Fishery Data Series No. 08-35

Fall Chum Salmon Mark–Recapture Abundance Estimation on the Tanana and Kantishna Rivers, 2007

Annual Report for Study FIS 05-210

USFWS Office of Subsistence Management

Fisheries Information Services Division

by

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and

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July 2008

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

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

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)

Measures (fisheries)

fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

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

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This investigation was partially funded by the Bering Sea Fishermen's Association, the Tanana Chiefs Conference the U.S. Fish and Wildlife Service Office of Subsistence Management, and the U.S. Department of Interior, Fish and Wildlife Service per special provisions of the grant agreement.

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This document should be cited as:
Cleary, P. M., and T. Hamazaki. 2008. Fall chum salmon mark–recapture abundance estimation on the Tanana and Kantishna rivers, 2007. Alaska Department of Fish and Game, Fishery Data Series No. 08-35, Anchorage.

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ABSTRACT

Fall chum salmon *Oncorhynchus keta* fish wheel mark–recapture studies have been conducted since 1995 on the Tanana River and since 1999 on the Kantishna River. In the Tanana River, chum salmon were captured and tagged using a fish wheel and recaptured in a second fish wheel 73 km upstream. In the Kantishna River, chum salmon were captured and tagged using a fish wheel, and recaptured at 2 sites: the Toklat River, 89 km upstream and the upper Kantishna River, 148 km upstream. The Darroch model was used for the Tanana River abundance estimate and Chapman model for the Kantishna River. Estimates were 320,811 (SE ± 23,069) for the Tanana River and 81,843 (SE ± 4,667) for the Kantishna River.

Key words: Tanana River, Kantishna River, chum salmon, *Oncorhynchus keta*, mark–recapture, fish wheel, abundance estimate.

INTRODUCTION

The Yukon River basin is the largest in Alaska (854,700 km^2) (USGS 2005) which includes its primary tributary, the Tanana River which has a watershed of 84,983 km^2 (ADNR 1991). Five species of Pacific salmon return to the Yukon River and its tributaries and are captured in subsistence, personal use, commercial, and sport fisheries. Chum salmon *Oncorhynchus keta* return to the Yukon River in genetically divergent summer and fall runs (Crane et al. 2001). Summer chum salmon enter the Yukon River in early May after the river is free of ice (Dunbar 2003) and fall chum salmon in mid July (Sollee and Hayes 2003). The fall chum salmon (fall chum) migration usually peaks in mid September in the Tanana River and continues into early October (Cleary and Hamazaki 2005). Spawning occurs from October through November, generally in areas where upwelling ground water prevents freezing. Fall chum are larger on average, have higher oil content than summer chum, and are important for subsistence, personal use, and commercial fisheries within the upper Yukon and Tanana rivers (Busher et al. 2007).

For management purposes, the Yukon River watershed is divided into 6 districts and 13 subdistricts. The Tanana River is called District 6, and is divided into Subdistricts 6-A, 6-B, and 6-C, and the area upstream of Subdistrict 6-C to the headwaters is called the upper Tanana River area. For the purpose of the Tanana River/Kantishna River mark–recapture project, the region upstream of Subdistrict 6-A is called the upper Tanana River (Bue and Hayes 2006). Tanana River summer and fall chum are managed as separate stocks based on run timing. For management proposes in the Tanana River drainage, chum stocks are divided into summer (before 16 August) and fall (after 16 August), although some overlap in migration timing occurs. Tanana River fall chum run strength is assessed by using mark–recapture abundance estimates, catch per unit effort (CPUE) data from agency contracted "test" fish wheels (wheels), and inseason and historical fishery data.

Subsistence and personal use salmon fisheries occur in District 6 and are regularly open for two 42-hour periods per week, with the exception of the "Old Minto" area where subsistence fishing is permitted 5 days a week. Subsistence fishing in the Kantishna River is ordinarily open 7 days per week. Commercial fishing occurs on the Tanana River by emergency order. The Tanana River commercial guideline harvest range is 2,750–20,500 fall chum, but harvest level may be exceeded if assessment of run size indicates both escapement goals and subsistence needs will be met (Bue and Hayes 2006).

Tanana River fall chum are harvested in various fisheries in the Yukon watershed and comprise a significant proportion of the total fall chum harvest. For instance, in 2007, roughly 45,000 of the

fall chum (commercial, subsistence, and personal use combined) were harvested in District 6 of the Tanana River (B. Busher, Commercial Fisheries Biologist, Alaska Department of Fish and Game (ADF&G), Fairbanks; personal communication). This is 31% of the 1995–2006 average total Alaska fall chum harvest (JTC 2008). Commercial harvests occur downstream of the Tanana River in the Lower Yukon River between 14 August and 19 September. Genetic stock identification data has indicated Tanana River stocks contribute 36%–72% of the chum entering the river during this time period. Based on this information, a significant number of Tanana River chum are harvested in the Lower Yukon Area River each year.

Primary objectives for this project are to provide management staff with inseason and postseason abundance estimates of fall chum in the Tanana (above the mouth of the Kantishna River) and Kantishna rivers, and to estimate the migration rate of fall chum in the Kantishna River. Secondary objectives are to provide all species CPUE data from 6 fish wheels and provide run timing estimates for fall chum migrating to the Delta, Toklat, and Kantishna rivers.

METHODS

TAG DEPLOYMENT

Tag deployment wheels were operated in the Tanana River approximately 9 km upstream of the mouth of the Kantishna River and in the Kantishna River, approximately 3 km upstream (Figure 1). These locations are used because there are few tributaries between the tag deployment and recovery wheel sites, except for the Tolovana River upstream of the Tanana River tag deployment wheel. In the event the marked proportion changed over time at the Tanana River tag recovery wheel, tag colors were changed bi-weekly at the Tanana River tag deployment wheel. Tag color stratification can be used to generate a postseason abundance estimate using the Darroch stratified model (Darroch 1961).

Tag deployment wheels were operated 24 hours per day unless interrupted by debris accumulation, repairs, adjustments, or relocation. At each location a daily 12-hour tag deployment schedule was from 0800 to 2000 hours. A 24-hour tagging day was designated as 0800–0800 hours the following day. The sampling crew checked the live box at each wheel in approximate 4-hour intervals (0730, 1200, 1600 and 1930 hours) or more often depending on catch rates. Using a dip net, chum salmon in the live box were individually transferred to a sampling tub continuously supplied with water. Fish were tagged with a 30-cm, hollow-core, individually numbered spaghetti tag (Floy Tag and Manufacturing Inc., Seattle, WA)[1] inserted with a 16-cm applicator needle into the musculature behind the dorsal fin and secured with an overhand knot. The adipose fin was removed as a secondary mark. Data recorded were sex, length, condition, and color. Length was measured mideye to tail fork (10 fish per day, per tag site); condition was determined by external aberrations that may affect survival or migration; and color (light or dark) was used as an indicator of maturity.

Because of the possible effect on the abundance estimate, chum considered to have severe wounds (bleeding, gashes, head injuries, fungus, etc.) were not tagged. To track migration rates for fish held in live boxes for different time periods, fish caught between 0800 and 2000 hours were categorized as day fish, while fish caught between 2000 and 0800 hours, tagged in the

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

morning and held in the live box for up to 12 hours, were classified as night fish. Handling time per fish during tagging procedures was approximately 1 minute. All Chinook salmon *O. tshawytscha* and coho salmon *O. kisutch* were enumerated by sex and released, while other species were identified, tallied, and released. Because of time required for tag deployment, a maximum of 150 fish were tagged at each site per day.

TAG RECOVERY

In the Tanana River, a tag recovery wheel was located roughly 73 km upstream of the tag deployment site and downstream of the Nenana River (Figure 1). At this site, tagged and untagged salmon and other species were tallied using a digital video system (Moore and Daum 2005). Fish captured by the wheel were counted when they exited the wheel baskets and were directed through a plastic chute designed to pass fish within the view of a camera. Inseason data was summarized and reported daily by the contract fisherman using software provided by ADF&G.

In the Kantishna River watershed, tags were recovered at 2 locations each with 2 wheels. One in the Toklat River, 89 km upstream and the other in the Kantishna River, 148 km upstream of the tag deployment wheel. At each site, tag number and color were recorded, coho salmon were counted by sex, and all other species were tallied.

To monitor wheel efficiency, wheel revolutions were recorded daily at the tag deployment wheels and the Toklat River tag recovery wheels. In addition, weather and water level were recorded daily. Water temperature data was collected using Hobo (Onset Inc.) data loggers at the Tanana and Kantishna tag deployment wheel sites, at the upper Kantishna, Toklat and Tanana recovery wheel sites, and at the spawning grounds on the Toklat River. Tagging data were recorded in the field using an Allegro CE handheld field computer and downloaded daily into an Access database. A data summary for the previous 24-hour tagging day was reported daily to the ADF&G Fairbanks office.

DATA ANALYSIS

Mark–recapture Assumption Tests

To test the assumption that tagged fish have equal chance of capture as untagged and are mixed in the population, a series of statistical tests were performed. The following assumptions were examined: 1) equal chance of capture between right and left banks, 2) equal chance of capture at the Toklat River and upper Kantishna River sites, 3) equal chance of capture by sex and length, and 4) equal chance of capture between day and night fish (i.e., no holding effects). Chi square (χ^2) tests were used to test assumptions 1, 2, and 4. For assumption 3, a logistic regression was used where probability of recapture was regressed with length and sex. Finally, χ^2 tests were used to examine if the ratio of marked to unmarked fish (captured in recovery wheels) varied over time. This test was conducted for all chum by sex.

Abundance Estimation

Daily inseason abundance estimates were provided to fishery managers when the coefficient of variance (CV) was less than 0.30. Inseason estimates were considered preliminary until postseason assumption tests were completed.

Chapman's estimate (equation 1) and variance (equation 2) were employed to estimate the total fall chum run size for the Tanana and Kantishna rivers (Chapman 1954).

Chapman's estimation equation is calculated as:

$$\hat{N} = \frac{(C+1)(M+1)}{R+1} - 1 \tag{1}$$

The variance was approximated as:

$$V\left[\hat{N}\right] \cong \frac{(M+1)(C+1)(M-R)(C-R)}{(R+1)^2(R+2)} \tag{2}$$

where:

$\hat{N}$ = Total run estimate.

C = The number of fish caught at the tag recovery wheels.

M = The number of fish tagged and released at the tag deployment wheels.

R = The number of tagged fish recaptured at the tag recovery wheels.

Migration Rate

The migration rate between the tagging and recovery wheels was calculated as:

$$\hat{M} = \frac{RD}{D} \tag{3}$$

where:

RD = Distance between the tagging wheel and recovery wheel(s).

D = Number of days travel time between the tag and recovery wheels.

To investigate migration rate differences between day and night fish and between sexes, a Holm Sidak test (Glantz 2002) was used.

Stock Timing

Tag recovery in fall chum spawning grounds provides general information stock timing. The Delta River is a significant fall chum spawning area in the Tanana River watershed. Tags are collected when possible during weekly foot surveys of the Delta River while counting live and dead chum and coho salmon. Like the Delta River, the Toklat watershed is an important fall chum spawning area in the Kantishna watershed. Foot surveys of the Toklat River have been conducted in the past but haven't been since 1995. However, some tags have been collected on the Toklat River while retrieving and deploying water temperature data loggers.

RESULTS

TAG DEPLOYMENT

Tag deployment wheels operated from 16 August until 27 September on the Tanana River and from 16 August to 25 September on the Kantishna River. Total fall chum catch at the Tanana River tag deployment wheel was 5,993 fish of which 3,759 were tagged. At the Kantishna River tag deployment wheel, 5,781 fall chum were captured of which 3,807 were tagged

(Appendix A1–A2). The peak chum CPUE of 58.2 fish per hour occurred on 22 September at the Tanana River tag deployment wheel and 20 September (32.0 fish per hour) at the Kantishna River tag deployment wheel (Figure 2; Appendix A1–A2).

TAG RECOVERY

On the Tanana River, the recovery wheel began operation on 16 August and continued through 1 October. Total fall chum catch was 16,683 of which 197 were tagged (Appendix A3). On the Toklat River, recovery wheel operations began on 19 August and ended on 30 September. Total fall chum catch (both wheels combined) was 4,204 fish, of which 193 were tagged (Appendix A4). On the upper Kantishna River, recovery wheels operated from 16 August and ended on 5 October. The total number of fall chum captured (both wheels combined) was 3,229 of which 100 were tagged (Appendix A5). At this site, the contractor voluntarily provided catch data and tag information from operation of a second (left bank wheel) which he began operating on 11 September. Total numbers of tags recovered, including public tag recoveries, are listed in Table 1.

