



State of Alaska  
Department of Fish and Game  
Division of Sport Fish

Nomination Form  
Anadromous Waters Catalog

E

Region: SCN USGS Quad(s): Kenai A-3, A-4

Anadromous Waters Catalog Number of Waterway: 244-30-10050-2058(-3008)(-4021)

Name of Waterway: WEST CL  USGS Name  Local Name

Addition  Deletion  Correction  Backup Information

For Office Use

Nomination #	<u>12-638</u>	<u>[Signature]</u>	<u>11/2/12</u>
Revision Year:	<u>2013</u>	Fisheries Scientist	Date
Revision to:	Atlas _____ Catalog _____	<u>[Signature]</u>	<u>11/2/12</u>
	Both <u>X</u>	Habitat Operations Manager	Date
Revision Code:	<u>A-3</u> <del><u>A-1, B-2</u></del>	<u>[Signature]</u>	<u>10/1/12</u>
		AWC Project Biologist	Date
		<u>[Signature]</u>	<u>11/9/12</u>
		Cartographer	Date

OBSERVATION INFORMATION

Species	Date(s) Observed	Spawning	Rearing	Present	Anadromous
coho salmon (7)	2008	X			<input checked="" type="checkbox"/>
					<input type="checkbox"/>
					<input type="checkbox"/>
					<input type="checkbox"/>
					<input type="checkbox"/>

**IMPORTANT:** Provide all supporting documentation that this water body is important for the spawning, rearing or migration of anadromous fish, including: number of fish and life stages observed; sampling methods, sampling duration and area sampled; copies of field notes; etc. Attach a copy of a map showing location of mouth and observed upper extent of each species, as well as other information such as: specific stream reaches observed as spawning or rearing habitat; locations, types, and heights of any barriers; etc.

**Comments:** Individual coho salmon were radio-tagged and tracked to spawning locations (USF&WS Report, Run Timing, Abundance, and Distribution of Adult Coho Salmon in the Kasilof River Watershed, Alaska, 2008, Alaska Fisheries Data Series Number 2009-14)

ref num # 12-491

Name of Observer (please print): Ken Gates

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

Agency: USF&WS

Address: 43655 Kalifornsky Beach Road  
Soldotna, AK 99669

This certifies that in my best professional judgment and belief the above information is evidence that this waterbody should be included in or deleted from the Anadromous Waters Catalog.

Signature of Area Biologist: \_\_\_\_\_ Date: \_\_\_\_\_ Revision 05/08

Name of Area Biologist (please print): \_\_\_\_\_



State of Alaska  
Department of Fish and Game  
Division of Sport Fish

Nomination Form  
Anadromous Waters Catalog

Region II

USGS Quad(s) 052(KEN) Kenai A-3

Anadromous Waters Catalog Number of Waterway \_\_\_\_\_

Name of Waterway West Creek (Tributary to Tustumene R. - AK)  USGS Name  Local Name

Addition  Deletion  Correction  Backup Information

For Office Use

Nomination # _____  Revision Year: _____ Revision to: Atlas _____ Catalog _____ Both _____  Revision Code: _____	_____	_____
	Fisheries Scientist	Date
	Habitat Operations Manager	Date
	AWC Project Biologist	Date
	_____	_____
	Cartographer	Date

OBSERVATION INFORMATION

Species	Date(s) Observed	Spawning	Rearing	Present	Anadromous
Coho Salmon	8/18/2008 - 10/13, 2008	X		X	<input checked="" type="checkbox"/>
					<input type="checkbox"/>
					<input type="checkbox"/>
					<input type="checkbox"/>

**IMPORTANT:** Provide all supporting documentation that this water body is important for the spawning, rearing or migration of anadromous fish, including: number of fish and life stages observed; sampling methods, sampling duration and area sampled; copies of field notes; etc. Attach a copy of a map showing location of mouth and observed upper extent of each species, as well as other information such as: specific stream reaches observed as spawning or rearing habitat; locations, types, and heights of any barriers; etc.

**Comments:**  
Submitting nomination on behalf of Ken Gates / USFWS, Biologist.  
Reference Run Timing, Abundance, and Distribution of Adult Coho Salmon in the Kasilof River Watershed, Alaska, 2008 (see attachment) Alaska Fisheries Data Series Number 2009-14.  
Methods - radio telemetry, tracked by Cessna 185  
8 coho spawners tracked in West Creek - See table & map on p.12 of referenced report.

Name of Observer (please print): Ken Gates  
Signature: \_\_\_\_\_ Date: 7/30/12  
Agency: USFWS  
Address: 43655 K Beach Rd.  
Soldotna, AK 99669

This certifies that in my best professional judgment and belief the above information is evidence that this waterbody should be included in or deleted from the Anadromous Waters Catalog.

Signature of Area Biologist: [Signature] Date: 7/30/2012 Revision \_\_\_\_\_  
02/08

Ginny Littlefield  
Ginny Littlefield -  
Kenai Peninsula Area Manager 7/30/12



State of Alaska  
Department of Fish and Game  
Division of Sport Fish

Nomination Form  
Anadromous Waters Catalog

Region II USGS Quad(s) 052(KEN) Kenai A-3

Anadromous Waters Catalog Number of Waterway \_\_\_\_\_

Name of Waterway West Creek (Tributary to Tustumene Rk.)  USGS Name  Local Name  
 Addition  Deletion  Correction  Backup Information

For Office Use

Nomination # _____	_____	_____
Revision Year: _____	Fisheries Scientist	Date _____
Revision to: Atlas _____ Catalog _____	Habitat Operations Manager	Date _____
Both _____	AWC Project Biologist	Date _____
Revision Code: _____	Cartographer	Date _____

OBSERVATION INFORMATION

Species	Date(s) Observed	Spawning	Rearing	Present	Anadromous
Coho Salmon	8/18/2008 - 10/13, 2008	X		X	<input checked="" type="checkbox"/>
					<input type="checkbox"/>
					<input type="checkbox"/>
					<input type="checkbox"/>
					<input type="checkbox"/>

**IMPORTANT:** Provide all supporting documentation that this water body is important for the spawning, rearing or migration of anadromous fish, including: number of fish and life stages observed; sampling methods, sampling duration and area sampled; copies of field notes; etc. Attach a copy of a map showing location of mouth and observed upper extent of each species, as well as other information such as: specific stream reaches observed as spawning or rearing habitat; locations, types, and heights of any barriers; etc.

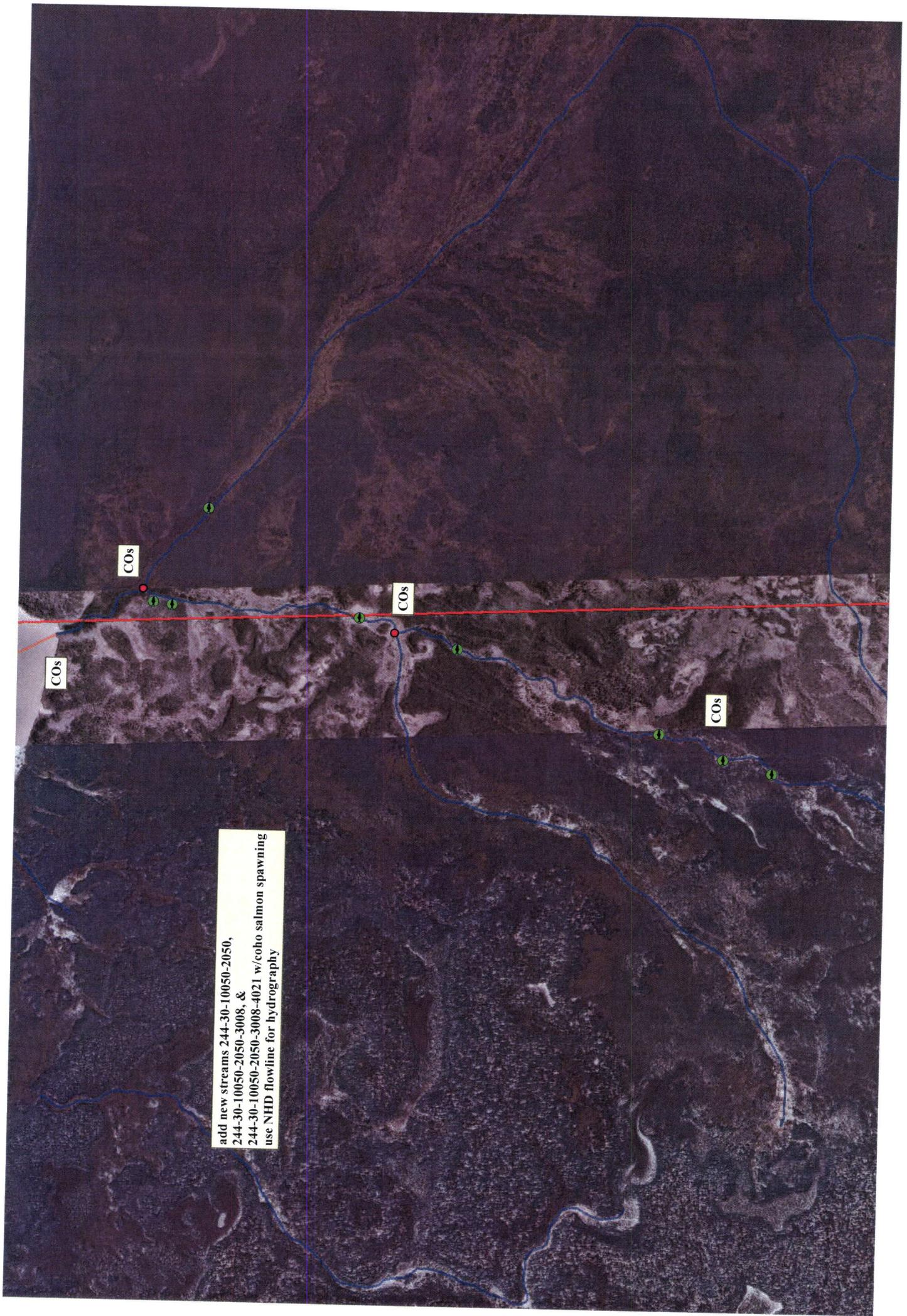
Comments:  
 Submitting nomination on behalf of Ken Gates / USFWS, Biologist  
 Reference Run Timing, Abundance, and Distribution of Adult Coho Salmon in the Kaslof River Watershed, Alaska, 2008 (see attachment)  
 Alaska Fisheries Data Series Number 2009-14.  
 Methods - radio telemetry, tracked by Cessna 185  
 8 coho spawners tracked in West Creek - See table & map on p. 12 of referenced report.

Name of Observer (please print): Ken Gates  
 Signature: \_\_\_\_\_ Date: 7/30/12  
 Agency: USFWS  
 Address: 43655 K Beach Rd.  
Soldotna, AK 99669

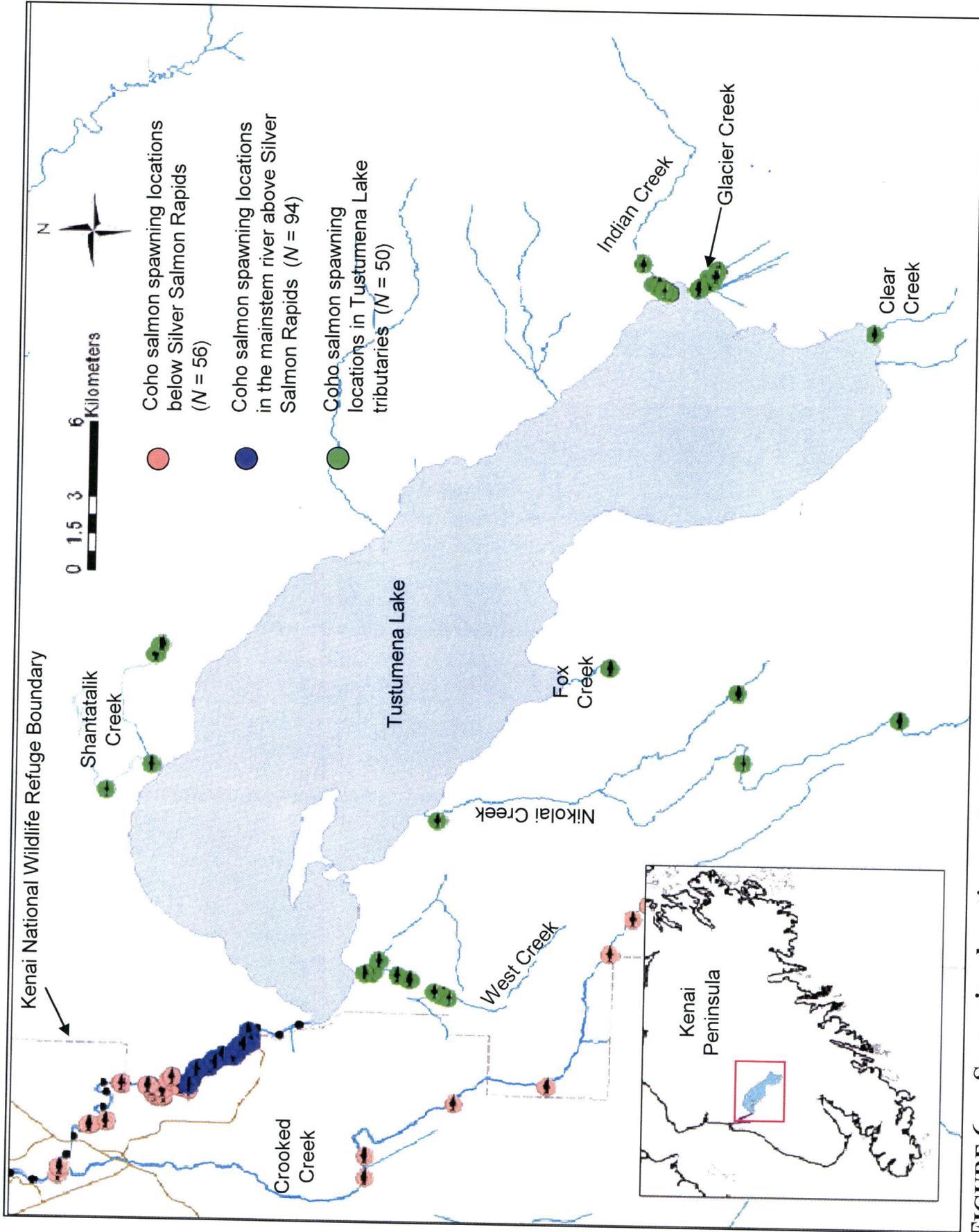
This certifies that in my best professional judgment and belief the above information is evidence that this waterbody should be included in or deleted from the Anadromous Waters Catalog.

Signature of Area Biologist: [Signature] Date: 7/30/2012 Revision \_\_\_\_\_

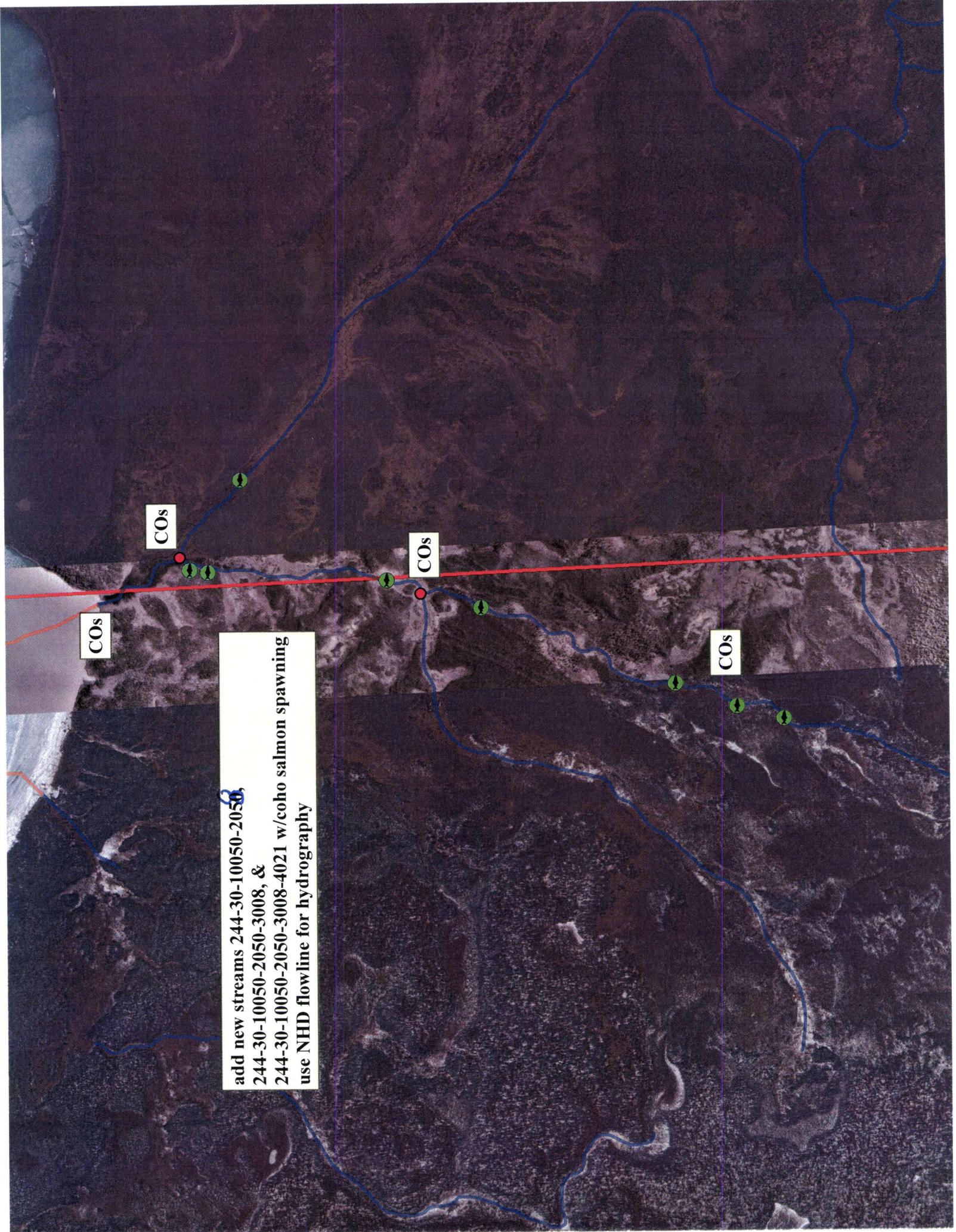
Ginny Litchfield  
 Ginny Litchfield - Area Manager  
 Kenai Peninsula 7/30/12



add new streams 244-30-10050-2050,  
244-30-10050-2050-3008, &  
244-30-10050-2050-3008-4021 w/coho salmon spawning  
use NHD flowline for hydrography



