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SUSITNA-WATANA HYDRO

Susitna-Watana Hydroelectric Project (FERC No. 14241)

Distribution of Spawning Susitna River Chinook *Oncorhynchus tshawytscha* and Pink *O. gorbuscha* Salmon, 2012

Prepared for

Alaska Energy Authority

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

Prepared by

Alaska Department of Fish and Game
Division of Sport Fish
Richard J. Yanusz, Pete Cleary, Sam Ivey, Jack W. Erickson, Dan J. Reed, Raye Ann Neustel, and Jan Bullock

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND SCIENTIFIC LABELS

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)

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

1. INTRODUCTION

This report provides the results of the 2012 Adult Salmon Distribution and Habitat Utilization Study (Chinook and Pink Salmon Spawning Distribution).

The Alaska Energy Authority (AEA) is preparing a License Application that will be submitted to the Federal Energy Regulatory Commission (FERC) for the Susitna–Watana Hydroelectric Project (FERC No. 14241) using the Integrated Licensing Process (ILP). The Project is located on the Susitna River, an approximately 300-mile long river in Southcentral Alaska. The Project's dam site will be located at river mile (RM) 184. The results of this study will provide information that will serve as the basis for the 2013–14 formal study program and in preparing Exhibit E of a license application (18 CFR 4.41) and for use in FERC's National Environmental Policy Act (NEPA) analysis for the Project license.

In recent years, the Alaska Department of Fish and Game (ADF&G) conducted studies to determine the distribution and abundance of sockeye *Oncorhynchus nerka*, coho *O. kisutch,* and chum *O. keta* salmon in the entire Susitna drainage. From 2006 to 2008 ADF&G estimated the abundance and distribution of sockeye salmon within the Susitna River drainage (Yanusz *et al.* 2007, Yanusz *et al.* 2011a, Yanusz *et al.* 2011b). In 2009, ADF&G conducted a study to determine the spawning distribution of chum and coho salmon in the Susitna River (Merizon *et al.* 2010). From 2010 to 2012 ADF&G conducted annual studies to determine both the distribution and abundance of spawning Susitna River chum and coho salmon (Cleary *et al.* in press, Cleary *et al.* in prep a, Cleary *et al.* in prep b).

The spawning distribution of pink salmon *O. gorbuscha* throughout the Susitna River drainage prior to 2012 was unknown. However, 100 pink salmon were scheduled to be radiotagged at one of four fish wheels operated by ADF&G near Flathorn (RM 24.5) in 2012 (funded by the Alaska Sustainable Salmon Fund (AKSSF), Studies 45921 and 45912 and a CIP from the State of Alaska). This study deployed 100 tags at each of the 3 remaining fish wheels and tracked all 400 radiotagged pink salmon. Pink salmon were tracked via a network of ground-based radio receivers and a series of fixed-wing and helicopter flights.

Prior to 2012, the spawning distribution of Chinook salmon *O. tshawytscha* throughout the Susitna River drainage had not been comprehensively assessed. The Adult Salmon Distribution and Habitat Utilization Study was developed to determine the spawning distribution of Chinook salmon in the Susitna drainage upstream of the confluence of the Yentna River in 2012 by deploying radio tags in Chinook salmon captured by 2 fish wheels and drifted gill nets. Chinook salmon were tracked in the same manner as the pink salmon were tracked. The results from the 2012 field season will be used to design a capture–recapture study to estimate the distribution and abundance of Chinook salmon for the entire Susitna drainage in 2013 and 2014.

Aerial survey counts of Chinook salmon have been conducted on 24 streams within the Northern Cook Inlet (NCI) Management Area since 1979 to provide an index of spawning escapement. Trends in Chinook salmon escapement are used to assist fisheries managers with future management strategies and refinement of escapement goals. Common practice is to use 3–5 observers on a given year to conduct these surveys. As part of this study, we examined variation between observers and identify areas for improvement in the current practice of using multiple observers to conduct annual aerial surveys in NCI.

This report documents the results for the 2012 field season.

2. STUDY OBJECTIVES

The purpose of this project is to determine the spawning distribution of Chinook salmon in the Susitna drainage upstream of the confluence with the Yentna River as well as the spawning distribution of pink salmon in the entire Susitna drainage. The information collected during the 2012 field season will be used to address the feasibility of conducting a basin-wide capture–recapture study of Chinook salmon in 2013.

3. STUDY AREA

The Susitna River drainage comprises 49,210 km^2 and originates in the Alaska Range north of Anchorage (Figure 1). It is the fourth largest drainage in the state of Alaska, and flows generally south from the Alaska Range for approximately 400 km before entering Cook Inlet west of Anchorage. The largest tributaries are the Yentna, Chulitna, and Talkeetna rivers, and there are numerous small lakes (King and Walker 1997). The morphology of the Susitna River varies by location. Rivers in the drainage originate in the Alaska or Talkeetna Mountain ranges and some are clear water or glacially turbid (Sweet et al. 2003).

4. METHODS

4.1. Radio Tag Application for Chinook salmon

Two fish wheels were operated in 2012 at the mainstem Susitna site (RM 30 [R&M Consultants 1981]) to collect Chinook salmon, one on each bank (Figure 2, Table 1). Each fish wheel had 2 × 2 m baskets that were adjusted as needed to fish 0.3 m or less from the river bottom. Picket weirs, located between the fish wheel and the river bank, were used to lead migrating salmon into fish wheel baskets and were operated the entire season. Two crews worked 2 shifts, such that each wheel was operated for a total of 12 h per day, from 5 AM to 10 PM, with a break each day from 1 PM to 2 PM. It was assumed that there was no substantial diel variation in the stock composition of fish passage and that all stocks of fish were subject to some non-zero probability of capture during this fishing schedule.

Fish wheels were checked at least once an hour during sampling shifts. Only uninjured Chinook salmon at least 400 mm in length from mid eye to tail fork (METF) were radiotagged. Most Chinook salmon less than 400 mm METF were jacks (males that spent only one winter at sea) and may not have had the same capture probability at the fish wheels as older fish because of their small size; these fish were also too small for the size of the radio tags used in this study. To minimize handling effects, Chinook salmon receiving a radio tag were either 1) tagged immediately after capture 2) tagged if fish wheel live box if the hold time did not exceed 1 h (Yanusz et al. 1999; Carlon and Evans 2007). A radio tag was not applied to Chinook salmon if the live box hold time exceeded 1 h; these fish were counted and released.

All captured Chinook salmon were counted, inspected, and recorded. All radiotagged Chinook salmon were sampled for tissue (axillary process clip) that was stored in ethanol for later genetic assay. An equal number of tags (200) was scheduled at each fish wheel to ensure that all stocks, no matter their abundance or distribution among the 2 wheels, had some non-zero probability of being marked. Crews started the season by radiotagging every healthy Chinook salmon. As the run continued, the tagging rate was adjusted to avoid running out of tags before the run was complete for the season (Table 1). Crews continued to operate the fish wheels to achieve the full 12 h/day of effort after the scheduled radio tags were deployed in order to establish a database of catch rates, run timing, and fish size.

Drift gillnetting was conducted in the vicinity of the fish wheels with 100 tags scheduled to be deployed in net caught fish (Figure 2). Gillnets were 5⅜ in or 7 in (stretch measure) mesh, multi-strand web, in nets 50 to 150 ft long, and 60 meshes deep. Drift duration was dependent upon the fishing site. The net was watched continuously until corks began to bob, signaling a fish was the net, at which point the entire net was immediately pulled in. To reduce bias due to the run timing of any individual stock and to ensure that all individual stocks of fish, regardless of run timing, had some non-zero probability of being marked, one crew of two technicians fished for up to 7.5 h/d, with start times rotating daily, until a cycle was completed each week. Once the scheduled number of radio tags per day was deployed, the crew stopped netting to minimize stress to additional fish.

The radio transmitters used in this study were manufactured by Advanced Telemetry Systems, Inc.[1] (ATS, Isanti, MN) and operated on 11 frequencies within the 150.000 to 151.999 MHz range. Each frequency had 100 different transmitting patterns (i.e., pulse codes), resulting in 500 uniquely identifiable transmitters. All Chinook salmon received ATS model F1845B transmitters, which were 52 mm long, 19 mm in diameter, and had a mass of 26 g, a 30-cm external whip antenna, and a nominal battery life of 311 d from activation. Each transmitter was equipped with an activity monitor as a mortality indicator. The activity monitor changes the signal pattern to an inactive mode if the transmitter was inactive for 24 h. Fish were tagged without anesthesia while restrained in a padded cradle held in a tub of river water. Radio tags were inserted through the esophagus and into the upper stomach of the fish using a 10-mm diameter, 30-cm long plastic tube.

4.2. Radio Tag Application for pink salmon

Pink salmon were radiotagged in conjunction with existing ADF&G research projects funded by the AKSSF, Studies 45921 and 45912, at Flathorn, RM 24.5 of the Susitna River, where 4 fish wheels were operated, one on each bank of the 2 channels in the river in that area (Figure 2, Table 2).

The ADF&G Commercial Fisheries Division (CF) only operated fish wheel 1 from 10 July to 14 August 2012 as part of AKSSF Study 45912. During this period, Sport Fish Division (SF) crews were responsible for fish wheels 2, 3, and 4 (Figure 2). SF crews took over operations of fish wheel 1 when the CF study concluded.

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

SF crews, working four 7.5-h shifts each day, operated fish wheels 2–4 during daylight hours until they reached the goal of 12 h/d of effort per wheel. CF crews, working two 9-h shifts each day, operated fish wheel 1 until they reached the goal of 18 h/d of effort, to achieve the sample size needed for AKSSF Study 45912. Fish wheel 1 effort was reduced to 12 h/d when the SF crew replaced the CF crew after 14 August. All four fish wheels were operated every day of the season, except for mechanical breakdowns, crew shortages, or unsafe weather (Table 2).

A subsample of healthy pink salmon captured at Flathorn, as above, were marked with an internal (esophageal) radio transmitter. A nearly equal number of tags were deployed at each fish wheel so that all stocks, no matter their abundance or distribution among the 4 wheels, had a non-zero probability of being marked (Table 2). Given that a fixed number of tags were to be deployed, tags were deployed systematically based on average historical run timing.

To minimize handling stress on pink salmon, only fish that had been held in the live box for less than 1 h were radiotagged. Three-person SF crews processed selected pink salmon one at a time and as quickly as possible, to reduce handling time and associated stress. Fish were in a holding tank onboard a boat during tagging. A bucket was used frequently to add fresh water to the tank. A padded, aluminum cradle (Larson 1995) was slipped around the fish to restrain it during tagging. One person restrained fish, the second inserted a radio tag into the stomach via the esophagus, and the third person recorded data. The crew measured METF and recorded the time taken to process the fish.

Radio tags were inserted through the esophagus and into the upper stomach of the fish using a 10-mm diameter, 30-cm long plastic tube. Pink salmon less than 400 mm METF were not radiotagged because the size and weight of the radio tags (about 1.6% of the body weight of a 400-mm METF fish) might have had a greater negative effect on such small fish than on larger fish. Smaller radio tags were used for pink salmon between 400 and 420 mm METF. The plastic tube was marked with reference points to assist in proper tag insertion depths. All marked pink salmon were released into the river adjacent to each fish wheel immediately after all data were recorded.

Pink salmon less than 420 mm METF received ATS F1835B transmitters, which are 48 mm long, 17 mm in diameter, have a mass of 16 g, have a 30-cm external whip antenna and a nominal battery life of 96 d after activation. All other pink salmon received ATS F1840B transmitters, which are 56 mm long, 17 mm in diameter, have a mass of 20 g, a 30-cm external whip antenna, and a battery life of 126 d after activation.

