U.S. Fish & Wildlife Service

Abundance and Run Timing of Adult Chinook Salmon and Steelhead in the Funny River, Kenai Peninsula, Alaska, 2009

Alaska Fisheries Data Series Number 2009-16

Kenai Fish and Wildlife Field Office
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Kenneth S. Gates and James K. Boersma

Abstract

A fish weir equipped with an underwater video system was installed and operated between 1 May and 17 August in the Funny River during 2009 to collect abundance, run timing, and biological information on adult Chinook salmon *Oncorhynchus tshawytscha* and steelhead *O. mykiss*. The total number of Chinook salmon and steelhead counted past the weir was 1,114 and 172, respectively. Non-target species enumerated included 81 rainbow trout *O. mykiss*, 566 Dolly Varden *Salvelinus malma*, 7 round whitefish *Prosopium cylindraceum*, 6 lamprey *Lampetra* spp., 10 sockeye salmon *O. nerka*, 339 pink salmon *O. gorbuscha*, 2 chum salmon *O. keta*, and 6 coho salmon *O. kisutch*. Peak weekly passage of Chinook salmon and steelhead occurred between 28 June and 4 July and 3 and 9 May, respectively. Age, sex, and length information was collected from 112 Chinook salmon and one steelhead. Sex of both species was also determined by examining recorded video images. Females comprised 34% of the Chinook salmon escapement and 70% of the steelhead escapement. The average length of male and female Chinook salmon sampled was 650 and 782 mm, respectively. Ages of Chinook salmon determined from scale analysis ranged between 3 and 7 years.

Introduction

The Kenai River supports one of the largest recreational fisheries for Chinook salmon *Oncorhynchus tshawytscha* in Alaska (Nelson et al. 1999). The popularity of this sport fishery requires intensive management and research programs focusing on Kenai River Chinook salmon stocks. The fishery is managed as two distinct runs; fish entering the river during May and June are managed as the early-run, whereas those entering the river after 30 June are managed as the late-run. In general, early-run fish spawn in the Kenai River tributaries and late-run fish spawn in the mainstem Kenai River. Early-run fish are harvested primarily by sport anglers in the Kenai River, whereas late-run fish are harvested by commercial, sport, and personal use fisheries. Chinook salmon returning to the Funny River are considered part of the early-run. The number of early-run Chinook salmon returning to the Kenai River has been estimated since 1987 using sonar located at river kilometer (rkm) 13. Sonar escapement estimates for the early-run have ranged from 7,162 to 27,080 fish between 1986 and 2009 (Pappas and Marsh 2004; Alaska Department of Fish and Game, unpublished data). These estimates provide the basis for estimating spawning escapement and implementing the Kenai River and Kasilof River Early-Run King Salmon Management Plan (5 AAC 57.160) that regulates harvest in the in-river sport fishery.

Sport harvest of early-run Chinook salmon occurs below Skilak Lake during May and June. Harvest also occurs, although not in great numbers, in three other fisheries: the Central Cook Inlet marine sport fishery, the Upper Subdistrict set gillnet (Eastside set net) commercial fishery,

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and an in-river educational fishery (McKinley et al. 2002). Sport harvest of early-run Chinook salmon is monitored by the Alaska Department of Fish and Game (Department) through an in-river creel survey between the Warren Ames Bridge (rkm 8) and the Soldotna Bridge (rkm 32) and through the Statewide Harvest Survey between the Soldotna Bridge and Skilak Lake (rkm 80). Annual sport harvest has ranged from 899 to 15,209 fish and has averaged 5,963 fish between 1986 and 2004 (Gamblin et al. 2004; Pappas and Marsh 2004; Larry Marsh, Alaska Department of Fish and Game, personal communication). On average, about 73% of the sport harvest occurs below the Soldotna Bridge. Much of the annual variation in harvest since 1986 can be explained by fluctuations in run strength and in-season liberalization or restriction of the sport fishery.

Radio telemetry studies conducted during the early 1980's and 1990's provide some insight regarding the migratory behavior and spawning destinations of early-run Kenai River Chinook salmon. Bendock and Alexandersdottir (1991, 1992) found that the majority of early-run fish spawned in larger tributaries such as the Killey (42 to 64%) and Funny (20 to 21%) rivers. The remainder of the radio-tagged fish spawned in smaller tributaries (6 to 10%) and the mainstem Kenai River (9 to 28%). Similarly, Burger et al. (1985) found that 56% spawned in the Killey River, 18% in the Funny River, 18% in the mainstem, and 5% in other Kenai River tributaries between 1980 and 1982. Peak spawning times, although subjectively based on small sample sizes, are thought to occur between 12 and 22 July in the Funny River (Burger et al. 1985). Furthermore, many Chinook salmon destined for the Funny River and other tributaries have a tendency to mill for long periods prior to spawning events. Burger et al. (1983) identified one radio-tagged Chinook salmon that milled near the mouth of the Funny River between 1 and 28 July before entering to spawn. Bendock and Alexandersdottir (1992) observed similar behavior and noted that early-run Chinook salmon mill for extended periods in the mainstem Kenai River at or below their destination confluence. Funny River spawners particularly exhibited this behavior along the south bank of the Kenai River between rkm 45 and 48. Similar milling behaviors have been observed by Liscom et al. (1978) for Columbia River Chinook salmon tributary spawners, which can spend 6 to 38 days near a confluence before entering to spawn. Because early-run Chinook salmon have a tendency to mill in the mainstem Kenai River near spawning tributaries into late July and slowly exit areas open to sport fishing, some early-run fish are susceptible to harvest throughout most of July when the sport fishery is targeting late-run fish (Bendock and Alexandersdottir 1992).

Regulations pertaining to early-run Chinook salmon change frequently to address biological issues. For example, a slot limit protecting fish between 44 and 55 inches, typically fish that spend four or five years in the ocean, was enacted in 2002 to address the biological concern of fewer large and older fish present in the in-river sport fishery. This slot limit was later changed to protect fish between 46 and 55 inches beginning in 2008. In January 2005, an optimum escapement goal (OEG) range of 5,300 to 9,000 fish was adopted by the Alaska Board of Fisheries, which replaced the previous biological escapement goal (BEG) of 7,200 to 14,400 early-run Chinook salmon. With the OEG, restrictions and liberalizations in the fishery would take place only when the lower limits are not met or the upper limits are exceeded. The effects of this change are unknown but most likely would create a more predictable sport fishery by reducing restrictions on the in-river sport fishery and allowing for an increase in harvest. For example, during the first year of management using an OEG, the in-river sport fishery was liberalized on 18 June allowing the use of bait from the mouth of the Kenai River upstream to 100 yards below the mouth of the Moose River (Alaska Department of Fish and Game Emergency Order Number 2-KS-1-10-05). Restricting or liberalizing the fishery early or late in

the run could increase the possibility of disproportionately harvesting early-run Chinook salmon. Because information is limited about run timing of specific tributary populations, disproportionately harvesting early or late in the run could be detrimental to smaller populations of early-run Chinook salmon (McKinley et al. 2002).