**FIGURE 6.**—Spawning locations selected by radio-tagged coho salmon in the Kasilof River watershed during 2008



COs

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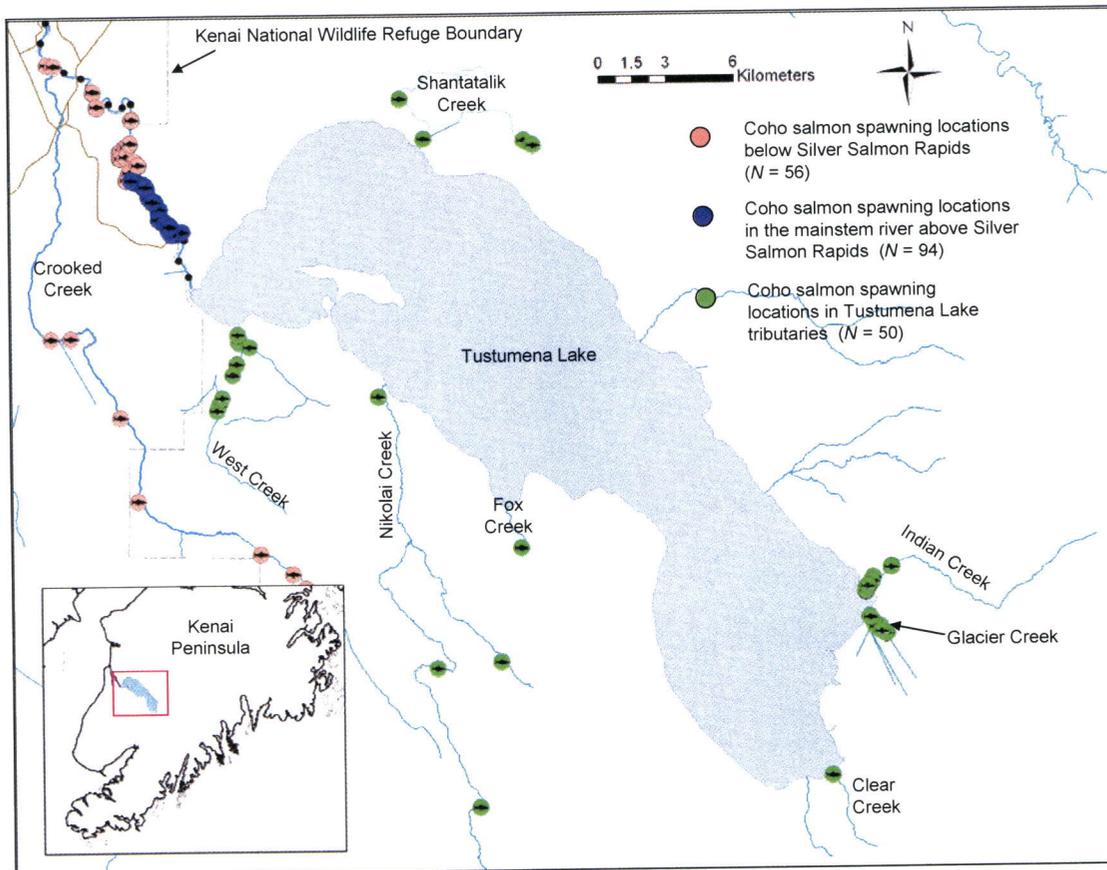
COs

add new streams 244-30-10050-2050,  
244-30-10050-2050-3008, &  
244-30-10050-2050-3008-4021 w/coho salmon spawning  
use NHD flow line for hydrography

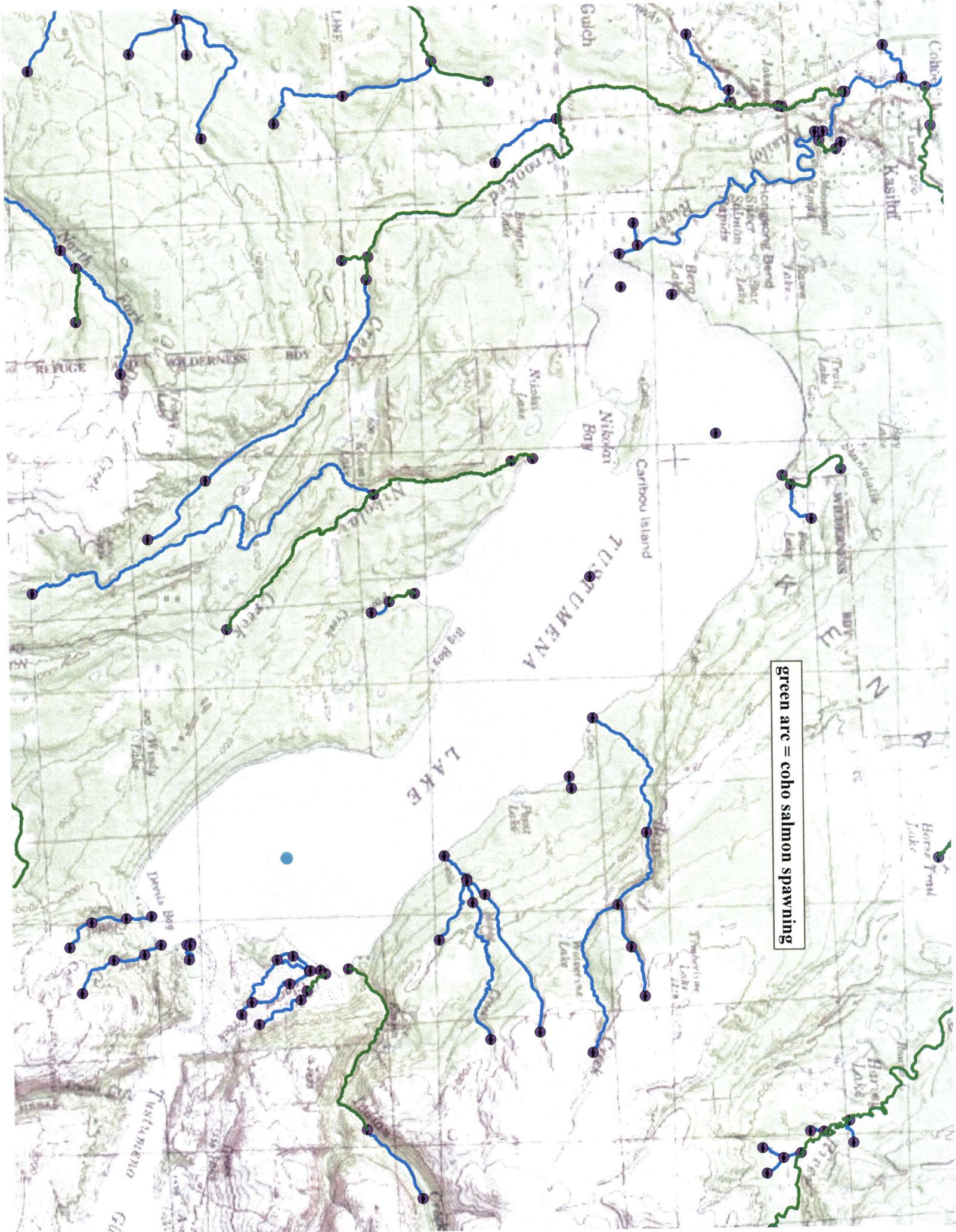
by changes in the relative abundance of tributary and mainstem spawners early and late in the run (Table 3).

**TABLE 3.** —Fates assigned to coho salmon radio-tagged in the Kasilof River between 18 August and 13 October, 2008.

Fate	Strata				Total	%
	1	2	3	4		
<b>Tributary Spawners</b>						
Shantatalik Creek	5	1			6	2.5
Nikoilai Creek	3	1			4	1.7
Indian Creek	13	7			20	8.3
Fox Creek	1				1	0.4
West Creek	8			1	9	3.8
Glacier Creek	2	3	2	2	9	3.8
Clear Creek		1			1	0.4
Mainstem Spawners above rkm 24 (Refuge)	5	31	30	28	94	39.2
<b>Other Spawners</b>						
Maintstem below rkm 24		7	17	22	46	19
Crooked Creek	8		1		9	3.8
Coal Creek	1				1	0.4
Dead/Regurgitated	6	6	7	5	24	10.0
Harvested	2		1		3	1.3
Back Out	3	2	2	1	8	3.3
Unknown	3	1	0	1	5	2.1



**FIGURE 6.** —Spawning locations selected by radio-tagged coho salmon in the Kasilof River watershed during 2008



green arc = coho salmon spawning

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**Johnson, J D (DFG)**

**From:** Westerman, David L (DFG)  
**Sent:** Tuesday, July 10, 2012 1:51 PM  
**To:** Johnson, J D (DFG)  
**Subject:** FW: Tustumena Stream  
**Attachments:** M10-065.pdf; Data Series 2009-14.pdf; Tustumena Strea.pdf

J

You may want to look at this report for a coho study conducted in Kasilof R drainage. West creek is not listed as anadromous in our catalog and should be. Check some of the other streams in this report too, might find something that we need to add to our AWC. Patty Berkhahn will probably notify you about this too.

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**From:** [Kenneth\\_Gates@fws.gov](mailto:Kenneth_Gates@fws.gov) [[mailto:Kenneth\\_Gates@fws.gov](mailto:Kenneth_Gates@fws.gov)]  
**Sent:** Tuesday, July 10, 2012 11:08 AM  
**To:** [pberkhahn@borough.kenai.ak.us](mailto:pberkhahn@borough.kenai.ak.us)  
**Cc:** Westerman, David L (DFG)  
**Subject:** Re: FW: Tustumena Stream

Patti,

Yes, this stream is anadromous. It supports a fair number of spawning coho salmon. We identified it as supporting coho salmon during a two year study focused at identifying the distribution and spawning locations of adult coho salmon using radio telemetry. Its unofficial name is West Creek. We have a few reports out with this info. The most recent are attached. You will have to scan through the text and tables but there are several tables and figures that identify West Creek. The M10-065 is a manuscript from the North American Journal of Fisheries Management and the Data Series report compliments the Journal. Let me know if you have any further questions. --Ken

