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Abundance and Run Timing of Adult Chinook Salmon in the Funny River, Kenai Peninsula, Alaska, 2007

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Kenneth S. Gates and Douglas E. Palmer

Abstract

A fish weir equipped with an underwater video system was installed and operated in the Funny River during 2007 to collect abundance, run timing, and biological information on adult Chinook salmon *Oncorhynchus tshawytscha*. A total of 2,075 Chinook salmon was counted past the Funny River weir between 25 May and 4 August. Other species enumerated included 442 Dolly Varden *Salvelinus malma*, 18 pink salmon *O. gorbuscha*, 14 sockeye salmon *O. nerka*, 55 rainbow trout *O. mykiss*, and 15 round whitefish *Prosopium cylindraceum*. Peak weekly passage of Chinook salmon occurred between 15 and 21 July. Age, sex, and length (ASL) data were collected from 235 Chinook salmon. Sex of Chinook salmon was also determined by examining recorded video footage. Females comprised 35% (ASL and video combined) of the escapement. The average length of male and female Chinook salmon sampled was 702 mm and 866 mm, respectively. Ages of Chinook salmon determined from scale analysis ranged between 1.1 and 1.4. Females were comprised of only two age classes, 1.3 and 1.4.

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, while those entering the river after 30 June are managed as the late-run. 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 2004 (Pappas and Marsh 2004). These estimates provide the basis for estimating spawning escapement and implementing the management plan 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, while 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, 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

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80). Annual sport harvest has ranged between 899 and 15,209 fish and has averaged 5,963 fish since 1986 (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 the early-run Kenai River Chinook salmon. Bendock and Alexandersdottir (1991 and 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 subjective 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 four and five year old ocean fish, was enacted in 2002 to address the biological concern of fewer large and older fish present in the in-river sport fishery. In January 2005, an optimum escapement goal (OEG) range of 5,300 to 9,000 fish was adopted by the Alaska Board of Fisheries. The new OEG replaced the previous biological escapement goal (BEG) of between 7,200 and 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 or late arriving 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 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 a cooperative study between the Service and Department. Our study focused on early-run Chinook salmon returning to the Funny River. By using a resistance board weir in conjunction with an underwater video system, we were able to (1) enumerate adult Chinook salmon entering the Funny River, (2) determine the run timing of Chinook salmon entering the Funny River, and (3) estimate the age, sex and length composition of the Chinook salmon escapement in the Funny River. Information pertaining to the run size, timing, and age and sex composition of Chinook salmon returning to the Funny River will provide a better understanding of tributary spawners and assist managers in refining 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.

Methods

Weir and Video Operations and Design

The Service operated a resistance board weir and video system in the Funny River approximately 0.8 km above the intersection of Funny River Road and Funny River from 23 May through 5 August.

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 Palmer (2006a and 2006b) in Crooked and Nikolai creeks during 2005 and 2006, 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. 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 a removable 120 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 daily. The video box and fish passage chute were artificially lit using a pair of 12-volt underwater pond lights. Pond lights were equipped with 20-watt bulbs which provided a quality image. The lights 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. Appendix 1 contains a complete list of video equipment.

