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Stock Assessment of the Return of Late-Run Chinook Salmon to the Kenai River, 1992

by

S. L. Hammarstrom

October 1993

Alaska Department of Fish and Game

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ABSTRACT

The estimated total return of late-run chinook salmon *Oncorhynchus tshawytscha* to the Kenai River in 1992 was 42,027. This estimate does not include fish harvested in the recreational marine fishery near Deep Creek, which will be available later in 1993 from the statewide harvest survey postal questionnaire. The total harvest in the marine gill net fisheries, commercial drift and set, personal use set, subsistence set and dip net, and Kenaitze Indian educational set gill net fisheries was 11,713. The total inriver return of late-run chinook salmon estimated through hydroacoustic techniques was 30,314. The estimated angler-effort and harvest of the late-run recreational fishery were measured through a creel survey and were 187,415 angler-hours and 6,680 chinook salmon, respectively.

Release mortality from the recreational fishery was estimated at 308 fish. Spawning escapement (23,326) was estimated by subtracting total inriver fishing mortality from total inriver return and met spawning requirements stipulated in the management plan. The predominant age class of the commercial harvest, inriver return, and recreational harvest was age-1.4 fish.

Migratory timing models were used to project spawning escapement during the 1992 fishery. Some restrictions to the fishery were required to achieve escapement goals.

The 1993 late-run return is forecast at 49,696 fish (SE = 13,911).

Production from the 1984 brood did little better than replacement. However, production from the 1985 brood was 1.86 returning fish-per-spawner. Production from the 1986 brood will approximate replacement.

KEY WORDS: Kenai River, chinook salmon, *Oncorhynchus tshawytscha*, creel survey, effort, harvest, migratory timing, sibling ratios, brood tables.

INTRODUCTION

The largest freshwater recreational fishery in Alaska occurs in the Kenai River with an average of nearly 270,000 angler-days of effort each year from 1983-1991 (Mills 1984-1992). This represents approximately 15% of the state's recreational fishing effort. The majority of the angler-effort occurs in the section of the river between the Soldotna Bridge and Cook Inlet (Figure 1) during a fishery directed primarily at returning chinook salmon *Oncorhynchus tshawytscha* during May, June, and July.

It has been long recognized that the Kenai River has two stocks of chinook salmon: (1) an early run which enters the river from mid-May through June, and (2) a late run which enters the river from late June through early August (Burger et al. 1985, Bendock and Alexandersdottir 1992). Early-run fish are destined primarily for tributary spawning locations although some mainstem spawning also occurs. Late-run fish are destined almost exclusively for mainstem spawning locations. The focus of this report is the late run.

Prior to 1970, the recreational fishery in the Kenai River was comprised of shorebased anglers targeting sockeye salmon *O. nerka* in July and coho salmon *O. kisutch* in August and early September. In 1973, large numbers of anglers began experimenting with bouncing brightly colored terminal gear along the river bottom from a drifting boat. This technique had been used effectively by anglers fishing for chinook salmon on rivers in the Pacific Northwest. It proved to be a very effective method for catching chinook salmon on the Kenai River, and the fishery began to expand rapidly (Figure 2).

The Alaska Department of Fish and Game (ADF&G), Division of Sport Fish, initiated creel surveys for this fishery in 1974 to estimate the recreational harvest and effort. Harvest of chinook salmon in this fishery has been estimated since 1974 and the catch has been estimated since 1986 (Hammarstrom 1975-1981, 1988-1992, *In prep*; Hammarstrom and Larson 1982-1984, 1986; Hammarstrom et al. 1985; Conrad and Hammarstrom 1987).

A comprehensive stock assessment program was initiated in 1984. The inriver return has been estimated annually since 1984. Two methods have been employed: (1) a tag/recapture program from 1984-1990 (Hammarstrom and Larson 1986, Conrad and Larson 1987, Conrad 1988, Carlon and Alexandersdottir 1989, Alexandersdottir and Marsh 1990); and (2) a hydroacoustic (sonar) program from 1984-1992 (Burwen and Skvorc *In prep* 1989 data, Burwen and Skvorc *In prep* 1990 data, Burwen and Skvorc *In prep* 1991 data, Burwen and Skvorc *In prep* 1992 data). Since 1987, sonar has provided the best estimate of the inriver return. The tag/recapture project was last conducted in 1990. Since 1984, the inriver return has averaged 39,341 chinook salmon.

By 1988, continued growth of both early-run and late-run fisheries heightened both agency and public concerns that stocks were vulnerable to over-exploitation. In response to this concern, the Alaska Board of Fisheries (BOF) in 1988 adopted management plans for the early and late returns of chinook salmon to the Kenai River (McBride et al. 1989). These plans stipulate both: (1) specific escapement goals for which the fisheries in question will be managed, and (2) the manner in which selected fisheries will be managed in the event of a conservation shortfall. These fisheries have been

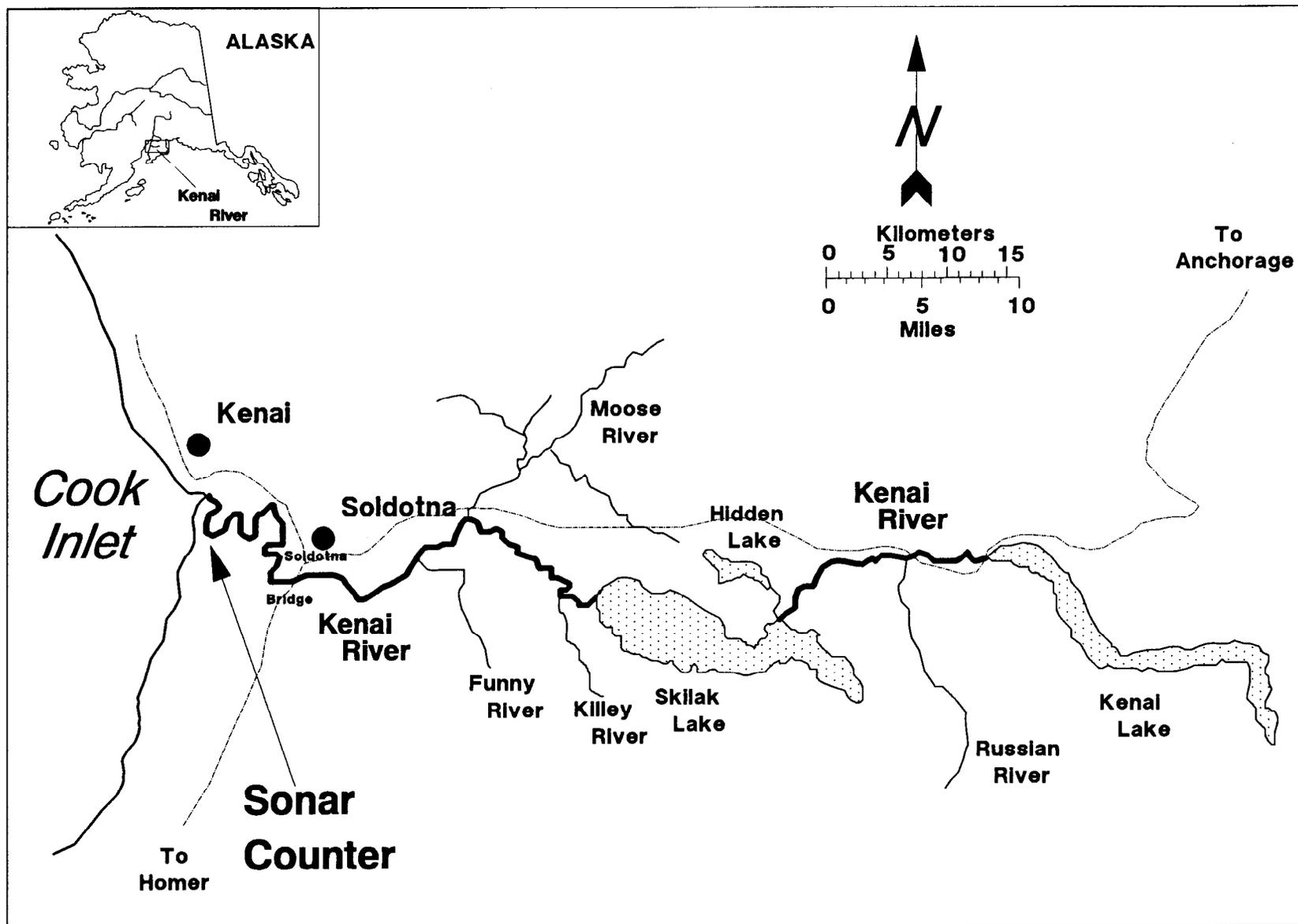


Figure 1. Map of Kenai River study area.

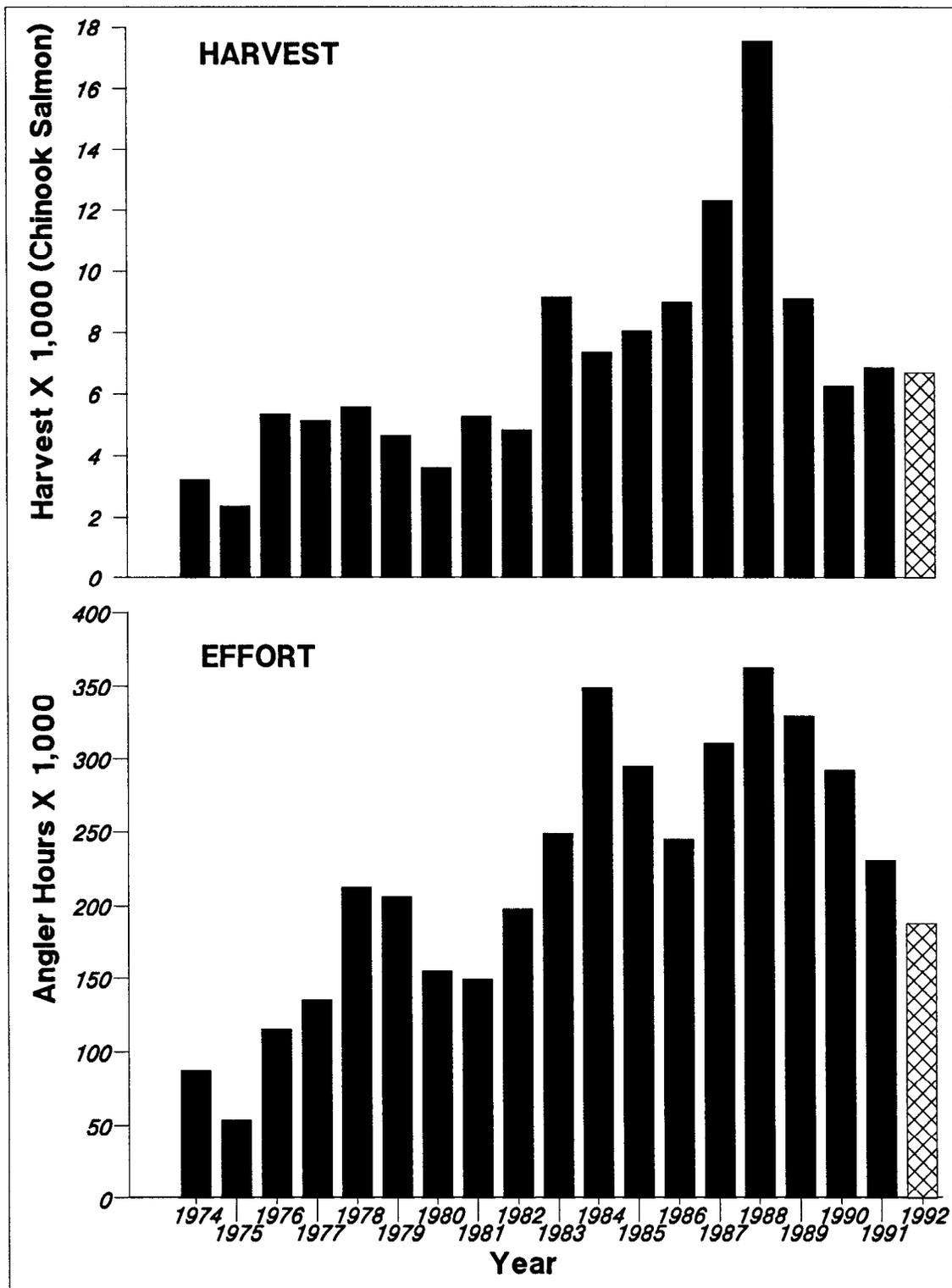


Figure 2. Historical harvest and effort in the recreational fishery for late-run chinook salmon, Kenai River, 1974-1992.

managed under the auspices of these management plans since 1989. The management plans were modified in 1990 by the BOF.

The objectives of the department's stock assessment program are twofold. First, return statistics are compiled to assess production and include estimates of harvest and abundance by age. Second, run timing is modeled to implement the escapement goal policy and includes migratory timing estimates of effort, harvest, and abundance.

In this report, I present statistics for the 1992 late-run return, including estimates of inriver return, fishery parameters, and escapement. These estimates are compared to historic performance and their application to the 1992 return is discussed. Finally, a forecast of the 1993 return is presented.

Details of the 1992 creel survey of the recreational fishery are reported by Hammarstrom (*In prep*). In addition, angler-effort and harvest by species for the recreational fishery have been estimated by Mills (1979-1992) via postal questionnaire. Rationale for the escapement goals and migratory timing data to implement the management plans are contained in McBride et al. (1989). Bendock and Alexandersdottir (1992) estimated hooking mortality for the Kenai River chinook salmon recreational fisheries. Estimates of total return by age have been summarized through 1990 by Sonnichsen and Alexandersdottir (1991).

METHODS

Fishing Regulations

The recreational fishery for late-run chinook salmon on the Kenai River begins 1 July and is conducted under the guidance of the Kenai River Late-Run King Salmon Management Plan. The late-run plan is depicted graphically in Figure 3 and presented in its entirety in Appendix A. The late-run management plan was amended by the BOF for implementation first during the 1991 season to provide for retention of large fish, 132 cm (52 in) or larger, if hook-and-release fishing was imposed. This provision is hereafter referred to as trophy fishing.

The regulations for the chinook salmon sport fishery in the Kenai River are the most restrictive of any in Alaska. Only the mainstem Kenai River between the outlet of Skilak Lake and Cook Inlet (Figure 1) is open to fishing for chinook salmon. By regulation, the season for chinook salmon is from 1 January through 31 July, but it effectively begins in mid-May when the fish first begin entering the river. The daily bag and possession limits are one chinook salmon per day greater than 41 cm (16 in) total length and a seasonal limit of two chinook salmon greater than 41 cm. Harvest of chinook salmon less than 41 cm is limited only by the daily bag limit of 10. In 1992, fishing from boats downstream from the outlet of Skilak Lake was prohibited on Mondays in July. Anyone retaining a chinook salmon that was 41 cm in length or greater was prohibited from fishing from a boat in the Kenai River for the remainder of that day.

There were further restrictions for anglers employing guides. In 1992, fishing from a guided boat was allowed only between 0600 and 1800 hours during July and only Tuesday through Saturday.

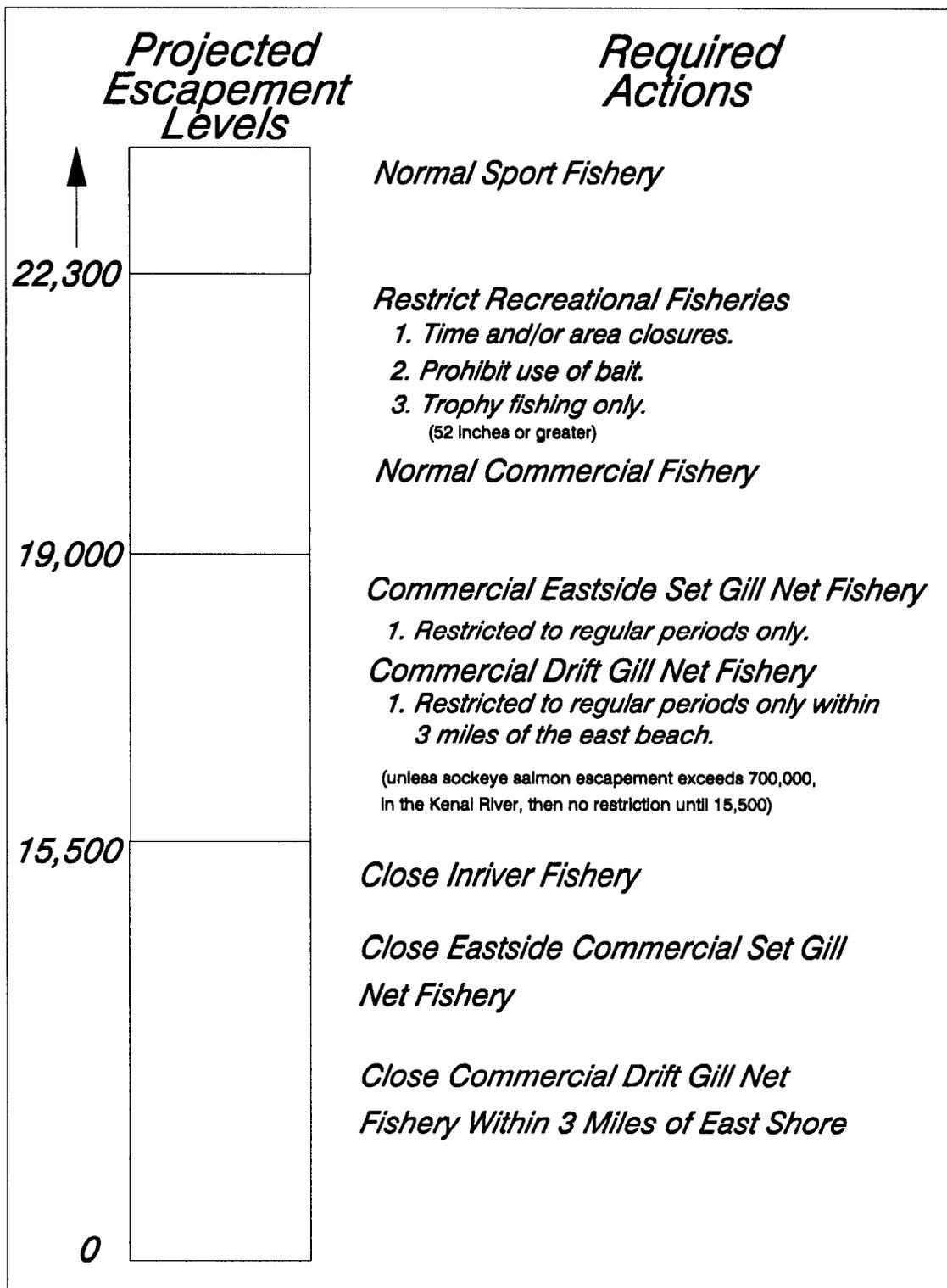


Figure 3. Escapement levels and required actions according to the Kenai River Late-Run King Salmon Management Plan.