*(See attached file: M10-065.pdf)(See attached file: Data Series 2009-14.pdf)*

~~~~~  
Ken Gates

Fishery Biologist  
U.S. Fish and Wildlife Service  
Kenai Fish and Wildlife Field Office  
43655 K-Beach Road  
Soldotna, Alaska 99669  
Direct Line: (907) 260-0126  
Fax: (907) 262-7145  
"Berkhahn, Patti" <[PBerkhahn@borough.kenai.ak.us](mailto:PBerkhahn@borough.kenai.ak.us)>

"Berkhahn, Patti"  
<[PBerkhahn@borough.kenai.ak.us](mailto:PBerkhahn@borough.kenai.ak.us)>

To <[david.westerman@alaska.gov](mailto:david.westerman@alaska.gov)>, <[kenneth\\_gates@fws.gov](mailto:kenneth_gates@fws.gov)>

07/10/2012 08:57 AM

cc

SubjectFW: Tustumena Stream

Have either of you done surveys on this Tustumena Lake tributary and know if it is anadromous or not? If you have evidence that it is anadromous, please send me the data and I'll nominate it for an addition to the Anadromous Waters Catalog.

(look for the yellow dot in Section 35 of the attached map.)

**From:** Czarnezki, John  
**Sent:** Tuesday, July 10, 2012 8:28 AM  
**To:** Berkhahn, Patti  
**Subject:** Tustumena Stream

Hi Patti,

Attached is a PDF map of the stream we explored this past weekend. We went in about ½ mile and stopped. It's a fairly wide channel (8 feet), and I suspect it has anadromous fish in it. I can't imagine why it wouldn't. I didn't see it listed in the catalog so I thought I send this out. The mouth of the stream is located in T2N R11W Section 35 (yellow dot on map).

John C (See attached file: *Tustumena Streaa.pdf*)

# Run Timing, Abundance, and Distribution of Adult Coho Salmon in the Kasilof River Watershed, Alaska, 2008

*Alaska Fisheries Data Series Number 2009-14*



**Kenai Fish and Wildlife Field Office  
Soldotna, Alaska  
September, 2009**



The Alaska Region Fisheries Program of the U.S. Fish and Wildlife Service conducts fisheries monitoring and population assessment studies throughout many areas of Alaska. Dedicated professional staff located in Anchorage, Juneau, Fairbanks and Kenai Fish and Wildlife Offices and the Anchorage Conservation Genetics Laboratory serve as the core of the Program's fisheries management study efforts. Administrative and technical support is provided by staff in the Anchorage Regional Office. Our program works closely with the Alaska Department of Fish and Game and other partners to conserve and restore Alaska's fish populations and aquatic habitats. Additional information about the Fisheries Program and work conducted by our field offices can be obtained at:

<http://alaska.fws.gov/fisheries/index.htm>

The Alaska Region Fisheries Program reports its study findings through two regional publication series. The **Alaska Fisheries Data Series** was established to provide timely dissemination of data to local managers and for inclusion in agency databases. The **Alaska Fisheries Technical Reports** publishes scientific findings from single and multi-year studies that have undergone more extensive peer review and statistical testing. Additionally, some study results are published in a variety of professional fisheries journals.

Disclaimer: The use of trade names of commercial products in this report does not constitute endorsement or recommendation for use by the federal government.

## Run Timing, Abundance, and Distribution of Adult Coho Salmon in the Kasilof River Watershed, Alaska, 2008

Kenneth S. Gates<sup>1</sup>, Douglas E. Palmer<sup>1</sup>, and Jeffrey F. Bromaghin<sup>2</sup>

262-9863

### Abstract

Run timing, abundance, and distribution information was collected on coho salmon *Oncorhynchus kisutch* in the upper Kasilof River watershed during 2008 using fish weirs equipped with underwater video systems and radio telemetry. A combined total of 1,315 coho salmon was counted past the Nikolai ( $N=721$ ) and Shantatalik ( $N=594$ ) creek weirs between 27 August and 2 November. Peak weekly passage occurred between 7 and 13 September for both creeks. Radio-transmitters were implanted in 240 coho salmon captured in the Kasilof River between 18 August and 13 October. Seventy-two percent ( $N=144$ ) of the radio-tagged coho salmon designated as spawners ( $N=200$ ) selected locations in the study area upstream of the Kenai National Wildlife Refuge boundary at Silver Salmon Rapids (rkm 24). Of those fish, 94 spawned in the upper mainstem Kasilof River and 50 selected spawning locations in tributaries of Tustumena Lake. Tustumena Lake tributary streams included Shantatalik ( $N=6$ ), Nikolai ( $N=4$ ), Indian ( $N=20$ ), Fox ( $N=1$ ), West ( $N=9$ ), Glacier ( $N=9$ ) and Clear ( $N=1$ ) creeks. Other radio-tagged fish spawned outside the study area in Crooked Creek ( $N=9$ ), Coal Creek ( $N=1$ ) and the mainstem Kasilof River downstream of the refuge boundary ( $N=46$ ). All remaining radio-tagged fish ( $N=40$ ) were determined to not have spawned and were classified as “Dead/Regurgitated”, “Harvested”, “Back Out”, or “Unknown”.

### Introduction

The Kasilof River watershed provides spawning and rearing habitat for Chinook *Oncorhynchus tshawytscha*, coho *O. kisutch*, sockeye *O. nerka*, and pink salmon *O. gorbuscha* (Johnson and Daigneault 2008). Sockeye salmon are targeted primarily by commercial fisheries in Cook Inlet and have been the focus of numerous research, enhancement, and assessment projects within the Kasilof River watershed for nearly 30 years (Kyle 1992; Burger et al. 1995, 1997; Finn et al. 1997; Woody et al. 2000; Shields 2006). Conversely, little research and monitoring effort has been directed toward understanding coho salmon within the watershed.

Coho salmon return to the Kasilof River beginning in late July. Returns to Crooked Creek, a lower Kasilof River tributary, were monitored by the U.S. Fish and Wildlife Service (Service) and the Alaska Department of Fish and Game (Department) using a weir between 2004 and 2007. Estimates of annual escapement during this period ranged from 2,756 to 5,703 fish (U.S. Fish and Wildlife Service and Alaska Department of Fish and Game, unpublished data). Coho salmon begin returning to Crooked Creek in early August and the run peaks in early September. Most fish passed the weir by early October. Monitoring efforts prior to 2007 for coho salmon in the upper Kasilof River watershed were limited to ground and aerial survey counts in Tustumena Lake tributaries (Faurot and Jones 1990;

Palmer and Gates 2007). Coho salmon were observed by Faurot and Jones (1990) in four of the eleven streams surveyed during 1987: Pipe, Indian, Glacier, and Seepage creeks. Index counts for all streams during 1987 were less than 50 fish, except for Indian Creek which had a peak count of 931 coho salmon on 9 November. Similar results were observed during ground and aerial surveys conducted for the same streams in 2006 by Palmer and Gates (2007). Coho salmon were found in only three streams during 2006: Glacier, Indian, and Shantatalik creeks. Peak counts during 2006 occurred between 17 and 30 October and ranged from 44 to 195 coho salmon. The greatest numbers were observed in Indian Creek. Coho salmon are also known to be present in Fox and Nikolai creeks (Johnson and Daigneault 2008), but were not observed in surveys conducted during 1987 or 2006. More recently in 2007, weirs equipped with underwater video systems and radio telemetry were used to further describe the run timing, abundance, and distribution of coho salmon in the upper Kasilof River watershed. Weirs were installed and operated in Nikolai and Shantatalik creeks to enumerate coho salmon between 4 August and 16 November (Palmer et al. 2008). A total of 1,556 coho salmon was counted past the Nikolai ( $N=837$ ) and Shantatalik ( $N=719$ ) creek weirs between 19 August and 15 November. Peak counts were observed between 16 and 22 September for both creeks. Results from radio-tagging identified four spawning locations in the upper Kasilof River watershed which included the mainstem Kasilof River, and Nikolai, Shantatalik, and Indian creeks.

Coho salmon returning to the Kasilof River watershed are harvested primarily in sport and personal use fisheries. Annual sport harvest in the Kasilof River has averaged 3,185 coho salmon between 1996 and 2003 (Howe et al. 2001a-d; Jennings et al. 2004, 2006a, 2006b; Walker et al. 2003). During the same period, estimated harvest of coho salmon in the personal use dip net fishery has averaged 625 fish annually (Reimer and Sigurdsson 2004). Harvest of coho salmon in federal subsistence fisheries has been minimal to date, but could increase in the near future. Ninilchik residents were granted a customary and traditional use designation for salmon, trout, Dolly Varden and other char on federal waters within the Kasilof River watershed by the Federal Subsistence Board in January 2006. In addition, new regulations implemented during 2007 and 2008 expanded the methods and means, seasons, and harvest limits for coho salmon and other fish species in the federal subsistence fisheries. These regulations include the use of a fish wheel to harvest salmon in the upper Kasilof River, but the organization approved to operate the fish wheel has not yet completed its construction.

The development of federal subsistence fisheries in the Kasilof River watershed has created a need for more detailed information on the abundance and distribution of coho salmon. To address this need, fish weirs equipped with underwater video systems and radio telemetry were used to estimate the abundance and run-timing of adult coho salmon in two tributaries of Tustumena Lake and to identify additional spawning areas upstream of the Kenai National Wildlife Refuge (Refuge) boundary at Silver Salmon Rapids. Project objectives during 2008 were to (1) determine the abundance and run-timing of adult coho salmon entering Nikolai and Shantatalik creeks, (2) identify the ultimate spawning destination upstream of Silver Salmon rapids (rkm 24), via the presence of at least one tagged fish, of a population comprising 5% or more of all the coho salmon passing the capture site during each temporal stratum with probability 0.95, (3) test the hypothesis that the distributions of spawners among temporal strata are equal, and (4) estimate the abundance of each identified spawning component upstream of Silver Salmon rapids using a maximum likelihood estimator. This report will document results for the first three objectives, while results for the fourth

objective will be published in a separate report. Information collected from this project will provide fisheries managers with a better understanding of spawning distribution and abundance for coho salmon throughout the upper Kasilof River watershed.

## Study Area

The Kasilof River drains a watershed of 2,150 km<sup>2</sup> of mountains, glaciers and forests, making it the second largest watershed on the Refuge. The Kasilof River is 31 km long and drains Tustumena Lake, the Kenai Peninsula's largest lake, which has a surface area of 29,450 hectares, a maximum depth of 287 m, and a mean depth of 124 m. All tributary streams in the watershed that drain refuge lands enter Tustumena Lake except Crooked Creek (Figure 1). Several species of fish use this watershed for spawning and rearing habitat (Johnson and Daigneault 2008), including Chinook, coho, sockeye, and pink salmon, rainbow/steelhead trout *O. mykiss*, Dolly Varden *Salvelinus malma*, lake trout *S. namaycush*, and round whitefish *Prosopium cylindraceum*.

Nikolai Creek enters the south shore of Tustumena Lake approximately 8 km SE of the lake outlet (60° 11.43'N and 151° 0.36'W; NAD83). Its watershed is approximately 95 km<sup>2</sup> and falls within the Refuge boundary and a designated wilderness area (Moser 1998). Nikolai Creek has a relatively steep gradient, low sinuosity, and predominately cobble substrate.

Shantatalik Creek is a tributary on the north shore of Tustumena Lake (60°17.54'N and 150°59.12'W; NAD83), approximately 12 km NE of the lake outlet (Figure 1). The creek is approximately 7 km long and can be described as having low gradient, moderate sinuosity, and a mixture of gravel and mud substrate. Shantatalik Creek provides spawning habitat for coho and sockeye salmon (Johnson and Daigneault 2008).

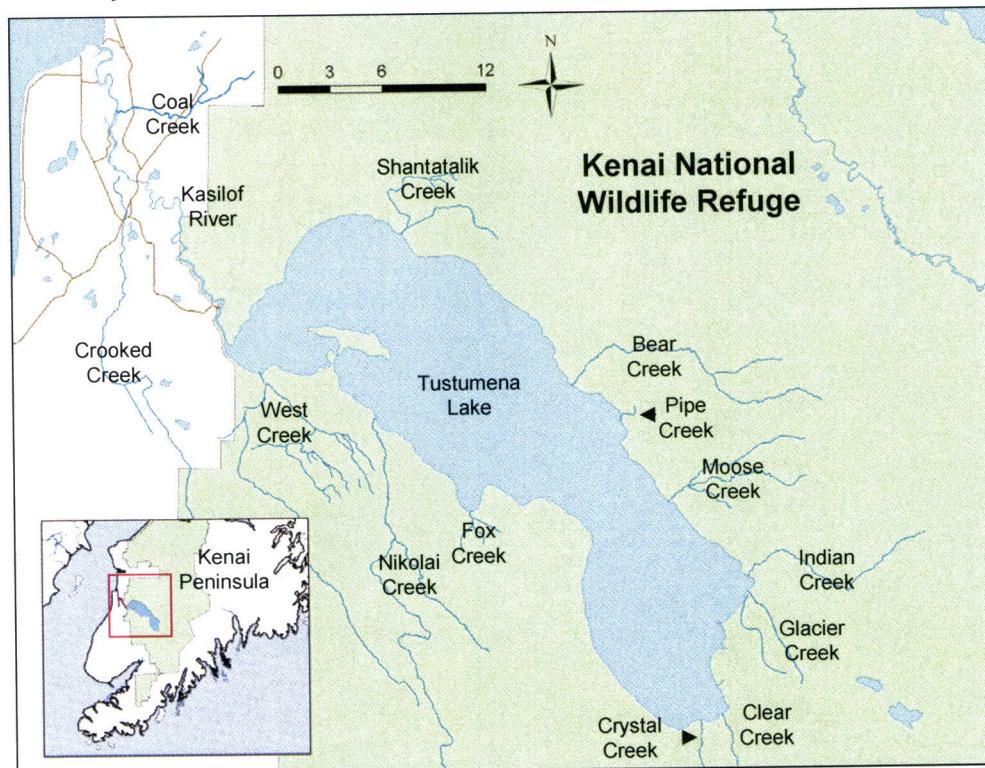


FIGURE 1.—Map of the Kasilof River watershed.

## Methods

### *Weir and Video Operations and Design*

Weirs equipped with video systems were operated in Nikolai and Shantatalik creeks to determine the abundance and run-timing of coho salmon (Figure 2). Both weirs were installed by 28 August. The weir in Nikolai Creek was operated through 23 October, and the weir in Shantatalik Creek was operated through 4 November.

The Nikolai Creek weir has been used since 2005 to enumerate steelhead trout during the spring season. This weir is approximately 200 m upstream from Tustumena Lake and is constructed using a combination of floating resistance board panels (Tobin 1994) and flexible-picket panels (Gates and Palmer 2004). The floating resistance board panels are constructed using specifications outlined by Tobin (1994), with minor changes to some materials, panel width, and resistance boards. The panels are attached to a steel rail anchored to the river bottom and are configured to pass fish near the deepest part of the channel through a fish passage panel. The flexible-picket panels are installed between the banks and bulkheads of the resistance board weir to create a fish-tight weir. The flexible-picket panels are constructed from 2.5-cm inside diameter polyvinyl chloride (PVC) electrical conduit. Panel dimensions are 3-m long by 1.5-m high with 1.9-cm spacing between pickets. Panels are held together by 3-mm stainless wire rope. The weir was unmanned, except when maintenance was required, and outfitted with a video and microwave system.

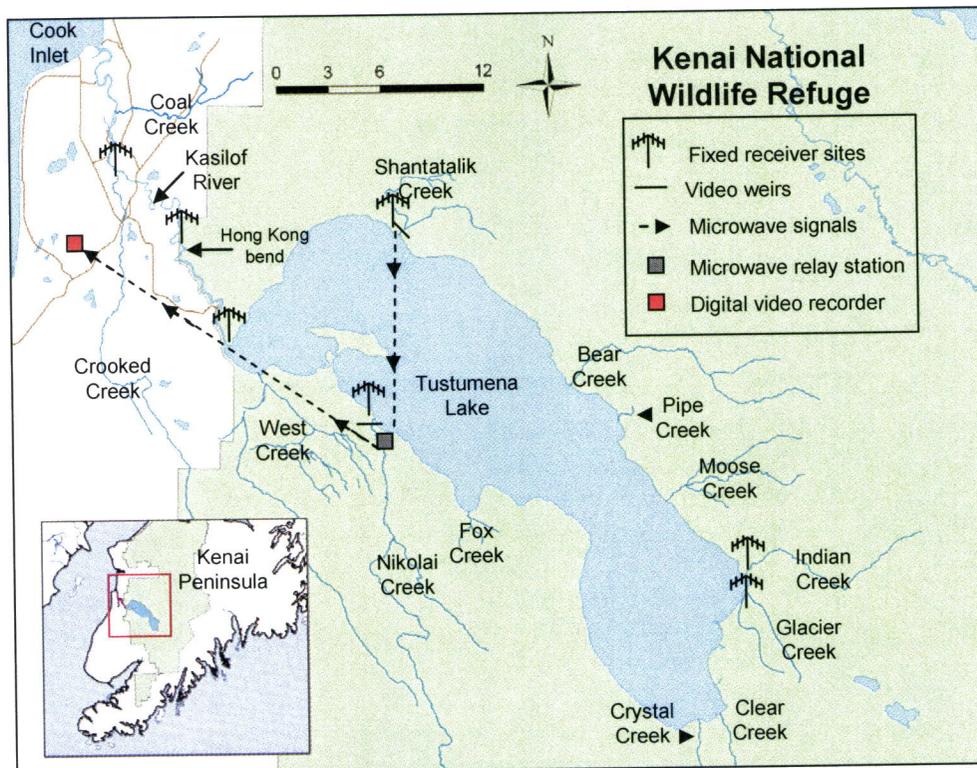


FIGURE 2.—Map of the Kasilof River watershed illustrating the locations of the fixed receivers, microwave relay station and transmission routes, video weirs, and the location of the digital video recorder during 2008.

A rigid picket weir was installed on Shantatalik Creek approximately 100 m upstream from Tustumena Lake. The creek is approximately 4-m wide at the weir site. The weir framework

consisted of several pieces of 6.4-cm aluminum angle bolted together forming a self-standing frame. The weir pickets were made from 25-mm schedule 40 aluminum pipe. Each picket measured 1.8-m in length and attached to the frame by individually sliding through 28.6-mm holes drilled in two 6-m pieces of aluminum angle bolted to the front of the weir frame. Weir pickets were spaced 3.2 cm apart. Like Nikolai Creek, the weir was unmanned and outfitted with a video and microwave system.

Setup and design of the video systems used to monitor fish passage is described by Gates and Palmer (2006) and was similar to that used by Anderson et al. (2004) on Big Creek during 2003. One underwater video camera was located inside a sealed video box attached to the fish passage chute. The video box was constructed of 3.2-mm aluminum sheeting and filled with filtered water. Safety glass was installed on the front of the video box to allow for a scratch-free, clear surface through which video images were captured. The passage chute was constructed from aluminum angle and was enclosed in plywood isolating it from exterior light. The backdrop of the passage chute from which video images were captured could be adjusted laterally to limit the number of fish passing through the chute at one time. The backdrop could be easily removed from the video chute when dirty and replaced with a new one. The video box and fish passage chute were artificially lit using a pair of 12-V underwater pond lights equipped with 10-W bulbs. This system provided a consistent light source during day and night hours and allowed recording of good quality images.

Video images from the Nikolai Creek weir site were transmitted via a 2.4 GHz microwave frequency signal to a digital video recorder (DVR) located at a private residence near the Sterling Highway. A combination of 1.8 and 2.4 GHz microwave transmitters were used at Shantatalik Creek because a relay station was necessary to transmit the video images from the creek to the DVR (Figure 2). The relay station was co-located with the Nikolai Creek microwave equipment. Microwave transmission of video signals reduced the power requirements at each remote site and allowed the field crew to remotely monitor fish passage. A pair of 80-W solar panels wired in parallel and one 54-W thermoelectric generator (TEG) provided power to four 400 Ah 6-volt batteries wired in series and parallel at each weir site. The batteries supplied 12-VDC power to the underwater camera, microwave transmitter, and underwater pond lights at Shantatalik Creek and only to the underwater pond lights at Nikolai Creek. One additional 80-W solar panel and two 100 Ah 12-V batteries powered the underwater camera and microwave equipment located on a hill near Nikolai Creek. All video images were recorded on a removable 500 gigabyte hard drive at 20 frames-per-second using a computer-based DVR. Fish passage was recorded 24 hours per day seven days each week. Stored video files were generally reviewed every two or three days. The DVR was equipped with motion detection to reduce the amount of blank video footage and review time. Appendix 1 provides a list of video and microwave equipment model numbers and manufacturers used with the project.

### *Radio Telemetry*

Radio telemetry was used to uniquely identify and track individual coho salmon. Movements of radio-tagged coho salmon were documented using a combination of fixed data-logging receiver stations located throughout the Kasilof River watershed and mobile tracking using boats and fixed-wing aircraft.

*Fish Capture.*—Drift gillnets were actively fished between rkm 15 and 24 to capture coho salmon for radio tagging (Figure 3). Methods for deploying gillnets were similar to those

