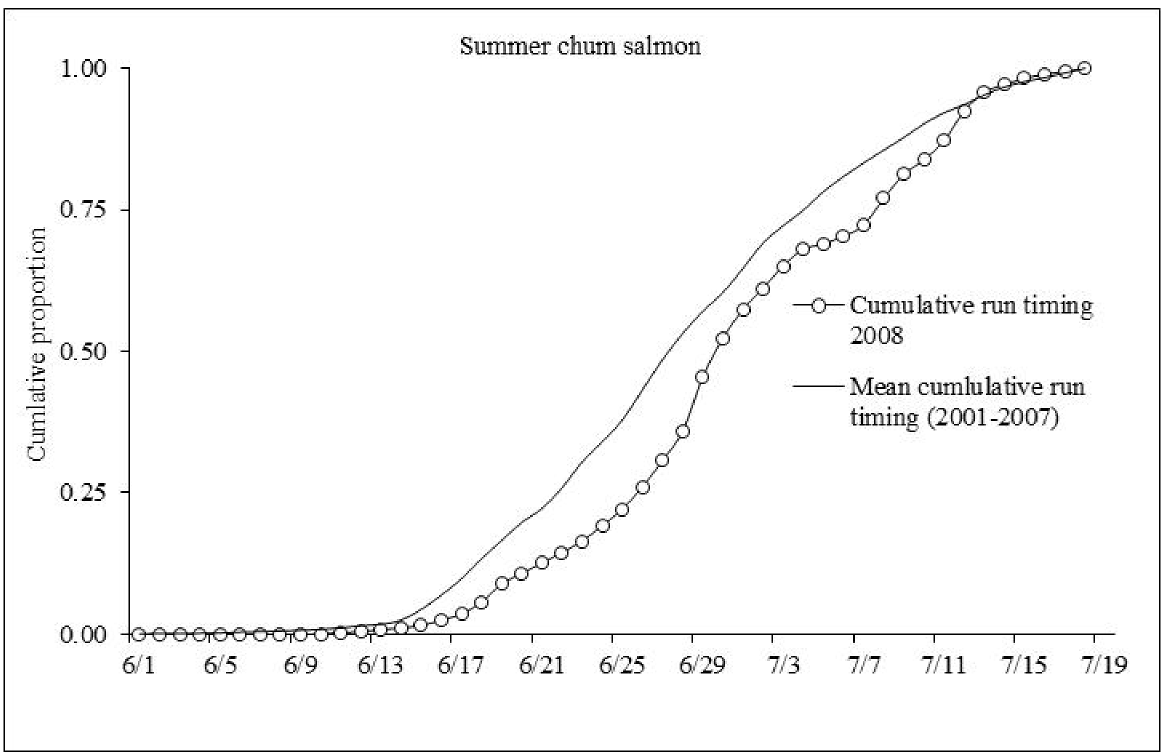


Figure 12.–2008 Chinook and summer chum salmon daily cumulative passage timing compared to the 2001–2007 mean passage timing at the Pilot Station sonar project on the Yukon River.

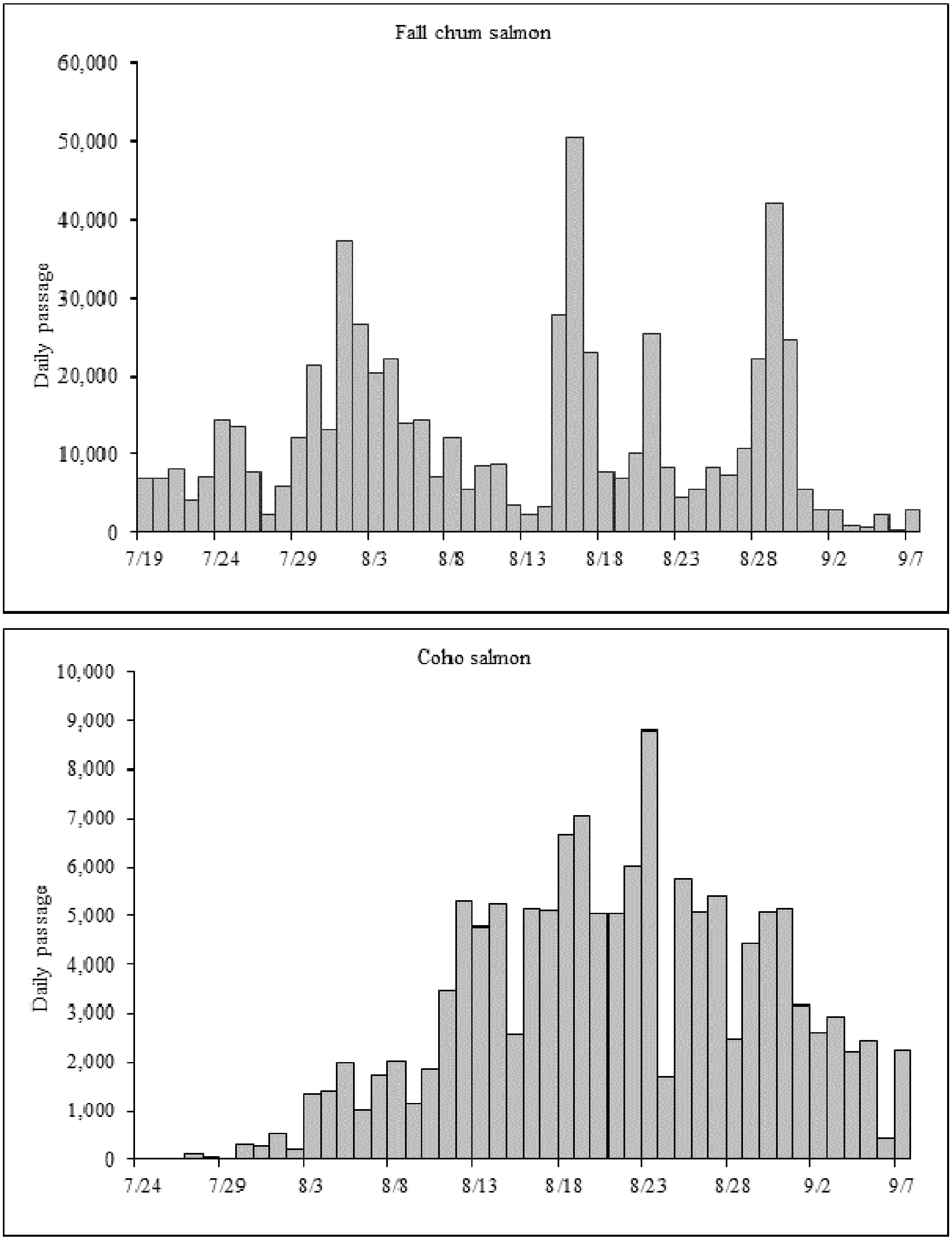
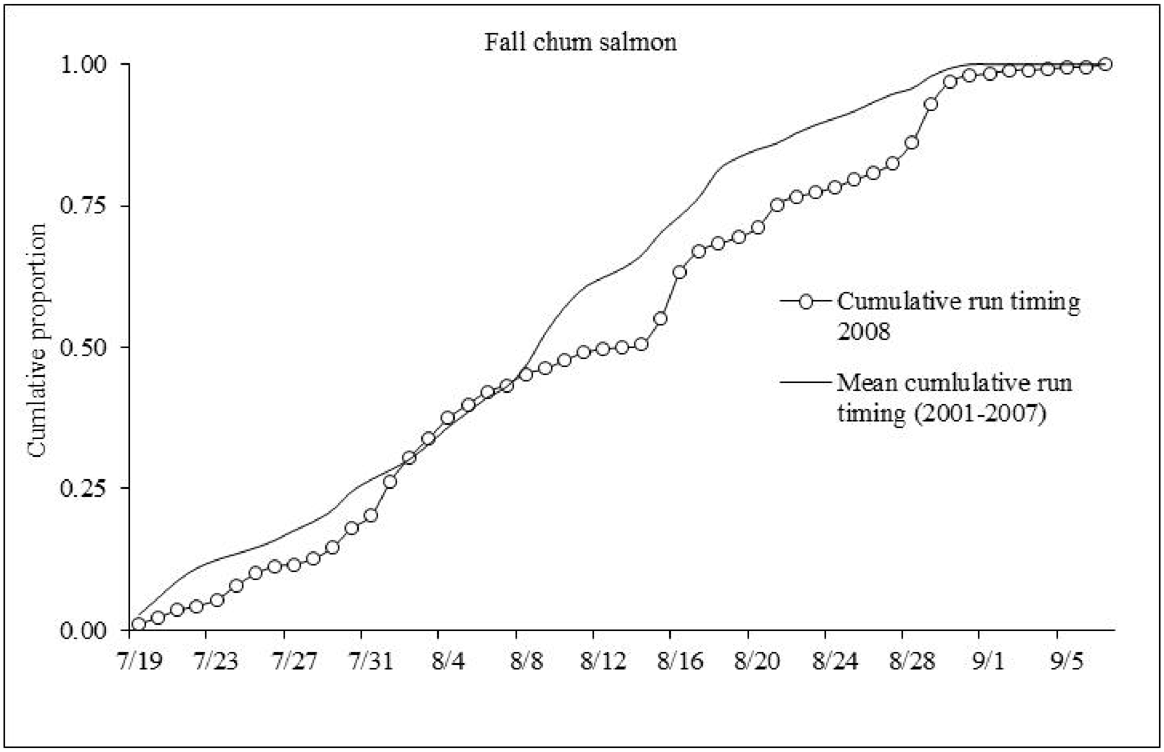
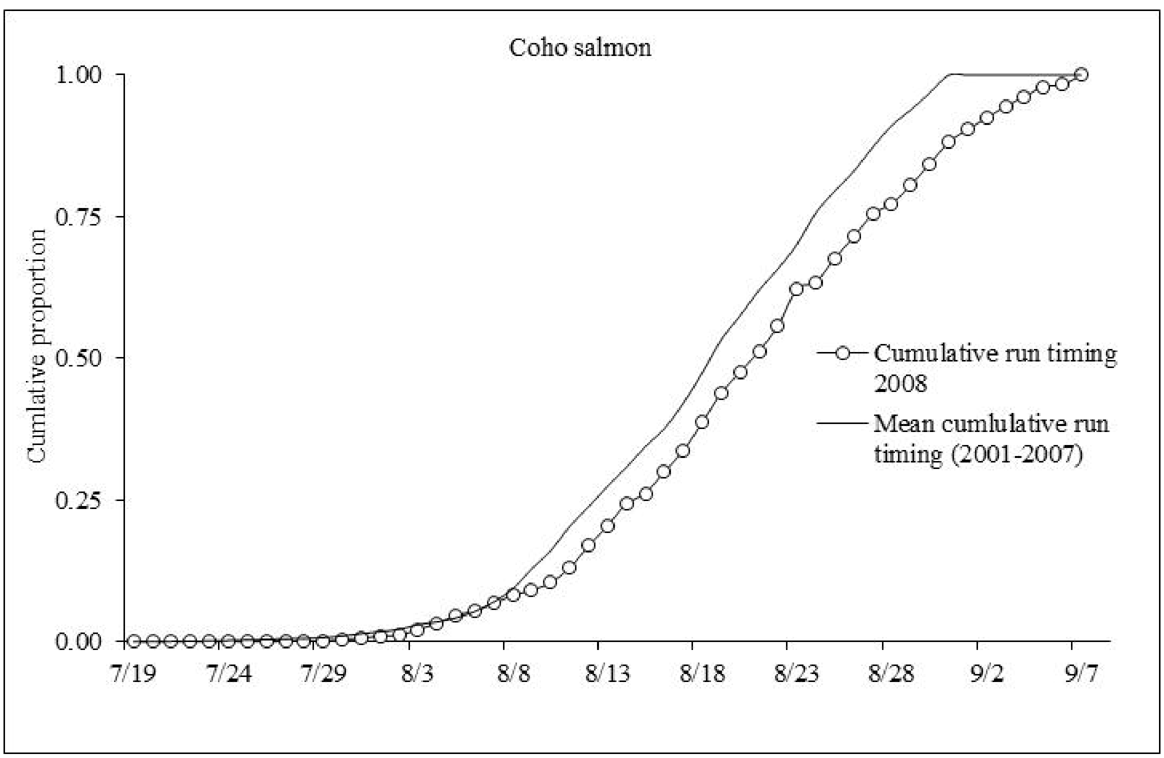


