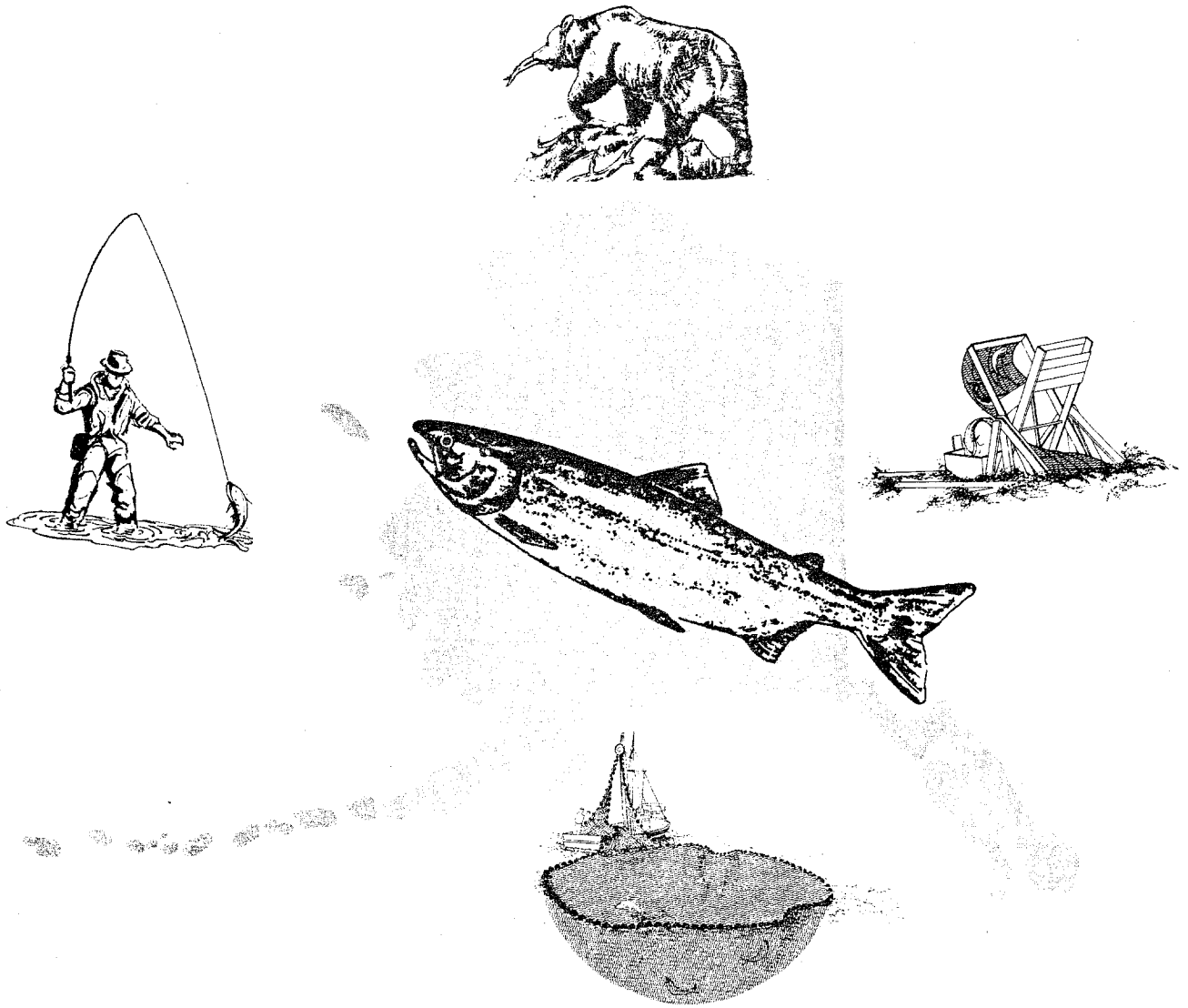
MIGRATION TIMING AND ABUNDANCE OF ADULT SALMONIDS IN THE UGANIK RIVER, KODIAK NATIONAL WILDLIFE REFUGE, ALASKA, 1990 and 1991

Alaska Fisheries Progress Report Number 93-1



March 1993

Region 7
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MIGRATION TIMING AND ABUNDANCE OF ADULT SALMONIDS IN THE UGANIK RIVER, KODIAK NATIONAL WILDLIFE REFUGE, ALASKA 1990 and 1991

Progress Report

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Abstract

The Uganik River drainage on the Kodiak National Wildlife Refuge (Refuge) provides spawning and rearing habitat for seven species of anadromous salmonids, including sockeye *Oncorhynchus nerka*, pink *O. gorbuscha*, chum *O. keta*, coho O. kisutch and chinook *O. tshawytscha* salmon, steelhead *O. mykiss*, and Dolly Varden char *Salvelinus malma*. The Alaska National Interest Lands Conservation Act specifically mandates that within the Refuge, salmon populations and their habitats be conserved. Lack of current and complete data on fish resources in the Uganik River hinders the ability to carry out this mandate and increased harvests by commercial, subsistence and sport fisheries could adversely affect refuge resources.

In 1990 and 1991 a resistance board weir was installed in the lower Uganik River to determine escapement, run timing, and age, length and weight composition of adult fish. A total of 65,551 sockeye, 77,015 pink, 2,560 chum, 5,621 coho and six chinook salmon were counted through the weir in 1990. In 1991, a total of 79,295 sockeye, 185,414 pink, 11,823 chum, 11,704 coho and one chinook salmon were counted. In addition, during 1990 and 1991 70,000 and 10,000 sockeye salmon, respectively, were estimated to have entered the system before weir operations and/or during high water events. The 1990 and 1991 escapements are two to nine times greater than escapement recorded in 1928-1932 for sockeye, pink and coho salmon. A total of 18,159 and 69,564 Dolly Varden also migrated upstream in 1990 and 1991, respectively. Peak escapement occurred in late June and early July for sockeye, July and August for chum, August for pink, and mid-September for coho salmon. The predominant age classes for sockeye, chum and coho salmon were 1.3, 0.3 and 1.2, respectively.

The resistance board weir worked effectively in the glacial fed Uganik River allowing the enumeration and sampling of adult salmon and char. The weir accommodated fluctuating water levels and high debris loads. The success of the weir demonstrates its usefulness for other Alaska river systems.

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Introduction

The Uganik River drainage (Figure 1) on the Kodiak National Wildlife Refuge (Refuge) provides spawning and rearing habitat for sockeye *Oncorhynchus nerka*, pink *O. gorbuscha*, chum *O. keta*, and coho *O. kisutch* salmon, steelhead *O. mykiss* and Dolly Varden char *Salvelinus malma*. These fish populations contribute to commercial, sport, and subsistence fisheries on the northwest side of Kodiak Island and also provide an important food source for a dense brown bear, *Ursus arctos*, population (U.S. Fish and Wildlife Service 1987). Approximately 20-50 bald eagles *Haliaeetus leucocephalus* use the drainage, with higher feeding concentrations present on the lower river during salmon spawning (T. Chatto, U.S. Fish and Wildlife Service, personal communication).

Information on Uganik River fish resources includes historical weir escapement counts from 1928 to 1932 (Table 1) and aerial surveys conducted by the Refuge and the Alaska Department of Fish and Game (Department) from 1958-1967 and 1976-1989 (Table 2). These data reveal that the Uganik River system is a moderate producer of sockeye salmon and has the fourth largest total pink salmon run on the Refuge (U.S. Fish and Wildlife Service 1990). The system is unique because it has consistent run sizes of pink salmon during both odd and even years and is bimodal in timing (U.S. Department of Interior 1968). The chum salmon run coincides with the early pink migration and is the second largest on the Refuge. The segregation of chum and pink salmon escapement poses significant management problems in determining appropriate harvest levels, as commercial fisheries exist in Uganik Bay for both species. The Uganik River is also the sixth largest producer of coho salmon on the Refuge (U.S. Fish and Wildlife Service 1990).

Currently, Uganik River salmon escapement is determined by Refuge and Department aerial index surveys. This method of escapement estimation can be difficult in glacial systems such as the Uganik River, often resulting in highly variable results (Bevan 1961, Schneiderhan 1987). Thus, aerial surveys may not be providing the necessary accuracy for managing the resources, protecting stocks from overharvest, or ensuring escapement given current increases in harvest on Kodiak Island.

Surveys of the sport fishery on Kodiak Island show an increase in both effort and harvest of most salmon species in recent years (U.S. Fish and Wildlife Service 1990 and 1992, Mills 1991). Commercial harvest of all salmon species is currently at or near record harvest levels (Holmes 1990, Alaska Department of Fish and Game 1992a) and effort and harvest in subsistence fisheries are at an all time high for sockeye and coho salmon, which make up over 80% of the subsistence harvest (Kodiak Regional Planning Team 1992). These increases in harvest have occurred simultaneously with favorable environmental conditions for previous brood years resulting in above average escapement for many Kodiak river systems (Alaska Department of Fish and Game 1993).

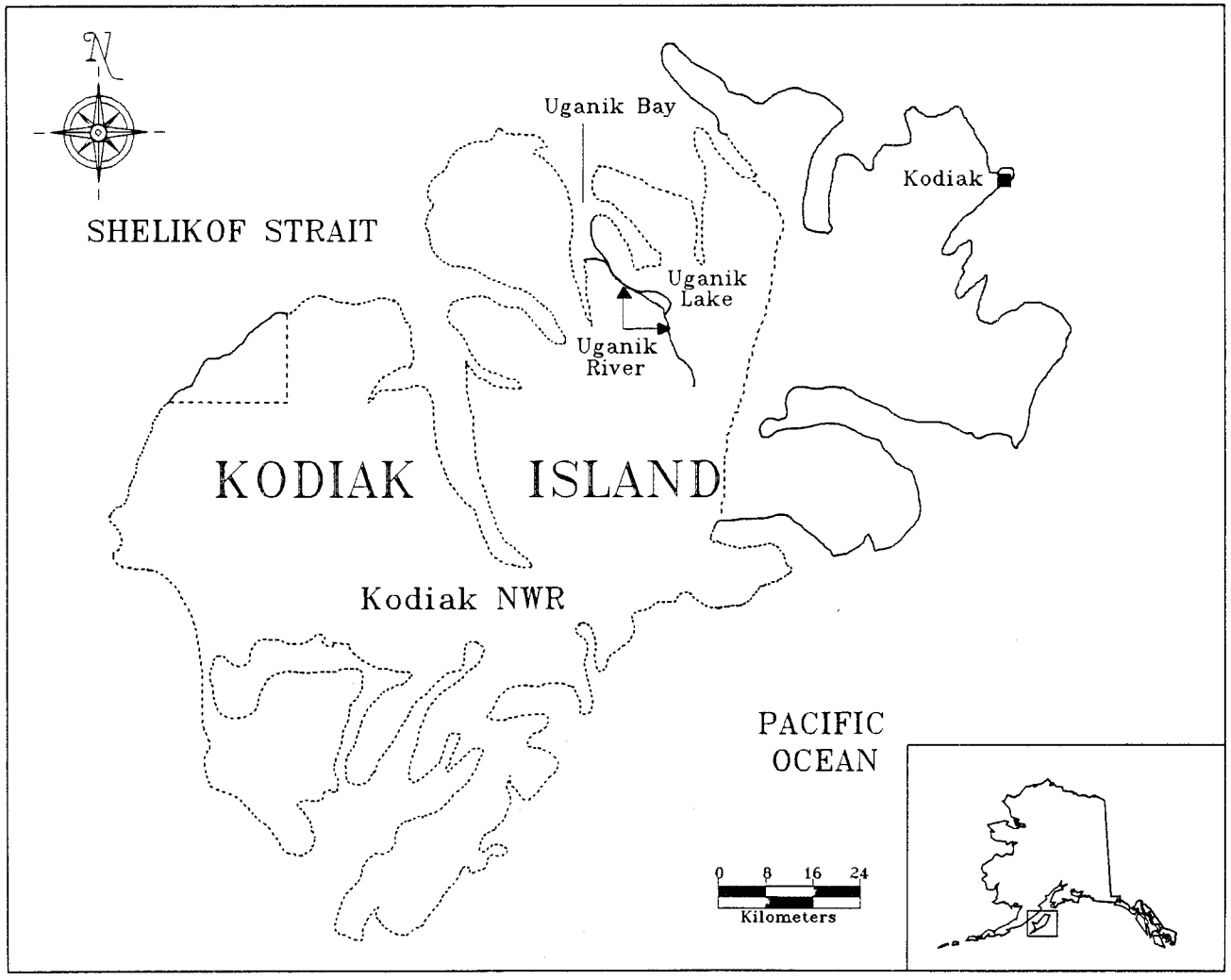

FIGURE 1. —Uganik River, Kodiak National Wildlife Refuge, Alaska.

