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Fall Chum Salmon Mark–Recapture Abundance Estimation on the Tanana and Kantishna Rivers, 2006

Annual Report for Study FIS 05-210

USFWS Office of Subsistence Management

Fisheries Information Services Division

by

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July 2007

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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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 two sites: the Toklat River, 89 km upstream and the upper Kantishna River, 148 km upstream. Fall chum salmon abundance estimates using the Darroch model were 202,669 (SE ± 16,545) for the Tanana River and 71,135 (SE ± 4,972) 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 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. *In prep*).

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/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 salmon are managed as separate stocks based on run timing. For management proposes, 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 Alaska Department of Fish and Game (ADF&G) contracted "test" fish wheels (wheels), 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 to 20,500 fall chum salmon, 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 in the Yukon watershed. For instance, in 2006, roughly 42,000 fall chum (commercial, subsistence, and personal use combined) were

harvested in District 6 of the Tanana River (B. Busher, Commercial Fisheries Biologist, ADF&G, Fairbanks; personal communication). This is 35% of the 1995–2004 average total Alaska fall chum harvest (JTC 2007).

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 count tagged and untagged fall chum and other species using a digital video system at the Tanana tag recovery wheel, and estimate run timing of fall chum 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 to 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 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

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

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 two 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 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 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 fish and 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:

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

The variance was approximated as:

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

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:

$$\hat{M} = \frac{RD}{D} \quad (3)$$

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

Ground surveys were conducted on the Delta River to count the number of live and dead chum and coho salmon for an abundance estimate. On the Delta River, eight surveys were conducted from 12 October through 2 December. On the Toklat River, one aerial survey was conducted of the fall chum spawning area known as the Toklat Springs on 2 November. One ground survey was conducted (by ADF&G and USFWS employees) in November (during peak spawning) at Bluff Cabin Slough on the Tanana River. When possible, tags were retrieved at these locations.

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 4,300 fish of which 3,270 were tagged. At the Kantishna River tag deployment wheel, 4,035 fall chum were captured of which 3,217 were tagged (Appendix A1–A2). The peak chum CPUE of 11.1 fish per hour occurred on 21 September at

the Tanana River tag deployment wheel and 14 September (also 11.1 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 2 October. Total fall chum catch was 12,665 of which 194 were tagged (Appendix A3). On the Toklat River, recovery wheel operations began on 16 August and ended on 30 September. Total fall chum catch (both wheels combined) was 5,904 fish, of which 270 were tagged (Appendix A4). On the Upper Kantishna River, recovery wheels operated from 16 August and ended on 8 October. The total number of fall chum captured (both wheels combined) was 891 of which 38 were tagged (Appendix A5). Total numbers of tags recovered, including public tag recoveries, are listed in Table 1.

Coho salmon represented a substantial portion of total catch at all wheels. Coho CPUE was greatest at the Tanana River tag recovery wheel (69.6 fish per hour) and occurred on 29 September (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 (χ^2 = 4.203**,** df =1, P = 0.04), but not between wheels on the upper Kantishna River (χ^2 = 0.197, df = 1, P = 0.657) or between tag recovery locations (χ^2 = 0.094, df = 1, P = 0.759). Because the marked ratio varied only between wheels on the Toklat River and not between tag recovery locations, all Kantishna River and Toklat River recovery data were pooled.

Logistic regression analysis indicated no significant difference in probability of recapture at recovery wheels due to length (Wald χ^2 = 1.93, df = 1, P = 0.165) or sex (Wald χ^2 = 0.415, df = 1, P = 0.519) (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 χ^2 = 18.961, df = 1, P = <0.001) but no significant difference between day versus night fish (Wald χ^2 = 0, df = 1, P = 0.988) (Table 2).

Chi square tests for marked ratio over time at recovery sites on the Toklat and upper Kantishna River indicated a significant difference for all fish (χ^2 = 20.664**,** df = 4, P = <0.001) and males (χ^2 17.609= 9**,** df = 4, P <0.001) but not for females (χ^2 = 6.925**,** df = 4, P = 0.140).

The Tanana River tag recovery site chi square test for variation in marked ratio over time indicated a significant difference for all fish (χ^2 = 62.172**,** df = 5 , P = <0.001), males (χ^2 = 23.345 df = 5 , P = <0.001) and females (χ^2 = 44.487**,** df = 5, P = <0.0001) (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 202,669 (SE ± 16,545) for the Tanana River (Table 4; Figure 3).

Like the Tanana River, the marked ratio at tag recovery wheels in the Toklat and upper Kantishna River changed over time. As a result, the Darroch model was used. The final estimate for the Kantishna River was 71,135 (SE ± 4,972) (Table 4; Figure 3).

Migration Rate

Toklat River fall chum average migration rates were 26 km/day for day tagged fish (n = 163) and 21 km/day for night tagged fish (n = 106). Migration rate averages for tagged chum salmon captured at the upper Kantishna River tag recovery wheel were 28 km/day (n = 18) for day tagged fish and 25 km/day (n = 19) for night tagged fish. The Holm Sidak test indicated night fish migration rates were less than day fish migration rates ($F = 38.799$, $df = 1$, $P < 0.001$) and female migration rates were less than male ($F = 4.50$, $df = 1$, $P = 0.035$) (Tables 2 and 4).

Stock Timing

During foot surveys, 40 tags were recovered from spawning grounds in the Delta River between October and November, 2006. The median tag deployment date for these fish was 20 September and tagging dates ranged from 28 August through 27 September (Table 1).

DISCUSSION

An above average fall chum run in the Yukon watershed was documented by several run estimate and escapement projects in 2006. For example, the 2006 Pilot Station fall chum preliminary estimate of 790,563 fish (2000–2005 mean = 719,852), the Chandalar River sonar project preliminary estimate of 245,090 (1995–2005 mean = 178,895) fish, and the Sheenjek River right bank sonar estimate of approximately 160,000 (2001–2005 mean = 87,784) (JTC 2007).

Similarly, the 2006 Tanana River mark–recapture run strength estimate was above the mean, the third highest on record (following 1995 and 2005), and exceeds the upper Tanana River management goal 46,000 to 103,000. This estimate is probably conservative because the tag deployment site had changed to some extent due to high water in August which reduced wheel efficiency compared to previous years and the fish wheel was moved on 18 September which increased CPUE.

The Delta River (Tanana watershed) escapement estimate of approximately 14,000 fall chum (JTC 2007) exceeds the biological escapement goal of 6,000 to 13,000. However, this estimate is low compared to the Tanana River mark–recapture estimate and below the 2001–2005 average of 34,000 fish. However, a low estimate may be indicative of poor survey conditions because of high water in October rather than below average escapement.

Migration rates of day tagged fall chum recaptured in Toklat and upper Kantishna rivers were greater than night fish. This is not unexpected because it is established that migration rates of night fish are usually less than day fish in years with high live box densities (Cleary and Hamazaki 2006, Cleary and Hamazaki 2005, Cleary and Hamazaki 2004) (Table 5). However, 2006 migration rates of all fish in the Kantishna River watershed in were greater than average. This could be a consequence of low water levels in the Tanana River watershed during September (Figure 4). Like 2005, water temperatures were also higher at all wheel sites than previous years (Appendix A7) which could also affect migration speed (Salinger and Anderson 2006).

The 2006 Kantishna River fall chum abundance estimate is nearly equal to the 2004 estimate, exceeds the 1999–2005 average abundance estimate of 57,078 and is the fourth largest estimate since 1999 (Table 4; Figure 4). A foot survey of the Toklat springs was not conducted in 2006. However during an aerial survey on 2 November, approximately 2,000 fall chum (live and dead) were counted. It is unclear why counts are low compared to the abundance estimate. However the survey was late compared to previous years and high water in September and October, due to unseasonably warm weather, may have washed carcasses out of the index area.

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TABLES AND FIGURES

Table 1.–Tags recovered by location from fall chum salmon in the Tanana and Kantishna rivers, 2006.

Recapture Location	Method	Number of Tags	Tag Deployment Dates	
			median	range
Delta River	Foot survey	40	9/20	8/28-9/27
Toklat Springs	Foot survey	6	-	9/10-9/20
Tanana River recovery wheel [a]	Fish wheel/digital video	194	9/03	8/27-9/23
Toklat River recovery [b]	Fish wheels	269	9/12	8/25-9/25
Kantishna River recovery [c]	Fish wheels	37	9/10	8/28-9/24
Other tag recoveries [d]	Fishermen/public	29	-	-
Total		575		

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

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

[c] Includes tags captured after 9/29 not used in the abundance estimate.

[d] Includes tags recovered from various locations in the Tanana and Yukon rivers.

Table 2.–Statistical test results for fall chum salmon captured in the Toklat, upper Kantishna, and Tanana rivers tag recovery fish wheels, 2006.