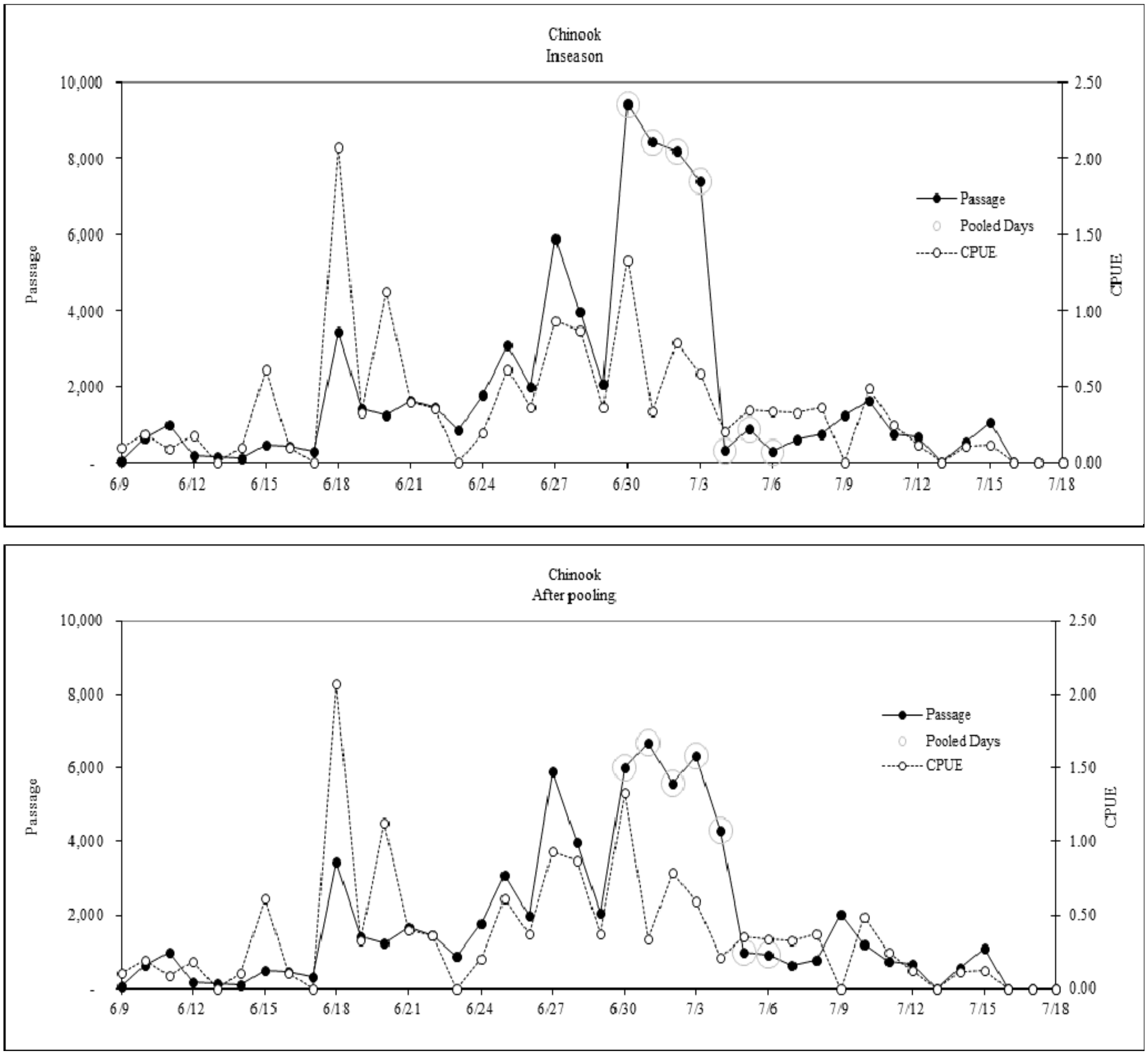
Figure 13.–Fall chum and coho salmon daily passage estimates, at the Pilot Station sonar project on the Yukon River, 2008.





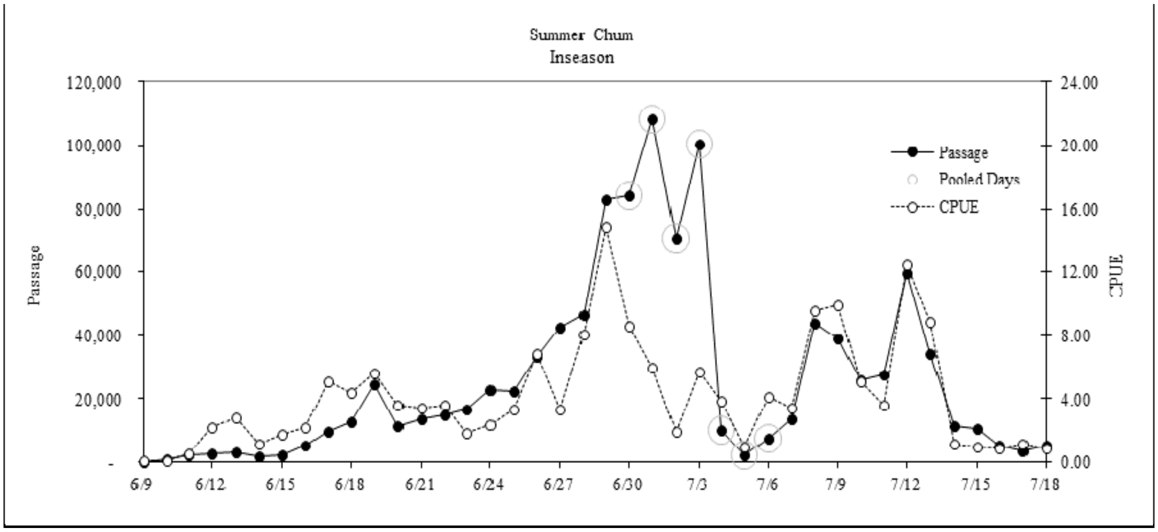
Note: In 2008 sampling operations were extended from August 31 to September 7.

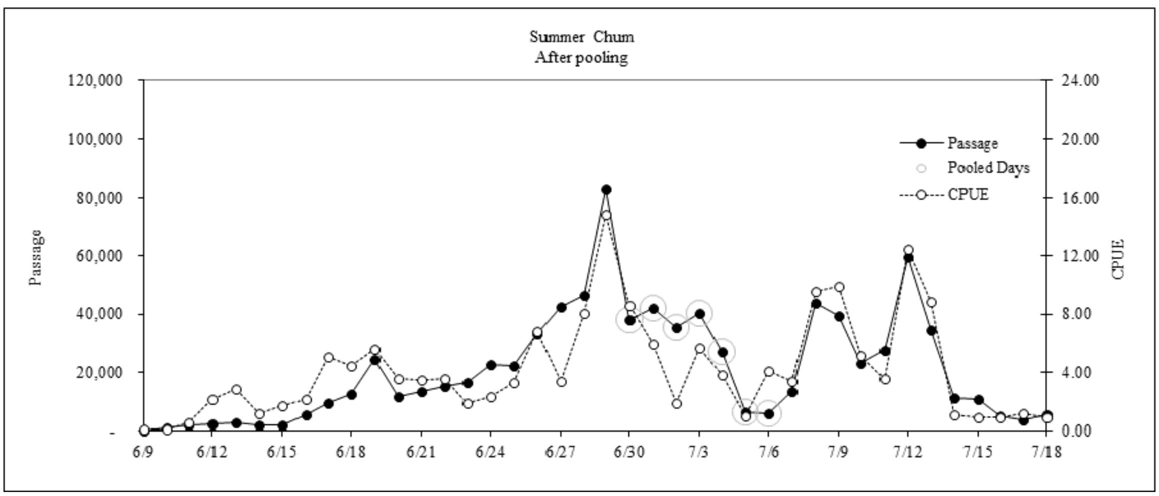
Figure 14.–2008 fall chum and coho salmon daily cumulative passage timing compared the 2001–2007 mean passage timing at the Pilot Station sonar project on the Yukon River.



Note: Pooled days are postseason adjustment.

Figure 15.–Comparison of test fish Chinook CPUE and passage estimate in zone 2 (left bank nearshore), inseason and with postseason adjustment.





Note: Pooled days are postseason adjustment.

Figure 16.–Comparison of test fish summer chum CPUE and passage estimate in zone 2 (left bank nearshore), inseason and with postseason adjustment.

APPENDIX A: NET SELECTIVITY PARAMETERS USED IN FISH SPECIES APPORTIONMENT AT THE PILOT STATION SONAR PROJECT

Appendix A1.–Net selectivity parameters used in fish species apportionment at the Pilot Station sonar project on the Yukon River, 2008.

Species	Tau	Sigma	Theta	Lambda	Tangle
large Chinook [a]	1.9239	0.2361	0.6261	-0.5191	0.0000
small Chinook [b]	1.9239	0.2361	0.6261	-0.5191	0.0000
summer chum	1.9651	0.1800	0.9414	-0.3884	0.0343
fall chum	1.8746	0.2255	1.2028	-1.2115	0.0276
coho	1.9821	0.3209	1.0248	-1.5954	0.0932
pink	1.8962	0.4828	2.0846	0.2148	0.1329
broad whitefish	1.8410	0.2118	0.9502	-1.9363	0.1114
humpback whitefish	1.9004	0.2249	1.1071	-1.8815	0.1022
cisco	2.0640	0.1929	1.7739	-1.2745	0.1728
other	2.2249	0.3304	0.9199	-2.2210	0.0834

[a] Chinook salmon > 655 mm.

[b] Chinook salmon ≤ 655mm.

APPENDIX B: SALMON SPECIES CPUE BY DAY AND BANK

Appendix B1.–Right bank CPUE by day and salmon species at the Pilot Station sonar project on the Yukon River, 2008.

	Large mesh	Chinook		Small mesh	Summer chum		Fall chum		Coho	
Date	Fathom hours	Catch	CPUE	Fathom hours	Catch	CPUE	Catch	CPUE	Catch	CPUE
06/01	9.71	0	0.00	8.35	0	0.00	0	0.00	0	0.00
06/02	8.81	0	0.00	9.50	0	0.00	0	0.00	0	0.00
06/03	9.35	0	0.00	9.52	0	0.00	0	0.00	0	0.00
06/04	8.33	0	0.00	8.80	0	0.00	0	0.00	0	0.00
06/05	9.63	0	0.00	8.32	0	0.00	0	0.00	0	0.00
06/06	6.42	0	0.00	8.27	0	0.00	0	0.00	0	0.00
06/07	9.00	0	0.00	9.13	0	0.00	0	0.00	0	0.00
06/08	8.06	0	0.00	9.52	0	0.00	0	0.00	0	0.00
06/09	8.26	0	0.00	8.51	0	0.00	0	0.00	0	0.00
06/10	8.35	2	0.24	8.40	2	0.24	0	0.00	0	0.00
06/11	7.77	4	0.51	8.03	3	0.37	0	0.00	0	0.00
06/12	8.46	0	0.00	7.53	6	0.80	0	0.00	0	0.00
06/13	7.38	2	0.27	7.97	6	0.75	0	0.00	0	0.00
06/14	8.61	0	0.00	10.00	13	1.30	0	0.00	0	0.00
06/15	8.30	9	1.08	8.00	8	1.00	0	0.00	0	0.00
06/16	7.77	1	0.13	8.84	18	2.04	0	0.00	0	0.00
06/17	7.76	1	0.13	7.04	5	0.71	0	0.00	0	0.00
06/18	6.55	11	1.68	4.45	31	6.96	0	0.00	0	0.00
06/19	6.12	1	0.16	5.97	32	5.36	0	0.00	0	0.00
06/20	7.83	3	0.38	6.61	28	4.23	0	0.00	0	0.00
06/21	4.69	1	0.21	3.80	15	3.95	0	0.00	0	0.00
06/22	7.70	6	0.78	5.55	29	5.23	0	0.00	0	0.00
06/23	7.28	1	0.14	6.77	13	1.92	0	0.00	0	0.00
06/24	6.96	0	0.00	5.99	21	3.51	0	0.00	0	0.00
06/25	6.90	2	0.29	5.35	21	3.92	0	0.00	0	0.00
06/26	5.94	1	0.17	4.68	38	8.12	0	0.00	0	0.00
06/27	6.99	9	1.29	5.40	29	5.37	0	0.00	0	0.00
06/28	6.71	5	0.74	4.38	42	9.60	0	0.00	0	0.00
06/29	6.54	5	0.76	4.50	71	15.78	0	0.00	0	0.00
06/30	5.94	5	0.84	3.66	55	15.01	0	0.00	0	0.00
07/01	9.92	12	1.21	3.17	14	4.42	0	0.00	0	0.00
07/02	7.64	6	0.79	5.31	49	9.24	0	0.00	0	0.00
07/03	7.46	3	0.40	4.15	21	5.07	0	0.00	0	0.00
07/04	3.88	2	0.52	3.24	26	8.03	0	0.00	0	0.00
07/05	7.05	1	0.14	6.41	19	2.96	0	0.00	0	0.00

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Appendix B1.–Page 2 of 3.