TABLE 1.-Salmon escapement counts obtained on the Uganik River, Kodiak National Wildlife Refuge, Alaska[a].

Year	Date	Species				
		Sockeye	Pink	Chum	Coho	Chinook
1928	7/1-8/22	15,732	765	4,205	1,001	0
1929	6/15-9/11	24,893	4,973	11,654	476	0
1930	6/5-9/10	9,823	4,075	2,714	1,978	0
1931	7/4-9/4	6,791	71,281	2,968	1,986	0
1932	6/8-8/26	25,808	N/C[b]	N/C	N/C	N/C
	Mean	16,609	20,274	5,385	1,360	0

[a] Data Source: U.S. Department of Interior 1968
[b] N/C = No counts available

TABLE 2.-Aerial survey counts of salmon in the Uganik River, Kodiak National Wildlife Refuge, Alaska[a,b].

Year	Species				
	Sockeye	Pink	Chum	Coho	Chinook
1958	N/C[c]	33,000	1,000	N/C	N/C
1959	5,000	132,000	9,000	N/C	N/C
1960	8,000	128,000	1,000	N/C	N/C
1961	N/C	95,000	1,000	N/C	N/C
1962	N/C	170,000	1,000	N/C	N/C
1964	4,500	105,000	5,500	N/C	N/C
1965	N/C	40,000	500	N/C	N/C
1967	4,000	30,000	14,000	N/C	N/C
1968-1975	N/C	N/C	N/C	N/C	N/C
1976	7,000	90,000	N/C	N/C	N/C
1977	N/C	40,000	N/C	N/C	N/C
1978	N/C	105,000	5,000	N/C	N/C
1979	55,000	100,000	2,000	N/C	N/C
1980	25,000	130,000	N/C	N/C	N/C
1981	65,000	80,000	10,000	N/C	N/C
1982	50,000	90,000	40,000	2,000	N/C
1983	22,000	130,000	30,000	N/C	N/C
1984	39,000	140,000	20,000	3,000	N/C
1985	39,000	120,000	10,000	N/C	N/C
1986	20,000	190,000	N/C	5,000	N/C
1987	8,000	180,000	35,000	1,000	N/C
1988	22,000	160,000	50,000	N/C	N/C
1989	58,000	570,000	90,000	2,000	N/C
Mean	26,969	129,909	18,055	2,600	N/C

[a] Data source: U.S. Fish and Wildlife Service and Alaska Department of Fish and Game data files, Kodiak, Alaska
[b] Expansion factors were used to estimate abundance
[c] N/C = No count available

Outdated or inadequate data on salmon escapement into the Uganik River drainage has hindered refinement of fishery management strategies to maintain population levels, provide adequate food resources for wildlife, allow subsistence and commercial harvests, and support sport fishing opportunities. The Alaska National Interest Lands Conservation Act specifically mandates that within the Refuge, salmonid populations and their habitats be conserved in their natural diversity. With the lack of current, accurate data on Uganik River fish resources, these mandates may not be ensured. The Refuge Fishery Management Plan recognizes this problem and identifies the characterization of Uganik River salmon migrations for management purposes as a priority item (U.S. Fish and Wildlife Service 1990).

In 1990, the U.S. Fish and Wildlife Service (Service) and the Department entered into a cooperative agreement to construct and operate a floating resistance board weir (weir) on the Uganik River. Specific objectives of the study included: 1) to determine the feasibility and limitations of a weir on the Uganik River, and 2) to determine the escapement, run timing, size and age composition of species migrating into the Uganik River.

After a successful season in 1990 the weir was installed in 1991 to obtain comparative data. This report is a summarization of the 1990 and 1991 field seasons.

Study Area

The Uganik River is a glacially fed river system located on the west side of Kodiak Island (Figure 1) approximately 50 km west of the city of Kodiak. The 33,510 hectare drainage lies entirely within the Refuge boundaries. The Uganik River flows approximately 50 km in a northwesterly direction before entering Uganik Lake. The 393 hectare lake is located in the northern portion of the drainage and bisects the river into an upper and lower section. After exiting Uganik Lake the river flows in a westerly direction for 6.5 km before entering the East Arm of Uganik Bay.

Stream discharge averages less than 3 m^3/s in late winter and spring to over 28 m^3/s in May through September. Extreme high flows have been recorded over 227 m^3/s with most occurring in May during the spring runoff and again in August and September associated with high precipitation periods (U.S. Geological Survey 1951-1978). The mean yearly discharge ranges from 14-28 m^3/s.

Methods

Weir

A floating resistance board weir was installed at river kilometer (rkm) 1.4 and was operational from June 25 to October 12, 1990 and May

19 to October 11 in 1991 (Figure 2). The weir was installed prior to salmon migration with the exception of 1990 when it was not installed until personnel and funding became available. The weir was removed when icing conditions made operations difficult and fewer than 100 fish were being passed weekly.

The weir was fabricated by the Department and is similar to one constructed for the Little Susitna River (Bartlett 1988). The design is patterned after the Japanese resistance-board weir. The weir consists of 2.5 cm diameter PVC plastic conduit pipe (pickets) strung together to form panels 1.2 m wide by 4.6 long (Figure 3). Panels were attached to 41 kg railroad track that was anchored to the stream bed perpendicular to the stream flow with rebar stakes and duckbill anchors. Water passing through the gaps between the conduit pickets hits a resistance board attached to the downstream end of each panel forcing the weir panels up out of the water.

Several modifications were incorporated into the weir in 1991 to allow it to effectively prohibit upstream migration at higher water levels. Individual pickets of each weir panel were lengthened by 1.5 m making each panel 1.2 m wide by 6.1 m long, and resistance boards were increased in size from 0.6 m wide by 1.2 m long to 0.8 m wide by 1.2 m long (equal to a 25% increase).

A total of 47 panels were used to span the 66 m wide river. Wood bulkheads (6 m long x 1.2 m wide x 1.8 m deep) filled with sandbags were constructed on each bank to prohibit erosion and make a fish tight surface to fasten the weir panels. A rectangular platform made of U-shaped (7.6 cm x 7.6 cm) aluminum angle served as a counting chute and was incorporated into the weir leading directly into a 4.6 m x 3.0 m adult live trap (Figure 4).

Installation and operation of the weir was accomplished by Service personnel. The weir was checked for holes and weaknesses and cleaned each day before 0900 hours. Snorkeling was used to check the integrity of the weir and substrate condition. A stream gauge was installed 90 m downstream of the weir to monitor water elevation and was checked daily.

Biological Data

Fish were individually counted by species with hand held tally whackers and passed through the weir on a daily basis from 0700 to 2100 hours. The counting chute directed fish through the weir one at a time to allow for species identification and escapement counts. During periods of high water, counts of fish escaping over the weir were added to the daily escapement. Estimates of fish passage during the June 19-29, 1991, high water event were obtained by assuming the estimated number of fish downstream of the weir before weir submersion migrated upstream.

The adult trap and holding area constructed into the face (upstream side) of the weir facilitated collecting subsamples and passing adult

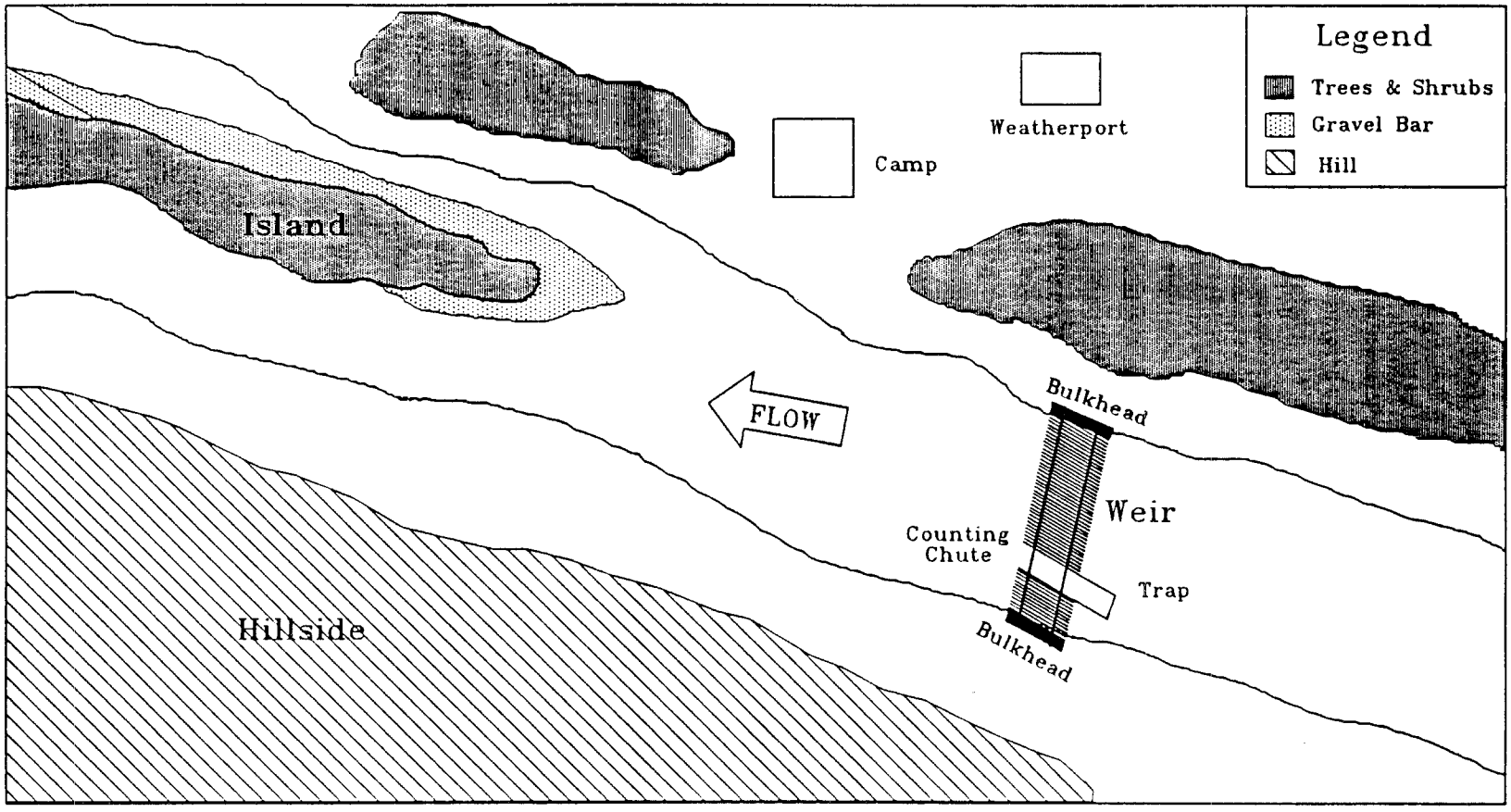

FIGURE 2. —Site map of the Uganik River weir, Kodiak National Wildlife Refuge, Alaska.