Stakeholders demand high levels of accuracy and repeated validation of ongoing Chinook salmon research programs and despite the current efforts several issues remain to be resolved. For instance, the degree of overlap in the run timing of tributary- and mainstem-spawning Chinook salmon is not known, nor is the abundance of tributary stocks which are a dominant component of the early-run. This need for more detailed information prompted the development of the Funny River study.

Our study initially focused on early-run Chinook salmon and now includes the assessment of steelhead *O. mykiss*. Observations of steelhead in the Funny River were first made during 2006 and 2007 while enumerating Chinook salmon (Gates and Palmer 2007, 2008a). Since then, the weir and video system have been installed early in the spring to capture the spawning migration and Gates and Boersma (2009a) observed 187 steelhead during 2008. Steelhead are also incidentally caught in other sport fisheries in the Kenai River but have never been officially documented. The life-histories of steelhead returning to the Funny River are poorly understood although we believe they are similar to behaviors documented in other steelhead populations in south central Alaska (Begich 1997; Larson and Balland 1989; Gates and Palmer 2008b; Gates and Boersma 2009b). Steelhead entering the Kenai River watershed are likely fall-run fish, entering fresh water in the fall and overwintering before spawning in tributaries during May and June.

Our study during 2009 used a resistance board weir and fish trap in conjunction with an underwater video system to (1) enumerate adult Chinook salmon and steelhead entering the Funny River, (2) determine the run timing of Chinook salmon and steelhead entering the Funny River, (3) estimate the age, sex and length composition of the Chinook salmon escapement into the Funny River, and (4) initiate genetic tissue sampling of steelhead to determine if the spawning group in the Funny river is genetically distinct from other populations on the Kenai Peninsula and, if so, estimate the level of genetic differentiation. Information pertaining to the run size, timing, age, sex and genetic composition of Chinook salmon and steelhead returning to the Funny River will provide managers valuable information to refine existing management strategies.

Study Area

The glacially turbid Kenai River originates in Cooper Landing at the outlet of Kenai Lake and flows 132 km before entering Cook Inlet (Figure 1). The watershed consists of mountains, glaciers, forests, and the Kenai Peninsula's second and third largest lakes, Skilak and Kenai lakes. The Funny River, one of several tributaries, enters the Kenai River at rkm 49 (60° 29.47'N and 150° 51.92'W; WGS84). The Funny River drains approximately 218 km^2 and most of the watershed lies within the Kenai National Wildlife Refuge. The river channel near the weir location has a moderate gradient, moderate to high sinuosity, and predominately coarse gravel substrate. Vegetation along the banks and throughout the flood plain consists primarily of willow and alders with some stands of spruce (Moser 1997). Water depth varies throughout the channel but is usually deepest near the outside bends and shallowest through the crossovers.

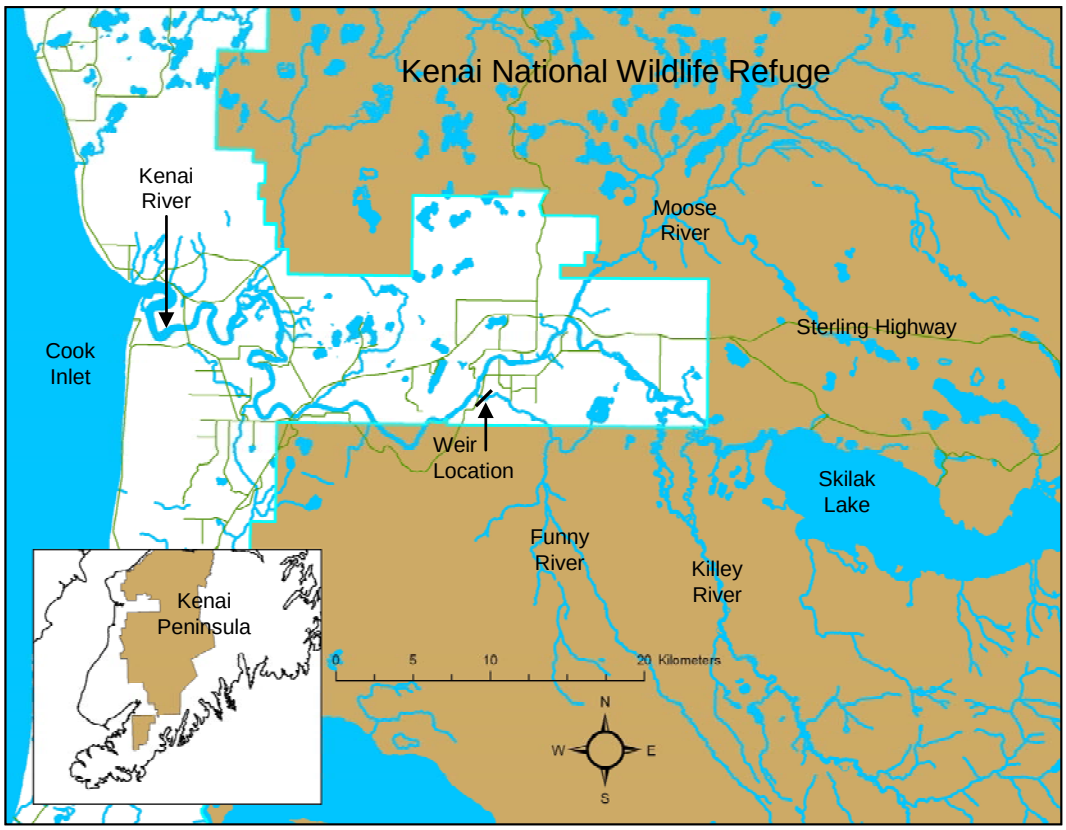

FIGURE 1. —Map of the Kenai River watershed below Skilak lake showing the weir location on Funny River.

Methods

Weir and Video Operations and Design

A resistance board weir and underwater video system was operated in the Funny River approximately 1.1 km above the bridge crossing the Funny River Road from 1 May through 17 August 2009. The weir was constructed using specifications outlined by Tobin (1994) with minor changes to some materials, panel width, and resistance boards. The resistance board weir design works well in systems that can experience higher seasonal discharges such as the Funny River. Other than weir maintenance and biological sampling, the weir was unmanned and outfitted with a video system. The weir was configured to pass fish near the deepest part of the channel through a fish passage panel. Each weir panel was attached to a steel rail anchored to the river bottom. A live trap facilitated biological sampling and was attached to the front of the fish passage panel. The video system, consisting of a sealed camera box and fish passage chute, was attached to the front of the live trap.