Date	Large mesh Fathom hours	Chinook Catch	Chinook CPUE	Small mesh Fathom hours	Summer chum Catch	Summer chum CPUE	Fall chum Catch	Fall chum CPUE	Coho Catch	Coho CPUE
07/06	4.65	1	0.21	3.89	29	7.46	0	0.00	0	0.00
07/07	8.19	1	0.12	5.41	22	4.06	0	0.00	0	0.00
07/08	6.88	5	0.73	4.49	27	6.01	0	0.00	0	0.00
07/09	7.06	2	0.28	3.67	9	2.45	0	0.00	0	0.00
07/10	5.10	2	0.39	3.15	30	9.52	0	0.00	0	0.00
07/11	7.24	1	0.14	5.33	45	8.45	0	0.00	0	0.00
07/12	7.56	0	0.00	4.56	30	6.58	0	0.00	0	0.00
07/13	12.28	0	0.00	3.29	24	7.29	0	0.00	0	0.00
07/14	8.07	0	0.00	5.14	15	2.92	0	0.00	0	0.00
07/15	7.35	1	0.14	4.67	8	1.71	0	0.00	0	0.00
07/16	4.32	0	0.00	3.85	10	2.60	0	0.00	0	0.00
07/17	8.22	0	0.00	6.36	9	1.41	0	0.00	0	0.00
07/18	7.40	0	0.00	6.71	8	1.19	0	0.00	0	0.00
07/19	6.70	0	0.00	4.73	0	0.00	8	1.69	0	0.00
07/20	2.59	0	0.00	3.93	0	0.00	1	0.25	0	0.00
07/21	3.14	0	0.00	6.76	0	0.00	4	0.59	0	0.00
07/22	2.48	0	0.00	8.02	0	0.00	9	1.12	0	0.00
07/23	2.32	0	0.00	4.76	0	0.00	7	1.47	0	0.00
07/24	2.46	0	0.00	6.31	0	0.00	11	1.74	0	0.00
07/25	2.62	1	0.38	7.67	0	0.00	22	2.87	0	0.00
07/26	2.25	0	0.00	8.38	0	0.00	5	0.60	0	0.00
07/27	2.77	0	0.00	6.84	0	0.00	8	1.17	0	0.00
07/28	2.39	0	0.00	8.23	0	0.00	8	0.97	0	0.00
07/29	2.14	0	0.00	6.59	0	0.00	30	4.55	0	0.00
07/30	1.81	0	0.00	2.23	0	0.00	20	8.97	0	0.00
07/31	2.60	0	0.00	6.92	0	0.00	17	2.46	0	0.00
08/01	2.04	0	0.00	5.08	0	0.00	45	8.86	0	0.00
08/02	1.66	0	0.00	2.91	0	0.00	36	12.37	0	0.00
08/03	1.10	0	0.00	5.37	0	0.00	32	5.96	2	0.37
08/04	1.32	0	0.00	4.58	0	0.00	31	6.76	2	0.44
08/05	1.69	0	0.00	5.44	0	0.00	20	3.68	0	0.00
08/06	2.64	0	0.00	6.57	0	0.00	21	3.20	3	0.46
08/07	2.79	0	0.00	7.00	0	0.00	11	1.57	1	0.14
08/08	2.89	0	0.00	6.39	0	0.00	2	0.31	0	0.00

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Appendix B1.–Page 3 of 3.

Date	Large mesh Fathom hours	Chinook Catch	Chinook CPUE	Small mesh Fathom hours	Summer chum Catch	Summer chum CPUE	Fall chum Catch	Fall chum CPUE	Coho Catch	Coho CPUE
08/09	2.57	0	0.00	8.32	0	0.00	7	0.84	1	0.12
08/10	2.18	0	0.00	6.62	0	0.00	13	1.96	2	0.30
08/11	2.21	0	0.00	6.93	0	0.00	11	1.59	6	0.87
08/12	2.58	0	0.00	7.71	0	0.00	6	0.78	9	1.17
08/13	2.61	0	0.00	7.64	0	0.00	4	0.52	7	0.92
08/14	2.47	0	0.00	7.73	0	0.00	4	0.52	13	1.68
08/15	2.42	0	0.00	4.45	0	0.00	28	6.30	1	0.22
08/16	2.31	0	0.00	2.90	0	0.00	20	6.91	0	0.00
08/17	2.77	0	0.00	4.77	0	0.00	23	4.82	5	1.05
08/18	3.32	0	0.00	5.67	0	0.00	6	1.06	13	2.29
08/19	2.11	0	0.00	7.31	0	0.00	4	0.55	13	1.78
08/20	2.69	0	0.00	8.28	0	0.00	13	1.57	12	1.45
08/21	2.39	0	0.00	6.60	0	0.00	27	4.09	7	1.06
08/22	2.77	0	0.00	7.68	0	0.00	7	0.91	12	1.56
08/23	2.51	0	0.00	8.08	0	0.00	7	0.87	10	1.24
08/24	2.44	0	0.00	7.76	0	0.00	17	2.19	7	0.90
08/25	2.78	0	0.00	4.23	0	0.00	14	3.31	3	0.71
08/26	2.77	0	0.00	8.97	0	0.00	12	1.34	24	2.68
08/27	2.64	0	0.00	5.69	0	0.00	27	4.74	14	2.46
08/28	2.49	0	0.00	3.84	0	0.00	14	3.65	3	0.78
08/29	2.73	0	0.00	4.49	0	0.00	26	5.79	2	0.45
08/30	3.07	0	0.00	4.55	0	0.00	34	7.47	2	0.44
08/31	2.48	0	0.00	5.82	0	0.00	5	0.86	14	2.41
09/01	2.63	0	0.00	5.04	0	0.00	2	0.40	5	0.99
09/02	2.42	0	0.00	7.63	0	0.00	2	0.26	7	0.92
09/03	2.33	0	0.00	7.61	0	0.00	2	0.26	6	0.79
09/04	0.01	0	0.00	0.00	0	0.00	0	0.00	0	0.00
09/05	2.66	0	0.00	7.92	0	0.00	5	0.63	4	0.51
09/06	2.56	0	0.00	7.86	0	0.00	12	1.53	3	0.38
09/07	0.01	0	0.00	0.00	0	0.00	0	0.00	0	0.00
Total	482.72	107	15.25	602.45	881	187.54	700	136.88	213	31.54

Appendix B2.–Left bank CPUE by day and salmon species at the Pilot Station sonar project on the Yukon River, 2008.

	Large mesh	Chinook		Small mesh	Summer chum		Fall chum		Coho	
Date	Fathom hours	Catch	CPUE	Fathom hours	Catch	CPUE	Catch	CPUE	Catch	CPUE
06/01	20.16	0	0.00	22.03	0	0.00	0	0.00	0	0.00
06/02	21.91	0	0.00	21.90	0	0.00	0	0.00	0	0.00
06/03	22.55	0	0.00	21.78	0	0.00	0	0.00	0	0.00
06/04	19.28	0	0.00	20.53	0	0.00	0	0.00	0	0.00
06/05	21.48	0	0.00	20.24	0	0.00	0	0.00	0	0.00
06/06	20.32	0	0.00	22.73	0	0.00	0	0.00	0	0.00
06/07	21.42	3	0.14	20.66	0	0.00	0	0.00	0	0.00
06/08	17.32	3	0.17	20.41	0	0.00	0	0.00	0	0.00
06/09	20.32	1	0.05	19.75	1	0.05	0	0.00	0	0.00
06/10	20.63	4	0.19	20.78	2	0.10	0	0.00	0	0.00
06/11	21.19	4	0.19	17.95	12	0.67	0	0.00	0	0.00
06/12	21.34	3	0.14	19.86	33	1.66	0	0.00	0	0.00
06/13	19.53	3	0.15	18.83	36	1.91	0	0.00	0	0.00
06/14	18.95	3	0.16	18.27	23	1.26	0	0.00	0	0.00
06/15	19.47	12	0.62	19.06	26	1.36	0	0.00	0	0.00
06/16	20.28	6	0.30	18.60	36	1.94	0	0.00	0	0.00
06/17	17.56	2	0.11	11.83	50	4.23	0	0.00	0	0.00
06/18	13.40	19	1.42	11.25	51	4.53	0	0.00	0	0.00
06/19	18.65	5	0.27	11.18	50	4.47	0	0.00	0	0.00
06/20	15.38	8	0.52	11.89	36	3.03	0	0.00	0	0.00
06/21	10.67	3	0.28	11.06	41	3.71	0	0.00	0	0.00
06/22	16.65	6	0.36	14.64	32	2.19	0	0.00	0	0.00
06/23	18.90	3	0.16	15.54	31	1.99	0	0.00	0	0.00
06/24	19.85	6	0.30	17.83	37	2.07	0	0.00	0	0.00
06/25	19.52	9	0.46	15.23	34	2.23	0	0.00	0	0.00
06/26	16.69	9	0.54	14.87	54	3.63	0	0.00	0	0.00
06/27	18.59	10	0.54	13.30	41	3.08	0	0.00	0	0.00
06/28	15.95	11	0.69	9.74	54	5.55	0	0.00	0	0.00
06/29	15.88	7	0.44	10.20	104	10.20	0	0.00	0	0.00
06/30	14.01	13	0.93	11.22	60	5.35	0	0.00	0	0.00
07/01	23.09	9	0.39	6.74	41	6.09	0	0.00	0	0.00
07/02	17.61	11	0.62	11.75	22	1.87	0	0.00	0	0.00
07/03	18.01	13	0.72	10.57	40	3.78	0	0.00	0	0.00
07/04	9.91	2	0.20	8.23	26	3.16	0	0.00	0	0.00
07/05	17.16	4	0.23	17.00	19	1.12	0	0.00	0	0.00

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Date	Large mesh Fathom hours	Chinook Catch	Chinook CPUE	Small mesh Fathom hours	Summer chum Catch	Summer chum CPUE	Fall chum Catch	Fall chum CPUE	Coho Catch	Coho CPUE
07/06	11.13	4	0.36	9.65	34	3.52	0	0.00	0	0.00
07/07	18.09	5	0.28	13.28	38	2.86	0	0.00	0	0.00
07/08	16.85	4	0.24	9.77	63	6.45	0	0.00	0	0.00
07/09	16.40	3	0.18	9.04	62	6.86	0	0.00	0	0.00
07/10	12.10	7	0.58	6.91	30	4.34	0	0.00	0	0.00
07/11	17.01	2	0.12	12.61	42	3.33	0	0.00	0	0.00
07/12	17.26	2	0.12	8.84	64	7.24	0	0.00	0	0.00
07/13	16.50	1	0.06	11.11	52	4.68	0	0.00	0	0.00
07/14	16.63	3	0.18	15.28	17	1.11	0	0.00	0	0.00
07/15	18.22	2	0.11	15.18	11	0.72	0	0.00	0	0.00
07/16	9.94	0	0.00	7.87	5	0.64	0	0.00	0	0.00
07/17	18.50	0	0.00	14.51	11	0.76	0	0.00	0	0.00
07/18	18.27	1	0.05	20.98	13	0.62	0	0.00	0	0.00
07/19	15.42	0	0.00	11.54	0	0.00	4	0.35	0	0.00
07/20	6.88	0	0.00	9.48	0	0.00	11	1.16	0	0.00
07/21	5.93	0	0.00	18.11	0	0.00	3	0.17	0	0.00
07/22	6.65	0	0.00	17.54	0	0.00	7	0.40	0	0.00
07/23	5.90	0	0.00	11.65	0	0.00	8	0.69	0	0.00
07/24	6.31	0	0.00	18.21	0	0.00	17	0.93	0	0.00
07/25	6.27	0	0.00	17.34	0	0.00	13	0.75	0	0.00
07/26	6.07	0	0.00	17.54	0	0.00	12	0.68	0	0.00
07/27	5.98	0	0.00	16.72	0	0.00	7	0.42	0	0.00
07/28	5.99	0	0.00	18.36	0	0.00	5	0.27	0	0.00
07/29	5.98	0	0.00	18.50	0	0.00	25	1.35	0	0.00
07/30	4.38	0	0.00	7.50	0	0.00	25	3.33	0	0.00
07/31	5.05	0	0.00	17.81	0	0.00	17	0.95	0	0.00
08/01	4.88	0	0.00	13.36	0	0.00	44	3.29	0	0.00
08/02	5.67	1	0.18	12.41	0	0.00	43	3.46	0	0.00
08/03	4.13	0	0.00	13.46	0	0.00	35	2.60	1	0.07
08/04	5.73	0	0.00	15.43	0	0.00	21	1.36	1	0.06
08/05	5.33	0	0.00	14.16	0	0.00	22	1.55	2	0.14
08/06	6.07	0	0.00	16.63	0	0.00	23	1.38	1	0.06
08/07	5.69	0	0.00	16.28	0	0.00	18	1.11	3	0.18
08/08	6.68	0	0.00	17.34	0	0.00	21	1.21	4	0.23

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Appendix B2.–Page 3 of 3.