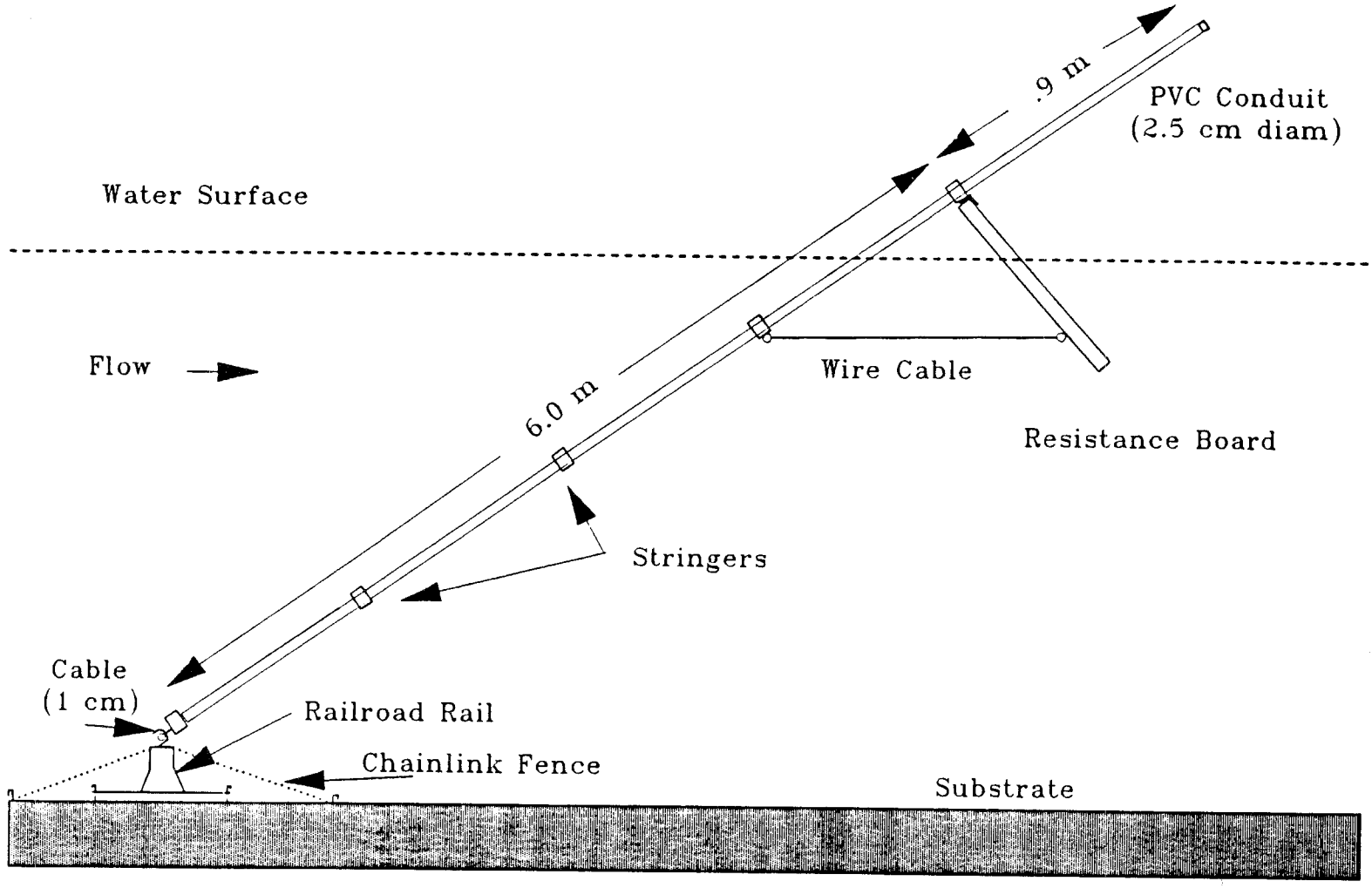

FIGURE 3. —Schematic drawing of a weir panel used on the Uganik River, Kodiak National Wildlife Refuge, Alaska.

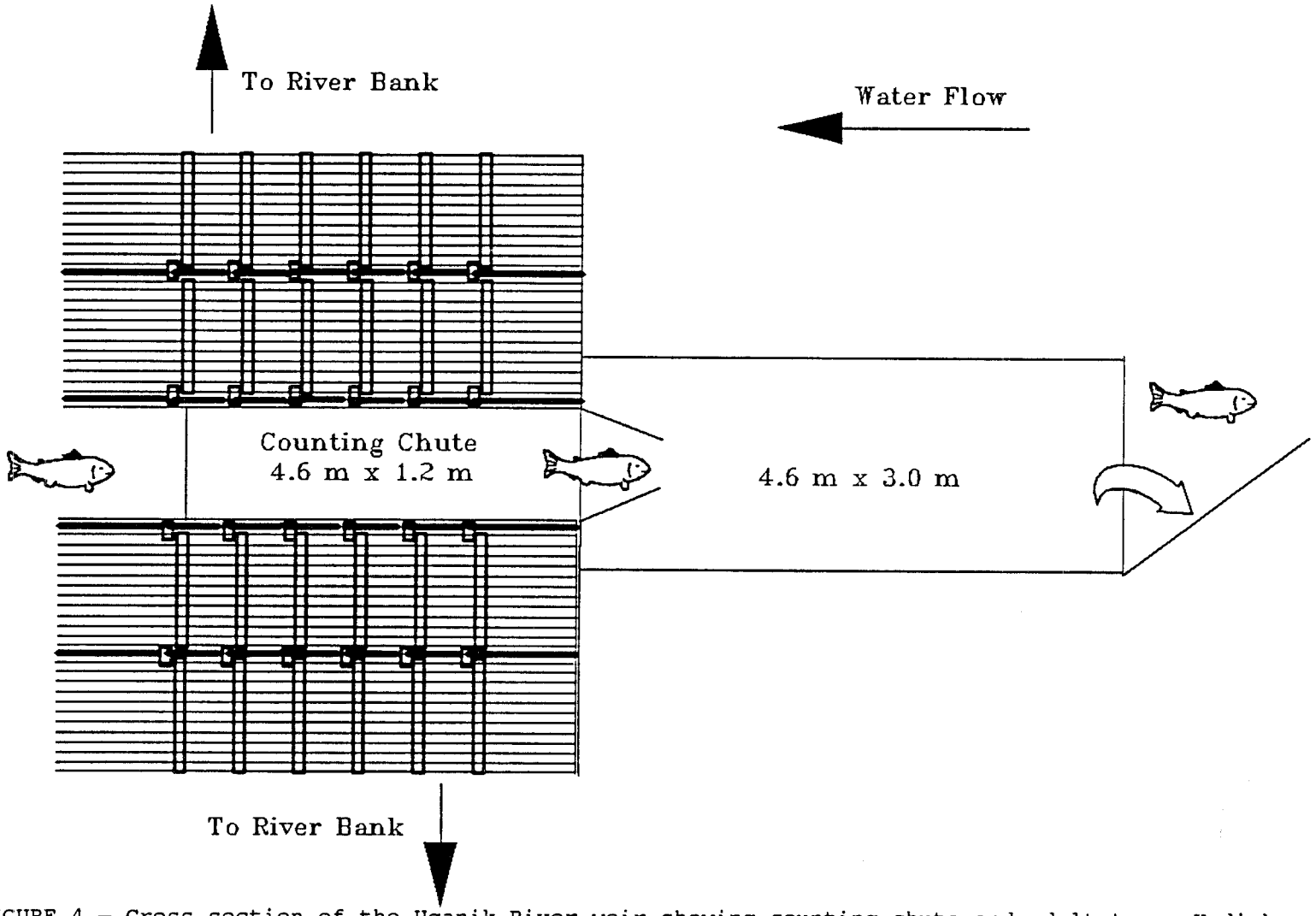

FIGURE 4.— Cross section of the Uganik River weir showing counting chute and adult trap, Kodiak National Wildlife Refuge, Alaska.

salmon through the weir. A subsample of each species (240 sockeye, 240 coho, 70 chum, and 70 pink salmon) was randomly hand dip netted from the trap on a weekly basis, when available. The trap was run continuously to ensure sample size requirements were met. Once samples were obtained the trap was opened and fish were passed until the next sampling period. Escapement counts were aggregated by week to smooth out daily fluctuations due to sampling. Sampled fish were measured from mid-eye to fork length (nearest mm), weighed (nearest 25 grams), sexed from external characteristics and aged. Scales were taken from the preferred area for age determination (Koo 1962, Mosher 1968). One scale was taken from each sockeye and chum salmon and four scales were taken from each coho salmon. Scales were not collected from pink salmon. Chi-square tests (Zar 1984) were used to test for significant differences in sex ratios and age composition.

Results

Weir

The weir was effective in restraining upstream movement (fish tight) on June 25, 1990 and on May 19, 1991 allowing us to individually count and capture fish for biological sampling. The system worked well with a few minor exceptions.

During high water periods the increased water level and velocity sank some of the panels below the water surface. Weir panels began to submerge at a gauge reading of 1.75 m. In 1990, panels were partially submerged a total of 456 hours during nine high water events (Figure 5). High water events generally resulted in a large amount of gravel and cobble accumulating on the weir panels which kept the weir below the water surface for several days after the water level declined. After raking the panels clear of debris, the weir surfaced with little damage and prohibited upstream passage of fish.

The modifications incorporated into the weir in 1991 helped keep the weir above the water surface at higher water flows. After each individual picket was lengthened by 1.5 m and resistance boards were enlarged by 25%, the weir stayed above the water surface at river levels up to 2.0 m. Weir panels were submerged for a total of 393 hours in 1991 during two high water events. The weir was also partially submerged during lower water levels on two occasions in September. High winds resulted in leaf matter accumulating on the weir submerging panels for an unknown period of time overnight.

During low water periods in 1990 fish were reluctant to enter the adult trap. Fish movement increased when water levels and flows began to rise. The counting chute and trap were located in faster, deeper water in 1991. This location allowed for better passage of fish and increased trap efficiency.