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	0.415	1.930	1	0.519	0.165	402
		Sex	Day vs. Night		Sex	Day vs. Night	
Toklat and upper Kantishna River	recapture probability based on sex and day vs. night	18.961	0.000	1	<0.001	0.988	3,218

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	4.500	38.799	1	0.035	<0.001	312

Chi Square tests

Location	Description	Chi Square	df	P-Value
Toklat River	marked ratio between recovery wheels	4.203	1	0.400
Upper Kantishna River	marked ratio between wheels	0.197	1	0.657
Toklat and upper Kantishna River	marked ratio between wheels	0.094	1	0.759
Toklat and upper Kantishna River	marked ratio over time - all fish	20.664	4	<0.001
Toklat and upper Kantishna River	marked ratio over time - males	17.609	4	0.001
Toklat and upper Kantishna River	marked ratio over time - females	6.925	4	0.140
Tanana River	marked ratio over time - all fish	62.172	5	<0.001
Tanana River	marked ratio over time - males	23.385	5	<0.001
Tanana River	marked ratio over time - females	44.487	5	<0.001

Table 3.–Chi square test data and strata for marked ratio through time for fall chum salmon captured at the Tanana, upper Kantishna, and Toklat rivers tag recovery fish wheels, 2006.

		Marked						Total catch					
Tag recovery locations	**Test**	**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**
Toklat and upper Kantishna River	marked ratio over time (all fish)	0	0	20	46	134	107	12	153	766	1,531	2,720	1,522
Toklat and upper Kantishna River	marked ratio over time (males)	0	0	14	28	84	63	5	83	414	812	1,350	659
Toklat and upper Kantishna River	marked ratio over time (females)	0	0	6	18	50	44	7	70	352	719	1,370	863
Tanana River	marked ratio over time (all fish)	0	27	29	15	30	93	298	750	1,519	2,721	3,031	4,073

Table 4.–Tanana and Kantishna rivers fall chum salmon abundance estimates, 1995–2006.

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
1995–2005 Mean	139,152	14,382	110,964	167,339

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
1999–2005 Mean	57,078	4,710	47,847	66,309

Table 5.–Estimated migration rates (km/day) for day and night caught fall chum salmon in the Tanana and Kantishna rivers, 1995–2006.

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

Year	Day km/day	n	Night km/day	n	Combined 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]
1995–2005 mean	27	37	26	20	27	80

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

Year	Day km/day	n	Night km/day	n	Combined 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
1999–2005 mean	18	74	18	67	18	141

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

Year	Day km/day	n	Night km/day	n	Combined 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
2000–2005 mean	22	11	21	5	22	16

Note: Migration rates for previous years were adjusted using GPS track distances.

[a] Migration rates estimated for all fish only.

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

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

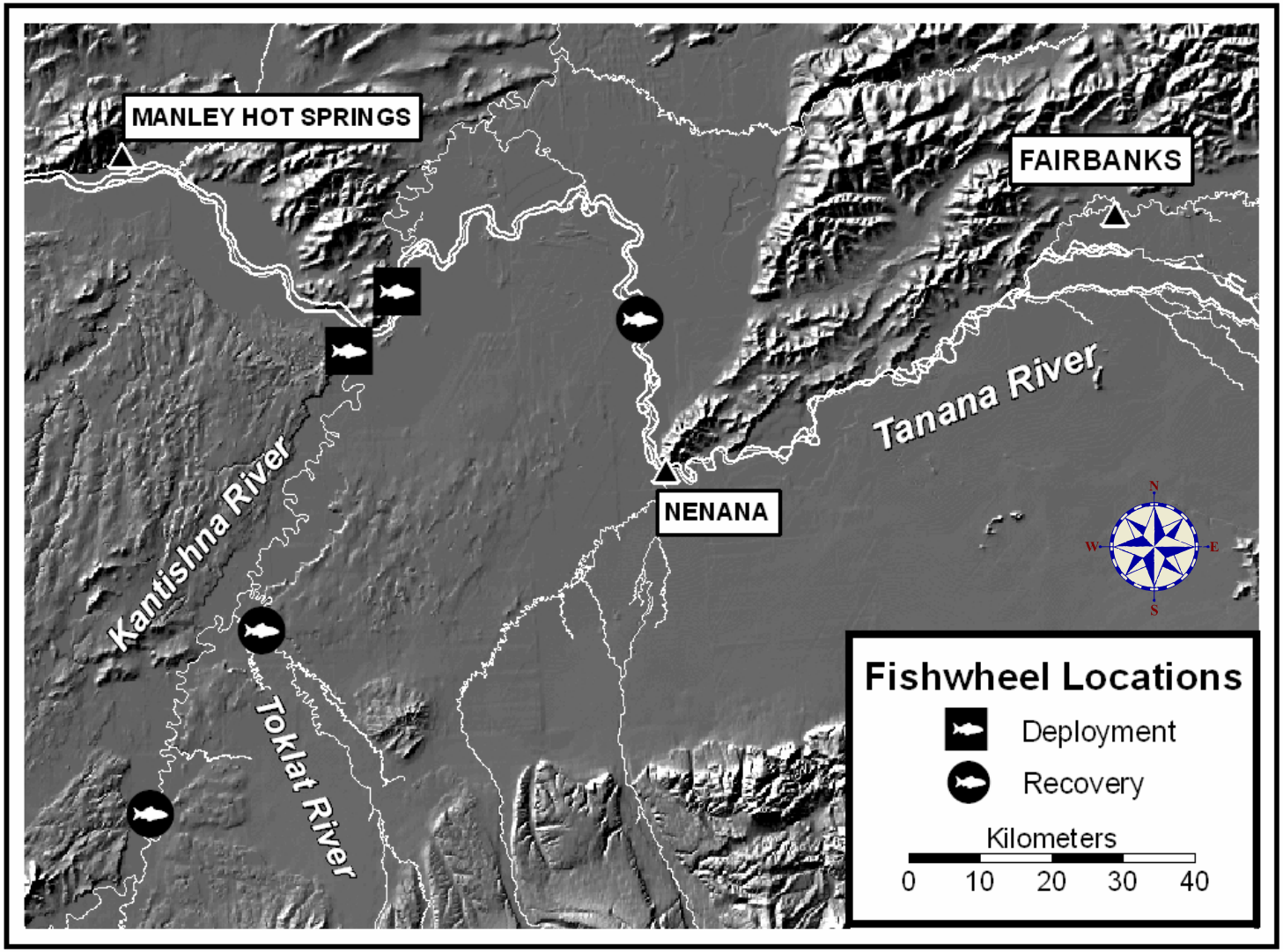
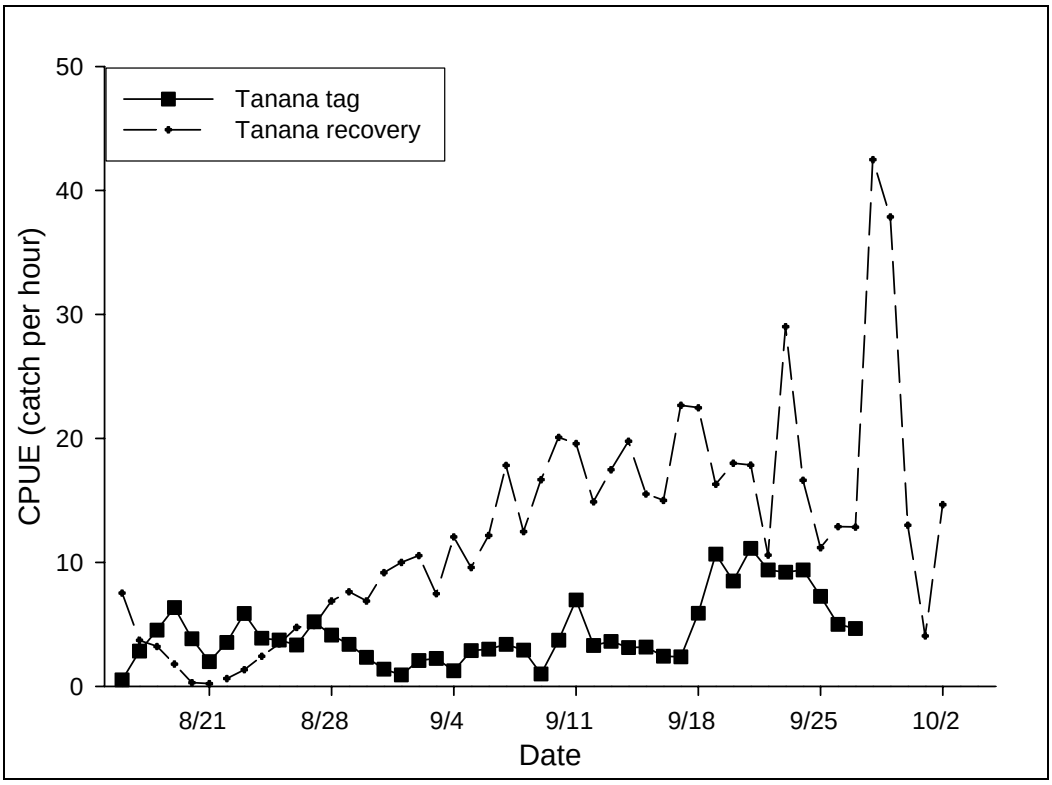


Figure 1.–Location of tag deployment and recovery wheels used in the Tanana and Kantishna rivers fall chum salmon mark–recapture project.