Setup and design of the video system was similar to that used by Gates and Boersma (2009b) in Crooked and Nikolai creeks during 2008, and Anderson et al. (2004) in 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 was 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 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 minimize the number of fish passing through the chute at one time and push fish closer to the

camera during turbid water conditions. The backdrop could also be easily removed from the video chute when dirty and replaced with a new one. All video images were recorded on an external 500 gigabyte hard drive at 22 frames-per-second using a computer-based digital video recorder (DVR). Fish passage was recorded 24 hours per day seven days each week. Stored video files were generally reviewed daily. The video box and fish passage chute were artificially lit using a pair of 12-V DC underwater pond lights. Pond lights were equipped with 20-watt bulbs which produced a quality image and provided a consistent source of lighting during day and night hours. The DVR was equipped with motion detection to minimize the amount of blank video footage and review time. All video equipment was supplied with 110-V AC power and further reduced to 12-V DC for the underwater camera and lights. A 1000-watt charger/inverter was used inline with two 6-V batteries rated at 400 Ah creating a large battery backup in the event of a power outage. Appendix 1 contains a complete list of all equipment used.

Biological Sampling

Data on fish age, sex, and length (ASL) were collected from Chinook salmon using a temporally stratified sample design (Cochran 1977). Sampling effort was divided into strata and was based upon the 2008 in-season run size and timing. Each stratum was a calendar week consisting of seven days, in which sampling took place in a 2-3 day time period. Samples were taken in as minimal amount of time as possible and are considered a "snap shot" sample (Geiger et al. 1990). Sampling of steelhead only occurred once and included ASL and genetic tissue from the axillary process of the captured fish.

ASL sampling consisted of sex determination, length measurements, and scale collections. Sex was determined by observing external characteristics. Length measurements for Chinook salmon were taken to the nearest 5 mm from the mid-eye to fork in the tail. Steelhead were also measured to the nearest 5 mm from the tip of the nose to the fork in the tail. Scales were removed from the preferred area using methods described by Mosher (1968) and Koo (1962). The preferred area is located on the left side of the fish, two scale rows above the lateral line and on a diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin. Four scales were taken from each Chinook salmon, mounted on gummed cards, and pressed on acetate to make an impression. Chinook salmon scales were aged by the U.S. Fish and Wildlife Service (Service) whereas steelhead scales will be forwarded to the Department's Trout Research Program in Juneau for age determinations once an adequate sample is achieved. Scale analysis and reporting utilize methods described by Mosher (1969). Age determinations for Chinook salmon include the number of years spent in freshwater as a juvenile and the number of years spent in saltwater as an adult. Steelhead age determinations will denote the number of years spent in freshwater as a juvenile followed by the number of years spent in salt water as an adult prior to each spawning event. Spawning events are incorporated into the reporting methods described by Mosher (1969) and are denoted using the letter "S" (e.g. 3.2S1).

Data Analysis

Age and sex composition for the total escapement of Chinook salmon were estimated directly from the age and sex composition in the weekly sample using a stratified sampling design (Cochran 1977), with the escapement in each stratum as a weight. Age and sex specific escapements in a stratum, A_{hij}, and their variances, $V[A_{hij}]$, were estimated as:

$$\hat{A}_{hij} = N_h \hat{p}_{hij} \quad (1)$$

and

$$\hat{V}\left[\hat{A}_{hij}\right] = \hat{N}_h^2\left(1-\frac{n_h}{N_h}\right)\left(\frac{\hat{p}_{hij}\left(1-\hat{p}_{hij}\right)}{n_h-1}\right) \quad (2)$$

where

N_h = total escapement during stratum *h*;
$\hat{p}_{hij}$ = estimated proportion of age *i* and sex *j* fish, of a given species, in the stratum *h*; and
n_h = total number of fish, of a given species, in the sample for stratum *h*.

Abundance estimates and their variances for each stratum were summed to estimate age and sex-specific escapements for the season as follows:

$$\hat{A}_{ij} = \sum_h \hat{A}_{hij} \quad (3)$$

and

$$\hat{V}\left[\hat{A}_{ij}\right] = \sum_h \hat{V}\left(\hat{A}_{hij}\right) \quad (4)$$

Results

Weir and Video Operations

The weir and video system was installed on 1 May and operated through 17 August. Video counts began at 1530 hours on 1 May. The video system and weir ran smoothly during the entire operational period, although the installation was delayed due to ice conditions during late April. Fish counts were not estimated during this period.

Biological Data

*Steelhead. —*A total of 172 steelhead was counted through the video system in the Funny River between 1 May and 9 June (Figure 2; Appendix 2). Peak weekly passage (*N*=96) took place between 3 and 9 May (Figure 2). The highest daily count occurred on 2 May (*N*=22), whereas the median cumulative passage occurred on 6 May. The number of steelhead counted after 13 May only represented 6% (*N*=10) of the total escapement (Figure 2; Appendix 2).

Sex composition of steelhead was determined primarily by reviewing video records and included 1 ASL sample. Female steelhead comprised 70% of the run and were dominant throughout the entire return (Figure 3, Appendix 2).

*Chinook salmon. —*A total of 1,114 Chinook salmon was counted through the video system at the Funny River weir between 8 June and 14 August (Figure 4; Appendix 3). Peak weekly passage (*N*=502) occurred between 28 June and 4 July. The highest daily count (*N*=118) and median cumulative passage occurred on 29 June and 4 July, respectively.

ASL samples were collected from 112 Chinook salmon between 11 June and 28 July. Four percent (*N*=5) of the sample could not be aged because of regeneration or the inability to

determine freshwater age. Of the aged scales, female Chinook salmon were comprised of three age groups, ages 1.3, 1.4 and 1.5 and males were comprised of five age groups, ages 1.1, 1.2, 1.3, 1.4 and 1.5 (Table 1). Overall, females averaged 798 mm in length and accounted for 42% (*N*=47) of the sample while males averaged 646 mm in length. Sex composition for the entire return of Chinook salmon including both ASL and video records was 34% female. Sex ratios favored males throughout most of the run (Figure 5).

