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ESCAPEMENT TIMING AND ABUNDANCE OF ADULT SALMONIDS IN THE UGANIK RIVER, KODIAK NATIONAL WILDLIFE REFUGE, ALASKA 1990, 1991 and 1992

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ESCAPEMENT TIMING AND ABUNDANCE OF ADULT SALMONIDS IN THE UGANIK RIVER, KODIAK NATIONAL WILDLIFE REFUGE, ALASKA 1990, 1991 and 1992

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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, 1991 and 1992, a resistance board weir was installed in the lower Uganik River to determine escapement, timing, and age, length and weight composition of adult fish. A total of 65,551 sockeye, 77,015 pink, 2,560 chum, 5,261 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 1992, a total of 16,461 sockeye, 117,515 pink, 11,771 chum, 9,927 coho, and five chinook salmon were counted. In addition, during 1990, 1991 and 1992, 32,206, 10,000 and 70,000 sockeye salmon, respectively, were estimated to have entered the system before weir operations and/or during high water events. Aerial surveys estimated 55,000, 63,590 and 51,840 pink salmon and 8,000, 10,000 and 17,980 chum salmon spawned below the weir in 1990, 1991 and 1992, respectively. Sockeye, pink and coho salmon escapements are two to seven times greater than escapements recorded in 1928-1932. A total of 18,159, 69,564, and 60,890 Dolly Varden also migrated upstream in 1990, 1991 and 1992, respectively. One steelhead trout was passed upstream in 1990, two in 1991, and three in 1992. Four steelhead trout were passed downstream in 1992. 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 salmon were 2.3 and 1.3. The predominant age class for chum and coho salmon were 0.3 and 2.1, respectively.

The resistance board weir worked effectively in the glacial fed Uganik River allowing the enumeration and sampling of adult salmon and char. However, high water events lead to weir submersion on several occasions in 1991 and 1992 resulting in undetected fish passage. The weir accommodated fluctuating water levels and high debris loads and remained intact from the end of May through early October. 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*, coho *O. kisutch*, and chinook *O. tshawytscha* salmon, steelhead and rainbow trout *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 wildlife populations including brown bears *Ursus arctos* and bald eagles *Haliaeetus leucocephalus* (U.S. Fish and Wildlife Service 1987).

Information on Uganik River fish resources includes historical weir escapement counts from 1928 to 1932 (Table 1) and aerial index 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 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 salmon migration and is one of the 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 estimated 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 commercial, sport and subsistence 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)(Figure 2). These increases in harvest have occurred simultaneously with favorable environmental conditions resulting in above average escapement for many Kodiak river systems (Alaska Department of Fish and Game 1993).