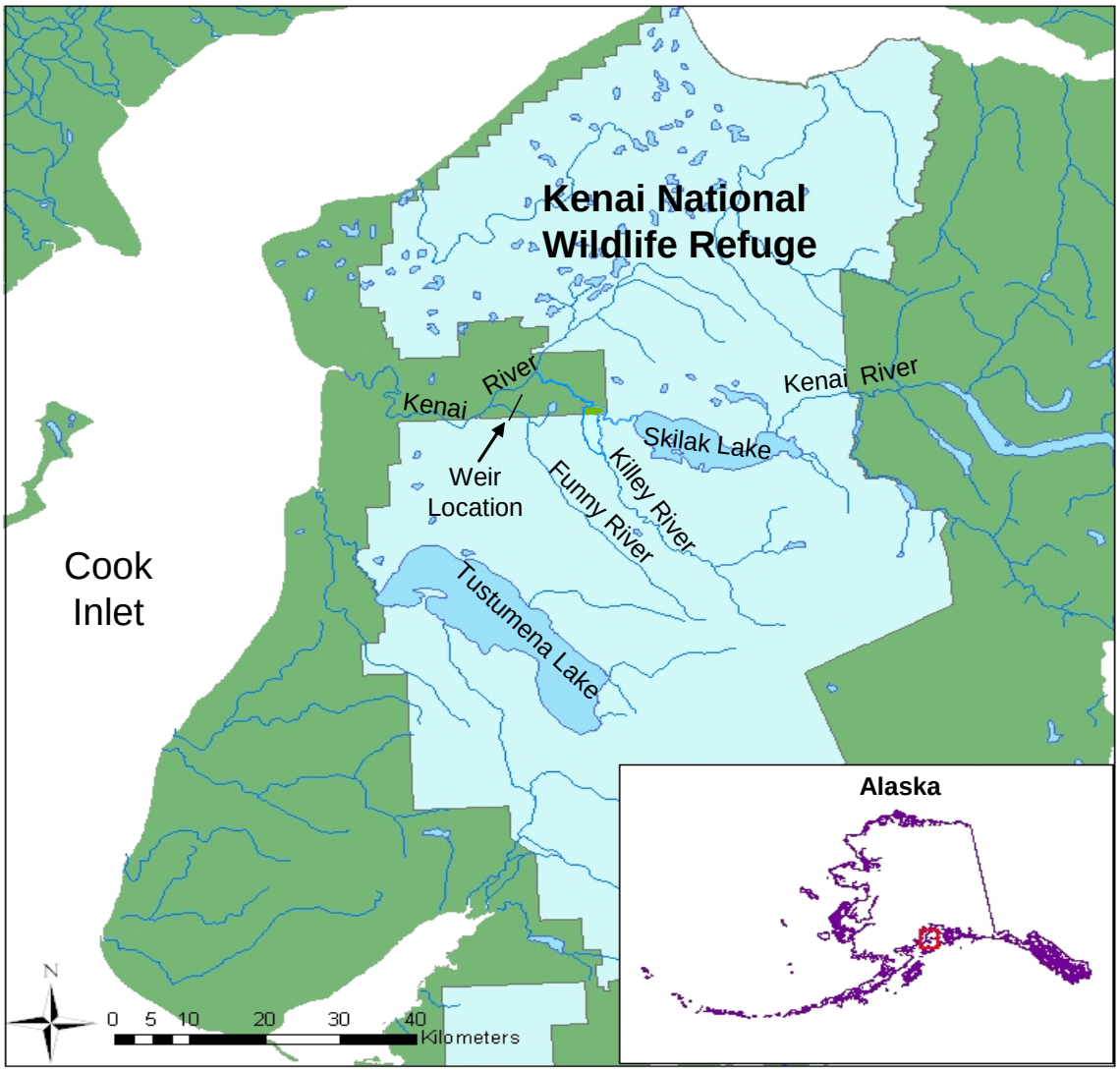

FIGURE 1. —Map of the Kenai River watershed showing weir location on Funny River.

Biological Sampling

Data on fish age, sex, and length (ASL) were collected using a temporally stratified sample design (Cochran 1977). Sampling effort was divided into strata and was based upon the 2006 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 consisted of sex determination, length measurements, and scale collections. Sex was determined by observing external characteristics. Length measurements were taken from the mid-eye to fork length to the nearest 5 mm. 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, pressed on acetate to make an impression and then viewed with a microfiche reader by the Department. Scale analysis and reporting utilize methods described by Mosher (1969). Age determination includes the number of years spent in freshwater as a juvenile and the number of years spent in saltwater as an adult.

Data Analysis: Age and sex composition for the total escapement 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 were installed on 22 and 23 May, respectively and operated through 5 August. Video counts began at 1300 hours on 23 May. The video system ran smoothly during the entire operational period except on 7 June and 10 to 13 July. A malfunction in software occurred early in the morning of 7 June and was discovered and repaired that afternoon. The second interruption of video recording occurred on 10 July during a power outage which ultimately caused the DVR to turn off. This was not discovered until 13 July during which time the DVR was restarted and remained operational through 5 August. Fish counts were incomplete during these time periods and no attempt was made to estimate passage.

Biological Data

Chinook salmon. —A total of 2,075 Chinook salmon was counted passing the video system at the Funny River between 25 May and 4 August (Figure 2; Appendix 2). Peak weekly passage (*N*=446) occurred between 15 and 21 July and median cumulative passage occurred on 1 July. The highest daily count (*N*=114) was on 17 June. Hatchery adipose-fin-clipped Chinook salmon from Cook Inlet watersheds other than the Kenai River comprised 0.3% (*N*=7) of the entire run.