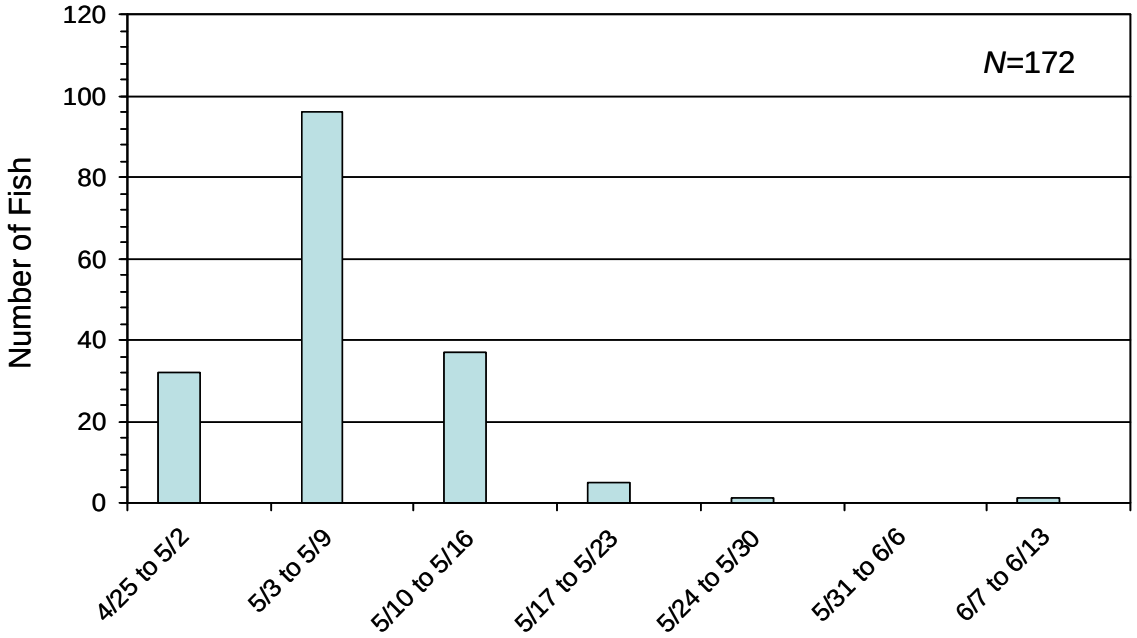

FIGURE 2. —Weekly escapement of adult steelhead passed through the Funny River weir during 2009. Video counts began mid-day on 1 May and ended mid-day on 17 August.

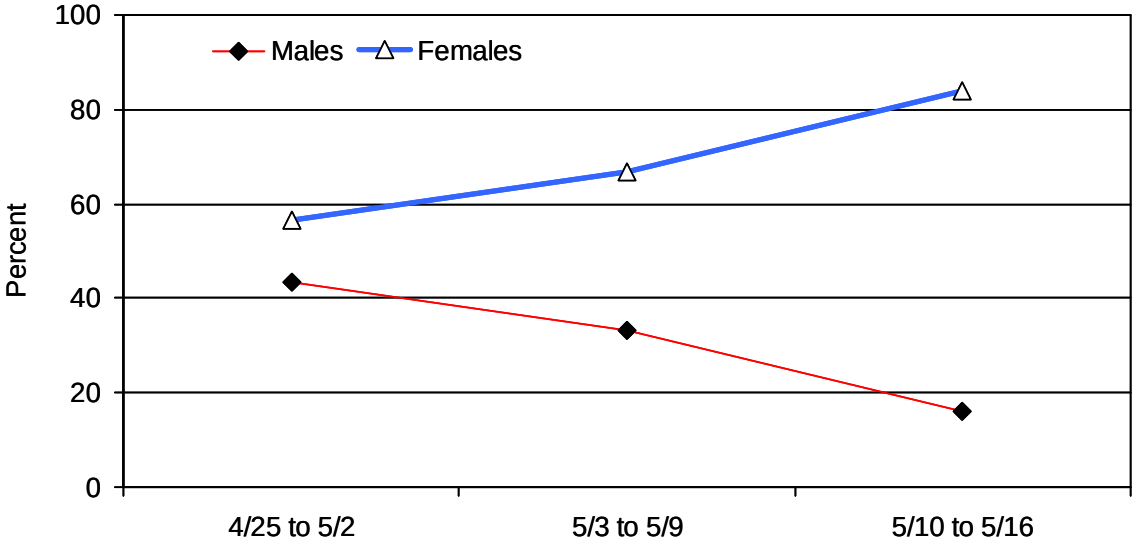

FIGURE 3. — Weekly percent of adult male and female steelhead observed during video review and ASL sampling at the Funny River weir from 1 May to 16 May, 2009. Steelhead observed after 16 May (*N*=7 females) were omitted from this figure.

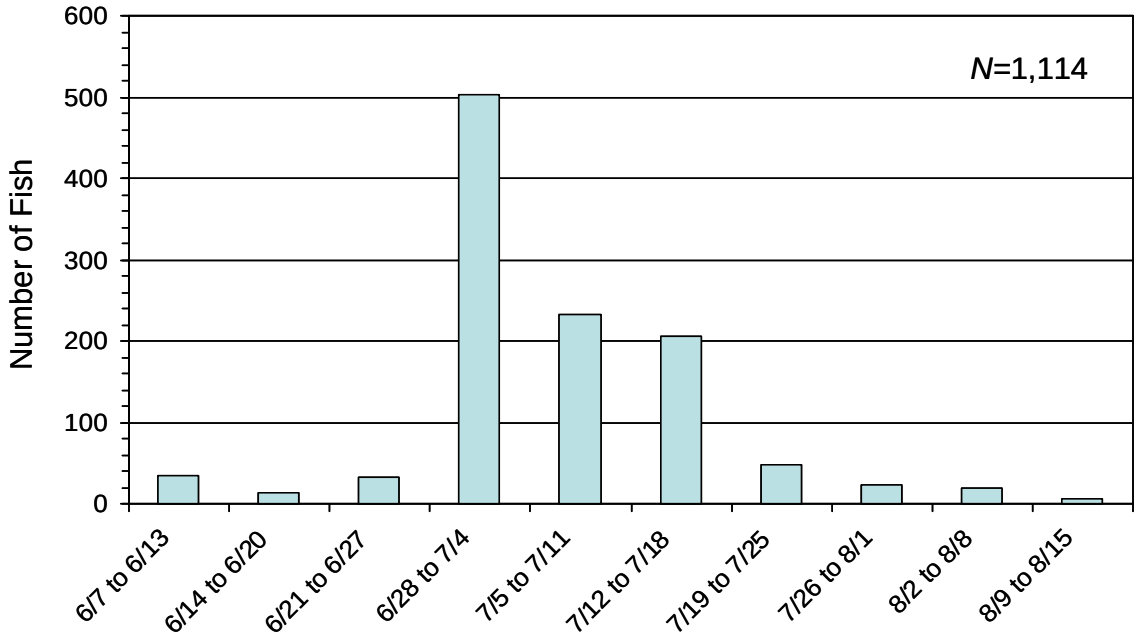

FIGURE 4. —Weekly escapement of adult Chinook salmon passed through the Funny River weir during 2009. Video counts began mid-day on 1 May and ended mid-day on 17 August.

TABLE 1. —Length-at-age for adult Chinook salmon sampled at the Funny River weir during 2009.

				Mid-Eye to Fork Length		
	Sex	Age	*N* [a]	Mean	Range	Standard Error
	Female	1.3	21	722	590 - 815	17.9
		1.4	22	863	615 - 945	13.5
		1.5	1	965	–	–
Total			44			
	Male	1.1	3	427	410 - 450	12.0
		1.2	32	572	485 - 640	7.5
		1.3	22	720	630 - 825	14.0
		1.4	5	866	795 - 925	24.8
		1.5	1	990	–	–
Total			63			

[a] Fish with incomplete age data were omitted from this table (*N*=5)

The age and sex composition was estimated for the entire return of Funny River Chinook salmon through further data analysis and was based upon the ASL sample. Females were comprised of age 1.3 (48%), 1.4 (50%) and 1.5 (2%) fish (Table 2). Males were comprised of age 1.1 (5%), 1.2 (51%), 1.3 (35%), 1.4 (8%) and 1.5 (2%) fish. Sex composition of the entire run was estimated to be 41% female (*N*=458) (Table 2).