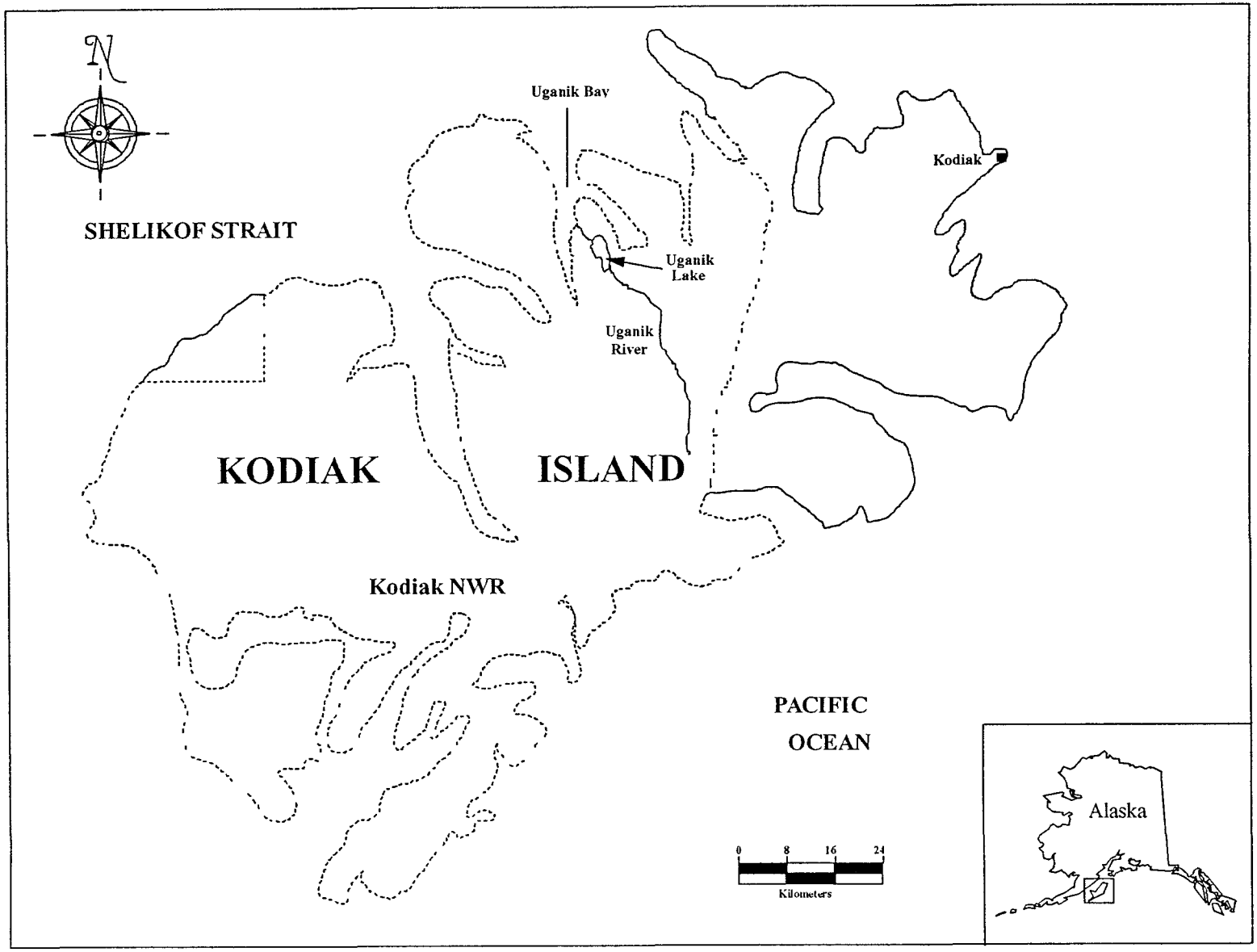

FIGURE 1.—Uganik River, Kodiak National Wildlife Refuge, Alaska.

TABLE 1.-Salmon escapement counts obtained at the Uganik River weir, Alaska, 1928-1932[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	-[b]	-	-	-
	Mean	16,609	20,274	5,385	1,360	0

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

TABLE 2.-Peak aerial survey counts of salmon, 1958-1967[a] and 1976-1989[b], for the Uganik River, Alaska.

Year	Species				
	Sockeye	Pink	Chum	Coho	Chinook
1958	2,500	33,200	1,000	-[c]	-
1959	-	130,000	5,000	-	-
1960	4,000	91,000	1,000	-	-
1961	-	75,000	1,100	-	-
1962	-	100,000	1,000	-	-
1963	-	45,000	-		
1964	8,000	201,800	5,000	-	-
1965	5,000	22,000	500	-	-
1966	-	124,000	-		
1967	4,000	15,000	12,000	-	-
1976	53,000	87,000	-	-	-
1977	42,000	40,000	5,000	-	-
1978	-	65,000	4,000	-	-
1979	55,000	56,000	2,000	-	-
1980	26,000	86,000	-	-	-
1981	64,000	62,000	8,000	-	-
1982	50,000	90,000	30,000	1,200	-
1983	23,000	125,000	25,000	-	-
1984	40,000	130,000	10,000	2,130	-
1985	40,000	60,000	5,000	660	-
1986	45,000	197,000	-	5,400	-
1987	35,000	160,000	15,000	1,750	-
1988	12,000	84,000	20,000	-	-
1989	38,000	520,000	53,000	2,681	-
Mean	30,361	108,292	10,716	2,303	-