In 1992, a subsistence gill net fishery, along with the Kenaitze tribal educational gill net fishery, was allowed in selected marine waters of Cook Inlet that harvested late-run chinook salmon of Kenai River origin. Additionally, a subsistence dip net fishery was allowed in the mouth of the Kenai River. These fisheries harvested chinook salmon incidentally to the other more abundant species of salmon, especially sockeye salmon *O. nerka*.

Stock Assessment

Late-run Kenai River chinook salmon are assessed at several locations on their spawning migration. Since the Kasilof River contains the only other population of late-run chinook salmon in Cook Inlet and they are believed to be much less abundant than the Kenai River population (McBride et al. 1985), chinook salmon harvested in the marine waters of Cook Inlet after 1 July are assumed to be of Kenai River origin. The first significant harvest occurs in the recreational marine fishery in the vicinity of Deep Creek. This harvest is estimated by postal questionnaire, the results of which are unavailable until the subsequent year (Mills 1979-1992). The estimates do not differentiate between early and late runs and thus the harvest is apportioned based on the historical average proportion as determined by creel survey work conducted onsite from 1973-1985 (Hammarstrom 1975-1981, Hammarstrom and Larson 1982-1984, 1986, Hammarstrom et al. 1985).

Additional harvest occurs in the commercial set gill net fishery along the eastern shore of Cook Inlet and to a lesser degree in the commercial drift gill net fishery. Total commercial harvest was determined from sales receipts (fish tickets) (ADF&G unpublished). Both of these commercial fisheries target sockeye salmon and the chinook salmon harvest is bycatch. The conduct of the commercial fisheries falls under the auspices of the Upper Cook Inlet Salmon Management Plan.

A single net educational fishery for members of the Kenaitze Indian tribe has been authorized since 1989 and total harvest was reported to the department per the terms of the permit. In 1992, a subsistence gill net and dip net fishery was authorized by the BOF. Individuals participating in the subsistence fishery were required to report their harvest on the permit which had to be returned to the department at the end of the season.

Of critical importance is estimating the age, sex, and size composition of the inriver return. Prior to 1991, scale samples collected from chinook salmon captured with large mesh gill nets for the tag/recapture study provided the samples for this analysis. Details of this program and the study design appear in Conrad and Larson 1987, Conrad 1988, Carlon and Alexandersdottir 1989, and Alexandersdottir and Marsh 1990. In 1990, the tagging program was discontinued. However, gill net sampling was still conducted in the lower river to collect age, sex, and length data. In combination with sonar data, these data provided estimates of the numbers of chinook salmon by age, sex, and size entering the river.

The commercial harvest in Cook Inlet is sampled for age, sex, and size composition by the Commercial Fish Division of ADF&G as described by Waltemyer *In prep*. These data provide estimates of the numbers of chinook salmon by age, sex, and size in the commercial set gill, drift gill net, and subsistence gill net and dip net harvest.

The age, sex, and size composition of the sport harvest is estimated from samples collected during angler interviews as part of the creel survey (Hammarstrom 1992). The result of the creel survey is an estimate of the number of fish by age and sex removed from the inriver system as a result of recreational fishing.

Bendock and Alexandersdottir (1992) estimated the release mortality of late-run fish at 13.2% for small males (< 750 mm), 5.0% for large males (> 750 mm), and 5.0% for females. However, it is not possible to measure the size or sex composition of the release component. Therefore, I used the grand average of their experiments on late-run fish to compute a single estimate of the release mortality at 8.3%. This approach introduces an unknown bias because of the higher mortality for small males and the tendency of anglers to release smaller fish. Age, sex, and size composition of the fish that were released and died was assumed equal to that of the inriver return.

To clarify terms, inriver return refers to all fish that are counted past the sonar in the Kenai River. Total return refers to all late-run Kenai River chinook salmon harvested in upper Cook Inlet marine fisheries plus the inriver return. Escapement (fish that survive all fisheries and are potential spawners) is estimated by subtracting total mortalities from the recreational fishery (harvest plus hook-and-release mortalities) from the inriver return.

Brood and Sibling Relationships

Chinook salmon in the Kenai River are managed to achieve optimum sustained production. In 1988, the escapement requirements to sustain levels of production realized during the years 1984 to 1988 were estimated and were based on limited information from the Kenai River and the experience of other researchers working with chinook salmon on the North American west coast (McBride et al. 1989). Total return data are being compiled to assess production and refine these escapement goals. Analysis of production from any escapement requires assimilation of returns by age class from that brood. Classic analysis of production from various levels of escapement will require data that span decades. For Kenai River chinook salmon, assessment of any year's spawning escapement requires annual return data out to 8 years of age.

A predictable relationship between consecutive-year returns of the same brood (i.e., sibling relationships) has been established for the late run (Sonnichsen and Alexandersdottir 1991). Estimation of sibling ratios (the ratio of one age to one or more younger ages in a brood year) was used to forecast expected returns for future years. By using mean sibling ratios of those years for which complete return data are available, models were developed to predict the returns for 1990-1992. These models were updated with the analysis of the 1992 return and a forecast for the 1993 return was developed using similar methodology described by Sonnichsen and Alexandersdottir (1991).

Migratory Timing

The following databases were used to estimate the annual migratory timing of the late-run chinook salmon return to the Kenai River: (1) inriver return, measured by daily gill net CPUE for 1984 to 1986 and by daily sonar counts for 1987 to 1991; and (2) inriver recreational fishery statistics to include effort, harvest per hour (HPUE), catch per hour (CPUE), harvest, and catch.

Historic cumulative daily proportions of each of these statistics were used to generate migratory timing models of each parameter that were applied to 1992 data to predict the season-end value, as described in McBride et al. 1989. Cumulative daily proportions of the inriver return for the years 1985-1991 (1989 excluded due to abnormally early timing) were averaged to formulate the model that projected total inriver return for 1992 (Appendix B1). Cumulative daily proportions of recreational effort, HPUE, and CPUE for the years 1984-1991 were used to generate the model that projected harvest and catch for 1992 (Appendices B2-B11).

On a daily basis, inriver return was projected by dividing the 1992 cumulative sonar count by the historic mean cumulative proportion through that same date. Similarly, harvest and catch were also projected. Escapement was projected by subtracting the projected fishing mortality (inriver harvest + hook-and-release mortality) from the projected inriver return. Although projections were made from the commencement of the fishery, precision of the estimates was insufficient to detect significant deviations from historic performance until mid July.

ASSESSMENT OF THE 1992 LATE RETURN OF CHINOOK SALMON TO THE KENAI RIVER

Recreational Marine Harvest

The harvest from the recreational marine fishery near Deep Creek has been estimated by postal questionnaire (Mills 1984-1992). The results from the 1992 fishery will not be available until late 1993. Harvest from the late run in this fishery has averaged approximately 1,000 chinook salmon annually.

Commercial Harvest

The commercial harvest in the set gill net fishery along the eastern shore of Cook Inlet was 10,718 fish. This is more than double the 1991 harvest and approximately 12% less than the 1984 to 1991 mean of 12,138.

The reported harvest of chinook salmon in the drift gill net fishery was 543 fish, well below the historical mean. A total of 50 chinook salmon was reported retained for personal use from the combined commercial set and drift gill net harvest.

A total of 688 fish with readable scales was sampled from the commercial set gill net harvest (Table 1). Most of the harvest was composed of age-1.4 fish (49.6%), followed by age-1.3 (27.6%), and -1.2 fish (15.0%).

Subsistence Harvest

In 1992, a total of seventeen 12-hour daily periods were open to subsistence fishing with set gill nets along the eastern beaches of Cook Inlet. Of these, 14 occurred after 1 July (9 in July, 2 in August, and 3 in September). Subsistence fishing with dip nets in the mouth of the Kenai River was allowed on 34 days (12-hour periods each), 28 after 1 July (11 in July, 9 in August and 8 in September). Additionally, the Kenaitze Indian Tribe conducted a single net educational fishery during the month of July and August under a

Table 1. Estimates by age class of the number of late-run chinook salmon harvested in the Upper Subdistrict commercial set and drift gill net fisheries, personal use/subsistence fisheries, and educational fisheries, Upper Cook Inlet, Alaska, 1992.

	Age Class								Total
	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	
Males									
Sample Size	11	71	124	2	215	5	19	0	447
Percent	1.6	10.3	18.0	0.3	31.3	0.7	2.8	0	65.0
SE Percent	0.5	1.2	1.5	0.2	1.8	0.3	0.6	0	1.8
Harvest	187	1,209	2,111	34	3,660	85	324	0	7,610
SE Harvest	56	136	172	24	207	38	73	0	213
Females									
Sample Size	6	32	66	2	126	1	7	1	241
Percent	0.9	4.7	9.6	0.3	18.3	0.1	1.0	0.1	35.0
SE Percent	0.4	0.8	1.1	0.2	1.5	0.1	0.4	0.1	1.8
Harvest	102	545	1,124	34	2,145	17	119	17	4,103
SE Harvest	42	94	132	24	173	17	45	17	213
Combined									
Sample Size	17	103	190	4	341	6	26	1	688
Percent	2.5	15.0	27.6	0.6	49.6	0.9	3.8	0.1	100.0
SE Percent	0.6	1.4	1.7	0.3	1.9	0.4	0.7	0.1	
Harvest	289	1,754	3,235	68	5,805	102	443	17	11,713
SE Harvest	69	159	200	34	223	42	85	17	

permit issued by the commissioner of Fish and Game. The combined late-run chinook salmon harvest from these fisheries was 402 fish.

Inriver Return

Sonar equipment was activated 16 May and operated continually through the early and late runs (Burwen and Skvorc *In prep* 1992 data). Inriver return from 1 July through 10 August was 30,314 fish (Table 2). The 1992 return was 12% smaller than the 1991 return and 25% smaller than the 1984 to 1991 mean of 40,469.

A total of 341 chinook salmon was captured in gill net test fishing during the late run (Table 3). There was a significant difference in the age composition between the first half of the run and the second half ($\chi^2 = 15.57$, $df = 3$, $P < 0.005$). The inriver return was comprised predominantly of age 1.4 (74.4%) followed by age class 1.3, 1.2, and 1.5 (16.0%, 7.3%, and 2.3%, respectively). The 1992 allocation of the total return by age along with the historical age composition (1986 to 1991) appears in Table 4.

Recreational Fishery

The 1992 recreational fishery for late-run chinook salmon started 1 July. Angler effort during the fishery for late-run chinook salmon was estimated at 187,415 angler-hours (SE = 6,808) (Hammarstrom *In prep*). Estimated harvest was nearly average at 6,680 (SE = 462) with an estimated catch of 10,394 (SE = 617). Anglers employing professional guides accounted for 63% of the harvest and 40% of the effort (Table 5).

A total of 201 fish with readable scales were sampled from the recreational harvest. There was no significant difference in age composition over time ($\chi^2 = 8.22$, $df = 4$, $P > 0.05$) between samples from the first and second half of July and samples were therefore combined. The majority of the harvest was age class 1.4 (76.1%) (Table 6). Historical comparison of the age composition of the late-run recreational harvest is presented in Table 7 (1976-1992).

Since 1986, the first year that estimates of total catch in the recreational fishery were available, an average of 28% of the catch has been released. In 1992, release mortality was estimated at 308 (SE = 130) fish. Historical hook-and-release mortality estimates are presented in Table 8. The age and sex composition of the hook-and-release mortality was assumed similar to that of the inriver return (Table 9).

Escapement and Total Return

Spawning escapement by age class was estimated by subtracting total inriver fishing mortality from the inriver return. In 1992, an estimated 23,326 (SE = 480) chinook salmon escaped all fisheries (Table 10). The majority (73.9%) of these spawners were age class 1.4. This age class has been the predominant spawning age class since 1986.

The total return of late-run chinook salmon to the Kenai River is the sum of the commercial, recreational, personal use and subsistence harvests plus the escapement (Table 11). The estimated total return of chinook salmon to the Kenai River in 1992 was 42,027

Table 2. Historical sonar counts of chinook salmon in the Kenai River during the late run, 1987-1992.

Date	1987		1988		1989		1990		1991		1992	
	Daily Counts	Cum Counts										
7/ 01	507	507	526	526	769	769	578	578	267	267	364	364
7/ 02	429	936	404	930	489	1,258	305	883	300	567	297	661
7/ 03	405	1,341	398	1,328	353	1,611	486	1,369	333	900	320	981
7/ 04	628	1,969	292	1,620	566	2,177	436	1,805	519	1,419	198	1,179
7/ 05	596	2,565	482	2,102	1,106	3,283	853	2,658	316	1,735	225	1,404
7/ 06	523	3,088	654	2,756	879	4,162	795	3,453	242	1,977	331	1,735
7/ 07	769	3,857	379	3,135	680	4,842	929	4,382	186	2,163	247	1,982
7/ 08	483	4,340	725	3,860	776	5,618	432	4,814	139	2,302	170	2,152
7/ 09	384	4,724	471	4,331	1,404	7,022	309	5,123	393	2,695	205	2,357
7/ 10	314	5,038	1,732	6,063	560	7,582	359	5,482	481	3,176	221	2,578
7/ 11	340	5,378	1,507	7,570	2,010	9,592	778	6,260	403	3,579	143	2,721
7/ 12	751	6,129	1,087	8,657	2,763	12,355	557	6,817	330	3,909	1,027	3,748
7/ 13	747	6,876	2,251	10,908	910	13,265	1,175	7,992	308	4,217	605	4,353
7/ 14	761	7,637	2,370	13,278	2,284	15,549	1,481	9,473	572	4,789	689	5,042
7/ 15	913	8,550	2,405	15,683	1,111	16,660	1,149	10,622	542	5,331	745	5,787
7/ 16	1,466	10,016	1,259	16,942	1,344	18,004	1,011	11,633	1,029	6,360	703	6,490
7/ 17	1,353	11,369	1,520	18,462	963	18,967	2,395	14,028	2,052	8,412	570	7,060
7/ 18	841	12,210	2,180	20,642	1,382	20,349	2,113	16,141	3,114	11,526	853	7,913
7/ 19	2,071	14,281	1,724	22,366	425	20,774	1,363	17,504	1,999	13,525	1,128	9,041
7/ 20	3,709	17,990	2,670	25,036	820	21,594	1,499	19,003	1,422	14,947	1,144	10,185
7/ 21	3,737	21,727	3,170	28,206	916	22,510	787	19,790	1,030	15,977	799	10,984
7/ 22	1,835	23,562	1,302	29,508	583	23,093	573	20,363	1,050	17,027	619	11,603
7/ 23	1,700	25,262	1,502	31,010	756	23,849	642	21,005	2,632	19,659	1,449	13,052
7/ 24	2,998	28,260	1,386	32,396	783	24,632	1,106	22,111	2,204	21,863	711	13,763
7/ 25	1,915	30,175	999	33,395	495	25,127	810	22,921	1,306	23,169	1,713	15,476
7/ 26	1,968	32,143	924	34,319	432	25,559	671	23,592	1,216	24,385	1,296	16,772
7/ 27	1,523	33,666	960	35,279	618	26,177	755	24,347	1,195	25,580	1,561	18,333
7/ 28	2,101	35,767	1,398	36,677	538	26,715	603	24,950	1,901	27,481	1,957	20,290
7/ 29	1,923	37,690	1,400	38,077	441	27,156	546	25,496	1,146	28,627	1,533	21,823
7/ 30	2,595	40,285	1,158	39,235	391	27,547	382	25,878	791	29,418	1,198	23,021
7/ 31	2,372	42,657	910	40,145	383	27,930	316	26,194	974	30,392	951	23,972
8/ 01	470	43,127	925	41,070	351	28,281	393	26,587	897	31,289	921	24,893
8/ 02	314	43,441	781	41,851	201	28,482	388	26,975	867	32,156	1,018	25,911
8/ 03	263	43,704	989	42,840	132	28,614	533	27,508	392	32,548	837	26,748
8/ 04	835	44,539	1,524	44,364	142	28,756	717	28,225	331	32,879	862	27,610
8/ 05	904	45,443	1,091	45,455	107	28,863	723	28,948	174	33,053	861	28,471
8/ 06	648	46,091	1,333	46,788	107	28,970	552	29,500	343	33,396	654	29,125
8/ 07	694	46,785	1,186	47,974	65	29,035	516	30,016	618	34,014	558	29,683
8/ 08	658	47,443	1,449	49,423			682	30,698	600	34,614	217	29,900
8/ 09	368	47,811	1,132	50,555			679	31,377			165	30,065
8/ 10	312	48,123	755	51,310			678	32,055			249	30,314
8/ 11		48,123	698	52,008			547	32,602				
8/ 12							362	32,964				
8/ 13							221	33,185				
8/ 14							139	33,324				
8/ 15							150	33,474				
Total		48,123		52,008		29,035		33,474		34,614		30,314

Table 3. Estimates by age class of the number of late-run chinook salmon in the inriver return to the Kenai River, 1992.