Coho salmon catch was 26% of total catch at all wheels. Like most years of the project, coho salmon CPUE was greatest at the Tanana River tag recovery wheel (34.0 fish per hour) and occurred on 13 September. Total coho salmon catch at this site was 32% of the total catch. Coho catch per hour and total catch at the other project fish wheel are listed in Appendix A6.

DATA ANALYSIS

Mark–recapture Assumption Tests

A significant difference was found in the ratio of marked fish between left and right bank recovery wheels on the Toklat ($\chi^2 = 6.57$, df =1, P = 0.01), between tag recovery locations ($\chi^2 = 9.59$, df = 1, P = 0.00) but not between wheels on the upper Kantishna River ($\chi^2 = 0.20$, df = 1, P = 0.65).

Logistic regression analysis indicated no significant difference in probability of recapture at recovery wheels due to length (Wald $\chi^2 = 0.98$, df = 1, P = 0.32) and for sex (Wald $\chi^2 = 2.65$, df = 1, P = 0.49) (Table 2). The logistic regression test for holding effects (day versus night) using all tag and recovery data indicated a significant difference in marked ratio in sex (Wald $\chi^2 = 4.89$, df = 1, P = 0.03) and between day versus night fish (Wald $\chi^2 = 8.34$, df = 1, P = 0.03) (Table 2).

Chi square tests for marked ratio over time at recovery sites on the Toklat and upper Kantishna River indicated no significant difference for all fish ($\chi^2 = 2.35$, df = 4, P = 0.67), for males ($\chi^2 = 0.04$, df = 3, P = 0.99) or females ($\chi^2 = 4.84$, df = 3 , P = 0.18).

The Tanana River tag recovery site chi square test for variation in marked ratio over time indicated a significant difference for all fish ($\chi^2 = 30.23$, df = 5 , P = <0.00), males ($\chi^2 = 11.74$, df = 4, P = 0.02) and females ($\chi^2 = 36.33$, df = 4, P <0.00) (Tables 2 and 3).

Abundance Estimate

Chi square tests indicated a significant difference in the marked proportion over time on the Tanana River. Accordingly, postseason tag color stratification was used for a Darroch model abundance estimate. The final abundance estimate for fall chum salmon was 320,811 (SE ± 23,069) for the Tanana River (Table 4; Figure 3).

On the Kantishna River, the marked ratio at tag recovery wheels in the Toklat and upper Kantishna River did not change over time. As a result, postseason stratification was not needed and the Chapman model was used for the abundance estimate. The final estimate for the Kantishna River was 81,843 (SE ± 4,667) (Table 4; Figure 3). However, there was a significant difference in the marked ratio between tag recovery sites hence an assumption of the mark–recapture model was violated.

Migration Rate

Toklat River fall chum average migration rates were 20 km/day for day tagged fish (n = 134) and 16 km/day for night tagged fish (n = 62). Average migration rates for tagged chum salmon captured at the upper Kantishna River tag recovery wheel were 27 km/day (n = 69) for day tagged fish and 22 km/day (n = 30) for night tagged fish. The Holm Sidak test indicated night fish migration rates were less than day fish migration rates ($F = 25.245$, $df = 1$, $P < 0.001$) and female migration rates were less than male ($F = 4.124$, $df = 1$, $P = 0.043$) (Tables 2 and 5; Figure 4).

Stock Timing

Eight weekly foot surveys of Delta River were conducted between October 12 and December 2, 2007. During the surveys, 32 tags were recovered from spawning grounds. The median tag deployment date for these fish was 16 September and tagging dates ranged from 1 September through 23 September (Table 1).

DISCUSSION

An above average fall chum run in the Yukon watershed was documented by several run estimate and escapement projects in 2007. For example, the Pilot Station fall chum preliminary estimate of 684,011 (1995–2006 mean = 629,801), the Chandalar River sonar project preliminary estimate of 228,056 (1995–2006 mean = 184,411) and the Department of Fisheries and Oceans fall chum catch on the upper Yukon River which was above the 10-year average and the second highest fall chum run on record (JTC 2008).

Similarly, the 2007 Tanana River mark–recapture run strength estimate was above the mean of 144,445 fish, the second highest on record following the 2005 run and exceeds the upper Tanana River management goal of 46,000 to 103,000 fish. This estimate is conservative because the daily tagging goal of 150 fish was exceeded for 19 days because of high catch rates. Another indication of an above average fall chum run in 2007 was the Delta River (Tanana watershed) escapement estimate. This estimate, calculated from the area under the curve method, was approximately 18,610 fish and exceeds the biological escapement goal of 6,000 to 13,000 (JTC 2008).

The 2007 Kantishna River fall chum abundance estimate surpasses the 1999–2006 average abundance estimate of 58,835 and is the third largest estimate since 1999 (Table 4; Figure 3). However, this estimate is biased because a chi square test indicated a significant difference in the marked ratio between at the Toklat and upper Kantishna tag recovery sites.

There are several reasons there was a significant difference in the marked ratio between the Toklat and upper Kantishna River tag recovery sites. The fish wheels at the Toklat River tag recovery site operate in a narrow channel in contrast to the upper Kantishna River where the

river channel is appreciably deeper and the width is almost twice that of the Toklat River. Water depth on the Toklat River is much less than Kantishna River which makes it easier to adjust fish wheel basket depth and keep fish wheel baskets turning close to the bottom where fish travel, thereby maintaining a high CPUE. In addition, the water velocities are greater in the Toklat River which may cause chum to migrate closer the river bank where water velocities are less and also where fish wheels are operated. In addition, migration rates of day tagged fish recaptured in Toklat and upper Kantishna rivers were greater than night fish which has been documented during other years (Cleary and Hamazaki 2004, 2005, 2007). In addition, night fish migrated more slowly than day fish (Table 5), there was a significant difference in migrations rate between day and night fish (Table 2), and the proportion of night fish captured at the Toklat River was greater than the upper Kantishna. This could indicate night fish are more susceptible to capture due the factors described above which affect fish wheel efficiencies and catch rates. These causes could account for the dissimilar mark ratios between tag recovery sites and consequently the violation of one of the assumptions of the Chapman mark–recapture model.

In addition, migration rates were greater than average for all tagged fish captured in both the upper Kantishna and Toklat recovery sites. However, migration rates less than 2006 are probably due to above average water levels in September which tend to slow migration.

Recommendations

Recent efforts by the United States Fish and Wildlife Service (USFWS) and ADF&G have produced chum salmon mixed stock genetic analyses (MSA) from samples collected at the Pilot Station Sonar site. These data provide timely inseason stock contribution estimates in the early stages of the run (Flannery et al. 2007). Analyses show a reasonably strong association between abundance estimates from MSA at Pilot Station Sonar and the postseason estimated total fall chum run, suggesting that MSA might be able to predict stock-specific abundance and reduce the need for up river escapement projects like the Tanana/Kantishna mark–recapture project.

However, Tanana River stocks migrate past the Pilot Station sonar project site later than other chum stocks therefore there is concern that chum stocks would be underestimated due to continued migration after sonar counts end. For instance, in 2006 (Cleary and Hamazaki 2007) and 2007, Tanana chum salmon estimates from the mark–recapture project were more than double those from MSA at Pilot Station (Unpublished data from Commercial Fisheries fall season data notebook in Fairbanks). Due to this uncertainty, sole trust in MSA could lead to conservative management and result in fewer subsistence, personal use, and commercial opportunities for residents in the Tanana River watershed. Due to funding shortfalls, the Tanana and Kantishna mark–recapture project will not be operated in 2008. However, for effective management of fall chum stocks in the Tanana basin, and to verify annual fall chum MSA estimates from Pilot Station sonar, there may be a future need for a run assessment project (mark–recapture or sonar) in the Tanana River watershed.

ACKNOWLEDGMENTS

The Bering Sea Fishermen's Association provided the funding for the Kantishna River tag deployment wheel. The Tanana Chiefs Conference funded operation of a tag recovery fish wheel on the upper Kantishna River. The U.S. Fish and Wildlife Service Office of Subsistence

Management provided funding for support of this project through the Fisheries Resource Monitoring Program, under agreement #701815J585.

We thank Dave Daum (USFWS) for his help with the deployment, operation and maintenance of the digital video system at the Tanana River tag recovery fish wheel. We are grateful to the following technicians for collecting data at the Tanana and Kantishna River tag deployment sites: Dave Ramey, Chris Sewright, Ian Fo, Desiree Ulroan (TCC) and also Gary Carpenter and Nick Butryn for data collection at the Toklat river tag recovery site. The following individuals operated the contracted project fish wheels: Charlie Boulding, Paul Kleinschmidt, and Mike Turner. We thank Percy Duyck Sr. for transporting fuel and supplies to our camp on the Tanana River. Special thanks to Mike Turner for contributing data from his subsistence fish wheel operated on the left bank in September and October, 2007.

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TABLES AND FIGURES

Table 1.–Tags recovered by location from fall chum salmon in the Tanana and Kantishna rivers, 2007.

Recapture Location	Method	Number of Tags	Tag Deployment Dates	
			median	range
Delta River	Foot survey	32	9/16	9/1–9/23
Toklat Springs	Foot survey	6	-	8/19–9/13
Tanana River recovery wheel [a]	Fish wheel/digital video	197	9/25	9/12–9/26
Toklat River recovery [b]	Fish wheels	190	9/15	8/23–9/24
Kantishna River recovery [c]	Fish wheels	99	9/16	8/31–9/24
Other tag recoveries [d]	Fishermen/public	18	-	-
Total		542		

[a] Tag deployment dates range is from tags (15) recovered during commercial periods.

[b] Includes only single (first time) recaptures and 1 tag loss.

[c] Includes tags captured after 9/29 not used in the abundance estimate. Does not include 1 tag loss.

[d] Includes tags recovered from various locations.

Table 2.–Statistical test results for fall chum salmon captured in the Toklat, upper Kantishna, and Tanana rivers tag recovery fish wheels, 2007.

Logistic Regression Tests

Location	Description	Wald Chi Square		df	P-Value		N
		Sex	Length		Sex	Length	
Toklat and upper Kantishna River	recapture probability based on sex and length	2.65	0.98	1	0.49	0.32	317
		Sex	Day vs. Night		Sex	Day vs. Night	
Toklat and upper Kantishna River	recapture probability based on sex and day vs. night	4.89	8.34	1	0.03	0.03	3732

Holm Sidak Test		F		df	P-Value		N
		Sex	Day vs. Night		Sex	Day vs. Night	
Toklat and upper Kantishna River	migration rate based on sex and day vs. night	4.124	25.245	1	0.043	<0.001	288

Chi Square Tests

Location	Description	Chi Square	df	P-Value	Marked ratio	
					RB	LB
Toklat River	marked ratio between recovery wheels	6.57	1	0.01	0.05	0.04
Upper Kantishna River	marked ratio between wheels	0.20	1	0.65	0.03	0.03
Toklat and upper Kantishna River	marked ratio between wheels	9.59	4	0.00	0.05	0.03
Toklat and upper Kantishna River	marked ratio over time - all fish	2.35	4	0.67	-	-
Toklat and upper Kantishna River	marked ratio over time - males	0.04	3	0.99	-	-
Toklat and upper Kantishna River	marked ratio over time - females	4.84	3	0.18	-	-
					-	-
Tanana River	marked ratio over time - all fish	30.23	5	<0.00	-	-
Tanana River	marked ratio over time - males	11.74	4	0.02	-	-
Tanana River	marked ratio over time - females	36.33	4	<0.00	-	-

Table 3.–Chi square test data, strata and marked ratio through time for fall chum salmon captured at the Tanana, upper Kantishna and Tanana river tag recovery fish wheels, 2007.