ASL samples were collected from 235 Chinook salmon between 13 June and 26 July. Nine percent (*N*=21) of the collected scales could not be aged because of regeneration or the inability to determine freshwater age. Of the aged scales, female Chinook salmon were comprised of two age groups, ages 1.3 and 1.4. Males were comprised of four age groups, ages 1.1, 1.2, 1.3, and 1.4 (Table 1). Overall, females averaged 866 mm in length and accounted for 38% (*N*=90) of the sample while males averaged 702 mm in length. Sex composition for the entire return of Chinook salmon (*N*=2,072, *N*=3 unsexed passed upstream), including both ASL and video records, was 35% female (*N*=734). Sex ratios favored males throughout most of the run (Figure 3).

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 primarily age 1.4 (57%) fish (Table 2). Males were primarily comprised of age 1.2 (59%) fish followed by age 1.3 (29%). Sex composition of the entire run was estimated to be 38% female (*N*=795) (Table 2).

Other Species. —Five additional species of fish were passed through the weir and video system in the Funny River. Passage included 442 Dolly Varden *Salvelinus malma*, 18 pink salmon *O. gorbuscha*, 14 sockeye salmon *O. nerka*, 55 rainbow trout *O. mykiss*, and 15 round whitefish *Prosopium cylindraceum* (Appendix 3). Weekly passage of all species is summarized in Table 3.

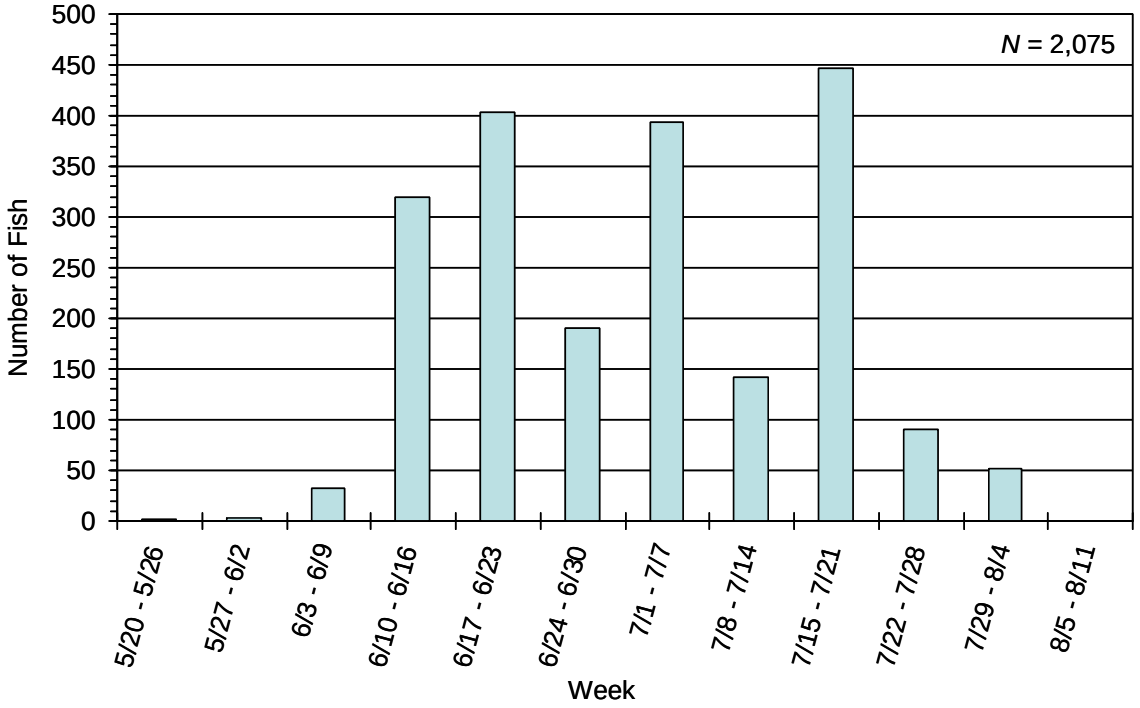

FIGURE 2. —Weekly escapement of Chinook salmon in the Funny River, Alaska, 2007. Video counts began mid-day on 23 May and ended mid-day on 5 August.

TABLE 1. —Length-at-age for Chinook salmon sampled at the Funny River weir, Alaska, 2007.