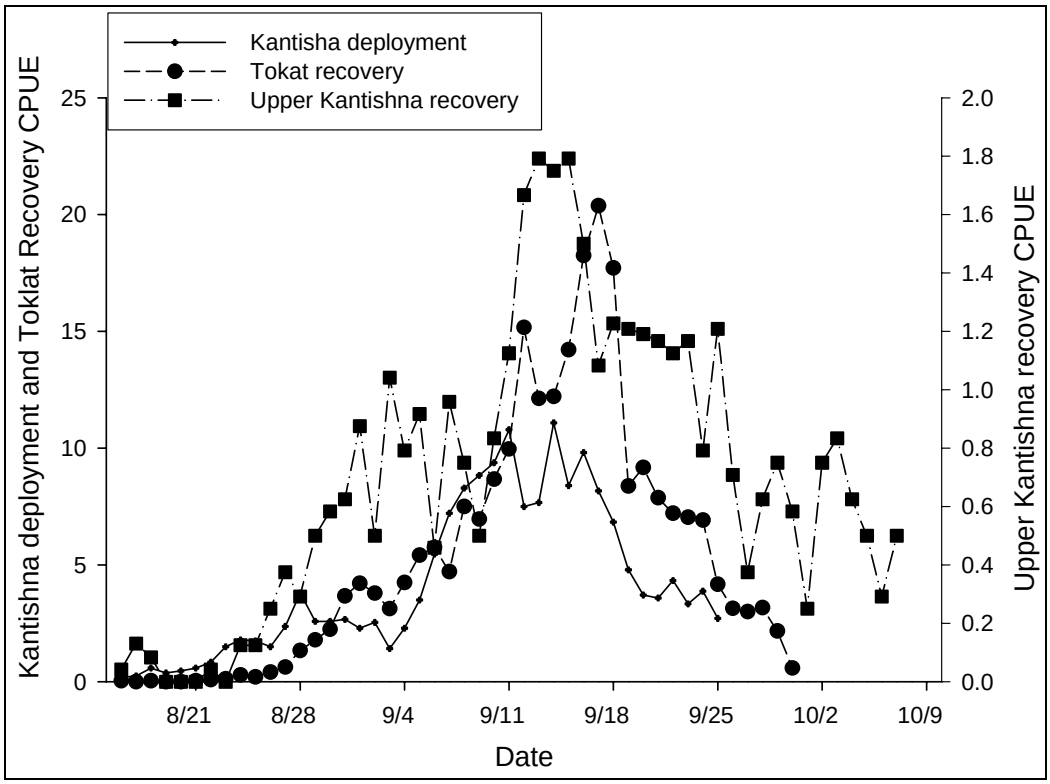


Figure 2.–Daily fall chum salmon CPUE at the Tanana River tagging and recovery fish wheels (top), and CPUE at the Kantishna River tag deployment wheel and recovery fish wheels on the Toklat and upper Kantishna rivers (bottom), 2006.

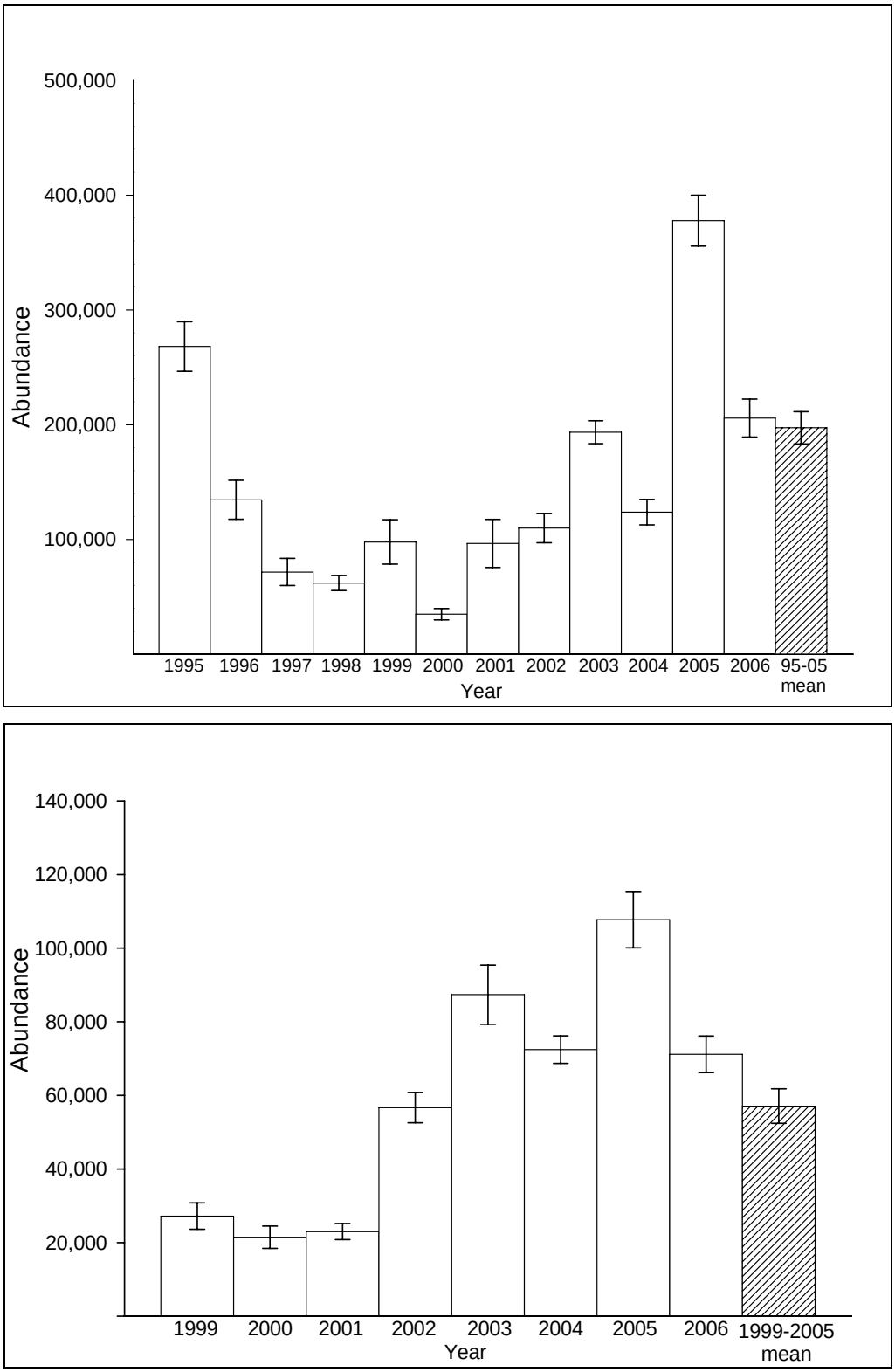
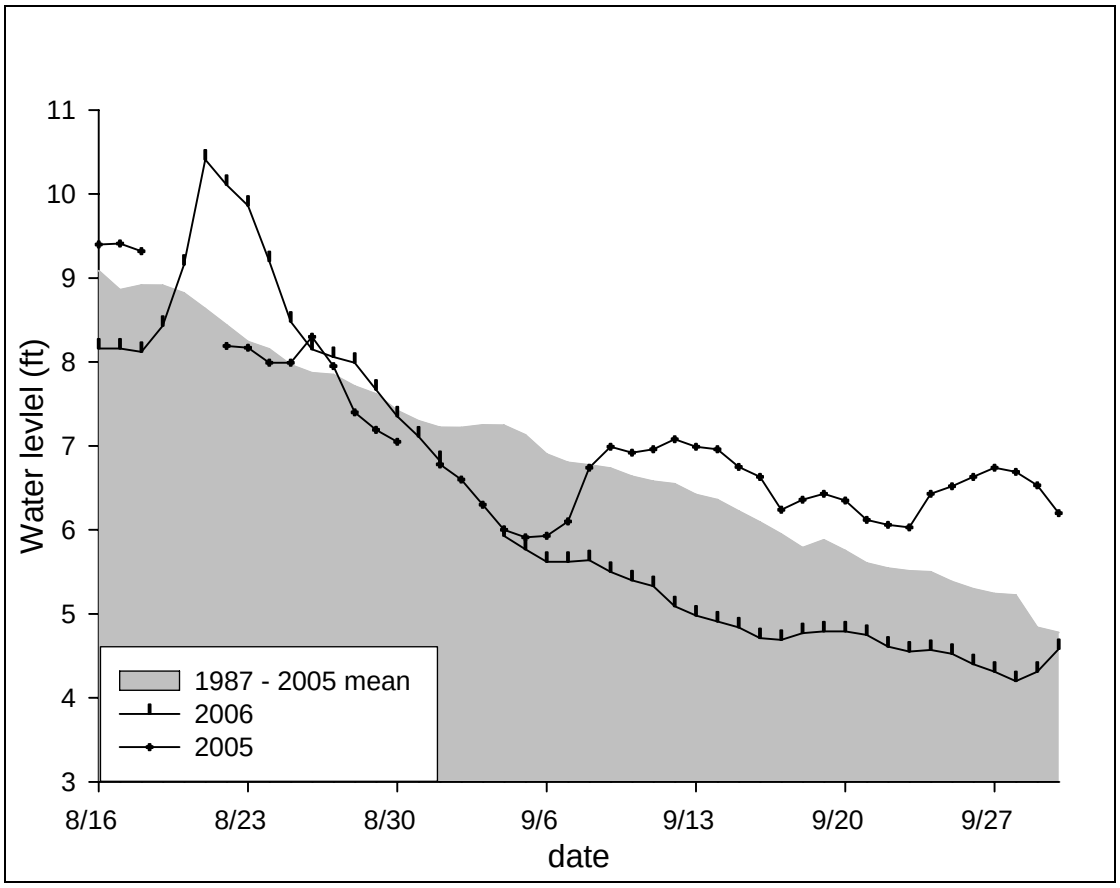