[a] Data source: U.S. Department of Interior, 1968.
[b] Data source: Alaska Department of Fish and Game, Division of Commercial Fisheries, Kodiak, Alaska.
[c] - = No counts available

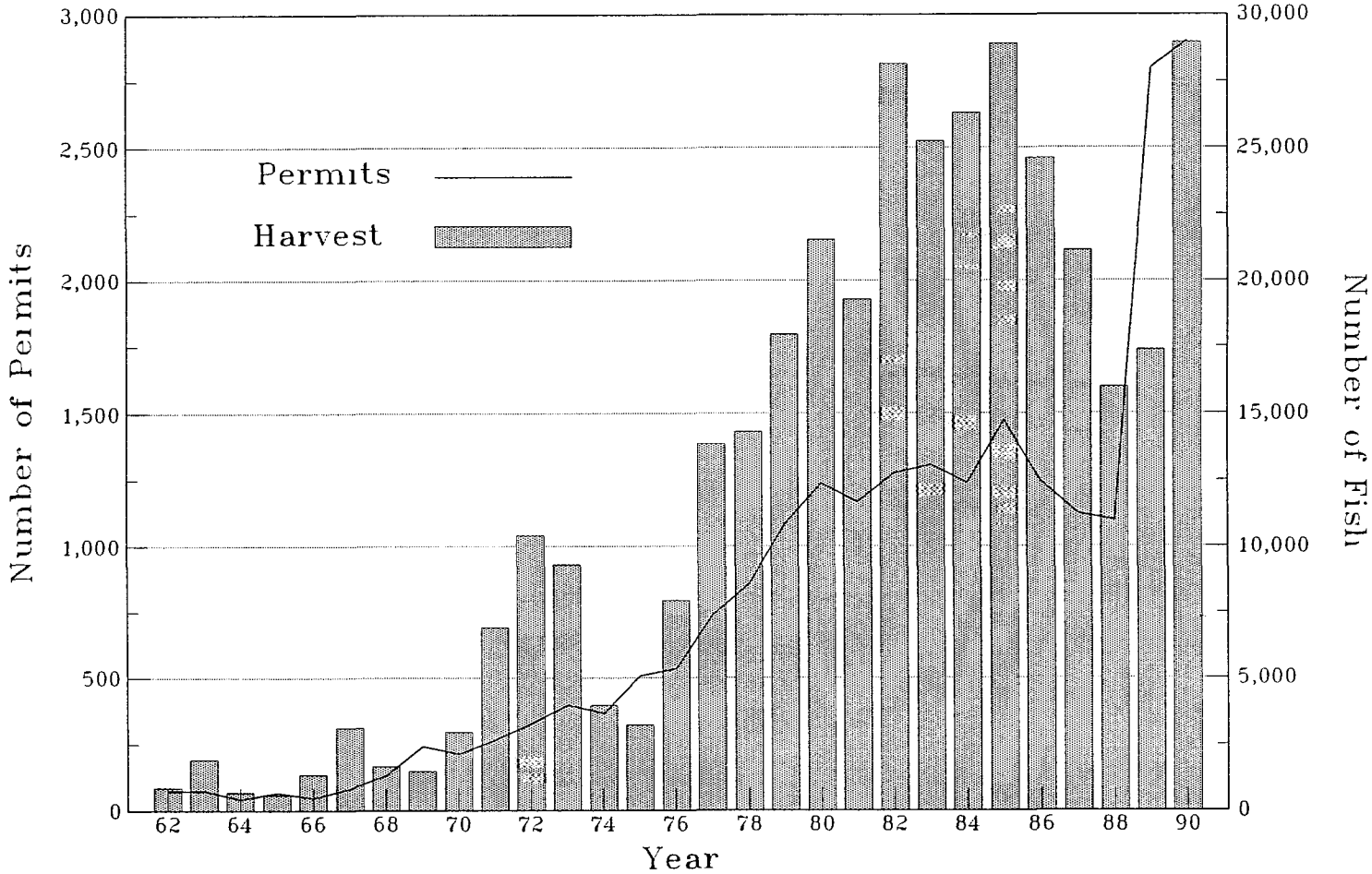

FIGURE 2.—Salmon harvest and participation (number of permits) in the Kodiak Management Area, subsistence fishery, Alaska. Data Source: Kodiak Regional Planning Team, 1992.