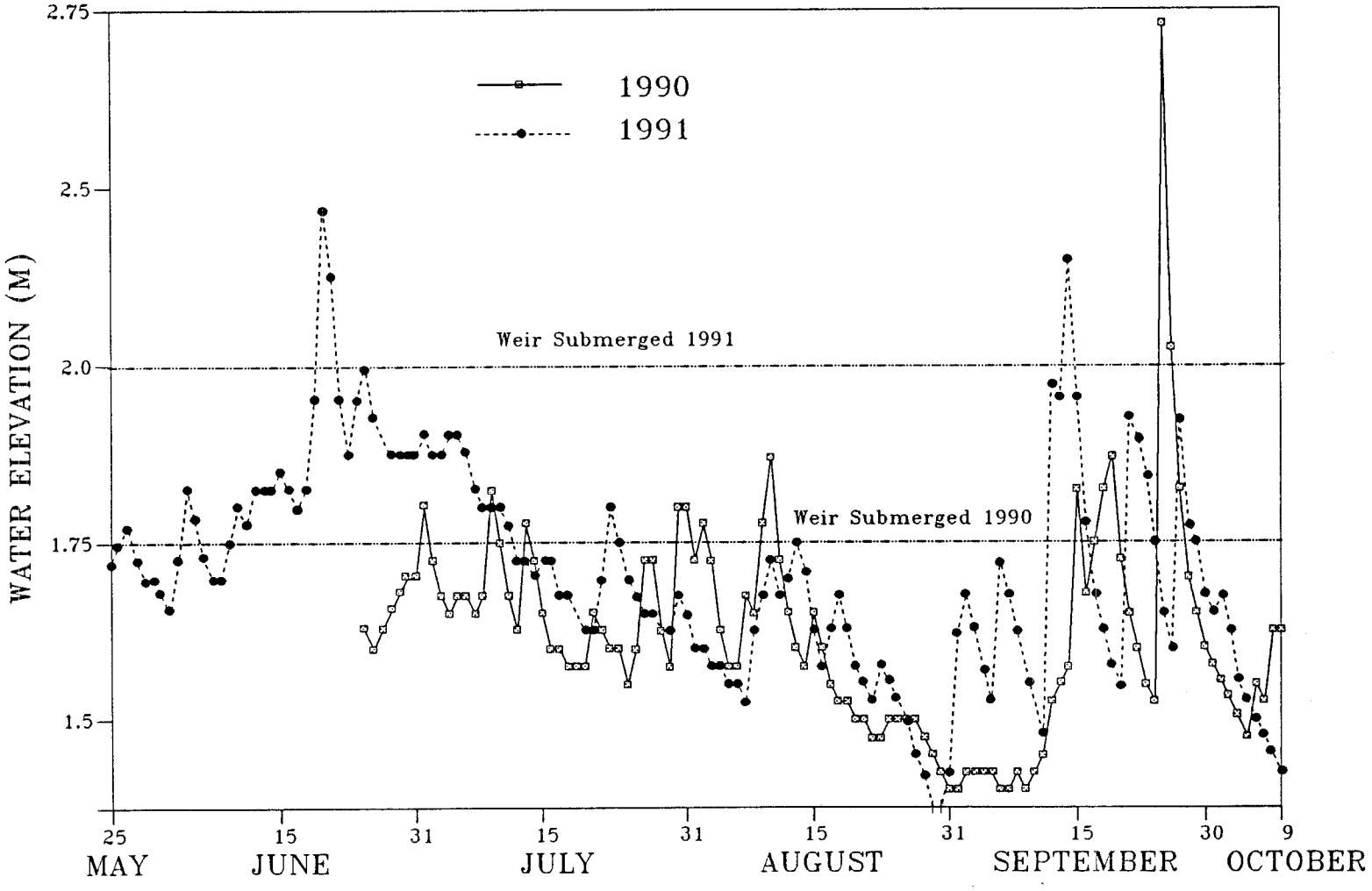

FIGURE 5. —Water elevation measured at the Uganik River weir, Kodiak National Wildlife Refuge, Alaska, 1990 and 1991.

The weir was able to pass large amounts of debris, including mature cottonwood trees over 1 m in diameter. Removing debris and fish carcasses from the weir was accomplished by walking across each panel until it partially submerged and letting the current wash the debris downstream. Following periods of high water raking was required to remove gravel and cobble.

Biological Data

Five species of Pacific salmon returned to the Uganik River in 1990 and 1991. Escapement counts were obtained on sockeye, pink, chum, coho and chinook *O. tshawytscha* salmon, steelhead and Dolly Varden char.

Sockeye salmon-A total of 65,551 sockeye salmon was counted between June 25 and September 20 (Appendix 1). Immediately after the weir became fish tight on June 25, 1990, fish began to congregate downstream of the weir. Peak escapement occurred the first week of July (Figure 6), decreased soon after, and by mid-August less than 100 sockeye salmon passed through the weir daily.

Aerial surveys conducted by the Department indicated an index of 35,000 sockeye salmon in Uganik Lake prior to the weir being fish tight in 1990. Aerial survey data is normally expanded by a factor of 2.0 for Kodiak Island sockeye salmon (P. Holmes, Alaska Department of Fish and Game, personal communication) resulting in an estimated abundance of 70,000. Combining the aerial and weir counts results in an estimated total escapement of approximately 135,550 sockeye salmon in 1990.

A total of 79,295 sockeye salmon was counted between May 25 and October 7, 1991 (Appendix 2). Two escapement peaks occurred, one in mid-June and another in early July (Figure 6). A high water event June 19-29, 1991, partially submerged several weir panels for a total of 223 hours preventing any counts of migrating salmon. Sockeye salmon numbers were increasing at this time and it was estimated that approximately 10,000 fish passed undetected. This estimate combined with the actual weir counts results in an estimated total escapement of 89,295 sockeye salmon for 1991.

Eight age groups were identified for sockeye salmon in 1990 and seven were identified in 1991. The dominant age groups for both years were 1.3 and 2.3 (Table 3). Age composition differed significantly between males and females in 1990 ($P < .001$). Over 80% of the males and females were aged 1.3, 2.2, and 2.3 in 1990, but age 1.3 predominated for females and age 2.2 for males. In 1991 age 1.3 was predominant for both males and females and age composition did not differ significantly by sex ($P > 0.50$). In 1990 the percentage of males (56%) differed significantly from the percentage of females ($P < .005$). In 1991 the percentage of males (47%) was similar to females ($P > 0.50$). Sockeye salmon averaged 530 mm (N=818) and 533 mm (N=748) in length and 2,583 g and 2,336 g in weight in 1990 and 1991, respectively

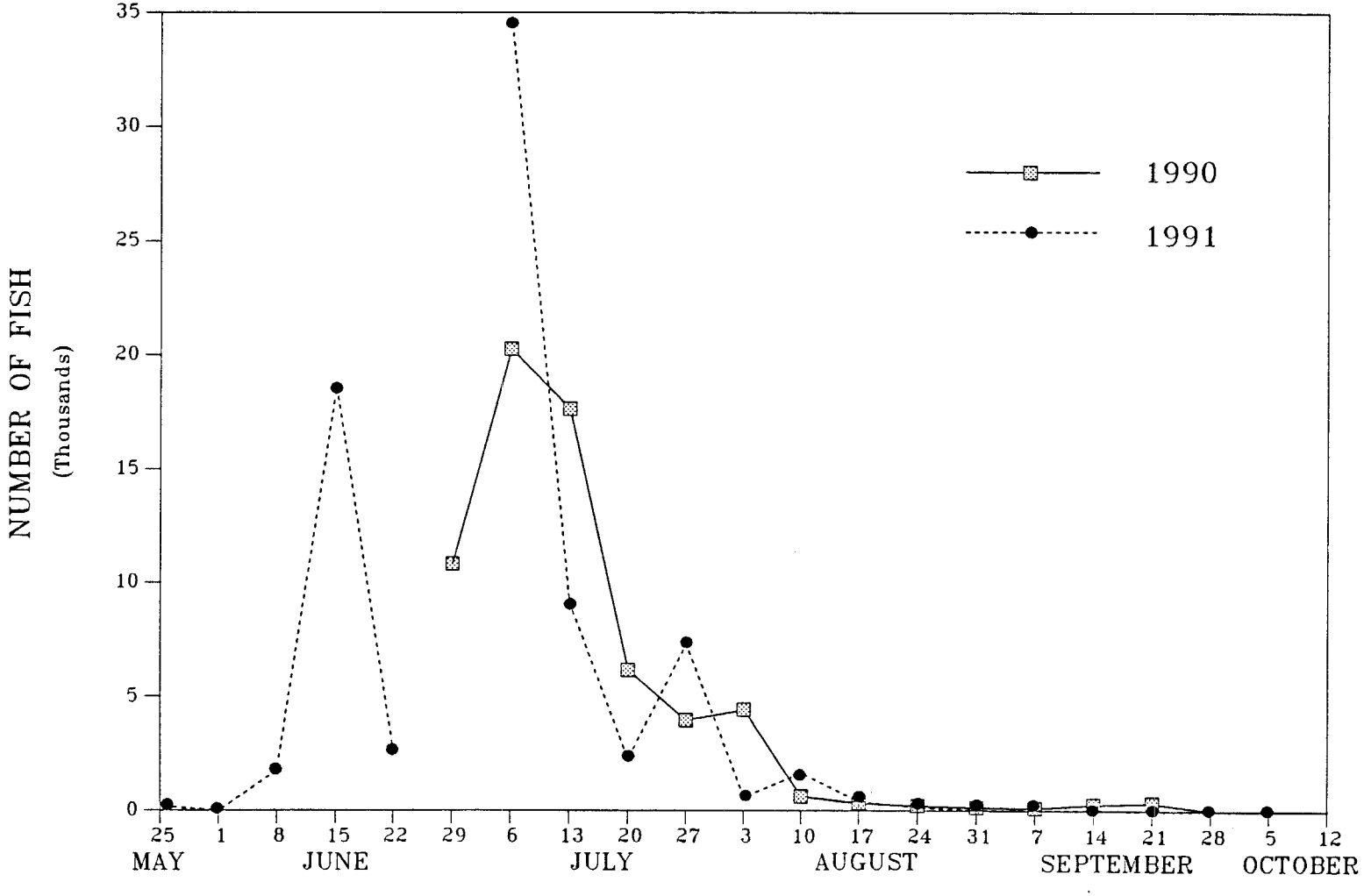

FIGURE 6. —Mean weekly escapement of sockeye salmon in the Uganik River, Kodiak National Wildlife Refuge, Alaska, 1990 and 1991.

TABLE 3.—Age, length, and weight composition of sockeye salmon sampled at the Uganik River weir, Kodiak National Wildlife Refuge, Alaska, 1990 and 1991.

	Females						Males					
			Length (mm)		Weight (g)				Length (mm)		Weight (g)	
Age	N	%	Mean	SE	Mean	SE	N	%	Mean	SE	Mean	SE
						1990						
0.3	1	0.1	535	-	2,875	-	0	0	0	-	-	-
1.2	38	4.6	469	7	1,800	40	74	9.1	466	6	2,025	7
2.1	1	0.1	305	-	1,150	-	3	0.4	325	6	1,225	5
1.3	133	16.3	555	3	2,750	11	118	14.4	593	2	3,250	13
2.2	71	8.7	478	4	2,325	7	131	16.0	469	4	1,925	6
2.3	116	14.2	552	3	2,925	16	127	15.5	589	3	2,900	11
3.2	0	0	0	-	-	-	2	0.2	508	23	2,175	6
2.4	2	0.2	573	18	4,150	62	1	0.1	605	-	3,675	-
Total	362	44.2	528		2,625		456	55.7	531		2,550	
						1991						
1.2	19	2.6	451	5	1,875	25	15	2.0	450	2	2,025	4
2.1	5	.7	0	-	-	-	13	1.7	330	1	1,600	14
1.3	181	24.2	549	3	2,850	11	162	21.7	569	1	2,450	6
2.2	60	8.0	480	5	1,950	11	56	7.5	462	6	1,975	48
2.3	125	16.7	560	6	2,675	16	105	14.0	572	5	2,675	15
2.4	4	0.5	581	14	3,425	23	3	0.4	591	19	3,950	31
Total	394	52.7	528		2,350		354	47.3	539		2,325	

Pink salmon-In 1990, a total of 77,015 pink salmon was counted through the weir and the run timing was unimodal (Figure 7). Pink salmon were first observed at the weir on June 27. Substantial numbers did not appear until the second week in July. Peak escapement occurred the third week of August. By early September fewer than 100 pink salmon were being passed daily.

In 1991, a total of 185,414 pink salmon was counted through the weir and the run timing was bimodal. Pink salmon were first observed at the weir July 5. Substantial numbers (>1,000/day) began to appear the last week in July (Figure 7). Two escapement peaks occurred, one the first week of August and another the last week of August. By late September fewer than 100 pink salmon were being passed daily.

The percentage of males (52% and 53%) was similar to females ($P > 0.50$) in 1990 and 1991, respectively. Female pink salmon averaged 461 mm (N=363) and 470 (N=433) in length and 1,600 g in weight in 1990 and 1991, respectively. Male pink salmon were approximately 6 mm smaller than females, averaging 453 mm and 466 mm in length and 1,575 g and 1,550 g in weight in 1990 and 1991, respectively.

Chum salmon-A total of 2,560 chum salmon was passed through the weir between June 27 and September 20, 1990 and the run timing was unimodal. Chum salmon were observed at the weir the second day of operation (June 27). A daily escapement of 1-217 passed through the weir between July and August with peak escapement occurring the last week of July (Figure 8).

In 1991, a total of 11,823 chum salmon were passed through the weir July to October 6 and the run timing was unimodal. A daily escapement of 13-556 fish were passed from mid-July through mid-September with peak escapement occurring the last week in August (Figure 8).