Figure 3.–Fall chum salmon abundance estimates (±SE for estimates with a CV < 0.30) for the Tanana River, 2006 (top) and for the Kantishna River, 1999–2006 (bottom).



Source: U.S. Geological Survey.

Figure 4.–Tanana River water levels near Nenana.

APPENDIX A

Appendix A1.–Daily effort and catch of fall chum salmon at the Tanana River tag deployment fish wheel, 2006.

	Tagged						Not Tagged					Total					
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	Catch Per Hour
8/16	19	2	5	0	7	7	2	1	0	3	3	4	6	0	10	10	0.5
8/17	24	25	24	0	49	56	12	6	1	19	22	37	30	1	68	78	2.8
8/18	24	30	49	0	79	135	17	13	0	30	52	47	62	0	109	187	4.5
8/19	20	30	68	0	98	233	17	12	0	29	81	47	80	0	127	314	6.4
8/20	24	33	38	0	71	304	11	10	0	21	102	44	48	0	92	406	3.8
8/21	24	22	15	0	37	341	5	6	0	11	113	27	21	0	48	454	2.0
8/22	24	32	34	0	66	407	11	8	0	19	132	43	42	0	85	539	3.5
8/23	24	65	50	0	115	522	4	20	2	26	158	69	70	2	141	680	5.9
8/24	24	33	41	0	74	596	5	14	0	19	177	38	55	0	93	773	3.9
8/25	23	28	33	0	61	657	12	13	0	25	202	40	46	0	86	859	3.7
8/26	24	23	40	0	63	720	5	12	0	17	219	28	52	0	80	939	3.3
8/27	24	50	51	0	101	821	9	13	2	24	243	59	64	2	125	1,064	5.2
8/28	21	29	41	0	70	891	12	5	0	17	260	41	46	0	87	1,151	4.1
8/29	24	30	40	0	70	961	5	6	0	11	271	35	46	0	81	1,232	3.4
8/30	24	24	18	0	42	1,003	8	6	0	14	285	32	24	0	56	1,288	2.3
8/31	24	18	12	0	30	1,033	2	1	0	3	288	20	13	0	33	1,321	1.4
9/01	24	11	8	0	19	1,052	2	1	0	3	291	13	9	0	22	1,343	0.9
9/02	24	19	22	0	41	1,093	3	6	0	9	300	22	28	0	50	1,393	2.1
9/03	24	29	20	0	49	1,142	1	4	0	5	305	30	24	0	54	1,447	2.3
9/04	12	7	6	0	13	1,155	2	0	0	2	307	9	6	0	15	1,462	1.3
9/05	16	21	15	1	37	1,192	3	6	0	9	316	24	21	1	46	1,508	2.9
9/06	24	39	21	0	60	1,252	5	7	0	12	328	44	28	0	72	1,580	3.0
9/07	24	36	34	0	70	1,322	7	4	0	11	339	43	38	0	81	1,661	3.4
9/08	12	23	9	0	32	1,354	1	2	0	3	342	24	11	0	35	1,696	2.9
9/09	1	1	0	0	1	1,355	0	0	0	0	342	1	0	0	1	1,697	1.0
9/10	22	38	27	0	65	1,420	13	4	0	17	359	51	31	0	82	1,779	3.7
9/11	24	79	60	0	139	1,559	15	13	0	28	387	94	73	0	167	1,946	7.0
9/12	24	40	27	0	67	1,626	4	8	0	12	399	44	35	0	79	2,025	3.3
9/13	24	47	25	0	72	1,698	4	10	1	15	414	51	35	1	87	2,112	3.6
9/14	24	49	19	0	68	1,766	2	4	1	7	421	51	23	1	75	2,187	3.1

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	Tagged						Not Tagged					Total					
Date	Hours Fished	No. Male	No. UNK [a] Female	Sex	Total	Cum	No. Male	No. UNK [a] Female	Sex	Total	Cum	No. Male	No. UNK [a] Female	Sex	Total	Cum	Catch Per Hour
9/15	24	36	32	0	68	1,834	3	5	0	8	429	39	37	0	76	2,263	3.2
9/16	24	36	14	0	50	1,884	6	2	0	8	437	42	16	0	58	2,321	2.4
9/17	24	30	19	0	49	1,933	4	4	0	8	445	34	23	0	57	2,378	2.4
9/18 [b]	20	51	47	0	98	2,031	9	11	0	20	465	60	58	0	118	2,496	5.9
9/19	24	65	86	0	151	2,182	49	56	0	105	570	114	142	0	256	2,752	10.7
9/20	24	72	79	0	151	2,333	27	26	0	53	623	99	105	0	204	2,956	8.5
9/21	24	58	92	0	150	2,483	48	69	0	117	740	106	161	0	267	3,223	11.1
9/22	24	67	83	0	150	2,633	30	45	0	75	815	97	128	0	225	3,448	9.4
9/23	24	62	90	0	152	2,785	26	43	0	69	884	88	133	0	221	3,669	9.2
9/24	24	69	81	0	150	2,935	29	46	0	75	959	98	127	0	225	3,894	9.4
9/25	24	58	92	0	150	3,085	7	17	0	24	983	65	109	0	174	4,068	7.3
9/26	24	39	56	0	95	3,180	11	14	0	25	1,008	50	70	0	120	4,188	5.0
9/27	24	31	59	0	90	3,270	9	13	0	22	1,030	40	72	0	112	4,300	4.7
Total	958	1,682	1,682	1	3,270		457	566	7	1,030		2,044	2,248	8	4,300		

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

[a] Unidentified sex.

[b] Wheel moved 200 meters downstream.

Appendix A2.–Daily effort and catch of fall chum salmon at the Kantishna River tag deployment fish wheel, 2006.

		Tagged					Not Tagged					Total					
	Hours			UNK [a]					UNK [a]					UNK [a]			Catch
Date	Fished	Males	Females	Sex	Total	Cum	Males	Females	Sex	Total	Cum	Males	Females	Sex	Total	Cum	Per Hour
8/16	11	1	1	0	2	2	0	0	0	0	0	1	1	0	2	2	0.2
8/17	24	1	3	0	4	6	2	0	0	2	0	3	3	0	6	8	0.3
8/18	24	5	8	0	13	19	1	0	0	1	0	6	8	0	14	22	0.6
8/19	24	3	6	0	9	28	0	0	0	0	0	3	6	0	9	31	0.4
8/20	24	6	4	0	10	38	0	1	0	1	0	6	5	0	11	42	0.5
8/21	24	8	5	0	13	51	1	0	0	1	0	9	5	0	14	56	0.6
8/22	24	13	6	0	19	70	1	0	0	1	0	14	6	0	20	76	0.8
8/23	24	15	14	0	29	99	6	1	0	7	0	21	15	0	36	112	1.5
8/24	24	20	17	0	37	136	4	2	0	6	0	24	19	0	43	155	1.8
8/25	24	26	11	0	37	173	4	1	0	5	0	30	12	0	42	197	1.8
8/26	24	18	9	0	27	200	6	3	0	9	0	24	12	0	36	233	1.5
8/27	27	35	19	0	54	254	4	6	0	10	0	39	25	0	64	297	2.4
8/28	20	38	27	0	65	319	5	6	0	11	0	43	33	0	76	373	3.8
8/29	24	33	23	0	56	375	4	2	0	6	0	37	25	0	62	435	2.6
8/30	24	23	24	0	47	422	4	11	0	15	0	27	35	0	62	497	2.6
8/31	24	33	23	0	56	478	5	3	0	8	0	38	26	0	64	561	2.7
9/01	24	23	24	0	47	525	4	4	0	8	0	27	28	0	55	616	2.3
9/02	24	31	23	0	54	579	3	4	0	7	0	34	27	0	61	677	2.5
9/03	24	17	12	0	29	608	3	2	0	5	0	20	14	0	34	711	1.4
9/04	24	19	29	0	48	656	2	5	0	7	0	21	34	0	55	766	2.3
9/05	24	41	38	0	79	735	2	3	0	5	0	43	41	0	84	850	3.5
9/06	24	70	46	0	116	851	6	9	0	15	0	76	55	0	131	981	5.5
9/07	24	76	78	0	154	1,005	11	8	0	19	0	87	86	0	173	1,154	7.2
9/08	24	91	61	0	152	1,157	22	24	1	47	0	113	85	1	199	1,353	8.3
9/09	24	83	68	0	151	1,308	27	33	1	61	0	110	101	1	212	1,565	8.8
9/10	24	83	72	0	155	1,463	41	29	0	70	0	124	101	0	225	1,790	9.4
9/11	24	90	61	0	151	1,614	62	45	0	107	0	152	106	0	258	2,048	10.8
9/12	24	74	77	0	151	1,765	16	13	0	29	0	90	90	0	180	2,228	7.5
9/13	24	78	73	0	151	1,916	17	16	0	33	0	95	89	0	184	2,412	7.7
9/14	24	72	79	0	151	2,067	48	66	1	115	0	120	145	1	266	2,678	11.1
9/15	20	74	75	0	149	2,216	7	12	0	19	0	81	87	0	168	2,846	8.4