used to capture coho salmon for radio telemetry studies in the Holitna, Kenai, and Kasilof rivers (Chythlook and Evenson 2003; Carlon and Evans 2007; Palmer et al. 2008). A three person crew would deploy a single gillnet using a 5.5-m boat. One crew member piloted the boat while two crewmembers positioned on the bow of the boat tended the net. Gillnets had 11.4-cm stretched mesh constructed from Miracle<sup>®</sup> (MS-30) brand twisted nylon webbing. Each gillnet fished was 12.2-m long and 29 meshes deep. Drift gillnets were fished until either the end of the fishing area was reached or a fish became entangled in the net. Once a fish became entangled in the net, the net was immediately pulled from the water. The portion of net containing the fish was placed in a large tote filled with river water, and the fish was disentangled or cut from the net. Once freed from the net, the condition of each coho salmon was examined and, based on physical appearance; it was either released or fitted with a radio-tag. Each tagged fish was immediately placed in a submerged fish cradle to measure its mid-eye to fork length. These methods were used to reduce stress associated with capture and handling.

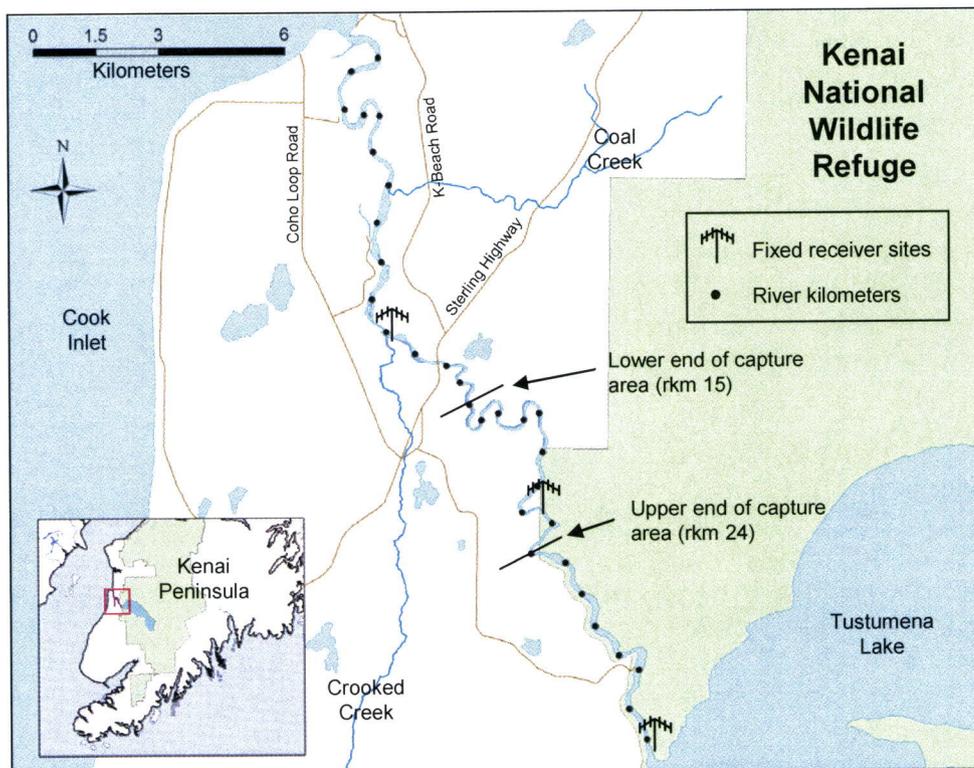


FIGURE 3.—Map of the Kasilof River illustrating the fixed receiver locations and fish capture area during 2008.

*Radio Tagging.*—Coho salmon were radio-tagged using radio transmitters developed by Lotek Wireless Incorporated<sup>®</sup>. Each radio transmitter (Model SR-M 16-25) measured 16 x 51 mm, was digitally encoded, equipped with a motion sensor, and outfitted with a 1,100-d battery which was programmed to shut off after 200 days. These radio transmitters were similar to those used by Ramstad and Woody (2003) when they examined transmitter retention and tag-related mortality in adult sockeye salmon. Each transmitter weighed 17 g in air and did not exceed 2% of the fish's body weight (Winter 1983). Radio transmitters were dispersed over eight radio frequencies between 162 and 166 MHz. Radio transmitters were gastrically implanted through the esophagus using methods similar to Burger et al. (1985). Radio-tagged fish were immediately released into the river after the tagging process.

Radio transmitters were scheduled to be deployed every other day over four 15-d strata between 17 August and 15 October (Table 1). Eight to nine radio transmitters were to be deployed during each tagging event and if the daily allocation was not met, the remaining tags were deployed the following day. Deploying radio transmitters every other day in a systematic fashion reduced the possibility of disproportionately representing a single group of fish moving through the tagging area. We assumed that 17 August to 15 October would encompass nearly the entire migration past Silver Salmon Rapids (rkm 24) based on previous radio-tagging by Palmer et al. (2008) during 2007. We also assumed that (1) capture and tagging of coho salmon did not cause them to change their ultimate spawning locations, (2) fish destined for the various spawning locations had an equal probability of capture within each stratum, and (3) tagged fish behaved independently. Sixty radio transmitters were allocated to each of the four strata to satisfy the criteria of Objective 2 using a multinomial probability model (Agresti 2002) of spawning distribution.

**TABLE 1.—Schedule for deploying radio transmitters in coho salmon during 2008.**

| Strata 1      |                | Strata 2      |                | Strata 3      |                | Strata 4      |                |
|---------------|----------------|---------------|----------------|---------------|----------------|---------------|----------------|
| Tagging Dates | Tag Allocation |
| 18-Aug        | 9              | 2-Sep         | 9              | 16-Sep        | 9              | 1-Oct         | 9              |
| 20-Aug        | 9              | 4-Sep         | 9              | 18-Sep        | 9              | 3-Oct         | 9              |
| 22-Aug        | 9              | 6-Sep         | 9              | 20-Sep        | 9              | 5-Oct         | 9              |
| 24-Aug        | 9              | 8-Sep         | 9              | 22-Sep        | 9              | 7-Oct         | 9              |
| 26-Aug        | 8              | 10-Sep        | 8              | 24-Sep        | 8              | 9-Oct         | 8              |
| 28-Aug        | 8              | 12-Sep        | 8              | 26-Sep        | 8              | 11-Oct        | 8              |
| 30-Aug        | 8              | 14-Sep        | 8              | 28-Sep        | 8              | 13-Oct        | 8              |
| Total         | 60             |               | 60             |               | 60             |               | 60             |

*Radio Tracking.*—Radio telemetry receivers manufactured by Lotek Wireless Incorporated<sup>®</sup> were used for all mobile and fixed station tracking. Fixed receiver stations were used to automatically identify and record fish movements at the mouths of Nikolai, Glacier, Indian, Shantatalik and Crooked creeks, the lake outlet, and Hong Kong bend (rkm 22.5) (Figure 2). Fixed receiver stations were similar to those used on the Kenai River to monitor rainbow trout movements (Palmer 1998). Each station was a strongbox and antenna mast comprised of a single data-logging receiver, two Yagi antennas, antenna switch box, three 12-V deep cycle batteries, solar panel, and voltage regulator. Mobile boat tracking was conducted each week from early September through mid November on the Kasilof River between the lake outlet and tidewater. Aerial surveys were conducted once during September, October, and December and twice during November using a PA-18 and Cessna 185 fixed-wing aircraft. Aerial surveys were conducted at approximately 300-400 m above ground for each tributary stream and the perimeter of Tustumena Lake. A portable global positioning system (GPS) was used during all mobile tracking surveys to accurately identify the latitude and longitude of each located fish.

*Data Analysis*

Daily counts of coho salmon passing the video weirs on Nikolai and Shantatalik creeks were entered into an Excel<sup>®</sup> spreadsheet to track the abundance and run-timing in each stream. Sex composition was estimated from external characteristics during the review of video records. Radio telemetry information collected with the various tracking methods was integrated into one Excel<sup>®</sup> database to archive the location and date for each encounter, as well as the fate of each radio-tagged coho salmon. Locations were recorded as latitude and

longitude coordinates (WGS84) and displayed on a geographic coverage of the Kasilof River watershed using ArcMap<sup>®</sup> software.

Each radio-tagged fish was assigned one of seven possible fates based on information collected from mobile and fixed radio receivers (Table 2). The collection of tagged fish known to enter the study area, any water upstream of rkm 24, constituted the sample for purposes of estimating spawning distribution from each stratum. Fish assigned a fate of harvested or dead/regurgitated were censored from the sample. Fish whose spawning location could not be determined with reasonable certainty were placed into an unknown category.

Spawning locations were defined based on the tracking results. A tagged fish that migrated to a particular location and remained in the area for an extended period of time without activating the mortality sensor was considered to have identified a potential spawning location. Potential spawning locations are considered to be the tributaries to Tustumena Lake and the Kasilof River mainstem between the lake and rkm 24.

**TABLE 2.—Possible fates of radio-tagged coho salmon in the Kasilof River watershed during 2008.**

| Fate              | Description                                                                                                                          |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| Tributary Spawner | A fish that spawns in a tributary to Tustumena Lake.                                                                                 |
| Mainstem Spawner  | A fish that spawns in the Kasilof River upstream of rkm 24.                                                                          |
| Other Spawner     | A fish that spawns in waters below rkm 24.                                                                                           |
| Dead/Regurgitated | A fish that did not complete its spawning migration because it has either died or regurgitated its radio transmitter.                |
| Harvested         | A fish that is harvested in either subsistence or sport fisheries.                                                                   |
| Back Out          | A fish that has dropped out of the Kasilof River watershed.                                                                          |
| Unknown           | A fish that has a loss of contact with mobile or fixed radio receivers or cannot be assigned another fate with reasonable certainty. |

The assumption that coho salmon destined for the various spawning locations had an equal probability of capture within each stratum was tested using chi-square tests of homogeneity (Greenwood and Nikulin 1996). Given the relatively small stratum sample size and the potential existence of small spawning aggregations, the stratum-by-location contingency table was expected to be sparse and the distribution of the Pearson test statistic for a test of homogeneity may not be well approximated by a chi-square distribution. For that reason, an exact chi-square test (Agresti 2002) was conducted using the function “chisq.test” of R version 2.9.0 (RDCT 2009), with 100,000 replications to estimate test significance.

Methods used to determine the abundance of each spawning component, based on the results of radio telemetry findings and information collected at each weir location using a maximum likelihood estimator, will be reported in a separate publication.

## Results

### *Weir and Video Operations*

The weir and video systems at Nikolai and Shantatalik creeks were installed on 26 and 28 August and operated through 23 October and 4 November, respectively. Both weirs and video systems were installed before large numbers of coho salmon entered either stream. Each video system functioned well except for periodic interruptions caused by flooding events and power failures. High water periodically rendered the Nikolai Creek weir inoperable on 11, 14, and 15 September. Low voltage in batteries supplying power to parts of the video system at Nikolai Creek and the microwave relay station resulted in a loss of

video from both sites sporadically during September and October. The low voltage in batteries was a direct result of decreased sunlight during the fall period.

### Biological Data

A total of 721 coho salmon was counted passing the video system at Nikolai Creek between 27 August and 22 October (Figure 2; Appendix 2). The total escapement estimate did not include 41 coho salmon that passed downstream through the video system. Peak weekly passage ( $N=367$ ) occurred between 7 and 13 September, and the median cumulative passage date was 9 September. The highest daily count ( $N=348$ ) also occurred on 9 September. The number of coho salmon counted after 30 September only represented 8% ( $N=60$ ) of the total escapement.

Sex was visually estimated for all but two of the coho salmon counted on Nikolai Creek video recordings. Overall about 48% of the total coho salmon return was estimated to be females, although weekly estimates ranged from about 30% to 57% (Figure 3).

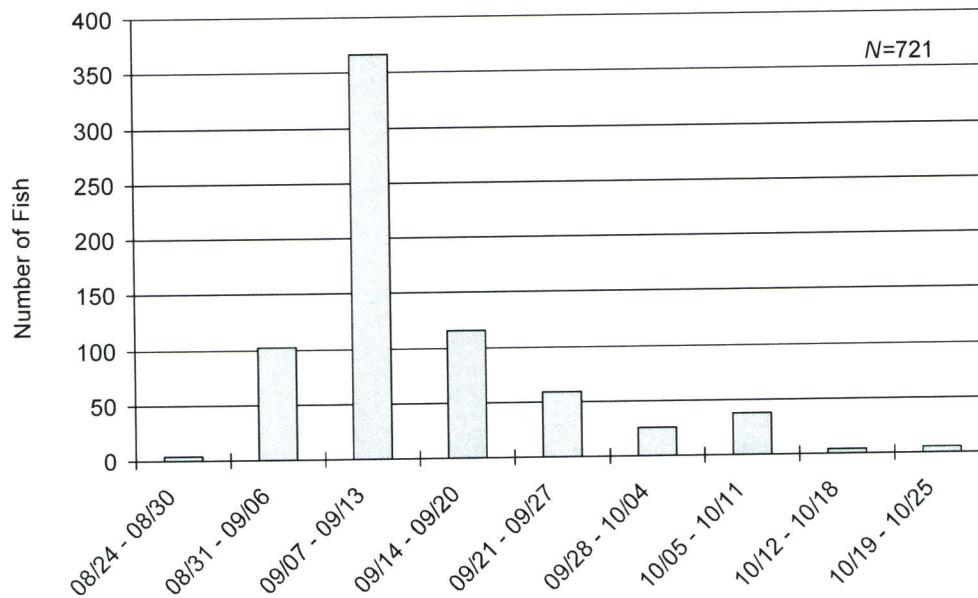


FIGURE 2. —Weekly escapement of coho salmon in Nikolai Creek, Alaska during 2008. Counts were made between 26 August and 23 October.

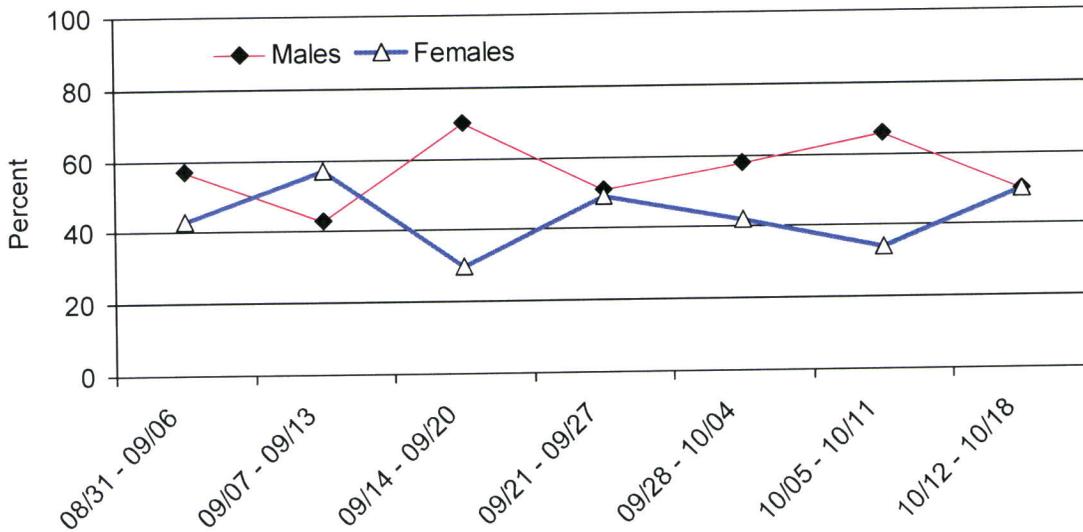


FIGURE 3. —Weekly percent of male and female coho salmon observed at Nikolai Creek weir during 2008. The first ( $N=4$  males) and last ( $N=5$  males and  $N=1$  female) weeks of operation were omitted from this figure.

A total of 594 coho salmon was counted passing Shantatalik Creek weir between 29 August and 3 November 2008 (Figure 4; Appendix 3). The total escapement estimate did not include 173 coho salmon that passed downstream through the video system. Peak weekly passage ( $N=215$ ) occurred between 7 and 13 September, and the median cumulative passage date was 18 September.

Sex was visually estimated for all of the coho salmon counted on Shantatalik Creek video recordings. Overall, about 39% of the total coho salmon return was estimated to be females, although weekly percentages ranged from about 22% to 57% (Figure 5). Sex composition was skewed towards males for most of the run (Figure 5).

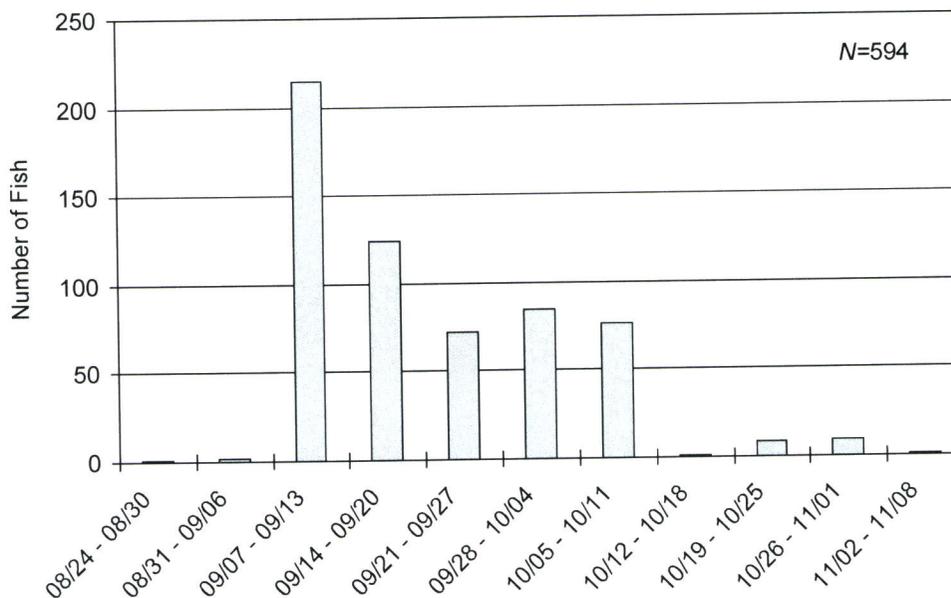


FIGURE 4. —Weekly escapement of coho salmon in Shantatalik Creek, Alaska during 2008. Counts were made between 28 August and 4 November.

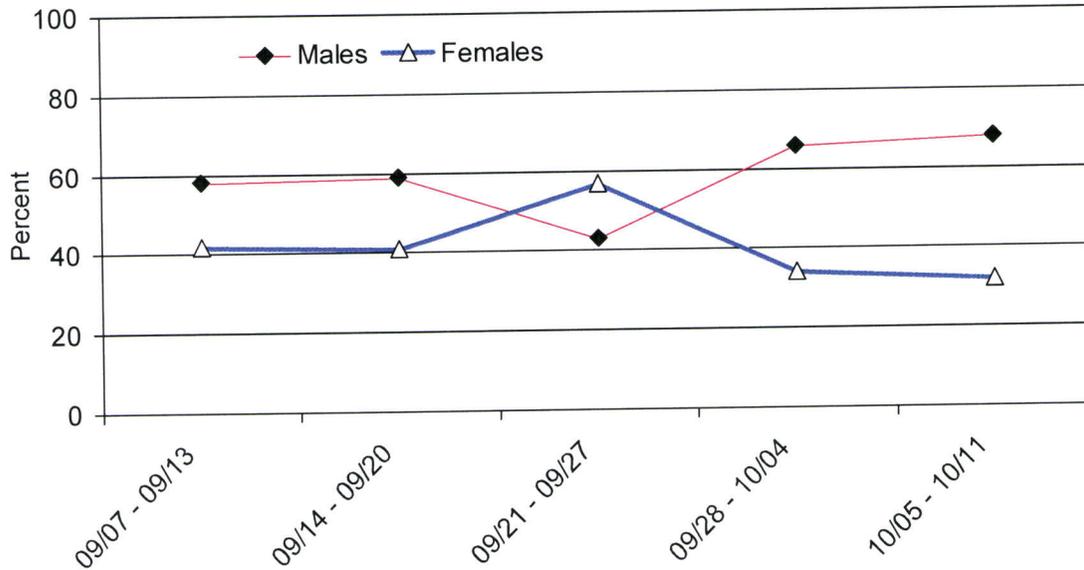


FIGURE 5. —Weekly percent of male and female coho salmon observed at Shantatalik Creek during 2008. Six weeks of operations were omitted from this figure because passage ( $N=22$ ) was less than 10 fish during each week.

#### Radio Telemetry

A total of 240 coho salmon (97 females and 143 males) was radio-tagged in the Kasilof River between 18 August and 13 October 2008 (Appendix 4). Radio transmitters were deployed over four temporal strata, containing equal numbers of radio-tagged coho salmon. All radio-tagged fish were captured in an approximate 8-km section of river immediately downstream from the refuge boundary at Silver Salmon Rapids. Coho salmon receiving a transmitter ranged in length from 465 to 770 mm.

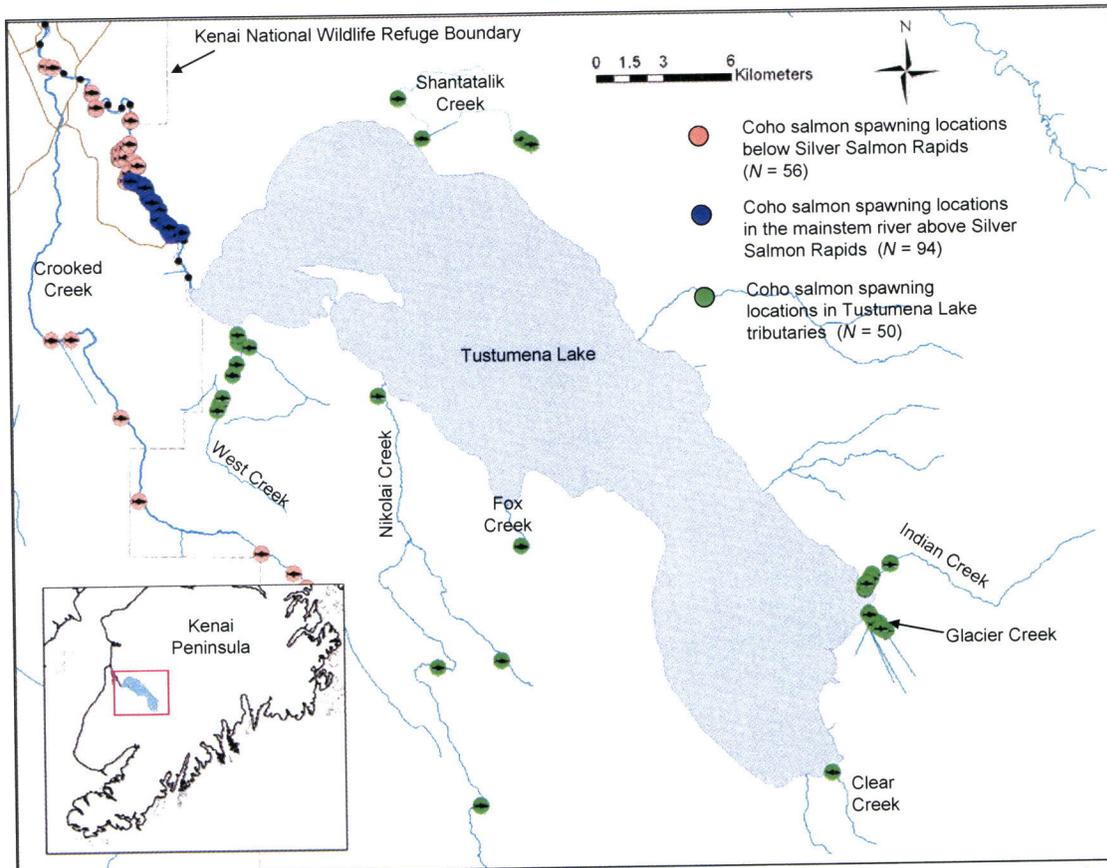
Eighty-three percent ( $N=200$ ) of all radio-tagged coho salmon were assigned to a spawning location based on information collected from mobile and fixed radio receivers (Table 3). Sixty percent ( $N=144$ ) of the radio-tagged fish selected spawning locations upstream of the refuge boundary at Silver Salmon Rapids. Of those fish, 94 spawned in the upper mainstem Kasilof River between rkm 24 and the Tustumena Lake boat ramp (Figure 6). Fifty radio-tagged coho salmon spawned in tributaries of Tustumena Lake including Shantatalik ( $N=6$ ), Nikolai ( $N=4$ ), Indian ( $N=20$ ), Fox ( $N=1$ ), West ( $N=9$ ), Glacier ( $N=9$ ) and Clear ( $N=1$ ) creeks. Other radio-tagged fish spawned outside the study area in Crooked Creek ( $N=9$ ), Coal Creek ( $N=1$ ) and the mainstem Kasilof River downstream of the refuge boundary ( $N=46$ ). No spawning destination could be determined for 17% of the radio-tagged fish ( $N=40$ ). These fish were assigned fates of “Dead/Regurgitated” ( $N=24$ ), “Back Out” ( $N=8$ ), “Unknown” ( $N=5$ ), and “Harvested” ( $N=3$ ). Radio-tagged fish that were classified as “Unknown” were last detected either below the study area ( $N=3$ ) or in Tustumena Lake ( $N=2$ ).

Spawners were classified into three categories for the exact chi-square procedure used to test the hypothesis that the distributions of spawners were equal among all temporal strata: tributary spawners ( $N=50$ ), mainstem refuge spawners ( $N=94$ ), and other spawners ( $N=56$ ). The test was significant ( $\chi^2 = 79.79$ ,  $p$ -value  $< 0.0001$ ), indicating that the distributions of spawners were not equal among all strata. The significance of the test was primarily driven

by changes in the relative abundance of tributary and mainstem spawners early and late in the run (Table 3).

**TABLE 3.** —Fates assigned to coho salmon radio-tagged in the Kasilof River between 18 August and 13 October, 2008.

| Fate                                           | Strata |    |    |    | Total | %    |
|------------------------------------------------|--------|----|----|----|-------|------|
|                                                | 1      | 2  | 3  | 4  |       |      |
| <b>Tributary Spawners</b>                      |        |    |    |    |       |      |
| Shantatalik Creek                              | 5      | 1  |    |    | 6     | 2.5  |
| Nikoilai Creek                                 | 3      | 1  |    |    | 4     | 1.7  |
| Indian Creek                                   | 13     | 7  |    |    | 20    | 8.3  |
| Fox Creek                                      | 1      |    |    |    | 1     | 0.4  |
| West Creek                                     | 8      |    |    | 1  | 9     | 3.8  |
| Glacier Creek                                  | 2      | 3  | 2  | 2  | 9     | 3.8  |
| Clear Creek                                    |        | 1  |    |    | 1     | 0.4  |
| <b>Mainstem Spawners above rkm 24 (Refuge)</b> | 5      | 31 | 30 | 28 | 94    | 39.2 |
| <b>Other Spawners</b>                          |        |    |    |    |       |      |
| Maintstem below rkm 24                         |        | 7  | 17 | 22 | 46    | 19   |
| Crooked Creek                                  | 8      |    | 1  |    | 9     | 3.8  |
| Coal Creek                                     | 1      |    |    |    | 1     | 0.4  |
| <b>Dead/Regurgitated</b>                       | 6      | 6  | 7  | 5  | 24    | 10.0 |
| <b>Harvested</b>                               | 2      |    | 1  |    | 3     | 1.3  |
| <b>Back Out</b>                                | 3      | 2  | 2  | 1  | 8     | 3.3  |
| <b>Unknown</b>                                 | 3      | 1  | 0  | 1  | 5     | 2.1  |



**FIGURE 6.** —Spawning locations selected by radio-tagged coho salmon in the Kasilof River watershed during 2008

## Discussion

A combined total of 1,315 coho salmon was counted past the Nikolai ( $N=721$ ) and Shantatalik ( $N=594$ ) creek weirs between 27 August and 2 November. These estimates of abundance represent the relative strength of the coho salmon return to each of these streams; however, estimates from each creek may be conservative because of periodic interruptions of video images. Interruptions in video signals were caused by a flooding event and power failures resulting in 8 days of lost video at Nikolai Creek and 6 days of lost video at Shantatalik Creek (Appendices 2 and 3).