4.3. Radio Tag Relocation

4.3.1. Tracking Stations

Radiotagged Chinook and pink salmon movement upriver was tracked by ADF&G and LGL Alaska Research Associated, Inc. (LGL) at 10 stations placed on major tributaries throughout the Susitna River drainage (Figure 1; Table 3; Nass et al. 2013). Tracking station equipment consisted of an ATS Model 4500 receiver/data logger and a self-contained power system. The equipment was housed in a waterproof enclosure and attached to a 9-m mast. An ATS Model 200 antenna switch was coupled with 2 Yagi antennas at each tracking station. One antenna was

oriented downstream, and the other upstream. Signal strength and time of reception were recorded separately for each antenna and provided information on direction of travel. Reference radio tags were deployed at each station to emit regular pulses to document continuous station operation. The ATS receiver detected radiotagged fish and recorded signal strength, activity pattern of the transmitter (active or inactive), date, time, and location of each fish in relation to the station (i.e., upriver or downriver from the site). Data were written to the logger memory in 10-min intervals. ADF&G tracking sites were visited 4 to 12 times over the season, with the more remote sites visited less often due to the extensive travel required.

4.3.2. Aerial Surveys

ADF&G surveys were conducted with a fixed-wing aircraft, travelling at approximately 90 knots and 1,000-ft elevation above ground. The aircraft was equipped with two, 4-element Yagi receiving antennas, one mounted on each side of the aircraft and oriented forward. Two ATS Model 4520 receiver/data loggers, with integrated global positioning system (GPS), were used to identify radio tags and record locations. Each receiver had an operator that listened for tag frequencies, held the receiver on a detected frequency until all tags at that frequency appeared to be decoded, and then released the receiver from that frequency to continue scanning the remaining frequencies for other tags. The 11 possible frequencies were divided between two receivers to reduce scan times and reduce the chance of missing fish. Automatically recorded data included the following: date and time of decoding, frequency and pulse code, latitude and longitude, signal strength, and activity mode of each decoded transmitter. For Chinook salmon, the mainstem and major tributaries of the mainstem Susitna River were flown approximately every two weeks, and the Yentna River once. For pink salmon, the Yentna and Susitna rivers were flown approximately every two weeks.

Aerial survey coverage described above augmented by rotary wing surveys by an affiliated AEA-sponsored project to examine the distribution of fish in the Susitna River mainstem (Nass et al. 2013).

4.4. Inter-observer Variation in Aerial Survey Counts of Chinook Salmon

In 2012, counts between three observers were compared on six streams draining into the east side of the Susitna River in order to assess count agreement: Willow, Little Willow, Montana, Clear, and Prairie creeks and the North Fork Kashwitna River. Survey methodology mirrored past annual surveys conducted by ADF&G (Oslund and Ivey 2010, Lafferty 1997). Standard procedure is to make a single pass survey by helicopter during peak spawning time. Observers wear sunglasses with polarized lenses and try to keep the sun behind their shoulders. The chosen air speed and height above the ground varies with light condition and terrain but generally the aircraft flies approximately 50 to 75 feet over the water. Generally, the streams were surveyed from their confluence with tidewater or a glacial river, upstream to the upper-most reach to which Chinook salmon can ascend. All major clear water tributaries of each stream were also surveyed. Observers used two hand-tally registers to count fish. One register was used to count single fish and the other register was used to count by 5s or 10s when estimation of aggregate fish was necessary. Total numbers of live and dead salmon were recorded in addition to date,

weather condition, stream level, and water visibility. In this study, each observer flew all six streams over a 2-d period with start dates staggered two days apart. In this way, each stream was counted two days apart over the course of six total days. Additional observations, such as number and general location of congregations where estimation of fish was necessary, presence of other fish species, and any other factors that might affect counting accuracy were noted.

4.5. Deviations from Study Plan

The study plan called for ADF&G to tag every adult Chinook salmon caught. High catch rates required modifying this protocol on 31 May to ensure fish were tagged throughout the run (Table 1). Because of a period of high water around 10 June and the unexpectedly early end of the Chinook salmon run, we did not meet the target of 200 radio tags being deployed from each fish wheel.

5. RESULTS

5.1. Radio Tag Application

In 2012, fish wheels were operated from 25 May to 26 August at the mainstem Susitna tagging site, while the last Chinook salmon was captured on 18 August (Table 1). From the two fish wheels, a total of 1,690 Chinook salmon were caught, of which 338 were radiotagged (Table 1): 178 radio tags were deployed in Chinook salmon from fish wheel 1 and 160 from fish wheel 2. A total of 226 Chinook salmon were caught in drift gill nets, of which 105 were radiotagged (Table 1).

To capture pink salmon, fish wheels were operated at Flathorn from 10 July to 26 August 2012 (Table 2). Among 4 fish wheels, a total of 37,490 pink salmon were caught, of which 401 were radiotagged (Table 2): 101 radio tags were deployed in pink salmon from fish wheel 1 and 100 each from fish wheels 2–4.

5.2. Tracking Stations

Tracking stations were installed in the Yentna River drainage between 9 May and 6 June and removed between 12 September and 2 October 2012. The Skwentna tracking station was found to be nonfunctional on 2 October, for unknown reasons. Tracking stations within the mainstem Susitna, Talkeetna, and Chulitna rivers were installed between 9 and 26 May and removed between 10 September and 4 October 2012. The Talkeetna station was destroyed by an extreme flood on 21 September 2012. Nass et al. (2013) describe the operational periods for the other tracking stations used to track fish tagged in 2012.

5.3. Aerial Surveys

There were 360 Chinook salmon spawning locations (Table 4 and Table 5) and 390 pink salmon spawning locations determined by aerial surveys (Table 6 and Table 7).

Of the 443 radiotagged Chinook salmon, one was never detected after release. Spawning locations were assigned to 385 Chinook salmon (including 25 that never migrated upstream of

the tagging site) based on aerial surveys and corroboration with ground tracking stations. Aerial survey efforts for Chinook salmon yielded four complete drainage-wide surveys of the Susitna River and one of the Yentna River drainage. These surveys relocated 406 different radiotagged fish (92% of the 442 detected by any means). Radio tags returned by anglers were not assigned spawning locations, given the possibility that Chinook salmon may have been intercepted prior to reaching their spawning site.

Of the 401 radiotagged pink salmon, spawning locations were assigned to 390 (including 5 that never migrated upstream of Susitna Station) based on aerial surveys and corroboration with ground tracking stations. Aerial efforts for pink salmon yielded 4 complete drainage-wide surveys of the Susitna River and Yentna River drainages. These surveys relocated 390 different radiotagged fish (97% of the 401 released).

5.4. Spawning Locations

Radiotagged Chinook and pink salmon were assigned a spawning location based on aerial surveys; tracking station data were used only to corroborate these locations. Radiotagged salmon were assigned one of eleven movement patterns (Table 4 and Table 6). This assignment was used to determine the most likely spawning location of each fish. No ground surveys were conducted to verify if radiotagged fish were indeed on spawning grounds or exhibiting spawning behavior at any time.

5.4.1. Chinook salmon

Of the 443 radiotagged Chinook salmon, 360 (81%) could be assigned to a spawning location (Table 5, Figure 3). There were 25 radiotagged Chinook salmon that never migrated upstream of the tagging site (Table 4). These fish were excluded from the experiment and locations were not reflected in the spawning distributions. One radiotagged Chinook salmon was never relocated by either ground or aerial methods. Approximately 8% of the radiotagged Chinook salmon were assigned to the mainstem Susitna River (Table 5).

The spawning locations of Chinook salmon tagged at RM 30 suggest that fish showed bank orientation. Based on aerial relocations, 24 (17%) of 144 Chinook salmon tagged on fish wheel 1 migrated to the Yentna River, while two (1%) of 139 Chinook salmon tagged on fish wheel 2 migrated to the Yentna River (Table 8, Figures 4 and 5). Similarly, nine (6%) of 144 Chinook salmon tagged on fish wheel 1 migrated to the eastside Susitna River tributaries, while 44 (32%) of 139 Chinook salmon tagged on fish wheel 2 migrated to eastside Susitna River tributaries (Table 8, Figures 4 and 5).

Gillnet-caught Chinook salmon appeared to be more evenly distributed among the Yentna and eastside Susitna rivers tributaries. Based on aerial relocations, 5 (6%) of 77 Chinook salmon captured with gillnets migrated to the Yentna River, and 20 (26%) migrated to eastside Susitna River tributaries (Table 8, Figure 6).

Anglers voluntarily returned 16 radio tags found in harvested Chinook salmon (Table 9). Locations of harvested fish were not used for spawning location calculations because we assumed these fish could have been intercepted prior to reaching their spawning sites.

Tissue samples were collected from all radiotagged Chinook salmon (443) and were stored at the ADF&G Gene Conservation Lab in Anchorage, AK.

5.4.2. Pink Salmon

Spawning locations were assigned to 385 (96%) of the 401 radiotagged pink salmon (Table 7, Figure 7). There were five radiotagged pink salmon that never migrated upstream of the Susitna Station (Table 6). These fish were excluded from the experiment and locations were not reflected in the spawning distributions. Eleven radiotagged pink salmon were never relocated by aerial methods.

The spawning locations of pink salmon tagged near Flathorn suggest that fish showed strong bank orientation. Based on aerial relocations, 88 (92%) of 96 pink salmon tagged on fish wheel 1 migrated to the Yentna River, while six (6%) of the 96 pink salmon tagged on fish wheel 4 migrated to the Yentna River (Table 10, Figures 8–11). Similarly, zero (0%) of 96 pink salmon tagged on fish wheel 1 migrated to the eastside Susitna River tributaries, while 25 (26%) of 96 pink salmon tagged on fish wheel 4 migrated to eastside Susitna River tributaries (Table 10, Figures 8-11).

Anglers voluntarily returned three radio tags they found, either in pink salmon they harvested or found on the ground (Table 9). Unlike for Chinook salmon, harvested fish were included in spawning location calculations for pink salmon because all three were captured in tributaries of the Susitna River and the aerial flights corroborated the location of each fish.

5.5. Inter-observer Variation in Aerial Survey Counts of Chinook Salmon

Surveys commenced on 16 July 2012. Stream level and visibility was considered normal and clear in most all streams throughout the period of study. Each stream was flown two days apart with the following exception: during the third set of surveys flown by the third observer, Prairie and Clear creeks were counted one week later than scheduled due to poor weather (Table 11). Percent agreement between observers was greatest for the North Fork Kashwitna River (99% between observers 1 and 2; 96% between 1 and 3; 98% between 2 and 3) and least for Montana Creek (97% between observers 1 and 2; 62% between 1 and 3; 64% between 2 and 3).

6. DISCUSSION AND CONCLUSION

6.1. Chinook salmon spawning distribution

In 2012, ADF&G successfully radiotagged 443 Chinook salmon captured in fish wheels and gill nets in the Susitna River upstream from the confluence with the Yentna River (RM 30). Spawning locations were assigned to 360 (81%) of the fish.

Although Chinook salmon were not tagged in proportion to the daily fish wheel catches, radio tags were deployed throughout the entire run (Table 1). However, care should be taken in interpreting the results. First, the distributions (Figures 3–6, Tables 5 and 8) are for radiotagged fish and should not be considered representative of the distribution of the entire population of Chinook salmon. We did not tag in proportion to apparent abundance (i.e., fish wheel catches), and if the run timing of individual stocks differed it is possible that we tagged stocks at different

rates. Second, we did not directly examine for size selective tagging in 2012. Similar to the effects of different run timing among stocks, size selective tagging could have influenced the distribution of tagged fish to represent the entire run.

This study provides the first drainage-wide documentation of spawning sites for Chinook salmon moving through the lower mainstem Susitna River (upstream of the confluence with the Yentna River) using radiotelemetry on such a large scale.

6.2. Feasibility to Conduct a Capture-recapture Experiment for Chinook Salmon

The results from this study are being used to design a capture–recapture abundance experiment to estimate the spawning escapement for the entire Susitna drainage in 2013 and 2014. Chinook salmon captured in fish wheels and gillnets will be marked with radio tags and recaptured at fish weirs established on upstream tributaries. The 2012 results suggest the weir ADF&G operates on the Deshka River will be a good recapture site because greater than 20% of the fish tagged at fish wheel 1, fish wheel 2, or by gillnet is likely to be recaptured at the Deshka River weir (Tables 5 and 8). In 2013, ADF&G plans to establish and operate fish weirs on the middle fork of the Chulitna River (below the confluence with the east fork) and Montana Creek. In 2012, 25 (7%) of the radiotagged Chinook salmon (Table 5) were assigned a spawning location upstream of the proposed fish weir site on the middle fork of the Chulitna River and 8 (2%) were assigned to a spawning location upstream of the proposed fish weir site on Montana Creek. The number of tags to be deployed in 2013 has been increased to 700 radio tags in order to increase the number of recaptures at the fish weirs and improve the precision of the escapement estimate.