Date	Large mesh Fathom hours	Chinook Catch	Chinook CPUE	Small mesh Fathom hours	Summer chum Catch	Summer chum CPUE	Fall chum Catch	Fall chum CPUE	Coho Catch	Coho CPUE
08/09	5.26	0	0.00	17.86	0	0.00	6	0.34	2	0.11
08/10	4.64	0	0.00	15.64	0	0.00	15	0.96	4	0.26
08/11	5.48	0	0.00	18.80	0	0.00	15	0.80	0	0.00
08/12	5.71	1	0.18	16.16	0	0.00	3	0.19	8	0.50
08/13	5.34	0	0.00	17.07	0	0.00	3	0.18	5	0.29
08/14	5.60	0	0.00	16.91	0	0.00	6	0.35	7	0.41
08/15	5.58	0	0.00	12.56	0	0.00	42	3.34	2	0.16
08/16	3.80	0	0.00	7.63	0	0.00	45	5.90	1	0.13
08/17	5.82	0	0.00	11.82	0	0.00	20	1.69	4	0.34
08/18	5.95	0	0.00	15.71	0	0.00	18	1.15	13	0.83
08/19	5.24	0	0.00	17.30	0	0.00	8	0.46	7	0.40
08/20	6.22	0	0.00	15.67	0	0.00	7	0.45	3	0.19
08/21	5.37	0	0.00	14.07	0	0.00	31	2.20	8	0.57
08/22	5.60	0	0.00	18.27	0	0.00	12	0.66	5	0.27
08/23	4.79	0	0.00	15.29	0	0.00	4	0.26	9	0.59
08/24	6.72	0	0.00	16.78	0	0.00	12	0.72	4	0.24
08/25	5.63	0	0.00	9.82	0	0.00	8	0.81	6	0.61
08/26	5.84	0	0.00	17.07	0	0.00	10	0.59	9	0.53
08/27	6.15	0	0.00	15.28	0	0.00	24	1.57	10	0.65
08/28	5.34	0	0.00	10.20	0	0.00	19	1.86	4	0.39
08/29	4.43	0	0.00	12.81	0	0.00	54	4.21	2	0.16
08/30	5.49	0	0.00	12.52	0	0.00	29	2.32	1	0.08
08/31	5.45	0	0.00	15.50	0	0.00	19	1.23	7	0.45
09/01	5.51	0	0.00	10.87	0	0.00	3	0.28	2	0.18
09/02	4.82	0	0.00	15.15	0	0.00	4	0.26	6	0.40
09/03	6.82	0	0.00	17.00	0	0.00	3	0.18	5	0.29
09/04	0.03	0	0.00	0.00	0	0.00	0	0.00	0	0.00
09/05	5.40	0	0.00	17.46	0	0.00	2	0.11	3	0.17
09/06	6.00	1	0.17	17.18	0	0.00	0	0.00	1	0.06
09/07	0.01	0	0.00	0.00	0	0.00	0	0.00	0	0.00
Total	1,129.63	229	14.10	1,432.14	1,434	124.36	800	60.31	150	10.00

APPENDIX C: DAILY FISH PASSAGE ESTIMATES BY ZONE WITH STANDARD ERRORS

Appendix C1.–Daily fish passage estimates by zone with standard errors (SE), at the Pilot Station sonar project on the Yukon River, 2008.

	Right Bank	Left Bank		Total		Percent by Bank	
Date		Nearshore	Offshore	Passage	SE	Right	Left
06/01	1,153	0	0	1,153	541	100.0	0.0
06/02	2,206	0	0	2,206	138	100.0	0.0
06/03	2,347	0	0	2,347	441	100.0	0.0
06/04	1,756	465	80	2,301	448	76.3	23.7
06/05	1,795	3,204	220	5,219	616	34.4	65.6
06/06	1,791	2,756	271	4,818	350	37.2	62.8
06/07	1,515	2,150	104	3,769	1,273	40.2	59.8
06/08	1,745	2,987	472	5,204	2,305	33.5	66.5
06/09	1,806	3,117	352	5,275	1,274	34.2	65.8
06/10	1,207	3,172	360	4,739	2,175	25.5	74.5
06/11	1,350	3,031	1,541	5,922	807	22.8	77.2
06/12	1,151	2,718	1,265	5,134	1,027	22.4	77.6
06/13	1,793	3,564	1,078	6,435	978	27.9	72.1
06/14	1,833	2,910	3,478	8,221	1,240	22.3	77.7
06/15	4,500	3,303	3,847	11,650	1,394	38.6	61.4
06/16	5,434	6,747	6,876	19,057	1,615	28.5	71.5
06/17	6,769	11,634	10,170	28,573	5,085	23.7	76.3
06/18	15,299	17,575	11,408	44,282	4,216	34.6	65.5
06/19	13,854	26,929	20,442	61,225	6,555	22.6	77.4
06/20	8,814	12,686	11,883	33,383	3,444	26.4	73.6
06/21	8,584	15,854	10,867	35,305	3,262	24.3	75.7
06/22	10,290	16,546	10,046	36,882	3,470	27.9	72.1
06/23	6,873	17,961	12,944	37,778	4,074	18.2	81.8
06/24	8,062	24,593	17,092	49,747	2,980	16.2	83.8
06/25	12,959	25,204	16,439	54,602	4,558	23.7	76.3
06/26	20,301	36,976	15,723	73,000	3,875	27.8	72.2
06/27	24,034	48,995	16,220	89,249	5,819	26.9	73.1
06/28	28,238	51,610	15,959	95,807	8,464	29.5	70.5
06/29	47,718	92,278	32,983	172,979	12,597	27.6	72.4
06/30	44,703	125,097	40,117	209,917	48,654	21.3	78.7
07/01	34,793	138,590	21,257	194,640	51,298	17.9	82.1
07/02	24,280	115,784	10,729	150,793	46,655	16.1	83.9
07/03	26,229	131,582	11,242	169,053	49,797	15.5	84.5
07/04	18,297	89,442	12,089	119,828	41,124	15.3	84.7
07/05	13,446	20,738	5,674	39,858	20,013	33.7	66.3
07/06	20,038	19,337	9,624	48,999	19,512	40.9	59.1
07/07	19,423	27,957	12,029	59,409	11,682	32.7	67.3
07/08	29,349	49,033	23,123	101,505	8,108	28.9	71.1
07/09	23,217	52,442	18,102	93,761	8,994	24.8	75.2
07/10	15,155	30,579	10,690	56,424	6,956	26.9	73.1
07/11	16,467	47,408	21,012	84,887	18,980	19.4	80.6
07/12	15,386	65,105	30,380	110,871	11,943	13.9	86.1
07/13	13,251	38,191	18,127	69,569	6,838	19.1	81.0
07/14	6,130	24,982	11,406	42,518	11,403	14.4	85.6
07/15	4,051	20,766	7,546	32,363	8,920	12.5	87.5
07/16	5,540	25,971	6,496	38,007	12,043	14.6	85.4
07/17	3,809	17,823	4,624	26,256	9,960	14.5	85.5
07/18	4,483	14,213	5,807	24,503	4,902	18.3	81.7
07/19	4,538	15,709	5,194	25,441	8,265	17.8	82.2
07/20	2,361	11,421	3,503	17,285	5,442	13.7	86.3

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Appendix C1.–Page 2 of 2.

Date	Right Bank	Left Bank		Total		Percent by Bank	
		Nearshore	Offshore	Passage	SE	Right	Left
07/21	2,950	14,119	3,139	20,208	5,948	14.6	85.4
07/22	2,826	9,363	2,033	14,222	1,746	19.9	80.1
07/23	2,973	8,056	3,392	14,421	3,237	20.6	79.4
07/24	5,141	13,296	5,790	24,227	4,493	21.2	78.8
07/25	3,725	18,293	6,142	28,160	2,500	13.2	86.8
07/26	3,390	11,264	3,687	18,341	5,225	18.5	81.5
07/27	3,941	9,949	4,533	18,423	2,697	21.4	78.6
07/28	3,135	9,458	4,380	16,973	4,444	18.5	81.5
07/29	2,996	14,738	10,067	27,801	5,984	10.8	89.2
07/30	3,204	16,910	12,940	33,054	6,167	9.7	90.3
07/31	2,096	10,107	7,975	20,178	4,730	10.4	89.6
08/01	4,581	21,774	14,842	41,197	3,582	11.1	88.9
08/02	10,337	15,983	9,239	35,559	6,326	29.1	70.9
08/03	8,265	11,532	9,817	29,614	5,705	27.9	72.1
08/04	8,002	14,546	8,850	31,398	3,193	25.5	74.5
08/05	5,316	12,324	4,691	22,331	3,654	23.8	76.2
08/06	4,911	10,623	3,264	18,798	1,996	26.1	73.9
08/07	2,813	7,477	2,639	12,929	1,799	21.8	78.2
08/08	4,063	10,180	2,463	16,706	2,119	24.3	75.7
08/09	2,427	7,281	2,300	12,008	3,076	20.2	79.8
08/10	3,205	8,926	1,621	13,752	3,073	23.3	76.7
08/11	3,338	10,340	1,762	15,440	2,053	21.6	78.4
08/12	3,242	8,067	1,292	12,601	1,747	25.7	74.3
08/13	2,731	6,940	1,374	11,045	2,197	24.7	75.3
08/14	2,443	5,863	1,803	10,109	1,428	24.2	75.8
08/15	6,670	20,014	6,184	32,868	4,693	20.3	79.7
08/16	8,955	37,390	13,994	60,339	5,377	14.8	85.2
08/17	6,151	16,515	10,088	32,754	4,414	18.8	81.2
08/18	3,808	13,905	6,010	23,723	7,289	16.1	84.0
08/19	3,499	11,611	3,865	18,975	3,455	18.4	81.6
08/20	3,536	13,998	3,592	21,126	5,971	16.7	83.3
08/21	5,810	19,449	7,294	32,553	2,402	17.9	82.2
08/22	3,391	11,794	4,049	19,234	4,934	17.6	82.4
08/23	2,466	11,131	3,360	16,957	2,809	14.5	85.5
08/24	2,964	9,352	4,704	17,020	3,283	17.4	82.6
08/25	2,942	10,121	8,857	21,920	5,197	13.4	86.6
08/26	3,722	7,454	7,712	18,888	4,556	19.7	80.3
08/27	5,584	10,270	9,479	25,333	3,996	22.0	78.0
08/28	7,547	10,209	11,328	29,084	5,272	26.0	74.1
08/29	11,520	21,344	21,197	54,061	7,293	21.3	78.7
08/30	7,622	12,986	14,809	35,417	4,557	21.5	78.5
08/31	5,008	8,657	6,180	19,845	4,690	25.2	74.8
09/01	2,323	4,274	3,660	10,257	3,069	22.7	77.4
09/02	1,493	3,256	2,440	7,189	2,096	20.8	79.2
09/03	1,488	4,814	2,864	9,166	1,423	16.2	83.8
09/04	1,305	3,149	2,248	6,702	1,220	19.5	80.5
09/05	1,722	4,403	2,940	9,065	3,588	19.0	81.0
09/06	1,297	8,184	2,568	12,049	2,594	10.8	89.2
09/07	1,765	7,821	4,605	14,191	4,419	12.4	87.6
Total	794,762	2,090,645	804,953	3,690,360			

APPENDIX D: DAILY FISH PASSAGE ESTIMATES BY SPECIES

Appendix D1.–Daily fish passage estimates by species at the Pilot Station sonar site, on the Yukon River 2008.