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	Tagged						Not Tagged					Total					
Date	Hours Fished	Males	Females	UNK [a] Sex	Total	Cum	Males	Females	UNK [a] Sex	Total	Cum	Males	Females	UNK [a] Sex	Total	Cum	Catch Per Hour
9/16	20	65	85	0	150	2,366	22	34	0	56	686	87	119	0	206	3,052	10.3
9/17	21	73	77	0	150	2,516	23	23	0	46	732	96	100	0	196	3,248	9.3
9/18	24	72	79	0	151	2,667	6	7	0	13	745	78	86	0	164	3,412	6.8
9/19	24	46	57	0	103	2,770	4	7	0	11	756	50	64	0	114	3,526	4.8
9/20	24	37	43	0	80	2,850	5	4	0	9	765	42	47	0	89	3,615	3.7
9/21	24	29	48	0	77	2,927	5	4	0	9	774	34	52	0	86	3,701	3.6
9/22	24	35	56	0	91	3,018	4	9	0	13	787	39	65	0	104	3,805	4.3
9/23	24	27	43	0	70	3,088	5	5	0	10	797	32	48	0	80	3,885	3.3
9/24	24	25	53	0	78	3,166	2	13	0	15	812	27	66	0	93	3,978	3.9
9/25	24	21	30	0	51	3,217	1	5	0	6	818	22	35	0	57	4,035	2.4
Total	1,630	1,630	1,587	0	3,217		395	420	3	818		2,025	2,007	3	4,035		

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, 2006.

	Tagged						Not Tagged					Total					
	Hours			UNK [a]					UNK [a]					UNK [a]			Catch
Date	Fished	Males	Females	Sex	Total	Cum	Males	Females	Sex	Total	Cum	Males	Females	Sex	Total	Cum	Per Hour
8/16	8	0	0	0	0	0	25	37	0	62	62	25	37	0	62	62	7.5
8/17	24	0	0	0	0	0	41	48	0	89	151	41	48	0	89	151	3.7
8/18	24	0	0	0	0	0	36	41	0	77	228	36	41	0	77	228	3.2
8/19	24	0	0	0	0	0	21	22	0	43	271	21	22	0	43	271	1.8
8/20	24	0	0	0	0	0	2	5	0	7	278	2	5	0	7	278	0.3
8/21	24	0	0	0	0	0	1	4	0	5	283	1	4	0	5	283	0.2
8/22	24	0	0	0	0	0	11	4	0	15	298	11	4	0	15	298	0.6
8/23	24	0	1	0	1	1	15	16	0	31	329	15	17	0	32	330	1.3
8/24	24	1	0	0	1	2	26	31	0	57	386	27	31	0	58	388	2.4
8/25	24	1	1	0	2	4	32	48	0	80	466	33	49	0	82	470	3.4
8/26	24	2	4	0	6	10	45	63	0	108	574	47	67	0	114	584	4.8
8/27	24	3	2	0	5	15	55	57	0	112	686	58	59	0	117	701	4.9
8/28	24	4	4	0	8	23	81	76	0	157	843	85	80	0	165	866	6.9
8/29	24	1	3	0	4	27	86	92	0	178	1,021	87	95	0	182	1,048	7.6
8/30	24	1	2	0	3	30	82	79	0	161	1,182	83	81	0	164	1,212	6.9
8/31	24	3	2	0	5	35	110	103	0	213	1,395	113	105	0	218	1,430	9.2
9/01	24	1	3	0	4	39	116	120	0	236	1,631	117	123	0	240	1,670	10.0
9/02	24	1	2	0	3	42	126	124	0	250	1,881	127	126	0	253	1,923	10.5
9/03	24	2	1	0	3	45	77	99	0	176	2,057	79	100	0	179	2,102	7.5
9/04	20	1	4	0	5	50	111	119	0	230	2,287	112	123	0	235	2,337	12.1
9/05	24	3	3	0	6	56	110	114	0	224	2,511	113	117	0	230	2,567	9.6
9/06	24	4	0	0	4	60	152	136	0	288	2,799	156	136	0	292	2,859	12.2
9/07	24	3	1	0	4	64	212	208	0	420	3,219	215	209	0	424	3,283	17.8
9/08	24	3	1	0	4	68	154	139	0	293	3,512	157	140	0	297	3,580	12.5
9/09	24	2	0	0	2	70	201	196	0	397	3,909	203	196	0	399	3,979	16.6
9/10	24	1	0	0	1	71	275	206	0	481	4,390	276	206	0	482	4,461	20.1
9/11	24	0	0	0	0	71	284	186	0	470	4,860	284	186	0	470	4,931	19.6
9/12	24	0	0	0	0	71	198	159	0	357	5,217	198	159	0	357	5,288	14.9

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	Tagged						Not Tagged					Total					
	Hours			UNK [a]					UNK [a]					UNK [a]			Catch
Date	Fished	Males	Females	Sex	Total	Cum	Males	Females	Sex	Total	Cum	Males	Females	Sex	Total	Cum	Per Hour
9/13	24	4	6	0	10	81	220	189	0	409	5,626	224	195	0	419	5,707	17.5
9/14	21	6	2	0	8	89	227	177	0	404	6,030	233	179	0	412	6,119	19.8
9/15	24	4	0	0	4	93	198	164	0	362	6,392	202	164	0	366	6,485	15.5
9/16	24	0	0	0	0	93	178	182	0	360	6,752	178	182	0	360	6,845	15.0
9/17	24	2	0	0	2	95	262	280	0	542	7,294	264	280	0	544	7,389	22.7
9/18	24	3	3	0	6	101	273	260	0	533	7,827	276	263	0	539	7,928	22.5
9/19	24	0	0	0	0	101	183	208	0	391	8,218	183	208	0	391	8,319	16.3
9/20	24	1	0	0	1	102	173	258	0	431	8,649	174	258	0	432	8,751	18.0
9/21	24	7	6	0	13	115	173	242	0	415	9,064	180	248	0	428	9,179	17.8
9/22	24	2	3	0	5	120	112	137	0	249	9,313	114	140	0	254	9,433	10.6
9/23	16	4	5	0	9	129	204	238	0	442	9,755	208	243	0	451	9,884	29.0
9/24	24	4	4	0	8	137	154	237	0	391	10,146	158	241	0	399	10,283	16.6
9/25	24	2	4	0	6	143	98	161	0	259	10,405	100	165	0	265	10,548	11.2
9/26	24	2	2	0	4	147	105	200	0	305	10,710	107	202	0	309	10,857	12.9
9/27	24	6	10	0	16	163	118	174	0	292	11,002	124	184	0	308	11,165	12.8
9/28	9	6	3	0	9	172	126	229	0	355	11,357	132	232	0	364	11,529	42.5
9/29	15	6	11	0	17	189	171	363	0	534	11,891	177	374	0	551	12,080	37.9
9/30	24	0	5	0	5	194	99	208	0	307	12,198	99	213	0	312	12,392	13.0
10/1	16	0	0	0	0	194	14	51	0	65	12,263	14	51	0	65	12,457	4.1
10/2	14	0	0	0	0	194	56	152	0	208	12,471	56	152	0	208	12,665	14.6
Total	1,117	96	98	0	194		5,829	6,642	0	12,471		5,925	6,740	0	12,665		

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), 2006.