Our findings show that the upper mainstem Kasilof River is an important spawning area for coho salmon and are generally consistent with the Department's Anadromous Water's Catalog (Johnson and Daigneault 2008) and previous studies conducted by the Service on Tustumena Lake in 1987 (Faurot and Jones 1990), 2006 (Palmer and Gates 2007), and 2007 (Palmer et al. 2008). The primary difference between observations made in 2008 and previous studies was that radio-tagged coho salmon were found in two additional streams, West and Clear creeks. This makes a total of seven Tustumena Lake tributary streams that have been identified as coho salmon spawning habitat: Shantatalik, Nikolai, Indian, Fox, West, Glacier, and Clear creeks.

We also observed differences in run-timing between mainstem and tributary spawners similar to that reported during 2007 (Palmer et al. 2008). Differences in run timing between tributary and mainstem spawners are common in *Onchorhynchus* spp., especially in streams, where timing of upstream migration extends over a period of several weeks (Groot and Margolis 1991). Although mainstem spawners were represented in all four of our tagging strata during 2008, most mainstem spawners (69%) were tagged in strata 3 and 4. Conversely, almost all tributary spawners (90%) were tagged in strata 1 and 2. However, there was one exception to this pattern. Radio-tagged coho salmon returning to Glacier Creek to spawn were represented in all four strata, which suggest this population could have a later run-timing than other tributary spawning populations. This could be a result of temperature conditions in Glacier creek since it is spring fed.

Our efforts during 2008 provided the most inclusive and representative spawning and distribution information available for coho salmon in the upper Kasilof River watershed. We were able to assign spawning destinations to a greater percentage of tagged fish in 2008 than Palmer et al. (2008) were able to do in 2007. In 2008, only 17% of radio-tagged coho salmon could not be assigned a spawning destination, which was a 34% reduction from what Palmer et al. (2008) observed in 2007. This was due to a much lower percentage of tagged coho salmon that backed out of the system in 2008 (3%) than in 2007 (22%) as well as much smaller percentage of tagged coho salmon that either died or regurgitated their transmitters in 2008 (10%) than in 2007 (16%). The remainder of the radio-tagged coho salmon were assigned a fate of "Unknown" ( $N=5$ ) for which no spawning destination could be determined. Two of these fish entered Tustumena Lake but did not select a spawning tributary. While the ultimate fates of these fish are unclear, it is possible that handling stress may have altered their behavior eventually leading to delayed mortality or these fish could have selected a spawning location within the lake.

Much of our success in 2008 is a result of being able to reduce handling effects on radio-tagged fish through use of the different tagging strategy. During 2007, radio transmitters were deployed in as short a time period as possible to help ensure that all allocated tags were

deployed in each stratum (Palmer et al. 2008). In contrast, we radio-tagged coho salmon every other day during 2008 in an attempt to get a more representative sample of the fish available within each strata. This also allowed tagging crews to capture greater numbers of fish and, therefore, to be more selective in choosing fish to tag. High rates of handling-induced mortality have been observed by other researchers that have captured and handled adult coho salmon during their transition from marine to freshwater habitats. For example, Carlon and Evans (2007) observed “failure” rates as high as 40% for coho salmon radio-tagged in the Kenai River.

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### References

- Agresti, A. 2002. Categorical data analysis, 2<sup>nd</sup> edition. John Wiley & Sons, Hoboken, New Jersey.
- Anderson, J. L., K. S. Whitton, K. K. Cornum, and T. D. Auth. 2004. Abundance and run timing of adult Pacific salmon in Big Creek, Becharof National Wildlife Refuge, 2003. U. S. Fish and Wildlife Service, Alaska Fisheries Data Series Report Number 2004-7, King Salmon, Alaska.
- Burger, C. V., R. L. Wilmot, and D. B. Wangaard. 1985. Comparison of spawning areas and times for two runs of Chinook salmon *Oncorhynchus tshawytscha* in the Kenai River, Alaska. Canadian Journal of Fisheries and Aquatic Sciences 42: 693-700.
- Burger, C. V., J. E. Finn, and L. Holland-Bartels. 1995. Pattern of shoreline spawning by sockeye salmon in a glacially turbid lake: Evidence for subpopulation differentiation. Transactions of the American Fisheries Society 124:1–15.
- Burger, C. V., W. J. Spearman, and M. A. Cronin. 1997. Genetic differentiation of sockeye salmon subpopulations from a geologically young Alaskan lake system. Transactions of the American Fisheries Society 126:926–938.
- Carlon, J. A., and D. Evans. 2007. Abundance of adult coho salmon in the Kenai River, Alaska, 1999-2003. Alaska Department of Fish and Game, Fishery Data Series Number 07-81, Anchorage, Alaska.
- Chythlook, J. S., and M. J. Evenson. 2003. Assessment of Chinook, chum, and coho salmon escapements in the Holitna River drainage using radio telemetry, 2002. Alaska Department of Fish and Game, Fishery Data Series Number 03-23, Anchorage, Alaska.

- Faurot, D., and R. N. Jones. 1990. Run timing and spawning distribution of coho and late run Chinook salmon in the Kasilof River watershed, Alaska, 1987. U.S. Fish and Wildlife Service, Alaska Fisheries Technical Report Number 9, Kenai, Alaska.
- Finn, J. E., C. V. Burger, and L. Holland-Bartels. 1997. Discrimination among populations of sockeye salmon fry with fourier analysis of otolith banding patterns formed during incubation. *Transactions of the American Fisheries Society* 126:559–578.
- Gates, K. S., and D. E. Palmer. 2004. Estimation of the sockeye salmon escapement into McLees Lake, Unalaska Island, Alaska, 2003. U.S. Fish and Wildlife Service, Alaska Fisheries Data Series Report Number 2004-1, Kenai, Alaska.
- Gates, K. S., and D. E. Palmer. 2006. Abundance and run timing of adult steelhead trout in Crooked and Nikolai Creeks, Kenai Peninsula, Alaska, 2006. U.S. Fish and Wildlife Service, Alaska Fisheries Data Series Report Number 2006-13, Kenai, Alaska.
- Greenwood, P. E., and M. S. Nikulin. 1996. A guide to chi-square testing. John Wiley & Sons, New York, New York.
- Groot, C., and L. Margolis. 1991. Pacific salmon life histories. University of British Columbia Press, Vancouver, British Columbia.
- Howe, A. L., R. J. Walker, C. Olnes, K. Sundet, and A. E. Bingham. 2001a. Revised Edition: Harvest, catch, and participation in Alaska sport fisheries during 1996. Alaska Department of Fish and Game, Fishery Data Series Number 97-29 (revised), Anchorage, Alaska.
- Howe, A. L., R. J. Walker, C. Olnes, K. Sundet, and A. E. Bingham. 2001b. Revised Edition: Harvest, catch, and participation in Alaska sport fisheries during 1997. Alaska Department of Fish and Game, Fishery Data Series Number 98-25 (revised), Anchorage, Alaska.
- Howe, A. L., R. J. Walker, C. Olnes, K. Sundet, and A. E. Bingham. 2001c. Revised Edition: Participation, catch, and harvest in Alaska sport fisheries during 1998. Alaska Department of Fish and Game, Fishery Data Series Number 99-41 (revised), Anchorage, Alaska.
- Howe, A. L., R. J. Walker, C. Olnes, K. Sundet, and A. E. Bingham. 2001d. Participation, catch, and harvest in Alaska sport fisheries during 1999. Alaska Department of Fish and Game, Fishery Data Series Number 01-8, Anchorage, Alaska.
- Jennings, G. B., K. Sundet, A. E. Bingham, and D. Sigurdsson. 2004. Participation, catch, and harvest in Alaska sport fisheries during 2001. Alaska Department of Fish and Game, Fishery Data Series Number 04-11, Anchorage, Alaska.
- Jennings, G. B., K. Sundet, A. E. Bingham, and D. Sigurdsson. 2006a. Participation, catch, and harvest in Alaska sport fisheries during 2002. Alaska Department of Fish and Game, Fishery Data Series Number 06-34, Anchorage, Alaska.
- Jennings, G. B., K. Sundet, A. E. Bingham, and D. Sigurdsson. 2006b. Participation, catch, and harvest in Alaska sport fisheries during 2003. Alaska Department of Fish and Game, Fishery Data Series Number 06-44, Anchorage, Alaska.
- Johnson, J., and M. Daigneault. 2008. Catalog of waters important for spawning, rearing, or migration of anadromous fishes – Southcentral Region, Effective June 2, 2008.

Alaska Department of Fish and Game, Special Publication Number 08-05,  
Anchorage, Alaska.

- Kyle, G. B. 1992. Summary of sockeye salmon (*Oncorhynchus nerka*) investigations in Tustumena Lake, 1981-1991. Alaska Department of Fish and Game, Fisheries Rehabilitation and Enhancement Division, Report 122, Juneau, Alaska.
- Moser, E. 1998. Water resource inventory and assessment, Kenai National Wildlife Refuge, 1997 stream discharge gaging data. U.S. Fish and Wildlife Service, Water Resource Branch, WRB 98-01, Anchorage, Alaska.
- Palmer, D. E. 1998. Migratory behavior and seasonal distribution of radio-tagged rainbow trout in the Kenai River, Alaska. U.S. Fish and Wildlife Service, Alaska Fisheries Technical Report Number 46, Kenai, Alaska.
- Palmer, D. E., and K. S. Gates. 2007. Coho salmon spawning assessment in Tustumena Lake tributaries, 2006. U.S. Fish and Wildlife Service, Alaska Fisheries Data Series Report Number 2007-10, Kenai, Alaska.
- Palmer, D. E., K. S. Gates, and J. F. Bromaghin. 2008. Run timing, abundance, and distribution of adult coho salmon in the Kasilof River watershed, Alaska, 2007. U.S. Fish and Wildlife Service, Alaska Fisheries Data Series Report Number 2008-19, Soldotna, Alaska.
- Ramstad, K. M., and C. A. Woody. 2003. Radio tag retention and tag-related mortality among adult sockeye salmon. North American Journal of Fisheries Management 23:978-982.
- RDCT (R Development Core Team). 2009. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL <http://www.R-project.org>.
- Reimer, A. M., and D. Sigurdsson. 2004. Upper Cook Inlet personal use salmon fisheries, 1996-2003. Alaska Department of Fish and Game, Fishery Data Series Number 04-31, Anchorage, Alaska.
- Shields, P. 2006. Upper Cook Inlet commercial fisheries annual management report, 2005. Alaska Department of Fish and Game, Fishery Management Report Number 06-42, Anchorage, Alaska.
- Tobin, J. H. 1994. Construction and performance of a portable resistance board weir for counting migrating adult salmon in rivers. U.S. Fish and Wildlife Service, Alaska Fisheries Technical Report Number 22, Kenai, Alaska.
- Walker, R. J., C. Olnes, K. Sundet, A. L. Howe, and A. E. Bingham. 2003. Participation, catch, and harvest in Alaska sport fisheries during 2000. Alaska Department of Fish and Game, Fishery Data Series Number 03-05, Anchorage, Alaska.
- Winter, J. D. 1983. Underwater biotelemetry. Pages 371 – 395 in L.A. Nielsen and D.L. Johnson, editors. Fisheries techniques. American Fisheries Society, Bethesda, Maryland.
- Woody, C. A., J. Olsen, J. Reynolds, and P. Bentzen. 2000. Temporal variation in phenotypic and genotypic traits in two sockeye salmon populations, Tustumena Lake, Alaska. Transactions of the American Fisheries Society 129:1031-1043.

**APPENDIX 1. —List of video and microwave equipment used to monitor coho salmon abundance at Nikolai and Shantatalik creeks, Alaska during 2008.**

| <b>Item</b>                   | <b>Model #</b>   | <b>Manufacturer</b>        | <b>Contact</b>                                                                    |
|-------------------------------|------------------|----------------------------|-----------------------------------------------------------------------------------|
| Digital Video Recorder        | DVSM 4-120       | Veltek International, Inc. | <a href="http://www.veltekctv.com/">http://www.veltekctv.com/</a>                 |
| Underwater Camera             | Model 10         | Applied Micro Video        | <a href="http://www.appliedmicrovideo.com/">http://www.appliedmicrovideo.com/</a> |
| Underwater Lights             | Lunaqua 2 12-v   | OASE                       | <a href="http://www.pondusa.com">http://www.pondusa.com</a>                       |
| External Harddrive            | One Touch 500 GB | Maxtor.com                 | <a href="http://www.maxstore.com">http://www.maxstore.com</a>                     |
| 2.4 GHz Microwave Transmitter | BE-530T          | Premier Wireless, Inc      | <a href="http://www.premierwirelessinc.com">http://www.premierwirelessinc.com</a> |
| 1.8 GHz Microwave Transmitter | BE-700T          | Premier Wireless, Inc      | <a href="http://www.premierwirelessinc.com">http://www.premierwirelessinc.com</a> |
| 2.4 GHz Microwave Receiver    | BE-322R          | Premier Wireless, Inc      | <a href="http://www.premierwirelessinc.com">http://www.premierwirelessinc.com</a> |
| 1.8 GHz Microwave Receiver    | BE-700R          | Premier Wireless, Inc      | <a href="http://www.premierwirelessinc.com">http://www.premierwirelessinc.com</a> |
| 2.4 GHz Parabolic Antennas    | 130135           | California Amplifier       | <a href="http://www.calamp.com">http://www.calamp.com</a>                         |
| 1.8 GHz Parabolic Antennas    | AB10227          | California Amplifier       | <a href="http://www.calamp.com">http://www.calamp.com</a>                         |
| 80 W Solar Module             | NE-80EJEA        | Sharp                      | <a href="http://solar.sharpusha.com">http://solar.sharpusha.com</a>               |
| 400 Ah 6 Volt Battery         | S-530            | Rolls                      | <a href="http://www.rollsbattery.com/">http://www.rollsbattery.com/</a>           |
| 100 Ah 12 Volt Battery        | ES27             | Exide Technologies         | <a href="http://www.exide.com/">http://www.exide.com/</a>                         |
| Charge Controller             | ASC8-12          | Specialty Concepts, Inc.   | <a href="http://www.specialtyconcepts.com/">http://www.specialtyconcepts.com/</a> |
| Charge Controller             | ASC16-12         | Specialty Concepts, Inc.   | <a href="http://www.specialtyconcepts.com/">http://www.specialtyconcepts.com/</a> |
| Thermoelectric Generator      | 5060L-12-SI-RS   | Global Thermoelectric      | <a href="http://www.globalte.com/">http://www.globalte.com/</a>                   |

**APPENDIX 2. —Daily counts and cumulative proportion of coho salmon passing through Nikolai Creek weir during 2008. Boxed areas represent the second and third quartile and median passage dates. Shaded areas represent complete days with no video because of high water and power outages.**

| Date  | Upstream |        | Downstream |        | Unknown | Total | Daily Cumulative | Cumulative Proportion |
|-------|----------|--------|------------|--------|---------|-------|------------------|-----------------------|
|       | Male     | Female | Male       | Female | Sex     |       |                  |                       |
| 8/26  | 0        | 0      | 0          | 0      | 0       | 0     | 0                | 0.0000                |
| 8/27  | 3        | 0      | 0          | 0      | 0       | 3     | 3                | 0.0042                |
| 8/28  | 0        | 0      | 0          | 0      | 0       | 0     | 3                | 0.0042                |
| 8/29  | 1        | 0      | 0          | 0      | 0       | 1     | 4                | 0.0055                |
| 8/30  | 0        | 0      | 0          | 0      | 0       | 0     | 4                | 0.0055                |
| 8/31  | 37       | 27     | 0          | 0      | 0       | 64    | 68               | 0.0943                |
| 9/1   | 19       | 16     | -1         | 0      | 0       | 34    | 102              | 0.1415                |
| 9/2   | 0        | 1      | 0          | 0      | 0       | 1     | 103              | 0.1429                |
| 9/3   | 3        | 1      | -1         | -1     | 0       | 2     | 105              | 0.1456                |
| 9/4   | 0        | 0      | 0          | 0      | 0       | 0     | 105              | 0.1456                |
| 9/5   | 0        | 0      | 0          | 0      | 0       | 0     | 105              | 0.1456                |
| 9/6   | 1        | 0      | 0          | 0      | 0       | 1     | 106              | 0.1470                |
| 9/7   | 2        | 1      | -2         | 0      | 0       | 1     | 107              | 0.1484                |
| 9/8   | 10       | 7      | 0          | 0      | 0       | 17    | 124              | 0.1720                |
| 9/9   | 155      | 206    | -8         | -5     | 0       | 348   | 472              | 0.6546                |
| 9/10  | 1        | 0      | -3         | -5     | 0       | -7    | 465              | 0.6449                |
| 9/11  | 0        | 0      | 0          | 0      | 0       | 0     | 465              | 0.6449                |
| 9/12  | 3        | 5      | -1         | 0      | 0       | 7     | 472              | 0.6546                |
| 9/13  | 0        | 2      | 0          | -1     | 0       | 1     | 473              | 0.6560                |
| 9/14  | 0        | 0      | 0          | 0      | 0       | 0     | 473              | 0.6560                |
| 9/15  | 0        | 0      | 0          | 0      | 0       | 0     | 473              | 0.6560                |
| 9/16  | 60       | 24     | 0          | -1     | 0       | 83    | 556              | 0.7712                |
| 9/17  | 5        | 3      | 0          | -1     | 0       | 7     | 563              | 0.7809                |
| 9/18  | 7        | 1      | -2         | 0      | 0       | 6     | 569              | 0.7892                |
| 9/19  | 7        | 5      | 0          | 0      | 0       | 12    | 581              | 0.8058                |
| 9/20  | 3        | 4      | 0          | 0      | 0       | 7     | 588              | 0.8155                |
| 9/21  | 7        | 3      | -1         | 0      | 1       | 10    | 598              | 0.8294                |
| 9/22  | 4        | 1      | 0          | 0      | 0       | 5     | 603              | 0.8363                |
| 9/23  | 0        | 3      | 0          | 0      | 0       | 3     | 606              | 0.8405                |
| 9/24  | 4        | 1      | 0          | 0      | 1       | 6     | 612              | 0.8488                |
| 9/25  | 10       | 18     | 0          | 0      | 0       | 28    | 640              | 0.8877                |
| 9/26  | 3        | 0      | 0          | 0      | 0       | 3     | 643              | 0.8918                |