Four age groups were identified for chum salmon in 1990 and 1991. The dominant age group was 0.3 followed by 0.4 and 0.5 (Table 4). Age composition differed significantly between males and females ($P < 0.05$ and $P < 0.01$) in 1990 and 1991, respectively. Age 0.3 predominated for females and age 0.4 for males. In 1990 the percentage of males (52% was similar to females ($P > 0.50$). However, in 1991 the percentage of males (57%) differed significantly from the percentage of females ($P < .005$). Chum salmon averaged 602 mm (N=256) and 595 mm (N=224) in length and 3,601 g and 3,693 g in weight in 1990 and 1991, respectively.

Coho salmon-A total of 5,261 coho salmon was counted in 1990. Coho salmon first appeared at the weir on August 14, 1991. This was followed by a low escapement for four weeks until a peak number (>2,500) was passed on September 12 (Figure 9). Coho salmon were passed through the weir in low numbers until the weir was disassembled on October 12.

A total of 11,704 coho salmon was counted in 1991. Coho salmon first appeared at the weir on August 14, 1991. This was followed by a low escapement for two weeks until a peak number (1,173) was passed on

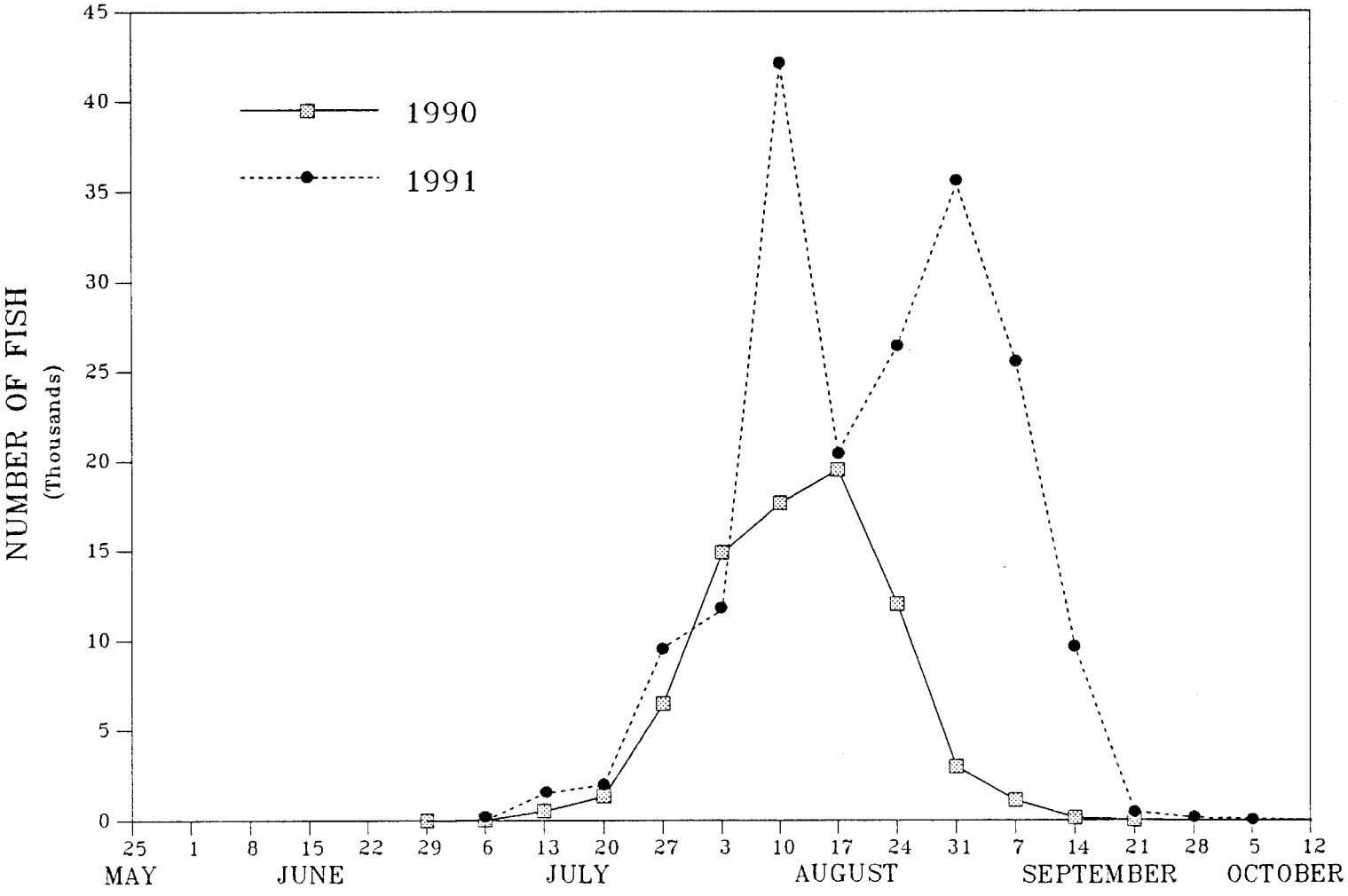

FIGURE 7.– Mean weekly escapement of pink salmon in the Uganik River, Kodiak National Wildlife Refuge, Alaska, 1990 and 1991.

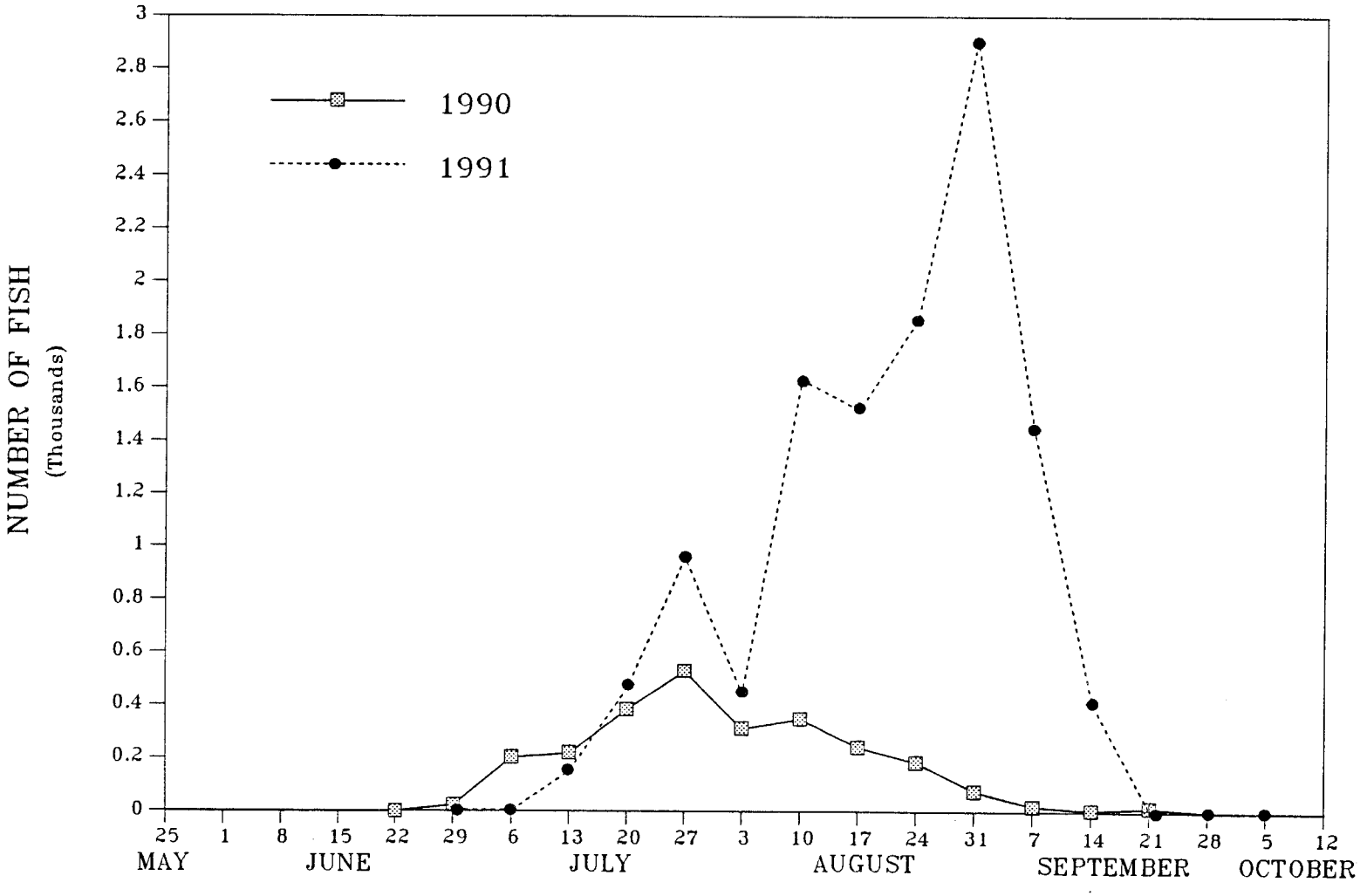

FIGURE 8. —Mean weekly escapement of chum salmon in the Uganik River, Kodiak National Wildlife Refuge, Alaska, 1990 and 1991.

TABLE 4.—Age, length, and weight composition of chum salmon sampled at the Uganik River weir, Kodiak National Wildlife Refuge, Alaska, 1990 and 1991.

	Females						Males					
			Length (mm)		Weight (g)				Length (mm)		Weight (g)	
Age	N	%	Mean	SE	Mean	SE	N	%	Mean	SE	Mean	SE
						1990						
0.2	0	0	0	-	-	-	1	0.4	345	-	2,750	-
0.3	77	30.1	576	4	3,475	9	61	23.8	588	5	3,350	7
0.4	42	16.4	607	6	3,675	14	67	26.2	639	5	3,800	15
0.5	3	1.2	672	6	5,225	22	5	1.9	667	15	4,975	10
Total	122	47.7	589		3,575		134	52.3	615		3,625	
						1991						
0.2	0	0	0	-	-	-	1	0.4	505	-	2,725	-
0.3	64	28.6	570	2	3,200	9	59	26.3	599	3	3,825	18
0.4	31	13.8	597	3	3,200	16	62	27.7	613	4	4,100	22
0.5	2	0.9	617	8	5,475	24	5	2.2	654	12	6,950	17
Total	97	43.3	580		3,225		127	56.6	607		4,050	