Date	Large Chinook[a]	Small Chinook[b]	Total Chinook	Summer Chum	Fall Chum	Pink	Coho	Other	Total
06/01	0	0	0	0	0	0	0	1,153	1,153
06/02	0	0	0	0	0	0	0	2,206	2,206
06/03	0	0	0	0	0	0	0	2,347	2,347
06/04	0	0	0	0	0	0	0	2,301	2,301
06/05	0	0	0	0	0	0	0	5,219	5,219
06/06	0	0	0	0	0	0	0	4,818	4,818
06/07	929	0	929	0	0	0	0	2,840	3,769
06/08	942	0	942	0	0	0	0	4,262	5,204
06/09	147	0	147	117	0	0	0	5,011	5,275
06/10	869	66	935	1,269	0	0	0	2,535	4,739
06/11	1,402	293	1,695	3,319	0	0	0	908	5,922
06/12	288	167	455	4,322	0	0	0	357	5,134
06/13	545	57	602	4,490	0	0	0	1,343	6,435
06/14	448	160	608	5,905	0	0	0	1,708	8,221
06/15	1,866	292	2,158	6,604	0	0	0	2,888	11,650
06/16	1,195	122	1,317	16,186	0	0	0	1,554	19,057
06/17	736	671	1,407	17,495	0	0	0	9,671	28,573
06/18	5,772	417	6,189	35,891	0	0	0	2,202	44,282
06/19	2,555	916	3,471	52,994	0	1,750	0	3,010	61,225
06/20	2,236	321	2,557	30,719	0	0	0	107	33,383
06/21	2,235	629	2,864	30,953	0	0	0	1,488	35,305
06/22	2,878	1,078	3,956	31,254	0	0	0	1,672	36,882
06/23	1,656	666	2,322	33,408	0	434	0	1,614	37,778
06/24	3,255	686	3,941	45,223	0	583	0	0	49,747
06/25	4,301	570	4,871	48,610	0	969	0	152	54,602
06/26	4,211	680	4,891	65,441	0	1,715	0	953	73,000
06/27	7,078	1,615	8,693	77,464	0	1,873	0	1,219	89,249
06/28	6,891	0	6,891	86,196	0	2,403	0	317	95,807
06/29	3,919	908	4,827	157,961	0	4,206	0	5,985	172,979
06/30	7,637	2,173	9,810	115,437	0	60,771	0	23,899	209,917
07/01	7,269	2,658	9,927	84,917	0	65,557	0	34,239	194,640
07/02	5,902	2,443	8,345	62,040	0	54,650	0	25,758	150,793
07/03	7,200	2,113	9,313	66,264	0	64,228	0	29,248	169,053
07/04	4,077	1,441	5,518	48,558	0	44,197	0	21,555	119,828
07/05	1,141	293	1,434	16,577	0	15,083	0	6,764	39,858
07/06	1,367	274	1,641	22,062	0	17,272	0	8,024	48,999
07/07	1,544	0	1,544	32,686	0	7,183	0	17,996	59,409
07/08	2,034	0	2,034	78,940	0	13,848	0	6,683	101,505
07/09	3,549	670	4,219	70,523	0	9,595	0	9,424	93,761
07/10	2,122	399	2,521	42,302	0	6,008	0	5,593	56,424
07/11	850	0	850	56,827	0	9,420	0	17,790	84,887
07/12	608	400	1,008	87,341	0	12,379	0	10,143	110,871
07/13	271	0	271	54,678	0	12,496	0	2,124	69,569
07/14	1,736	0	1,736	23,047	0	4,584	0	13,151	42,518
07/15	1,094	757	1,851	18,144	0	5,609	0	6,759	32,363
07/16	29	0	29	11,978	0	13,793	0	12,207	38,007
07/17	48	0	48	8,078	0	10,373	0	7,757	26,256
07/18	242	0	242	9,447	0	10,666	0	4,148	24,503
07/19	168	0	168	0	6,849	8,628	26	9,770	25,441
07/20	0	0	0	0	6,968	8,311	13	1,993	17,285

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Appendix D1.–Page 2 of 2.

Date	Large Chinook[a]	Small Chinook[b]	Total Chinook	Summer Chum	Fall Chum	Pink	Coho	Other	Total
07/21	0	0	0	0	8,270	10,270	0	1,668	20,208
07/22	721	0	721	0	4,249	4,600	0	4,652	14,222
07/23	0	0	0	0	7,199	4,869	0	2,353	14,421
07/24	0	0	0	0	14,408	6,400	0	3,419	24,227
07/25	45	0	45	0	13,710	13,963	0	442	28,160
07/26	0	0	0	0	7,854	3,412	0	7,075	18,341
07/27	0	0	0	0	2,364	5,961	123	9,975	18,423
07/28	0	0	0	0	5,877	6,496	28	4,572	16,973
07/29	0	0	0	0	12,134	9,689	0	5,978	27,801
07/30	0	0	0	0	21,369	2,830	312	8,543	33,054
07/31	0	0	0	0	13,307	1,637	277	4,957	20,178
08/01	0	0	0	0	37,185	3,069	554	389	41,197
08/02	164	0	164	0	26,671	4,250	225	4,249	35,559
08/03	0	0	0	0	20,375	2,434	1,374	5,431	29,614
08/04	0	0	0	0	22,209	1,930	1,413	5,846	31,398
08/05	0	0	0	0	14,135	622	2,007	5,567	22,331
08/06	0	0	0	0	14,395	771	1,014	2,618	18,798
08/07	0	0	0	0	7,128	906	1,740	3,155	12,929
08/08	0	0	0	0	12,223	587	2,027	1,869	16,706
08/09	0	0	0	0	5,424	524	1,170	4,890	12,008
08/10	0	0	0	0	8,680	86	1,861	3,125	13,752
08/11	0	0	0	0	8,839	819	3,477	2,305	15,440
08/12	349	0	349	0	3,540	462	5,303	2,947	12,601
08/13	0	0	0	0	2,339	210	4,779	3,717	11,045
08/14	0	0	0	0	3,335	361	5,245	1,168	10,109
08/15	0	0	0	0	27,852	81	2,561	2,374	32,868
08/16	0	0	0	0	50,463	143	5,133	4,600	60,339
08/17	0	0	0	0	23,045	0	5,100	4,609	32,754
08/18	0	0	0	0	7,771	0	6,649	9,303	23,723
08/19	0	0	0	0	6,983	1,447	7,073	3,472	18,975
08/20	0	0	0	0	10,149	0	5,043	5,934	21,126
08/21	0	0	0	0	25,347	0	5,047	2,159	32,553
08/22	0	0	0	0	8,348	110	6,024	4,752	19,234
08/23	0	0	0	0	4,717	0	8,803	3,437	16,957
08/24	0	0	0	0	5,480	0	1,695	9,845	17,020
08/25	0	0	0	0	8,479	0	5,739	7,702	21,920
08/26	0	0	0	0	7,334	0	5,067	6,487	18,888
08/27	0	0	0	0	10,655	295	5,419	8,964	25,333
08/28	0	0	0	0	22,298	0	2,479	4,307	29,084
08/29	0	0	0	0	42,162	0	4,448	7,451	54,061
08/30	0	0	0	0	24,792	0	5,073	5,552	35,417
08/31	0	0	0	0	5,532	0	5,158	9,155	19,845
09/01	0	0	0	0	2,896	0	3,169	4,192	10,257
09/02	0	0	0	0	2,926	232	2,607	1,424	7,189
09/03	0	0	0	0	787	0	2,923	5,456	9,166
09/04	0	0	0	0	597	0	2,238	3,867	6,702
09/05	0	0	0	0	2,277	0	2,434	4,354	9,065
09/06	187	0	187	0	278	0	443	11,141	12,049
09/07	0	0	0	0	2,923	0	2,277	8,991	14,191
Total	106,708	23,935	130,643	1,665,667	615,127	558,050	135,570	585,303	3,690,360

[a] Chinook salmon > 655 mm.

[b] Chinook salmon < 655 mm.

APPENDIX E: PILOT STATION SONAR FISH PASSAGE ESTIMATES BY SPECIES, 1998–2008

Appendix E1.–Pilot Station sonar project total fish passage estimates by species, 1998–2008.

Species	2008	2007	2006	2005[a]	2004	2003	2002	2001[b]	2000	1999	1998
Lg. Chinook[c]	106,708	90,184	145,553	142,007	110,236	245,037	92,584	85,511	39,233	127,809	71,177
Sm. Chinook	23,935	35,369	23,850	17,434	46,370	23,500	30,629	13,892	5,195	16,914	16,675
Chinook Total	130,643	125,553	169,403	159,441	156,606	268,537	123,213	99,403	44,428	144,723	87,852
Summer Chum	1,665,667	1,726,885	3,767,044	2,439,616	1,357,826	1,168,518	1,088,463	441,450	456,271	973,708	826,385
Fall Chum[d]	615,127	684,011	790,563	1,813,589	594,060	889,778	326,858	376,182	247,935	379,493	372,927
Chum Total	2,280,794	2,410,896	4,557,607	4,253,205	1,951,886	2,058,296	1,415,321	817,632	704,206	1,353,201	1,199,312
Coho[d]	135,570	173,289	131,919	184,718	188,350	269,081	122,566	137,769	175,421	62,521	136,906
Pink	558,050	71,699	115,624	37,932	243,375	4,656	64,891	665	35,501	1,801	66,751
Other Species[e]	585,303	1,085,316	875,899	593,248	637,257	502,878	557,779	353,431	361,222	465,515	277,566
Season Total	3,690,360	3,866,753	5,850,452	5,228,544	3,177,474	3,103,448	2,283,770	1,408,900	1,320,778	2,027,761	1,768,387

Note: Estimates for all years were generated with the most current apportionment model and may differ from earlier estimates.

[a] Estimates include extrapolations for the dates June 10 to June 18, 2005 to account for the time before the DIDSON was deployed.

[b] High water levels were experienced at Pilot Station in 2001, and therefore passage estimates are considered conservative.

[c] Chinook salmon >655 mm.

[d] This estimate may not include the entire run, however in 2008, operations were extended to September 7, instead of the usual end date of August 31.

[e] Includes sockeye salmon, cisco, whitefish, sheefish, burbot, suckers, Dolly Varden, and northern pike.

APPENDIX F: DIDSON GENERATED COMPONENT AND PROPORTIONS OF THE LEFT BANK NEARSHORE DAILY FISH PASSAGE ESTIMATES

Appendix F1.–DIDSON generated component of the left bank nearshore daily fish passage estimates at the Pilot Station sonar site, on the Yukon River 2008.