Other species. —Eight additional species of fish were observed passing the Funny River weir and video system including 81 rainbow trout *O. mykiss*, 566 Dolly Varden *Salvelinus malma*, seven round whitefish *Prosopium cylindraceum*, six lamprey *Lampetra* spp., 10 sockeye salmon *O. nerka*, 339 pink salmon *O. gorbuscha*, two chum salmon *O. keta*, and six coho salmon *O. kisutch* (Appendix 4). Weekly passage of all non-target species is summarized in Table 3.

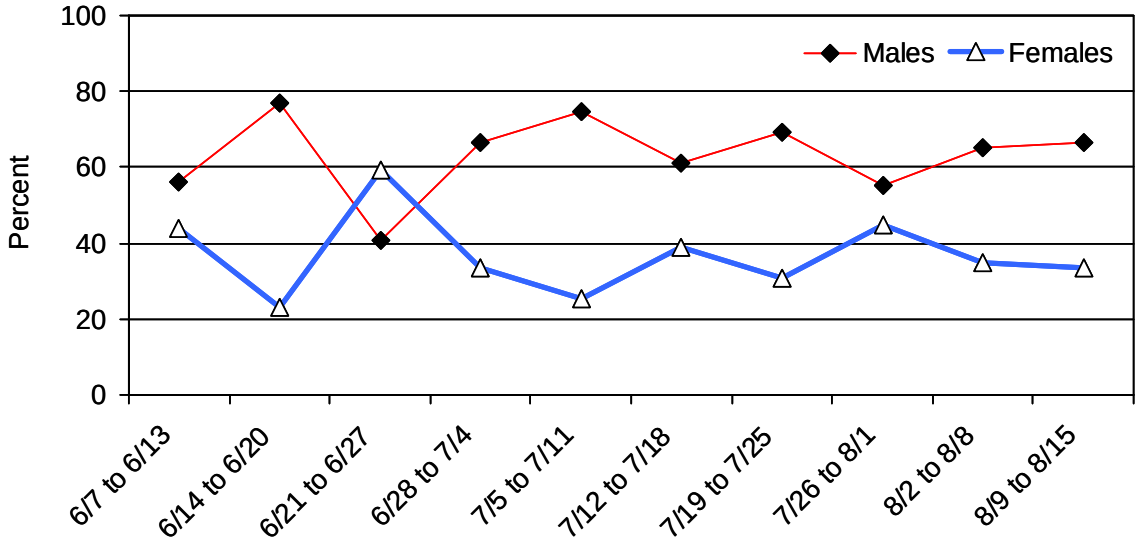

FIGURE 5. —Weekly percent of adult male and female Chinook salmon observed during video review and ASL sampling at the Funny River weir from 8 June to 14 August, 2009

TABLE 2. —Age and sex composition for the entire Funny River Chinook salmon return estimated from the age, sex, and length samples collected during 2009.

		Brood Year and Age Group					
		2006	2005	2004	2003	2002	
		1.1	1.2	1.3	1.4	1.5	Total
Sample Period: 11 June to 28 July							
Female:	Number in Sample:			21	22	1	44
	% Females in Age Group:			47.7	50.0	2.3	100.0
	Estimated % of Escapement:			19.6	20.6	0.9	41.1
	Estimated Escapement:			219	229	10	458
	Standard Error:			40.9	41.6	9.9	
Male:	Number in Sample:	3	32	22	5	1	63
	% Males in Age Group:	4.8	50.8	34.9	7.9	1.6	100.0
	Estimated % of Escapement:	2.8	29.9	20.6	4.7	0.9	58.9
	Estimated Escapement:	31	333	229	52	10	656
	Standard Error:	17.0	47.1	41.6	21.7	9.9	
Total:	Number in Sample:	3	32	43	27	2	107
	Estimated % of Escapement:	2.8	29.9	40.2	25.2	1.9	100.0
	Estimated Escapement:	31	333	448	281	21	1,114
	Standard Error:	17.0	47.1	50.4	44.7	13.9	

TABLE 3. —Weekly passage of non-target fish species observed at the Funny River weir during 2009. Video counts began mid-day on 1 May and ended mid-day on 17 August.

Week	Rainbow Trout	Dolly Varden	Round Whitefish	Lamprey spp.	Sockeye Salmon	Pink Salmon	Chum Salmon	Coho Salmon
4/26 to 5/2	9	0	0	0	0	0	0	0
5/3 to 5/9	21	0	0	1	0	0	0	0
5/10 to 5/16	5	0	1	2	0	0	0	0
5/17 to 5/23	21	0	0	2	0	0	0	0
5/24 to 5/30	8	2	1	0	0	0	0	0
5/31 to 6/6	3	2	1	0	0	0	0	0
6/7 to 6/13	0	1	1	0	0	0	0	0
6/14 to 6/20	1	5	0	0	0	0	0	0
6/21 to 6/27	6	3	0	0	0	0	0	0
6/28 to 7/4	3	33	0	0	0	0	0	0
7/5 to 7/11	0	28	0	0	1	0	0	0
7/12 to 7/18	1	38	1	0	5	6	1	0
7/19 to 7/25	0	47	0	0	1	5	0	0
7/26 to 8/1	1	48	2	0	2	87	1	0
8/2 to 8/8	2	122	0	0	0	166	0	2
8/9 to 8/15	0	195	0	1	1	64	0	2
8/16 to 8/22	0	42	0	0	0	11	0	2
Total	81	566	7	6	10	339	2	6

Discussion

We feel that the estimates of 1,114 Chinook salmon and 172 steelhead represent the relative run strength of these species in the Funny River. The weir and video system were fully operational by 1 May. An earlier installation was anticipated but was not possible due to ice conditions in the river. Steelhead were observed passing the weir immediately following installation, suggesting that the spawning migration had started before the weir was installed. The high percentage of females during the first week of the return and the overall skewed sex ratio of females to males (2.3:1) also indicate that the steelhead migration was already in progress. Observations of other steelhead populations on the Kenai Peninsula show that early stages of steelhead spawning migrations are generally comprised of males (Gates and Palmer 2006, 2008b; Gates and Boersma 2009b). However, Gates and Boersma (2009a) documented a similar sex ratio (2.2:1 females to males) for steelhead in the Funny River during 2008 when the weir was thought to be operational prior to the steelhead spawning migration. The mechanisms driving these sex ratios in the Funny River are not well understood; however, installing the weir and video equipment earlier might document a sex ratio less skewed towards females and determining the age composition and spawning histories of steelhead through scale analysis may provide additional knowledge. No attempt was made to estimate escapement using information previously collected prior to 1 May for steelhead because recorded escapement information during this period is minimal. We do not believe that estimating this portion of the return would have substantially affected the overall numbers. We are planning to monitor and sample steelhead returning to the Funny River during 2010. Our ASL and genetic tissue sampling goals will be at least 50 steelhead. The scale and genetic tissue samples will be processed by the Department and the Service's Conservation Genetics Laboratory, respectively.