Tag recovery location	Test	Marked						Total catch/marked ratio (M.R)											
		8/16–8/22	8/23–8/29	8/30–9/5	9/6–9/12	9/13–9/19	9/20–9/30	8/16–8/22		8/23–8/29		8/30–9/5		9/6–9/12		9/13–9/19		9/20–9/30	
								Total	M.R.	Total	M.R.	Total	M.R.	Total	M.R.	Total	M.R.	Total	M.R.
Toklat and upper Kantishna River	All fish	0	2	6	9	46	178	9	0.00	19	0.11	196	0.03	243	0.04	1130	0.04	3737	0.05
Toklat and upper Kantishna River	Males	0	2	4	7	36	114	3	0.00	13	0.15	98	0.04	138	0.05	660	0.05	2100	0.05
Toklat and upper Kantishna River	Females	0	0	2	2	10	63	6	0.00	2	0.00	98	0.02	105	0.02	470	0.02	1636	0.04
Tanana River	All fish	0	2	1	2	35	82	154	0.00	106	0.02	493	0.00	276	0.01	1788	0.02	8032	0.01

Table 4.–Tanana and Kantishna rivers fall chum salmon abundance estimates, 1995–2007.

Tanana River

Year	Point Estimate	SE	95% Lower bound	95% Upper bound
1995	268,173	21,597	225,842	310,503
1996	134,563	16,945	101,351	167,775
1997	71,661	11,876	48,384	94,937
1998	62,014	6,556	49,164	74,863
1999	97,843	19,362	59,893	135,792
2000	34,844	4,970	25,104	44,584
2001	96,556	20,955	55,484	137,627
2002	109,961	12,724	85,022	134,900
2003	193,418	9,976	173,866	212,970
2004	123,879	11,071	102,179	145,579
2005	337,755	22,166	294,309	381,202
2006	202,669	16,545	170,241	235,097
2007	320,811	23,069	275,596	366,026
1995–2006 Mean	144,445	14,351	115,870	172,127

Kantishna River

Year	Point Estimate	SE	95% Lower bound	95% Upper bound
1999	27,199	3,562	20,218	34,180
2000	21,450	3,031	15,510	27,390
2001	22,992	2,172	18,734	27,250
2002	56,665	4,122	48,587	64,743
2003	87,359	8,041	71,600	103,118
2004	76,163	4,391	67,557	84,769
2005	107,719	7,649	92,726	122,712
2006	71,135	4,972	61,390	80,880
2007	81,843[a]	4,667	72,697	90,989
1999–2006 Mean	58,835	4,742	48,741	66,515

[a] Biased estimate – significant difference in the marked ratio between tag recovery sites.

Table 5.–Estimated migration rates (km/day) for day and night caught fall chum salmon in the Tanana and Kantishna rivers, 1995–2007.

Tanana River tagging fish wheel to Tanana River recovery fish wheel (73 km)

	Day		Night		Combined	
Year	km/day	n	km/day	n	km/day	Total - n
1995 [a]	-	-	-	-	26	166
1996 [a]	-	-	-	-	31	187
1997 [a]	-	-	-	-	21	104
1998	29	49	31	30	30	79
1999	29	8	16	14	23	22
2000	25	25	20	20	23	45
2001	24	10	49	7	37	17
2002	28	22	29	47	29	69
2003	27	21	21	13	24	34
2004	-	-	-	-	-	
2005	29	123	19	10	24	133 [b]
2006	26	11	21	4	24	15 [c]
2007	18	14	18	1	18	15 [b]
1995–2006 mean	27	34	26	18	26	80[d]

Kantishna River tag deployment wheel to the Toklat River tag recovery wheels (89 km)

	Day		Night		Combined	
Year	km/day	n	km/day	n	km/day	Total - n
1999	18	25	19	28	19	53
2000	18	23	24	9	21	32
2001	21	52	24	35	23	87
2002	19	84	21	81	20	165
2003	15	54	13	31	14	85
2004	15	151	12	178	14	329
2005	20	128	16	108	18	236
2006	26	163	21	106	23	269
2007	20	134	16	62	19	196
1999–2006 mean	19	85	19	72	19	157

Kantishna River tag deployment wheel to the Kantishna River tag recovery wheels (148 km)

	Day		Night		Combined	
Year	km/day	n	km/day	n	km/day	Total - n
2000	26	10	27	1	27	11
2001	31	2	28	3	30	5
2002	21	10	21	4	21	14
2003	16	22	15	4	16	26
2004	16	7	14	12	15	19
2005	24	12	23	8	23	20
2006	28	18	25	19	27	37
2007	27	69	22	30	25	99
2000–2006 mean	23	12	22	7	22	19

[a] Migration rates estimated for all fish only.

[b] Tag numbers from commercial harvest not the total number of tags viewed on video.

[c] Migration rates were calculated from tags recovered during commercial periods.

[d] Does not include tags recovered where no tag number was collected.

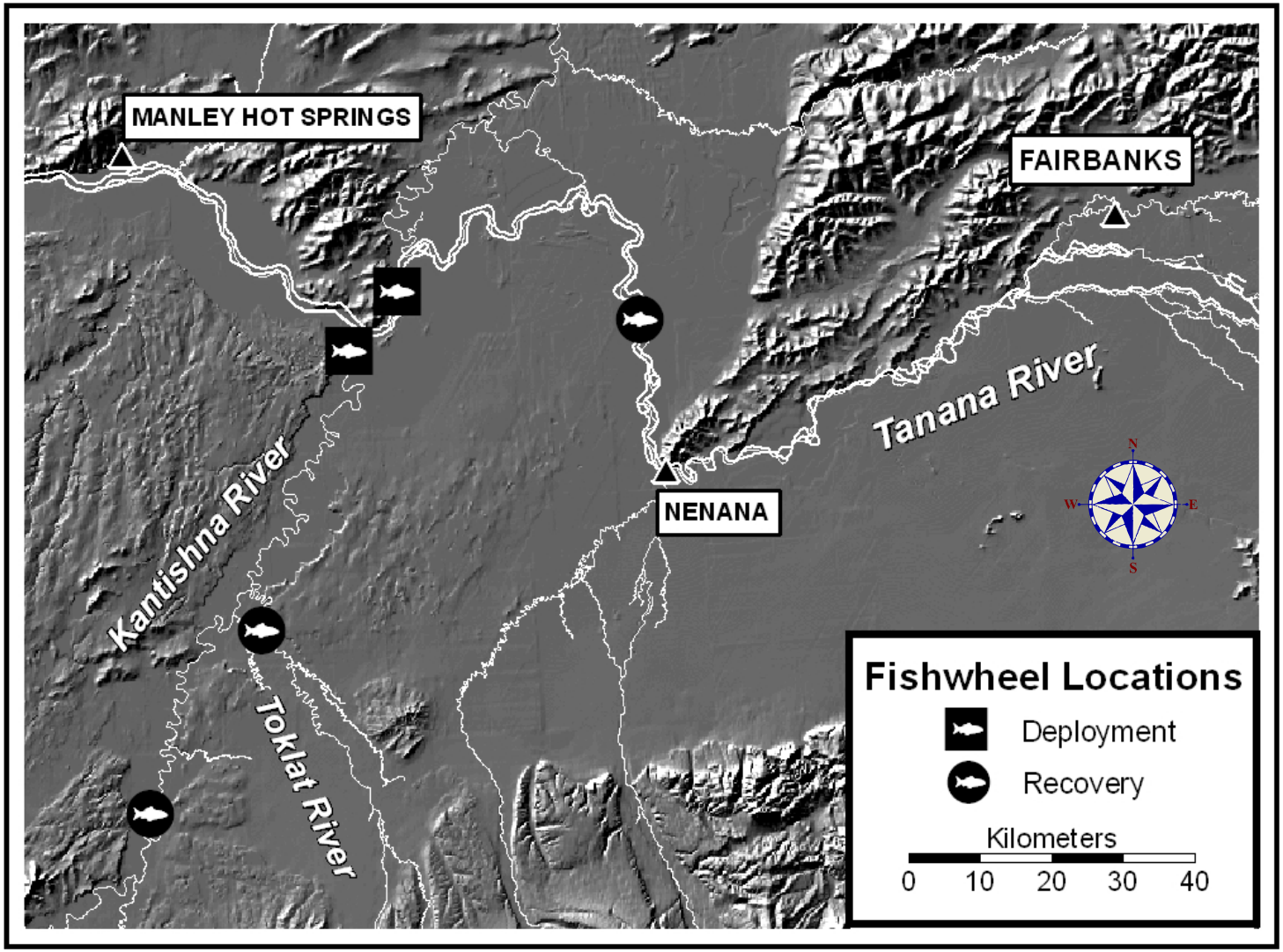


Figure 1.–Location of tag deployment and recovery wheels used in the Tanana and Kantishna rivers fall chum salmon mark–recapture project, 2007.

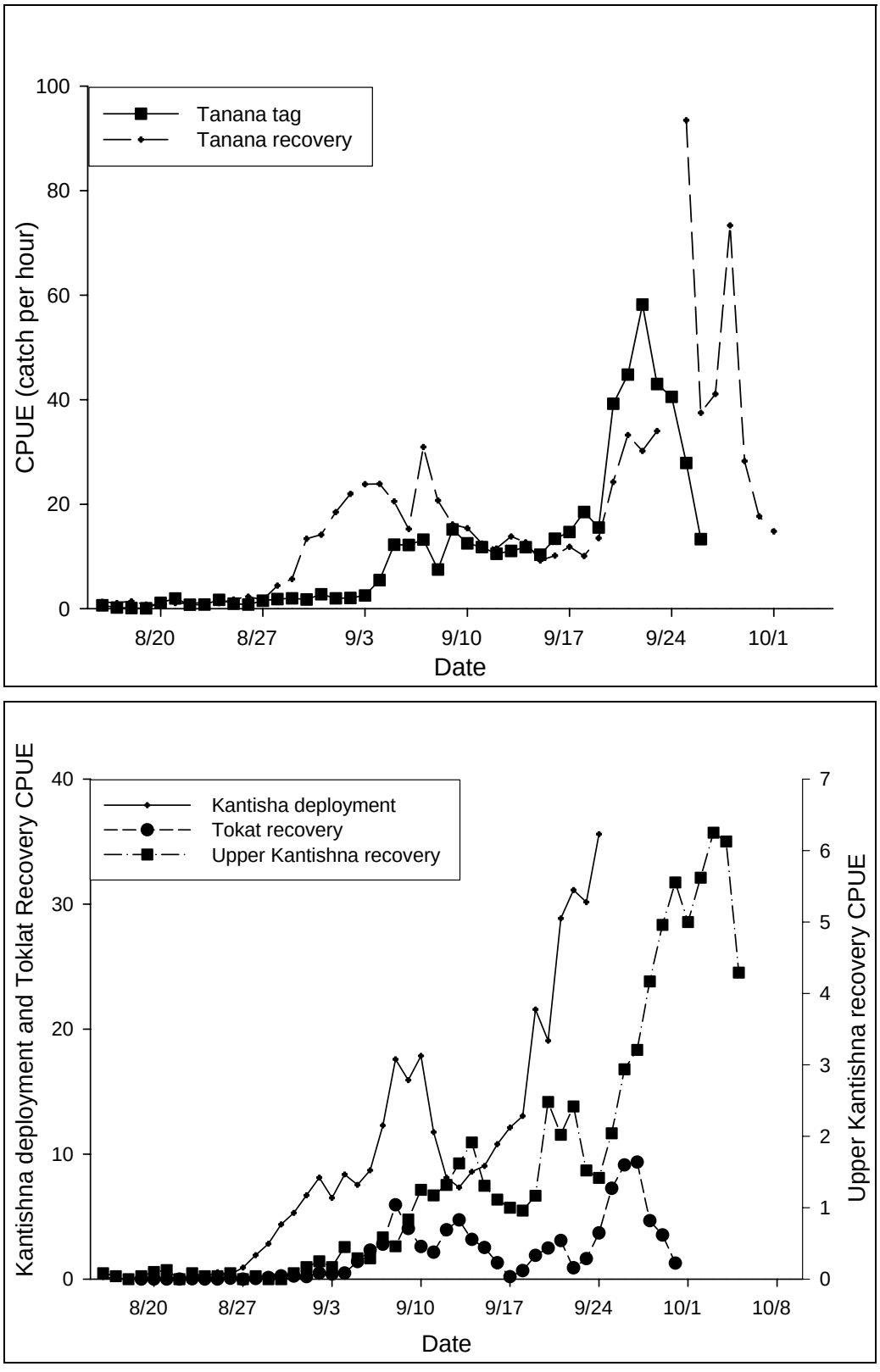


Figure 2.–Daily fall chum salmon CPUE at the Tanana River tag deployment and recovery fish wheels (top), and CPUE at the Kantishna River tag deployment wheel and recovery fish wheels on the Toklat and upper Kantishna rivers (bottom), 2007.