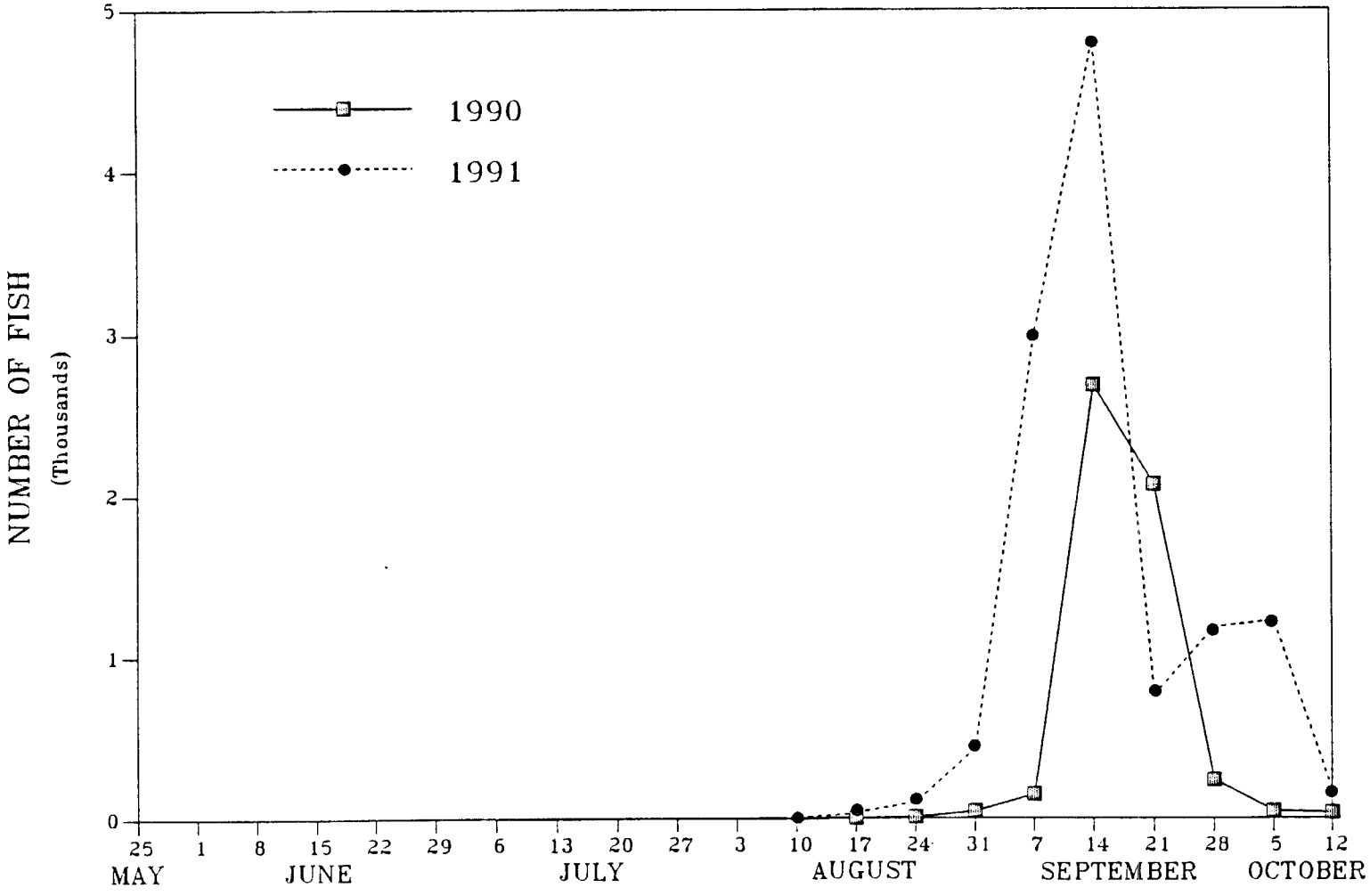

FIGURE 9. —Mean weekly escapement of coho salmon in the Uganik River, Kodiak National Wildlife Refuge, Alaska, 1990 and 1991.

September 11 (Figure 9). Coho salmon were passed through the weir until October 7.

Five age groups of coho salmon were identified in 1990 and three in 1991. The dominant age group was 2.1 for males and females both years (Table 5). The percentage of males (63%) differed significantly from the percentage of females ($P < .005$) in 1990. In 1991 the percentage of males (49%) was similar to the percentage of females ($P > 0.50$). Coho salmon averaged 601 mm (N=123) and 628 mm (N=210) in length and 3,122 g and 3,479 in weight in 1990 and 1991, respectively.

Chinook salmon-Six chinook salmon were observed in the Uganik River in 1990 and one in 1991. The majority of these fish were passed in July, with the first observed in early July.

Other species-A total of 18,159 Dolly Varden was passed through the weir in 1990. Dolly Varden were present at the weir during construction. A bimodal run timing pattern was observed with an early peak in mid-July and another in early August (Figure 10). In 1991 a total of 69,564 Dolly Varden was passed through the weir. A bimodal run timing was also observed in 1991 with an early peak the last week of July and a late peak the second week of August.

In addition, to the upstream movement of Dolly Varden, some downstream passage was observed in 1991. A total of 18,523 Dolly Varden were passed downstream between May 19 and June 7, 1991.

One adult steelhead was counted upstream through the weir in 1990 and two were observed in 1991. These fish were passed in September and October. No samples were obtained from these fish and no downstream migration was observed either year.

Discussion

Weir

The floating resistance board weir worked effectively on the Uganik River. The weir allowed us to individually count fish as they passed upstream and capture fish for biological sampling. Weir modifications in 1991 improved our ability to count and pass fish during extreme high and low water levels.

The longer pickets and larger resistance boards allowed the weir to stay above the water surface during higher water levels and reduced the over the weir escapement in 1991 with the exception of one extreme high water event in late June. Placement of the counting chute into deeper water helped facilitate passage of fish during low water levels and the earlier weir installation in 1991 provided more information on early returning sockeye salmon and outmigrating Dolly Varden.

TABLE 5.—Age, length, and weight composition of coho salmon sampled at the Uganik River weir, Kodiak National Wildlife Refuge, Alaska, 1990 and 1991[a].

	Females						Males					
			Length (mm)		Weight (g)				Length (mm)		Weight (g)	
Age	N	%	Mean	SE	Mean	SE	N	%	Mean	SE	Mean	SE
						1990						
1.1	8	6.5	623	17	3,325	9	24	19.5	614	14	2,625	24
2.0	1	0.8	390	-	1,175	-	12	9.8	367	14	0,650	31
2.1	35	28.5	645	35	3,675	10	37	30.0	631	12	3,625	10
3.0	0	-	-	-	-	-	1	0.8	325	-	0,725	-
3.1	1	0.8	640	-	4,100	-	4	3.3	654	4	3,975	18
Total	45	36.6	635		3,550		78	63.4	582		2,875	
						1991						
1.1	1	.6	600	-	2,075	40	3	1.9	563	13	3,325	15
2.1	56	34.6	609	6	3,425	19	59	36.4	616	6	3,775	11
3.1	22	13.6	623	9	3,600	32	21	12.9	637	11	4,275	21
Total	79	48.8	613		3,450		83	51.2	619		3,825	

[a] Scale analysis conducted by Alaska Department of Fish and Game, Kodiak, Alaska.

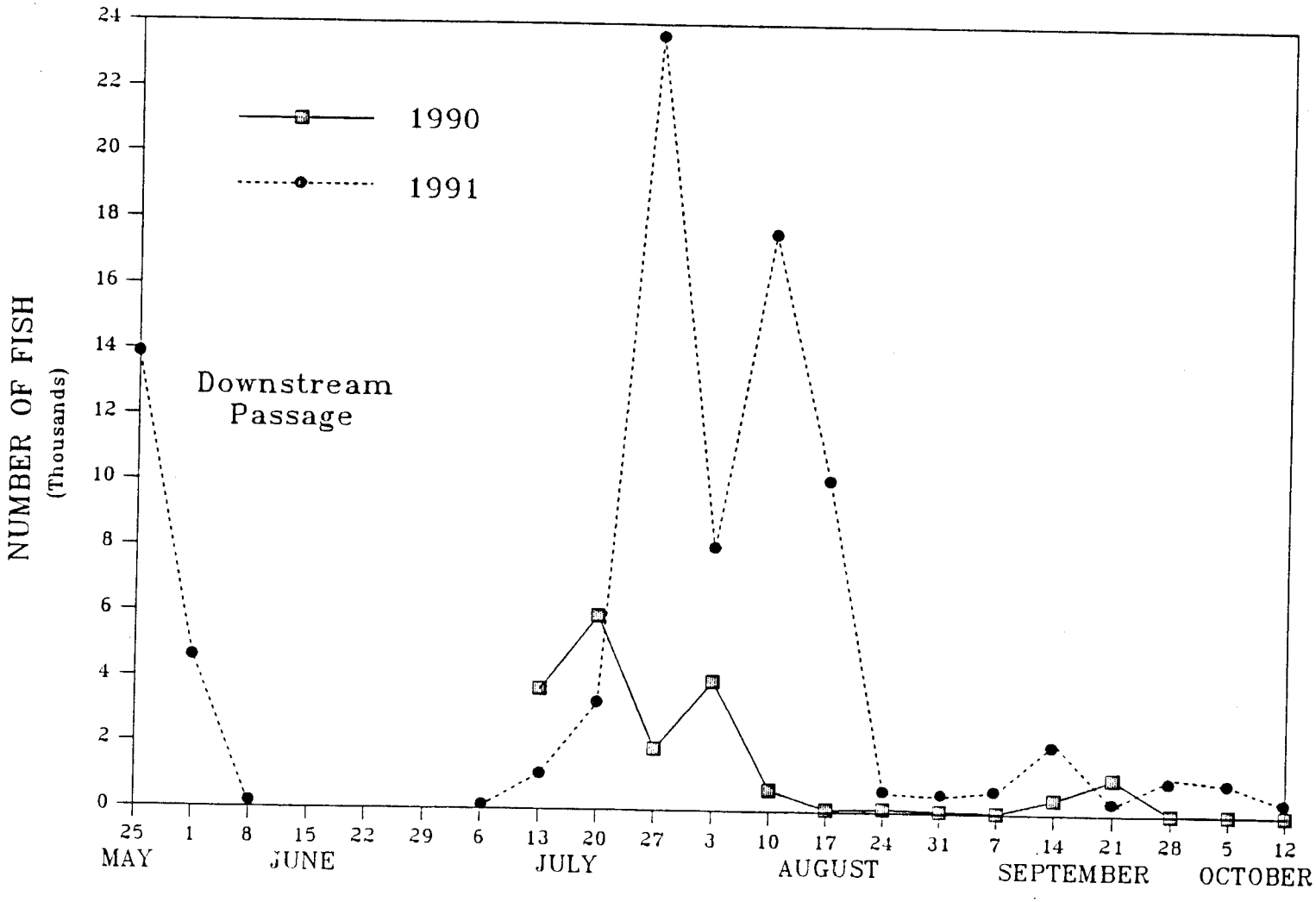

FIGURE 10. —Mean weekly escapement of Dolly Varden in the Uganik River, Kodiak National Wildlife Refuge, Alaska, 1990 and 1991.

In contrast to standard picket weirs, the floating resistance board weir lends itself to areas otherwise deemed unweirable due to fluctuating water levels and high debris loads. The floating weir has the ability to immediately begin fishing after water levels recede and debris is removed, unlike the conventional weirs where they may have to be re-installed or repaired.

Biological Data

Run timing observed at the weir in 1990 and 1991 was similar to weir counts in 1928-1931 for sockeye and chum salmon (U.S. Department of Interior 1968). Years in which the weir has been installed by early June show a bimodal return of sockeye salmon into the Uganik River. An early peak occurred in mid-June in 1929, 1930, 1932 and 1991. During other years (1928, 1931 and 1990), the weir was not operational during this time period. The bimodal escapement observed in 1991 may have been influenced by the high water event experienced in late June. This event resulted in no escapement counts for an 11 day period during the peak of the migration. If a larger number of fish passed undetected than was estimated during this time period a less distinctive bimodal entry pattern would have been observed and may have resulted in a single escapement peak.

Run timing for chum salmon was similar for all years of operation. Chum salmon are present in the system for approximately three months, with the peak of migration occurring from late July to late August.

A bimodal entry pattern was evident for pink salmon in 1929 and 1991. An early peak occurred in late July and early August and was followed by lower escapement into mid-August until another peak occurred in late August. In most years (1928, 1930, 1931 and 1990) a single escapement peak occurred in August. Thus, a high degree of overlap exists between the run timing of pink and chum salmon in the Uganik River.

Run timing for coho salmon was later in 1990 and 1991 than that shown by the earlier weir counts. The 1990 and 1991 escapement data show the majority of coho salmon passage occurring in September while the earlier weir information shows most escapement occurring in August.

Our data on coho salmon run timing are the only complete data available as the earlier weir on the Uganik River was removed in late August or early September. Peak coho salmon escapement in 1990 and 1991 occurred the second week in September, later than the weir has previously been operated.

The later movement of coho salmon upriver in 1990 may have been due to low water levels. The river level was at a seasonal low during the last two weeks in August and first two weeks in September (Figure 5). Coho salmon were observed building up behind the weir and were reluctant to pass through the counting chute and adult trap during this low water

period. Substantial numbers of fish were not passed until water levels began to rise and an alternate counting chute in deeper water was used.