| 9/27  | 2        | 2      | 0          | 0      | 0       | 4     | 647              | 0.8974                |
| 9/28  | 4        | 2      | -1         | 0      | 0       | 5     | 652              | 0.9043                |
| 9/29  | 5        | 2      | -2         | 0      | 0       | 5     | 657              | 0.9112                |
| 9/30  | 2        | 2      | 0          | 0      | 0       | 4     | 661              | 0.9168                |
| 10/1  | 0        | 1      | 0          | 0      | 0       | 1     | 662              | 0.9182                |
| 10/2  | 1        | 0      | -2         | 0      | 0       | -1    | 661              | 0.9168                |
| 10/3  | 5        | 1      | 0          | 0      | 0       | 6     | 667              | 0.9251                |
| 10/4  | 3        | 3      | 0          | 0      | 0       | 6     | 673              | 0.9334                |
| 10/5  | 5        | 3      | 0          | 0      | 0       | 8     | 681              | 0.9445                |
| 10/6  | 6        | 2      | -2         | 0      | 0       | 6     | 687              | 0.9528                |
| 10/7  | 3        | 0      | 0          | 0      | 0       | 3     | 690              | 0.9570                |
| 10/8  | 6        | 4      | -1         | 0      | 0       | 9     | 699              | 0.9695                |
| 10/9  | 5        | 1      | 0          | 0      | 0       | 6     | 705              | 0.9778                |
| 10/10 | 0        | 2      | 0          | 0      | 0       | 2     | 707              | 0.9806                |
| 10/11 | 3        | 1      | 0          | 0      | 0       | 4     | 711              | 0.9861                |
| 10/12 | 0        | 0      | 0          | 0      | 0       | 0     | 711              | 0.9861                |
| 10/13 | 0        | 0      | 0          | 0      | 0       | 0     | 711              | 0.9861                |
| 10/14 | 0        | 0      | 0          | 0      | 0       | 0     | 711              | 0.9861                |
| 10/15 | 1        | 0      | 0          | 0      | 0       | 1     | 712              | 0.9875                |
| 10/16 | 0        | 1      | 0          | 0      | 0       | 1     | 713              | 0.9889                |
| 10/17 | 0        | 1      | 0          | 0      | 0       | 1     | 714              | 0.9903                |
| 10/18 | 1        | 0      | 0          | 0      | 0       | 1     | 715              | 0.9917                |
| 10/19 | 0        | 0      | 0          | 0      | 0       | 0     | 715              | 0.9917                |
| 10/20 | 2        | 1      | 0          | 0      | 0       | 3     | 718              | 0.9958                |
| 10/21 | 0        | 0      | 0          | 0      | 0       | 0     | 718              | 0.9958                |
| 10/22 | 3        | 0      | 0          | 0      | 0       | 3     | 721              | 1.0000                |
| 10/23 | 0        | 0      | 0          | 0      | 0       | 0     | 721              | 1.0000                |
| Total | 402      | 358    | -27        | -14    | 2       | 721   |                  |                       |

**APPENDIX 3. —Daily counts and cumulative proportion of coho salmon passing through Shantatalik Creek weir during 2008. Boxed areas represent the second and third quartile and median passage dates. Shaded areas represent complete days with no video because of power outages.**

| Date  | Upstream |        | Downstream |        | Unknown | Total | Daily Cumulative | Cumulative Proportion |
|-------|----------|--------|------------|--------|---------|-------|------------------|-----------------------|
|       | Male     | Female | Male       | Female | Sex     |       |                  |                       |
| 8/28  | 0        | 0      | 0          | 0      | 0       | 0     | 0                | 0.0000                |
| 8/29  | 0        | 1      | 0          | 0      | 0       | 1     | 1                | 0.0017                |
| 8/30  | 0        | 0      | 0          | 0      | 0       | 0     | 1                | 0.0017                |
| 8/31  | 0        | 0      | 0          | 0      | 0       | 0     | 1                | 0.0017                |
| 9/1   | 0        | 0      | 0          | 0      | 0       | 0     | 1                | 0.0017                |
| 9/2   | 0        | 0      | 0          | 0      | 0       | 0     | 1                | 0.0017                |
| 9/3   | 1        | 0      | 0          | 0      | 0       | 1     | 2                | 0.0034                |
| 9/4   | 0        | 0      | 0          | 0      | 0       | 0     | 2                | 0.0034                |
| 9/5   | 2        | 0      | -1         | 0      | 0       | 1     | 3                | 0.0051                |
| 9/6   | 0        | 1      | 0          | -1     | 0       | 0     | 3                | 0.0051                |
| 9/7   | 1        | 0      | 0          | 0      | 0       | 1     | 4                | 0.0067                |
| 9/8   | 9        | 1      | 0          | 0      | 0       | 10    | 14               | 0.0236                |
| 9/9   | 67       | 57     | -3         | -1     | 0       | 120   | 134              | 0.2256                |
| 9/10  | 14       | 6      | -1         | -2     | 0       | 17    | 151              | 0.2542                |
| 9/11  | 1        | 1      | 0          | -1     | 0       | 1     | 152              | 0.2559                |
| 9/12  | 26       | 20     | 0          | 0      | 0       | 46    | 198              | 0.3333                |
| 9/13  | 12       | 9      | -1         | 0      | 0       | 20    | 218              | 0.3670                |
| 9/14  | 4        | 6      | -1         | -1     | 0       | 8     | 226              | 0.3805                |
| 9/15  | 1        | 1      | 0          | 0      | 0       | 2     | 228              | 0.3838                |
| 9/16  | 0        | 0      | 0          | 0      | 0       | 0     | 228              | 0.3838                |
| 9/17  | 24       | 12     | -12        | -2     | 0       | 22    | 250              | 0.4209                |
| 9/18  | 67       | 28     | -20        | -4     | 0       | 71    | 321              | 0.5404                |
| 9/19  | 17       | 4      | -12        | -1     | 0       | 8     | 329              | 0.5539                |
| 9/20  | 12       | 12     | -7         | -4     | 0       | 13    | 342              | 0.5758                |
| 9/21  | 3        | 6      | 0          | -4     | 0       | 5     | 347              | 0.5842                |
| 9/22  | 2        | 3      | -1         | 0      | 0       | 4     | 351              | 0.5909                |
| 9/23  | 1        | 1      | 0          | 0      | 0       | 2     | 353              | 0.5943                |
| 9/24  | 6        | 10     | 0          | -1     | 0       | 15    | 368              | 0.6195                |
| 9/25  | 11       | 10     | 0          | 0      | 0       | 21    | 389              | 0.6549                |
| 9/26  | 7        | 13     | 0          | -1     | 0       | 19    | 408              | 0.6869                |
| 9/27  | 3        | 6      | -1         | -2     | 0       | 6     | 414              | 0.6970                |
| 9/28  | 6        | 8      | -5         | -1     | 0       | 8     | 422              | 0.7104                |
| 9/29  | 1        | 4      | -1         | -1     | 0       | 3     | 425              | 0.7155                |
| 9/30  | 0        | 1      | -2         | -1     | 0       | -2    | 423              | 0.7121                |
| 10/1  | 2        | 0      | -1         | 0      | 0       | 1     | 424              | 0.7138                |
| 10/2  | 3        | 2      | 0          | 0      | 0       | 5     | 429              | 0.7222                |
| 10/3  | 43       | 16     | -3         | 0      | 0       | 56    | 485              | 0.8165                |
| 10/4  | 13       | 3      | 0          | -2     | 0       | 14    | 499              | 0.8401                |
| 10/5  | 4        | 1      | -4         | 0      | 0       | 1     | 500              | 0.8418                |
| 10/6  | 4        | 3      | -5         | -4     | 0       | -2    | 498              | 0.8384                |
| 10/7  | 3        | 2      | -1         | -2     | 0       | 2     | 500              | 0.8418                |
| 10/8  | 0        | 2      | -2         | -3     | 0       | -3    | 497              | 0.8367                |
| 10/9  | 7        | 7      | -1         | 0      | 0       | 13    | 510              | 0.8586                |
| 10/10 | 44       | 17     | -1         | -4     | 0       | 56    | 566              | 0.9529                |
| 10/11 | 6        | 5      | -2         | 0      | 0       | 9     | 575              | 0.9680                |
| 10/12 | 4        | 1      | 0          | -2     | 0       | 3     | 578              | 0.9731                |
| 10/13 | 1        | 0      | -1         | 0      | 0       | 0     | 578              | 0.9731                |
| 10/14 | 0        | 0      | 0          | -2     | 0       | -2    | 576              | 0.9697                |
| 10/15 | 4        | 0      | -1         | -2     | 0       | 1     | 577              | 0.9714                |
| 10/16 | 1        | 0      | -1         | -3     | 0       | -3    | 574              | 0.9663                |
| 10/17 | 3        | 0      | -1         | -1     | 0       | 1     | 575              | 0.9680                |
| 10/18 | 1        | 2      | -1         | -1     | 0       | 1     | 576              | 0.9697                |
| 10/19 | 4        | 0      | 0          | -2     | 0       | 2     | 578              | 0.9731                |
| 10/20 | 0        | 2      | -2         | 0      | 0       | 0     | 578              | 0.9731                |
| 10/21 | 0        | 0      | -1         | -2     | 0       | -3    | 575              | 0.9680                |

-continued-

APPENDIX 3. —(Page 2 of 2)

| Date  | Upstream |        | Downstream |        | Unknown |     | Total | Daily Cumulative | Cumulative Proportion |
|-------|----------|--------|------------|--------|---------|-----|-------|------------------|-----------------------|
|       | Male     | Female | Male       | Female | Sex     | Sex |       |                  |                       |
| 10/22 | 8        | 0      | -9         | 0      | 0       | 0   | -1    | 574              | 0.9663                |
| 10/23 | 2        | 0      | -1         | 0      | 0       | 0   | 1     | 575              | 0.9680                |
| 10/24 | 5        | 2      | -1         | 0      | 0       | 0   | 6     | 581              | 0.9781                |
| 10/25 | 4        | 0      | -1         | 0      | 0       | 0   | 3     | 584              | 0.9832                |
| 10/26 | 3        | 0      | -2         | 0      | 0       | 0   | 1     | 585              | 0.9848                |
| 10/27 | 2        | 2      | 0          | 0      | 0       | 0   | 4     | 589              | 0.9916                |
| 10/28 | 3        | 0      | 0          | 0      | 0       | 0   | 3     | 592              | 0.9966                |
| 10/29 | 2        | 0      | -1         | 0      | 0       | 0   | 1     | 593              | 0.9983                |
| 10/30 | 1        | 0      | -2         | 0      | 0       | 0   | -1    | 592              | 0.9966                |
| 10/31 | 2        | 0      | -1         | 0      | 0       | 0   | 1     | 593              | 0.9983                |
| 11/1  | 0        | 0      | 0          | 0      | 0       | 0   | 0     | 593              | 0.9983                |
| 11/2  | 0        | 1      | 0          | 0      | 0       | 0   | 1     | 594              | 1.0000                |
| 11/3  | 1        | 0      | -1         | 0      | 0       | 0   | 0     | 594              | 1.0000                |
| 11/4  | 0        | 0      | 0          | 0      | 0       | 0   | 0     | 594              | 1.0000                |
| Total | 478      | 289    | -115       | -58    | 0       | 0   | 594   |                  |                       |

**APPENDIX 4. —Tagging and fate summaries for coho salmon radio-tagged in the Kaslof River during 2008.**

| Transmitter number | Stratum | Mid-eye to fork length (mm) | Sex | Tagging date | Tagging Location (WGS84) |            | Final fate                          |
|--------------------|---------|-----------------------------|-----|--------------|--------------------------|------------|-------------------------------------|
|                    |         |                             |     |              | Latitude                 | Longitude  |                                     |
| 13                 | 1       | 530                         | F   | 18-Aug       | 60.30884                 | -151.23684 | Tributary Spawner (Indian Cr.)      |
| 233                | 1       | 595                         | M   | 18-Aug       | 60.30884                 | -151.23684 | Tributary Spawner (Fox Cr.)         |
| 363                | 1       | 620                         | M   | 18-Aug       | 60.30821                 | -151.23765 | Other Spawner (Crooked Cr.)         |
| 43                 | 1       | 660                         | F   | 18-Aug       | 60.30910                 | -151.23657 | Back Out                            |
| 533                | 1       | 585                         | F   | 18-Aug       | 60.30872                 | -151.23712 | Tributary Spawner (Shantatalik Cr.) |
| 663                | 1       | 680                         | F   | 18-Aug       | 60.30793                 | -151.23845 | Tributary Spawner (Indian Cr.)      |
| 73                 | 1       | 635                         | M   | 18-Aug       | 60.30772                 | -151.23799 | Tributary Spawner (Indian Cr.)      |
| 833                | 1       | 490                         | F   | 18-Aug       | 60.30747                 | -151.23860 | Dead/Regurgitated                   |
| 14                 | 1       | 640                         | F   | 18-Aug       | 60.30872                 | -151.23642 | Tributary Spawner (Nikolai Cr.)     |
| 234                | 1       | 600                         | F   | 20-Aug       | 60.30934                 | -151.23538 | Tributary Spawner (West Cr.)        |
| 364                | 1       | 650                         | M   | 20-Aug       | 60.30928                 | -151.23625 | Tributary Spawner (Indian Cr.)      |
| 44                 | 1       | 545                         | M   | 20-Aug       | 60.30825                 | -151.23751 | Unknown                             |
| 534                | 1       | 610                         | F   | 20-Aug       | 60.30860                 | -151.23759 | Tributary Spawner (Indian Cr.)      |
| 664                | 1       | 635                         | F   | 20-Aug       | 60.30934                 | -151.23576 | Dead/Regurgitated                   |
| 74                 | 1       | 650                         | M   | 20-Aug       | 60.30649                 | -151.24022 | Tributary Spawner (Nikolai Cr.)     |
| 834                | 1       | 605                         | M   | 20-Aug       | 60.30371                 | -151.22948 | Tributary Spawner (West Cr.)        |
| 15                 | 1       | 590                         | F   | 20-Aug       | 60.30851                 | -151.23755 | Tributary Spawner (Shantatalik Cr.) |
| 235                | 1       | 590                         | M   | 20-Aug       | 60.30894                 | -151.23607 | Tributary Spawner (Indian Cr.)      |
| 365                | 1       | 640                         | F   | 22-Aug       | 60.28676                 | -151.21406 | Dead/Regurgitated                   |
| 45                 | 1       | 575                         | F   | 22-Aug       | 60.28880                 | -151.22023 | Other Spawner (Crooked Cr.)         |
| 535                | 1       | 685                         | M   | 22-Aug       | 60.30871                 | -151.23636 | Sport Harvest                       |
| 665                | 1       | 465                         | M   | 22-Aug       | 60.30896                 | -151.23558 | Tributary Spawner (Glacier Cr.)     |
| 75                 | 1       | 475                         | F   | 22-Aug       | 60.30834                 | -151.23709 | Unknown                             |
| 835                | 1       | 725                         | M   | 22-Aug       | 60.30765                 | -151.23808 | Mainstem Spawners above rkm 24      |
| 16                 | 1       | 695                         | M   | 22-Aug       | 60.31606                 | -151.23187 | Tributary Spawner (Indian Cr.)      |
| 236                | 1       | 580                         | M   | 22-Aug       | 60.30713                 | -151.23281 | Other Spawner (Crooked Cr.)         |
| 366                | 1       | 680                         | M   | 22-Aug       | 60.30852                 | -151.23685 | Tributary Spawner (Nikolai Cr.)     |
| 46                 | 1       | 610                         | M   | 24-Aug       | 60.30749                 | -151.24026 | Tributary Spawner (Indian Cr.)      |
| 536                | 1       | 615                         | F   | 24-Aug       | 60.30782                 | -151.23783 | Mainstem Spawners above rkm 24      |
| 666                | 1       | 630                         | F   | 24-Aug       | 60.30899                 | -151.23577 | Mainstem Spawners above rkm 24      |
| 76                 | 1       | 620                         | M   | 24-Aug       | 60.30854                 | -151.23657 | Tributary Spawner (Shantatalik Cr.) |
| 836                | 1       | 585                         | M   | 24-Aug       | 60.30791                 | -151.23804 | Tributary Spawner (Indian Cr.)      |
| 17                 | 1       | 600                         | M   | 24-Aug       | 60.30727                 | -151.23924 | Tributary Spawner (West Cr.)        |
| 237                | 1       | 620                         | F   | 24-Aug       | 60.30552                 | -151.24017 | Sport Harvest                       |