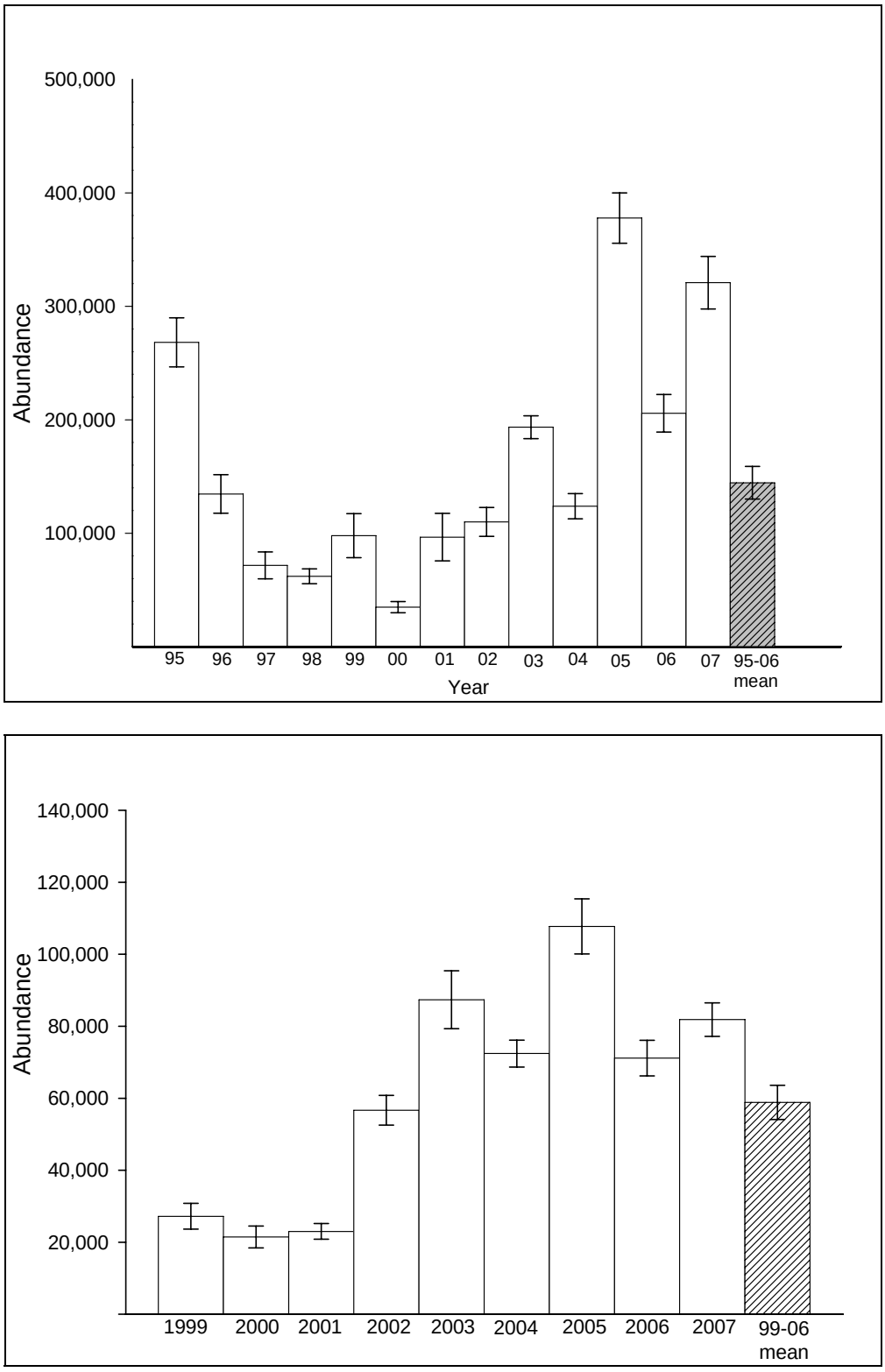
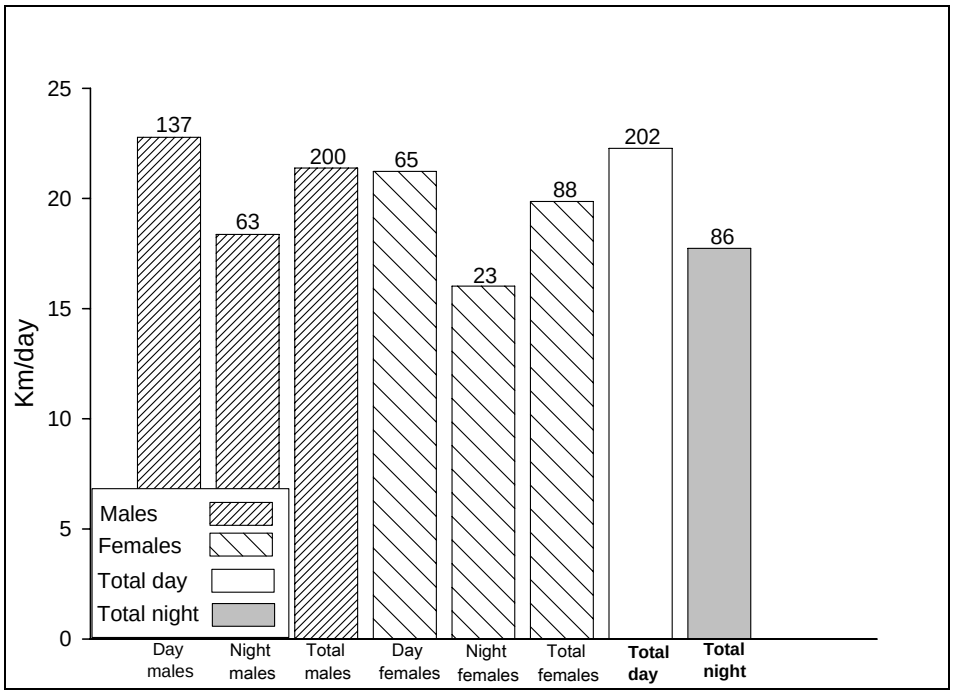
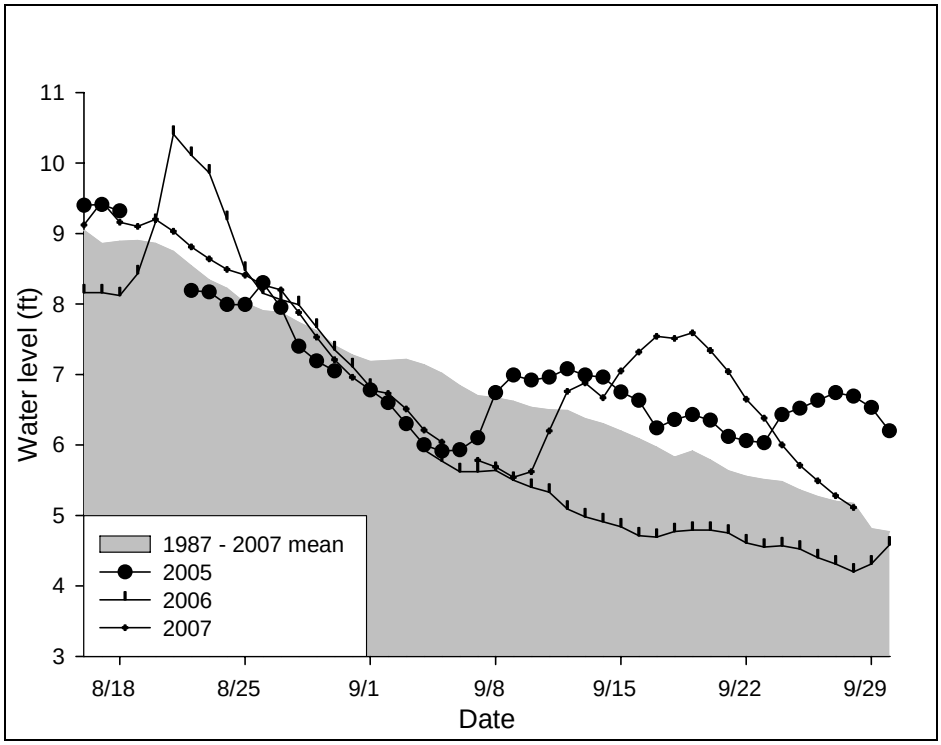


Figure 3.–Fall chum salmon abundance estimates (±SE for estimates with a CV < 0.30) for the Tanana River, 1995–2007 (top) and for the Kantishna River, 1999–2007 (bottom).



Note: Values above bars indicate number recaptured.

Figure 4.–Fall chum salmon migration rates (km per day) in the Kantishna River drainage, 2007.



Source: U.S. Geological Survey.

Figure 5.–Tanana River water levels near Nenana, Alaska.

APPENDIX A

Appendix A1.–Daily effort and catch of fall chum salmon at the Tanana River tag deployment fish wheel, 2007.

		Tagged					Not Tagged					Total					Catch
Date	Hours Fished	No. Male	No. Female	UNK [a] Sex	Total	Cum	No. Male	No. Female	UNK [a] Sex	Total	Cum	No. Male	No. Female	UNK [a] Sex	Total	Cum	Per Hour
8/16	17	4	7	0	11	11	0	0	0	0	0	4	7	0	11	11	0.6
8/17	24	2	3	0	5	16	0	0	0	0	0	2	3	0	5	16	0.2
8/18	24	2	0	0	2	18	0	1	0	1	1	2	1	0	3	19	0.1
8/19	24	0	2	0	2	20	0	0	0	0	1	0	2	0	2	21	0.1
8/20	22.3	9	16	0	25	45	0	0	0	0	1	9	16	0	25	46	1.1
8/21	24	19	19	0	38	83	3	6	0	9	10	22	25	0	47	93	2.0
8/22	24	9	6	0	15	98	0	3	0	3	13	9	9	0	18	111	0.8
8/23	23	10	7	0	17	115	0	1	0	1	14	10	8	0	18	129	0.8
8/24	24	11	13	0	24	139	1	16	0	17	31	12	29	0	41	170	1.7
8/25	24	6	8	0	14	153	2	7	0	9	40	8	15	0	23	193	1.0
8/26	24	8	6	0	14	167	1	4	0	5	45	9	10	0	19	212	0.8
8/27	24	12	14	0	26	193	4	7	0	11	56	16	21	0	37	249	1.5
8/28	24	12	16	0	28	221	6	10	0	16	72	18	26	0	44	293	1.8
8/29	24	16	19	0	35	256	5	8	0	13	85	21	27	0	48	341	2.0
8/30	24	15	14	0	29	285	6	7	0	13	98	21	21	0	42	383	1.8
8/31	24	29	24	0	53	338	3	10	0	13	111	32	34	0	66	449	2.8
90/1	24	23	14	0	37	375	4	7	0	11	122	27	21	0	48	497	2.0
9/02	24	23	15	0	38	413	4	7	0	11	133	27	22	0	49	546	2.0
9/03	24	25	24	0	49	462	8	4	0	12	145	33	28	0	61	607	2.5
9/04	24	59	42	0	101	563	13	17	0	30	175	72	59	0	131	738	5.5
9/05	20	91	57	0	148	711	46	51	0	97	272	137	108	0	245	983	12.3
9/06	11.25	61	50	0	111	822	12	14	0	26	298	73	64	0	137	1,120	12.2
9/07	24	90	70	0	160	982	80	76	1	157	455	170	146	1	317	1,437	13.2
9/08	24	103	50	0	153	1,135	12	15	0	27	482	115	65	0	180	1,617	7.5
9/09	24	115	49	0	164	1,299	115	85	0	200	682	230	134	0	364	1,981	15.2
9/10	18.5	129	26	0	155	1,454	47	29	0	76	758	176	55	0	231	2,212	12.5
9/11	24	118	35	0	153	1,607	87	43	0	130	888	205	78	0	283	2,495	11.8
9/12	24	34	12	104	150	1,757	54	48	0	102	990	88	60	104	252	2,747	10.5
9/13	24	92	62	0	154	1,911	56	55	0	111	1,101	148	117	0	265	3,012	11.0
9/14	24	81	76	0	157	2,068	74	51	0	125	1,226	155	127	0	282	3,294	11.8