In 2012, fish radiotagged at RM 30 had bank orientation (Table 8), which would need to be accounted for in an abundance model unless equal probability of capture is maintained throughout the marking event. When designing a capture–recapture experiment to estimate the abundance of Chinook salmon for 2013, we anticipate that assumption of equal probability of capture for all Chinook salmon may be violated during one or both sampling events. Diagnostic tests described in Seber (1982) and in more specific detail relative to the 2013 experiment in Cleary et al. (*In press*) will be used to detect evidence of unequal probability of capture by size, across time, and between sampling sites. Sufficient radio tags out and recaptures will allow for the necessary diagnostic testing and model selection to produce an unbiased abundance estimate. The low probability of recaptures anticipated at Montana Creek may be marginal for diagnostic testing and testing of different tag rates among stocks, but a larger number of deployed tags planned for 2013 should help to address this issue. We did not examine for size-selective tagging in 2012 but this should be looked at in future years in the event that size stratification is required for an abundance estimate.

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6.3. Pink salmon spawning distribution

In 2012, ADF&G successfully radiotagged 401 pink salmon captured in 4 fish wheels in the Susitna River at Flathorn (RM 24.5). Spawning location was assigned to 385 (96%) of the fish (Table 7).

As above, pink salmon were not tagged in proportion to the apparent abundance (fish wheel catch), but radio tags were deployed throughout the entire run (Table 2). The spawning distributions (Figures 7–11, Tables 6–7) reflect only radiotagged fish and not the entire population of pink salmon. If different stocks were tagged at different rates, then the distributions would be biased.

Although ADF&G estimated pink salmon escapement for the Susitna River in the 1980s (Thompson et al. 1986), the data presented here are the first drainage-wide documentation of spawning sites for pink salmon in the Susitna and Yentna rivers.

6.4. Inter-observer Variation in Aerial Survey Counts of Chinook Salmon

We found high agreement among the three observers who surveyed six streams over a 6-d period. Between observers on the escapement surveys, agreement in escapement estimates above 80% was considered to be acceptable for the purpose of this study and in most cases this standard was met. Several instances where agreement was less than 80% on Prairie and Montana creeks may be explained by variations in stream morphology between streams and in fish behavior. Prairie Creek is noted as a somewhat difficult system to count fish due to multiple pools of fish where estimation is necessary and the common occurrence of cut banks that make sighting fish difficult. Run timing is also much later in Prairie Creek relative to other NCI streams due to its location further upstream on the Susitna River drainage. In consideration of late run timing, Prairie Creek may not fit within this study design and the condition of peak spawning may not have been fully met. A better approach in the future might be to conduct three consecutive surveys flown late in July, e.g., after about 26 July. In Lafferty (1997), agreement between observers was lowest (80%) in a 1994 survey of Prairie Creek. In Montana Creek, it is possible that fish noted by the first two observers as holding at the mouth may have been, at least in part, destined for upstream tributaries of the Susitna River because the third observer did not note any fish at the mouth and only counted about half what the first two observers counted. The phenomena of fish holding at the mouth of Montana Creek has not been noted in past years' surveys. Agreement was highest in streams holding fewer fish, which was expected.

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8. REFERENCES

Carlon, J. A., and D. Evans. 2007. Abundance of adult Chinook salmon in the Kenai River, Alaska, 1999-2003. Alaska Department of Fish and Game, Fishery Data Series No. 07-81, Anchorage. **http://www.sf.adfg.state.ak.us/FedAidpdfs/fds07-81.pdf**

Cleary, P.M., R. A. Merizon, R. J. Yanusz, and D. J. Reed. (In press). Abundance and Spawning Distribution of Susitna River chum *Oncorhynchus keta* and coho *O. kisutch* salmon, 2010. Alaska Department of Fish and Game, Fishery Data Series No. YY-XX, Anchorage.

King, B. E., and S. C. Walker. 1997. Susitna River sockeye salmon fry studies, 1994 and 1995. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 2A97-26, Anchorage. **http://www.sf.adfg.state.ak.us/FedAidPDFs/RIR.2A.1997.26.pdf**

Lafferty, R. 1997. Summary of escapement index counts of Chinook salmon in the Northern Cook Inlet management area, 1958-1996. Alaska Department of Fish and Game, Fishery Data Series No. 97-8, Anchorage.

Larson, L. 1995. A portable restraint cradle for handling large salmonids. North American Journal of Fisheries Management. 15:654-656.

Merizon, R. A., R. J. Yanusz, D. J. Reed, and T. R. Spencer. 2010. Distribution of spawning Susitna River chum *Oncorhynchus keta* and coho *O. kisutch* salmon, 2009. Alaska Department of Fish and Game, Fishery Data Series No. 10-72, Anchorage.

Nass, B. A., M. R. Link, J. J. Smith, D. Robichaud, S. E. Burril, K. E. English, S. T. Crawford, J. T. Priest, and M. J. Nemeth. 2013. Adult Salmon Distribution and Habitat Utilization Study, Susitna-Watana Hydroelectric Project (FERC No. 14241). Prepared by LGL Alaska Research Associates, Inc., for Alaska Energy Authority, 813 West Northern Lights Boulevard, Anchorage, Alaska 99503. 141 p. + Appendices.

Oslund, S. and S. Ivey. 2010. Recreational Fishers of Northern Cook Inlet, 2009-1010: Report to the Alaska Board of Fisheries, February 2011. Alaska Department of Fish and Game, Fishery Management Report No. 10-50, Anchorage.

R&M Consultants. 1981. Susitna River Mile Index, Mouth to Susitna Glacier. Prepared for Acres American Incorporated, Buffalo, NY.

Seber, G.A.F. 1982. On the estimation of animal abundance and related parameters. 2nd. ed. Charles Griffin and Sons, Ltd., London. 654 p.

Sweet, D., S. Ivey, and D. Rutz. 2003. Area management report for the recreational fisheries of Northern Cook Inlet, 2001 and 2002. Alaska Department of Fish and Game, Fishery Management Report No. 03-10, Anchorage. **http://www.sf.adfg.state.ak.us/FedAidPDFs/fmr03-10.pdf**

Thompson, F. M., S. N. Wick, and B. L. Stratton. 1986. Adult salmon investigations May – October 1985. Alaska Department of Fish and Game, Susitna Hydro Aquatic Studies Report Series 13, Anchorage.

Yanusz, R., R. Merizon, D. Evans, M. Willette, T. Spencer, and S. Raborn. 2007. Inriver abundance and distribution of spawning Susitna River sockeye salmon Oncorhynchus nerka, 2006. Alaska Department of Fish and Game, Fishery Data Series No. 07-83, Anchorage.

Yanusz, R., R. Merizon, M. Willette, D.G. Evans. and T.R. Spencer. 2011a. Inriver abundance and distribution of spawning Susitna River sockeye salmon Oncorhynchus nerka, 2008. Alaska Department of Fish and Game, Fishery Data Series No. 11-12, Anchorage.

Yanusz, R., R. Merizon, M. Willette, D.G. Evans. and T.R. Spencer. 2011b. Inriver abundance and distribution of spawning Susitna River sockeye salmon Oncorhynchus nerka, 2007. Alaska Department of Fish and Game, Fishery Data Series No. 11-19, Anchorage.

Yanusz, R. J., S. A. McPherson, and D. R. Bernard. 1999. Production of Chinook salmon from the Taku River, 1997-1998. Alaska Department of Fish and Game, Fishery Data Series No. 99-34, Anchorage. **http://www.sf.adfg.state.ak.us/FedAidPDFs/fds99-34.pdf**

TABLES

Table 1. Total Chinook salmon catch, radio tags applied, and total daily fish wheel and gillnet effort at the mainstem Susitna River site (RM 30) in 2012.

	Fish wheel 1 (west)		Fish wheel 2 (east)		Gillnet					Fish wheel effort (min)	
Date	Total catch	Radio-tagged	Total catch	Radio-tagged	Total catch	Radio-tagged	Total catch	Total radio-tagged	Gillnet effort (min)	1	2
5/25	2	2	0	0	3	0	5	2	174	782	738
5/26	4	3	1	1	0	0	5	4	173	720	494
5/27	3	3	2	2	2	1	7	6	154	738	720
5/28	4	4	3	3	4	2	11	9	205	720	720
5/29	3	3	0	0	3	3	6	6	163	720	720
5/30	7	7	6	5	6	3	19	15	122	720	720
5/31	14	12	14	13	8	4	36	29	207	720	720
6/1	38	10	38	6	6	3	82	19	173	720	720
6/2	71	6	62	6	16	3	149	15	163	720	720
6/3	62	6	46	6	8	3	116	15	217	720	720
6/4	42	6	11	6	10	3	63	15	230	720	720
6/5	38	5	16	5	15	5	69	15	192	721	720
6/6	75	5	39	5	9	5	123	15	198	722	720
6/7	58	5	14	5	11	5	83	15	186	723	720
6/8	37	5	12	5	7	5	56	15	217	720	720
6/9	78	5	16	5	11	5	105	15	181	720	720
6/10	3	2	7	4	3	2	13	8	170	720	720
6/11	14	6	20	6	2	2	36	14	216	720	720
6/12	26	5	23	5	4	4	53	14	171	720	728
6/13	32	6	21	6	24	5	77	17	163	720	720
6/14	17	5	33	5	9	6	59	16	165	720	720
6/15	36	6	56	6	15	5	107	17	176	720	720
6/16	41	5	60	5	21	7	122	17	166	720	720
6/17	40	5	72	5	5	5	117	15	170	720	720
6/18	36	5	41	5	4	4	81	14	247	727	720
6/19	15	5	29	3	7	4	51	12	220	720	720
6/20	14	5	17	4	2	2	33	11	231	720	730
6/21	12	7	18	8	5	4	35	19	233	720	720
6/22	12	7	19	3	4	4	35	14	239	720	720
6/23	8	3	8	3	2	1	18	7	293	720	720
6/24	5	3	6	2	0	0	11	5	250	720	720
6/25	5	1	8	4	0	0	13	5	286	720	720
6/26	1	1	5	1	0	0	6	2	291	720	720
6/27	6	4	12	4	0	0	18	8	295	720	720
6/28	4	0	11	2	0	0	15	2	279	720	720
6/29	4	1	8	0	0	0	12	1	310	727	728
6/30	2	1	6	2	0	0	8	3	335	720	720
7/1	6	2	6	0	0	0	12	2	249	721	722

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Table 1. Part 2 of 2.

Date	Fish wheel 1 (west)		Fish wheel 2 (east)		Gillnet		Total	Total radio-tagged	Gillnet effort (min)	Fish wheel effort (min)	
	Total catch	Radio-tagged	Total catch	Radio-tagged	Total catch	Radio-tagged				1	2
7/2	6	0	7	0			13	0		720	720
7/3	1	0	6	1			7	1		720	720
7/4	0	0	0	0			0	0		0	0
7/5	0	0	0	0			0	0		0	0
7/6	1	0	5	1			6	1		720	360
7/7	3	2	1	0			4	2		720	720
7/8	0	0	2	0			2	0		721	723
7/9	1	0	2	0			3	0		720	720
7/10	2	0	2	0			4	0		720	721
7/11	1	1	1	0			2	1		720	720
7/12	1	1	2	0			3	1		728	722
7/13	2	1	1	1			3	2		720	720
7/14	0	0	0	0			0	0		720	722
7/15	0	0	0	0			0	0		722	722
7/16	0	0	1	1			1	1		720	720
8/18	1	1	0	0			1	1		720	720
Total	894	178	796	160	226	105	1,916	443	8,110	37,552	36,910

Table 2. Total daily pink salmon catch, radio tags applied, and total daily fish wheel effort at the Flathorn (RM 24.5) tagging site in 2012.