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 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, timing, size and age composition of species migrating into the Uganik River.

After a successful season in 1990, the weir was installed in 1991 and 1992 to obtain comparative data. This final report is a summarization of the 1990, 1991 and 1992 field seasons.

Study Area

The Uganik River is a glacially fed river system located on the northwest 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 resistance board weir was installed at river kilometer (rkm) 1.4 and was operational from June 25 to October 12, 1990, May 19 to October 11 in 1991, and May 12 to October 10 in 1992 (Figure 3). 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

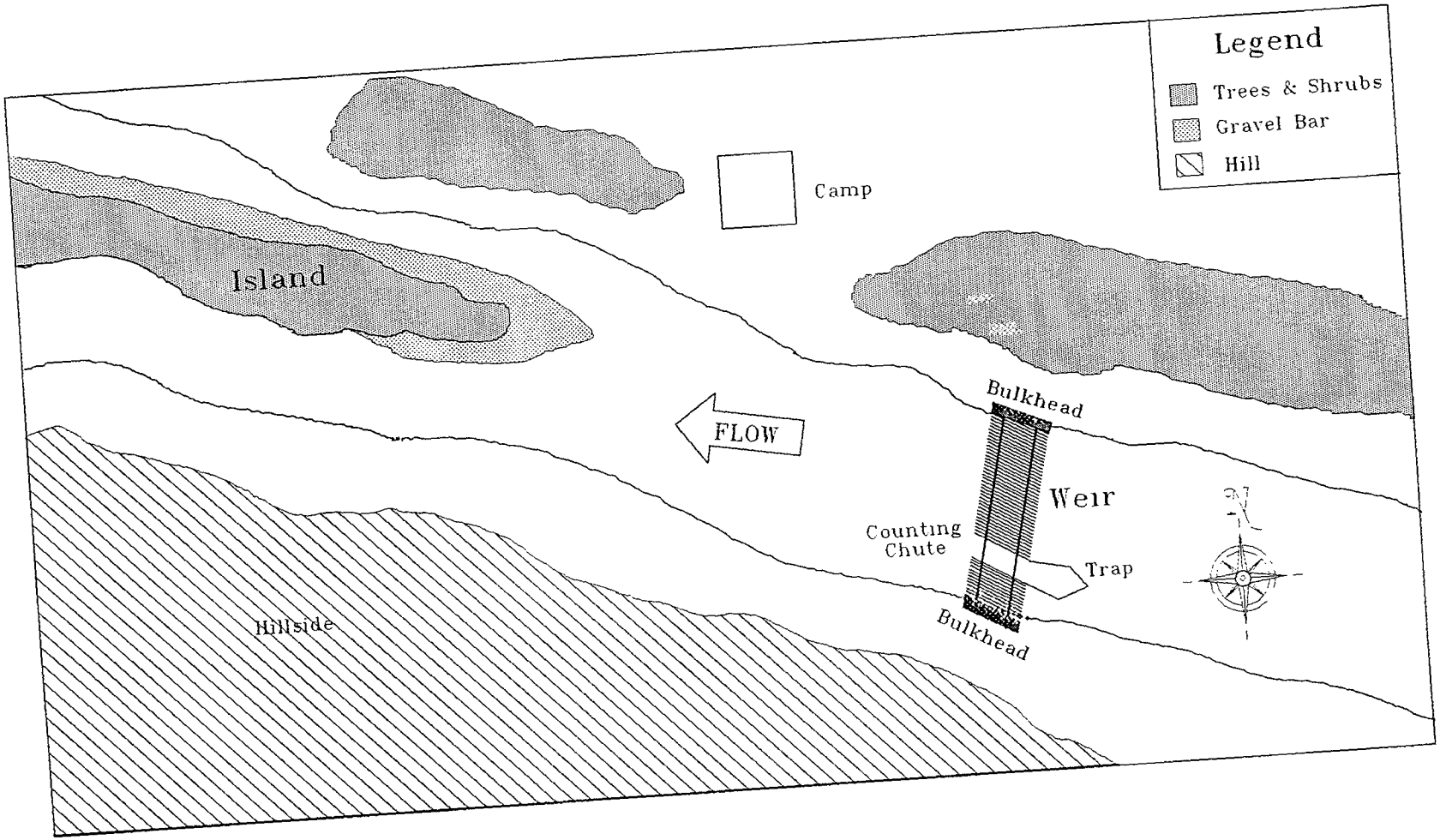

FIGURE 3.—Site map of the Uganik River weir, Alaska.

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)(Figure 4). The original weir consisted of 2.5 cm diameter plastic conduit pipe (pickets) strung together to form panels 1.2 m wide by 4.6 m long. 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.

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 6.1 m long, and resistance boards were increased in width from 0.6 m to 0.8 m wide (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 provide a fish tight surface to fasten the weir panels. A rectangular opening 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 5). The top of the rectangular opening provided a surface for weir personnel to count fish as they passed underneath into the trap.

Installation and operation of the weir was accomplished by Service personnel. The weir was checked for holes and weaknesses and cleaned daily before 0900 hours. Snorkeling was used to check the integrity of the weir and substrate condition. A stream gauge was installed 30 m downstream of the weir to monitor water elevation and was checked daily.

Biological Data

Fish were individually counted by species 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. In 1990, an aerial survey count for sockeye salmon was included in the total escapement to include fish entering the system before weir installation. Estimates of sockeye salmon passage during a high water event June 19-29, 1991, were obtained by taking the average daily escapement seven days before weir submersion (993 sockeye salmon) and multiplying it by the number of days it was submerged (10 d).

In 1992, estimates of sockeye salmon passage during high water events were obtained by expanding aerial survey counts and Area Under the Curve (AUC) methodology described by Johnson and Barrett (1988). An expansion factor of 2.8 was derived from a ratio between a weir count (80,000 fish) and an aerial survey count (29,100 fish) on July 19, 1991, and was