The observation of chinook salmon in the Uganik River is the first documentation of this species in the system. These fish could possibly be strays from systems such as the Karluk or Ayakulik rivers which support strong runs of chinook salmon (Holmes 1988, U.S. Fish and Wildlife Service 1990). The possibility also exists that it is a very small run that has not been detected during previous surveys. Small numbers ($\leq$ 10) of chinook salmon have been recorded in other Kodiak river systems according to Department weir records (Alaska Department of Fish and Game 1992b).

The small number of steelhead observed in the Uganik River indicates this system does not presently support a strong return of this species. Weir operational dates may have missed returning adults late in the fall (October, November) and kelts moving back out to the salt water environment in early spring. However, most steelhead kelts have been found to exit Kodiak Island river systems in mid-May to early June with adults returning in the fall as early as September (Chatto 1987).

The bimodal entry pattern of Dolly Varden appears to coincide with peak escapement of other species. In both 1990 and 1991 an early peak was comparable to increases in chum salmon escapement and the later peak occurred simultaneous to increases in pink salmon escapement. The migration patterns of anadromous Dolly Varden are complex with spawning adults returning to their natal streams in the summer and fall and non-spawners entering the freshwater environment to overwinter in lakes (Morrow 1980). Dolly Varden have also been documented entering fresh water streams in succession with salmon runs to feed on spawn (Armstrong 1965, Reed 1967, Armstrong and Morrow 1980).

The escapement numbers of all species in 1990, with the exception of chum salmon, were above that recorded by weir counts over 60 years ago (Table 1). Sockeye, pink, and coho salmon counts averaged approximately four times greater than that observed in 1928-1932, indicating either an increase in production and escapement of these species or changes in management strategies allowing for greater in-river escapement. However, chum salmon escapement during 1990 was one-half the 1928-1932 levels.

In 1991, escapement levels were over two times greater than 1990 levels with the exception of sockeye salmon. Sockeye salmon escapement in 1990 was 47% greater than 1991 if estimates of fish passage before weir operation in 1990 and high water events in 1991 are included with actual weir counts. Commercial harvest (Table 6) for the Inner Uganik Bay (Figure 11) was over 100% greater in 1990 than in 1991. This combined with escapement data indicates the sockeye salmon return in 1990 was much stronger than 1991.

Total escapement numbers should be considered conservative for all species as the weir was partially submerged during periods that each

TABLE 6.-Commercial salmon harvest in the Northwest Kodiak District, statistical area 025312, Kodiak, Alaska, 1990 and 1991[a].

Catch week	Sockeye salmon	Pink salmon	Chum salmon	Coho salmon
		1990		
6/09	1,729	-	-	-
6/16	4,449	2	133	-
6/23	1,184	11	68	-
7/07	4,990	712	1,934	-
7/14	4,514	6,257	3,563	-
7/21	4,510	20,518	3,359	29
7/28	3,609	33,272	5,209	152
8/04	930	16,431	3,225	68
8/11	568	9,057	1,924	84
8/18	299	505	38	62
8/25	-	-	-	-
9/01	-	-	-	-
9/08	-	-	-	-
9/15	-	-	-	-
Totals	26,782	86,765	19,453	395
		1991		
6/15	6,080	127	174	1
6/22	928	16	25	0
7/06	1,876	795	141	0
7/13	1,132	1,677	368	0
7/20	1,182	4,478	653	20
7/27	1,022	1,481	754	61
8/03	237	610	132	7
8/10	N/O[b]	N/O	N/O	N/O
8/17	532	647	118	38
8/24	-	-	-	-
8/31	-	-	-	-
9/07	-	-	-	-
9/14	-	-	-	-
Totals	12,989	9,831	2,365	127

[a] Preliminary data from Alaska Department of Fish and Game, Kodiak, Alaska

[b] N/O = No commercial opening

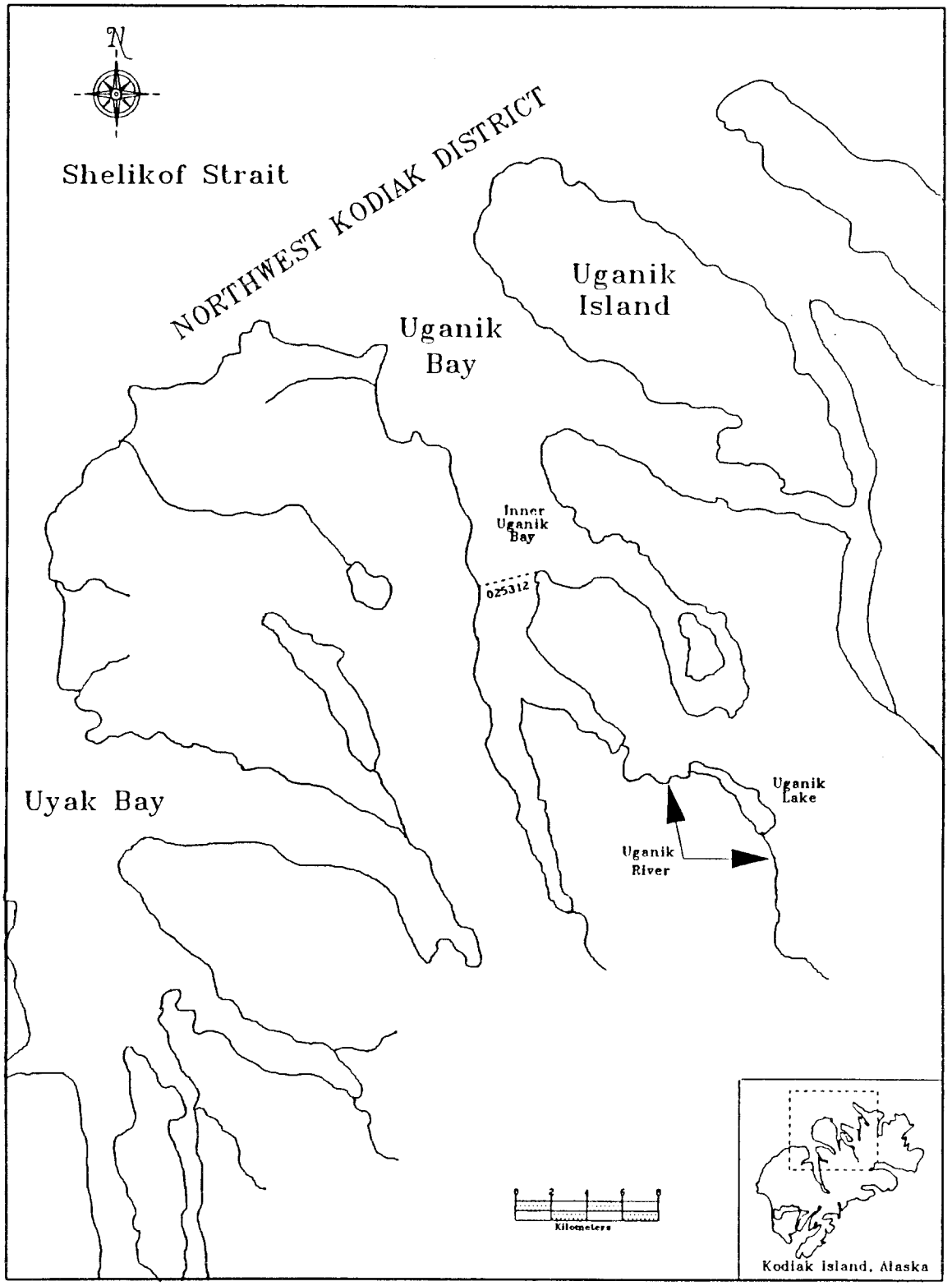

FIGURE 11.—The Inner Uganik Bay commercial fishery section (statistical area 025312) of the Northwest Kodiak District, Alaska.

species was present. Attempts to estimate undetected passage were difficult due to high water turbidity and the inability of most fish to negotiate the high water flow going over the weir. However, some over the weir escapement was observed and actual counts were added to the daily escapement.

Visual observations and aerial surveys also indicate a substantial number of pink and chum salmon spawn below the weir. When aerial survey counts of fish below the weir are combined with weir counts a much larger total escapement is obtained and is more compatible to aerial stream counts from previous years. Aerial survey estimates of salmon spawning below the weir in 1990 and 1991 ranged from 55,000 to 63,590 pink salmon and 8,000 to 10,000 chum salmon, respectively (T. Chatto, U.S. Fish and Wildlife Service, personal communication).

In the past, aerial survey index counts have been used to estimate escapement levels into the Uganik River. These aerial surveys conducted by the Refuge and the Department in 1958-1967 and 1976-1989 have estimated much higher estimate escapement levels on average of pink and chum salmon but fewer sockeye and coho salmon than recorded at the weir in 1990 and 1991 (Table 2). However, pink and chum salmon escapement at the weir cannot be directly compared with previous aerial survey counts which also include fish spawning below the weir. Many of these aerial survey counts may only be based on one or two flights and are used as a relative index and not for estimating total escapement.

Estimating salmon escapement by aerial surveys can produce highly variable results from year to year on the same river system (Bevan 1961, Neilson and Geen 1981, Schneiderhan 1987). Because the Uganik River is glacial and the species overlap in run timing, it is likely that the aerial survey indexes may not reflect relative abundance of escapement, thus making weir escapement counts a much more accurate and precise method of monitoring the Uganik River. However, a weir is much more costly due to the materials and personnel required for operation when compared to aerial surveys.

In the future, the method chosen to gather escapement data from the Uganik River should be based upon the precision of the estimate necessary for management. Aerial surveys, which are inexpensive to conduct compared to weirs, give only relative abundance data and can not be used effectively to manage commercial fisheries in-season other than on a very coarse level. Conversely, weirs are expensive to operate, but give daily escapement by species and can be used to develop predictive models on run timing and abundance for future returns. This information may allow managers to more precisely manage in-season commercial harvest of individual species while ensuring adequate in-river escapement.

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APPENDIX 1.-Total daily weir count of anadromous fish species, Uganik River, Kodiak National Wildlife Refuge, Alaska, 1990.

Date	Sockeye salmon	Pink salmon	Chum salmon	Coho salmon	Chinook salmon	Dolly Varden	Steelhead
6/25	1,012	0	0	0	0	N/C[a]	0
6/26	1,782	0	0	0	0	N/C	0
6/27	1,227	3	15	0	0	N/C	0
6/28	1,647	0	4	0	0	N/C	0
6/29	1,896	0	3	0	0	N/C	0
6/30	3,287	0	2	0	0	N/C	0
7/1	2,592	0	1	0	0	N/C	0
7/2	4,150	0	26	0	0	N/C	0
7/3	1,576	0	21	0	0	N/C	0
7/4	N/C	N/C	N/C	N/C	N/C	N/C	N/C
7/5	2,279	0	54	0	0	N/C	0
7/6	3,514	14	46	0	0	N/C	0
7/7	6,179	18	32	0	0	N/C	0
7/8	4,970	79	48	0	2	1,200	0
7/9[b]	7,552	152	67	0	0	1,300	0
7/10[b]	2,542	83	14	0	0	500	0
7/11	1,157	57	3	0	0	300	0
7/12	84	5	7	0	0	30	0
7/13	87	3	7	0	0	10	0
7/14	1,274	187	74	0	0	360	0
7/15	4,637	553	122	0	0	1,850	0
7/16	946	108	32	0	0	3,000	0
7/17	46	15	3	0	0	350	0
7/18	18	11	5	0	0	26	0
7/19	37	38	16	0	0	166	0
7/20	33	28	44	0	0	96	0
7/21	457	619	164	0	0	456	0
7/22	1,180	1,865	217	0	0	1,151	0
7/23	991	483	58	0	1	261	0
7/24	180	201	21	0	0	106	0
7/25	18	83	12	0	1	36	0
7/26	21	106	24	0	0	17	0
7/27	212	118	33	0	0	23	0
7/28	1,391	3,616	167	0	0	299	0
7/29	393	1,591	50	0	0	141	0
7/30	239	581	11	0	0	42	0
7/31	126	502	29	0	0	76	0
8/1[b]	3,411	9,870	134	0	0	2,921	0
8/2[b]	18	275	7	0	0	89	0
8/3	19	103	8	0	0	13	0
8/4	246	2,006	74	0	1	676	0

APPENDIX 1.-(Continued).