	Age Class				Total
	1.2	1.3	1.4	1.5	
Stratum 1 (1 July - 25 July)					
Males					
Sample Size	19	22	55	1	97
Percent	12.2	14.1	35.3	0.6	62.2
SE Percent	2.6	2.8	3.8	0.6	3.9
Return	1,885	2,183	5,456	99	9,623
SE Return	407	433	594	99	603
Females					
Sample Size	0	6	51	2	59
Percent	0	3.8	32.7	1.3	37.8
SE Percent	0	1.5	3.8	0.9	3.9
Return	0	595	5,060	198	5,853
SE Return	0	239	583	140	603
Combined					
Sample Size	19	28	106	3	156
Percent	12.2	17.9	67.9	1.9	100.0
SE Percent	2.6	3.1	3.7	1.1	
Return	1,885	2,778	10,516	297	15,476
SE Return	407	477	580	171	0
Stratum 2 (26 July - 10 August)					
Males					
Sample Size	4	18	46	3	71
Percent	2.2	9.7	24.9	1.6	38.4
SE Percent	1.1	2.2	3.2	0.9	3.6
Return	321	1,444	3,689	241	5,695
SE Return	159	324	473	138	532
Females					
Sample Size	0	8	104	2	114
Percent	0	4.3	56.2	1.1	61.6
SE Percent	0	1.5	3.7	0.8	3.6
Return	0	642	8,341	160	9,143
SE Return	0	222	543	113	532
Combined					
Sample Size	4	26	150	5	185
Percent	2.2	14.1	81.1	2.7	100.0
SE Percent	1.1	2.6	2.9	1.2	
Return	321	2,086	12,030	401	14,838
SE Return	159	380	428	177	0

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Table 3. (Page 2 of 2).

	Age Class				Total
	1.2	1.3	1.4	1.5	
Stratum 1 and 2 combined					
Males					
Percent	7.3	12.0	30.2	1.1	50.5
SE Percent	1.4	1.8	2.5	0.6	2.7
Return	2,206	3,627	9,145	340	15,318
SE Return	427	534	755	173	822
Females					
Percent	0.0	4.1	44.2	1.2	49.5
SE Percent	0.0	1.1	2.7	0.6	2.7
Return	0	1,237	13,401	358	14,996
SE Return	0	325	816	178	822
Combined					
Percent	7.3	16.0	74.4	2.3	100.0
SE Percent	1.4	2.0	2.4	0.8	
Return	2,206	4,864	22,546	698	30,314
SE Return	427	603	718	247	0

Table 4. Estimates by age class of the number of late-run chinook salmon in the total return to the Kenai River, 1986-1992.

	Age Class														Total
	0.2	0.3	0.4	0.5	1.1	1.2	1.3	1.4	1.5	1.6	2.1	2.2	2.3	2.4	
1986															
Percent	0.1	0.1	0.0	0.0	0.3	15.1	44.2	36.4	3.5	0.0	0.1	0.1	0.2	0.1	100.0
Return	43	43	22	22	260	12,017	35,314	29,039	2,774	22	43	43	152	43	79,837
SE Return	24	24	17	17	60	3,436	9,106	6,482	776	17	24	24	46	24	19,458
1987															
Percent	0	0	0	0	0.5	4.9	30.2	63.0	1.0	0.1	0.1	0.1	0.1	0.1	100.0
Return	0	0	0	0	361	3,635	22,427	46,812	775	99	51	44	97	58	74,359
SE Return					75	315	796	823	173	70	51	23	57	50	0
1988															
Percent	0	0	0.1	0	0.7	3.3	6.0	75.0	14.8	0	0	0.1	0.0	0.1	100.0
Return	0	0	35	0	454	2,235	4,116	51,233	10,121	0	0	46	15	101	68,356
SE Return			17		72	241	375	820	735			23	13	36	0
1989															
Percent	0	0	0	0	0.3	12.2	15.0	60.3	11.8	0.2	0.0	0.1	0	0.0	100.0
Return	0	0	0	0	108	5,053	6,194	24,908	4,888	76	0	34	0	13	41,274
SE Return					38	438	468	662	456	69		24		13	0
1990															
Percent	0	0.0	0.0	0	0.2	14.5	16.6	63.6	4.6	0	0.1	0.1	0.1	0.2	100.0
Return	0	11	11	0	65	5,749	6,572	25,237	1,841	0	45	23	23	79	39,656
SE Return		10	10		22	480	519	655	307		19	14	14	26	0
1991															
Percent	0.0	0	0.1	0	0.1	10.3	18.5	64.4	5.8	0	0.0	0	0.6	0.0	100.0
Return	15	0	31	0	46	4,291	7,687	26,732	2,396	0	15	0	261	15	41,489
SE Return	15		22		27	526	721	903	479		15		154	15	0
1992															
Percent	0	0	0	0	0.7	9.4	19.3	67.5	2.7	0	0	0.2	0.2	0.0	100.0
Return	0	0	0	0	289	3,960	8,098	28,351	1,142	0	0	68	102	17	42,027 ^a
SE Return					69	456	635	752	261			34	42	17	0

^a Deep Creek marine recreational harvest is unaccounted for until harvest estimates are available in 1993.

Table 5. Historical summary of harvest, angler effort and harvest rate in the recreational fishery for late-run chinook salmon, Kenai River, 1974-1992.

Year	Harvest			Effort in Angler Hours			Harvest per Hour		
	Unguided	Guided	Total	Unguided	Guided	Total	Unguided	Guided	Total
1974			3,225			87,162			0.037
1975			2,355			53,523			0.044
1976			5,353			114,795			0.047
1977			5,148			135,082			0.038
1978			5,578			212,217			0.026
1979			4,634			205,887			0.023
1980			3,608			154,435			0.023
1981	2,755	2,530	5,285	112,569	36,727	149,296	0.024	0.069	0.035
1982	2,413	2,397	4,810	146,947	50,828	197,775	0.016	0.047	0.024
1983	4,064	5,110	9,174	197,324	51,195	248,519	0.021	0.100	0.037
1984	4,448	2,928	7,376	302,915	45,664	348,579	0.015	0.064	0.021
1985	5,010	3,045	8,055	248,517	45,936	294,453	0.020	0.066	0.027
1986	5,458	3,546	9,004	191,597	52,843	244,440	0.028	0.067	0.037
1987	6,361	5,966	12,327	231,511	79,329	310,840	0.027	0.075	0.040
1988	8,103	9,409	17,512	266,578	95,181	361,759	0.030	0.099	0.048
1989	3,799	5,328	9,127	231,085	97,966	329,051	0.016	0.054	0.028
1990 ^a	2,439	3,808	6,247	190,743	101,223	291,966	0.013	0.038	0.022
1991	2,985	3,864	6,849	147,293	82,706	229,999	0.020	0.047	0.030
Mean	3,986	3,687	6,614	188,923	56,892	208,936	0.019	0.056	0.031
1992 ^a	2,504	4,176	6,680	112,091	75,324	187,415	0.024	0.064	0.039

^a Harvest per hour only for periods open to retention of chinook salmon.

Table 6. Estimates by age class of the number of late-run chinook salmon harvested in the recreational fishery on the Kenai River, 1992.

	Age Class					Total
	1.1	1.2	1.3	1.4	1.5	
Males						
Sample Size	1	3	19	74	7	104
Percent	0.5	1.5	9.5	36.8	3.5	51.7
SE Percent	0.5	0.9	2.1	3.4	1.3	3.5
Harvest	33	100	631	2,459	233	3,456
SE Harvest	33	58	145	284	88	336
Females						
Sample Size	0	1	12	79	5	97
Percent	0	0.5	6.0	39.3	2.5	48.3
SE Percent	0	0.5	1.7	3.5	1.1	3.5
Harvest	0	33	399	2,626	166	3,224
SE Harvest	0	33	115	293	74	324
Combined						
Sample Size	1	4	31	153	12	201
Percent	0.5	2.0	15.4	76.1	6.0	100.0
SE Percent	0.5	1.0	2.6	3.0	1.7	
Harvest	33	133	1,030	5,085	399	6,680
SE Harvest	33	66	185	405	115	462

Table 7. Estimates by age class of the number of late-run chinook salmon harvested in the recreational fishery on the Kenai River, 1976-1992.

	Age Class											Total
	1.1	1.2	1.3	1.4	1.5	1.6	2.2	2.3	2.4	2.5	Other	
1976												
Percent	10.7	27.0	18.3	40.1	3.6		0.3					100.0
Harvest	481	1,210	817	1,794	160		15					4,477
SE Harvest	79	114	99	125	48		15					
1977												
Percent		11.5	41.4	44.8	1.7				0.6			100.0
Harvest		592	2,130	2,307	89				30			5,148
SE Harvest		125	193	195	51				30			
1978												
Percent		12.6	8.0	77.7	1.7							100.0
Harvest		701	446	4,335	96							5,578
SE Harvest		68	73	89	0							
1979												
Percent		15.1	17.8	54.8	12.3							100.0
Harvest		698	825	2,540	571							4,634
SE Harvest		195	209	272	180							
1980												
Percent		21.2	21.5	49.8	7.5							100.0
Harvest		763	776	1,797	272							3,608
SE Harvest		88	89	108	57							
1981												
Percent		12.8	22.2	62.4	2.6							100.0
Harvest		678	1,174	3,297	136							5,285
SE Harvest		164	204	238	78							

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Table 7. (Page 2 of 3).

	Age Class										Total	
	1.1	1.2	1.3	1.4	1.5	1.6	2.2	2.3	2.4	2.5		Other
1982												
Percent		11.8	26.0	58.8	1.7						1.7	100.0
Harvest		566	1,253	2,829	81						81	4,810
SE Harvest		143	194	218	57						57	
1983												
Percent		3.7	4.9	86.4	2.5				2.5			100.0
Harvest		340	453	7,927	227				227			9,174
SE Harvest		194	222	351	159				159			
1984												
Percent		8.8	16.0	62.5	12.7							100.0
Harvest		650	1,179	4,610	937							7,376
SE Harvest		95	122	162	111							
1985												
Percent		3.9	12.8	73.5	8.0						1.8	100.0
Harvest		315	1,031	5,923	646						140	8,055
SE Harvest		73	125	166	102						49	
1986												
Percent	0.4	10.1	39.0	45.2	5.3							100.0
Harvest	37	913	3,507	4,072	475							9,004
SE Harvest	26	131	266	289	94							458
1987												
Percent	0.4	1.0	22.8	72.7	3.1							100.0
Harvest	51	127	2,787	8,892	380							12,237
SE Harvest	36	57	292	611	99							769

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Table 7. (Page 3 of 3).

	Age Class											Total
	1.1	1.2	1.3	1.4	1.5	1.6	2.2	2.3	2.4	2.5	Other	
1988												
Percent	0.7	0.2	3.4	78.6	17.1							100.0
Harvest	126	42	589	13,766	2,989							17,512
SE Harvest	73	42	159	887	368							1,036
1989												
Percent		1.0	10.9	71.3	15.8				1.0			100.0
Harvest		90	994	6,507	1,446				90			9,127
SE Harvest		90	291	585	345				90			582
1990												
Percent	0.6	9.7	15.8	62.2	11.7							100.0
Harvest	37	605	989	3,883	733							6,247
SE Harvest	26	109	142	322	121							445
1991												
Percent		4.9	11.7	76.2	6.3			0.9				100.0
Harvest		338	799	5,221	430			61				6,849
SE Harvest		101	155	369	114			43				410
1992												
Percent	0.5	2.0	15.4	76.1	6.0							100.0
Harvest	33	133	1,030	5,085	399							6,680
SE Harvest	33	66	185	405	115							462

Table 8. Estimates of the number of late-run chinook salmon mortalities attributable to hook-and-release fishing, Kenai River, 1986-1992.

Year	Sport Catch	Sport Harvest	Number Released	SE Released	Percent Mortality ^a	SE Percent	Hook and Release Mortality	SE Mortality
1986	15,331	9,004	6,327	872	8.3 (E)	3.39	522	220
1987	16,701	12,237	4,464	1,214	8.3 (E)	3.39	368	174
1988	23,238	17,512	5,726	1,590	8.3 (E)	3.39	472	225
1989	12,210	9,127	3,083	1,097	10.6 (M)	3.30	327	148
1990	8,637	6,247	2,390	709	5.9 (M)	3.30	141	65
1991	8,091	6,849	1,242	248	8.3 (E)	3.39	103	46
1992	10,394	6,680	3,714	409	8.3 (E)	3.39	308	130

^a (E) Estimated as the mean of the 1989 and 1990 mortality ratios (Bendock and Alexandersdottir 1992).
(M) Measured.

Table 9. Estimates by age class of the number of late-run chinook salmon that died as a result of hook-and-release fishing in the recreational fishery on the Kenai River, 1992.

	Age Class				Total
	1.2	1.3	1.4	1.5	
Males					
Sample Size ^a	23	40	101	4	168
Percent	6.7	11.7	29.6	1.2	49.3
SE Percent	1.4	1.7	2.5	0.6	2.7
Mortality	21	36	91	4	152
SE Mortality	10	16	39	2	64
Females					
Sample Size ^a	0	14	155	4	173
Percent	0	4.1	45.5	1.2	50.7
SE Percent	0	1.1	2.7	0.6	2.7
Mortality	0	13	140	4	156
SE Mortality	0	6	60	2	66
Combined					
Sample Size ^a	23	54	256	8	341
Percent	6.7	15.8	75.1	2.3	100.0
SE Percent	1.4	2.0	2.3	0.8	
Mortality	21	49	231	7	308
SE Mortality	10	21	98	4	130

^a Age/sex composition of released fish that died as a result of hook-and-release fishing was assumed equal to the age/sex composition of the inriver return.

Table 10. Estimates by age class of the number of late-run chinook salmon in the spawning escapement to the Kenai River, 1986-1992.

	Age Class									Total
	1.1	1.2	1.3	1.4	1.5	1.6	2.1	2.3	2.4	
1986										
Inriver Return	0	7,009	27,141	21,413	2,000	0	0	0	0	57,563
SE Return	0	3,428	9,101	6,474	769	0	0	0	0	19,457
Harvest	37	913	3,507	4,072	475	0	0	0	0	9,004
SE Harvest	26	131	266	289	94	0	0	0	0	458
H&R ^a Mortality	0	63	229	207	23	0	0	0	0	522
SE H&R	0	27	96	87	10	0	0	0	0	220
Escapement ^b	0	6,033	23,405	17,134	1,502	0	0	0	0	48,037
SE Escapement	0	3,431	9,105	6,481	775	0	0	0	0	19,464
1987										
Inriver Return	0	898	13,407	33,119	500	99	50	0	50	48,123
SE Return	0	209	696	719	157	70	50	0	50	0
Harvest	51	127	2,787	8,892	380	0	0	0	0	12,237
SE Harvest	36	57	292	611	99	0	0	0	0	769
H&R ^a Mortality	0	7	103	253	4	1	0	0	0	368
SE H&R	0	4	49	120	2	1	0	0	0	174
Escapement ^b	0	764	10,517	23,974	116	98	50	0	50	35,518
SE Escapement	0	217	756	951	186	70	50	0	50	788
1988										
Inriver Return	0	628	1,888	39,860	9,632	0	0	0	0	52,008
SE Return	0	198	340	793	732	0	0	0	0	0
Harvest	126	42	589	13,766	2,989	0	0	0	0	17,512
SE Harvest	73	42	159	887	368	0	0	0	0	1,036
H&R ^a Mortality	0	6	18	367	81	0	0	0	0	472
SE H&R	0	3	9	175	39	0	0	0	0	225
Escapement ^b	0	580	1,281	25,727	6,562	0	0	0	0	34,024
SE Escapement	0	202	375	1,203	820	0	0	0	0	1,060

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Table 10. (Page 2 of 3).