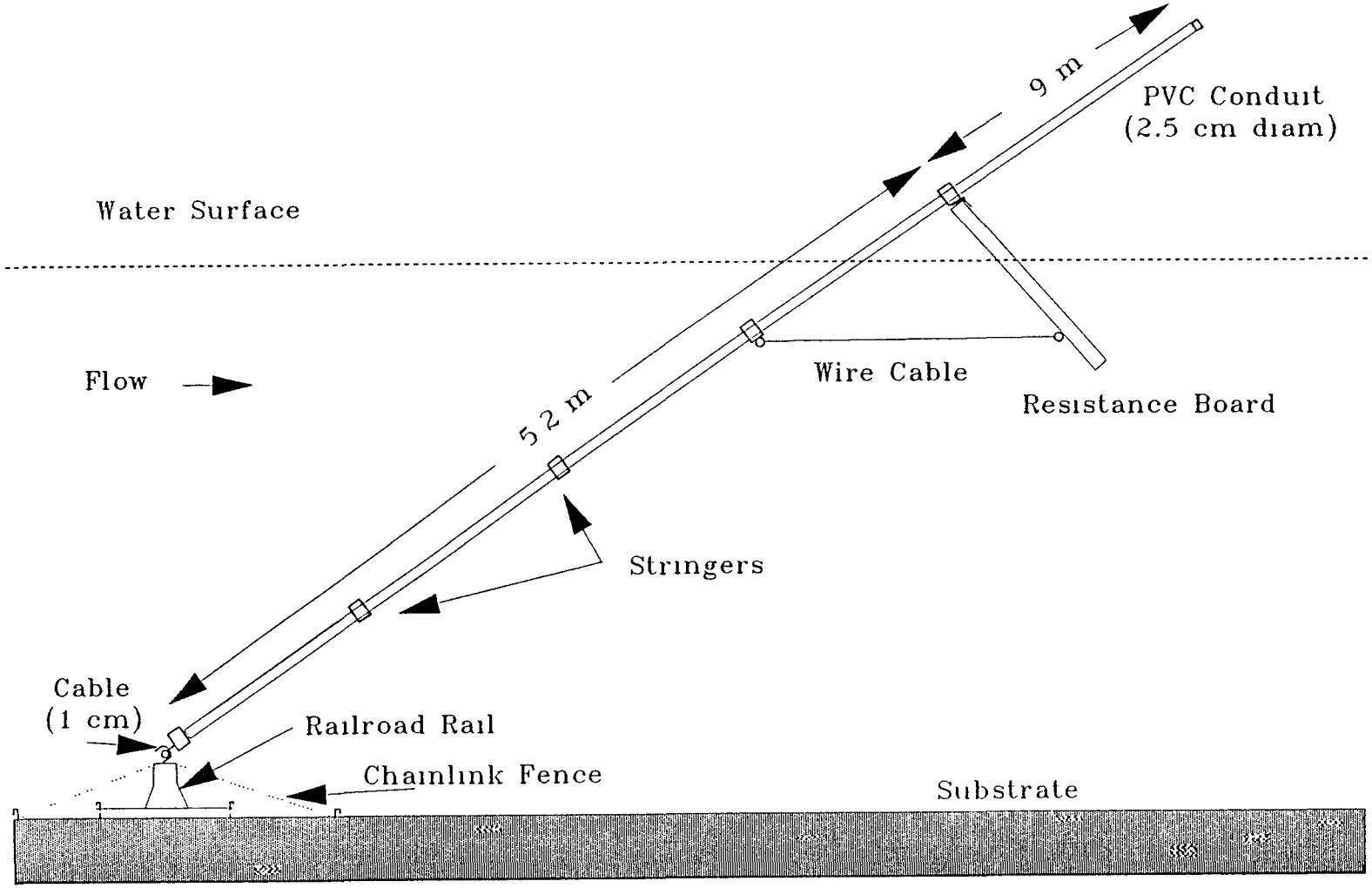

FIGURE 4.—Schematic drawing of a weir panel used on the Uganik River, Alaska.