Date	Sockeye salmon	Pink salmon	Chum salmon	Coho salmon	Chinook salmon	Dolly Varden	Steelhead
8/5	51	744	48	0	0	142	0
8/6	9	291	4	0	0	15	0
8/7	65	1,948	90	0	0	51	0
8/8	55	2,229	86	0	0	116	0
8/9	25	826	21	0	0	15	0
8/10	22	991	30	0	0	8	0
8/11[b]	429	10,652	71	0	0	314	0
8/12[b]	67	2,137	26	0	0	29	0
8/13[b]	19	331	32	0	0	11	0
8/14[b]	19	819	26	0	0	5	0
8/15	165	11,457	74	0	0	9	0
8/16	3	684	16	0	0	1	0
8/17	25	777	23	0	0	12	0
8/18	62	3,338	48	2	1	28	0
8/19	11	2,842	10	0	0	14	0
8/20	24	2,065	38	2	0	15	0
8/21	47	2,308	25	3	0	23	0
8/22	4	1,853	33	0	0	32	0
8/23	36	777	16	3	0	5	0
8/24	41	728	21	0	0	6	0
8/25	46	1,476	44	4	0	21	0
8/26	61	1,151	29	8	0	28	0
8/27	28	714	11	13	0	16	0
8/28	7	331	12	3	0	7	0
8/29	27	314	8	14	0	5	0
8/30	0	171	4	3	0	0	0
8/31	23	197	2	2	0	1	0
9/1	5	140	12	1	0	3	0
9/2	19	218	7	14	0	5	0
9/3	21	379	4	8	0	4	0
9/4	26	113	1	42	0	8	0
9/5	26	279	3	54	0	5	0
9/6	3	25	2	3	0	0	0
9/7	5	29	3	2	0	4	0
9/8	26	103	2	28	0	10	0
9/9	6	40	0	24	0	9	0
9/10	1	11	0	27	0	5	0
9/11	7	14	0	8	0	8	0
9/12	230	90	2	2,545	0	229	1
9/13	0	0	0	0	0	0	0
9/14	23	15	4	49	0	200	0
9/15	0	0	0	20	0	6	0
9/16[b]	22	7	4	15	0	493	0

APPENDIX 1.-(Continued).

Date	Sockeye salmon	Pink salmon	Chum salmon	Coho salmon	Chinook salmon	Dolly Varden	Steelhead
9/17[b]	300	27	10	1,207	0	379	0
9/18	1	0	1	3	0	30	0
9/19	1	0	0	220	0	82	0
9/20[b]	32	0	2	314	0	112	0
9/21[b]	0	0	0	200	0	0	0
9/22[b]	0	0	0	100	0	0	0
9/23	0	0	0	6	0	2	0
9/24	0	0	0	28	0	6	0
9/25	0	1	0	2	0	2	0
9/26	0	0	0	2	0	9	0
9/27[b]	0	0	0	100	0	0	0
9/28[b]	0	0	0	50	0	0	0
9/29[b]	0	0	0	50	0	0	0
9/30[b]	0	0	0	10	0	0	0
10/1[b]	0	0	0	10	0	0	0
10/2[b]	0	0	0	10	0	0	0
10/3	0	0	0	10	0	8	0
10/4	0	0	0	2	0	2	0
10/5	0	0	0	0	0	0	0
10/6	0	0	0	4	0	5	0
10/7	0	0	0	0	0	0	0
10/8	0	0	0	17	0	46	0
10/9	0	0	0	3	0	19	0
10/10	0	0	0	15	0	28	0
10/11	0	0	0	1	0	16	0
10/12	0	0	0	0	0	0	0
Total	65,551	77,015	2,560	5,261	6	18,159	1

[a] N/C No counts
[b] A percentage of these figures is an over-the-weir count

APPENDIX 2.-Total daily weir count of anadromous fish species, Uganik River, Kodiak National Wildlife Refuge, Alaska, 1991.

Date	Sockeye salmon	Pink salmon	Chum salmon	Coho salmon	Chinook salmon	Dolly Varden	Steelhead
5/19	0	0	0	0	0	600	0
5/20	0	0	0	0	0	2,860	0
5/21	0	0	0	0	0	1,460	0
5/22	0	0	0	0	0	0	0
5/23	0	0	0	0	0	5,147	0
5/24	0	0	0	0	0	3,310	0
5/25	8	0	0	0	0	408	0
5/26	0	0	0	0	0	2,450	0
5/27	0	0	0	0	0	1,552	0
5/28	0	0	0	0	0	140	0
5/29	0	0	0	0	0	0	0
5/30	0	0	0	0	0	422	0
5/31	1	0	0	0	0	64	0
6/1	0	0	0	0	0	0	0
6/2	1	0	0	0	0	40	1
6/3	36	0	0	0	0	20	0
6/4	3	0	0	0	0	10	0
6/5	0	0	0	0	0	0	0
6/6	0	0	0	0	0	20	0
6/7	444	0	0	0	0	20	0
6/8	1,285	0	0	0	0	0	0
6/9	5,865	0	0	0	0	0	0
6/10	6,210	0	0	0	0	0	0
6/11	2,274	0	0	0	0	0	0
6/12	1,286	0	0	0	0	0	0
6/13	433	0	0	0	0	0	0
6/14	82	0	0	0	0	0	0
6/15	2,471	0	0	0	0	0	0
6/16	682	0	0	0	0	0	0
6/17	544	0	0	0	0	0	0
6/18	1,450	0	0	0	0	0	0
6/19[a]	0	0	0	0	0	0	0
6/20[a]	0	0	0	0	0	0	0
6/21[a]	0	0	0	0	0	0	0
6/22[a]	0	0	0	0	0	0	0
6/23[a]	0	0	0	0	0	0	0
6/24[a]	0	0	0	0	0	0	0
6/25[a]	0	0	0	0	0	0	0
6/26[a]	0	0	0	0	0	0	0
6/27[a]	0	0	0	0	0	0	0
6/28[a]	0	0	0	0	0	0	0
6/29[a]	0	0	0	0	0	0	0

APPENDIX 2.-(Continued).

Date	Sockeye salmon	Pink salmon	Chum salmon	Coho salmon	Chinook salmon	Dolly Varden	Steelhead
6/30	7,474	0	0	0	0	0	0
7/1	4,960	0	0	0	0	0	0
7/2	2,103	0	0	0	0	0	0
7/3	175	0	1	0	0	6	0
7/4	152	0	1	0	0	4	0
7/5	12,969	12	2	0	0	49	0
7/6	6,669	5	1	0	0	40	0
7/7	4,770	28	18	0	0	16	0
7/8	2,365	28	5	0	0	9	0
7/9	2,265	75	19	0	0	18	0
7/10	190	12	5	0	0	1	0
7/11	18	21	0	0	0	10	0
7/12	20	238	8	0	0	84	0
7/13	487	1,126	96	0	0	860	0
7/14	653	333	111	0	0	342	0
7/15	749	608	85	0	0	603	0
7/16	520	386	121	0	0	633	0
7/17	58	84	13	0	0	148	0
7/18	17	91	13	0	0	313	0
7/19	22	254	23	0	0	546	0
7/20	254	269	101	0	0	693	0
7/21	504	548	80	0	0	970	0
7/22	204	270	82	0	0	440	0
7/23	6,095	5,415	556	0	0	15,651	0
7/24	260	602	32	0	0	2,082	0
7/25	1	394	15	0	0	137	0
7/26	119	1,206	89	0	0	2,373	0
7/27	154	1,191	107	0	1	2,008	0
7/28	92	1,903	67	0	0	1,176	0
7/29	41	1,072	63	0	0	555	0
7/30	139	2,292	94	0	0	1,391	0
7/31	149	2,266	57	0	0	930	0
8/1	37	1,150	28	0	0	571	0
8/2	101	1,136	77	0	0	676	0
8/3	67	1,904	60	0	0	2,693	0
8/4	45	1,899	42	0	0	576	0
8/5	333	2,281	147	0	0	1,428	0
8/6	256	2,570	109	0	0	1,432	0
8/7	143	3,220	182	0	0	1,926	0
8/8	248	9,194	422	0	0	2,247	0
8/9	371	13,899	348	0	0	4,522	0
8/10	285	9,001	383	0	0	5,501	0
8/11	188	8,304	404	0	0	5,374	0

APPENDIX 2.-(Continued).

Date	Sockeye salmon	Pink salmon	Chum salmon	Coho salmon	Chinook salmon	Dolly Varden	Steelhead
8/12	36	2,779	206	0	0	3,021	0
8/13	19	1,164	99	0	0	322	0
8/14	92	1,888	152	13	0	655	0
8/15	44	2,065	257	2	0	306	0
8/16	32	1,584	196	0	0	214	0
8/17	31	2,737	207	24	0	189	0
8/18	18	2,651	246	2	0	123	0
8/19	39	3,117	175	6	0	110	0
8/20	54	2,760	161	19	0	127	0
8/21	19	3,387	244	4	0	54	0
8/22	12	3,655	309	36	0	68	0
8/23	5	5,291	415	8	0	64	0
8/24	5	5,618	313	25	0	61	0
8/25	2	5,873	320	30	0	68	0
8/26	9	4,630	345	43	0	92	0
8/27	9	5,207	357	20	0	97	0
8/28	2	6,374	478	67	0	92	0
8/29	6	4,868	477	52	0	51	0
8/30	2	5,076	476	86	0	73	0
8/31	4	3,415	453	143	0	52	0
9/1	5	4,380	410	108	0	101	0
9/2	4	3,272	209	168	0	137	0
9/3	8	4,748	191	285	0	82	0
9/4	3	3,730	193	438	0	49	0
9/5	2	1,753	76	222	0	62	0
9/6	0	2,209	124	838	0	87	0
9/7	2	5,436	240	924	0	177	0
9/8	3	2,852	110	863	0	157	0
9/9	9	2,581	109	533	0	293	0
9/10	4	1,722	95	839	0	559	0
9/11	1	1,188	41	1,173	0	488	0
9/12	2	825	41	815	0	229	0
9/13	1	496	18	593	0	439	0
9/14[a]	0	0	0	0	0	0	0
9/15[a]	0	0	0	0	0	0	0
9/16[a]	0	0	0	0	0	0	0
9/17[a]	0	0	0	0	0	0	0
9/18	0	283	3	147	0	150	0
9/19	0	47	0	108	0	9	0
9/20	0	107	1	394	0	77	0
9/21	1	70	5	114	0	70	0
9/22	2	65	2	275	0	370	0
9/23[a]	0	0	0	0	0	0	0

APPENDIX 2.-(Continued).

Date	Sockeye salmon	Pink salmon	Chum salmon	Coho salmon	Chinook salmon	Dolly Varden	Steelhead
9/24[a]	0	0	0	0	0	0	0
9/25	1	20	0	293	0	90	0
9/26	0	45	0	254	0	203	0
9/27	2	46	1	177	0	279	0
9/28	0	13	0	180	0	198	0
9/29[a]	0	0	0	0	0	0	0
9/30	1	33	0	381	0	187	0
10/1	0	35	0	246	0	208	0
10/2	2	13	0	229	0	191	0
10/3	0	7	0	116	0	133	0
10/4	0	5	0	155	0	110	0
10/5	0	3	0	93	0	139	0
10/6	0	2	1	121	0	173	0
10/7	1	2	0	52	0	181	1
10/8	0	0	0	0	0	0	0
10/9	0	0	0	0	0	0	0
10/10	0	0	0	0	0	0	0
10/11	0	0	0	0	0	0	0
Totals	79,295	185,414	11,823	11,704	1	69,564	2

[a] No counts weir submerged