Date	Large Chinook[a]	Small Chinook[b]	All Chinook	Chum Summer	Chum Fall	Pink	Coho	Other	Total
06/01	0	0	0	0	0	0	0	0	0
06/02	0	0	0	0	0	0	0	0	0
06/03	0	0	0	0	0	0	0	0	0
06/04	0	0	0	0	0	0	0	0	0
06/05	0	0	0	0	0	0	0	437	437
06/06	0	0	0	0	0	0	0	347	347
06/07	115	0	115	0	0	0	0	185	300
06/08	45	0	45	0	0	0	0	144	188
06/09	6	0	6	4	0	0	0	390	400
06/10	38	0	38	56	0	0	0	92	185
06/11	314	60	373	759	0	0	0	0	1,133
06/12	105	42	147	2,013	0	0	0	0	2,161
06/13	98	0	98	2,168	0	0	0	331	2,597
06/14	26	23	50	807	0	0	0	492	1,349
06/15	230	27	256	1,076	0	0	0	427	1,760
06/16	65	24	89	1,043	0	0	0	196	1,328
06/17	31	46	77	2,372	0	0	0	476	2,925
06/18	1,013	49	1,062	3,895	0	0	0	437	5,393
06/19	537	113	649	11,156	0	0	0	412	12,217
06/20	650	0	650	5,962	0	0	0	0	6,612
06/21	695	163	858	7,032	0	0	0	348	8,238
06/22	476	158	634	6,522	0	0	0	0	7,156
06/23	127	200	327	6,189	0	0	0	258	6,774
06/24	559	351	910	11,676	0	0	0	0	12,586
06/25	1,809	224	2,034	14,604	0	0	0	0	16,638
06/26	861	446	1,307	21,899	0	420	0	625	24,251
06/27	3,570	783	4,353	31,577	0	0	0	303	36,234
06/28	2,764	0	2,764	32,421	0	497	0	221	35,903
06/29	954	542	1,496	60,519	0	1,364	0	3,917	67,296
06/30	2,946	1,226	4,172	26,406	0	39,505	0	16,551	86,633
07/01	3,967	1,651	5,618	35,557	0	53,196	0	22,286	116,657
07/02	3,463	1,441	4,904	31,039	0	46,438	0	19,455	101,836
07/03	3,950	1,644	5,593	35,404	0	52,968	0	22,191	116,157
07/04	2,553	1,062	3,615	22,880	0	34,231	0	14,341	75,066
07/05	406	169	575	3,640	0	5,446	0	2,281	11,942
07/06	357	148	505	3,198	0	4,784	0	2,004	10,492
07/07	260	0	260	5,639	0	231	0	5,528	11,658
07/08	238	0	238	13,625	0	405	0	1,038	15,306
07/09	514	190	704	13,632	0	1,128	0	2,668	18,131
07/10	371	137	509	9,853	0	815	0	1,929	13,105
07/11	417	0	417	15,500	0	925	0	9,934	26,775
07/12	151	218	370	32,602	0	2,588	0	0	35,559
07/13	0	0	0	16,383	0	1,836	0	0	18,219
07/14	315	0	315	6,436	0	540	0	6,924	14,215
07/15	131	307	438	4,339	0	1,442	0	2,209	8,428
07/16	0	0	0	2,701	0	5,195	0	5,885	13,780

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Appendix F1.–Page 2 of 3.

Date	Large Chinook[a]	Small Chinook[b]	All Chinook	Chum Summer	Chum Fall	Pink	Coho	Other	Total
07/17	0	0	0	1,572	0	3,024	0	3,426	8,022
07/18	0	0	0	1,488	0	1,664	0	903	4,056
07/19	76	0	76	0	948	2,089	0	3,952	7,063
07/20	0	0	0	0	2,280	2,142	0	307	4,729
07/21	0	0	0	0	2,974	2,794	0	400	6,167
07/22	363	0	363	0	1,029	1,232	0	2,086	4,711
07/23	0	0	0	0	1,271	675	0	549	2,496
07/24	0	0	0	0	1,998	1,060	0	863	3,922
07/25	0	0	0	0	4,035	6,804	0	0	10,838
07/26	0	0	0	0	2,324	862	0	2,686	5,872
07/27	0	0	0	0	228	1,131	37	2,890	4,285
07/28	0	0	0	0	920	1,917	0	1,191	4,027
07/29	0	0	0	0	1,172	2,442	0	1,518	5,132
07/30	0	0	0	0	3,409	443	112	2,103	6,067
07/31	0	0	0	0	2,318	301	76	1,430	4,126
08/01	0	0	0	0	5,801	954	0	123	6,878
08/02	0	0	0	0	2,670	834	0	592	4,096
08/03	0	0	0	0	576	133	85	288	1,083
08/04	0	0	0	0	2,520	235	177	834	3,766
08/05	0	0	0	0	1,830	174	335	1,102	3,440
08/06	0	0	0	0	2,081	93	80	345	2,600
08/07	0	0	0	0	1,648	0	356	866	2,870
08/08	0	0	0	0	2,420	117	249	117	2,904
08/09	0	0	0	0	279	81	141	622	1,123
08/10	0	0	0	0	2,029	0	141	1,060	3,229
08/11	0	0	0	0	2,238	164	765	471	3,638
08/12	71	0	71	0	455	76	581	451	1,633
08/13	0	0	0	0	321	0	917	895	2,132
08/14	0	0	0	0	1,190	141	1,353	159	2,844
08/15	0	0	0	0	5,968	0	495	380	6,842
08/16	0	0	0	0	10,486	0	826	1,275	12,587
08/17	0	0	0	0	5,294	0	892	906	7,091
08/18	0	0	0	0	2,282	0	2,265	4,431	8,977
08/19	0	0	0	0	3,924	1,074	3,036	585	8,619
08/20	0	0	0	0	4,281	0	1,817	2,493	8,590
08/21	0	0	0	0	7,332	0	1,209	204	8,745
08/22	0	0	0	0	2,591	0	1,495	2,758	6,844
08/23	0	0	0	0	1,973	0	3,365	1,281	6,619
08/24	0	0	0	0	476	0	160	3,164	3,801
08/25	0	0	0	0	1,364	0	709	2,464	4,537
08/26	0	0	0	0	800	0	416	1,446	2,662
08/27	0	0	0	0	1,336	0	1,050	1,939	4,326
08/28	0	0	0	0	2,656	0	218	517	3,391
08/29	0	0	0	0	6,016	0	494	1,171	7,682
08/30	0	0	0	0	2,197	0	356	1,216	3,768
08/31	0	0	0	0	503	0	231	2,632	3,366

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Date	Large Chinook	Small Chinook	All Chinook	Chum Summer	Chum Fall	Pink	Coho	Other	Total
9/01	0	0	0	0	317	0	145	1,659	2,122
9/02	0	0	0	0	382	98	530	373	1,383
9/03	0	0	0	0	38	0	109	874	1,021
9/04	0	0	0	0	23	0	64	518	605
9/05	0	0	0	0	134	0	273	844	1,252
9/06	0	0	0	0	0	0	68	3,490	3,558
9/07	0	0	0	0	0	0	62	3,192	3,254
Total	35,637	11,444	47,081	505,644	111,337	286,708	25,690	217,303	1,193,758

[a] Chinook salmon > 655 mm.

[b] Chinook salmon < 655 mm.

Appendix F2.–Proportions by species, of daily total passage (both banks combined) for sectors 1 and 2 of Strata 3 of the left bank nearshore region generated by the DIDSON, at the Pilot Station sonar project on the Yukon River, 2008.

Date	Large Chinook [a]	Small Chinook [b]	All Chinook	S. Chum	F. Chum	Pink	Coho	Other	Daily Total
06/01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06/02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06/03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06/04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06/05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.08
06/06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.07
06/07	0.12	0.00	0.12	0.00	0.00	0.00	0.00	0.07	0.08
06/08	0.05	0.00	0.05	0.00	0.00	0.00	0.00	0.03	0.04
06/09	0.04	0.00	0.04	0.03	0.00	0.00	0.00	0.08	0.08
06/10	0.04	0.00	0.04	0.04	0.00	0.00	0.00	0.04	0.04
06/11	0.22	0.20	0.22	0.23	0.00	0.00	0.00	0.00	0.19
06/12	0.36	0.25	0.32	0.47	0.00	0.00	0.00	0.00	0.42
06/13	0.18	0.00	0.16	0.48	0.00	0.00	0.00	0.25	0.40
06/14	0.06	0.14	0.08	0.14	0.00	0.00	0.00	0.29	0.16
06/15	0.12	0.09	0.12	0.16	0.00	0.00	0.00	0.15	0.15
06/16	0.05	0.20	0.07	0.06	0.00	0.00	0.00	0.13	0.07
06/17	0.04	0.07	0.05	0.14	0.00	0.00	0.00	0.05	0.10
06/18	0.18	0.12	0.17	0.11	0.00	0.00	0.00	0.20	0.12
06/19	0.21	0.12	0.19	0.21	0.00	0.00	0.00	0.14	0.20
06/20	0.29	0.00	0.25	0.19	0.00	0.00	0.00	0.00	0.20
06/21	0.31	0.26	0.30	0.23	0.00	0.00	0.00	0.23	0.23
06/22	0.17	0.15	0.16	0.21	0.00	0.00	0.00	0.00	0.19
06/23	0.08	0.30	0.14	0.19	0.00	0.00	0.00	0.16	0.18
06/24	0.17	0.51	0.23	0.26	0.00	0.00	0.00	0.00	0.25
06/25	0.42	0.39	0.42	0.30	0.00	0.00	0.00	0.00	0.30
06/26	0.20	0.66	0.27	0.33	0.00	0.24	0.00	0.66	0.33
06/27	0.50	0.48	0.50	0.41	0.00	0.00	0.00	0.25	0.41
06/28	0.40	0.00	0.40	0.38	0.00	0.21	0.00	0.70	0.37
06/29	0.24	0.60	0.31	0.38	0.00	0.32	0.00	0.65	0.39
06/30	0.39	0.56	0.43	0.23	0.00	0.65	0.00	0.69	0.41
07/01	0.55	0.62	0.57	0.42	0.00	0.81	0.00	0.65	0.60
07/02	0.59	0.59	0.59	0.50	0.00	0.85	0.00	0.76	0.68
07/03	0.55	0.78	0.60	0.53	0.00	0.82	0.00	0.76	0.69
07/04	0.63	0.74	0.66	0.47	0.00	0.77	0.00	0.67	0.63
07/05	0.36	0.58	0.40	0.22	0.00	0.36	0.00	0.34	0.30
07/06	0.26	0.54	0.31	0.14	0.00	0.28	0.00	0.25	0.21
07/07	0.17	0.00	0.17	0.17	0.00	0.03	0.00	0.31	0.20
07/08	0.12	0.00	0.12	0.17	0.00	0.03	0.00	0.16	0.15
07/09	0.14	0.28	0.17	0.19	0.00	0.12	0.00	0.28	0.19
07/10	0.17	0.34	0.20	0.23	0.00	0.14	0.00	0.34	0.23
07/11	0.49	0.00	0.49	0.27	0.00	0.10	0.00	0.56	0.32
07/12	0.25	0.55	0.37	0.37	0.00	0.21	0.00	0.00	0.32
07/13	0.00	0.00	0.00	0.30	0.00	0.15	0.00	0.00	0.26
07/14	0.18	0.00	0.18	0.28	0.00	0.12	0.00	0.53	0.33
07/15	0.12	0.41	0.24	0.24	0.00	0.26	0.00	0.33	0.26
07/16	0.00	0.00	0.00	0.23	0.00	0.38	0.00	0.48	0.36