		Tagged					Not Tagged					Total					
	Hours			UNK [a]					UNK [a]					UNK [a]			Catch
Date	Fished	Males	Females	Sex	Total	Cum	Males	Females	Sex	Total	Cum	Males	Females	Sex	Total	Cum	Per Hour
8/16	24	0	0	0	0	0	0	1	0	1	1	0	1	0	1	1	0.0
8/17	24	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0.0
8/18	24	0	0	0	0	0	1	0	0	1	2	1	0	0	1	2	0.0
8/19	22	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	0.0
8/20	24	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	0.0
8/21	24	0	0	0	0	0	1	0	0	1	3	1	0	0	1	3	0.0
8/22	24	0	0	0	0	0	0	2	0	2	5	0	2	0	2	5	0.1
8/23	24	0	0	0	0	0	1	2	0	3	8	1	2	0	3	8	0.1
8/24	24	0	0	0	0	0	4	3	0	7	15	4	3	0	7	15	0.3
8/25	20	0	0	0	0	0	0	4	0	4	19	0	4	0	4	19	0.2
8/26	22	0	0	0	0	0	5	4	0	9	28	5	4	0	9	28	0.4
8/27	24	0	0	0	0	0	6	9	0	15	43	6	9	0	15	43	0.6
8/28	24	0	0	0	0	0	16	16	0	32	75	16	16	0	32	75	1.3
8/29	24	2	0	0	2	2	23	18	0	41	116	25	18	0	43	118	1.8
8/30	24	1	0	0	1	3	26	27	0	53	169	27	27	0	54	172	2.3
8/31	24	2	1	0	3	6	43	42	0	85	254	45	43	0	88	260	3.7
9/01	24	3	0	0	3	9	61	37	0	98	352	64	37	0	101	361	4.2
9/02	24	2	1	0	3	12	49	39	0	88	440	51	40	0	91	452	3.8
9/03	24	2	1	0	3	15	30	41	0	71	511	32	42	0	74	526	3.1
9/04	24	2	2	0	4	19	50	48	0	98	609	52	50	0	102	628	4.3
9/05	24	2	1	0	3	22	68	57	1	126	735	70	58	1	129	757	5.4
9/06	20	2	0	0	2	24	63	50	0	113	848	65	50	0	115	872	5.8
9/07	24	1	0	0	1	25	58	54	0	112	960	59	54	0	113	985	4.7
9/08	24	5	3	0	8	33	85	88	0	173	1,133	90	91	0	181	1,166	7.5
9/09	24	7	1	0	8	41	76	82	0	158	1,291	83	83	0	166	1,332	6.9
9/10	24	5	6	0	11	52	119	76	0	195	1,486	124	82	0	206	1,538	8.6
9/11	24	3	4	0	7	59	123	108	0	231	1,717	126	112	0	238	1,776	9.9
9/12	24	17	8	0	25	84	171	165	0	336	2,053	188	173	0	361	2,137	15.0

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	Tagged						Not Tagged					Total					
Date	Hours Fished	Males	Females	UNK [a] Sex	Total	Cum	Males	Females	UNK [a] Sex	Total	Cum	Males	Females	UNK [a] Sex	Total	Cum	Catch Per Hour
9/13	24	7	3	0	10	94	146	135	0	281	2,334	153	138	0	291	2,428	12.1
9/14	24	11	3	0	14	108	157	121	0	278	2,612	168	124	0	292	2,720	12.2
9/15	24	8	7	0	15	123	153	171	0	324	2,936	161	178	0	339	3,059	14.1
9/16	24	8	5	0	13	136	220	205	0	425	3,361	228	210	0	438	3,497	18.3
9/17	24	12	12	0	24	160	215	249	0	464	3,825	227	261	0	488	3,985	20.3
9/18	24	8	8	0	16	176	191	218	0	409	4,234	199	226	0	425	4,410	17.7
9/19	24	7	7	0	14	190	79	108	0	187	4,421	86	115	0	201	4,611	8.4
9/20	24	14	9	0	23	213	89	108	0	197	4,618	103	117	0	220	4,831	9.2
9/21	24	5	6	0	11	224	76	100	0	176	4,794	81	106	0	187	5,018	7.8
9/22	24	8	2	0	10	234	65	98	0	163	4,957	73	100	0	173	5,191	7.2
9/23	24	3	2	0	5	239	56	107	0	163	5,120	59	109	0	168	5,359	7.0
9/24	24	6	7	0	13	252	60	92	0	152	5,272	66	99	0	165	5,524	6.9
9/25	24	3	0	0	3	255	48	49	0	97	5,369	51	49	0	100	5,624	4.2
9/26	21	2	1	0	3	258	24	39	0	63	5,432	26	40	0	66	5,690	3.1
9/27	24	4	2	0	6	264	30	36	0	66	5,498	34	38	0	72	5,762	3.0
9/28	24	0	4	0	4	268	28	44	0	72	5,570	28	48	0	76	5,838	3.2
9/29	24	2	0	0	2	270	22	28	0	50	5,620	24	28	0	52	5,890	2.2
9/30	24	0	0	0	0	270	7	7	0	14	5,634	7	7	0	14	5,904	0.6
Total	1,088	164	106	0	270		2,745	2,888	1	5,634		2,909	2,994	1	5,904		

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), 2006.

		Tagged					Not Tagged					Total					
	Hours			UNK [a]					UNK [a]					UNK [a]			Catch
Date	Fished	Males	Females	Sex	Total	Cum	Males	Females	Sex	Total	Cum	Males	Females	Sex	Total	Cum	Per Hour
8/16	24	0	0	0	0	0	1	0	0	1	1	1	0	0	1	1	0.0
8/17	23	0	0	0	0	0	1	2	0	3	4	1	2	0	3	4	0.1
8/18	24	0	0	0	0	0	1	1	0	2	6	1	1	0	2	6	0.1
8/19	24	0	0	0	0	0	0	0	0	0	6	0	0	0	0	6	0.0
8/20	24	0	0	0	0	0	0	0	0	0	6	0	0	0	0	6	0.0
8/21	24	0	0	0	0	0	0	0	0	0	6	0	0	0	0	6	0.0
8/22	24	0	0	0	0	0	0	1	0	1	7	0	1	0	1	7	0.0
8/23	19	0	0	0	0	0	0	0	0	0	7	0	0	0	0	7	0.0
8/24	24	0	0	0	0	0	2	1	0	3	10	2	1	0	3	10	0.1
8/25	24	0	0	0	0	0	2	1	0	3	13	2	1	0	3	13	0.1
8/26	24	0	0	0	0	0	3	3	0	6	19	3	3	0	6	19	0.3
8/27	24	0	0	0	0	0	7	2	0	9	28	7	2	0	9	28	0.4
8/28	24	0	0	0	0	0	5	2	0	7	35	5	2	0	7	35	0.3
8/29	24	0	0	0	0	0	7	5	0	12	47	7	5	0	12	47	0.5
8/30	24	0	0	0	0	0	11	3	0	14	61	11	3	0	14	61	0.6
8/31	24	0	0	0	0	0	9	6	0	15	76	9	6	0	15	76	0.6
9/1	24	0	0	0	0	0	12	9	0	21	97	12	9	0	21	97	0.9
9/2	24	0	0	0	0	0	6	6	0	12	109	6	6	0	12	109	0.5
9/3	24	0	1	0	1	1	12	12	0	24	133	12	13	0	25	134	1.0
9/4	24	0	0	0	0	1	11	8	0	19	152	11	8	0	19	153	0.8
9/5	24	0	2	0	2	3	12	8	0	20	172	12	10	0	22	175	0.9
9/6	24	0	0	0	0	3	6	5	0	11	183	6	5	0	11	186	0.5
9/7	24	0	0	0	0	3	11	12	0	23	206	11	12	0	23	209	1.0
9/8	24	0	0	0	0	3	10	8	0	18	224	10	8	0	18	227	0.8
9/9	24	0	0	0	0	3	8	4	0	12	236	8	4	0	12	239	0.5
9/10	24	1	0	0	1	4	7	12	0	19	255	8	12	0	20	259	0.8
9/11	24	2	1	0	3	7	15	9	0	24	279	17	10	0	27	286	1.1
9/12	24	3	2	0	5	12	14	21	0	35	314	17	23	0	40	326	1.7
9/13	24	1	0	0	1	13	19	23	0	42	356	20	23	0	43	369	1.8