	Fish wheel 1		Fish wheel 2		Fish wheel 3		Fish wheel 4		Fish wheel effort (min)			
Date	Total catch	Radio-tagged	Total catch	Radio-tagged	Total catch	Radio-tagged	Total catch	Radio-tagged	1	2	3	4
7/10	1	1	0	0	0	0	0	0	1,200	720	732	724
7/12	7	3	0	0	0	0	0	0	1,200	723	720	720
7/13	3	1	0	0	0	0	0	0	1,200	720	738	720
7/14	5	2	3	1	0	0	0	0	1,200	720	720	720
7/15	15	2	3	0	1	1	0	0	1,200	720	720	720
7/16	18	3	6	1	2	1	2	1	1,200	720	720	720
7/17	25	3	10	1	1	1	6	2	1,200	720	720	720
7/18	33	3	5	0	1	1	2	1	1,200	720	720	720
7/19	67	3	4	3	2	2	6	5	1,200	720	720	722
7/20	101	3	25	7	6	4	13	4	1,200	720	720	720
7/21	145	3	28	4	10	7	28	4	1,200	720	720	720
7/22	595	4	130	4	51	4	212	4	1,200	720	720	730
7/23	640	5	81	6	95	6	143	6	1,200	720	720	720
7/24	941	4	81	8	103	8	145	8	1,200	720	720	720
7/25	973	3	111	9	151	9	252	9	1,200	720	720	725
7/26	2,050	2	279	7	775	7	643	7	1,200	720	720	720
7/27	2,396	3	574	6	1,214	6	782	6	1,200	720	720	722
7/28	3,045	4	577	6	1,251	6	629	6	1,200	720	720	720
7/29	2,438	4	667	6	1,212	6	630	6	1,200	720	720	720
7/30	1,825	4	737	5	828	5	879	5	1,200	720	720	720
7/31	670	4	340	4	249	4	546	4	1,200	720	720	720
8/1	453	5	160	4	221	4	351	4	1,200	720	720	720
8/2	386	6	201	4	215	4	341	4	1,200	720	720	720
8/3	308	3	115	2	145	2	381	2	1,200	720	720	720
8/4	392	3	137	1	225	1	376	1	1,200	720	720	722
8/5	707	7	166	1	167	1	265	1	1,200	720	720	720
8/6	193	1	77	1	58	1	147	1	1,200	720	720	720
8/7	130	6	15	1	43	1	46	1	1,200	720	725	720
8/8	85	2	16	1	20	1	37	1	1,200	720	720	720
8/9	61	2	9	1	9	1	30	1	1,200	720	720	720
8/10	59	0	12	1	8	1	24	1	1,200	720	720	720
8/11	12	0	6	1	7	1	11	1	1,200	720	720	720
8/12	6	1	7	1	3	0	13	1	1,200	720	720	720
8/13	14	1	4	1	2	1	4	1	1,200	720	726	720

-continued-

Table 2. Part 2 of 2.

	Fish wheel 1		Fish wheel 2		Fish wheel 3		Fish wheel 4		Fish wheel effort (min)			
Date	Total catch	Radio-tagged	Total catch	Radio-tagged	Total catch	Radio-tagged	Total catch	Radio-tagged	1	2	3	4
8/14	6	0	4	1	6	2	11	1	899	720	720	720
8/15	5	0	1	0	4	0	6	0	720	720	720	720
8/16	0	0	3	1	1	0	6	0	728	720	720	720
8/17	0	0	0	0	0	0	0	0	720	720	720	720
8/18	0	0	0	0	0	0	2	0	727	720	720	720
8/19	0	0	1	0	1	0	1	1	720	720	720	720
8/20	0	0	1	0	1	0	0	0	724	720	720	720
8/21	0	0	1	0	0	0	5	0	720	720	720	720
8/22	0	0	2	0	0	0	3	0	720	720	723	720
8/23	0	0	2	0	2	1	2	0	720	720	720	720
8/24	1	0	0	0	1	0	2	0	733	726	720	720
8/25	0	0	3	0	0	0	0	0	720	720	720	720
8/26	0	0	1	0	0	0	1	0	720	720	720	724
Totals	18,811	101	4,605	100	7,091	100	6,983	100	50,371	33,849	33,884	33,869

Table 3. Locations of radio logger stations to monitor the movements of radiotagged Chinook salmon in the Susitna River during 2012.

River	Station	Operator	Miles from saltwater
Susitna	Susitna Station	ADF&G	25.6
	Deshka Mouth	ADF&G	40.6
	Sunshine	ADF&G	83.8
	Talkeetna	ADF&G	101.6
	Lane Creek (Middle Susitna River)	LGL	113.6
	Chulitna	ADF&G	112.1
	Devil Creek	LGL	161.3
Yentna	Lower Yentna	ADF&G	37.2
	Skwentna	ADF&G	89.2
	Upper Yentna	ADF&G	101.7

Table 4. Definitions of movement patterns used to determine Chinook salmon spawning location.

Criterion	Movement patterns	Chinook salmon	
		Number	Percent
1	Did not migrate upstream at least 1 river mile.	25	5.7
2	Progressive upstream movement through all aerial surveys.	81	18.3
3	Progressive upstream movement except the last 1-2 aerial surveys, assigned the furthest upstream location.	106	24.0
4	Initially display upstream movement but then display downstream movement >2 aerial surveys, assigned the furthest upstream location.	13	2.9
5	A cluster of locations (within 20 miles), assigned a known location in the middle of cluster.	57	12.9
6	A cluster of locations except one outlier, assigned location in the middle of cluster, unless the outlier was observed during a late season (>15 September) survey; then it was assigned the furthest upstream location.	42	9.5
7	Migrated up river A and then had >2 locations up river B. If strong signal strengths (>120) exist among cluster in river B then fish was assigned to river B, otherwise river A.	27	6.1
8	Single aerial relocation only.	34	7.7
9	Sport caught by angler.	16	3.6
10	Aerial records exist, but station is furthest upstream location.	5	1.1
11	No aerial records, furthest upstream station used.	36	8.1
	Total[a]	442	100.0

[a] Does not include one tag never located by any method.

Table 5. Aerial survey distribution of Chinook salmon that were radiotagged at Susitna River RM 30 in 2012.

River	Major tributary	Spawning location	Radio tags	
			Number [a]	Percent
Susitna River	Susitna River RM 0–30	Alexander Creek	1	0.3
	Susitna River RM 31–98 mainstem		24	6.7
		Deshka River	104	28.9
		Willow Creek	20	5.6
		Goose Creek	2	0.6
		Little Willow Creek	22	6.1
		Kashwitna River	12	3.3
		Sheep Creek	9	2.5
		Montana Creek	8	2.2
	Talkeetna River mainstem		8	2.2
		Chunilna Creek (Clear Creek)	27	7.5
		Sheep River	2	0.6
		Iron Creek	7	1.9
		Prairie Creek / Stephan Lake	6	1.7
	Susitna River RM 99–154 mainstem		4	1.1
		Portage Creek	11	3.1
		Indian River	6	1.7
	Chulitna River mainstem		21	5.8
		East Fork	7	1.9
		Tokositna River	6	1.7
		Troublesome Creek	2	0.6
		Middle Fork	18	5.0
	Susitna River above RM 154 mainstem		0	0.0
		Kosina Creek	2	0.6
Yentna River	Yentna River mainstem		1	0.3
		Cache Creek	3	0.8
		Peters Creek	10	2.8
		Lake Creek	11	3.1
		Johnson Creek	1	0.3
		Kichatna River	1	0.3
	Skwentna River mainstem		1	0.3
		Talachulitna River	2	0.6
		Talachulitna Creek / Judd Lake	1	0.3
Susitna/Yentna	All	All	360	100.0

[a] Does not include 16 fish that were reported captured, 36 that had no aerial detections, five with spawning locations determined from stationary records, and 25 fish that did not move at least 1 mile upstream of the tagging site at RM 30.

Table 6. Definitions of movement patterns used to determine pink salmon spawning location.

		Pink salmon	
Criterion	Movement patterns	Number	Percent
1	Did not migrate upstream at least 1 river mile.	5	1.3
2	Progressive upstream movement through all aerial surveys.	54	13.8
3	Progressive upstream movement except the last 1-2 aerial surveys, assigned the furthest upstream location.	123	31.5
4	Initially display upstream movement but then display downstream movement >2 aerial surveys, assigned the furthest upstream location.	136	34.9
5	A cluster of locations (within 20 miles), assigned a known location in the middle of cluster.	51	13.1
6	A cluster of locations except one outlier, assigned location in the middle of cluster, unless the outlier was observed during a late season (>15 September) survey; then it was assigned the furthest upstream location.	5	1.3
7	Migrated up river A and then had >2 locations up river B. If strong signal strengths (>120) exist among cluster in river B then fish was assigned to river B, otherwise river A.	5	1.3
8	Single aerial relocation only.	9	2.3
9	Sport caught by angler.	2	0.5
10	Aerial records exist, but station is furthest upstream location.	0	0.0
11	No aerial records, furthest upstream station used.	0	0.0
	Total	390	100.0

Table 7. Aerial survey distribution of pink salmon that were radiotagged at Susitna River RM 24.5 (Flathorn) in 2012.

River	Major tributary	Spawning location	Radio tags	
			Number [a]	Percent
Susitna River	Susitna River RM 25.8–98 mainstem		21	5.5
		Deshka River	41	10.6
		Willow Creek	16	4.2
		Goose Creek	0	0.0
		Little Willow Creek	5	1.3
		Kashwitna River	4	1.0
		Sheep Creek	0	0.0
		Montana Creek	6	1.6
	Talkeetna River mainstem		8	2.1
		Chunilna Creek (Clear Creek)	20	5.2
		Sheep River	0	0.0
		Iron Creek	0	0.0
		Prairie Creek / Stephan Lake	0	0.0
	Susitna River RM 99–154 mainstem		1	0.3
		Portage Creek	0	0.0
		Indian River	5	1.3
	Chulitna River mainstem		60	15.6
		Byers Creek	30	7.8
		East Fork Chulitna River	0	0.0
		Tokositna River	4	1.0
		Troublesome Creek	2	0.5
		Middle Fork Chulitna River	0	0.0
	Susitna River above RM 154 mainstem		0	0.0
		Kosina Creek	0	0.0
Yentna River	Yentna River mainstem		17	4.4
		Cache Creek	0	0.0
		Kahiltna River	9	2.3
		Peters Creek	1	0.3
		Lake Creek	49	12.7
		Johnson Creek	5	1.3
		Kichatna River	1	0.3
	Skwentna River mainstem		10	2.6
		Shell Creek	2	0.5
		Talachulitna River	52	13.5
		Talachulitna Creek / Judd Lake	16	4.2
Susitna/Yentna	All	All	385	100.0

[a] Does not include 5 fish that did not move upstream of Susitna Station (RM 25.8).

Table 8. Unweighted spawning distribution (number of fish and percent) of radiotagged Chinook salmon in the Susitna River drainage in 2012, by tagging gear.

	Gillnet		Fish wheel 1 (west)		Fish wheel 2 (east)		Total	
System	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Alexander Creek	0	0	1	1	0	0	1	0
Yentna River	5	6	24	17	2	1	31	9
Chulitna River	10	13	22	15	22	16	54	15
Talkeetna River	16	21	14	10	20	14	50	14
Deshka River	15	19	56	39	33	24	104	29
East Side Susitna River[a]	20	26	9	6	44	32	73	20
Susitna River RM 99–154	4	5	11	8	8	6	23	6
Susitna River RM 31–98	7	9	7	5	10	7	24	7
Grand Total	77	100	144	100	139	100	360	100

[a] Willow, Little Willow, Montana, and Sheep creeks, and Kashwitna River.

Table 9. Susitna River Chinook and pink salmon radio tags returned to ADF&G by the public in 2012.