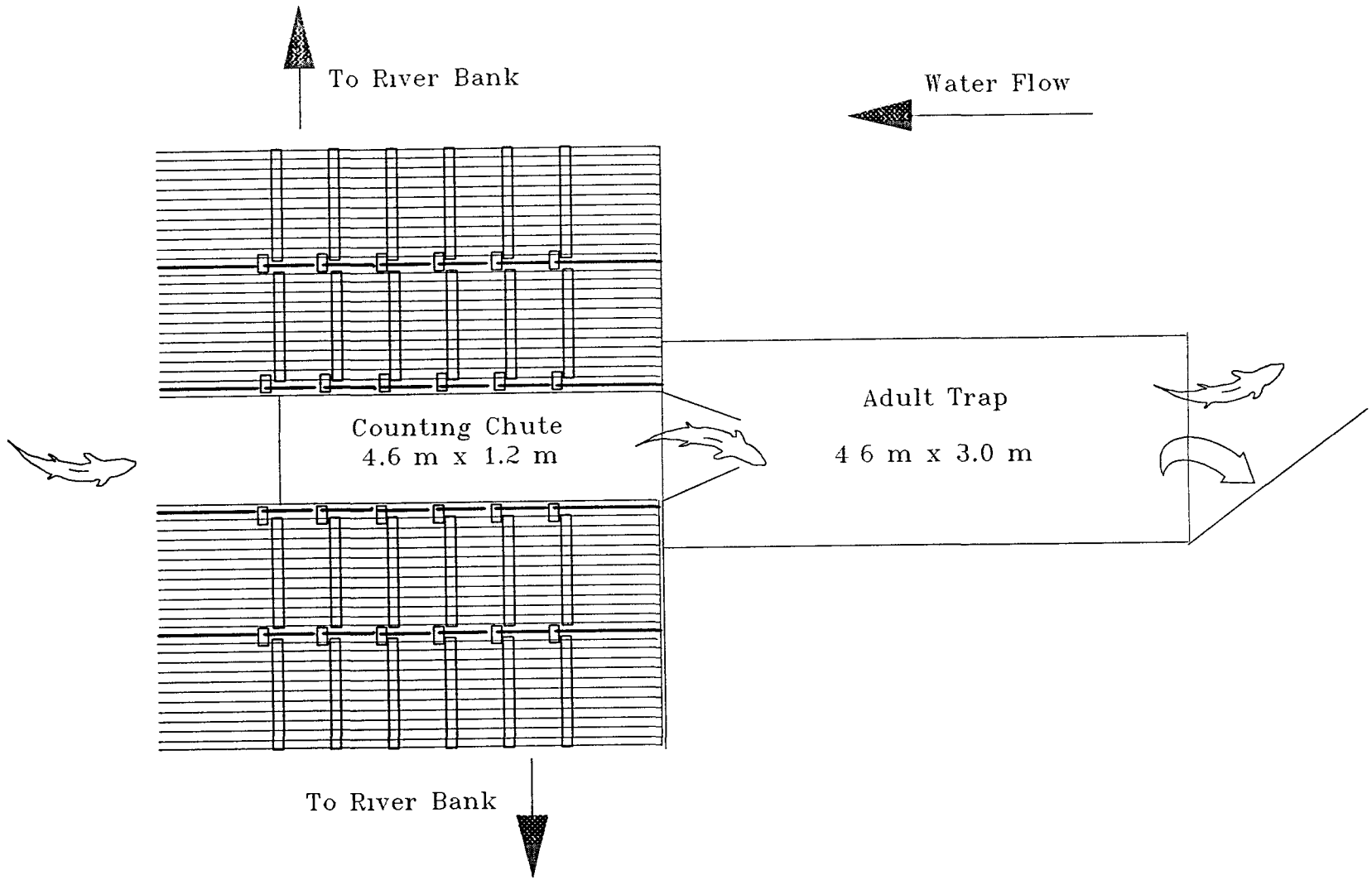

FIGURE 5.—Section of the Uganik River weir showing counting chute and adult trap, Alaska.

used to expand a peak aerial survey count of 25,000 sockeye salmon on July 29, 1992. The AUC escapement estimate was obtained from five aerial survey counts, conducted in July, August and September, using an average stream life of 15 days (Perrin and Irvine 1990).

Aerial index surveys conducted by the Refuge and Department were also used to account for pink and chum salmon spawning in the lower reaches of the river. A peak count of each species observed spawning below the weir was added to the weir counts to estimate the total spawning escapements of these species in 1990, 1991 and 1992.

The adult trap and holding area constructed into the face (upstream side) of the weir facilitated collecting subsamples and passing adult salmon through the weir. A subsample of each species (240 sockeye, 240 coho, and 70 chum salmon) was randomly netted from the trap on a weekly basis, when available. A subsample of 600-1,000 pink salmon was sampled during the peak of migration (mid-August). 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 and were presented graphically on the last day of the sampling week. Sampled fish were measured from mid-eye to the fork of the tail (nearest mm), weighed (nearest 25 grams), and sexed from external characteristics. Scales were taken from the preferred area for age determination and expressed according to the European method (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. Scale impressions were made on cellulose acetate cards and examined with a microfiche reader. Scale analysis for sockeye and coho salmon was conducted by the Department. Chum salmon scale analysis was conducted by the Service. 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) beginning June 25, 1990, May 19, 1991, and May 12, 1992, 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 submerged portions of the weir. Weir panels began to submerge at a stream gauge reading of 1.75 m. In 1990, several panels were submerged a total of 456 hours during nine high water events (Figure 6). High water events generally resulted in a large amount of gravel and cobble accumulating on the weir panels which kept the weir submerged for several days after the water level declined. After raking the panels