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		Tagged					Not Tagged					Total					Catch
Date	Hours Fished	No. Male	No. Female	UNK [a] Sex	Total	Cum	No. Male	No. Female	UNK [a] Sex	Total	Cum	No. Male	No. Female	UNK [a] Sex	Total	Cum	Per Hour
9/15	24	77	79	0	156	2,224	48	44	0	92	1,318	125	123	0	248	3,542	10.3
9/16	23	92	62	0	154	2,378	61	93	0	154	1,472	153	155	0	308	3,850	13.4
9/17	12	73	72	0	145	2,523	6	25	0	31	1,503	79	97	0	176	4,026	14.7
9/18	2	15	21	0	36	2,559	0	1	0	1	1,504	15	22	0	37	4,063	18.5
9/19	10.5	76	68	0	144	2,703	2	17	0	19	1,523	78	85	0	163	4,226	15.5
9/20	9	75	75	0	150	2,853	73	130	0	203	1,726	148	205	0	353	4,579	39.2
9/21	6.25	58	95	0	153	3,006	57	70	0	127	1,853	115	165	0	280	4,859	44.8
9/22	5.5	81	74	0	155	3,161	70	95	0	165	2,018	151	169	0	320	5,179	58.2
9/23	4	61	90	0	151	3,312	8	13	0	21	2,039	69	103	0	172	5,351	43.0
9/24	7.5	77	75	0	152	3,464	58	94	0	152	2,191	135	169	0	304	5,655	40.5
9/25	7	66	88	0	154	3,618	16	25	0	41	2,232	82	113	0	195	5,850	27.9
9/26	10.75	64	77	0	141	3,759	2	0	0	2	2,234	66	77	0	143	5,993	13.3
Total		2,023	1,632	104	3,759		1,044	1,189	1	2,234		3,067	2,821	105	5,993		

Note: Does not include recaptures or other data omitted before the final abundance estimate.

[a] Unidentified sex.

Appendix A2.–Daily effort and catch of fall chum salmon at the Kantishna River tag deployment fish wheel, 2007.

		Tagged					Not Tagged					Total					Catch
	Hours			UNK [a]					UNK [a]					UNK [a]			Per
Date	Fished	Males	Females	Sex	Total	Cum	Males	Females	Sex	Total	Cum	Males	Females	Sex	Total	Cum	Hour
8/16	18	0	2	0	2	2	1	0	0	1	0	1	2	0	3	3	0.2
8/17	24	0	1	0	1	3	0	0	0	0	0	0	1	0	1	4	0.0
8/18	24	1	0	0	1	4	0	0	0	0	0	1	0	0	1	5	0.0
8/19	24	2	0	0	2	6	0	0	0	0	0	2	0	0	2	7	0.1
8/20	24	2	1	0	3	9	0	0	0	0	0	2	1	0	3	10	0.1
8/21	24	1	1	0	2	11	0	0	0	0	0	1	1	0	2	12	0.1
8/22	24	0	0	0	0	11	0	0	0	0	0	0	0	0	0	12	0.0
8/23	24	3	1	0	4	15	1	0	0	1	0	4	1	0	5	17	0.2
8/24	24	2	2	0	4	19	1	0	0	1	0	3	2	0	5	22	0.2
8/25	24	4	5	0	9	28	2	2	0	4	0	6	7	0	13	35	0.5
8/26	24	4	4	0	8	36	0	1	0	1	0	4	5	0	9	44	0.4
8/27	24	12	4	0	16	52	1	5	0	6	0	13	9	0	22	66	0.9
8/28	24	22	11	0	33	85	3	10	0	13	0	25	21	0	46	112	1.9
8/29	24	19	31	0	50	135	9	9	0	18	0	28	40	0	68	180	2.8
8/30	24	39	37	0	76	211	12	17	0	29	0	51	54	0	105	285	4.4
8/31	24	55	39	0	94	305	18	15	0	33	0	73	54	0	127	412	5.3
9/01	24	69	57	0	126	431	22	13	0	35	0	91	70	0	161	573	6.7
9/02	24	106	43	0	149	580	24	22	0	46	0	130	65	0	195	768	8.1
9/03	24	76	47	0	123	703	15	18	0	33	0	91	65	0	156	924	6.5
9/04	24	85	49	0	134	837	33	34	0	67	0	118	83	0	201	1,125	8.4
9/05	24	62	37	0	99	936	36	46	0	82	0	98	83	0	181	1,306	7.5
9/06	24	95	57	0	152	1,088	33	24	0	57	0	128	81	0	209	1,515	8.7
9/07	24	102	57	0	159	1,247	80	56	0	136	0	182	113	0	295	1,810	12.3
9/08	24	116	41	0	157	1,404	177	88	0	265	0	293	129	0	422	2,232	17.6
9/09	12	91	60	0	151	1,555	29	11	0	40	0	120	71	0	191	2,423	15.9
9/10	10	84	50	0	134	1,689	29	20	0	49	0	113	70	0	183	2,606	17.9
9/11	24	103	48	0	151	1,840	89	42	0	131	0	192	90	0	282	2,888	11.8
9/12	24	55	20	75	150	1,990	25	20	0	45	0	80	40	75	195	3,083	8.1
9/13	24	91	50	0	141	2,131	19	16	0	35	0	110	66	0	176	3,259	7.3
9/14	24	96	56	0	152	2,283	35	19	0	54	0	131	75	0	206	3,465	8.6
9/15	24	94	58	0	152	2,435	39	26	0	65	0	133	84	0	217	3,682	9.0

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		Tagged					Not Tagged					Total					Catch
	Hours			UNK [a]					UNK [a]					UNK [a]			Per
Date	Fished	Males	Females	Sex	Total	Cum	Males	Females	Sex	Total	Cum	Males	Females	Sex	Total	Cum	Hour
9/16	24	86	67	0	153	2,588	64	42	0	106	1,353	150	109	0	259	3,941	10.8
9/17	24	88	68	0	156	2,744	88	47	0	135	1,488	176	115	0	291	4,232	12.1
9/18	24	94	59	0	153	2,897	101	59	0	160	1,648	195	118	0	313	4,545	13.0
9/19	24	77	62	0	139	3,036	8	4	0	12	1,660	85	66	0	151	4,696	6.3
9/20	7	108	48	0	156	3,192	43	25	0	68	1,728	151	73	0	224	4,920	32.0
9/21	12	96	59	0	155	3,347	36	47	0	83	1,811	132	106	0	238	5,158	20.3
9/22	8	85	70	0	155	3,502	59	35	0	94	1,905	144	105	0	249	5,407	30.2
9/23	8	86	66	0	152	3,654	26	18	0	44	1,949	112	84	0	196	5,603	24.5
9/24	7	79	74	0	153	3,807	14	11	0	25	1,974	93	85	0	178	5,781	27.4
Total		2,290	1,442	75	3,807		1,172	802	0	1,974		3,462	2,244	75	5,781		

Note: Does not include recaptures or other data omitted before the final abundance estimate.

[a] Unidentified sex.

Appendix A3.–Daily effort and catch of fall chum salmon at the Tanana River recovery fish wheel, 2007.

		Tagged					Not Tagged					Total					Catch
	Hours			UNK [a]					UNK [a]					UNK [a]			Per
Date	Fished	Males	Females	Sex	Total	Cum	Males	Females	Sex	Total	Cum	Males	Females	Sex	Total	Cum	Hour
8/16	8	0	0	0	0	0	8	3	0	11	11	8	3	0	11	11	1.3
8/17	24	0	0	0	0	0	10	16	0	26	37	10	16	0	26	37	1.1
8/18	24	0	0	0	0	0	14	20	0	34	71	14	20	0	34	71	1.4
8/19	24	0	0	0	0	0	7	12	0	19	90	7	12	0	19	90	0.8
8/20	24	0	0	0	0	0	4	12	0	16	106	4	12	0	16	106	0.7
8/21	24	0	0	0	0	0	7	19	0	26	132	7	19	0	26	132	1.1
8/22	22	0	0	0	0	0	9	13	0	22	154	9	13	0	22	154	1.0
8/23	24	0	2	0	2	2	12	14	0	26	180	12	16	0	28	182	1.2
8/24	24	0	0	0	0	2	11	15	0	26	206	11	15	0	26	208	1.1
8/25	24	1	0	0	1	3	16	25	0	41	247	17	25	0	42	250	1.8
8/26	24	2	0	0	2	5	22	31	0	53	300	24	31	0	55	305	2.3
8/27	24	0	0	0	0	5	23	17	0	40	340	23	17	0	40	345	1.7
8/28	24	1	1	0	2	7	47	57	0	104	444	48	58	0	106	451	4.4
8/29	24	1	5	0	6	13	61	69	0	130	574	62	74	0	136	587	5.7
8/30	20	3	0	0	3	16	124	134	0	258	832	127	134	0	261	848	13.4
8/31	24	1	2	0	3	19	154	183	0	337	1,169	155	185	0	340	1,188	14.2
9/01	24	0	1	0	1	20	221	221	0	442	1,611	221	222	0	443	1,631	18.5
9/02	24	1	0	0	1	21	267	259	0	526	2,137	268	259	0	527	2,158	22.0
9/03	24	1	2	0	3	24	281	284	0	565	2,702	282	286	0	568	2,726	23.8
9/04	24	7	6	0	13	37	303	257	0	560	3,262	310	263	0	573	3,299	23.9
9/05	24	1	0	0	1	38	294	198	0	492	3,754	295	198	0	493	3,792	20.5
9/06	24	7	2	0	9	47	213	144	0	357	4,111	220	146	0	366	4,158	15.3
9/07	17	2	2	0	4	51	306	208	0	514	4,625	308	210	0	518	4,676	30.9
9/08	24	1	6	0	7	58	257	233	0	490	5,115	258	239	0	497	5,173	20.7
9/09	24	2	1	0	3	61	207	175	0	382	5,497	209	176	0	385	5,558	16.1
9/10	24	5	1	0	6	67	219	144	0	363	5,860	224	145	0	369	5,927	15.4
9/11	24	4	5	0	9	76	165	124	0	289	6,149	169	129	0	298	6,225	12.5
9/12	24	2	0	0	2	78	160	114	0	274	6,423	162	114	0	276	6,501	11.5

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	Tagged						Not Tagged					Total					Catch
	Hours			UNK [a]					UNK [a]					UNK [a]			Per
Date	Fished	Males	Females	Sex	Total	Cum	Males	Females	Sex	Total	Cum	Males	Females	Sex	Total	Cum	Hour
9/13	21	3	0	0	3	81	160	123	0	283	6,706	163	123	0	286	6,787	13.8
9/14	15	5	2	0	7	88	101	79	0	180	6,886	106	81	0	187	6,974	12.7
9/15	24	3	3	0	6	94	114	101	0	215	7,101	117	104	0	221	7,195	9.2
9/16	24	5	6	0	11	105	109	124	0	233	7,334	114	130	0	244	7,439	10.2
9/17	24	1	1	0	2	107	136	146	0	282	7,616	137	147	0	284	7,723	11.8
9/18	24	1	0	0	1	108	107	134	0	241	7,857	108	134	0	242	7,965	10.1
9/19	24	4	1	0	5	113	149	170	0	319	8,176	153	171	0	324	8,289	13.5
9/20	24	13	3	0	16	129	254	312	0	566	8,742	267	315	0	582	8,871	24.3
9/21	24	5	5	0	10	139	346	433	0	779	9,521	351	438	0	789	9,660	33.2
9/22	24	4	1	0	5	144	360	354	0	714	10,235	364	355	0	719	10,379	30.2
9/23	24	2	2	0	4	148	435	377	0	812	11,047	437	379	0	816	11,195	34.0
9/24	11	0	0	0	0	148	0	0	0	0	11,047	0	0	0	0	11,195	0.0
9/25	29	4	8	0	12	160	491	422	0	913	11,960	495	430	0	925	12,120	32.1
9/26	24	5	0	0	5	165	463	431	0	894	12,854	468	431	0	899	13,019	37.5
9/27	24	4	1	0	5	170	493	488	0	981	13,835	497	489	0	986	14,005	41.1
9/28	18	9	7	0	16	186	679	625	0	1,304	15,139	688	632	0	1,320	15,325	73.3
9/29	24	6	3	0	9	195	357	312	0	669	15,808	363	315	0	678	16,003	28.3
9/30	18	0	0	0	0	195	140	178	0	318	16,126	140	178	0	318	16,321	17.7
10/01	25	1	1	0	2	197	153	207	0	360	16,486	154	208	0	362	16,683	14.8
Total		117	80	0	197		8,469	8,017	0	16,486		8,586	8,097	0	16,683		

Note: Does not include recaptures or undetermined tags from video counting.