	Age Class									Total
	1.1	1.2	1.3	1.4	1.5	1.6	2.2	2.3	2.4	
1989										
Inriver Return	8	3,129	3,734	18,366	3,722	76	0	0	0	29,035
SE Return	8	409	437	629	440	69	0	0	0	0
Harvest	0	90	994	6,507	1,446	0	0	0	90	9,127
SE Harvest	0	90	291	585	345	0	0	0	90	582
H&R ^a Mortality	1	34	40	211	40	1	0	0	0	327
SE H&R	1	16	19	96	18	1	0	0	0	148
Escapement ^b	7	3,005	2,700	11,648	2,236	75	0	0	(90)	19,581
SE Escapement	8	419	525	864	559	69	0	0	90	601
1990										
Inriver Return	0	4,204	4,934	22,808	1,528	0	0	0	0	33,474
SE Return	0	471	510	647	304	0	0	0	0	0
Harvest	37	605	989	3,883	733	0	0	0	0	6,247
SE Harvest	26	109	142	322	121	0	0	0	0	445
H&R ^a Mortality	0	17	21	97	6	0	0	0	0	141
SE H&R	0	8	10	45	3	0	0	0	0	65
Escapement ^b	0	3,582	3,924	18,828	789	0	0	0	0	27,086
SE Escapement	0	484	529	724	327	0	0	0	0	450
1991										
Inriver Return	0	2,580	5,482	24,080	2,257	0	0	215	0	34,614
SE Return	0	507	705	889	477	0	0	152	0	0
Harvest	0	338	799	5,221	430	0	0	61	0	6,849
SE Harvest	0	101	155	369	114	0	0	43	0	410
H&R ^a Mortality	0	8	16	71	7	0	0	1	0	103
SE H&R	0	4	8	32	3	0	0	0	0	46
Escapement ^b	0	2,234	4,667	18,788	1,820	0	0	153	0	27,662
SE Escapement	0	517	722	963	490	0	0	158	0	413

-continued-

Table 10. (Page 3 of 3).

	Age Class									Total
	1.1	1.2	1.3	1.4	1.5	1.6	2.2	2.3	2.4	
1992										
Inriver Return	0	2,206	4,863	22,546	699	0	0	0	0	30,314
SE Return	0	427	603	718	247	0	0	0	0	0
Harvest	33	133	1,030	5,085	399	0	0	0	0	6,680
SE Harvest	33	66	185	405	115	0	0	0	0	462
H&R ^a Mortality	0	21	49	231	7	0	0	0	0	308
SE H&R	0	10	21	98	4	0	0	0	0	130
Escapement ^b	0	2,052	3,784	17,230	293	0	0	0	0	23,326
SE Escapement	0	432	631	830	272	0	0	0	0	480

^a Hook and Release.

^b For some age classes in some years the estimates of the number harvested in the sport fishery is greater than the estimate of the number in the inriver return. The spawning escapement for the age class was set to zero. When this occurred, the total spawning escapement (calculated by subtracting the total sport harvest plus the hook-and-release mortality from the inriver return) is not the sum of the escapement across age classes.

Table 11. Summary of late-run Kenai River chinook salmon population data, 1984-1992.

Year	Deep Creek	Eastside	Drift	Commercial		Inriver Return	Total Return	Kenai River		
	Marine Harvest	Set Net Harvest	Gill Net Harvest	Personal Use	Subsistence ^a			Sport Harvest	Hook and Release Mortality	Escapement
1984	835	6,165	1,377			39,172	47,549	7,376	Unknown	31,796
1985	1,731	17,723	2,046			29,763	51,263	8,055	Unknown	21,708
1986	630	19,810	1,834			57,563	79,837	9,004	522	48,037
1987	1,097	20,588	4,551			48,123	74,359	12,237	368	35,518
1988	1,262	12,870	2,216			52,008	68,356	17,512	472	34,024
1989	1,294	10,919	0 ^b	4	22	29,035	41,274	9,127	327	19,581
1990	1,318	4,139	621	91	13	33,474	39,656	6,247	141	27,086
1991	1,325	4,891	241	130	288	34,614	41,489	6,849	103	27,662
1992	Unknown	10,718	543	50	402 ^c	30,314	42,027 ^d	6,680	308	23,326

^a Includes harvest in Kenaitze educational gill net fishery.

^b Drift gill net fishery closed due to Exxon Valdez oil spill.

^c Includes 10 fish harvested in the Kenaitze educational fishery, 260 fish harvested in the subsistence set net fishery and 132 fish harvested in the subsistence dip net fishery.

^d Total return data are incomplete until the estimated Deep Creek Marine Harvest becomes available.

Brood Relationships

Age components of measured returns are presented in Table 12 and a summary of the production from each brood year appears in Table 13. Total production from the first measured escapement (31,796 fish in 1984) barely exceeded replacement. Production from the 1985 escapement (21,708) was nearly a twofold return. However, production from the largest measured escapement of 48,037 in 1986 appears only able to replace itself. Analysis will not be complete until the return of age-7 fish in 1993.

Sibling Relationships

Sonnichsen and Alexandersdottir (1991) developed a sibling model to forecast future returns (Table 14). Total return for the 1990 late run was forecast at 33,517 fish; the observed value was 39,656 or 18% greater than the expected value (Table 15). Using similar techniques, but including values observed in 1990, they predicted a return of 43,487 for 1991. The observed value was 41,849, 4.6% less than the forecast value. A return of 42,949 was forecast for 1992; the observed return was 42,027, 2.1% less than the forecast value. Total return for 1993 is forecast at 49,696 fish (SE = 13,911).

MIGRATORY TIMING AND IMPLEMENTATION OF THE MANAGEMENT PLAN

In 1988, the Board of Fisheries adopted the Kenai River Late-Run King Salmon Management Plan which put into regulation escapement levels and the procedures by which the recreational fisheries would be managed to achieve those levels. Implementation of the management plan hinges upon the department's ability to project the strength of the return in a timely manner with confidence.

The key ingredient in the projection of escapement is the real time estimate of the inriver return of chinook salmon. The current hydroacoustic project provides daily estimates of chinook salmon entering the river. Counts during the first 3 weeks of July were among the lowest recorded since 1987. From 1 July through 24 July, only three daily counts exceeded 1,000 (1,027 on 12 July, 1,128 on 19 July, and 1,144 on 23 July). Entry timing was similar to 1987 in that the first half of the return appeared weak while the second half appeared quite strong. The 50% point of the 1992 return occurred on 25 July, the latest date yet measured. The August component, which has averaged 14.4% since 1987, was 20.9% in 1992, the third largest measured. The peak daily count was 1,957 on 28 July (Table 2).

Projections of the total inriver return fluctuated around 18,000 during the first 2 weeks of July (Figure 4), very close to the escapement level requiring actions that impact the commercial and recreational fisheries. The 50% point of the 1992 late run was approximately 4 days later than the mean timing curve indicated (Figure 5). The cumulative daily proportions in 1992 were below (later timing) the 95% confidence interval of the model from approximately 17 July through 29 July. Trophy fishing and prohibiting the use of bait was employed on 24 July to minimize the probability of falling below the desired escapement goal while still preserving fishing opportunity. Because counts and projections continued to climb, the restrictions were removed on 30 July. No additional fishing time was offered for the recreational fishery in August as the likelihood of compromising the 22,300 escapement goal was too high.

Table 12. Age components of total returns of Kenai River late-run chinook salmon, 1986-1992.

<u>Year</u>	(0.2, 1.1) <u>Age 3</u>	(0.3, 1.2, 2.1) <u>Age 4</u>	(0.4, 1.3, 2.2) <u>Age 5</u>	(0.5, 1.4, 2.3) <u>Age 6</u>	(1.5, 2.4) <u>Age 7</u>	(1.6, 2.5) <u>Age 8</u>	<u>Total Return</u>
1986	303	12,103	35,379	29,213	2,817	22	79,837
1987	361	3,686	22,471	46,909	833	99	74,359
1988	454	2,235	4,197	51,249	10,221		68,356
1989	108	5,053	6,228	24,908	4,901	76	41,274
1990	65	5,805	6,606	25,260	1,920		39,656
1991	61	4,306	7,718	26,993	2,411		41,489
1992	289	3,960	8,166	28,453	1,159		42,027 ^a

^a Deep Creek marine recreational harvest is unaccounted for until harvest estimates are available in 1993.

Table 13. Summary of returns from each brood year, late-run Kenai River chinook salmon, 1978-1992.

Year	Spawning Escapement	RETURN						Total Return To Date	Return Per Spawner
		(0.2,1.1) Age 3	(0.3,1.2,2.1) Age 4	(0.4,1.3,2.2) Age 5	(0.5,1.4,2.3) Age 6	(1.5,2.4) Age 7	(1.6,2.5) Age 8		
1978	Unknown						(1986) 22	22	
1979	Unknown					(1986) 2,817	(1987) 99	2,916	
1980	Unknown				(1986) 29,213	(1987) 833		30,046	
1981	Unknown			(1986) 35,379	(1987) 46,909	(1988) 10,221	(1989) 76	92,585	
1982	Unknown		(1986) 12,103	(1987) 22,471	(1988) 51,249	(1989) 4,901		90,724	
1983	Unknown	(1986) 303	(1987) 3,686	(1988) 4,197	(1989) 24,908	(1990) 1,920		35,014	
1984	31,796	(1987) 361	(1988) 2,235	(1989) 6,228	(1990) 25,260	(1991) 2,411		36,495	1.15
1985	21,708	(1988) 454	(1989) 5,053	(1990) 6,606	(1991) 26,993	(1992) 1,159		40,265 ^a	1.85
1986	48,037	(1989) 108	(1990) 5,805	(1991) 7,718	(1992) 28,453			42,084 ^a	0.88
1987	35,518	(1990) 65	(1991) 4,306	(1992) 8,166				12,537 ^a	0.35
1988	34,024	(1991) 61	(1992) 3,960					4,021 ^a	0.12
1989	19,581	(1992) 289						289 ^a	0.01
1990	27,086								
1991	27,662								
1992	23,326								

^a 1992 Deep Creek marine recreational harvest unaccounted for until harvest estimates are available in 1993.

Table 14. Sibling return ratios^a for late-run Kenai River chinook salmon from brood years 1980-1988.

Brood Year	Age 4/ Age3	Age 5/ Age4	Age 6/ Age 5	Age 6/ Age4+5	Age 7/ Age 6	Age 7/ Age 5+6	Age 7/ Age4+5+6
1980					0.029		
1981			1.326		0.218	0.124	
1982		1.857	2.281	1.482	0.096	0.066	0.057
1983	12.165	1.139	5.935	3.160	0.077	0.066	0.059
1984	6.191	2.787	4.056	2.985	0.095	0.077	0.071
1985	11.130	1.307	4.086	2.315	0.043	0.035	0.030
1986	53.750	1.330	3.690	2.100			
1987	66.246	1.900					
1988	64.920						
Mean	35.73	1.72	3.56	2.41	0.09	0.07	0.05
Std. Dev.	28.78	0.61	1.60	0.68	0.07	0.03	0.02
% Coeff. Var.	81	35	45	28	72	44	32
Maximum	66.246	2.787	5.935	3.160	0.218	0.124	0.071
Minimum	6.191	1.139	1.326	1.482	0.029	0.035	0.030

^a 1992 Deep Creek marine recreational harvest is unaccounted for until harvest estimates are available in 1993.

Table 15. Summary of expected returns based on sibling ratios versus observed returns, late-run Kenai River chinook salmon, 1990-1992, and 1993 projections.

	RETURN					
	<u>Age 3</u>	<u>Age 4</u>	<u>Age 5</u>	<u>Age 6</u>	<u>Age 7</u>	<u>Total</u>
1990						
Expected	306	1,061	9,736	19,639	2,775	33,517
Observed	65	5,806	6,606	25,259	1,920	39,656
Difference	(241)	4,745	(3,130)	5,620	(855)	6,139
Obs. as % of Exp.	21.2	547.2	67.9	128.6	69.2	118.3
1991						
Expected	258	1,353	10,289	29,637	1,950	43,487
Observed	61	4,306	7,718	26,993	2,411	41,489
Difference	(197)	2,953	(2,571)	(2,644)	461	(1,998)
Obs. as % of Exp.	23.6	318.3	75.0	91.1	123.6	95.4
1992						
Expected	223	1,328	6,634	32,397	2,367	42,949
Observed	289	3,799	8,103	28,665	1,171	42,027
Difference	66	2,471	1,469	(3,732)	(1,196)	(922)
Obs. as % of Exp.	129.6	286.1	122.1	88.5	49.5	97.9
1993						
Projected	234	10,327	6,808	30,048	2,279	49,696
Standard Error	59	10,214	2,790	8,979	876	13,911

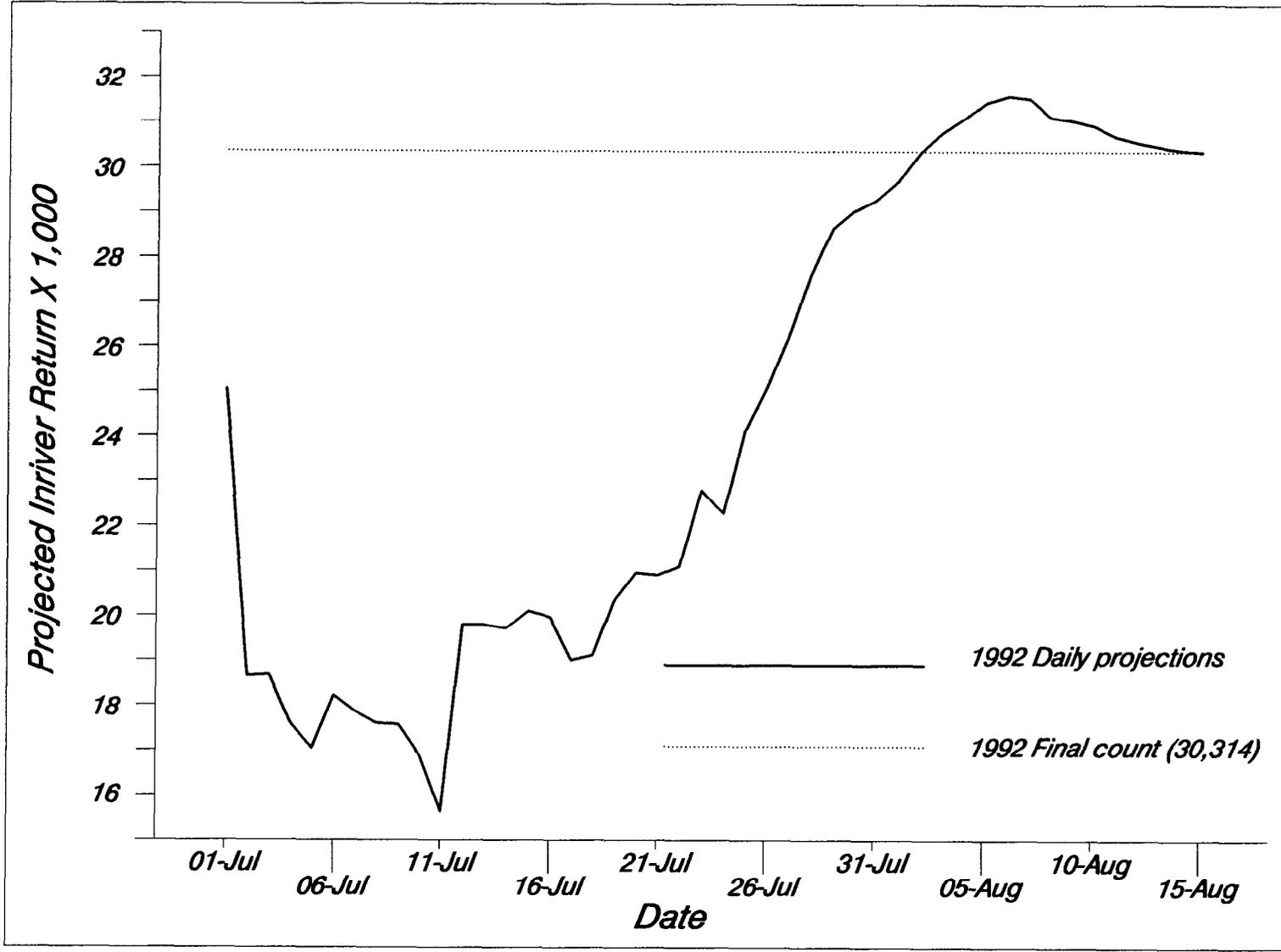


Figure 4. Daily projections of the inriver return of late-run chinook salmon based on historical proportions and current cumulative sonar counts, Kenai River, 1992.