| 367                | 1       | 625                         | F   | 24-Aug       | 60.30675                 | -151.24166 | Mainstem Spawners above rkm 24      |
| 47                 | 1       | 635                         | M   | 24-Aug       | 60.30633                 | -151.24210 | Tributary Spawner (West Cr.)        |
| 537                | 1       | 660                         | F   | 26-Aug       | 60.30858                 | -151.23326 | Tributary Spawner (Indian Cr.)      |
| 667                | 1       | 585                         | M   | 26-Aug       | 60.30805                 | -151.23880 | Tributary Spawner (Shantatalik Cr.) |
| 77                 | 1       | 670                         | M   | 26-Aug       | 60.30790                 | -151.23901 | Tributary Spawner (Glacier Cr.)     |
| 837                | 1       | 650                         | M   | 26-Aug       | 60.30755                 | -151.23968 | Back Out                            |
| 18                 | 1       | 685                         | M   | 26-Aug       | 60.30752                 | -151.23979 | Tributary Spawner (West Cr.)        |
| 238                | 1       | 665                         | F   | 26-Aug       | 60.30098                 | -151.21331 | Tributary Spawner (West Cr.)        |
| 368                | 1       | 595                         | M   | 26-Aug       | 60.30098                 | -151.21331 | Tributary Spawner (West Cr.)        |
| 48                 | 1       | 510                         | F   | 26-Aug       | 60.30382                 | -151.22542 | Other Spawner (Crooked Cr.)         |
| 538                | 1       | 555                         | F   | 28-Aug       | 60.28103                 | -151.21299 | Back Out                            |
| 668                | 1       | 540                         | F   | 28-Aug       | 60.28103                 | -151.21299 | Other Spawner (Crooked Cr.)         |
| 78                 | 1       | 650                         | M   | 28-Aug       | 60.30632                 | -151.24210 | Dead/Regurgitated                   |
| 838                | 1       | 575                         | M   | 28-Aug       | 60.30509                 | -151.24195 | Tributary Spawner (Indian Cr.)      |
| 19                 | 1       | 653                         | M   | 28-Aug       | 60.30410                 | -151.24184 | Mainstem Spawners above rkm 24      |
| 239                | 1       | 660                         | M   | 28-Aug       | 60.30513                 | -151.24156 | Other Spawner (Crooked Cr.)         |
| 369                | 1       | 650                         | F   | 28-Aug       | 60.30891                 | -151.23614 | Other Spawner (Crooked Cr.)         |
| 49                 | 1       | 505                         | F   | 28-Aug       | 60.31706                 | -151.25904 | Other Spawner (Crooked Cr.)         |
| 539                | 1       | 625                         | M   | 30-Aug       | 60.31706                 | -151.25904 | Unknown                             |
| 669                | 1       | 580                         | F   | 30-Aug       | 60.30675                 | -151.24177 | Tributary Spawner (Shantatalik Cr.) |
| 79                 | 1       | 595                         | F   | 30-Aug       | 60.30893                 | -151.23604 | Tributary Spawner (West Cr.)        |
| 839                | 1       | 620                         | F   | 30-Aug       | 60.30899                 | -151.23565 | Tributary Spawner (Indian Cr.)      |
| 110                | 1       | 655                         | M   | 30-Aug       | 60.30913                 | -151.23475 | Other Spawner (Coal Cr.)            |
| 240                | 1       | 530                         | M   | 30-Aug       | 60.30883                 | -151.23623 | Tributary Spawner (Indian Cr.)      |
| 370                | 1       | 590                         | M   | 30-Aug       | 60.28577                 | -151.21445 | Dead/Regurgitated                   |
| 410                | 1       | 595                         | M   | 30-Aug       | 60.30698                 | -151.23996 | Dead/Regurgitated                   |

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APPENDIX 4. —(Page 2 of 4)

| Transmitter number | Stratum | Mid-eye to fork length (mm) | Sex | Tagging date | Tagging Location (WGS84) |            | Final fate                             |
|--------------------|---------|-----------------------------|-----|--------------|--------------------------|------------|----------------------------------------|
|                    |         |                             |     |              | Latitude                 | Longitude  |                                        |
| 540                | 2       | 630                         | M   | 2-Sep        | 60.30804                 | -151.23882 | Tributary Spawner (Indian Cr.)         |
| 670                | 2       | 560                         | M   | 2-Sep        | 60.30755                 | -151.23928 | Mainstem Spawners above rkm 24         |
| 710                | 2       | 595                         | M   | 2-Sep        | 60.30756                 | -151.23961 | Tributary Spawner (Glacier Cr.)        |
| 840                | 2       | 580                         | M   | 2-Sep        | 60.30756                 | -151.23961 | Tributary Spawner (Indian Cr.)         |
| 111                | 2       | 600                         | F   | 2-Sep        | 60.28028                 | -151.21351 | Mainstem Spawners above rkm 24         |
| 241                | 2       | 595                         | M   | 2-Sep        | 60.28535                 | -151.21981 | Mainstem Spawners above rkm 24         |
| 371                | 2       | 640                         | F   | 2-Sep        | 60.30767                 | -151.23940 | Mainstem Spawners above rkm 24         |
| 411                | 2       | 545                         | F   | 2-Sep        | 60.30842                 | -151.23697 | Other Spawner (Maintstem Below rkm 24) |
| 541                | 2       | 585                         | M   | 2-Sep        | 60.30779                 | -151.23918 | Tributary Spawner (Nikolai Cr.)        |
| 412                | 2       | 635                         | M   | 4-Sep        | 60.30621                 | -151.24210 | Mainstem Spawners above rkm 24         |
| 542                | 2       | 560                         | M   | 4-Sep        | 60.30770                 | -151.23951 | Tributary Spawner (Indian Cr.)         |
| 671                | 2       | 700                         | M   | 4-Sep        | 60.30761                 | -151.23962 | Mainstem Spawners above rkm 24         |
| 711                | 2       | 615                         | F   | 4-Sep        | 60.30728                 | -151.24010 | Tributary Spawner (Indian Cr.)         |
| 841                | 2       |                             | F   | 4-Sep        | 60.30723                 | -151.24040 | Mainstem Spawners above rkm 24         |
| 112                | 2       | 665                         | F   | 4-Sep        | 60.30368                 | -151.22896 | Mainstem Spawners above rkm 24         |
| 242                | 2       | 540                         | M   | 4-Sep        | 60.28111                 | -151.21258 | Tributary Spawner (Indian Cr.)         |
| 372                | 2       | 560                         | F   | 4-Sep        | 60.30817                 | -151.23721 | Other Spawner (Maintstem Below rkm 24) |
| 672                | 2       | 610                         | M   | 4-Sep        | 60.30817                 | -151.23721 | Dead/Regurgitated                      |
| 712                | 2       | 615                         | F   | 6-Sep        | 60.30658                 | -151.24002 | Mainstem Spawners above rkm 24         |
| 842                | 2       | 590                         | F   | 6-Sep        | 60.30543                 | -151.24202 | Mainstem Spawners above rkm 24         |
| 113                | 2       | 685                         | M   | 6-Sep        | 60.30766                 | -151.23956 | Mainstem Spawners above rkm 24         |
| 243                | 2       | 630                         | F   | 6-Sep        | 60.30738                 | -151.24015 | Dead/Regurgitated                      |
| 373                | 2       | 660                         | M   | 6-Sep        | 60.30714                 | -151.24087 | Tributary Spawner (Shantatalik Cr.)    |
| 413                | 2       | 565                         | M   | 6-Sep        | 60.28137                 | -151.21239 | Tributary Spawner (Glacier Cr.)        |
| 543                | 2       | 600                         | F   | 6-Sep        | 60.28517                 | -151.22007 | Dead/Regurgitated                      |
| 673                | 2       | 700                         | M   | 6-Sep        | 60.28990                 | -151.21730 | Tributary Spawner (Indian Cr.)         |
| 713                | 2       | 615                         | F   | 6-Sep        | 60.30748                 | -151.23988 | Tributary Spawner (Glacier Cr.)        |
| 843                | 2       | 660                         | M   | 8-Sep        | 60.30703                 | -151.24106 | Unknown                                |
| 114                | 2       | 575                         | F   | 8-Sep        | 60.28583                 | -151.21393 | Dead/Regurgitated                      |
| 244                | 2       | 710                         | M   | 8-Sep        | 60.30366                 | -151.22727 | Mainstem Spawners above rkm 24         |
| 374                | 2       | 680                         | M   | 9-Sep        | 60.30602                 | -151.24256 | Mainstem Spawners above rkm 24         |
| 414                | 2       | 535                         | M   | 9-Sep        | 60.30701                 | -151.24141 | Mainstem Spawners above rkm 24         |
| 544                | 2       | 630                         | M   | 9-Sep        | 60.30453                 | -151.24710 | Mainstem Spawners above rkm 24         |
| 674                | 2       | 620                         | F   | 9-Sep        | 60.30363                 | -151.22961 | Back Out                               |
| 714                | 2       | 730                         | M   | 9-Sep        | 60.28652                 | -151.21738 | Mainstem Spawners above rkm 24         |
| 844                | 2       | 630                         | M   | 9-Sep        |                          |            | Other Spawner (Maintstem Below rkm 24) |
| 115                | 2       | 675                         | F   | 10-Sep       | 60.28552                 | -151.22057 | Mainstem Spawners above rkm 24         |
| 245                | 2       | 720                         | M   | 10-Sep       | 60.28552                 | -151.22057 | Back Out                               |
| 375                | 2       | 640                         | F   | 10-Sep       | 60.28548                 | -151.22018 | Mainstem Spawners above rkm 24         |
| 415                | 2       | 730                         | M   | 10-Sep       | 60.28550                 | -151.22190 | Dead/Regurgitated                      |
| 545                | 2       | 670                         | M   | 10-Sep       | 60.28514                 | -151.22034 | Dead/Regurgitated                      |
| 675                | 2       | 615                         | F   | 10-Sep       | 60.30101                 | -151.21298 | Mainstem Spawners above rkm 24         |
| 715                | 2       | 675                         | F   | 10-Sep       | 60.30101                 | -151.21298 | Mainstem Spawners above rkm 24         |
| 845                | 2       | 580                         | M   | 10-Sep       | 60.30911                 | -151.22000 | Mainstem Spawners above rkm 24         |
| 116                | 2       | 720                         | M   | 12-Sep       | 60.28661                 | -151.21568 | Other Spawner (Maintstem Below rkm 24) |
| 246                | 2       | 720                         | M   | 12-Sep       | 60.28613                 | -151.21870 | Other Spawner (Maintstem Below rkm 24) |
| 376                | 2       | 655                         | F   | 12-Sep       | 60.28659                 | -151.21634 | Mainstem Spawners above rkm 24         |
| 416                | 2       | 690                         | F   | 12-Sep       | 60.28632                 | -151.21439 | Mainstem Spawners above rkm 24         |
| 546                | 2       | 550                         | F   | 12-Sep       | 60.28527                 | -151.21348 | Mainstem Spawners above rkm 24         |
| 676                | 2       | 650                         | M   | 12-Sep       | 60.28601                 | -151.21384 | Mainstem Spawners above rkm 24         |
| 716                | 2       | 630                         | M   | 12-Sep       | 60.28601                 | -151.21384 | Mainstem Spawners above rkm 24         |
| 846                | 2       | 660                         | F   | 12-Sep       | 60.28632                 | -151.21468 | Other Spawner (Maintstem Below rkm 24) |
| 117                | 2       | 645                         | M   | 14-Sep       | 60.28655                 | -151.21664 | Mainstem Spawners above rkm 24         |
| 247                | 2       | 560                         | M   | 14-Sep       | 60.28655                 | -151.21664 | Mainstem Spawners above rkm 24         |
| 377                | 2       | 675                         | M   | 14-Sep       | 60.28599                 | -151.21421 | Mainstem Spawners above rkm 24         |
| 417                | 2       | 660                         | M   | 14-Sep       | 60.28648                 | -151.21538 | Tributary Spawner (Clear Cr.)          |
| 547                | 2       | 655                         | M   | 14-Sep       | 60.28613                 | -151.21443 | Tributary Spawner (Indian Cr.)         |
| 677                | 2       | 510                         | M   | 14-Sep       | 60.28580                 | -151.21385 | Mainstem Spawners above rkm 24         |
| 717                | 2       | 655                         | M   | 14-Sep       | 60.28634                 | -151.21468 | Mainstem Spawners above rkm 24         |
| 847                | 2       | 585                         | M   | 14-Sep       | 60.28210                 | -151.20970 | Other Spawner (Maintstem Below rkm 24) |

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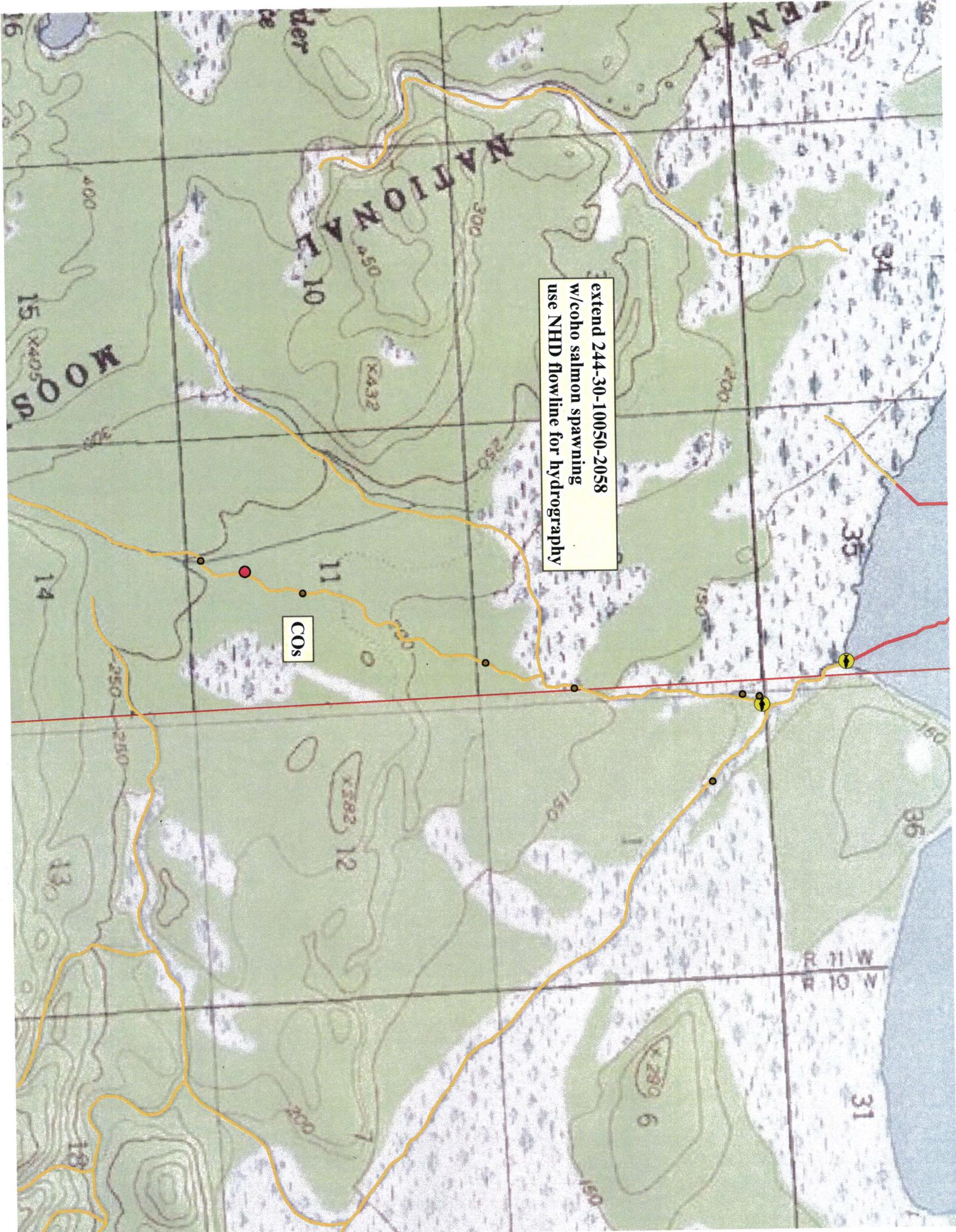
APPENDIX 4. —(Page 3 of 4)

| Transmitter number | Stratum | Mid-eye to fork length (mm) | Sex | Tagging date | Tagging Location (WGS84) |            | Final fate                             |
|--------------------|---------|-----------------------------|-----|--------------|--------------------------|------------|----------------------------------------|
|                    |         |                             |     |              | Latitude                 | Longitude  |                                        |
| 118                | 3       | 740                         | M   | 16-Sep       | 60.28585                 | -151.21389 | Mainstem Spawners above rkm 24         |
| 248                | 3       | 650                         | F   | 16-Sep       | 60.28608                 | -151.21420 | Mainstem Spawners above rkm 24         |
| 378                | 3       | 720                         | M   | 16-Sep       | 60.28586                 | -151.21383 | Mainstem Spawners above rkm 24         |
| 418                | 3       | 655                         | M   | 16-Sep       | 60.28146                 | -151.21217 | Sport Harvest                          |
| 548                | 3       | 730                         | M   | 16-Sep       | 60.28160                 | -151.21193 | Tributary Spawner (Glacier Cr.)        |
| 678                | 3       | 670                         | F   | 16-Sep       | 60.28170                 | -151.21173 | Mainstem Spawners above rkm 24         |
| 718                | 3       | 655                         | M   | 16-Sep       | 60.28324                 | -151.20949 | Mainstem Spawners above rkm 24         |
| 848                | 3       | 630                         | F   | 16-Sep       | 60.30662                 | -151.24165 | Other Spawner (Maintstem Below rkm 24) |
| 119                | 3       | 673                         | M   | 16-Sep       | 60.28239                 | -151.20886 | Mainstem Spawners above rkm 24         |
| 249                | 3       | 615                         | F   | 18-Sep       | 60.28610                 | -151.21409 | Mainstem Spawners above rkm 24         |
| 379                | 3       | 615                         | F   | 18-Sep       | 60.28602                 | -151.21424 | Dead/Regurgitated                      |
| 419                | 3       | 690                         | F   | 18-Sep       | 60.28626                 | -151.21438 | Mainstem Spawners above rkm 24         |
| 549                | 3       | 685                         | M   | 18-Sep       | 60.28606                 | -151.21443 | Mainstem Spawners above rkm 24         |
| 679                | 3       | 615                         | M   | 18-Sep       | 60.28650                 | -151.21596 | Mainstem Spawners above rkm 24         |
| 719                | 3       | 640                         | M   | 18-Sep       | 60.28482                 | -151.21293 | Other Spawner (Maintstem Below rkm 24) |
| 849                | 3       | 655                         | F   | 18-Sep       | 60.30363                 | -151.22809 | Back Out                               |
| 120                | 3       | 605                         | F   | 18-Sep       | 60.30375                 | -151.22941 | Other Spawner (Maintstem Below rkm 24) |
| 250                | 3       | 530                         | M   | 18-Sep       | 60.30716                 | -151.24079 | Mainstem Spawners above rkm 24         |
| 380                | 3       | 640                         | F   | 20-Sep       | 60.30709                 | -151.24086 | Other Spawner (Maintstem Below rkm 24) |