Frequency	Pulse code	Species	Date recovered	Location of radio tag
151.514	18	Chinook salmon	6/16/2012	Deshka River
151.514	43	Chinook salmon	7/18/2012	Deshka RM 3
151.514	63	Chinook salmon	6/8/2012	Deshka River mouth
151.514	87	Chinook salmon	7/20/2012	Sunshine Creek mouth
151.524	51	Chinook salmon	6/12/2012	Deshka River
151.524	54	Chinook salmon	2nd week of August	Chulitna River
151.533	37	Chinook salmon	7/10/2012	Clear Creek
151.533	59	Chinook salmon	7/30/2012	Willow Creek
151.533	88	Chinook salmon	7/10/2012	Clear Creek
151.544	17	Chinook salmon	6/15/2012	Deshka River
151.544	31	Chinook salmon	6/19/2012	Deshka River mouth
151.544	56	Chinook salmon	6/4/2012	Deshka River mouth
151.544	56	Chinook salmon	6/4/2012	Deshka River
151.544	73	Chinook salmon	6/15/2012	Deshka River mouth
151.584	48	Chinook salmon	8/19/2012	Sheep Creek
151.584	50	Chinook salmon	9/1/2012	Montana Creek
151.504	9	pink salmon	9/15/2012	Montana Creek
151.573	1	pink salmon	8/27/2012	Willow Creek
151.573	54	pink salmon	7/18/2012	Indian River

Table 10. Unweighted spawning distribution (number of fish and percent) of radiotagged pink salmon in the Susitna River drainage in 2012, by tagging gear.

	Fish wheel 1 (west bank of west channel)		Fish wheel 2 (east bank of west channel)		Fish wheel 3 (west bank of east channel)		Fish wheel 4 (east bank of east channel)		Total	
System	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Alexander Creek	0	0	0	0	0	0	0	0	0	0
Yentna River	88	92	39	40	29	31	6	6	162	42
Chulitna River	4	4	25	26	36	38	31	32	96	25
Talkeetna River	1	1	6	6	11	12	10	10	28	7
Deshka River	1	1	15	15	11	12	14	15	41	11
East Side Susitna River[a]	0	0	3	3	3	3	25	26	31	8
Susitna River RM 99–154	0	0	2	2	1	1	3	3	6	2
Susitna River RM 31–98	2	2	8	8	4	4	7	7	21	5
Grand Total	96	100	98	1	95	100	96	100	385	100

[a] Willow, Little Willow, Montana, and Sheep creeks, and Kashwitna River.

Table 11. Comparison of helicopter counts of spawning Chinook salmon on six index tributaries of the Susitna River by three observers during 2012.

Index Stream	Observer 1	Observer 2	Observer 3	Observer comments	% Agreement 1 & 2	% Agreement 1 & 3	% Agreement 2 & 3
Clear Creek							
Date	17-Jul	19-Jul	26-Jul	1st- low water, excellent visibility			
Count	1,177	990	805	2nd- Viewing conditions were excellent.	84%	68%	81%
Weather	C	C	C	3rd-Bright sun made for dark shadows in the water.			
Stream	C	L	C	Lots of other salmon in the 1st half not as many KS at mouth.			
Visibility	E	E	N	Fish very spread out KS all the way to the end.			
				Counted 1 week later than planned due to bad weather.			
Prairie Creek							
Date	17-Jul	19-Jul	26-Jul				
Count	853	970	1,185	1st-Fish still holding at the mouth - not as many just below lake as normal.	88%	72%	82%
Weather	C	C	C	Grizzly Creek not counted			
Stream	C	L	L	3rd- counted 1 week later than planned due to bad weather.			
Visibility	N	E	E				
Montana Creek							
Date	17-Jul	19-Jul	21-Jul	1st-At least 200 fish holding at the mouth, most fish just below			
Count	416	402	258	forks (east) holding. Hardly any fish in forks.	97%	62%	64%
Weather	C	C	O	2nd - 60 at the mouth. Included group at forks with mainstem count.			
Stream	N	N	N	3rd -none at mouth, solid rain came back to Wasilla at 3pm.			
Visibility	E	E	N				
N. Fork Kashwitna							
Date	16-Jul	18-Jul	20-Jul				
Count	82	83	85	1st -Viewing conditions were dark due to dense cloud cover.	99%	96%	98%
Weather	O	C	O	Lots of log jams first 2 miles.			
Stream	C	N	N	3rd- Flew pretty fast, still some groups of 4-6 fish, no groups of 10.			
Visibility	O	E	E				

-continued-

Table 11. Part 2 of 2.

Index Stream	Observer 1	Observer 2	Observer 3	Observer comments	% Agreement 1 & 2	% Agreement 1 & 3	% Agreement 2 & 3
Little Willow Creek							
Date	16-Jul	18-Jul	20-Jul				
Count	437	427	494	1st-Viewing conditions were dark until parks hwy bridge, hard to see	98%	88%	86%
Weather	O	O	O	into deep holes until reached bridge where conditions improved to good.			
Stream	N	N	N	Most fish upstream of power lines			
Visibility	N	E	E	3rd - Few fish upper end, less than 10 last 5 miles. Small groups of fish, 1-10.			
Willow Creek							
Date	16-Jul	18-Jul	20-Jul				
Count	712	756	744	1st-Partly sunny conditions, most fish were above RR bridge.	94%	96%	98%
Weather	O	C	O	2nd - Groups of 10-12 common from Parks Hwy to Ghett's bridge.			
Stream	N	N	N	3rd- one dead			
Visibility	N	E	E				

Note: Survey conditions for weather are C = clear, O = overcast, T = turbulent; conditions for stream are L = low, N = normal, H = high, C = clear, and S = silty; conditions for visibility are E = excellent, N = normal, and P = poor.

FIGURES

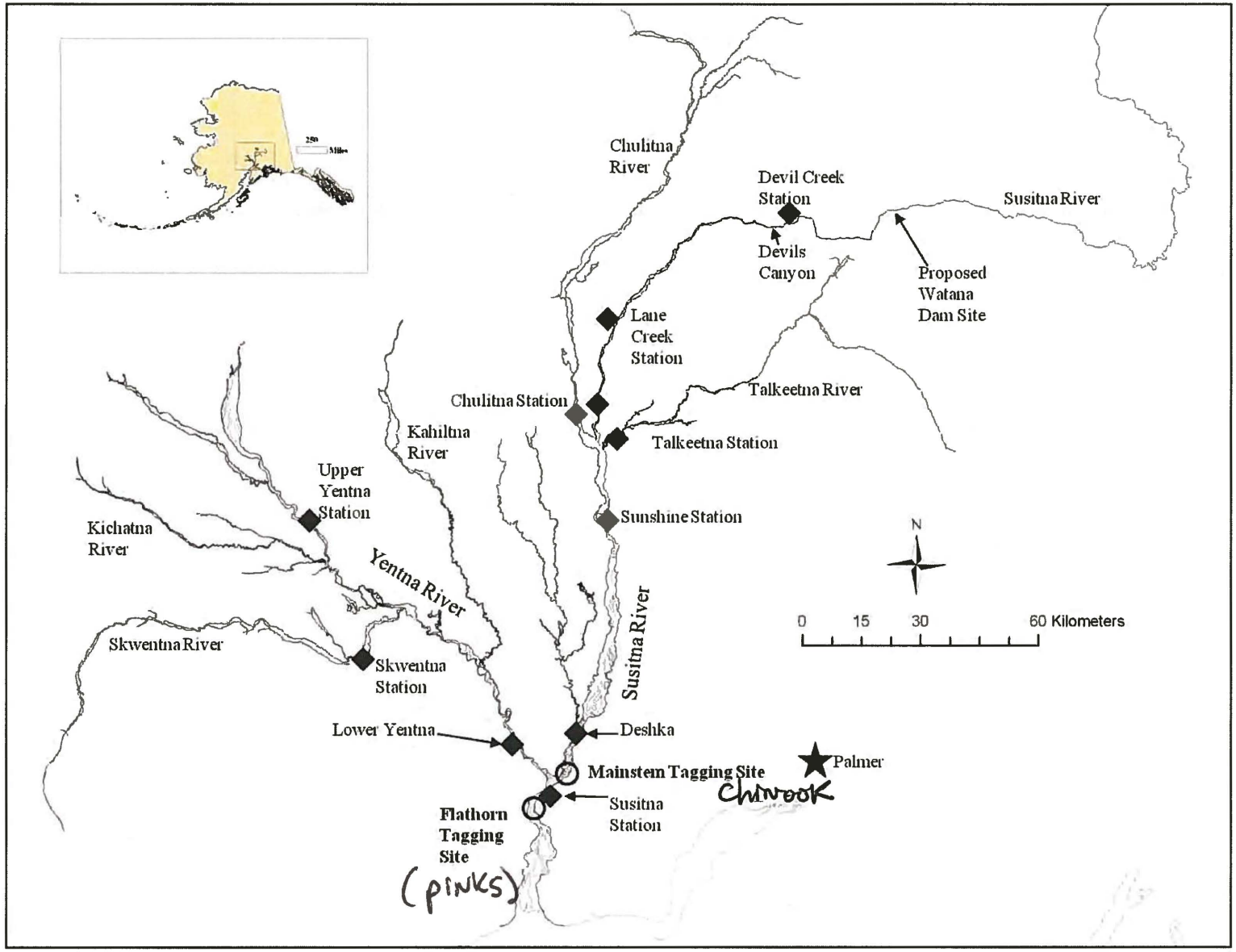

Figure 1. Locations of the tagging sites and radiotelemetry stations used in this study for Chinook and pink salmon in the Susitna River in 2012.

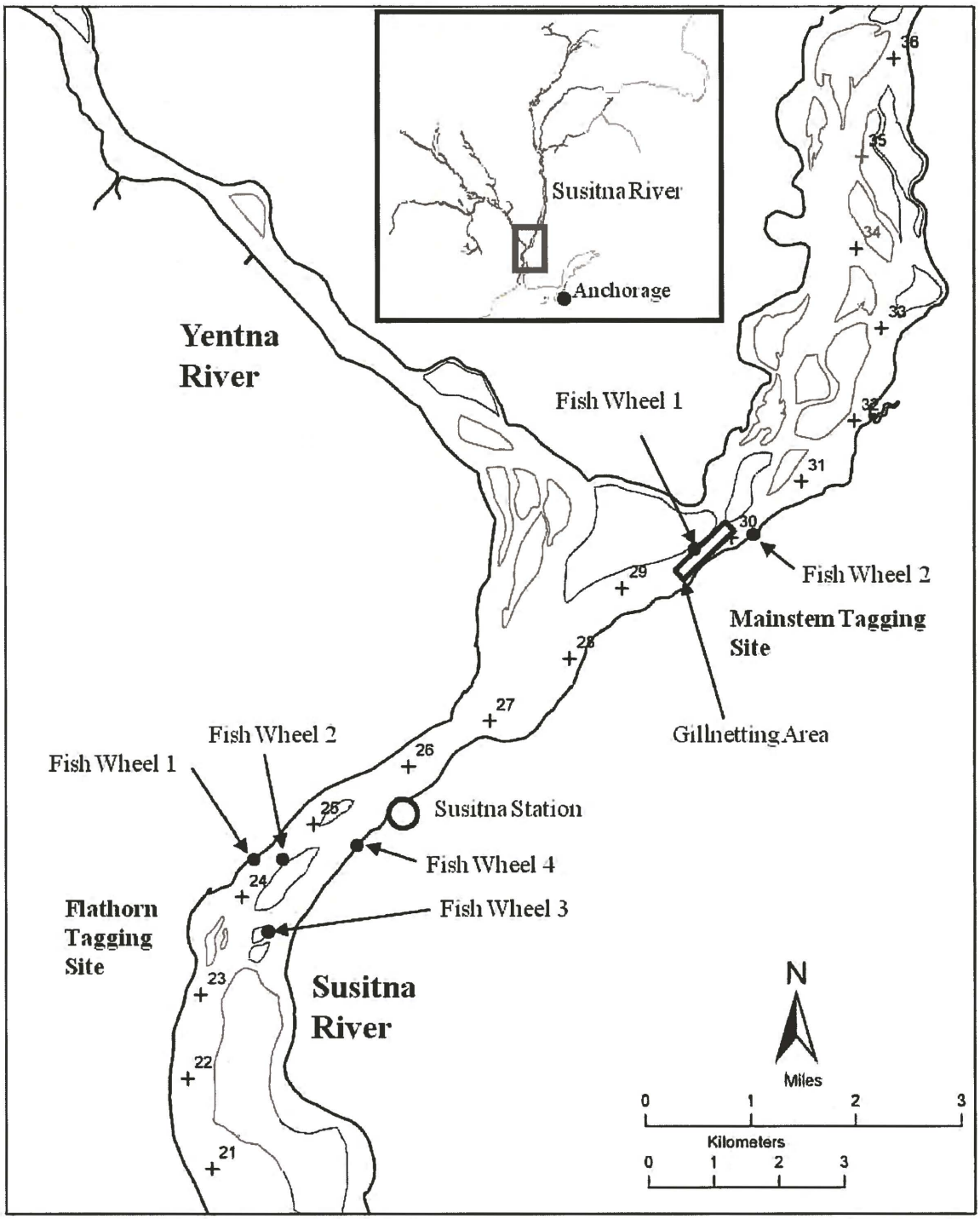

Figure 2. Locations of the mainstem and Flathorn sites for tagging Chinook and pink salmon, and river miles, in the lower Susitna River in 2012.