Preliminary escapement and in-river harvest estimates for early-run Chinook salmon during 2009 from Warren Ames Bridge to Soldotna Bridge were 11,334 and 898, respectively (Jeff Perschbacher, Alaska Department of Fish and Game, personal communication). Based on these estimates, approximately 10,436 early-run Chinook salmon escaped upstream of the Soldotna

Bridge to spawn. Sport harvest of early-run Chinook salmon above the Soldotna Bridge is estimated using the Statewide Harvest Survey. This information is not yet available; however, the estimated annual harvest in this reach over a 19-year period (1986 to 2004) has averaged 1,672 fish. Using the current year escapement obtained with the sonar in the lower Kenai River and harvest estimates for early-run Chinook salmon, we estimated that approximately 13% of the early-run fish entered the Funny River to spawn. This estimate is lower than what we observed in 2006 (15%) and 2007 (18%), but higher than 2008 (11%). These estimates of contribution are crude and could be off by several percentage points because the harvest above the Soldotna Bridge is likely below the 19 year average based on the low harvest numbers below the Soldotna Bridge during 2009. Regardless, this level of escapement into the Funny River is markedly lower than the 19% average observed from earlier radio telemetry studies conducted by the Service and Department in the early 1980's and 1990's (Burger et al. 1985; Bendock and Alexandersdottir 1991, 1992). The reduced contribution of Chinook salmon from the Funny River to the overall Kenai River early-run escapement during 2009 could be a result of several factors including natural variations in run strength, selective harvest in the in-river sport fishery, or an overestimation of the Kenai River early-run Chinook salmon escapement using the split-beam sonar near rkm 13. A mixed-stock genetic analysis of harvest could address any selective harvest occurring in the in-river sport fishery by identifying which stocks are being harvested spatially and temporally. The Department is currently developing a genetic baseline for Chinook salmon spawning groups in the Kenai River watershed, which will later identify the origins of harvested fish (Tim McKinely, Alaska Department of Fish and Game, personal communication). Several issues pertaining to the split-beam sonar remain unresolved; most importantly its inability to distinguish between salmon species during times of high passage rates (e.g. sockeye salmon vs. Chinook salmon). To address this concern, the Department plans to install two Dual-Frequency Identification Sonar's (DIDSON™) beginning in 2010, one on the North and South banks (Robert Begich, Alaska Department of Fish and Game, personal communication). The DIDSON's™ are expected to aid in the identification of multiple species because it operates at two frequencies resulting in high-definition images.

Age, sex and length information was collected from Funny River Chinook salmon between 11 June and 28 July. Our sample strategy coincided with the observed Chinook salmon run and included one additional age group (age 1.5) never previously observed in the Funny River. We feel that the identified age groups accurately represent the ages of Chinook salmon present in the Funny River during 2009 but the age and sex composition from the ASL sample may have been misrepresented. Greater numbers of small males were observed during video review in 2009 and appear to not have been accurately represented within the ASL sample. These fish are likely age 1.1 or 1.2 males which could have easily exited the fish trap downstream through the entry fyke. This could explain the greater percentage of females present in the ASL sample (42%) compared to the 34% observed when combining the ASL and video records. The mean length of male Chinook salmon sampled during 2009 was also the lowest recorded since 2006 which indicates that smaller males were present in greater numbers than in previous years. Overall, after combining the ASL sample and video records, we feel that the sex composition of 34% females is accurate and is similar to sex compositions observed between 2006 and 2008 (Gates and Palmer 2007, 2008a; Gates and Boersma 2009a).

Chinook salmon of like ages were identified in both the Kenai and Funny river ASL samples during 2009; however, dissimilar proportions of like-aged fish were observed (Table 4). The most prominent differences occur between the estimated proportion of age 1.2, 1.3, and 1.4 fish identified in the sonar passage and Funny River weir escapement. The reduced proportion of age

1.4 fish observed at the Funny River weir during 2009 compared to the estimated sonar passage could be partially explained by selective harvest in the in-river sport fishery; harvest was determined from an in-river creel survey and was estimated at 46% within the 1.4 age group (Jeff Perschbacher, Alaska Department of Fish and Game, personal communication). This selective harvest could consequently amplify the proportion of age 1.2 and 1.3 fish present in the Funny River sample indicating that sport harvest in the lower Kenai River potentially can affect the age and sex composition of the spawning escapement in the Funny River. Similar results were observed during 2006, 2007 and 2008 (Appendix 5). Run timing observed between 2006 and 2009 will be used to determine our ASL sampling strategy at the Funny River weir during 2010.

TABLE 4. —Estimated age composition of adult early-run Chinook salmon from the Funny River weir, Kenai River sonar and Kenai River creel survey during 2009.

	Age Groups				
2009	1.1	1.2	1.3	1.4	1.5
Estimated Funny River weir escapement					
Female			19.6%	20.6%	0.9%
Male	2.8%	29.9%	20.6%	4.7%	0.9%
Estimated Kenai River sonar passage[a]					
Female		0.8%	12.5%	32.8%	
Male	3.1%	14.1%	11.7%	23.4%	1.6%
Estimated Kenai River early-run harvest[a]					
Female			14.2%	30.1%	
Male	1.0%	19.2%	19.3%	16.2%	

[a] Jeff Perschbacher, Alaska Department of Fish and Game, personal communication.

In conclusion, installing the Funny River weir during early May and successfully operating it through 17 August resulted in an accurate estimate of escapement for early-run Chinook salmon and a conservative estimate for adult steelhead. The use of underwater video is an inexpensive and reliable method to estimate the abundance and run timing of Chinook salmon and steelhead in the Funny River. We are planning to continue operating the video weir during 2010. Information collected from the Funny River will be useful in formulating future management strategies for early-run Chinook salmon and steelhead in the Kenai River watershed.

Acknowledgements

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APPENDIX 1. —List of video equipment used to monitor Chinook salmon and steelhead abundance and run timing in the Funny River during 2009.

Item	Model #	Manufacturer	Contact
Digital Video Recorder	DVSM 4-120	Veltek International, Inc.	http://www.veltekcctv.com/
Underwater Camera	Model 10	Applied Micro Video	http://www.appliedmicrovideo.com/
Underwater Lights	Lunaqua 2 12-v	OASE	http://www.pondusa.com
External Harddrive	One Touch 500 GB	Maxtor.com	http://www.maxstore.com
400 Ah 6 Volt Battery	S-530	Rolls	http://www.rollsbattery.com/
Inverter/Charger	Prosine 2.0	Xantrex	http://www.xantrex.com

APPENDIX 2.—Daily counts of adult steelhead observed at the Funny River weir during 2009. Boxed areas represent the second and third quartile and median passage dates. Shaded areas represent periods when the fish trap was operated for age, sex, and length sampling of steelhead.