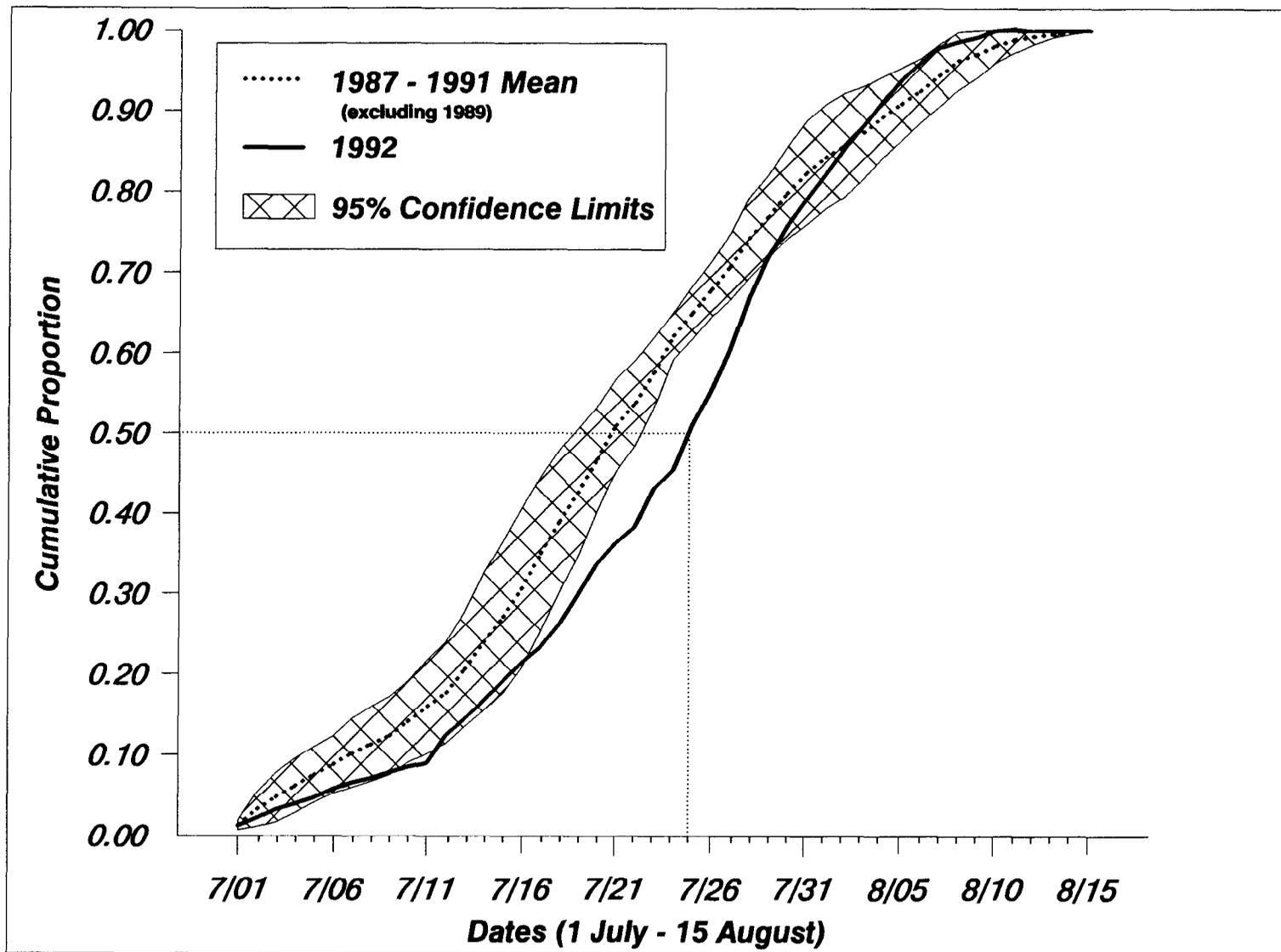


Figure 5. Cumulative proportions by date of inriver return of late-run chinook salmon to the Kenai River, 1987-1991 mean (excluding 1989) versus 1992.

Because of the extremely strong return of sockeye salmon to the Kenai River, additional fishing time was granted the commercial set gill net fishery beyond that scheduled by regulation and accounted for 78% of the total fishing time allowed. Concerns that chinook salmon would not achieve an escapement level of 19,000 prompted closure of additional fishing time from 1900 hours on 24 July to 0700 hours on 27 July. On 27 July, escapements of chinook and sockeye salmon into the Kenai River were projected to exceed 19,000 and 700,000 respectively. In conformance with the management plan, management priority switched back to sockeye salmon and additional fishing time was provided to harvest surpluses of this species.

DISCUSSION

With each year's data from the sonar project, confidence in the reliability of the equipment is enhanced. The ability to obtain real time estimates of the inriver return has greatly improved the department's ability to react to changing situations on relatively short notice. The ability to offer less severe restrictions to the recreational fishery as an alternative to total closure in response to a relatively weak return would diminish without this hydroacoustic project.

One source of bias in my estimate of total return may be underestimation of precocious males (age 1.1) due to gear selectivity. Representatives of this age class are reported in the commercial gill net harvest to a larger extent than in either the recreational fishery or the gill nets that sample the inriver return. Additionally, fish of this age class are not enumerated by the existing sonar gear (P. Skvorc, Alaska Department of Fish and Game, Anchorage, personal communication). Thus estimates of this age class are probably biased low, however, I do not believe that fish of this age class account for a significant portion of the population.

Observations by creel survey personnel detected changes in the behavior of the recreational fishery that had significant impact on management. For example, in 1990 when the recreational fishery moved from early-run to late-run management and reopened to retention and to the use of bait on 1 July, many anglers moved upstream of the Soldotna Bridge to target on early-run fish that were staging off the mouths of tributary streams. Appropriate actions were taken to correct this problem in 1992.

The forecasted return of 49,696 fish in 1993 is greater than any return since 1989. One area that Sonnichsen and Alexandersdottir (1991) examined was the relationship between age-5 and age-6 fish at different return levels. These two age groups contained the majority of chinook salmon returning to the Kenai River. Their analysis suggested that at lower abundance levels, the ratio of age 6 to age 5 is greater. From the 1981 and 1982 brood year, fish that returned as age 5 numbered 35,379 and 22,471, respectively. The following year's age 6 returned at a ratio of 1.3 and 2.3, respectively. For the brood years 1983-1986, age 6 returned at ratios of 5.9, 4.1, 4.1, and 3.7, respectively. These ratios occurred at levels of age-5 fish of 4,197, 6,228, 6,606 and 7,718, respectively (Figure 6). The return of age 5 from the 1987 brood was 8,166. If the assumption of a greater return ratio occurring at lower abundance levels holds true, the forecasted return of age 6 in 1993 is 36,277 (using the mean age 5 to age 6 ratio from brood years 1983-1986). This is 21%

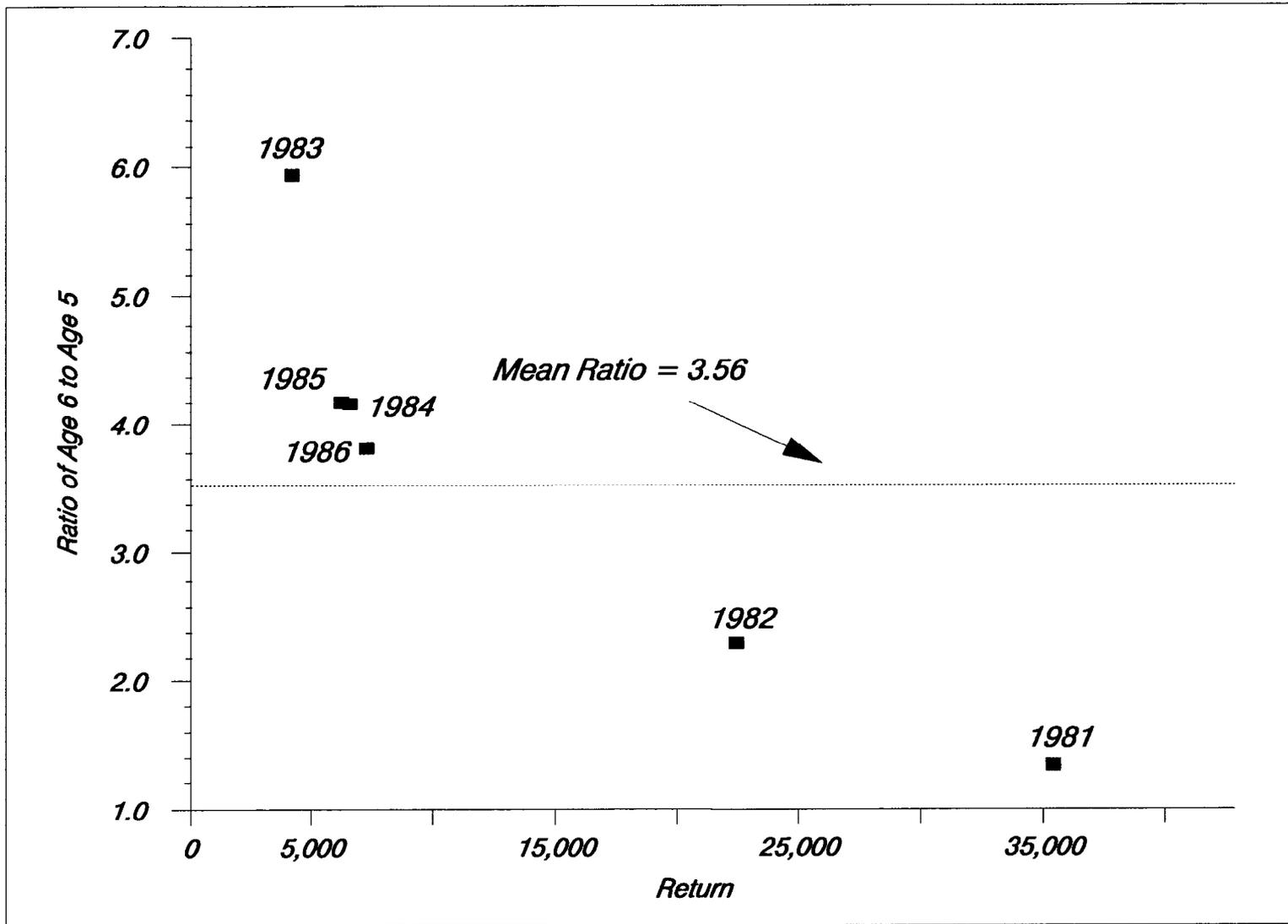


Figure 6. Ratio of the return of age 6 adults to age 5 adults compared to the numbers of age 5 adult late-run chinook salmon returning to the Kenai River, 1981-1986.

more age-6 fish than predicted by the sibling relationship. The ability of the sibling model to predict future returns has been extremely encouraging. If this technique continues to perform well, inseason management should become more predictable to the various user groups.

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APPENDIX A

Kenai River Late-Run King Salmon Management Plan

Appendix A. Kenai River Late-Run King Salmon Management Plan.

5 AAC 21.359 KENAI RIVER LATE-RUN KING SALMON MANAGEMENT PLAN.

(a) The purpose of this management plan is to insure an adequate escapement of late-run chinook salmon into the Kenai River system and to provide management guidelines to the department.

(b) The department shall manage the late-run Kenai River chinook salmon to achieve a minimum spawning escapement level of 15,500 salmon and an optimum spawning escapement level of 22,300 salmon as follows:

(1) if the projected spawning escapement level is less than 15,500, the department shall

(A) close the recreational fisheries in the Kenai River and in the salt waters of Cook Inlet north of the latitude of Bluff Point to the taking of chinook salmon;

(B) close the drift gill net fishery in the Central District within 3 miles of the Kenai Peninsula shoreline; and

(C) close the set gill net fishery in the Upper Subdistrict of the Central District;

(2) if the projected spawning escapement level is between 15,500 and 22,300 chinook salmon, the department shall restrict the taking of chinook salmon in the Kenai River recreational fisheries as necessary to achieve the optimum escapement; the department shall establish periods by emergency order during which

(A) time or area is reduced;

(B) bag or possession limits are zero; when the sport fishery is restricted to catch-and-release only, king salmon 52 inches or more in length may be retained; or

Note: changed from "(B) bag or possession limits are zero; or" in 1990

(C) only artificial lures may be used.

Note: The following sections modified the original plan above and were adopted at the December 1990 meeting of the Board of Fisheries.

(3) if the projected spawning escapement of chinook salmon is between 15,500 and 19,900, the department shall restrict the commercial fisheries as follows;

(A) within three miles of the Kenai Peninsula shoreline, the department shall limit the drift gill net fishery to regular periods;

-continued-

Appendix A. (Page 2 of 2).

(B) the department shall limit the set gill net fishery in the Upper Subdistrict of the Central District to regular periods;

(C) however, if the final inriver sonar count is projected to exceed 700,000 sockeye salmon, then the drift gill net fishery and the set gill net fishery will not be restricted to conserve Kenai River chinook salmon unless the projected spawning escapement is less than 15,500, consistent with (b)(1).

(D) consistent with the purpose of this management plan, the department shall not reduce closed waters at the mouth of the Kenai River when the projected escapement level is less than 22,300 chinook salmon.

(E) the Kasilof River Sockeye Salmon Special Harvest Area Management Plan (5 AAC 21.356) is exempt from all provisions of this management plan.

Effective 1989, modified 1991.

APPENDIX B

Supporting statistics used to prepare the migratory timing model for the return of late-run chinook salmon to the Kenai River and used in season to project the inriver return and associated harvest in the recreational fishery, 1992.

Appendix B1. Historical daily cumulative proportions of the inriver return of late-run chinook salmon to the Kenai River, 1985-1992.

Date	Daily cumulative proportions [P(t)] by year of inriver return								95% Confidence Interval		Rel ^b Prec	1992	
	1985	1986	1987	1988	1989	1990	1991	Mean ^a	SE	Low			High
7/01	0.025	0.014	0.012	0.012	0.036	0.016	0.008	0.014	0.002	0.009	0.020	40.4%	0.012
7/02	0.049	0.070	0.028	0.031	0.072	0.025	0.016	0.037	0.008	0.017	0.056	53.0%	0.022
7/03	0.080	0.095	0.040	0.063	0.088	0.038	0.026	0.057	0.011	0.030	0.084	47.3%	0.032
7/04	0.099	0.111	0.040	0.076	0.120	0.050	0.041	0.070	0.013	0.039	0.100	44.1%	0.039
7/05	0.120	0.116	0.067	0.101	0.158	0.075	0.050	0.088	0.012	0.060	0.116	32.3%	0.046
7/06	0.138	0.122	0.086	0.117	0.198	0.096	0.057	0.103	0.012	0.073	0.132	28.4%	0.057
7/07	0.170	0.127	0.104	0.148	0.235	0.117	0.062	0.121	0.015	0.084	0.159	30.7%	0.065
7/08	0.190	0.131	0.117	0.176	0.267	0.129	0.066	0.135	0.018	0.090	0.179	32.9%	0.071
7/09	0.206	0.142	0.127	0.210	0.326	0.139	0.077	0.150	0.021	0.100	0.201	33.5%	0.078
7/10	0.232	0.154	0.139	0.243	0.386	0.150	0.091	0.168	0.024	0.110	0.226	34.6%	0.085
7/11	0.264	0.166	0.150	0.265	0.435	0.171	0.103	0.187	0.027	0.122	0.251	34.8%	0.090
7/12	0.292	0.181	0.163	0.301	0.498	0.188	0.112	0.206	0.031	0.131	0.281	36.2%	0.124
7/13	0.325	0.219	0.185	0.337	0.531	0.223	0.121	0.235	0.034	0.152	0.318	35.2%	0.144
7/14	0.376	0.250	0.204	0.362	0.603	0.267	0.138	0.266	0.037	0.175	0.358	34.4%	0.166
7/15	0.414	0.283	0.220	0.395	0.631	0.301	0.153	0.294	0.041	0.195	0.394	33.9%	0.191
7/16	0.458	0.333	0.249	0.446	0.662	0.332	0.183	0.334	0.044	0.226	0.441	32.3%	0.214
7/17	0.485	0.377	0.298	0.474	0.694	0.405	0.241	0.380	0.039	0.284	0.476	25.3%	0.233
7/18	0.495	0.397	0.328	0.498	0.727	0.469	0.331	0.420	0.032	0.341	0.498	18.7%	0.261
7/19	0.510	0.421	0.355	0.534	0.743	0.510	0.390	0.453	0.030	0.379	0.528	16.4%	0.298
7/20	0.523	0.441	0.386	0.555	0.766	0.556	0.433	0.482	0.029	0.411	0.554	14.9%	0.336
7/21	0.565	0.466	0.429	0.583	0.793	0.580	0.464	0.515	0.028	0.446	0.583	13.4%	0.362
7/22	0.596	0.490	0.469	0.620	0.811	0.596	0.494	0.544	0.027	0.477	0.611	12.3%	0.383
7/23	0.627	0.527	0.499	0.649	0.835	0.616	0.571	0.582	0.024	0.522	0.641	10.2%	0.431
7/24	0.656	0.589	0.533	0.673	0.847	0.650	0.635	0.623	0.021	0.570	0.675	8.4%	0.454
7/25	0.692	0.603	0.578	0.696	0.864	0.675	0.672	0.653	0.020	0.603	0.702	7.6%	0.511
7/26	0.723	0.629	0.616	0.717	0.883	0.695	0.708	0.681	0.019	0.634	0.728	6.9%	0.553
7/27	0.767	0.654	0.648	0.739	0.899	0.718	0.742	0.711	0.020	0.662	0.761	6.9%	0.605
7/28	0.808	0.678	0.686	0.756	0.911	0.737	0.797	0.744	0.022	0.689	0.798	7.3%	0.669
7/29	0.825	0.700	0.711	0.769	0.924	0.754	0.830	0.765	0.022	0.710	0.819	7.2%	0.720
7/30	0.865	0.728	0.751	0.783	0.937	0.766	0.852	0.791	0.023	0.735	0.846	7.0%	0.759
7/31	0.885	0.754	0.801	0.814	0.948	0.776	0.880	0.818	0.022	0.765	0.872	6.6%	0.791
8/01	0.909	0.778	0.841	0.850	0.966	0.788	0.906	0.845	0.023	0.790	0.901	6.6%	0.821
8/02	0.920	0.799	0.841	0.887	0.973	0.800	0.930	0.863	0.024	0.805	0.921	6.7%	0.855
8/03	0.929	0.829	0.864	0.917	0.977	0.816	0.941	0.883	0.022	0.829	0.937	6.1%	0.882
8/04	0.939	0.855	0.891	0.941	0.986	0.838	0.950	0.902	0.020	0.854	0.951	5.3%	0.911
8/05	0.952	0.874	0.913	0.968	0.986	0.860	0.955	0.920	0.019	0.875	0.966	4.9%	0.939
8/06	0.962	0.895	0.924	0.987	0.986	0.877	0.965	0.935	0.018	0.892	0.978	4.6%	0.961
8/07	0.984	0.917	0.945	1.000	1.000	0.893	0.983	0.953	0.017	0.911	0.996	4.4%	0.979
8/08	0.997	0.935	0.965	1.000	1.000	0.915	1.000	0.969	0.015	0.932	1.006	3.8%	0.986
8/09	1.000	0.956	0.977	1.000	1.000	0.936	1.000	0.978	0.011	0.951	1.005	2.8%	0.992
8/10	1.000	0.968	0.989	1.000	1.000	0.957	1.000	0.986	0.008	0.967	1.005	1.9%	1.000
8/11	1.000	0.975	1.000	1.000	1.000	0.974	1.000	0.991	0.005	0.978	1.005	1.3%	1.000
8/12	1.000	0.984	1.000	1.000	1.000	0.985	1.000	0.995	0.003	0.987	1.003	0.8%	1.000
8/13	1.000	0.992	1.000	1.000	1.000	0.992	1.000	0.997	0.002	0.993	1.001	0.4%	1.000
8/14	1.000	1.000	1.000	1.000	1.000	0.996	1.000	0.999	0.001	0.998	1.001	0.2%	1.000
8/15	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000	1.000	1.000	0.0%	1.000

^a 1989 excluded due to abnormally early timing.