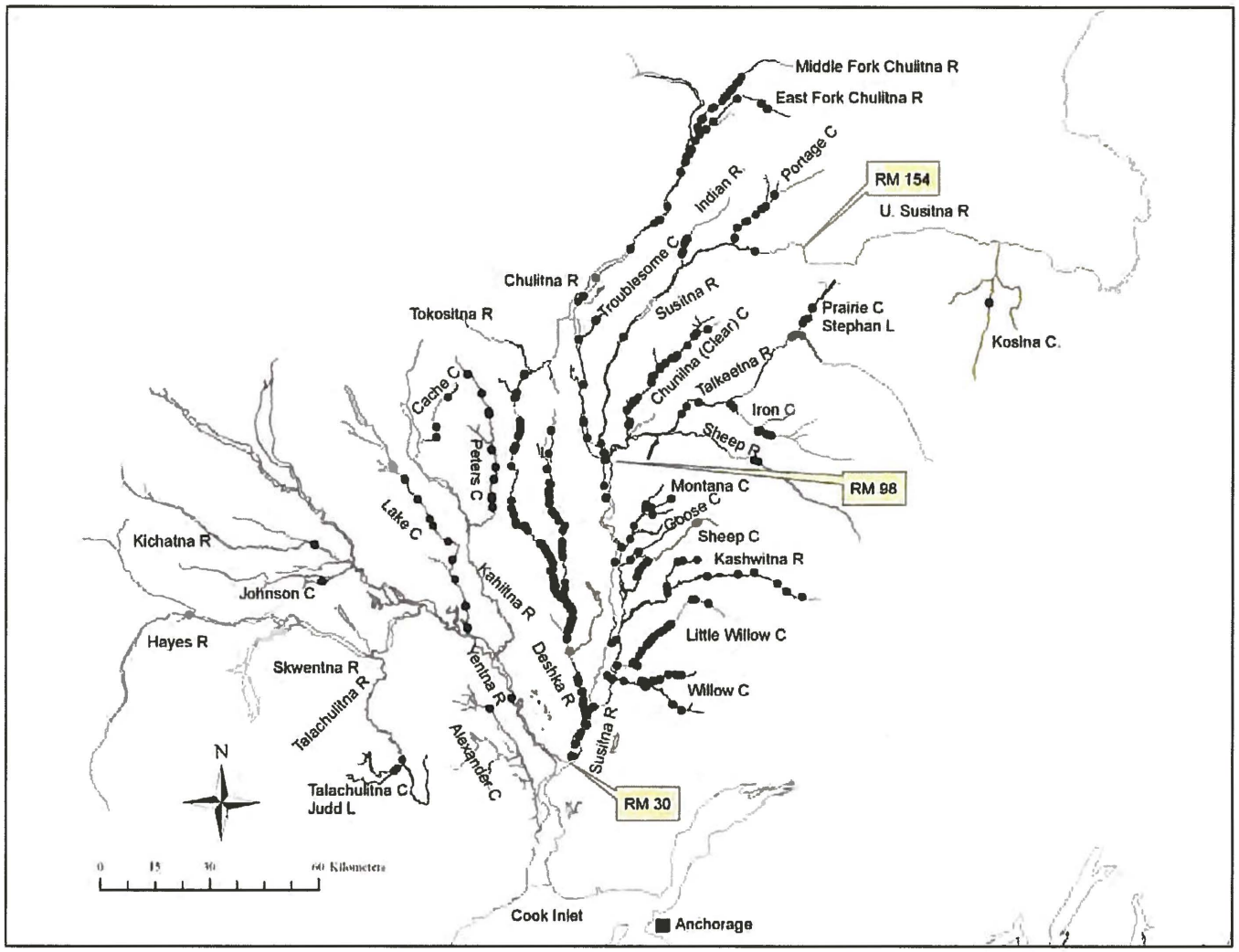

Figure 3. Spawning locations of radiotagged Chinook salmon in the Susitna River for all capture gears combined, 2012.

Note: RM is river mile.

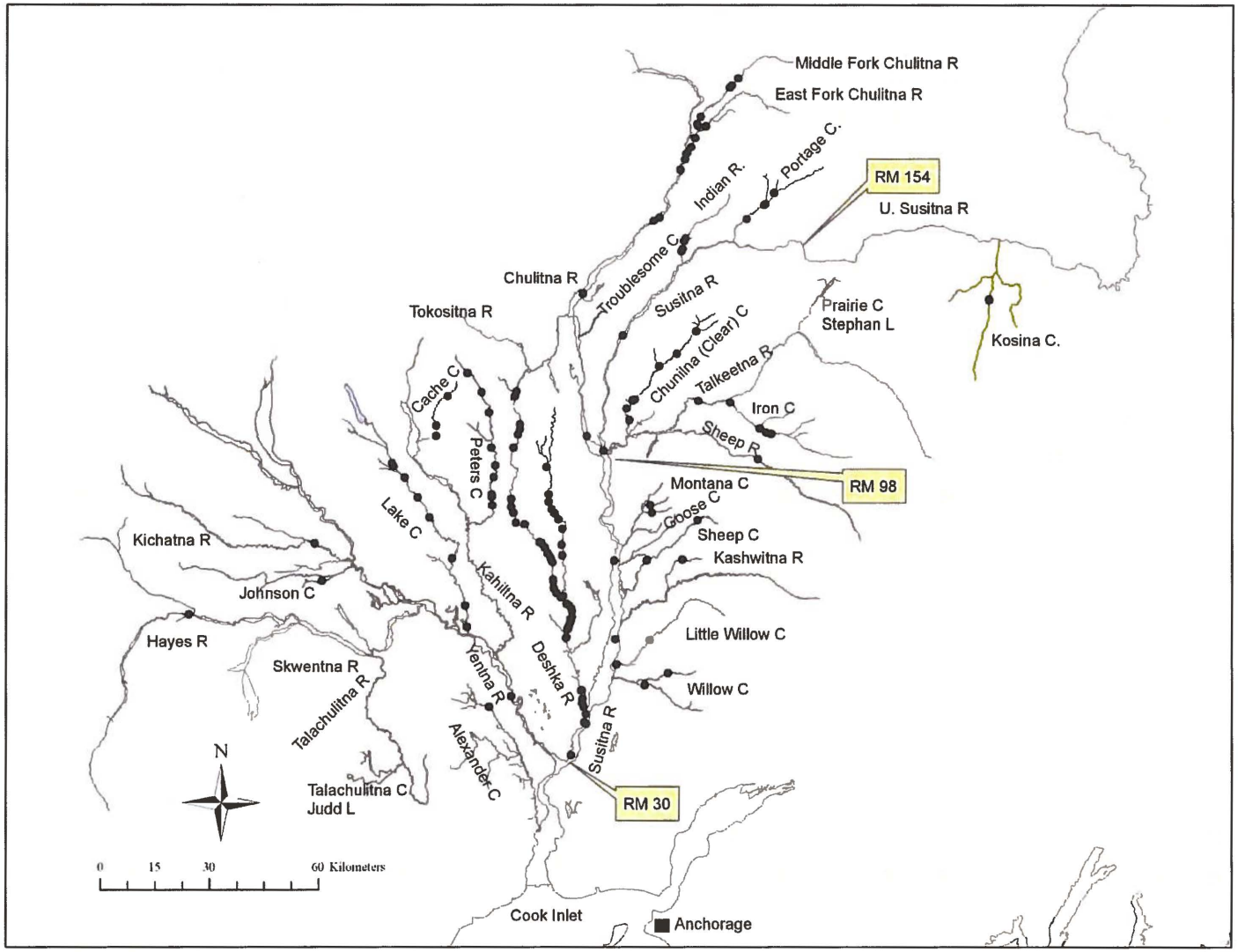

Figure 4. Spawning locations of Chinook salmon radiotagged at fish wheel 1 (west) in the Susitna River, 2012.

Note: RM is river mile.

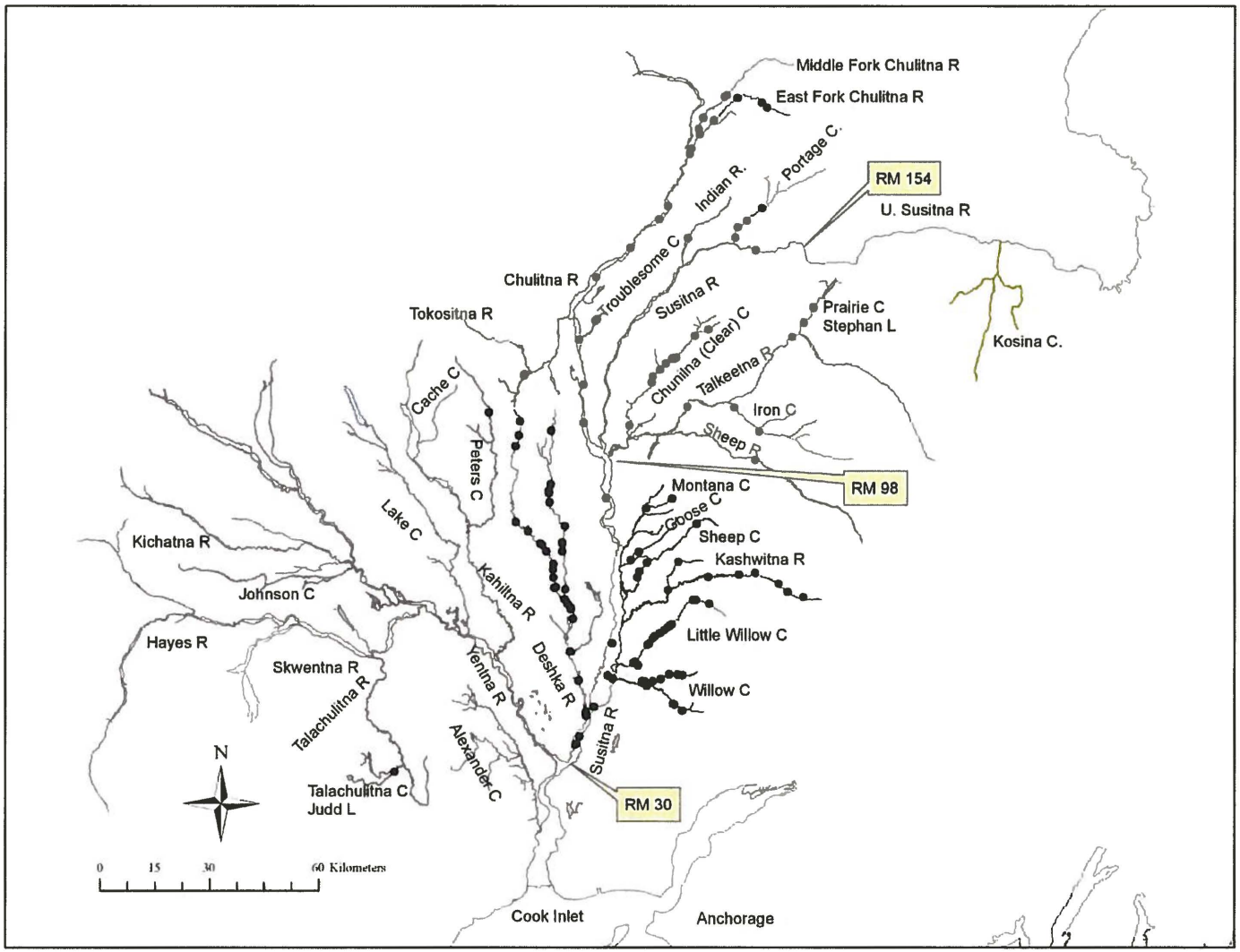

Figure 5. Spawning locations of Chinook salmon radiotagged at fish wheel 2 (east) in the Susitna River, 2012

Note: RM is river mile.