Date	Male	Female	Unknown Sex	Daily Total	Daily Cumulative	Cumulative Proportion
5/1	3	5	2	10	10	0.0581
5/2	10	12	0	22	32	0.1860
5/3	12	7	0	19	51	0.2965
5/4	3	4	0	7	58	0.3372
5/5	4	8	0	12	70	0.4070
5/6	5	12	0	17	87	0.5058
5/7	3	10	0	13	100	0.5814
5/8	2	10	0	12	112	0.6512
5/9	3	13	0	16	128	0.7442
5/10	2	8	0	10	138	0.8023
5/11	2	9	0	11	149	0.8663
5/12	1	6	0	7	156	0.9070
5/13	1	5	0	6	162	0.9419
5/14	0	1	0	1	163	0.9477
5/15	0	2	0	2	165	0.9593
5/16	0	0	0	0	165	0.9593
5/17	0	0	0	0	165	0.9593
5/18	0	0	0	0	165	0.9593
5/19	0	2	0	2	167	0.9709
5/20	0	1	0	1	168	0.9767
5/21	0	2	0	2	170	0.9884
5/22	0	0	0	0	170	0.9884
5/23	0	0	0	0	170	0.9884
5/24	0	0	0	0	170	0.9884
5/25	0	0	0	0	170	0.9884
5/26	0	0	0	0	170	0.9884
5/27	0	0	0	0	170	0.9884
5/28	0	0	0	0	170	0.9884
5/29	0	1	0	1	171	0.9942
5/30	0	0	0	0	171	0.9942
5/31	0	0	0	0	171	0.9942
6/1	0	0	0	0	171	0.9942
6/2	0	0	0	0	171	0.9942
6/3	0	0	0	0	171	0.9942
6/4	0	0	0	0	171	0.9942
6/5	0	0	0	0	171	0.9942
6/6	0	0	0	0	171	0.9942
6/7	0	0	0	0	171	0.9942
6/8	0	0	0	0	171	0.9942
6/9	0	1	0	1	172	1.0000
Total	51	119	2	172		

APPENDIX 3. —Daily counts of adult Chinook salmon observed at the Funny River weir during 2009. Boxed areas represent the second and third quartile and median passage dates. Shaded areas represent periods when fish trap was operated for age, sex, and length sampling.

Date	Male	Female	Daily Total	Daily Cumulative	Cumulative Proportion
6/1	0	0	0	0	0.0000
6/2	0	0	0	0	0.0000
6/3	0	0	0	0	0.0000
6/4	0	0	0	0	0.0000
6/5	0	0	0	0	0.0000
6/6	0	0	0	0	0.0000
6/7	0	0	0	0	0.0000
6/8	1	0	1	1	0.0009
6/9	6	6	12	13	0.0117
6/10	2	0	2	15	0.0135
6/11	1	3	4	19	0.0171
6/12	8	6	14	33	0.0296
6/13	0	1	1	34	0.0305
6/14	2	0	2	36	0.0323
6/15	0	0	0	36	0.0323
6/16	5	2	7	43	0.0386
6/17	0	0	0	43	0.0386
6/18	1	0	1	44	0.0395
6/19	3	1	4	48	0.0431
6/20	0	0	0	48	0.0431
6/21	0	2	2	50	0.0449
6/22	2	0	2	52	0.0467
6/23	1	0	1	53	0.0476
6/24	1	5	6	59	0.0530
6/25	0	1	1	60	0.0539
6/26	4	7	11	71	0.0637
6/27	5	4	9	80	0.0718
6/28	52	39	91	171	0.1535
6/29	68	50	118	289	0.2594
6/30	67	31	98	387	0.3474
7/1	54	26	80	467	0.4192
7/2	14	8	22	489	0.4390
7/3	39	8	47	536	0.4811
7/4	35	11	46	582	0.5224
7/5	43	9	52	634	0.5691
7/6	65	27	92	726	0.6517
7/7	8	3	11	737	0.6616
7/8	1	2	3	740	0.6643
7/9	31	7	38	778	0.6984
7/10	7	2	9	787	0.7065
7/11	19	8	27	814	0.7307
7/12	13	4	17	831	0.7460
7/13	29	16	45	876	0.7864
7/14	41	30	71	947	0.8501

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Date	Male	Female	Daily Total	Daily Cumulative	Cumulative Proportion
7/15	2	1	3	950	0.8528
7/16	8	7	15	965	0.8662
7/17	18	13	31	996	0.8941
7/18	13	10	23	1019	0.9147
7/19	8	5	13	1032	0.9264
7/20	3	1	4	1036	0.9300
7/21	11	3	14	1050	0.9425
7/22	1	0	1	1051	0.9434
7/23	2	1	3	1054	0.9461
7/24	5	3	8	1062	0.9533
7/25	3	1	4	1066	0.9569
7/26	2	1	3	1069	0.9596
7/27	3	3	6	1075	0.9650
7/28	5	2	7	1082	0.9713
7/29	0	1	1	1083	0.9722
7/30	1	1	2	1085	0.9740
7/31	0	1	1	1086	0.9749
8/1	1	1	2	1088	0.9767
8/2	1	1	2	1090	0.9785
8/3	3	1	4	1094	0.9820
8/4	3	3	6	1100	0.9874
8/5	1	1	2	1102	0.9892
8/6	1	0	1	1103	0.9901
8/7	3	1	4	1107	0.9937
8/8	1	0	1	1108	0.9946
8/9	0	0	0	1108	0.9946
8/10	1	0	1	1109	0.9955
8/11	1	2	3	1112	0.9982
8/12	1	0	1	1113	0.9991
8/13	0	0	0	1113	0.9991
8/14	1	0	1	1114	1.0000
8/15	0	0	0	1114	1.0000
8/16	0	0	0	1114	1.0000
8/17	0	0	0	1114	1.0000
Total	731	383			

APPENDIX 4. —Daily counts of non-target fish species passing through the Funny River weir during 2009. Shaded areas represent periods when the fish trap was operated for age, sex, and length sampling of Chinook salmon and steelhead.

Date	Rainbow Trout	Dolly Varden	Round Whitefish	Lamprey spp.	Sockeye Salmon	Pink Salmon	Chum Salmon	Coho Salmon
5/1	2	0	0	0	0	0	0	0
5/2	7	0	0	0	0	0	0	0
5/3	4	0	0	1	0	0	0	0
5/4	3	0	0	0	0	0	0	0
5/5	1	0	0	0	0	0	0	0
5/6	2	0	0	0	0	0	0	0
5/7	3	0	0	0	0	0	0	0
5/8	3	0	0	0	0	0	0	0
5/9	5	0	0	0	0	0	0	0
5/10	0	0	0	0	0	0	0	0
5/11	2	0	0	0	0	0	0	0
5/12	2	0	1	0	0	0	0	0
5/13	1	0	0	1	0	0	0	0
5/14	0	0	0	0	0	0	0	0
5/15	0	0	0	1	0	0	0	0
5/16	0	0	0	0	0	0	0	0
5/17	0	0	0	1	0	0	0	0
5/18	5	0	0	1	0	0	0	0
5/19	2	0	0	0	0	0	0	0
5/20	2	0	0	0	0	0	0	0
5/21	0	0	0	0	0	0	0	0
5/22	8	0	0	0	0	0	0	0
5/23	4	0	0	0	0	0	0	0
5/24	2	0	0	0	0	0	0	0
5/25	2	0	0	0	0	0	0	0
5/26	2	0	1	0	0	0	0	0
5/27	0	1	0	0	0	0	0	0
5/28	0	1	0	0	0	0	0	0
5/29	1	0	0	0	0	0	0	0
5/30	1	0	0	0	0	0	0	0
5/31	0	1	0	0	0	0	0	0
6/1	1	1	0	0	0	0	0	0
6/2	0	0	0	0	0	0	0	0
6/3	1	0	0	0	0	0	0	0
6/4	1	0	0	0	0	0	0	0
6/5	0	0	1	0	0	0	0	0
6/6	0	0	0	0	0	0	0	0
6/7	0	1	1	0	0	0	0	0
6/8	0	0	0	0	0	0	0	0
6/9	0	0	0	0	0	0	0	0
6/10	0	0	0	0	0	0	0	0
6/11	0	0	0	0	0	0	0	0
6/12	0	0	0	0	0	0	0	0
6/13	0	0	0	0	0	0	0	0