^b Relative precision.

Appendix B2. Historical daily cumulative proportions of the effort by unguided anglers during the return of late-run chinook salmon to the Kenai River, 1984-1992.

Date	Daily cumulative proportions [P(t)] by year of unguided angler effort									95% Confidence Interval				Rel ^a Prec
	1984	1985	1986	1987	1988	1989	1990	1991	1992	Mean	SE	Low	High	
7/01	0.009	0.005	0.015	0.004	0.018	0.032	0.051	0.000	0.030	0.018	0.006	0.005	0.031	70.6%
7/02	0.022	0.011	0.026	0.016	0.044	0.070	0.051	0.022	0.052	0.035	0.007	0.018	0.052	48.5%
7/03	0.040	0.013	0.046	0.053	0.069	0.070	0.091	0.036	0.087	0.056	0.009	0.036	0.076	35.9%
7/04	0.063	0.024	0.069	0.090	0.069	0.101	0.109	0.059	0.127	0.079	0.010	0.057	0.102	28.4%
7/05	0.092	0.046	0.112	0.142	0.089	0.129	0.138	0.084	0.155	0.110	0.012	0.082	0.137	24.9%
7/06	0.108	0.084	0.124	0.142	0.102	0.151	0.169	0.118	0.155	0.128	0.010	0.105	0.152	18.3%
7/07	0.163	0.102	0.124	0.162	0.123	0.181	0.209	0.141	0.170	0.153	0.012	0.124	0.182	19.1%
7/08	0.214	0.102	0.151	0.184	0.147	0.228	0.242	0.141	0.196	0.178	0.017	0.137	0.219	22.9%
7/09	0.214	0.121	0.169	0.211	0.204	0.280	0.242	0.164	0.219	0.203	0.017	0.161	0.244	20.3%
7/10	0.237	0.148	0.188	0.250	0.252	0.280	0.269	0.188	0.246	0.229	0.016	0.190	0.268	17.0%
7/11	0.260	0.180	0.209	0.299	0.252	0.323	0.297	0.215	0.282	0.257	0.018	0.215	0.300	16.3%
7/12	0.280	0.206	0.248	0.336	0.285	0.357	0.331	0.243	0.326	0.290	0.019	0.246	0.334	15.2%
7/13	0.306	0.278	0.298	0.336	0.314	0.394	0.361	0.300	0.326	0.324	0.014	0.292	0.356	9.9%
7/14	0.367	0.354	0.298	0.387	0.352	0.425	0.422	0.366	0.383	0.373	0.014	0.338	0.407	9.2%
7/15	0.431	0.354	0.350	0.418	0.384	0.484	0.490	0.366	0.427	0.412	0.020	0.365	0.458	11.3%
7/16	0.431	0.413	0.376	0.450	0.445	0.530	0.490	0.403	0.466	0.445	0.017	0.404	0.486	9.2%
7/17	0.462	0.477	0.426	0.491	0.491	0.530	0.542	0.451	0.504	0.486	0.014	0.454	0.518	6.7%
7/18	0.506	0.503	0.470	0.547	0.491	0.583	0.590	0.483	0.576	0.528	0.016	0.489	0.566	7.3%
7/19	0.556	0.525	0.525	0.595	0.583	0.618	0.645	0.532	0.674	0.584	0.016	0.546	0.621	6.5%
7/20	0.594	0.556	0.590	0.595	0.620	0.638	0.679	0.581	0.674	0.614	0.014	0.582	0.646	5.2%
7/21	0.649	0.575	0.590	0.633	0.659	0.678	0.766	0.641	0.714	0.656	0.021	0.607	0.705	7.4%
7/22	0.705	0.575	0.615	0.654	0.689	0.727	0.836	0.641	0.762	0.689	0.028	0.622	0.756	9.7%
7/23	0.705	0.616	0.649	0.686	0.741	0.761	0.836	0.682	0.827	0.723	0.024	0.665	0.780	8.0%
7/24	0.741	0.663	0.696	0.727	0.785	0.761	0.881	0.722	0.840	0.757	0.023	0.702	0.812	7.3%
7/25	0.778	0.717	0.746	0.790	0.785	0.807	0.930	0.759	0.855	0.796	0.022	0.743	0.850	6.7%
7/26	0.801	0.761	0.812	0.840	0.827	0.838	0.975	0.804	0.873	0.837	0.022	0.784	0.889	6.3%
7/27	0.842	0.845	0.874	0.840	0.858	0.875	0.986	0.852	0.873	0.872	0.017	0.831	0.912	4.6%
7/28	0.894	0.903	0.874	0.884	0.892	0.915	0.992	0.967	0.891	0.912	0.015	0.877	0.947	3.8%
7/29	0.957	0.903	0.923	0.920	0.929	0.960	0.996	0.967	0.902	0.940	0.011	0.914	0.965	2.7%
7/30	0.957	0.962	0.959	0.959	0.967	1.000	0.996	0.990	0.957	0.972	0.006	0.956	0.987	1.6%
7/31	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000	1.000	1.000	0.0%

^a Relative precision.

Appendix B3. Historical daily cumulative proportions of the HPUE for chinook salmon by unguided anglers during the return of late-run chinook salmon to the Kenai River, 1984-1992.

Date	Daily cumulative proportions [P(t)] by year of unguided angler HPUE									95% Confidence Interval				Rel ^a Prec
	1984	1985	1986	1987	1988	1989	1990	1991	1992	Mean	SE	Low	High	
7/01	0.010	0.018	0.044	0.018	0.055	0.026	0.063	0.000	0.023	0.029	0.007	0.012	0.045	56.4%
7/02	0.037	0.018	0.073	0.018	0.068	0.053	0.063	0.045	0.056	0.048	0.007	0.032	0.063	32.2%
7/03	0.072	0.028	0.096	0.121	0.078	0.053	0.161	0.064	0.068	0.082	0.013	0.052	0.112	36.7%
7/04	0.101	0.033	0.103	0.138	0.078	0.071	0.188	0.064	0.077	0.095	0.015	0.060	0.130	36.9%
7/05	0.123	0.033	0.139	0.190	0.100	0.099	0.188	0.068	0.094	0.115	0.017	0.075	0.155	34.7%
7/06	0.142	0.060	0.159	0.190	0.136	0.168	0.298	0.074	0.094	0.147	0.024	0.092	0.202	37.5%
7/07	0.154	0.075	0.159	0.229	0.171	0.253	0.307	0.126	0.113	0.176	0.024	0.120	0.233	32.0%
7/08	0.191	0.075	0.188	0.250	0.183	0.253	0.327	0.126	0.130	0.192	0.026	0.132	0.251	30.8%
7/09	0.191	0.107	0.203	0.284	0.196	0.366	0.327	0.210	0.179	0.229	0.027	0.167	0.291	27.1%
7/10	0.206	0.153	0.240	0.352	0.225	0.366	0.339	0.235	0.190	0.256	0.026	0.197	0.315	23.1%
7/11	0.221	0.214	0.315	0.358	0.225	0.463	0.339	0.253	0.209	0.288	0.029	0.222	0.355	23.1%
7/12	0.238	0.237	0.323	0.398	0.294	0.519	0.375	0.270	0.233	0.321	0.032	0.247	0.394	22.9%
7/13	0.250	0.264	0.369	0.398	0.369	0.578	0.414	0.270	0.233	0.349	0.037	0.265	0.434	24.1%
7/14	0.260	0.333	0.369	0.407	0.384	0.584	0.440	0.305	0.316	0.378	0.032	0.305	0.451	19.4%
7/15	0.288	0.333	0.476	0.455	0.441	0.584	0.521	0.305	0.346	0.417	0.034	0.337	0.496	19.0%
7/16	0.288	0.434	0.528	0.477	0.453	0.592	0.521	0.342	0.391	0.447	0.032	0.374	0.521	16.4%
7/17	0.376	0.476	0.556	0.511	0.471	0.592	0.613	0.438	0.485	0.502	0.025	0.444	0.560	11.5%
7/18	0.422	0.501	0.585	0.527	0.471	0.592	0.667	0.514	0.502	0.531	0.024	0.475	0.587	10.6%
7/19	0.466	0.501	0.604	0.550	0.502	0.677	0.717	0.521	0.517	0.562	0.029	0.496	0.628	11.8%
7/20	0.555	0.525	0.620	0.550	0.536	0.677	0.726	0.566	0.517	0.586	0.024	0.529	0.642	9.6%
7/21	0.634	0.541	0.620	0.585	0.646	0.725	0.732	0.597	0.588	0.630	0.021	0.581	0.679	7.8%
7/22	0.713	0.541	0.627	0.640	0.764	0.733	0.798	0.597	0.617	0.670	0.029	0.604	0.736	9.8%
7/23	0.713	0.621	0.658	0.662	0.794	0.762	0.798	0.611	0.782	0.711	0.025	0.653	0.769	8.1%
7/24	0.786	0.660	0.697	0.713	0.837	0.762	0.899	0.669	0.820	0.760	0.027	0.697	0.823	8.3%
7/25	0.840	0.722	0.744	0.733	0.837	0.768	0.935	0.669	0.835	0.787	0.027	0.725	0.849	7.9%
7/26	0.866	0.810	0.772	0.769	0.900	0.800	0.952	0.732	0.835	0.826	0.023	0.773	0.880	6.5%
7/27	0.890	0.857	0.812	0.769	0.913	0.816	1.000	0.829	0.835	0.858	0.023	0.805	0.910	6.1%
7/28	0.906	0.936	0.812	0.821	0.916	0.968	1.000	0.891	0.835	0.898	0.022	0.848	0.949	5.6%
7/29	0.941	0.936	0.876	0.868	0.946	0.982	1.000	0.891	0.835	0.919	0.018	0.877	0.962	4.6%
7/30	0.941	0.966	0.930	0.911	0.966	1.000	1.000	0.949	0.898	0.951	0.012	0.924	0.979	2.9%
7/31	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000	1.000	1.000	0.0%

^a Relative precision.

Appendix B4. Historical daily cumulative proportions of the CPUE for chinook salmon by unguided anglers during the return of late-run chinook salmon to the Kenai River, 1984-1992.

Date	Daily cumulative proportions [P(t)] by year of unguided angler CPUE									95% Confidence Interval				Rel ^a Prec
	1984	1985	1986	1987	1988	1989	1990	1991	1992	Mean	SE	Low	High	
7/01	0.007	0.023	0.034	0.014	0.043	0.017	0.050	0.000	0.065	0.028	0.007	0.011	0.044	59.0%
7/02	0.029	0.023	0.050	0.014	0.053	0.047	0.050	0.062	0.083	0.045	0.007	0.029	0.062	35.8%
7/03	0.059	0.029	0.082	0.093	0.068	0.047	0.115	0.078	0.088	0.073	0.009	0.053	0.093	27.2%
7/04	0.089	0.032	0.104	0.122	0.068	0.108	0.133	0.091	0.093	0.093	0.010	0.070	0.116	24.7%
7/05	0.119	0.032	0.133	0.171	0.084	0.162	0.133	0.101	0.100	0.115	0.014	0.082	0.148	28.3%
7/06	0.144	0.050	0.163	0.171	0.127	0.213	0.244	0.109	0.100	0.147	0.020	0.101	0.192	31.0%
7/07	0.164	0.066	0.163	0.206	0.170	0.294	0.264	0.153	0.130	0.179	0.023	0.126	0.232	29.5%
7/08	0.193	0.066	0.211	0.229	0.189	0.294	0.288	0.153	0.137	0.196	0.024	0.140	0.251	28.4%
7/09	0.193	0.098	0.224	0.264	0.203	0.367	0.288	0.223	0.178	0.226	0.025	0.168	0.284	25.6%
7/10	0.205	0.149	0.244	0.317	0.244	0.367	0.304	0.245	0.192	0.252	0.023	0.200	0.304	20.7%
7/11	0.220	0.216	0.309	0.326	0.244	0.450	0.327	0.259	0.208	0.284	0.026	0.225	0.344	21.1%
7/12	0.234	0.244	0.316	0.377	0.326	0.527	0.397	0.274	0.224	0.324	0.033	0.249	0.399	23.1%
7/13	0.246	0.265	0.385	0.377	0.426	0.564	0.437	0.274	0.224	0.355	0.037	0.269	0.442	24.3%
7/14	0.254	0.338	0.385	0.397	0.444	0.571	0.476	0.303	0.268	0.382	0.035	0.302	0.462	20.9%
7/15	0.277	0.338	0.516	0.436	0.488	0.571	0.530	0.303	0.283	0.416	0.039	0.326	0.505	21.5%
7/16	0.277	0.449	0.555	0.462	0.500	0.578	0.530	0.405	0.308	0.452	0.035	0.371	0.533	17.9%
7/17	0.382	0.501	0.582	0.506	0.514	0.578	0.690	0.485	0.347	0.509	0.035	0.430	0.589	15.7%
7/18	0.446	0.524	0.602	0.525	0.514	0.674	0.732	0.548	0.365	0.548	0.037	0.462	0.633	15.6%
7/19	0.492	0.528	0.614	0.550	0.551	0.729	0.766	0.555	0.373	0.573	0.040	0.482	0.665	15.9%
7/20	0.575	0.554	0.623	0.550	0.577	0.729	0.786	0.599	0.373	0.596	0.039	0.507	0.686	15.0%
7/21	0.638	0.570	0.623	0.590	0.681	0.760	0.800	0.625	0.403	0.632	0.038	0.544	0.720	14.0%
7/22	0.723	0.570	0.633	0.639	0.783	0.774	0.853	0.625	0.427	0.670	0.043	0.570	0.769	14.8%
7/23	0.723	0.644	0.656	0.662	0.806	0.798	0.853	0.636	0.498	0.697	0.037	0.613	0.782	12.1%
7/24	0.790	0.682	0.683	0.705	0.844	0.798	0.927	0.703	0.576	0.745	0.035	0.665	0.826	10.8%
7/25	0.841	0.733	0.730	0.729	0.844	0.802	0.956	0.703	0.657	0.777	0.031	0.707	0.848	9.1%
7/26	0.876	0.809	0.754	0.770	0.910	0.843	0.968	0.755	0.736	0.825	0.027	0.763	0.886	7.5%
7/27	0.900	0.854	0.786	0.770	0.923	0.853	1.000	0.837	0.736	0.851	0.027	0.788	0.914	7.4%
7/28	0.921	0.914	0.786	0.827	0.927	0.975	1.000	0.905	0.798	0.895	0.025	0.837	0.953	6.5%
7/29	0.951	0.914	0.847	0.874	0.950	0.984	1.000	0.905	0.919	0.927	0.017	0.889	0.965	4.1%
7/30	0.951	0.970	0.921	0.914	0.972	1.000	1.000	0.958	0.955	0.960	0.010	0.937	0.983	2.4%
7/31	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000	1.000	1.000	0.0%

^a Relative precision.