[a] Unidentified sex.

Appendix A4.–Daily effort and catch of fall chum salmon at the Toklat River recovery fish wheels (both sites combined), 2007.

		Tagged					Not Tagged					Total					Catch
	Hours			UNK [a]					UNK [a]					UNK [a]			Per
Date	Fished	Males	Females	Sex	Total	Cum	Males	Females	Sex	Total	Cum	Males	Females	Sex	Total	Cum	Hour
8/16																	
8/17																	
8/18																	
8/19	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
8/20	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
8/21	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
8/22	48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
8/23	48	0	0	0	0	0	1	0	0	1	1	1	0	0	1	1	0.0
8/24	48	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0.0
8/25	48	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0.0
8/26	48	1	0	0	1	1	2	0	0	2	3	3	0	0	3	4	0.1
8/27	48	0	0	0	0	1	0	0	0	0	3	0	0	0	0	4	0.0
8/28	48	0	0	0	0	1	2	0	0	2	5	2	0	0	2	6	0.0
8/29	48	1	0	0	1	2	3	2	0	5	10	4	2	0	6	12	0.1
8/30	48	0	0	0	0	2	3	9	0	12	22	3	9	0	12	24	0.3
8/31	48	1	0	0	1	3	5	5	0	10	32	6	5	0	11	35	0.2
9/01	48	0	0	0	0	3	5	4	0	9	41	5	4	0	9	44	0.2
9/02	48	2	0	0	2	5	14	7	0	21	62	16	7	0	23	67	0.5
9/03	48	1	0	0	1	6	7	11	0	18	80	8	11	0	19	86	0.4
9/04	48	0	0	0	0	6	11	12	0	23	103	11	12	0	23	109	0.5
9/05	48	0	1	0	1	7	32	34	0	66	169	32	35	0	67	176	1.4
9/06	48	4	1	0	5	12	57	49	0	106	275	61	50	0	111	287	2.3
9/07	41	2	2	0	4	16	62	48	0	110	385	64	50	0	114	401	2.8
9/08	47	7	5	0	12	28	144	120	0	264	649	151	125	0	276	677	5.9
9/09	48	8	1	0	9	37	105	80	0	185	834	113	81	0	194	871	4.0
9/10	48	2	1	0	3	40	61	61	0	122	956	63	62	0	125	996	2.6
9/11	48	7	0	0	7	47	55	41	0	96	1,052	62	41	0	103	1,099	2.1
9/12	48	7	2	0	9	56	96	84	0	180	1,232	103	86	0	189	1,288	3.9

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	Tagged						Not Tagged					Total					Catch
	Hours			UNK [a]					UNK [a]					UNK [a]			Per
Date	Fished	Males	Females	Sex	Total	Cum	Males	Females	Sex	Total	Cum	Males	Females	Sex	Total	Cum	Hour
9/13	48	10	4	0	14	70	102	111	0	213	1,445	112	115	0	227	1,515	4.7
9/14	48	4	0	0	4	74	86	62	0	148	1,593	90	62	0	152	1,667	3.2
9/15	48	4	2	0	6	80	61	54	0	115	1,708	65	56	0	121	1,788	2.5
9/16	42	1	1	0	2	82	34	26	0	60	1,768	35	27	0	62	1,850	1.5
9/17	45	0	0	0	0	82	2	7	0	9	1,777	2	7	0	9	1,859	0.2
9/18	48	2	0	0	2	84	15	15	0	30	1,807	17	15	0	32	1,891	0.7
9/19	48	2	0	0	2	86	53	36	0	89	1,896	55	36	0	91	1,982	1.9
9/20	48	4	2	0	6	92	55	58	0	113	2,009	59	60	0	119	2,101	2.5
9/21	48	4	4	0	8	100	80	60	0	140	2,149	84	64	0	148	2,249	3.1
9/22	48	2	0	0	2	102	19	22	0	41	2,190	21	22	0	43	2,292	0.9
9/23	48	2	1	0	3	105	46	29	0	75	2,265	48	30	0	78	2,370	1.6
9/24	48	10	3	0	13	118	78	86	0	164	2,429	88	89	0	177	2,547	3.7
9/25	48	12	7	0	19	137	168	161	0	329	2,758	180	168	0	348	2,895	7.3
9/26	46	18	8	0	26	163	196	198	0	394	3,152	214	206	0	420	3,315	9.1
9/27	47	15	6	0	21	184	220	194	0	414	3,566	235	200	0	435	3,750	9.4
9/28	48	5	4	0	9	193	106	109	0	215	3,781	111	113	0	224	3,974	4.7
9/29	48	0	0	0	0	193	91	78	0	169	3,950	91	78	0	169	4,143	3.5
9/30	25	0	0	0	0	193	27	34	0	61	4,011	27	34	0	61	4,204	2.4
Total		138	55	0	193		2,104	1,907	0	4,011		2,242	1,962	0	4,204		

Note: Does not include recaptures or undetermined tags from video counting.

[a] Unidentified sex.

Appendix A5.–Daily effort and catch of fall chum salmon at the Kantishna River recovery fish wheels (both sites combined), 2007.

	Tagged						Not Tagged					Total					Catch
	Hours			UNK [a]					UNK [a]					UNK [a]			Per
Date	Fished	Males	Females	Sex	Total	Cum	Males	Females	Sex	Total	Cum	Males	Females	Sex	Total	Cum	Hour
8/16	24	0	0	0	0	0	0	2	0	2	2	0	2	0	2	2	0.1
8/17	24	0	0	0	0	0	0	1	0	1	3	0	1	0	1	3	0.0
8/18	24	0	0	0	0	0	0	0	0	0	3	0	0	0	0	3	0.0
8/19	24	0	0	0	0	0	0	1	0	1	4	0	1	0	1	4	0.0
8/20	20	0	0	0	0	0	1	1	0	2	6	1	1	0	2	6	0.1
8/21	24	0	0	0	0	0	2	1	0	3	9	2	1	0	3	9	0.1
8/22	24	0	0	0	0	0	0	0	0	0	9	0	0	0	0	9	0.0
8/23	24	0	0	0	0	0	1	1	0	2	11	1	1	0	2	11	0.1
8/24	24	0	0	0	0	0	0	1	0	1	12	0	1	0	1	12	0.0
8/25	24	0	0	0	0	0	1	0	0	1	13	1	0	0	1	13	0.0
8/26	24	0	0	0	0	0	0	2	0	2	15	0	2	0	2	15	0.1
8/27	24	0	0	0	0	0	0	0	0	0	15	0	0	0	0	15	0.0
8/28	24	0	0	0	0	0	1	0	0	1	16	1	0	0	1	16	0.0
8/29	24	0	0	0	0	0	0	0	0	0	16	0	0	0	0	16	0.0
8/30	24	0	0	0	0	0	0	0	0	0	16	0	0	0	0	16	0.0
8/31	24	0	0	0	0	0	1	1	0	2	18	1	1	0	2	18	0.1
9/01	24	0	0	0	0	0	4	0	0	4	22	4	0	0	4	22	0.2
9/02	24	0	0	0	0	0	3	3	0	6	28	3	3	0	6	28	0.3
9/03	24	0	0	0	0	0	3	1	0	4	32	3	1	0	4	32	0.2
9/04	20	0	1	0	1	1	4	4	0	8	40	4	5	0	9	41	0.5
9/05	24	0	0	0	0	1	2	5	0	7	47	2	5	0	7	48	0.3
9/06	24	0	1	0	1	2	4	2	0	6	53	4	3	0	7	55	0.3
9/07	24	1	0	0	1	3	8	5	0	13	66	9	5	0	14	69	0.6
9/08	24	0	0	0	0	3	6	5	0	11	77	6	5	0	11	80	0.5
9/09	24	0	0	0	0	3	8	12	0	20	97	8	12	0	20	100	0.8
9/10	24	2	1	0	3	6	16	11	0	27	124	18	12	0	30	130	1.3
9/11 [b]	39	1	1	0	2	8	32	14	0	46	170	33	15	0	48	178	1.2
9/12	41	0	0	0	0	8	35	19	0	54	224	35	19	0	54	232	1.3
9/13	50	3	1	0	4	12	53	24	0	77	301	56	25	0	81	313	1.6

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	Tagged						Not Tagged					Total					Catch
	Hours			UNK [a]					UNK [a]					UNK [a]			Per
Date	Fished	Males	Females	Sex	Total	Cum	Males	Females	Sex	Total	Cum	Males	Females	Sex	Total	Cum	Hour
9/14	46	3	0	0	3	15	53	32	0	85	386	56	32	0	88	401	1.9
9/15	50	1	0	0	1	16	48	19	0	67	453	49	19	0	68	469	1.4
9/16	50	1	0	0	1	17	32	16	0	48	501	33	16	0	49	518	1.0
9/17	48	0	0	0	0	17	28	20	0	48	549	28	20	0	48	566	1.0
9/18	48	3	2	0	5	22	26	15	0	41	590	29	17	0	46	612	1.0
9/19	48	2	0	0	2	24	31	23	0	54	644	33	23	0	56	668	1.2
9/20	44	6	4	0	10	34	77	32	0	109	753	83	36	0	119	787	2.7
9/21	48	11	0	0	11	45	59	27	0	86	839	70	27	0	97	884	2.0
9/22	48	4	4	0	8	53	62	46	0	108	947	66	50	0	116	1,000	2.4
9/23	48	2	1	0	3	56	41	29	0	70	1,017	43	30	0	73	1,073	1.5
9/24	48	1	2	0	3	59	50	15	0	65	1,082	51	17	0	68	1,141	1.4
9/25	48	4	0	1	5	64	53	40	0	93	1,175	57	40	1	98	1,239	2.0
9/26	48	3	1	0	4	68	84	53	0	137	1,312	87	54	0	141	1,380	2.9
9/27	48	5	3	0	8	76	92	54	0	146	1,458	97	57	0	154	1,534	3.2
9/28	48	2	4	0	6	82	111	83	0	194	1,652	113	87	0	200	1,734	4.2
9/29	48	4	1	0	5	87	141	92	0	233	1,885	145	93	0	238	1,972	5.0
9/30	38	0	8	0	8	95	130	73	0	203	2,088	130	81	0	211	2,183	5.6
10/01	48	4	0	0	4	99	118	118	0	236	2,324	122	118	0	240	2,423	5.0
10/02	49	1	0	0	1	100	149	131	0	280	2,604	150	131	0	281	2,704	5.7
10/03	46	0	0	0	0	100	114	161	0	275	2,879	114	161	0	275	2,979	6.0
10/04	24	0	0	0	0	100	81	66	0	147	3,026	81	66	0	147	3,126	6.1
10/05	24	0	0	0	0	100	35	68	0	103	3,129	35	68	0	103	3,229	4.3
Total		64	35	1	100		1,800	1,329	0	3,129		1,864	1,364	1	3,229		

[a] Unidentified sex.

[b] Second (left bank) wheel began operation.

Appendix A6.–Daily effort and catch of coho salmon at the Tanana/Kantishna River mark–recapture project fish wheels, 2007.