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Date	Rainbow Trout	Dolly Varden	Round Whitefish	Lamprey spp.	Sockeye Salmon	Pink Salmon	Chum Salmon	Coho Salmon
6/14	0	4	0	0	0	0	0	0
6/15	0	0	0	0	0	0	0	0
6/16	0	0	0	0	0	0	0	0
6/17	0	1	0	0	0	0	0	0
6/18	0	0	0	0	0	0	0	0
6/19	1	0	0	0	0	0	0	0
6/20	0	0	0	0	0	0	0	0
6/21	1	0	0	0	0	0	0	0
6/22	0	0	0	0	0	0	0	0
6/23	0	0	0	0	0	0	0	0
6/24	0	0	0	0	0	0	0	0
6/25	2	1	0	0	0	0	0	0
6/26	1	1	0	0	0	0	0	0
6/27	2	1	0	0	0	0	0	0
6/28	0	3	0	0	0	0	0	0
6/29	0	9	0	0	0	0	0	0
6/30	0	0	0	0	0	0	0	0
7/1	2	15	0	0	0	0	0	0
7/2	1	2	0	0	0	0	0	0
7/3	0	1	0	0	0	0	0	0
7/4	0	3	0	0	0	0	0	0
7/5	0	7	0	0	0	0	0	0
7/6	0	0	0	0	0	0	0	0
7/7	0	0	0	0	0	0	0	0
7/8	0	2	0	0	0	0	0	0
7/9	0	0	0	0	0	0	0	0
7/10	0	1	0	0	0	0	0	0
7/11	0	18	0	0	1	0	0	0
7/12	0	9	0	0	1	0	0	0
7/13	0	9	0	0	0	0	0	0
7/14	0	7	1	0	0	2	0	0
7/15	0	0	0	0	0	0	0	0
7/16	1	0	0	0	0	0	0	0
7/17	0	13	0	0	3	2	1	0
7/18	0	0	0	0	1	2	0	0
7/19	0	9	0	0	0	0	0	0
7/20	0	8	0	0	0	0	0	0
7/21	0	2	0	0	0	0	0	0
7/22	0	5	0	0	0	0	0	0
7/23	0	8	0	0	0	1	0	0
7/24	0	10	0	0	1	1	0	0
7/25	0	5	0	0	0	3	0	0
7/26	0	5	0	0	0	9	0	0
7/27	1	12	0	0	1	13	0	0

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APPENDIX 4. —(Page 3 of 3)

Date	Rainbow Trout	Dolly Varden	Round Whitefish	Lamprey spp.	Sockeye Salmon	Pink Salmon	Chum Salmon	Coho Salmon
7/28	0	4	1	0	0	13	0	0
7/29	0	4	1	0	0	14	0	0
7/30	0	9	0	0	0	12	1	0
7/31	0	3	0	0	1	14	0	0
8/1	0	11	0	0	0	12	0	0
8/2	0	4	0	0	0	25	0	0
8/3	0	21	0	0	0	46	0	1
8/4	0	33	0	0	0	20	0	0
8/5	2	9	0	0	0	18	0	0
8/6	0	6	0	0	0	21	0	0
8/7	0	35	0	0	0	21	0	0
8/8	0	14	0	0	0	15	0	1
8/9	0	12	0	0	0	12	0	0
8/10	0	9	0	1	1	13	0	0
8/11	0	58	0	0	0	12	0	0
8/12	0	20	0	0	0	2	0	0
8/13	0	27	0	0	0	6	0	0
8/14	0	42	0	0	0	6	0	1
8/15	0	27	0	0	0	13	0	1
8/16	0	24	0	0	0	6	0	1
8/17	0	18	0	0	0	5	0	1
Total	81	566	7	6	10	339	2	6

APPENDIX 5. —Age compositions of early-run Chinook salmon estimated for the Kenai and Funny River escapements and Kenai River harvest between Warren Ames and Soldotna bridges from 2006 to 2008.

	Age Groups						
2006	1.1	1.2	1.3	1.4	1.5	2.2	2.4
Estimated Funny River weir escapement[a]							
Female			9.1%	10.7%			
Male	6.6%	39.7%	26.4%	7.4%			
Estimated Kenai River sonar passage[b]							
Female		8.6%	8.6%	24.5%	1.5%		
Male	1.2%	22.9%	12.6%	18.0%	2.0%		
Estimated Kenai River early-run harvest[b]							
Female		1.9%	17.2%	32.5%			
Male	1.3%	14.7%	22.7%	9.7%			

	Age Groups						
2007	1.1	1.2	1.3	1.4	1.5	2.2	2.4
Estimated Funny River weir escapement[c]							
Female			16.4%	22.0%			
Male	0.5%	36.4%	17.8%	7.0%			
Estimated Kenai River sonar passage[b]							
Female		7.7%	18.6%	19.9%	0.9%		
Male		23.1%	16.7%	12.7%	0.1%	0.5%	
Estimated Kenai River early-run harvest[b]							
Female		2.7%	23.6%	15.5%	0.9%		
Male		17.3%	33.6%	6.4%			

	Age Groups						
2008	1.1	1.2	1.3	1.4	1.5	2.2	2.4
Estimated Funny River weir escapement[d]							
Female			23.8%	25.4%			
Male	0.8%	32.0%	14.8%	3.3%			
Estimated Kenai River sonar passage[b]							
Female		2.4%	20.7%	28.9%	0.6%		
Male		11.3%	21.4%	13.4%	0.6%		0.7%
Estimated Kenai River early-run harvest[b]							
Female			26.0%	22.3%	0.3%		
Male		11.4%	30.5%	9.6%			

[a] U.S. Fish and Wildlife Service, unpublished data.

[b] Jeff Perschbacher, Alaska Department of Fish and Game, personal communication.

[c] Gates and Palmer 2008a.

[d] Gates and Boersma 2009a.