Appendix B5. Historical daily cumulative proportions of the harvest of chinook salmon by unguided anglers during the return of late-run chinook salmon to the Kenai River, 1984-1992.

Date	Daily cumulative proportions [P(t)] by year of unguided angler harvest									95% Confidence Interval				Rel ^a Prec
	1984	1985	1986	1987	1988	1989	1990	1991	1992	Mean	SE	Low	High	
7/01	0.002	0.002	0.017	0.002	0.028	0.022	0.071	0.000	0.015	0.018	0.007	0.000	0.035	97.7%
7/02	0.011	0.002	0.025	0.002	0.037	0.049	0.071	0.024	0.032	0.028	0.008	0.011	0.046	61.6%
7/03	0.027	0.002	0.037	0.102	0.044	0.049	0.157	0.031	0.041	0.055	0.016	0.019	0.090	65.8%
7/04	0.044	0.003	0.042	0.119	0.044	0.064	0.168	0.031	0.050	0.063	0.017	0.024	0.101	61.4%
7/05	0.060	0.003	0.082	0.193	0.056	0.084	0.168	0.033	0.060	0.082	0.020	0.035	0.129	57.1%
7/06	0.067	0.025	0.088	0.193	0.070	0.125	0.245	0.038	0.060	0.101	0.025	0.045	0.158	55.9%
7/07	0.083	0.031	0.088	0.213	0.090	0.193	0.253	0.069	0.067	0.121	0.026	0.061	0.180	49.5%
7/08	0.131	0.031	0.108	0.226	0.099	0.193	0.268	0.069	0.077	0.133	0.026	0.073	0.194	45.5%
7/09	0.131	0.044	0.115	0.250	0.120	0.350	0.268	0.115	0.102	0.166	0.033	0.090	0.243	46.0%
7/10	0.140	0.070	0.133	0.321	0.158	0.350	0.275	0.130	0.109	0.187	0.034	0.110	0.265	41.4%
7/11	0.149	0.112	0.174	0.328	0.158	0.460	0.275	0.142	0.124	0.214	0.039	0.123	0.304	42.2%
7/12	0.157	0.124	0.183	0.367	0.223	0.510	0.303	0.154	0.148	0.241	0.043	0.142	0.340	41.1%
7/13	0.165	0.165	0.242	0.367	0.284	0.569	0.328	0.154	0.148	0.269	0.046	0.163	0.376	39.6%
7/14	0.179	0.276	0.242	0.380	0.300	0.574	0.364	0.210	0.254	0.309	0.040	0.217	0.401	29.6%
7/15	0.225	0.276	0.385	0.419	0.351	0.574	0.487	0.210	0.284	0.357	0.041	0.263	0.451	26.3%
7/16	0.225	0.402	0.420	0.438	0.372	0.584	0.487	0.244	0.324	0.388	0.038	0.301	0.476	22.5%
7/17	0.294	0.459	0.457	0.476	0.394	0.584	0.593	0.356	0.406	0.446	0.033	0.371	0.522	16.9%
7/18	0.345	0.473	0.490	0.499	0.394	0.584	0.650	0.416	0.433	0.476	0.032	0.403	0.549	15.3%
7/19	0.401	0.473	0.516	0.529	0.476	0.663	0.711	0.426	0.466	0.518	0.035	0.437	0.598	15.5%
7/20	0.485	0.488	0.543	0.529	0.510	0.663	0.718	0.480	0.466	0.542	0.030	0.474	0.611	12.5%
7/21	0.595	0.494	0.543	0.565	0.632	0.714	0.730	0.525	0.531	0.592	0.028	0.528	0.657	10.9%
7/22	0.705	0.494	0.548	0.596	0.731	0.725	0.832	0.525	0.562	0.635	0.039	0.546	0.724	14.0%
7/23	0.705	0.565	0.574	0.615	0.774	0.751	0.832	0.539	0.806	0.684	0.038	0.598	0.771	12.7%
7/24	0.771	0.602	0.623	0.670	0.827	0.751	0.932	0.596	0.818	0.732	0.039	0.642	0.822	12.3%
7/25	0.820	0.674	0.683	0.704	0.827	0.758	0.971	0.596	0.822	0.762	0.037	0.676	0.848	11.3%
7/26	0.835	0.755	0.731	0.752	0.902	0.784	0.989	0.664	0.822	0.804	0.032	0.729	0.879	9.3%
7/27	0.860	0.838	0.794	0.752	0.913	0.800	1.000	0.779	0.822	0.840	0.025	0.781	0.899	7.0%
7/28	0.881	0.935	0.794	0.813	0.915	0.964	1.000	0.954	0.822	0.898	0.025	0.841	0.955	6.3%
7/29	0.936	0.935	0.875	0.858	0.947	0.981	1.000	0.954	0.822	0.923	0.020	0.878	0.968	4.9%
7/30	0.936	0.972	0.926	0.903	0.969	1.000	1.000	0.987	0.901	0.955	0.013	0.925	0.985	3.2%
7/31	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000	1.000	1.000	0.0%

^a Relative precision.

Appendix B6. Historical daily cumulative proportions of the catch of chinook salmon by unguided anglers during the return of late-run chinook salmon to the Kenai River, 1984-1992.

Date	Daily cumulative proportions [P(t)] by year of unguided angler catch									95% Confidence Interval				Rel ^a Prec
	1984	1985	1986	1987	1988	1989	1990	1991	1992	Mean	SE	Low	High	
7/01	0.002	0.002	0.013	0.001	0.021	0.014	0.057	0.000	0.063	0.019	0.008	0.001	0.038	96.6%
7/02	0.009	0.002	0.017	0.001	0.029	0.044	0.057	0.033	0.076	0.030	0.009	0.010	0.050	65.8%
7/03	0.023	0.003	0.034	0.077	0.039	0.044	0.115	0.039	0.081	0.051	0.011	0.024	0.077	52.0%
7/04	0.040	0.003	0.048	0.106	0.039	0.094	0.122	0.046	0.088	0.065	0.013	0.035	0.095	45.7%
7/05	0.061	0.003	0.080	0.173	0.048	0.133	0.122	0.052	0.094	0.085	0.017	0.046	0.125	46.3%
7/06	0.072	0.018	0.089	0.173	0.064	0.163	0.200	0.059	0.094	0.104	0.020	0.057	0.150	45.2%
7/07	0.100	0.024	0.089	0.191	0.090	0.227	0.217	0.084	0.110	0.126	0.023	0.072	0.179	42.4%
7/08	0.137	0.024	0.122	0.205	0.102	0.227	0.235	0.084	0.116	0.139	0.023	0.085	0.193	38.9%
7/09	0.137	0.038	0.128	0.230	0.124	0.327	0.235	0.123	0.145	0.165	0.028	0.100	0.230	39.5%
7/10	0.144	0.066	0.138	0.283	0.178	0.327	0.245	0.136	0.157	0.186	0.028	0.123	0.250	34.1%
7/11	0.153	0.112	0.174	0.295	0.178	0.420	0.259	0.146	0.177	0.213	0.032	0.139	0.287	34.8%
7/12	0.160	0.127	0.180	0.344	0.256	0.487	0.313	0.156	0.200	0.247	0.039	0.157	0.336	36.2%
7/13	0.168	0.159	0.270	0.344	0.336	0.524	0.340	0.156	0.200	0.277	0.041	0.183	0.371	33.9%
7/14	0.180	0.276	0.270	0.370	0.356	0.529	0.393	0.203	0.281	0.318	0.036	0.235	0.400	26.0%
7/15	0.218	0.276	0.444	0.402	0.395	0.529	0.475	0.203	0.301	0.360	0.039	0.271	0.449	24.7%
7/16	0.218	0.414	0.470	0.424	0.415	0.539	0.475	0.294	0.333	0.398	0.033	0.321	0.475	19.3%
7/17	0.301	0.484	0.505	0.471	0.433	0.539	0.662	0.388	0.381	0.463	0.035	0.382	0.543	17.3%
7/18	0.372	0.497	0.528	0.499	0.433	0.672	0.707	0.439	0.422	0.508	0.038	0.420	0.595	17.2%
7/19	0.430	0.499	0.545	0.530	0.529	0.723	0.748	0.446	0.450	0.544	0.039	0.455	0.633	16.4%
7/20	0.509	0.516	0.559	0.530	0.556	0.723	0.763	0.500	0.450	0.567	0.035	0.486	0.648	14.3%
7/21	0.598	0.522	0.559	0.571	0.669	0.755	0.790	0.538	0.488	0.610	0.035	0.529	0.691	13.3%
7/22	0.718	0.522	0.566	0.598	0.754	0.773	0.874	0.538	0.526	0.652	0.043	0.552	0.752	15.3%
7/23	0.718	0.587	0.586	0.617	0.787	0.795	0.874	0.549	0.675	0.688	0.038	0.601	0.774	12.6%
7/24	0.778	0.625	0.619	0.663	0.834	0.795	0.948	0.614	0.709	0.732	0.038	0.643	0.820	12.1%
7/25	0.826	0.683	0.679	0.704	0.834	0.799	0.981	0.614	0.747	0.763	0.037	0.678	0.848	11.1%
7/26	0.846	0.754	0.719	0.757	0.912	0.833	0.992	0.671	0.792	0.809	0.033	0.732	0.885	9.5%
7/27	0.871	0.833	0.770	0.757	0.923	0.843	1.000	0.768	0.792	0.840	0.027	0.777	0.902	7.4%
7/28	0.898	0.907	0.770	0.823	0.927	0.973	1.000	0.960	0.829	0.899	0.026	0.839	0.958	6.6%
7/29	0.946	0.907	0.847	0.867	0.951	0.984	1.000	0.960	0.874	0.926	0.018	0.884	0.968	4.5%
7/30	0.946	0.975	0.917	0.908	0.974	1.000	1.000	0.989	0.937	0.961	0.012	0.934	0.988	2.8%
7/31	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000	1.000	1.000	0.0%

^a Relative precision.

Appendix B7. Historical daily cumulative proportions of the effort by guided anglers during the return of late-run chinook salmon to the Kenai River, 1984-1992.

Date	Daily cumulative proportions [P(t)] by year of guided angler effort									95% Confidence Interval				Rel ^a Prec
	1984	1985	1986	1987	1988	1989	1990	1991	1992	Mean	SE	Low	High	
7/01	0.000	0.023	0.025	0.006	0.025	0.032	0.000	0.000	0.035	0.016	0.005	0.005	0.027	68.5%
7/02	0.014	0.029	0.039	0.028	0.045	0.032	0.000	0.033	0.059	0.031	0.006	0.018	0.044	42.2%
7/03	0.027	0.033	0.055	0.055	0.045	0.032	0.045	0.063	0.088	0.049	0.006	0.035	0.064	29.4%
7/04	0.047	0.044	0.079	0.077	0.045	0.073	0.076	0.092	0.109	0.071	0.007	0.054	0.088	23.9%
7/05	0.073	0.064	0.103	0.077	0.079	0.104	0.102	0.131	0.109	0.094	0.007	0.077	0.110	17.7%
7/06	0.123	0.087	0.103	0.077	0.111	0.140	0.134	0.162	0.109	0.116	0.009	0.096	0.137	17.7%
7/07	0.199	0.087	0.103	0.107	0.138	0.179	0.173	0.162	0.151	0.144	0.013	0.115	0.174	20.5%
7/08	0.199	0.087	0.152	0.129	0.173	0.213	0.173	0.162	0.188	0.164	0.013	0.135	0.193	17.9%
7/09	0.199	0.122	0.181	0.172	0.211	0.213	0.173	0.223	0.217	0.190	0.011	0.165	0.214	12.9%
7/10	0.252	0.169	0.206	0.204	0.211	0.213	0.232	0.263	0.250	0.222	0.010	0.199	0.245	10.3%
7/11	0.320	0.228	0.242	0.225	0.211	0.276	0.290	0.309	0.291	0.266	0.013	0.235	0.296	11.5%
7/12	0.360	0.279	0.294	0.225	0.267	0.335	0.349	0.344	0.291	0.305	0.015	0.270	0.339	11.4%
7/13	0.412	0.322	0.294	0.225	0.319	0.388	0.409	0.388	0.291	0.339	0.021	0.289	0.388	14.6%
7/14	0.484	0.322	0.294	0.308	0.374	0.444	0.459	0.388	0.349	0.380	0.023	0.327	0.433	14.0%
7/15	0.484	0.322	0.339	0.384	0.408	0.493	0.459	0.388	0.398	0.408	0.020	0.362	0.455	11.3%
7/16	0.484	0.416	0.392	0.437	0.461	0.493	0.459	0.444	0.443	0.448	0.011	0.424	0.472	5.4%
7/17	0.534	0.485	0.455	0.486	0.461	0.493	0.507	0.509	0.475	0.489	0.008	0.470	0.509	3.9%
7/18	0.609	0.530	0.510	0.538	0.461	0.565	0.628	0.551	0.521	0.546	0.017	0.507	0.585	7.1%
7/19	0.654	0.577	0.569	0.538	0.527	0.621	0.692	0.604	0.521	0.589	0.020	0.544	0.634	7.7%
7/20	0.723	0.627	0.569	0.538	0.591	0.674	0.736	0.655	0.521	0.626	0.026	0.566	0.685	9.5%
7/21	0.737	0.627	0.569	0.596	0.650	0.724	0.793	0.655	0.608	0.662	0.025	0.605	0.719	8.6%
7/22	0.737	0.627	0.617	0.630	0.685	0.774	0.793	0.655	0.669	0.687	0.022	0.637	0.738	7.3%
7/23	0.737	0.677	0.645	0.679	0.745	0.774	0.793	0.713	0.730	0.721	0.016	0.684	0.758	5.1%
7/24	0.793	0.731	0.705	0.735	0.745	0.774	0.866	0.767	0.763	0.764	0.015	0.729	0.800	4.7%
7/25	0.842	0.790	0.770	0.782	0.745	0.837	0.918	0.813	0.785	0.809	0.017	0.770	0.849	4.9%
7/26	0.874	0.841	0.829	0.782	0.807	0.884	0.962	0.859	0.785	0.847	0.019	0.803	0.890	5.1%
7/27	0.926	0.918	0.829	0.782	0.864	0.922	0.990	0.912	0.785	0.881	0.024	0.826	0.935	6.2%
7/28	0.951	0.918	0.829	0.842	0.915	0.961	0.995	0.912	0.825	0.905	0.020	0.858	0.952	5.2%
7/29	0.951	0.918	0.902	0.894	0.960	1.000	0.995	0.912	0.857	0.932	0.016	0.895	0.969	3.9%
7/30	0.951	0.960	0.961	0.944	1.000	1.000	0.995	0.960	0.929	0.967	0.009	0.947	0.986	2.0%
7/31	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000	1.000	1.000	0.0%

^a Relative precision.

Appendix B8. Historical daily cumulative proportions of the HPUE for chinook salmon by guided anglers during the return of late-run chinook salmon to the Kenai River, 1984-1992.