	Tanana Tag Deployment			Tanana Tag Recovery			Kantishna Tag Deployment			Toklat Tag Recovery			Kantishna Tag Recovery		
Date	Catch	Cum.	Catch Per Hour	Catch	Cum.	Catch Per Hour	Catch	Cum.	Catch Per Hour	Catch	Cum.	Catch Per Hour	Catch	Cum.	Catch Per Hour
8/16	0	0	0.0	0	0	0.0	1	1	0.1		0	0.0	0	0	0.0
8/17	0	0	0.0	0	0	0.0	0	1	0.0		0	0.0	0	0	0.0
8/18	0	0	0.0	0	0	0.0	1	2	0.0		0	0.0	0	0	0.0
8/19	0	0	0.0	0	0	0.0	0	2	0.0	0	0	0.0	0	0	0.0
8/20	0	0	0.0	0	0	0.0	0	2	0.0	0	0	0.0	0	0	0.0
8/21	0	0	0.0	1	1	0.0	0	2	0.0	0	0	0.0	0	0	0.0
8/22	1	1	0.0	2	3	0.1	1	3	0.0	0	0	0.0	0	0	0.0
8/23	1	2	0.0	2	5	0.1	0	3	0.0	0	0	0.0	0	0	0.0
8/24	1	3	0.0	4	9	0.2	0	3	0.0	0	0	0.0	0	0	0.0
8/25	2	5	0.1	10	19	0.4	3	6	0.1	0	0	0.0	0	0	0.0
8/26	0	5	0.0	18	37	0.8	1	7	0.0	0	0	0.0	0	0	0.0
8/27	1	6	0.0	19	56	0.8	1	8	0.0	0	0	0.0	0	0	0.0
8/28	0	6	0.0	35	91	1.5	0	8	0.0	0	0	0.0	0	0	0.0
8/29	0	6	0.0	37	128	1.5	1	9	0.0	0	0	0.0	0	0	0.0
8/30	0	6	0.0	44	172	2.3	1	10	0.0	1	1	0.0	0	0	0.0
8/31	0	6	0.0	69	241	2.9	0	10	0.0	0	1	0.0	0	0	0.0
9/01	0	6	0.0	108	349	4.5	0	10	0.0	3	4	0.0	0	0	0.0
9/02	2	8	0.1	209	558	8.7	4	14	0.2	3	7	0.0	0	0	0.0
9/03	5	13	0.2	230	788	9.6	2	16	0.1	8	15	0.0	0	0	0.0
9/04	5	18	0.2	246	1,034	10.3	3	19	0.1	10	25	0.1	0	0	0.0
9/05	35	53	1.8	247	1,281	10.3	2	21	0.1	26	51	0.1	0	0	0.0
9/06	15	68	1.3	207	1,488	8.6	5	26	0.2	26	77	0.2	1	1	0.0
9/07	49	117	2.0	307	1,795	18.3	2	28	0.1	21	98	0.2	0	1	0.0
9/08	24	141	1.0	315	2,110	13.1	8	36	0.3	23	121	0.6	1	2	0.0
9/09	61	202	2.5	357	2,467	15.0	6	42	0.5	41	162	0.5	0	2	0.0
9/10	61	263	3.3	521	2,988	21.7	8	50	0.8	42	204	0.4	15	17	0.6
9/11	55	318	2.3	426	3,414	17.8	7	57	0.3	29	233	0.5	4	21	0.1
9/12	43	361	1.8	298	3,712	12.4	1	58	0.0	53	286	0.9	15	36	0.4
9/13	73	434	3.0	704	4,416	34.0	2	60	0.1	32	318	0.9	7	43	0.1

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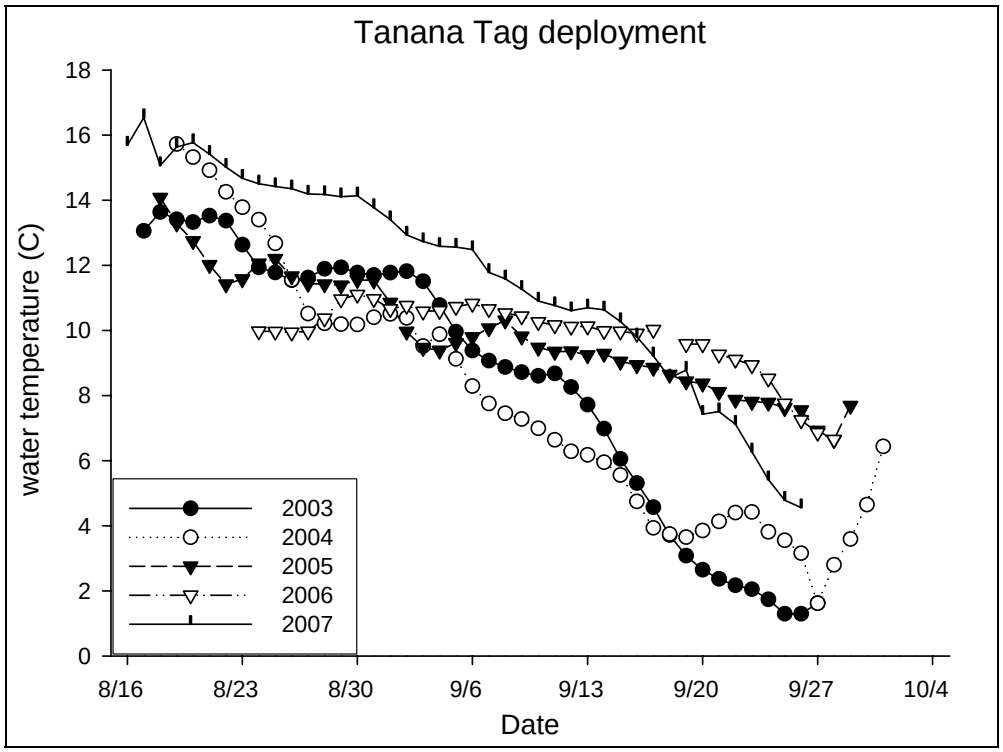
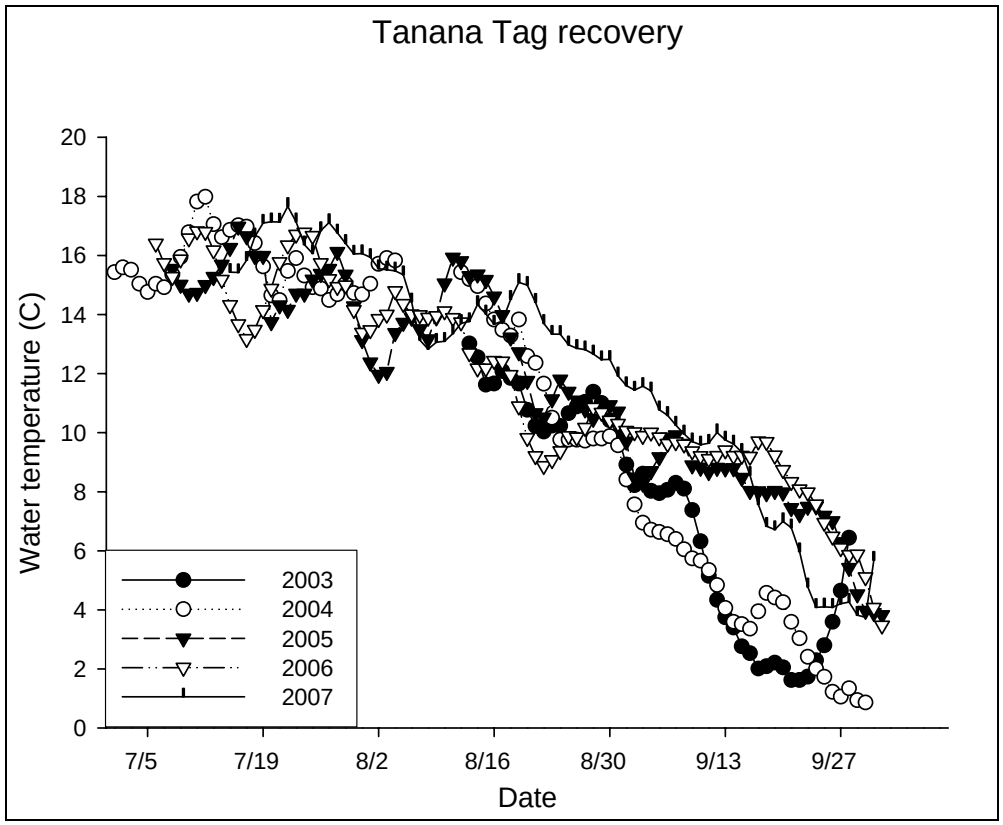
	Tanana Tag Deployment			Tanana Tag Recovery			Kantishna Tag Deployment			Toklat Tag Recovery			Kantishna Tag Recovery		
Date	Catch	Cum.	Catch Per Hour	Catch	Cum.	Catch Per Hour	Catch	Cum.	Catch Per Hour	Catch	Cum.	Catch Per Hour	Catch	Cum.	Catch Per Hour
9/14	29	463	1.2	290	4,706	19.7	0	60	0.0	3	321	0.6	10	53	0.2
9/15	29	492	1.2	248	4,954	10.3	4	64	0.2	8	329	1.1	3	56	0.1
9/16	30	522	1.3	153	5,107	6.4	8	72	0.3	32	361	0.8	12	68	0.2
9/17	10	532	0.8	147	5,254	6.1	9	81	0.4	35	396	0.1	9	77	0.2
9/18	5	537	2.5	132	5,386	5.5	9	90	0.4	50	446	0.2	8	85	0.2
9/19	31	568	3.0	157	5,543	6.5	1	91	0.1	13	459	0.7	4	89	0.1
9/20	27	595	3.0	153	5,696	6.4	2	93	0.2	31	490	0.7	7	96	0.2
9/21	17	612	2.7	160	5,856	6.7	11	104	1.3	59	549	1.0	10	106	0.2
9/22	24	636	4.4	99	5,955	4.2	10	114	1.3	54	603	0.3	13	119	0.3
9/23	5	641	1.3	123	6,078	5.1	12	126	1.8	38	641	0.6	13	132	0.3
9/24	12	653	1.6	170	6,248	15.7	8	134	1.6	29	670	1.2	10	142	0.2
9/25	3	656	0.4	177	6,425	6.1	0	134	0.0	29	699	1.1	5	147	0.1
9/26	4	660	0.4	0	6,425	0.0				45	744	0.8	12	159	0.3
9/27				234	6,659	9.8				11	755	0.6	25	184	0.5
9/28				346	7,005	19.2							21	205	0.4
9/29				203	7,208	8.5							28	233	0.6
9/30				101	7,309	5.6							19	252	0.5
10/01				95	7,404	3.9							30	282	0.6
10/02													26	308	0.5
10/03													22	330	0.5
10/04													8	338	0.3
10/05															
10/06															
10/07															
10/08															
10/09															
Total	660			7,404			134			755			338		

Appendix A7.–Water temperatures at the Tanana/Kantishna River mark–recapture project fish wheels and the Toklat River Springs (Geiger Creek).