			Mid-Eye to Fork Length	
Sex	Age	*N* [a]	Mean	Range
Female	1.3	35	815	750 - 880
	1.4	47	906	840 -1030
Total		82		
Male	1.1	1	470	N/A
	1.2	78	617	520 - 745
	1.3	38	785	580 - 870
	1.4	15	944	855 - 1080
Total		132		

[a] Fish with incomplete age data were omitted from this table (*N*=21).

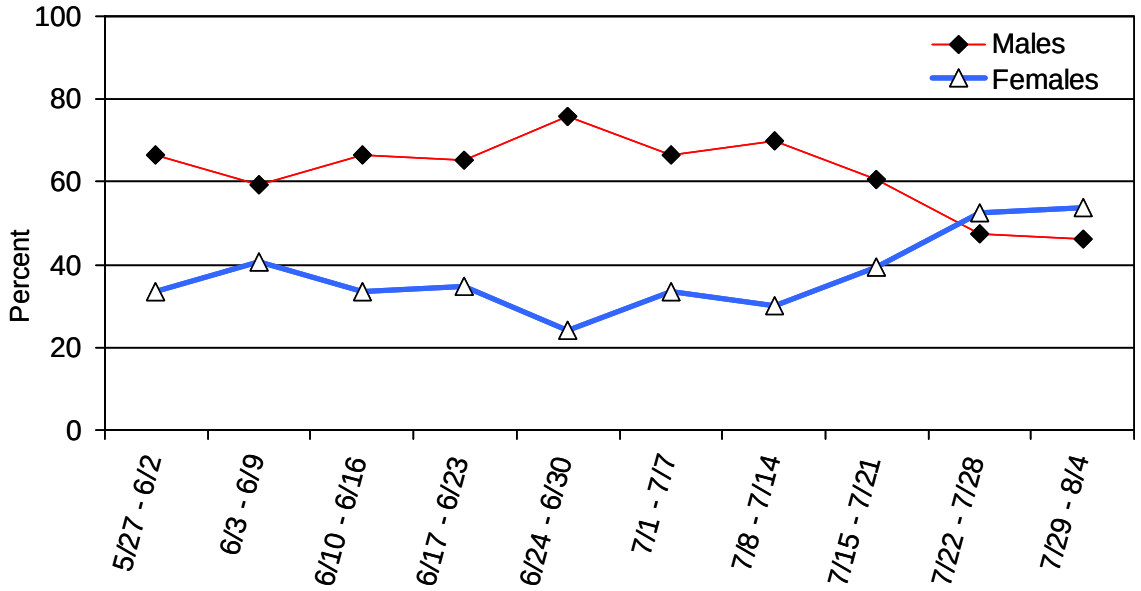

FIGURE 3. —Weekly percent of male and female Chinook salmon observed at the Funny River weir, Alaska, 2007. Data includes sex determinations from the video and ASL samples. One female Chinook salmon observed prior to 27 May was omitted from this figure.

TABLE 2. —Age and sex composition estimated for the entire Funny River Chinook salmon return, Alaska, 2007.

		Brood Year and Age Group				
		2004	2003	2002	2001	
		1.1	1.2	1.3	1.4	Total
Sample Period: 23 May to 5 August						
Female:	Number in Sample:			35	47	82
	% Females in Age Group:			42.7	57.3	100.0
	Estimated % of Escapement:			16.4	22.0	38.3
	Estimated Escapement:			339	456	795
	Standard Error:			49.8	55.7	
Male:	Number in Sample:	1	78	38	15	132
	% Males in Age Group:	0.8	59.1	28.8	11.4	100.0
	Estimated % of Escapement:	0.5	36.4	17.8	7.0	61.7
	Estimated Escapement:	10	756	368	145	1,280
	Standard Error:	9.2	64.8	51.5	34.4	
Total:	Number in Sample:	1	78	73	62	214
	Estimated % of Escapement:	0.5	36.4	34.1	29.0	100.0
	Estimated Escapement:	10	756	708	601	2,075
	Standard Error:	9.2	64.8	63.8	61.1	

TABLE 3. —Weekly passage of all species observed passing the weir and video system in the Funny River, Alaska, 2007.