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		Tagged					Not Tagged					Total					
Date	Hours Fished	Males	Females	UNK [a] Sex	Total	Cum	Males	Females	UNK [a] Sex	Total	Cum	Males	Females	UNK [a] Sex	Total	Cum	Catch Per Hour
9/14	24	1	0	0	1	14	21	20	0	41	397	22	20	0	42	411	1.8
9/15	24	2	1	0	3	17	22	18	0	40	437	24	19	0	43	454	1.8
9/16	24	2	1	0	3	20	13	15	5	33	470	15	16	5	36	490	1.5
9/17	24	1	0	0	1	21	11	14	0	25	495	12	14	0	26	516	1.1
9/18	22	3	0	0	3	24	12	12	0	24	519	15	12	0	27	543	1.2
9/19	24	0	1	0	1	25	15	13	0	28	547	15	14	0	29	572	1.2
9/20	21	1	0	0	1	26	13	11	0	24	571	14	11	0	25	597	1.2
9/21	24	1	0	0	1	27	6	21	0	27	598	7	21	0	28	625	1.2
9/22	24	0	1	0	1	28	10	16	0	26	624	10	17	0	27	652	1.1
9/23	24	2	0	0	2	30	11	15	0	26	650	13	15	0	28	680	1.2
9/24	24	0	1	0	1	31	11	7	0	18	668	11	8	0	19	699	0.8
9/25	24	2	0	0	2	33	9	18	0	27	695	11	18	0	29	728	1.2
9/26	24	1	0	0	1	34	7	9	0	16	711	8	9	0	17	745	0.7
9/27	24	0	0	0	0	34	6	3	0	9	720	6	3	0	9	754	0.4
9/28	24	0	0	0	0	34	8	7	0	15	735	8	7	0	15	769	0.6
9/29	24	2	1	0	3	37	9	6	0	15	750	11	7	0	18	787	0.8
9/30	24	0	1	0	1	38	8	5	0	13	763	8	6	0	14	801	0.6
10/1	24	0	0	0	0	38	3	3	0	6	769	3	3	0	6	807	0.3
10/2	24	0	0	0	0	38	8	10	0	18	787	8	10	0	18	825	0.8
10/3	24	0	0	0	0	38	3	17	0	20	807	3	17	0	20	845	0.8
10/4	24	0	0	0	0	38	5	10	0	15	822	5	10	0	15	860	0.6
10/5	24	0	0	0	0	38	6	6	0	12	834	6	6	0	12	872	0.5
10/6	24	0	0	0	0	38	3	4	0	7	841	3	4	0	7	879	0.3
10/7	24	0	0	0	0	38	8	4	0	12	853	8	4	0	12	891	0.5
Total	1,303	25	13	0	38		420	428	5	853		445	441	5	891		

[a] Unidentified sex.

Appendix A6.–Daily effort and catch of coho salmon at the Tanana/Kantishna River mark–recapture project fish wheels, 2006.

	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	0	0	0.0	0	0	0.0	0	0	0.0
8/17	0	0	0.0	2	2	0.1	1	1	0.0	0	0	0.0	0	0	0.0
8/18	0	0	0.0	3	5	0.1	0	1	0.0	0	0	0.0	0	0	0.0
8/19	4	4	0.2	2	7	0.1	0	1	0.0	0	0	0.0	1	1	0.0
8/20	3	7	0.1	0	7	0.0	0	1	0.0	0	0	0.0	0	1	0.0
8/21	3	10	0.1	0	7	0.0	0	1	0.0	1	1	0.0	0	1	0.0
8/22	8	18	0.3	1	8	0.0	1	2	0.0	0	1	0.0	1	2	0.0
8/23	9	27	0.4	1	9	0.0	2	4	0.1	0	1	0.0	3	5	0.2
8/24	18	45	0.8	4	13	0.2	0	4	0.0	0	1	0.0	1	6	0.0
8/25	7	52	0.3	6	19	0.3	3	7	0.1	0	1	0.0	3	9	0.1
8/26	8	60	0.3	12	31	0.5	0	7	0.0	0	1	0.0	4	13	0.2
8/27	24	84	1.0	14	45	0.6	3	10	0.1	0	1	0.0	5	18	0.2
8/28	19	103	0.9	15	60	0.6	3	13	0.2	0	1	0.0	9	27	0.4
8/29	13	116	0.5	36	96	1.5	4	17	0.2	1	2	0.0	4	31	0.2
8/30	5	121	0.2	71	167	3.0	4	21	0.2	1	3	0.0	9	40	0.4
8/31	5	126	0.2	109	276	4.6	1	22	0.0	1	4	0.0	6	46	0.3
9/01	3	129	0.1	121	397	5.0	1	23	0.0	4	8	0.2	8	54	0.3
9/02	13	142	0.5	157	554	6.5	6	29	0.3	1	9	0.0	12	66	0.5
9/03	5	147	0.2	170	724	7.1	4	33	0.2	2	11	0.1	14	80	0.6
9/04	8	155	0.7	233	957	11.9	2	35	0.1	8	19	0.3	12	92	0.5
9/05	7	162	0.4	203	1,160	8.5	1	36	0.0	9	28	0.4	9	101	0.4
9/06	15	177	0.6	277	1,437	11.5	5	41	0.2	7	35	0.4	13	114	0.5
9/07	9	186	0.4	281	1,718	11.8	8	49	0.3	14	49	0.6	14	128	0.6
9/08	3	189	0.3	233	1,951	9.8	11	60	0.5	8	57	0.3	11	139	0.5
9/09	0	189	0.0	481	2,432	20.0	12	72	0.5	18	75	0.8	9	148	0.4
9/10	12	201	0.5	405	2,837	16.9	17	89	0.7	15	90	0.6	20	168	0.8
9/11	53	254	2.2	385	3,222	16.0	15	104	0.6	15	105	0.6	26	194	1.1
9/12	16	270	0.7	378	3,600	15.8	13	117	0.5	23	128	1.0	12	206	0.5
9/13	17	287	0.7	446	4,046	18.6	22	139	0.9	28	156	1.2	18	224	0.8

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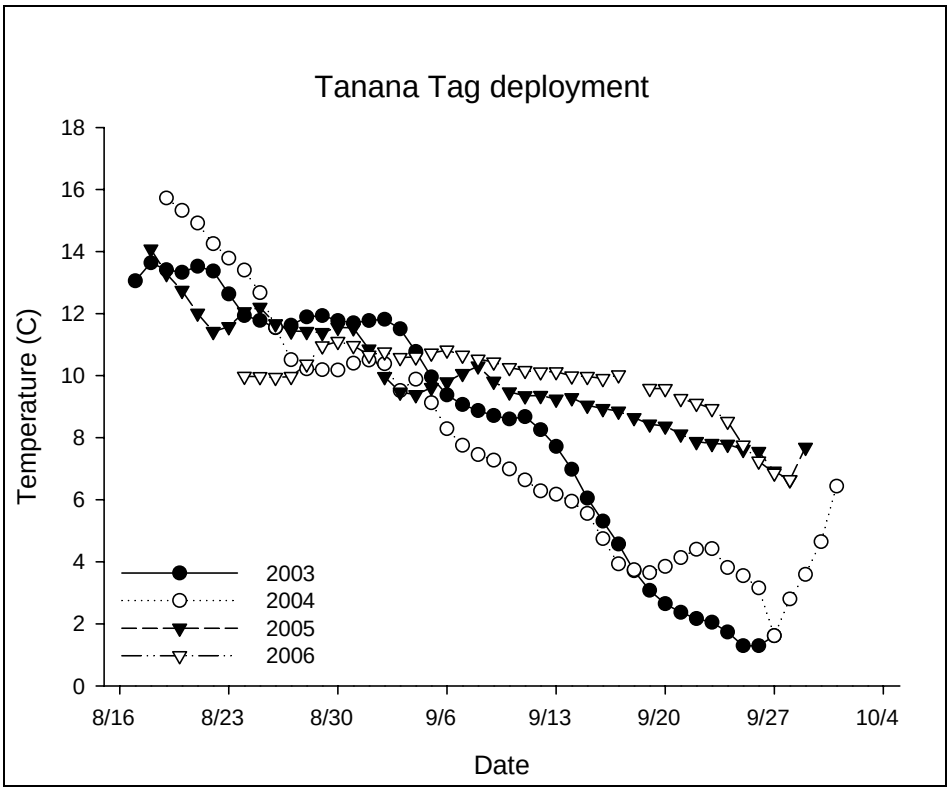
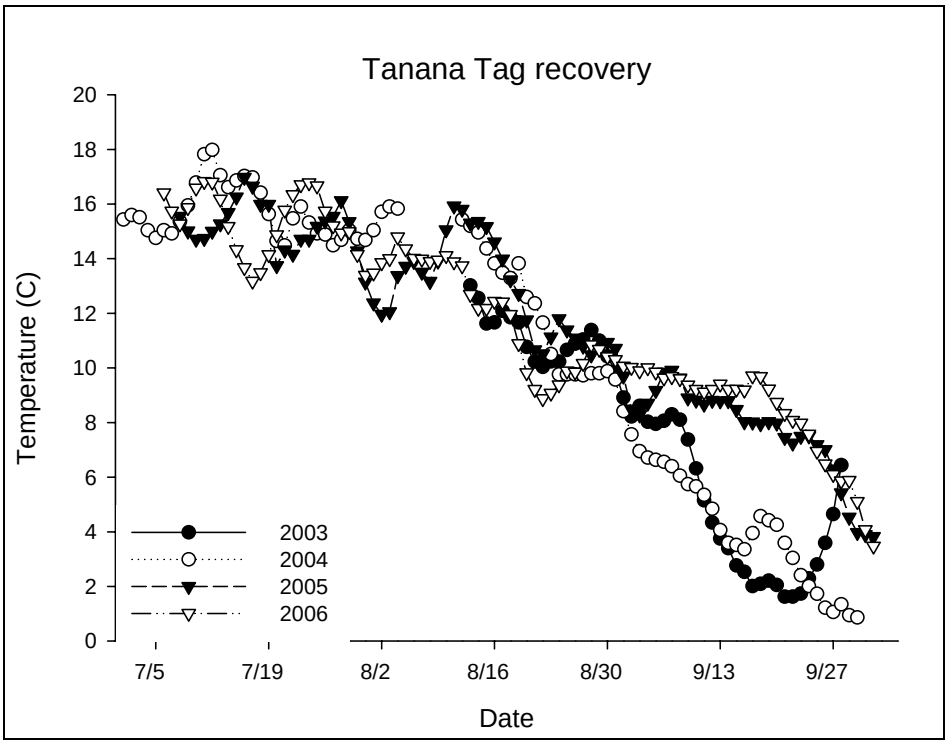
	Tanana Tag Deployment			Tanana Tag Recovery			Kantishna Tag Deployment			Toklat Tag Recovery			Kantishna Tag Recovery		
Date	Catch	Cum.	Catch Per Hour	Catch	Cum.	Catch Per Hour	Catch	Cum.	Catch Per Hour	Catch	Cum.	Catch Per Hour	Catch	Cum.	Catch Per Hour
9/14	21	308	0.9	430	4,476	20.6	27	166	1.1	27	183	1.1	12	236	0.5
9/15	9	317	0.4	635	5,111	26.9	20	186	1.0	28	211	1.2	8	244	0.3
9/16	12	329	0.5	432	5,543	18.0	39	225	1.9	34	245	1.4	16	260	0.7
9/17	4	333	0.2	715	6,258	29.8	32	257	1.3	64	309	2.7	7	267	0.3
9/18	15	348	0.8	803	7,061	33.5	50	307	2.1	72	381	3.0	12	279	0.5
9/19	31	379	1.3	818	7,879	34.1	47	354	2.0	66	447	2.8	15	294	0.6
9/20	41	420	1.7	625	8,504	26.0	34	388	1.4	59	506	2.5	12	306	0.6
9/21	57	477	2.4	930	9,434	38.8	34	422	1.4	72	578	3.0	18	324	0.8
9/22	51	528	2.1	696	10,130	29.0	31	453	1.3	55	633	2.3	19	343	0.8
9/23	53	581	2.2	1,069	11,199	68.7	37	490	1.5	72	705	3.0	18	361	0.8
9/24	54	635	2.3	1,201	12,400	50.0	55	545	2.3	74	779	3.1	17	378	0.7
9/25	65	700	2.7	1,021	13,421	43.1	23	568	1.1	44	823	1.8	13	391	0.5
9/26	72	772	3.0	933	14,354	38.9				54	877	2.6	16	407	0.7
9/27	116	888	4.8	717	15,071	29.9				51	928	2.1	10	417	0.4
9/28				409	15,480	47.7				64	992	2.7	9	426	0.4
9/29				1,013	16,493	69.6				49	1,041	2.0	19	445	0.8
9/30				734	17,227	30.6				9	1,050	0.4	25	470	1.0
10/1				205	17,432	12.8							21	491	0.9
10/2				612	18,044	43.1							23	514	1.0
10/3													33	547	1.4
10/4													21	568	0.9
10/5													16	584	0.7
10/6													18	602	0.8
10/7													26	628	1.1
10/8															
10/9															
Total	888			18,044			568			1,050			628		