Date	Daily cumulative proportions [P(t)] by year of guided angler HPUE									95% Confidence Interval				Rel ^a Prec
	1984	1985	1986	1987	1988	1989	1990	1991	1992	Mean	SE	Low	High	
7/01	0.000	0.075	0.025	0.050	0.047	0.020	0.000	0.000	0.069	0.032	0.010	0.009	0.054	71.6%
7/02	0.026	0.092	0.046	0.113	0.064	0.020	0.000	0.042	0.099	0.056	0.013	0.026	0.086	53.4%
7/03	0.091	0.118	0.079	0.182	0.064	0.020	0.027	0.098	0.099	0.086	0.016	0.049	0.124	43.2%
7/04	0.144	0.142	0.118	0.244	0.064	0.075	0.091	0.116	0.117	0.124	0.018	0.083	0.164	32.9%
7/05	0.186	0.166	0.130	0.244	0.104	0.115	0.151	0.116	0.117	0.148	0.015	0.113	0.182	23.5%
7/06	0.226	0.211	0.130	0.244	0.173	0.184	0.233	0.189	0.117	0.190	0.015	0.155	0.224	18.0%
7/07	0.264	0.211	0.130	0.298	0.201	0.288	0.271	0.189	0.144	0.222	0.021	0.174	0.270	21.4%
7/08	0.264	0.211	0.163	0.341	0.253	0.319	0.271	0.189	0.186	0.244	0.020	0.197	0.292	19.3%
7/09	0.264	0.251	0.187	0.375	0.282	0.319	0.271	0.189	0.203	0.260	0.021	0.213	0.308	18.3%
7/10	0.285	0.296	0.201	0.404	0.282	0.319	0.298	0.216	0.248	0.283	0.020	0.237	0.329	16.3%
7/11	0.301	0.346	0.246	0.417	0.282	0.377	0.318	0.272	0.308	0.318	0.018	0.277	0.360	12.9%
7/12	0.317	0.373	0.266	0.417	0.345	0.419	0.379	0.302	0.308	0.347	0.018	0.306	0.388	11.8%
7/13	0.347	0.409	0.266	0.417	0.368	0.512	0.425	0.315	0.308	0.374	0.025	0.316	0.432	15.4%
7/14	0.365	0.409	0.266	0.444	0.409	0.536	0.456	0.315	0.406	0.401	0.026	0.340	0.462	15.2%
7/15	0.365	0.409	0.313	0.470	0.468	0.547	0.456	0.315	0.482	0.425	0.027	0.363	0.487	14.5%
7/16	0.365	0.455	0.382	0.502	0.496	0.547	0.456	0.374	0.526	0.456	0.023	0.403	0.509	11.6%
7/17	0.408	0.492	0.419	0.549	0.496	0.547	0.537	0.392	0.570	0.490	0.023	0.438	0.542	10.6%
7/18	0.438	0.508	0.487	0.575	0.496	0.634	0.581	0.472	0.598	0.532	0.022	0.481	0.583	9.6%
7/19	0.481	0.533	0.519	0.575	0.542	0.698	0.622	0.552	0.598	0.569	0.021	0.519	0.618	8.7%
7/20	0.538	0.556	0.519	0.575	0.569	0.708	0.648	0.601	0.598	0.590	0.019	0.546	0.635	7.6%
7/21	0.626	0.556	0.519	0.603	0.618	0.740	0.716	0.601	0.626	0.623	0.023	0.569	0.676	8.6%
7/22	0.626	0.556	0.569	0.638	0.731	0.794	0.716	0.601	0.695	0.658	0.027	0.597	0.720	9.4%
7/23	0.626	0.661	0.593	0.703	0.805	0.794	0.716	0.623	0.722	0.694	0.025	0.636	0.751	8.3%
7/24	0.688	0.719	0.635	0.750	0.805	0.794	0.752	0.663	0.722	0.725	0.019	0.682	0.769	6.0%
7/25	0.739	0.773	0.685	0.804	0.805	0.840	0.781	0.711	0.722	0.762	0.017	0.723	0.802	5.1%
7/26	0.833	0.789	0.716	0.804	0.867	0.873	0.835	0.768	0.722	0.801	0.019	0.757	0.845	5.5%
7/27	0.901	0.859	0.716	0.804	0.901	0.929	0.857	0.847	0.722	0.837	0.025	0.779	0.896	7.0%
7/28	0.934	0.859	0.716	0.839	0.917	1.000	0.881	0.847	0.729	0.858	0.031	0.787	0.928	8.2%
7/29	0.934	0.859	0.817	0.886	0.950	1.000	0.881	0.847	0.729	0.878	0.027	0.817	0.939	7.0%
7/30	0.934	0.925	0.906	0.930	1.000	1.000	0.881	0.938	0.884	0.933	0.014	0.900	0.966	3.6%
7/31	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000	1.000	1.000	0.0%

^a Relative precision.

Appendix B9. Historical daily cumulative proportions of the CPUE for chinook salmon by guided anglers during the return of late-run chinook salmon to the Kenai River, 1984-1992.

Date	Daily cumulative proportions [P(t)] by year of guided angler CPUE									95% Confidence Interval				Rel ^a Prec
	1984	1985	1986	1987	1988	1989	1990	1991	1992	Mean	SE	Low	High	
7/01	0.000	0.067	0.032	0.042	0.036	0.017	0.000	0.000	0.050	0.027	0.008	0.008	0.046	69.2%
7/02	0.030	0.079	0.068	0.106	0.049	0.017	0.000	0.046	0.070	0.052	0.011	0.026	0.077	49.1%
7/03	0.082	0.097	0.095	0.169	0.049	0.017	0.031	0.091	0.070	0.078	0.015	0.044	0.112	44.0%
7/04	0.129	0.114	0.141	0.234	0.049	0.062	0.084	0.106	0.084	0.111	0.018	0.069	0.154	37.9%
7/05	0.172	0.131	0.159	0.234	0.085	0.111	0.142	0.129	0.084	0.138	0.016	0.102	0.174	26.0%
7/06	0.210	0.167	0.159	0.234	0.148	0.173	0.219	0.189	0.084	0.176	0.015	0.141	0.211	19.7%
7/07	0.244	0.167	0.159	0.299	0.177	0.258	0.260	0.189	0.102	0.206	0.021	0.158	0.254	23.4%
7/08	0.244	0.167	0.204	0.333	0.217	0.293	0.260	0.189	0.130	0.226	0.021	0.177	0.275	21.6%
7/09	0.244	0.241	0.225	0.371	0.240	0.293	0.260	0.192	0.141	0.245	0.021	0.196	0.294	19.9%
7/10	0.265	0.311	0.239	0.393	0.240	0.293	0.281	0.225	0.197	0.272	0.019	0.227	0.316	16.4%
7/11	0.289	0.374	0.276	0.407	0.240	0.373	0.303	0.277	0.237	0.309	0.021	0.261	0.356	15.4%
7/12	0.307	0.396	0.294	0.407	0.301	0.419	0.369	0.307	0.237	0.337	0.021	0.289	0.385	14.2%
7/13	0.331	0.435	0.294	0.407	0.325	0.528	0.417	0.317	0.237	0.366	0.029	0.298	0.434	18.6%
7/14	0.350	0.435	0.294	0.427	0.370	0.547	0.454	0.317	0.314	0.390	0.028	0.326	0.453	16.3%
7/15	0.350	0.435	0.365	0.457	0.438	0.567	0.454	0.317	0.370	0.417	0.025	0.359	0.475	13.9%
7/16	0.350	0.503	0.451	0.490	0.461	0.567	0.454	0.408	0.408	0.455	0.021	0.406	0.503	10.6%
7/17	0.407	0.549	0.500	0.533	0.461	0.567	0.543	0.430	0.446	0.493	0.020	0.448	0.538	9.1%
7/18	0.447	0.564	0.551	0.554	0.461	0.649	0.610	0.496	0.467	0.533	0.023	0.479	0.587	10.1%
7/19	0.497	0.581	0.578	0.554	0.503	0.709	0.656	0.564	0.467	0.568	0.026	0.509	0.627	10.4%
7/20	0.561	0.600	0.578	0.554	0.531	0.717	0.687	0.613	0.467	0.590	0.026	0.531	0.649	10.0%
7/21	0.644	0.600	0.578	0.583	0.626	0.748	0.747	0.613	0.486	0.625	0.027	0.561	0.688	10.1%
7/22	0.644	0.600	0.611	0.621	0.743	0.792	0.747	0.613	0.543	0.657	0.028	0.593	0.721	9.8%
7/23	0.644	0.705	0.630	0.683	0.812	0.792	0.747	0.632	0.562	0.690	0.027	0.626	0.753	9.2%
7/24	0.714	0.754	0.660	0.725	0.812	0.792	0.782	0.685	0.607	0.726	0.022	0.674	0.777	7.1%
7/25	0.763	0.805	0.703	0.798	0.812	0.832	0.823	0.734	0.659	0.770	0.020	0.724	0.816	6.0%
7/26	0.847	0.819	0.735	0.798	0.873	0.879	0.866	0.801	0.659	0.809	0.024	0.753	0.864	6.9%
7/27	0.908	0.892	0.735	0.798	0.916	0.930	0.884	0.875	0.659	0.844	0.031	0.773	0.916	8.5%
7/28	0.937	0.892	0.735	0.849	0.928	0.993	0.903	0.875	0.735	0.872	0.029	0.805	0.939	7.7%
7/29	0.937	0.892	0.830	0.891	0.956	1.000	0.903	0.875	0.767	0.895	0.023	0.842	0.947	5.9%
7/30	0.937	0.947	0.912	0.940	1.000	1.000	0.903	0.949	0.901	0.943	0.012	0.915	0.972	3.0%
7/31	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000	1.000	1.000	0.0%

^a Relative precision.

Appendix B10. Historical daily cumulative proportions of the harvest of chinook salmon by guided anglers during the return of late-run chinook salmon to the Kenai River, 1984-1992.

Date	Daily cumulative proportions [P(t)] by year of guided angler harvest									95% Confidence Interval				Rel ^a Prec
	1984	1985	1986	1987	1988	1989	1990	1991	1992	Mean	SE	Low	High	
7/01	0.000	0.037	0.013	0.008	0.026	0.013	0.000	0.000	0.045	0.016	0.006	0.003	0.029	81.6%
7/02	0.008	0.039	0.019	0.041	0.034	0.013	0.000	0.031	0.059	0.027	0.006	0.013	0.041	52.5%
7/03	0.030	0.041	0.030	0.085	0.034	0.013	0.027	0.068	0.059	0.043	0.008	0.025	0.061	41.1%
7/04	0.055	0.047	0.049	0.118	0.034	0.060	0.072	0.079	0.066	0.065	0.008	0.046	0.083	29.1%
7/05	0.080	0.058	0.055	0.118	0.064	0.085	0.107	0.079	0.066	0.079	0.007	0.062	0.096	21.2%
7/06	0.128	0.079	0.055	0.118	0.111	0.136	0.167	0.129	0.066	0.110	0.012	0.082	0.138	25.4%
7/07	0.197	0.079	0.055	0.157	0.129	0.220	0.201	0.129	0.088	0.139	0.020	0.094	0.185	32.4%
7/08	0.197	0.079	0.088	0.179	0.169	0.241	0.201	0.129	0.118	0.156	0.018	0.113	0.198	27.3%
7/09	0.197	0.109	0.102	0.215	0.193	0.241	0.201	0.129	0.127	0.168	0.017	0.129	0.208	23.4%
7/10	0.223	0.155	0.109	0.237	0.193	0.241	0.237	0.154	0.155	0.189	0.016	0.152	0.226	19.5%
7/11	0.249	0.217	0.143	0.244	0.193	0.316	0.262	0.211	0.202	0.226	0.016	0.189	0.264	16.6%
7/12	0.264	0.248	0.164	0.244	0.271	0.367	0.343	0.234	0.202	0.260	0.021	0.211	0.308	18.8%
7/13	0.301	0.281	0.164	0.244	0.297	0.469	0.407	0.246	0.202	0.290	0.032	0.216	0.364	25.4%
7/14	0.332	0.281	0.164	0.297	0.346	0.496	0.442	0.246	0.311	0.324	0.033	0.248	0.400	23.5%
7/15	0.332	0.281	0.207	0.345	0.392	0.508	0.442	0.246	0.380	0.348	0.032	0.275	0.421	21.0%
7/16	0.332	0.374	0.283	0.387	0.424	0.508	0.442	0.321	0.418	0.388	0.023	0.334	0.441	13.7%
7/17	0.384	0.428	0.330	0.442	0.424	0.508	0.528	0.347	0.445	0.426	0.022	0.375	0.477	11.9%
7/18	0.438	0.444	0.407	0.475	0.424	0.635	0.649	0.422	0.469	0.485	0.031	0.414	0.555	14.6%
7/19	0.483	0.469	0.446	0.475	0.490	0.709	0.709	0.514	0.469	0.529	0.034	0.450	0.609	15.0%
7/20	0.578	0.493	0.446	0.475	0.529	0.720	0.734	0.571	0.469	0.557	0.035	0.475	0.639	14.7%
7/21	0.606	0.493	0.446	0.513	0.592	0.753	0.821	0.571	0.515	0.590	0.041	0.495	0.685	16.1%
7/22	0.606	0.493	0.495	0.541	0.680	0.809	0.821	0.571	0.596	0.624	0.041	0.529	0.718	15.1%
7/23	0.606	0.607	0.509	0.619	0.778	0.809	0.821	0.600	0.628	0.664	0.037	0.579	0.749	12.7%
7/24	0.688	0.675	0.561	0.682	0.778	0.809	0.882	0.647	0.628	0.705	0.033	0.629	0.782	10.9%
7/25	0.748	0.743	0.627	0.742	0.778	0.868	0.916	0.696	0.628	0.750	0.032	0.675	0.824	10.0%
7/26	0.820	0.761	0.664	0.742	0.863	0.899	0.969	0.754	0.628	0.789	0.037	0.704	0.874	10.7%
7/27	0.903	0.876	0.664	0.742	0.905	0.943	0.983	0.848	0.628	0.833	0.042	0.736	0.929	11.6%
7/28	0.924	0.876	0.664	0.794	0.923	1.000	0.985	0.848	0.633	0.850	0.044	0.749	0.950	11.9%
7/29	0.924	0.876	0.818	0.853	0.956	1.000	0.985	0.848	0.633	0.877	0.037	0.791	0.963	9.8%
7/30	0.924	0.936	0.924	0.906	1.000	1.000	0.985	0.945	0.843	0.940	0.017	0.902	0.979	4.1%
7/31	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000	1.000	1.000	0.0%

^a Relative precision.

Appendix B11. Historical daily cumulative proportions of the catch of chinook salmon by guided anglers during the return of late-run chinook salmon to the Kenai River, 1984-1992.

Date	Daily cumulative proportions [P(t)] by year of guided angler catch									95% Confidence Interval				Rel ^a Prec
	1984	1985	1986	1987	1988	1989	1990	1991	1992	Mean	SE	Low	High	
7/01	0.000	0.031	0.017	0.006	0.019	0.011	0.000	0.000	0.036	0.013	0.004	0.003	0.024	77.5%
7/02	0.010	0.033	0.027	0.040	0.025	0.011	0.000	0.033	0.045	0.025	0.005	0.013	0.037	46.8%
7/03	0.026	0.034	0.036	0.080	0.025	0.011	0.030	0.063	0.045	0.039	0.007	0.023	0.055	41.7%
7/04	0.047	0.038	0.059	0.114	0.025	0.049	0.064	0.072	0.051	0.058	0.008	0.038	0.077	33.6%
7/05	0.072	0.045	0.069	0.114	0.051	0.080	0.095	0.092	0.051	0.074	0.008	0.056	0.092	24.0%
7/06	0.117	0.061	0.069	0.114	0.094	0.125	0.148	0.132	0.051	0.101	0.011	0.075	0.128	25.9%
7/07	0.176	0.061	0.069	0.160	0.112	0.193	0.181	0.132	0.067	0.128	0.018	0.087	0.169	31.8%
7/08	0.176	0.061	0.114	0.179	0.141	0.217	0.181	0.132	0.088	0.143	0.017	0.105	0.182	26.8%
7/09	0.176	0.115	0.127	0.217	0.160	0.217	0.181	0.136	0.095	0.158	0.014	0.125	0.192	21.1%
7/10	0.202	0.181	0.135	0.234	0.160	0.217	0.208	0.165	0.132	0.182	0.012	0.154	0.209	15.3%
7/11	0.239	0.257	0.163	0.241	0.160	0.320	0.234	0.218	0.166	0.222	0.018	0.182	0.263	18.2%
7/12	0.256	0.280	0.182	0.241	0.234	0.376	0.315	0.241	0.166	0.254	0.021	0.205	0.304	19.4%
7/13	0.285	0.315	0.182	0.241	0.260	0.493	0.377	0.251	0.166	0.286	0.034	0.208	0.363	27.1%
7/14	0.316	0.315	0.182	0.282	0.314	0.516	0.415	0.251	0.259	0.317	0.033	0.242	0.392	23.7%
7/15	0.316	0.315	0.249	0.335	0.365	0.535	0.415	0.251	0.314	0.344	0.029	0.276	0.412	19.7%
7/16	0.316	0.443	0.345	0.377	0.391	0.535	0.415	0.363	0.349	0.393	0.022	0.342	0.443	12.9%
7/17	0.382	0.507	0.409	0.428	0.391	0.535	0.504	0.395	0.374	0.436	0.021	0.388	0.484	11.0%
7/18	0.452	0.521	0.468	0.454	0.391	0.655	0.676	0.454	0.394	0.496	0.035	0.417	0.576	16.0%
7/19	0.503	0.538	0.501	0.454	0.451	0.724	0.738	0.533	0.394	0.537	0.040	0.446	0.629	17.0%
7/20	0.606	0.557	0.501	0.454	0.489	0.733	0.766	0.588	0.394	0.565	0.041	0.470	0.660	16.8%
7/21	0.631	0.557	0.501	0.494	0.610	0.763	0.837	0.588	0.427	0.601	0.044	0.500	0.702	16.7%
7/22	0.631	0.557	0.534	0.524	0.698	0.809	0.837	0.588	0.499	0.631	0.042	0.535	0.727	15.2%
7/23	0.631	0.665	0.545	0.598	0.788	0.809	0.837	0.613	0.523	0.668	0.039	0.578	0.757	13.4%
7/24	0.721	0.719	0.583	0.654	0.788	0.809	0.893	0.675	0.553	0.711	0.036	0.627	0.794	11.8%
7/25	0.777	0.780	0.641	0.735	0.788	0.860	0.937	0.724	0.576	0.758	0.036	0.675	0.840	10.9%
7/26	0.840	0.794	0.681	0.735	0.869	0.905	0.977	0.792	0.576	0.796	0.040	0.704	0.889	11.7%
7/27	0.912	0.910	0.681	0.735	0.921	0.945	0.987	0.878	0.576	0.838	0.047	0.731	0.946	12.8%
7/28	0.929	0.910	0.681	0.809	0.935	0.995	0.989	0.878	0.638	0.863	0.043	0.764	0.961	11.4%
7/29	0.929	0.910	0.826	0.861	0.962	1.000	0.989	0.878	0.659	0.891	0.035	0.810	0.971	9.0%
7/30	0.929	0.957	0.927	0.919	1.000	1.000	0.989	0.955	0.855	0.948	0.016	0.912	0.984	3.8%
7/31	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000	1.000	1.000	0.0%

^a Relative precision.