Week	Rainbow Trout	Dolly Varden	Whitefish spp.	Sockeye Salmon	Pink Salmon	Chinook Salmon
5/20 to 5/26	9	0	1	0	0	1
5/27 to 6/2	5	5	6	0	0	3
6/3 to 6/9	9	5	4	0	0	33
6/10 to 6/16	8	7	2	0	0	319
6/17 to 6/23	5	8	1	2	0	404
6/24 to 6/30	3	15	0	3	0	190
7/1 to 7/7	10	21	0	3	3	394
7/8 to 7/14	0	25	1	0	0	142
7/15 to 7/21	5	74	0	2	2	446
7/22 to 7/28	0	54	0	0	0	91
7/29 to 8/4	1	217	0	4	13	52
8/5 to 8/11	0	11	0	0	0	0

Discussion

A total of 2,075 Chinook salmon was counted past the Funny River weir between 25 May and 4 August. We feel that these estimates of abundance accurately represent the relative run strength of Funny River Chinook salmon. The weir and video system were fully operational by 22 May which ensured that early arriving Chinook salmon would be enumerated. Software malfunction on the DVR and power outages caused lapses in video coverage on two occasions (7 June and 10 to 13 July). No attempt was made to estimate escapement for these periods because we do not believe that these estimates would have substantially affected our overall escapement. To avoid the potential effects of future power surges and outages, we are planning to install a large deep-cycle battery backup to prevent the video system from shutting down during these events.

The preliminary escapement and in-river harvest estimates between Warren Ames Bridge and Soldotna Bridge for early-run Chinook salmon during 2007 were 16,217 and 2,645, respectively (Anthony Eskelin, Alaska Department of Fish and Game, personal communication). Based on these estimates, approximately 13,572 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 an 18-year period (1986 to 2003) has averaged 1,731 fish. Using the current year escapement and harvest estimates for early-run Chinook salmon, we estimated that approximately 18% of the early-run fish entered the Funny River to spawn. Our 2007 estimate is slightly higher than what we observed in 2006 (15%). This level of escapement into the Funny River is similar to the 19% observed from combining all radio tagged early-run Chinook salmon from 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; Bendock and Alexandersdottir 1992).

Age, sex and length information was collected from Funny River Chinook salmon between 13 June and 26 July. We feel that our sample was representative of the entire run based on our sampling strategy and the observed Chinook salmon run-timing. Our sample during 2007 was comprised of the same age groups observed during 2006 and our estimated sex composition (Female=38%) was similar to what was observed during video review and ASL (Female=35%)

sampling. In addition, when comparing age by sex, fewer age groups were present in the 2007 Funny River sample than what was observed in the Department's inriver test-net fishery and creel survey (Table 4). Similar results were observed in 2006. Run timing observed during 2006 and 2007 will be used to determine our sampling strategy during 2008.

TABLE 4. — Age compositions of early-run Chinook salmon from the Funny River weir and Kenai River inriver test-net fishery and creel survey, 2007.

	Age Groups				
Sample Location	1.1	1.2	1.3	1.4	1.5
Funny River Weir					
Female			X	X	
Male	X	X	X	X	
Inriver Test-Net Fishery					
Female		X	X	X	X
Male		X	X	X	X
Inriver Creel Survey					
Female		X	X	X	X
Male	X	X	X	X	

In conclusion, installing the Funny River weir during late May and successfully operating it through 5 August resulted in an accurate estimate of early-run Chinook salmon. The use of underwater video in the Funny River to estimate the abundance and run-timing of adult salmon and resident species has been relatively inexpensive and reliable. We plan to continue monitoring the return of early-run Chinook salmon to the Funny River during 2008. Weather conditions permitting in the spring of 2008, the weir may be installed and operational by 20 April to provide an assessment of run-timing, abundance, and sex composition of spawning rainbow trout. Information collected from the Funny River weir and video system will be useful in formulating future management strategies for early-run Chinook salmon and resident species in the Kenai River watershed.

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APPENDIX 1. —List of video equipment used to monitor Chinook salmon abundance in the Funny River, Alaska, 2007.

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 250 GB	Maxtor.com	http://www.maxstore.com

APPENDIX 2. —Daily counts, ASL samples, and cumulative proportion of Chinook salmon returning to Funny River during 2007. Included is hatchery adipose-fin-clipped Chinook salmon identified during video review and ASL sampling. Boxed areas represent the second and third quartile and median passage dates. Shaded areas represent periods of incomplete or no counts.