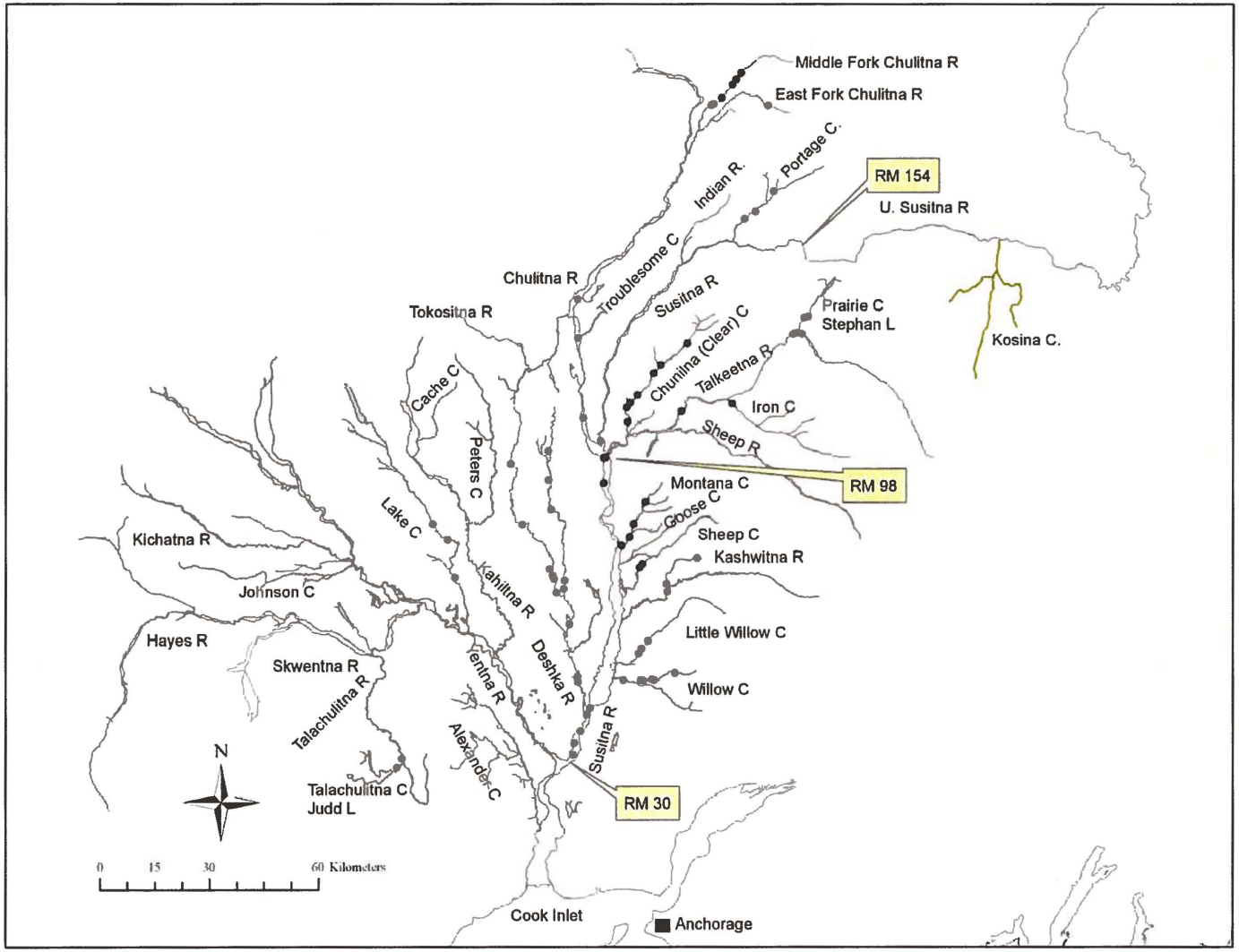

Figure 6. Spawning locations of Chinook salmon radiotagged from drift gillnets in the Susitna River, 2012.

Note: RM is river mile.

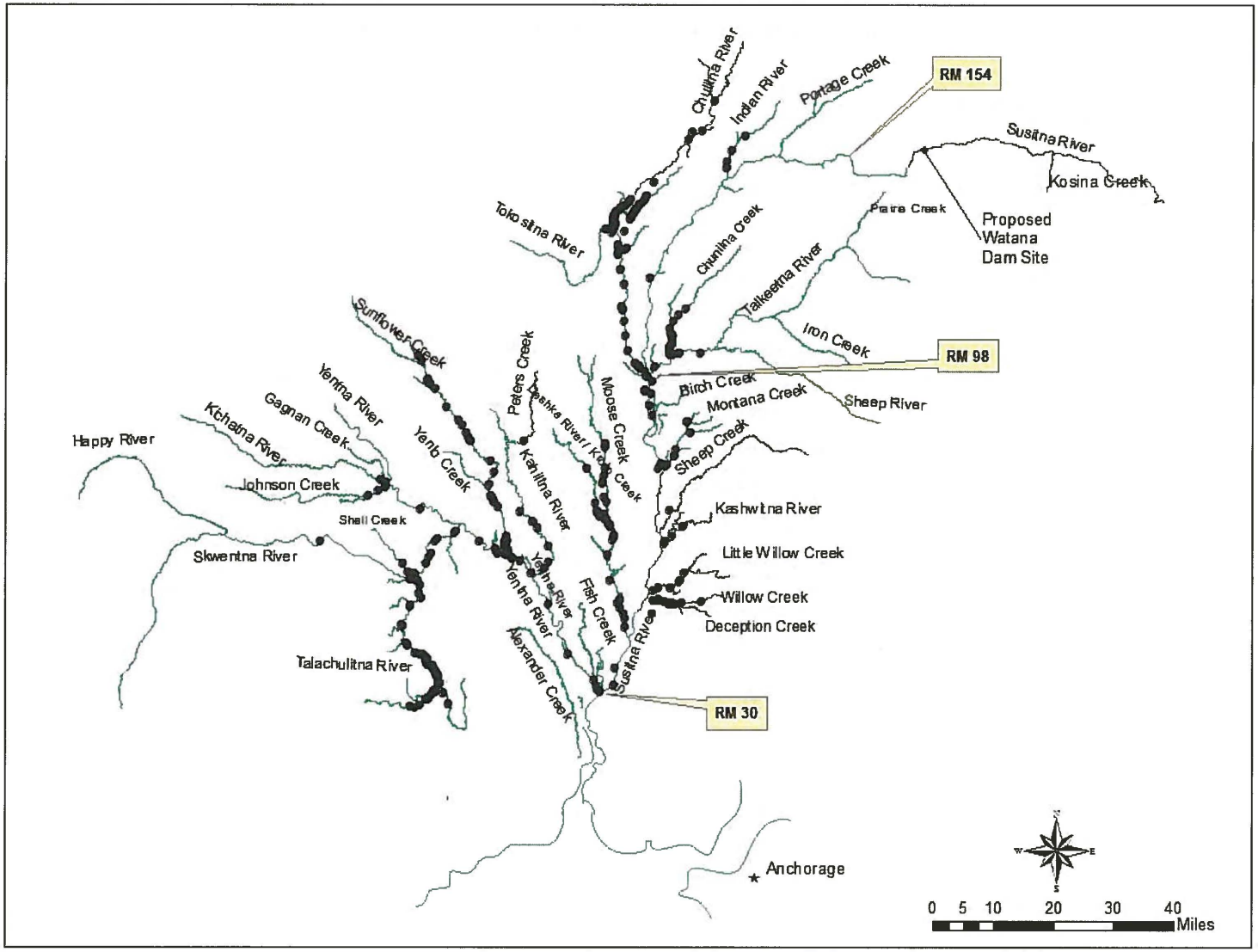

Figure 7. Spawning locations of radiotagged pink salmon in the Susitna River for all fish wheels combined, 2012.

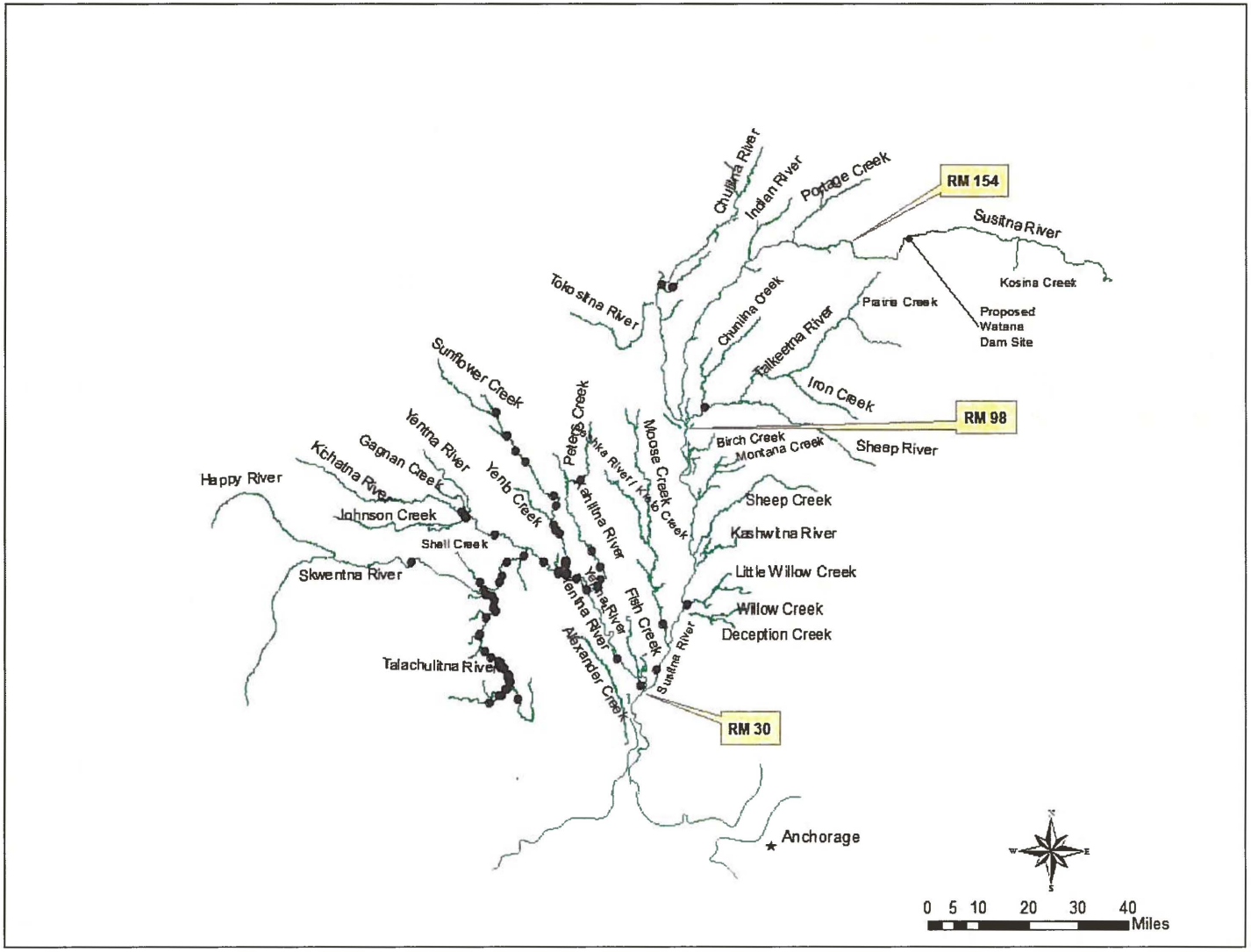

Figure 8. Spawning locations of pink salmon radiotagged at fish wheel 1 in the Susitna River, 2012.