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Date	Large Chinook[a]	Small Chinook[b]	All Chinook	S. Chum	F. Chum	Pink	Coho	Other	Daily Total
07/17	0.00	0.00	0.00	0.19	0.00	0.29	0.00	0.44	0.31
07/18	0.00	0.00	0.00	0.16	0.00	0.16	0.00	0.22	0.17
07/19	0.45	0.00	0.45	0.00	0.14	0.24	0.00	0.40	0.28
07/20	0.00	0.00	0.00	0.00	0.33	0.26	0.00	0.15	0.27
07/21	0.00	0.00	0.00	0.00	0.36	0.27	0.00	0.24	0.31
07/22	0.50	0.00	0.00	0.00	0.12	0.12	0.00	1.25	0.23
07/23	0.00	0.00	0.00	0.00	0.30	0.15	0.00	0.12	0.18
07/24	0.00	0.00	0.00	0.00	0.28	0.22	0.00	0.37	0.27
07/25	0.00	0.00	0.00	0.00	0.28	1.06	0.00	0.00	0.45
07/26	0.00	0.00	0.00	0.00	0.17	0.06	0.00	6.08	0.21
07/27	0.00	0.00	0.00	0.00	0.03	0.33	0.00	0.41	0.23
07/28	0.00	0.00	0.00	0.00	0.39	0.32	0.00	0.12	0.22
07/29	0.00	0.00	0.00	0.00	0.20	0.38	0.00	0.33	0.30
07/30	0.00	0.00	0.00	0.00	0.28	0.05	0.00	0.35	0.22
07/31	0.00	0.00	0.00	0.00	0.11	0.11	0.24	0.17	0.12
08/01	0.00	0.00	0.00	0.00	0.44	0.58	0.00	0.02	0.34
08/02	0.00	0.00	0.00	0.00	0.07	0.27	0.00	1.52	0.10
08/03	0.00	0.00	0.00	0.00	0.02	0.03	0.38	0.07	0.03
08/04	0.00	0.00	0.00	0.00	0.12	0.10	0.13	0.15	0.13
08/05	0.00	0.00	0.00	0.00	0.08	0.09	0.24	0.19	0.11
08/06	0.00	0.00	0.00	0.00	0.15	0.15	0.04	0.06	0.12
08/07	0.00	0.00	0.00	0.00	0.11	0.00	0.35	0.33	0.15
08/08	0.00	0.00	0.00	0.00	0.34	0.13	0.14	0.04	0.22
08/09	0.00	0.00	0.00	0.00	0.02	0.14	0.07	0.33	0.07
08/10	0.00	0.00	0.00	0.00	0.37	0.00	0.12	0.22	0.27
08/11	0.00	0.00	0.00	0.00	0.26	1.91	0.41	0.15	0.26
08/12	0.00	0.00	0.00	0.00	0.05	0.09	0.17	0.20	0.11
08/13	0.00	0.00	0.00	0.00	0.09	0.00	0.17	0.30	0.17
08/14	0.00	0.00	0.00	0.00	0.51	0.67	0.28	0.04	0.26
08/15	0.00	0.00	0.00	0.00	1.79	0.00	0.09	0.33	0.68
08/16	0.00	0.00	0.00	0.00	0.38	0.00	0.32	0.54	0.38
08/17	0.00	0.00	0.00	0.00	0.10	0.00	0.17	0.20	0.12
08/18	0.00	0.00	0.00	0.00	0.10	0.00	0.44	0.96	0.27
08/19	0.00	0.00	0.00	0.00	0.50	0.00	0.46	0.06	0.36
08/20	0.00	0.00	0.00	0.00	0.61	0.00	0.26	0.72	0.45
08/21	0.00	0.00	0.00	0.00	0.72	0.00	0.24	0.03	0.41
08/22	0.00	0.00	0.00	0.00	0.10	0.00	0.30	1.28	0.21
08/23	0.00	0.00	0.00	0.00	0.24	0.00	0.56	0.27	0.34
08/24	0.00	0.00	0.00	0.00	0.10	0.00	0.02	0.92	0.22
08/25	0.00	0.00	0.00	0.00	0.25	0.00	0.42	0.25	0.27
08/26	0.00	0.00	0.00	0.00	0.09	0.00	0.07	0.19	0.12
08/27	0.00	0.00	0.00	0.00	0.18	0.00	0.21	0.30	0.23
08/28	0.00	0.00	0.00	0.00	0.25	0.00	0.04	0.06	0.13
08/29	0.00	0.00	0.00	0.00	0.27	0.00	0.20	0.27	0.26
08/30	0.00	0.00	0.00	0.00	0.05	0.00	0.08	0.16	0.07
08/31	0.00	0.00	0.00	0.00	0.02	0.00	0.05	0.47	0.10

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Appendix F2.–Page 3 of 3.

Date	Large Chinook[a]	Small Chinook[b]	All Chinook	S. Chum	F. Chum	Pink	Coho	Other	Daily Total
09/01	0.00	0.00	0.00	0.00	0.06	0.00	0.03	0.18	0.11
09/02	0.00	0.00	0.00	0.00	0.13	0.00	0.17	0.09	0.13
09/03	0.00	0.00	0.00	0.00	0.01	0.00	0.04	0.61	0.14
09/04	0.00	0.00	0.00	0.00	0.03	0.00	0.02	0.09	0.07
09/05	0.00	0.00	0.00	0.00	0.22	0.00	0.12	0.22	0.19
09/06	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.80	0.39
09/07	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.29	0.27
Season Total	0.334	0.478	0.360	0.304	0.181	0.514	0.189	0.371	0.323

[a] Chinook salmon > 655 mm.

[b] Chinook salmon < 655 mm.

APPENDIX G: DAILY CUMULATIVE FISH PASSAGE ESTIMATES, PROPORTIONS, AND TIMING BY SPECIES

Appendix G1.–Daily cumulative fish passage estimates by species, at the Pilot Station sonar project on the Yukon River, 2008.

Date	Large Chinook	Small Chinook	Total Chinook	Summer Chum	Fall Chum	Pink	Coho	Other	All Species Total
06/01	0	0	0	0	0	0	0	1,153	1,153
06/02	0	0	0	0	0	0	0	3,359	3,359
06/03	0	0	0	0	0	0	0	5,706	5,706
06/04	0	0	0	0	0	0	0	8,007	8,007
06/05	0	0	0	0	0	0	0	13,226	13,226
06/06	0	0	0	0	0	0	0	18,044	18,044
06/07	929	0	929	0	0	0	0	20,884	21,813
06/08	1,871	0	1,871	0	0	0	0	25,146	27,017
06/09	2,018	0	2,018	117	0	0	0	30,157	32,292
06/10	2,887	66	2,953	1,386	0	0	0	32,692	37,031
06/11	4,289	359	4,648	4,705	0	0	0	33,600	42,953
06/12	4,577	526	5,103	9,027	0	0	0	33,957	48,087
06/13	5,122	583	5,705	13,517	0	0	0	35,300	54,522
06/14	5,570	743	6,313	19,422	0	0	0	37,008	62,743
06/15	7,436	1,035	8,471	26,026	0	0	0	39,896	74,393
06/16	8,631	1,157	9,788	42,212	0	0	0	41,450	93,450
06/17	9,367	1,828	11,195	59,707	0	0	0	51,121	122,023
06/18	15,139	2,245	17,384	95,598	0	0	0	53,323	166,305
06/19	17,694	3,161	20,855	148,592	0	1,750	0	56,333	227,530
06/20	19,930	3,482	23,412	179,311	0	1,750	0	56,440	260,913
06/21	22,165	4,111	26,276	210,264	0	1,750	0	57,928	296,218
06/22	25,043	5,189	30,232	241,518	0	1,750	0	59,600	333,100
06/23	26,699	5,855	32,554	274,926	0	2,184	0	61,214	370,878
06/24	29,954	6,541	36,495	320,149	0	2,767	0	61,214	420,625
06/25	34,255	7,111	41,366	368,759	0	3,736	0	61,366	475,227
06/26	38,466	7,791	46,257	434,200	0	5,451	0	62,319	548,227
06/27	45,544	9,406	54,950	511,664	0	7,324	0	63,538	637,476
06/28	52,435	9,406	61,841	597,860	0	9,727	0	63,855	733,283
06/29	56,354	10,314	66,668	755,821	0	13,933	0	69,840	906,262
06/30	63,991	12,487	76,478	871,258	0	74,704	0	93,739	1,116,179
07/01	71,260	15,145	86,405	956,175	0	140,261	0	127,978	1,310,819
07/02	77,162	17,588	94,750	1,018,215	0	194,911	0	153,736	1,461,612
07/03	84,362	19,701	104,063	1,084,479	0	259,139	0	182,984	1,630,665
07/04	88,439	21,142	109,581	1,133,037	0	303,336	0	204,539	1,750,493
07/05	89,580	21,435	111,015	1,149,614	0	318,419	0	211,303	1,790,351
07/06	90,947	21,709	112,656	1,171,676	0	335,691	0	219,327	1,839,350
07/07	92,491	21,709	114,200	1,204,362	0	342,874	0	237,323	1,898,759
07/08	94,525	21,709	116,234	1,283,302	0	356,722	0	244,006	2,000,264
07/09	98,074	22,379	120,453	1,353,825	0	366,317	0	253,430	2,094,025
07/10	100,196	22,778	122,974	1,396,127	0	372,325	0	259,023	2,150,449
07/11	101,046	22,778	123,824	1,452,954	0	381,745	0	276,813	2,235,336
07/12	101,654	23,178	124,832	1,540,295	0	394,124	0	286,956	2,346,207
07/13	101,925	23,178	125,103	1,594,973	0	406,620	0	289,080	2,415,776
07/14	103,661	23,178	126,839	1,618,020	0	411,204	0	302,231	2,458,294
07/15	104,755	23,935	128,690	1,636,164	0	416,813	0	308,990	2,490,657
07/16	104,784	23,935	128,719	1,648,142	0	430,606	0	321,197	2,528,664
07/17	104,832	23,935	128,767	1,656,220	0	440,979	0	328,954	2,554,920
07/18	105,074	23,935	129,009	1,665,667	0	451,645	0	333,102	2,579,423
07/19	105,242	23,935	129,177	1,665,667	6,849	460,273	26	342,872	2,604,864

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Appendix G1.-Page 2 of 2.

Date	Large Chinook	Small Chinook	Total Chinook	Summer Chum	Fall Chum	Pink	Coho	Other	All Species Total
07/20	105,242	23,935	129,177	1,665,667	13,817	468,584	39	344,865	2,622,149
07/21	105,242	23,935	129,177	1,665,667	22,087	478,854	39	346,533	2,642,357
07/22	105,963	23,935	129,898	1,665,667	26,336	483,454	39	351,185	2,656,579
07/23	105,963	23,935	129,898	1,665,667	33,535	488,323	39	353,538	2,671,000
07/24	105,963	23,935	129,898	1,665,667	47,943	494,723	39	356,957	2,695,227
07/25	106,008	23,935	129,943	1,665,667	61,653	508,686	39	357,399	2,723,387
07/26	106,008	23,935	129,943	1,665,667	69,507	512,098	39	364,474	2,741,728
07/27	106,008	23,935	129,943	1,665,667	71,871	518,059	162	374,449	2,760,151
07/28	106,008	23,935	129,943	1,665,667	77,748	524,555	190	379,021	2,777,124
07/29	106,008	23,935	129,943	1,665,667	89,882	534,244	190	384,999	2,804,925
07/30	106,008	23,935	129,943	1,665,667	111,251	537,074	502	393,542	2,837,979
07/31	106,008	23,935	129,943	1,665,667	124,558	538,711	779	398,499	2,858,157
08/01	106,008	23,935	129,943	1,665,667	161,743	541,780	1,333	398,888	2,899,354
08/02	106,172	23,935	130,107	1,665,667	188,414	546,030	1,558	403,137	2,934,913
08/03	106,172	23,935	130,107	1,665,667	208,789	548,464	2,932	408,568	2,964,527
08/04	106,172	23,935	130,107	1,665,667	230,998	550,394	4,345	414,414	2,995,925
08/05	106,172	23,935	130,107	1,665,667	245,133	551,016	6,352	419,981	3,018,256
08/06	106,172	23,935	130,107	1,665,667	259,528	551,787	7,366	422,599	3,037,054
08/07	106,172	23,935	130,107	1,665,667	266,656	552,693	9,106	425,754	3,049,983
08/08	106,172	23,935	130,107	1,665,667	278,879	553,280	11,133	427,623	3,066,689
08/09	106,172	23,935	130,107	1,665,667	284,303	553,804	12,303	432,513	3,078,697
08/10	106,172	23,935	130,107	1,665,667	292,983	553,890	14,164	435,638	3,092,449
08/11	106,172	23,935	130,107	1,665,667	301,822	554,709	17,641	437,943	3,107,889
08/12	106,521	23,935	130,456	1,665,667	305,362	555,171	22,944	440,890	3,120,490
08/13	106,521	23,935	130,456	1,665,667	307,701	555,381	27,723	444,607	3,131,535
08/14	106,521	23,935	130,456	1,665,667	311,036	555,742	32,968	445,775	3,141,644
08/15	106,521	23,935	130,456	1,665,667	338,888	555,823	35,529	448,149	3,174,512
08/16	106,521	23,935	130,456	1,665,667	389,351	555,966	40,662	452,749	3,234,851
08/17	106,521	23,935	130,456	1,665,667	412,396	555,966	45,762	457,358	3,267,605
08/18	106,521	23,935	130,456	1,665,667	420,167	555,966	52,411	466,661	3,291,328
08/19	106,521	23,935	130,456	1,665,667	427,150	557,413	59,484	470,133	3,310,303
08/20	106,521	23,935	130,456	1,665,667	437,299	557,413	64,527	476,067	3,331,429
08/21	106,521	23,935	130,456	1,665,667	462,646	557,413	69,574	478,226	3,363,982
08/22	106,521	23,935	130,456	1,665,667	470,994	557,523	75,598	482,978	3,383,216
08/23	106,521	23,935	130,456	1,665,667	475,711	557,523	84,401	486,415	3,400,173
08/24	106,521	23,935	130,456	1,665,667	481,191	557,523	86,096	496,260	3,417,193
08/25	106,521	23,935	130,456	1,665,667	489,670	557,523	91,835	503,962	3,439,113
08/26	106,521	23,935	130,456	1,665,667	497,004	557,523	96,902	510,449	3,458,001
08/27	106,521	23,935	130,456	1,665,667	507,659	557,818	102,321	519,413	3,483,334
08/28	106,521	23,935	130,456	1,665,667	529,957	557,818	104,800	523,720	3,512,418
08/29	106,521	23,935	130,456	1,665,667	572,119	557,818	109,248	531,171	3,566,479
08/30	106,521	23,935	130,456	1,665,667	596,911	557,818	114,321	536,723	3,601,896
08/31	106,521	23,935	130,456	1,665,667	602,443	557,818	119,479	545,878	3,621,741
09/01	106,521	23,935	130,456	1,665,667	605,339	557,818	122,648	550,070	3,631,998
09/02	106,521	23,935	130,456	1,665,667	608,265	558,050	125,255	551,494	3,639,187
09/03	106,521	23,935	130,456	1,665,667	609,052	558,050	128,178	556,950	3,648,353
09/04	106,521	23,935	130,456	1,665,667	609,649	558,050	130,416	560,817	3,655,055
09/05	106,521	23,935	130,456	1,665,667	611,926	558,050	132,850	565,171	3,664,120
09/06	106,708	23,935	130,643	1,665,667	612,204	558,050	133,293	576,312	3,676,169
09/07	106,708	23,935	130,643	1,665,667	615,127	558,050	135,570	585,303	3,690,360