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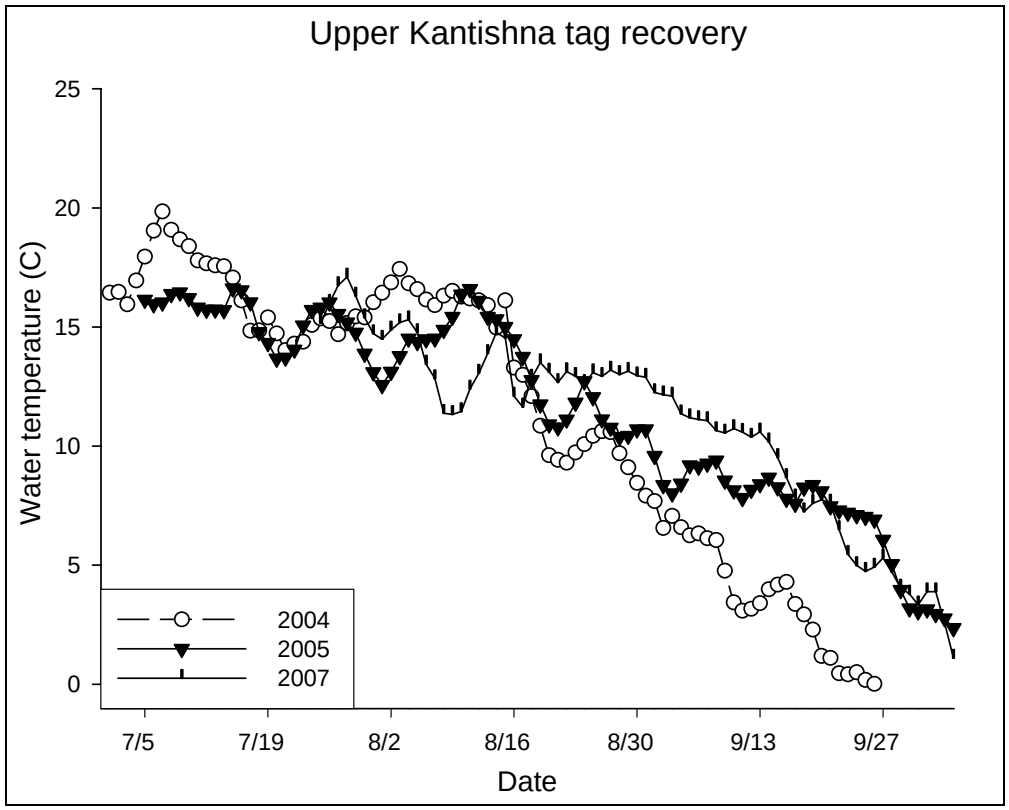
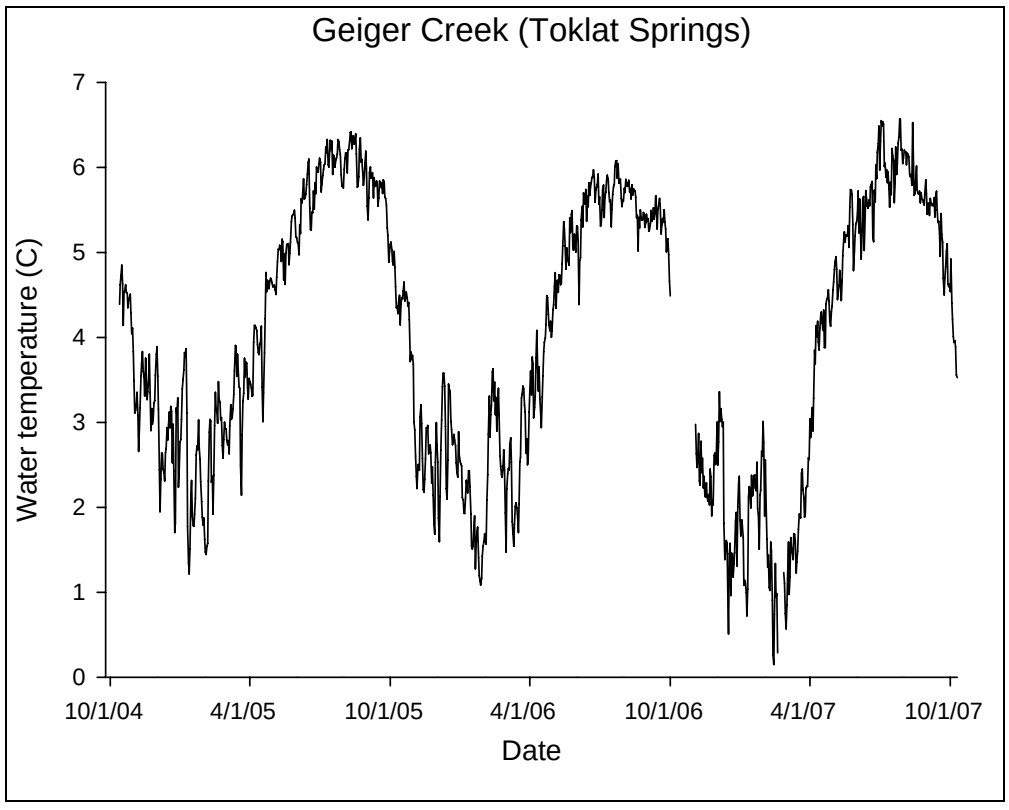
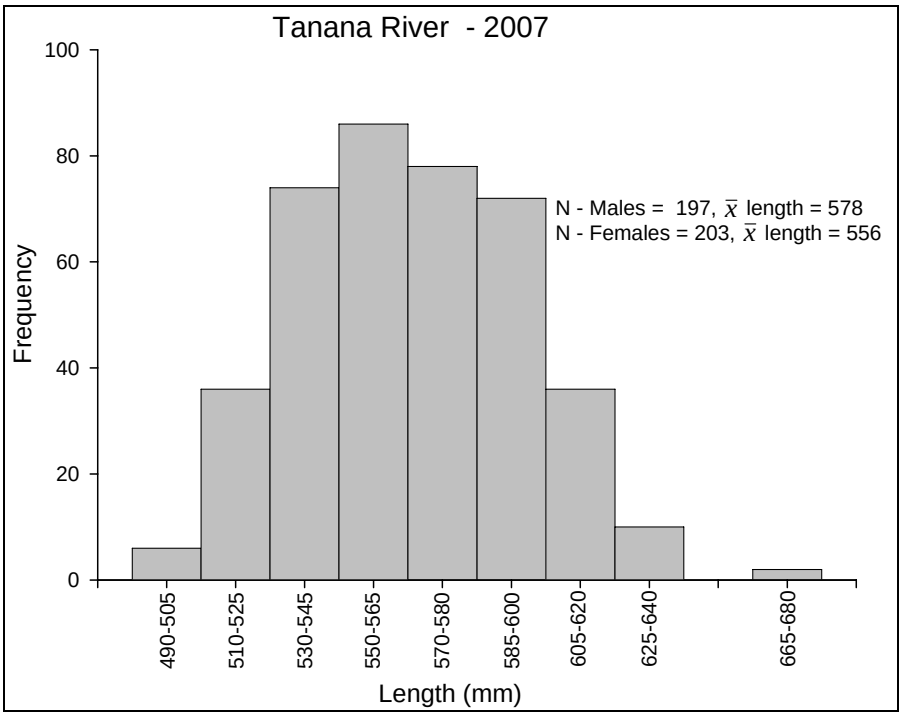
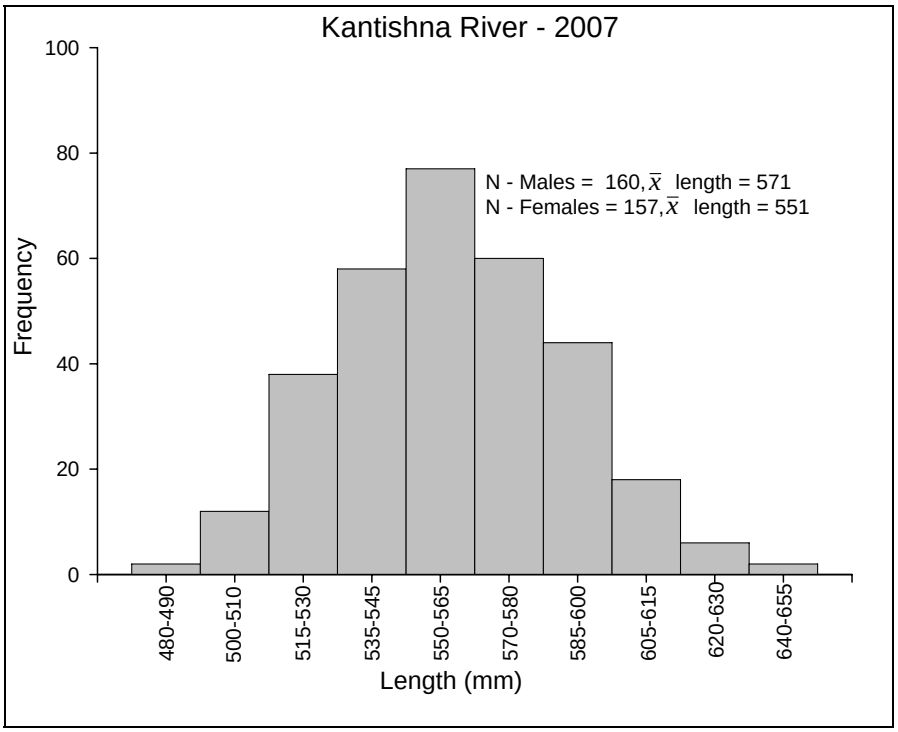




Appendix A8.–Length frequency of fall chum captured at the Tanana and Kantishna River tag deployment fish wheels, 2005–2007.





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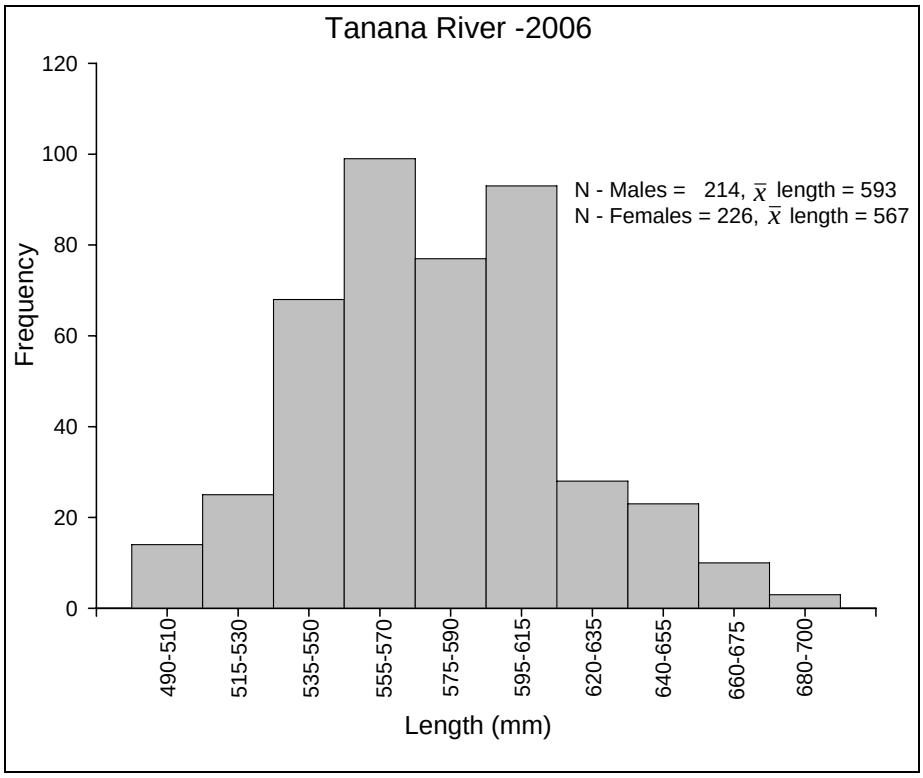

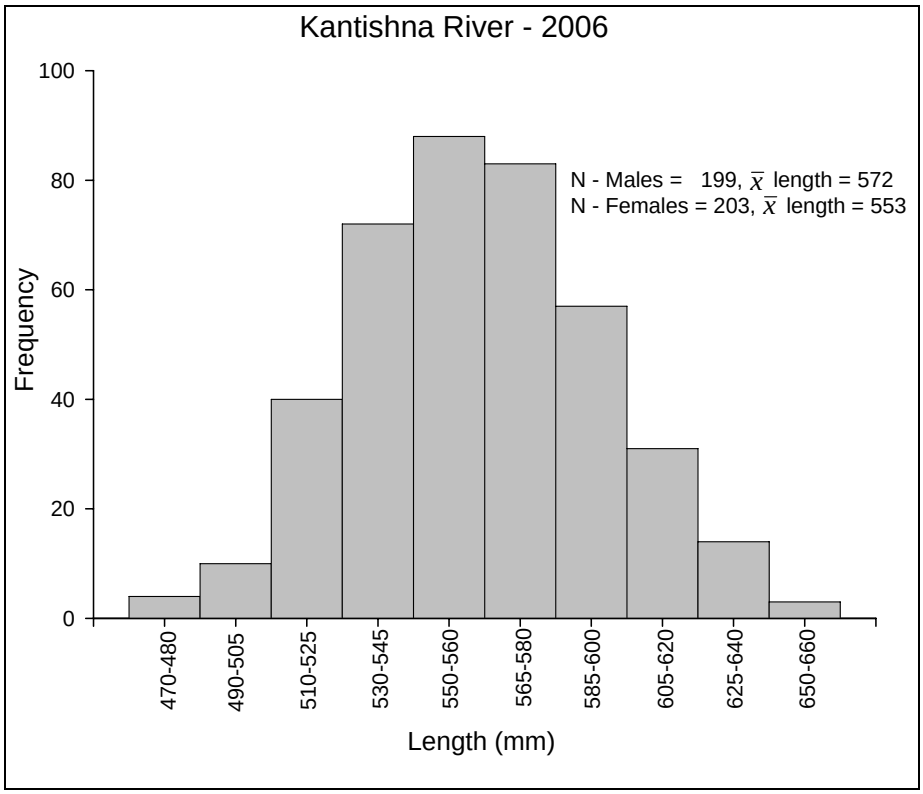

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