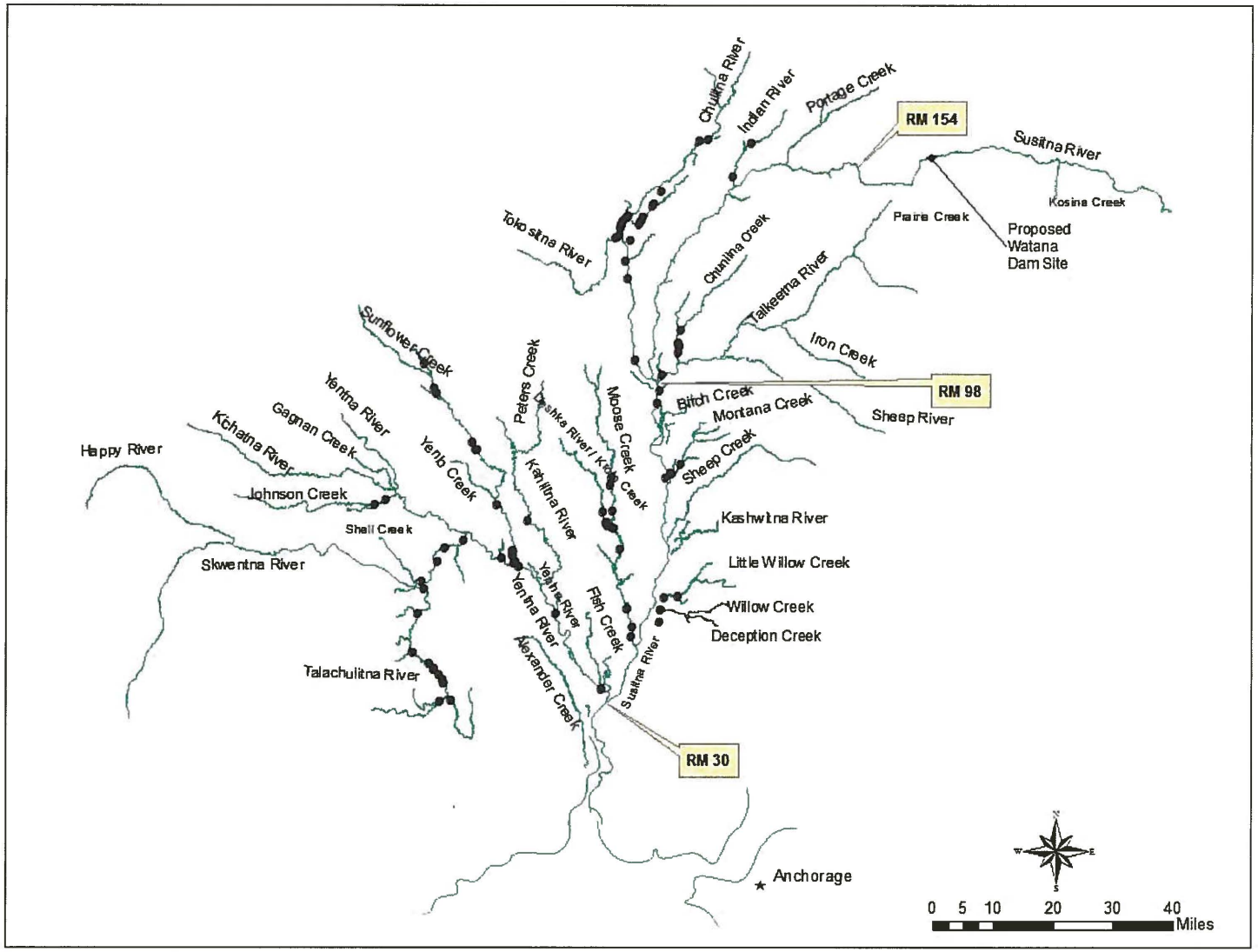

Figure 9. Spawning locations of pink salmon radiotagged at fish wheel 2 in the Susitna River, 2012.

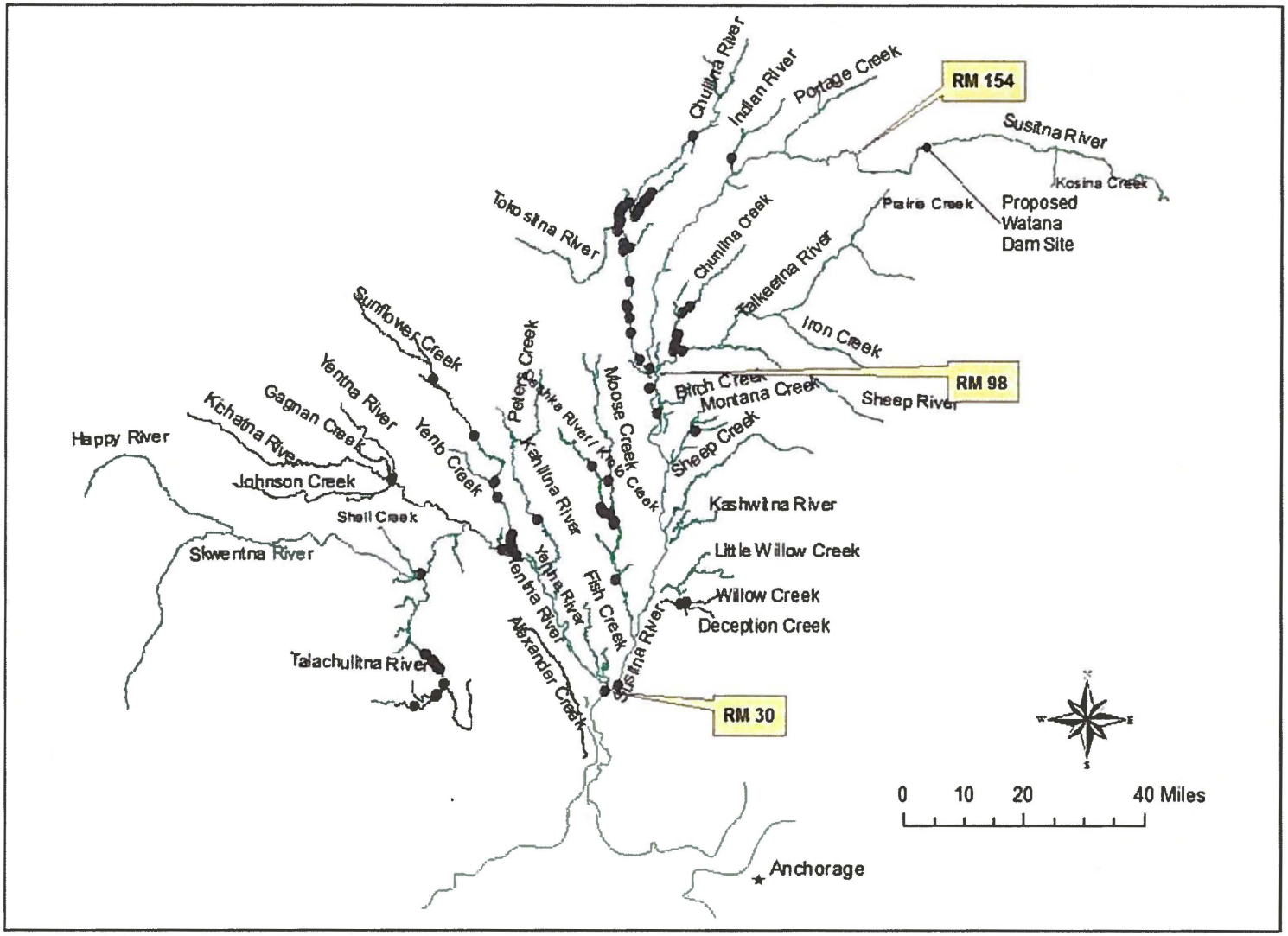

Figure 10. Spawning locations of pink salmon radiotagged at fish wheel 3 in the Susitna River, 2012.

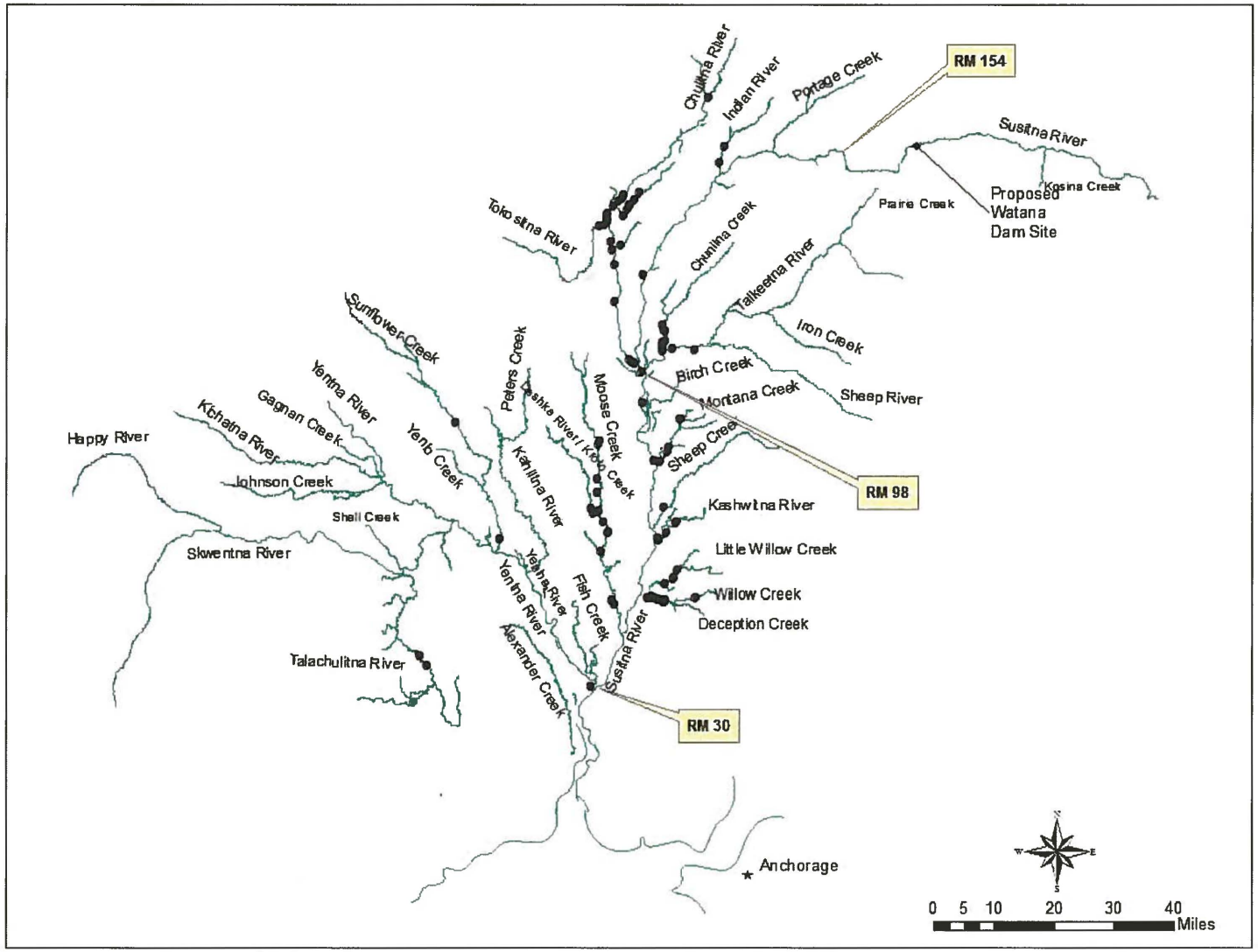

Figure 11. Spawning locations of pink salmon radiotagged at fish wheel 4 in the Susitna River, 2012.