Appendix G2.–Daily cumulative fish passage proportions and timing by species, at the Pilot Station sonar project on the Yukon River, 2008.

Date	Large Chinook	Small Chinook	Total Chinook	Summer Chum	Fall Chum	Pink	Coho	Other	All Species Total
06/01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1,153
06/02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	3,359
06/03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	5,706
06/04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	8,007
06/05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	13,226
06/06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	18,044
06/07	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.04	21,813
06/08	0.02	0.00	0.01	0.00	0.00	0.00	0.00	0.04	27,017
06/09	0.02	0.00	0.02	0.00	0.00	0.00	0.00	0.05	32,292
06/10	0.03	0.00	0.02	0.00	0.00	0.00	0.00	0.06	37,031
06/11	0.04	0.01	0.04	0.00	0.00	0.00	0.00	0.06	42,953
06/12	0.04	0.02	0.04	0.01	0.00	0.00	0.00	0.06	48,087
06/13	0.05	0.02	0.04	0.01	0.00	0.00	0.00	0.06	54,522
06/14	0.05	0.03	0.05	0.01	0.00	0.00	0.00	0.06	62,743
06/15	0.07	0.04	0.06	0.02	0.00	0.00	0.00	0.07	74,393
06/16	0.08	0.05	0.07	0.03	0.00	0.00	0.00	0.07	93,450
06/17	0.09	0.08	0.09	0.04	0.00	0.00	0.00	0.09	122,023
06/18	0.14	0.09	0.13	0.06	0.00	0.00	0.00	0.09	166,305
06/19	0.17	0.13	0.16	0.09	0.00	0.00	0.00	0.10	227,530
06/20	0.19	0.15	0.18	0.11	0.00	0.00	0.00	0.10	260,913
06/21	0.21	0.17	0.20	0.13	0.00	0.00	0.00	0.10	296,218
06/22	0.23	0.22	0.23	0.14	0.00	0.00	0.00	0.10	333,100
06/23	**0.25**	0.24	**0.25**	0.17	0.00	0.00	0.00	0.10	370,878
06/24	0.28	**0.27**	0.28	0.19	0.00	0.00	0.00	0.10	420,625
06/25	0.32	0.30	0.32	0.22	0.00	0.01	0.00	0.10	475,227
06/26	0.36	0.33	0.35	**0.26**	0.00	0.01	0.00	0.11	548,227
06/27	0.43	0.39	0.42	0.31	0.00	0.01	0.00	0.11	637,476
06/28	0.49	0.39	0.47	0.36	0.00	0.02	0.00	0.11	733,283
06/29	**0.53**	0.43	**0.51**	0.45	0.00	0.02	0.00	0.12	906,262
06/30	0.60	**0.52**	0.59	**0.52**	0.00	0.13	0.00	0.16	1,116,179
07/01	0.67	0.63	0.66	0.57	0.00	**0.25**	0.00	0.22	1,310,819
07/02	0.72	0.73	0.73	0.61	0.00	0.35	0.00	**0.26**	1,461,612
07/03	**0.79**	**0.82**	**0.80**	0.65	0.00	0.46	0.00	0.31	1,630,665
07/04	0.83	0.88	0.84	0.68	0.00	**0.54**	0.00	0.35	1,750,493
07/05	0.84	0.90	0.85	0.69	0.00	0.57	0.00	0.36	1,790,351
07/06	0.85	0.91	0.86	0.70	0.00	0.60	0.00	0.37	1,839,350
07/07	0.87	0.91	0.87	0.72	0.00	0.61	0.00	0.41	1,898,759
07/08	0.89	0.91	0.89	**0.77**	0.00	0.64	0.00	0.42	2,000,264
07/09	0.92	0.93	0.92	0.81	0.00	0.66	0.00	0.43	2,094,025
07/10	0.94	0.95	0.94	0.84	0.00	0.67	0.00	0.44	2,150,449
07/11	0.95	0.95	0.95	0.87	0.00	0.68	0.00	0.47	2,235,336
07/12	0.95	0.97	0.96	0.92	0.00	0.71	0.00	0.49	2,346,207
07/13	0.96	0.97	0.96	0.96	0.00	0.73	0.00	0.49	2,415,776
07/14	0.97	0.97	0.97	0.97	0.00	0.74	0.00	**0.52**	2,458,294
07/15	0.98	1.00	0.99	0.98	0.00	**0.75**	0.00	0.53	2,490,657
07/16	0.98	1.00	0.99	0.99	0.00	0.77	0.00	0.55	2,528,664
07/17	0.98	1.00	0.99	0.99	0.00	0.79	0.00	0.56	2,554,920
07/18	0.98	1.00	0.99	1.00	0.0	0.81	0.00	0.57	2,579,423

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Date	Large Chinook	Small Chinook	Total Chinook	Summer Chum	Fall Chum	Pink	Coho	Other	All Species Total
07/19	0.99	1.00	0.99	1.00	0.01	0.82	0.00	0.59	2,604,864
07/20	0.99	1.00	0.99	1.00	0.02	0.84	0.00	0.59	2,622,149
07/21	0.99	1.00	0.99	1.00	0.04	0.86	0.00	0.59	2,642,357
07/22	0.99	1.00	0.99	1.00	0.04	0.87	0.00	0.60	2,656,579
07/23	0.99	1.00	0.99	1.00	0.05	0.88	0.00	0.60	2,671,000
07/24	0.99	1.00	0.99	1.00	0.08	0.89	0.00	0.61	2,695,227
07/25	0.99	1.00	0.99	1.00	0.10	0.91	0.00	0.61	2,723,387
07/26	0.99	1.00	0.99	1.00	0.11	0.92	0.00	0.62	2,741,728
07/27	0.99	1.00	0.99	1.00	0.12	0.93	0.00	0.64	2,760,151
07/28	0.99	1.00	0.99	1.00	0.13	0.94	0.00	0.65	2,777,124
07/29	0.99	1.00	0.99	1.00	0.15	0.96	0.00	0.66	2,804,925
07/30	0.99	1.00	0.99	1.00	0.18	0.96	0.00	0.67	2,837,979
07/31	0.99	1.00	0.99	1.00	0.20	0.97	0.01	0.68	2,858,157
08/01	0.99	1.00	0.99	1.00	**0.26**	0.97	0.01	0.68	2,899,354
08/02	0.99	1.00	1.00	1.00	0.31	0.98	0.01	0.69	2,934,913
08/03	0.99	1.00	1.00	1.00	0.34	0.98	0.02	0.70	2,964,527
08/04	0.99	1.00	1.00	1.00	0.38	0.99	0.03	0.71	2,995,925
08/05	0.99	1.00	1.00	1.00	0.40	0.99	0.05	0.72	3,018,256
08/06	0.99	1.00	1.00	1.00	0.42	0.99	0.05	0.72	3,037,054
08/07	0.99	1.00	1.00	1.00	0.43	0.99	0.07	0.73	3,049,983
08/08	0.99	1.00	1.00	1.00	0.45	0.99	0.08	0.73	3,066,689
08/09	0.99	1.00	1.00	1.00	0.46	0.99	0.09	0.74	3,078,697
08/10	0.99	1.00	1.00	1.00	0.48	0.99	0.10	0.74	3,092,449
08/11	0.99	1.00	1.00	1.00	0.49	0.99	0.13	0.75	3,107,889
08/12	1.00	1.00	1.00	1.00	**0.50**	0.99	0.17	**0.75**	3,120,490
08/13	1.00	1.00	1.00	1.00	0.50	1.00	0.20	0.76	3,131,535
08/14	1.00	1.00	1.00	1.00	0.51	1.00	0.24	0.76	3,141,644
08/15	1.00	1.00	1.00	1.00	0.55	1.00	**0.26**	0.77	3,174,512
08/16	1.00	1.00	1.00	1.00	0.63	1.00	0.30	0.77	3,234,851
08/17	1.00	1.00	1.00	1.00	0.67	1.00	0.34	0.78	3,267,605
08/18	1.00	1.00	1.00	1.00	0.68	1.00	0.39	0.80	3,291,328
08/19	1.00	1.00	1.00	1.00	0.69	1.00	0.44	0.80	3,310,303
08/20	1.00	1.00	1.00	1.00	0.71	1.00	0.48	0.81	3,331,429
08/21	1.00	1.00	1.00	1.00	**0.75**	1.00	**0.51**	0.82	3,363,982
08/22	1.00	1.00	1.00	1.00	0.77	1.00	0.56	0.83	3,383,216
08/23	1.00	1.00	1.00	1.00	0.77	1.00	0.62	0.83	3,400,173
08/24	1.00	1.00	1.00	1.00	0.78	1.00	0.64	0.85	3,417,193
08/25	1.00	1.00	1.00	1.00	0.80	1.00	0.68	0.86	3,439,113
08/26	1.00	1.00	1.00	1.00	0.81	1.00	0.71	0.87	3,458,001
08/27	1.00	1.00	1.00	1.00	0.83	1.00	**0.75**	0.89	3,483,334
08/28	1.00	1.00	1.00	1.00	0.86	1.00	0.77	0.89	3,512,418
08/29	1.00	1.00	1.00	1.00	0.93	1.00	0.81	0.91	3,566,479
08/30	1.00	1.00	1.00	1.00	0.97	1.00	0.84	0.92	3,601,896
08/31	1.00	1.00	1.00	1.00	0.98	1.00	0.88	0.93	3,621,741
09/01	1.00	1.00	1.00	1.00	0.98	1.00	0.90	0.94	3,631,998
09/02	1.00	1.00	1.00	1.00	0.99	1.00	0.92	0.94	3,639,187
09/03	1.00	1.00	1.00	1.00	0.99	1.00	0.95	0.95	3,648,353
09/04	1.00	1.00	1.00	1.00	0.99	1.00	0.96	0.96	3,655,055
09/05	1.00	1.00	1.00	1.00	0.99	1.00	0.98	0.97	3,664,120
09/06	1.00	1.00	1.00	1.00	1.00	1.00	0.98	0.98	3,676,169
09/07	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	3,690,360

Note: The 25th, 50th, and 75th percentiles are in bold. Boxes indicate percentiles.

[a] Chinook salmon > 655 mm.

[b] Chinook salmon < 655 mm.