	Video			ASL				Ad-Clip						
Date	Male	Female	Unknown Sex	Male	Female	Male AD-Clip	Female Ad-Clip	Male	Female	Downstream Male	Downstream Female	Daily Total	Daily Cumulative	Cumulative Proportion
5/23	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0000
5/24	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0000
5/25	0	1	0	0	0	0	0	0	0	0	0	1	1	0.0005
5/26	0	0	0	0	0	0	0	0	0	0	0	0	1	0.0005
5/27	0	0	0	0	0	0	0	0	0	0	0	0	1	0.0005
5/28	2	1	0	0	0	0	0	0	0	0	0	3	4	0.0019
5/29	0	0	0	0	0	0	0	0	0	0	0	0	4	0.0019
5/30	0	0	0	0	0	0	0	0	0	0	0	0	4	0.0019
5/31	0	0	0	0	0	0	0	0	0	0	0	0	4	0.0019
6/1	0	0	0	0	0	0	0	0	0	0	0	0	4	0.0019
6/2	0	0	0	0	0	0	0	0	0	0	0	0	4	0.0019
6/3	1	0	0	0	0	0	0	0	0	0	0	1	5	0.0024
6/4	1	0	0	0	0	0	0	0	0	0	0	1	6	0.0029
6/5	2	2	0	0	0	0	0	0	0	0	0	4	10	0.0048
6/6	0	1	1	0	0	0	0	0	0	0	0	2	12	0.0058
6/7	2	0	0	0	0	0	0	0	0	0	0	2	14	0.0067
6/8	9	8	0	0	0	0	0	0	0	0	0	17	31	0.0149
6/9	4	2	0	0	0	0	0	0	0	0	0	6	37	0.0178
6/10	4	4	0	0	0	0	0	0	0	0	0	8	45	0.0217
6/11	40	24	0	0	0	0	0	0	0	0	0	64	109	0.0525
6/12	34	19	0	0	0	0	0	0	0	0	0	53	162	0.0781
6/13	8	7	0	26	10	0	0	0	0	-6	-1	44	206	0.0993
6/14	14	7	0	16	16	0	0	0	0	-4	-3	46	252	0.1214
6/15	23	8	1	0	0	0	0	0	0	0	0	32	284	0.1369
6/16	56	15	0	0	0	0	0	1	0	0	0	72	356	0.1716
6/17	70	43	0	0	0	0	0	1	0	0	0	114	470	0.2265
6/18	18	8	0	0	0	0	0	0	0	0	0	26	496	0.2390

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	Video			ASL				Ad-Clip						
Date	Male	Female	Unknown Sex	Male	Female	Male AD-Clip	Female Ad-Clip	Male	Female	Downstream Male	Downstream Female	Daily Total	Daily Cumulative	Cumulative Proportion
6/19	0	0	0	12	8	1	0	0	0	-1	-1	19	515	0.2482
6/20	50	17	0	12	6	0	0	0	0	-1	-1	83	598	0.2882
6/21	50	25	1	0	0	0	0	0	0	0	0	76	674	0.3248
6/22	45	32	0	0	0	0	0	0	0	0	0	77	751	0.3619
6/23	6	3	0	0	0	0	0	0	0	0	0	9	760	0.3663
6/24	1	1	0	0	0	0	0	0	0	0	0	2	762	0.3672
6/25	1	0	0	0	0	0	0	0	0	0	0	1	763	0.3677
6/26	1	0	0	0	1	0	0	0	0	0	0	2	765	0.3687
6/27	1	0	0	0	0	0	0	0	0	0	0	1	766	0.3692
6/28	29	6	0	0	0	0	0	0	0	0	0	35	801	0.3860
6/29	55	23	0	0	0	0	0	0	0	0	0	78	879	0.4236
6/30	56	15	0	0	0	0	0	0	0	0	0	71	950	0.4578
7/1	63	49	0	0	0	0	0	0	0	0	0	112	1062	0.5118
7/2	5	0	0	15	9	0	0	0	0	-2	0	27	1089	0.5248
7/3	0	0	0	6	3	0	1	0	0	-2	-2	6	1095	0.5277
7/4	18	10	0	0	0	0	0	0	1	0	0	29	1124	0.5417
7/5	54	17	0	0	0	0	0	0	0	0	0	71	1195	0.5759
7/6	73	33	0	0	0	0	0	0	0	0	0	106	1301	0.6270
7/7	32	11	0	0	0	0	0	0	0	0	0	43	1344	0.6477
7/8	7	0	0	0	0	0	0	0	0	0	0	7	1351	0.6511
7/9	12	0	0	19	4	0	0	0	0	-1	-2	32	1383	0.6665
7/10	0	4	0	14	14	0	0	0	0	-1	-3	28	1411	0.6800
7/11	0	0	0	0	0	0	0	0	0	0	0	0	1411	0.6800
7/12	0	0	0	0	0	0	0	0	0	0	0	0	1411	0.6800
7/13	30	19	0	0	0	0	0	0	0	0	0	49	1460	0.7036
7/14	19	7	0	0	0	0	0	0	0	0	0	26	1486	0.7161
7/15	40	19	0	0	0	0	0	0	0	0	0	59	1545	0.7446
7/16	2	0	0	5	2	0	0	0	0	0	-1	8	1553	0.7484
7/17	21	11	0	11	7	0	0	0	0	-1	0	49	1602	0.7720
7/18	57	34	0	0	0	0	0	1	0	0	0	92	1694	0.8164