| 420                | 3       | 610                         | M   | 20-Sep       | 60.30671                 | -151.24144 | Mainstem Spawners above rkm 24         |
| 550                | 3       | 615                         | F   | 20-Sep       | 60.28924                 | -151.21928 | Mainstem Spawners above rkm 24         |
| 680                | 3       | 540                         | F   | 20-Sep       | 60.30744                 | -151.22259 | Mainstem Spawners above rkm 24         |
| 720                | 3       | 665                         | M   | 20-Sep       | 60.30420                 | -151.24666 | Mainstem Spawners above rkm 24         |
| 850                | 3       | 645                         | M   | 20-Sep       | 60.30674                 | -151.24489 | Dead/Regurgitated                      |
| 121                | 3       | 500                         | F   | 20-Sep       | 60.30537                 | -151.24643 | Tributary Spawner (Glacier Cr.)        |
| 251                | 3       | 620                         | F   | 22-Sep       | 60.28627                 | -151.21424 | Other Spawner (Maintstem Below rkm 24) |
| 381                | 3       | 645                         | M   | 22-Sep       | 60.28666                 | -151.21621 | Other Spawner (Maintstem Below rkm 24) |
| 421                | 3       | 595                         | M   | 22-Sep       | 60.30582                 | -151.22239 | Other Spawner (Maintstem Below rkm 24) |
| 551                | 3       | 655                         | M   | 22-Sep       | 60.30386                 | -151.23207 | Back Out                               |
| 681                | 3       | 610                         | F   | 22-Sep       | 60.30378                 | -151.23142 | Mainstem Spawners above rkm 24         |
| 721                | 3       | 630                         | F   | 22-Sep       | 60.30602                 | -151.24208 | Mainstem Spawners above rkm 24         |
| 851                | 3       | 590                         | F   | 22-Sep       | 60.30601                 | -151.24216 | Other Spawner (Crooked Cr.)            |
| 122                | 3       | 640                         | M   | 22-Sep       | 60.30682                 | -151.24452 | Other Spawner (Maintstem Below rkm 24) |
| 252                | 3       | 615                         | F   | 22-Sep       | 60.30427                 | -151.24163 | Dead/Regurgitated                      |
| 382                | 3       | 525                         | F   | 22-Sep       | 60.30396                 | -151.22488 | Mainstem Spawners above rkm 24         |
| 422                | 3       | 630                         | M   | 22-Sep       | 60.30456                 | -151.24685 | Other Spawner (Maintstem Below rkm 24) |
| 552                | 3       | 680                         | M   | 24-Sep       | 60.30365                 | -151.22830 | Mainstem Spawners above rkm 24         |
| 682                | 3       | 670                         | M   | 24-Sep       | 60.30365                 | -151.22919 | Other Spawner (Maintstem Below rkm 24) |
| 722                | 3       | 675                         | M   | 24-Sep       | 60.29194                 | -151.21391 | Dead/Regurgitated                      |
| 852                | 3       | 665                         | F   | 24-Sep       | 60.29129                 | -151.21424 | Mainstem Spawners above rkm 24         |
| 123                | 3       | 675                         | M   | 25-Sep       | 60.28619                 | -151.21434 | Other Spawner (Maintstem Below rkm 24) |
| 253                | 3       | 690                         | M   | 25-Sep       | 60.28533                 | -151.21972 | Other Spawner (Maintstem Below rkm 24) |
| 383                | 3       | 595                         | F   | 25-Sep       | 60.28205                 | -151.21045 | Mainstem Spawners above rkm 24         |
| 423                | 3       | 640                         | F   | 25-Sep       | 60.29104                 | -151.21426 | Mainstem Spawners above rkm 24         |
| 553                | 3       | 535                         | M   | 25-Sep       | 60.27893                 | -151.21520 | Mainstem Spawners above rkm 24         |
| 723                | 3       | 680                         | F   | 25-Sep       | 60.28648                 | -151.22315 | Other Spawner (Maintstem Below rkm 24) |
| 683                | 3       | 560                         | M   | 25-Sep       | 60.28645                 | -151.22391 | Other Spawner (Maintstem Below rkm 24) |
| 853                | 3       | 675                         | M   | 25-Sep       | 60.28749                 | -151.22398 | Mainstem Spawners above rkm 24         |
| 124                | 3       | 680                         | M   | 26-Sep       | 60.30599                 | -151.23409 | Mainstem Spawners above rkm 24         |
| 254                | 3       | 680                         | M   | 26-Sep       | 60.30729                 | -151.24028 | Mainstem Spawners above rkm 24         |
| 384                | 3       | 655                         | M   | 26-Sep       | 60.28615                 | -151.21417 | Other Spawner (Maintstem Below rkm 24) |
| 424                | 3       | 645                         | M   | 26-Sep       | 60.28538                 | -151.22156 | Dead/Regurgitated                      |
| 554                | 3       | 640                         | M   | 26-Sep       | 60.28623                 | -151.21423 | Mainstem Spawners above rkm 24         |
| 684                | 3       | 645                         | F   | 26-Sep       | 60.28590                 | -151.21392 | Dead/Regurgitated                      |
| 724                | 3       | 635                         | M   | 26-Sep       | 60.28555                 | -151.21970 | Other Spawner (Maintstem Below rkm 24) |
| 854                | 3       | 630                         | M   | 26-Sep       | 60.28633                 | -151.21467 | Other Spawner (Maintstem Below rkm 24) |
| 125                | 3       | 600                         | M   | 28-Sep       | 60.28610                 | -151.21452 | Mainstem Spawners above rkm 24         |
| 255                | 3       | 665                         | M   | 28-Sep       | 60.28688                 | -151.22408 | Mainstem Spawners above rkm 24         |
| 385                | 3       | 630                         | M   | 28-Sep       | 60.28795                 | -151.22266 | Dead/Regurgitated                      |
| 425                | 3       | 655                         | M   | 28-Sep       | 60.28668                 | -151.22416 | Mainstem Spawners above rkm 24         |

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| Transmitter<br>number | Stratum | Mid-eye to<br>fork length<br>(mm) | Sex | Tagging<br>date | Tagging Location<br>(WGS84) |            | Final fate                             |
|-----------------------|---------|-----------------------------------|-----|-----------------|-----------------------------|------------|----------------------------------------|
|                       |         |                                   |     |                 | Latitude                    | Longitude  |                                        |
| 555                   | 4       | 640                               | F   | 1-Oct           | 60.28247                    | -151.20870 | Other Spawner (Maintstem Below rkm 24) |
| 685                   | 4       | 645                               | M   | 1-Oct           | 60.28265                    | -151.20847 | Mainstem Spawners above rkm 24         |
| 725                   | 4       | 680                               | F   | 1-Oct           | 60.28256                    | -151.20868 | Tributary Spawner (Glacier Cr.)        |
| 855                   | 4       | 660                               | M   | 1-Oct           | 60.28186                    | -151.21126 | Mainstem Spawners above rkm 24         |
| 126                   | 4       | 620                               | F   | 1-Oct           | 60.27671                    | -151.21864 | Other Spawner (Maintstem Below rkm 24) |
| 256                   | 4       | 620                               | F   | 1-Oct           | 60.27691                    | -151.21807 | Other Spawner (Maintstem Below rkm 24) |
| 386                   | 4       | 535                               | M   | 1-Oct           | 60.30369                    | -151.22944 | Tributary Spawner (West Cr.)           |
| 426                   | 4       | 635                               | F   | 2-Oct           | 60.28716                    | -151.22431 | Other Spawner (Maintstem Below rkm 24) |
| 556                   | 4       | 590                               | M   | 2-Oct           | 60.28935                    | -151.21892 | Tributary Spawner (Glacier Cr.)        |
| 686                   | 4       | 550                               | M   | 2-Oct           | 60.28959                    | -151.21841 | Other Spawner (Maintstem Below rkm 24) |
| 726                   | 4       | 635                               | M   | 2-Oct           | 60.28640                    | -151.21684 | Other Spawner (Maintstem Below rkm 24) |
| 856                   | 4       | 610                               | M   | 2-Oct           | 60.28569                    | -151.21561 | Other Spawner (Maintstem Below rkm 24) |
| 127                   | 4       | 710                               | M   | 2-Oct           | 60.28145                    | -151.21218 | Mainstem Spawners above rkm 24         |
| 257                   | 4       | 490                               | F   | 2-Oct           | 60.28212                    | -151.21008 | Mainstem Spawners above rkm 24         |
| 387                   | 4       | 675                               | M   | 3-Oct           | 60.30361                    | -151.23237 | Mainstem Spawners above rkm 24         |
| 427                   | 4       | 660                               | M   | 3-Oct           | 60.27829                    | -151.21622 | Other Spawner (Maintstem Below rkm 24) |
| 557                   | 4       | 585                               | F   | 3-Oct           | 60.27880                    | -151.21760 | Other Spawner (Maintstem Below rkm 24) |
| 687                   | 4       | 610                               | M   | 3-Oct           | 60.27850                    | -151.21582 | Mainstem Spawners above rkm 24         |
| 727                   | 4       | 610                               | F   | 5-Oct           | 60.28655                    | -151.21665 | Mainstem Spawners above rkm 24         |
| 857                   | 4       | 630                               | F   | 5-Oct           | 60.28045                    | -151.21321 | Unknown                                |
| 128                   | 4       | 615                               | F   | 5-Oct           | 60.28162                    | -151.21180 | Mainstem Spawners above rkm 24         |
| 258                   | 4       | 580                               | F   | 5-Oct           | 60.28122                    | -151.21257 | Mainstem Spawners above rkm 24         |
| 388                   | 4       | 555                               | F   | 5-Oct           | 60.28058                    | -151.21360 | Back Out                               |
| 428                   | 4       | 665                               | M   | 5-Oct           | 60.28189                    | -151.21095 | Dead/Regurgitated                      |
| 558                   | 4       | 585                               | F   | 5-Oct           | 60.28621                    | -151.21423 | Mainstem Spawners above rkm 24         |
| 688                   | 4       | 665                               | M   | 5-Oct           | 60.30362                    | -151.23238 | Mainstem Spawners above rkm 24         |
| 728                   | 4       | 660                               | F   | 5-Oct           | 60.30366                    | -151.23251 | Mainstem Spawners above rkm 24         |
| 858                   | 4       | 630                               | M   | 7-Oct           | 60.28036                    | -151.21311 | Mainstem Spawners above rkm 24         |
| 129                   | 4       | 620                               | M   | 7-Oct           | 60.28183                    | -151.21094 | Mainstem Spawners above rkm 24         |
| 259                   | 4       | 635                               | M   | 7-Oct           | 60.28044                    | -151.21344 | Other Spawner (Maintstem Below rkm 24) |
| 389                   | 4       | 660                               | F   | 7-Oct           | 60.28176                    | -151.21117 | Other Spawner (Maintstem Below rkm 24) |
| 429                   | 4       | 645                               | M   | 7-Oct           | 60.27950                    | -151.21415 | Other Spawner (Maintstem Below rkm 24) |
| 559                   | 4       | 670                               | F   | 7-Oct           | 60.27637                    | -151.21801 | Mainstem Spawners above rkm 24         |
| 689                   | 4       | 655                               | F   | 7-Oct           | 60.28598                    | -151.21431 | Mainstem Spawners above rkm 24         |
| 729                   | 4       | 680                               | M   | 7-Oct           | 60.28106                    | -151.21257 | Mainstem Spawners above rkm 24         |
| 859                   | 4       | 645                               | M   | 7-Oct           | 60.28104                    | -151.21303 | Other Spawner (Maintstem Below rkm 24) |
| 130                   | 4       | 770                               | M   | 7-Oct           | 60.28358                    | -151.20595 | Mainstem Spawners above rkm 24         |
| 260                   | 4       | 645                               | M   | 7-Oct           | 60.28358                    | -151.20595 | Other Spawner (Maintstem Below rkm 24) |
| 390                   | 4       | 525                               | M   | 7-Oct           | 60.28512                    | -151.22076 | Mainstem Spawners above rkm 24         |
| 430                   | 4       | 580                               | M   | 7-Oct           | 60.28564                    | -151.21377 | Other Spawner (Maintstem Below rkm 24) |
| 560                   | 4       | 680                               | F   | 9-Oct           | 60.28134                    | -151.21238 | Dead/Regurgitated                      |
| 690                   | 4       | 600                               | M   | 9-Oct           | 60.28117                    | -151.21245 | Mainstem Spawners above rkm 24         |
| 730                   | 4       | 660                               | M   | 9-Oct           | 60.28139                    | -151.21237 | Other Spawner (Maintstem Below rkm 24) |
| 860                   | 4       | 610                               | F   | 9-Oct           | 60.28119                    | -151.21233 | Mainstem Spawners above rkm 24         |
| 131                   | 4       | 615                               | F   | 9-Oct           | 60.28099                    | -151.21283 | Other Spawner (Maintstem Below rkm 24) |
| 261                   | 4       | 635                               | F   | 9-Oct           | 60.28233                    | -151.20820 | Dead/Regurgitated                      |
| 391                   | 4       | 720                               | M   | 9-Oct           | 60.28240                    | -151.20789 | Mainstem Spawners above rkm 24         |
| 431                   | 4       | 670                               | M   | 9-Oct           | 60.28124                    | -151.21257 | Dead/Regurgitated                      |
| 561                   | 4       | 645                               | M   | 9-Oct           | 60.28619                    | -151.22568 | Mainstem Spawners above rkm 24         |
| 691                   | 4       | 675                               | F   | 9-Oct           | 60.28748                    | -151.22413 | Mainstem Spawners above rkm 24         |
| 731                   | 4       | 590                               | M   | 11-Oct          | 60.28104                    | -151.21268 | Other Spawner (Maintstem Below rkm 24) |
| 861                   | 4       | 490                               | M   | 11-Oct          | 60.28122                    | -151.21248 | Other Spawner (Maintstem Below rkm 24) |
| 132                   | 4       | 635                               | M   | 11-Oct          | 60.28182                    | -151.21106 | Other Spawner (Maintstem Below rkm 24) |
| 262                   | 4       | 545                               | M   | 11-Oct          | 60.28541                    | -151.21957 | Other Spawner (Maintstem Below rkm 24) |
| 392                   | 4       | 640                               | F   | 11-Oct          | 60.28658                    | -151.22435 | Mainstem Spawners above rkm 24         |
| 432                   | 4       | 705                               | M   | 13-Oct          | 60.28227                    | -151.20926 | Other Spawner (Maintstem Below rkm 24) |
| 562                   | 4       | 655                               | F   | 13-Oct          | 60.28155                    | -151.21159 | Dead/Regurgitated                      |
| 692                   | 4       | 690                               | M   | 13-Oct          | 60.28093                    | -151.21274 | Mainstem Spawners above rkm 24         |
| 732                   | 4       | 665                               | F   | 13-Oct          | 60.28148                    | -151.21209 | Mainstem Spawners above rkm 24         |
| 862                   | 4       | 535                               | M   | 13-Oct          | 60.27717                    | -151.21962 | Mainstem Spawners above rkm 24         |



extend 244-30-10050-2058  
w/coho salmon spawning  
use NHD flowline for hydrography

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