Note: Days with zero indicate days when the project wheels were not operating.

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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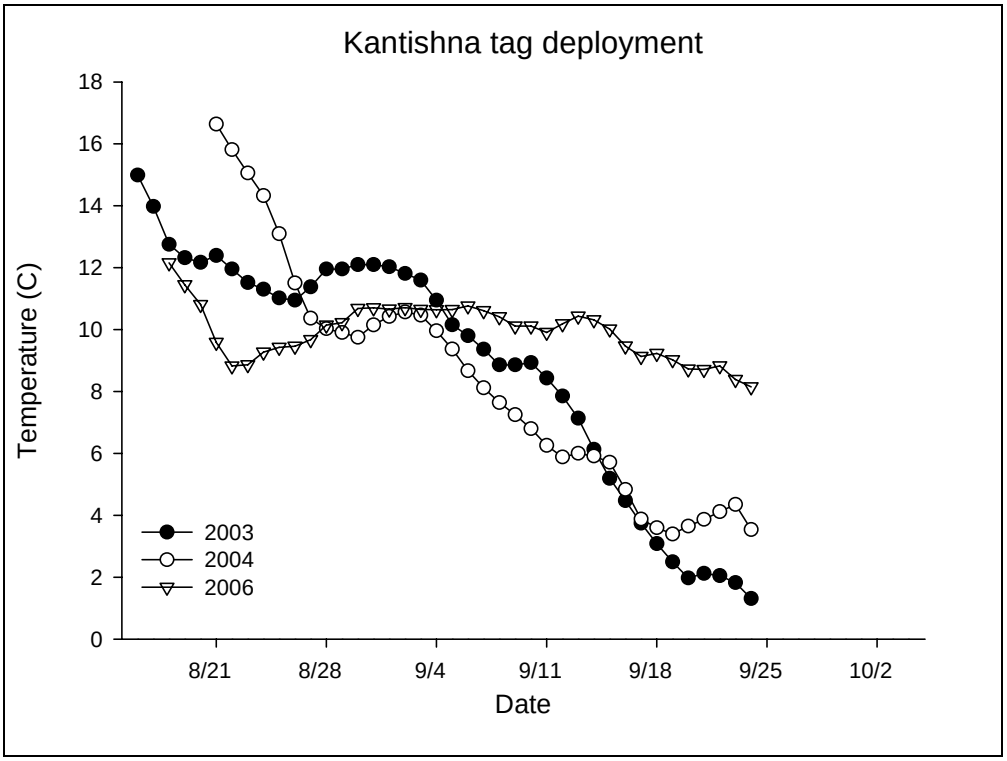
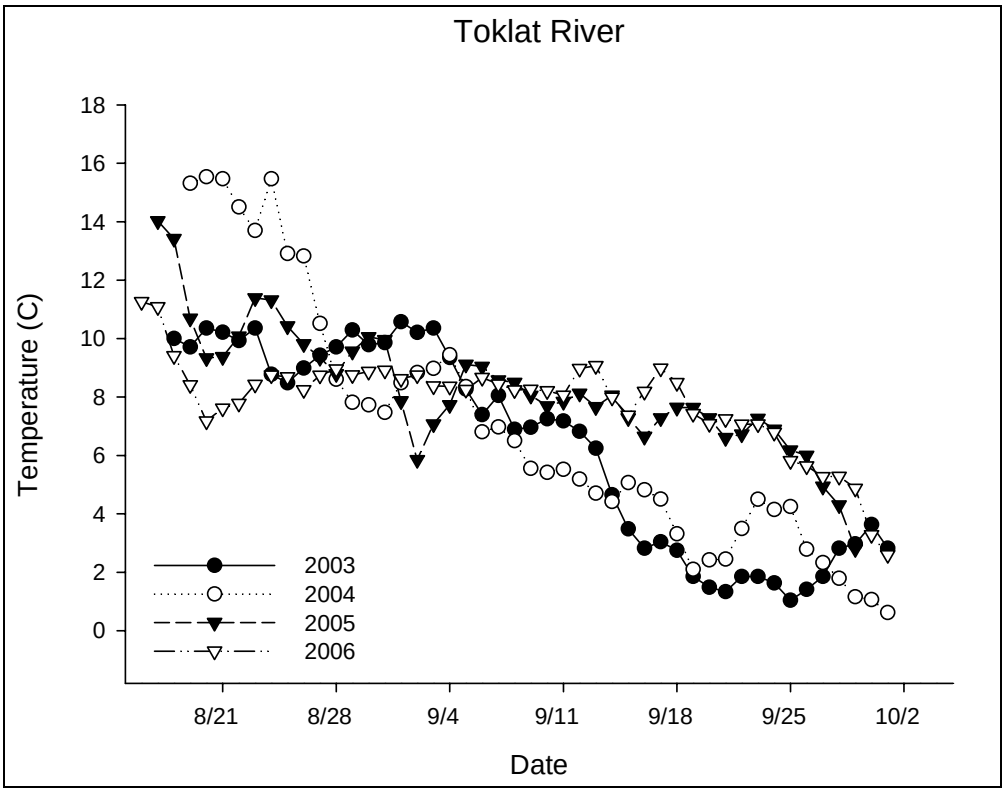

Kantishna tag deployment
Temperature (C)
18
16
14
12
10
8
6
4
2
0
8/21
8/28
9/4
9/11
9/18
9/25
10/2
Date
2003
2004
2006


Toklat River
Temperature (C)
18
16
14
12
10
8
6
4
2
0
8/21
8/28
9/4
9/11
9/18
9/25
10/2
Date
2003
2004
2005
2006

-continued-

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