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	Video			ASL				Ad-Clip						
Date	Male	Female	Unknown Sex	Male	Female	Male AD-Clip	Female Ad-Clip	Male	Female	Downstream Male	Downstream Female	Daily Total	Daily Cumulative	Cumulative Proportion
7/19	66	34	0	0	0	0	0	0	1	0	0	101	1795	0.8651
7/20	48	41	0	0	0	0	0	0	0	0	0	89	1884	0.9080
7/21	20	28	0	0	0	0	0	0	0	0	0	48	1932	0.9311
7/22	7	12	0	0	0	0	0	0	0	0	0	19	1951	0.9402
7/23	7	9	0	0	0	0	0	0	0	0	0	16	1967	0.9480
7/24	0	0	0	4	6	0	0	0	0	0	0	10	1977	0.9528
7/25	1	0	0	2	2	0	0	0	0	0	0	5	1982	0.9552
7/26	3	5	0	2	1	0	0	0	0	0	0	11	1993	0.9605
7/27	11	8	0	0	0	0	0	0	0	0	0	19	2012	0.9696
7/28	6	5	0	0	0	0	0	0	0	0	0	11	2023	0.9749
7/29	2	9	0	0	0	0	0	0	0	0	0	11	2034	0.9802
7/30	8	15	0	0	0	0	0	0	0	0	0	23	2057	0.9913
7/31	3	2	0	0	0	0	0	0	0	0	0	5	2062	0.9937
8/1	3	1	0	0	0	0	0	0	0	0	0	4	2066	0.9957
8/2	1	0	0	0	0	0	0	0	0	0	0	1	2067	0.9961
8/3	2	1	0	0	0	0	0	0	0	0	0	3	2070	0.9976
8/4	5	0	0	0	0	0	0	0	0	0	0	5	2075	1.0000
8/5	0	0	0	0	0	0	0	0	0	0	0	0	2075	1.0000

APPENDIX 3. —Daily counts of salmon and resident fish species passing through the Funny River weir, Alaska, 2007. Shaded areas represent a period of incomplete or no counts.

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

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Date	Rainbow Trout	Dolly Varden	Round Whitefish	Sockeye Salmon	Pink Salmon
7/5	2	6	0	0	0
7/6	3	3	0	0	1
7/7	1	8	0	0	0
7/8	0	8	0	0	0
7/9	0	7	1	0	0
7/10	0	0	0	0	0
7/11	0	0	0	0	0
7/12	0	0	0	0	0
7/13	0	3	0	0	0
7/14	0	7	0	0	0
7/15	0	3	0	0	0
7/16	1	3	0	0	0
7/17	0	2	0	0	0
7/18	3	22	0	1	0
7/19	1	4	0	0	0
7/20	0	21	0	0	2
7/21	0	19	0	1	0
7/22	0	9	0	0	0
7/23	0	9	0	0	0
7/24	0	0	0	0	0
7/25	0	1	0	0	0
7/26	0	0	0	0	0
7/27	0	20	0	0	0
7/28	0	15	0	0	0
7/29	1	28	0	0	1
7/30	0	51	0	0	4
7/31	0	21	0	3	3
8/1	0	44	0	0	2
8/2	0	14	0	0	2
8/3	0	14	0	1	0
8/4	0	45	0	0	1
8/5	0	11	0	0	0