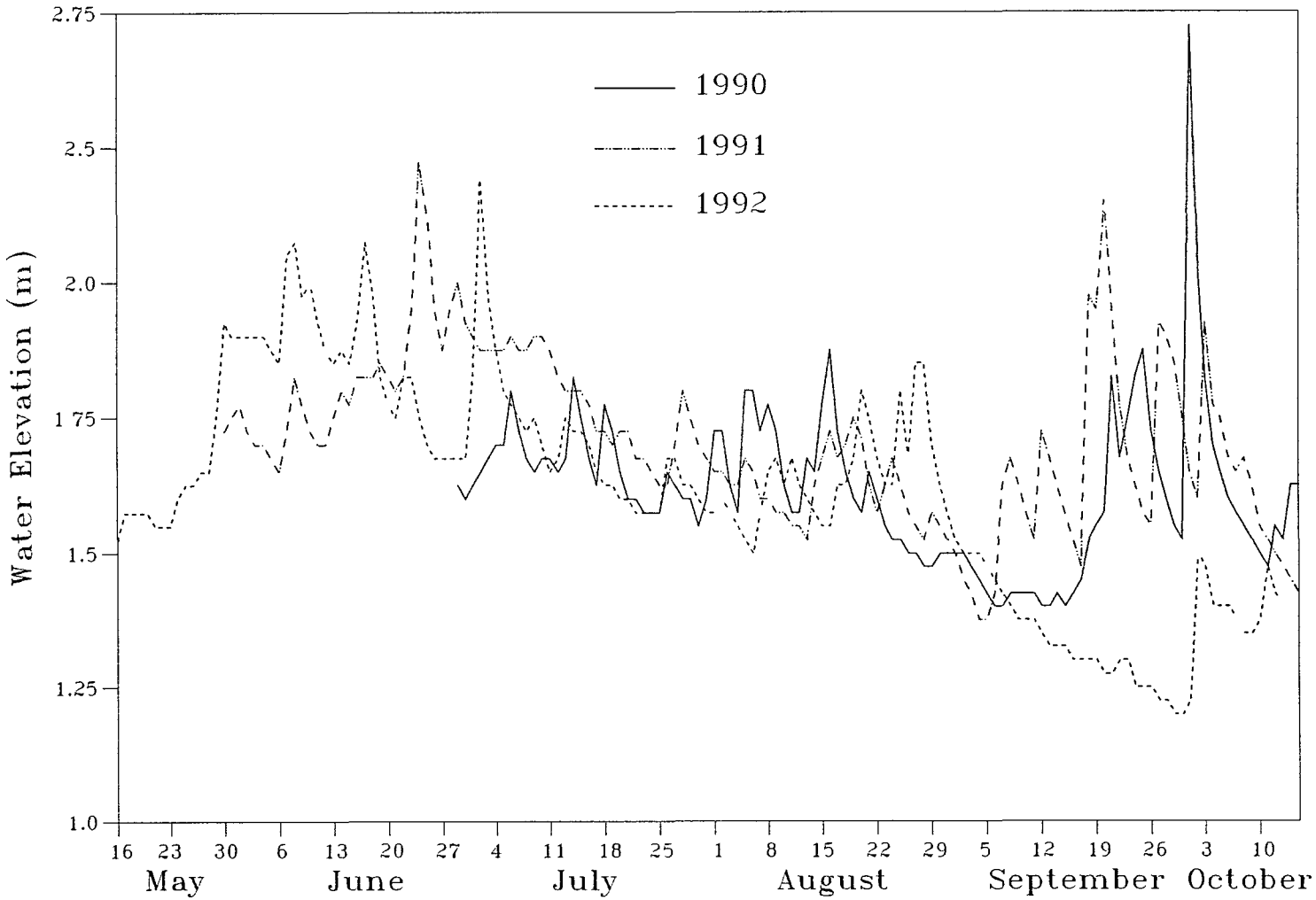

FIGURE 6.—Water elevation measured at the Uganik River weir, Alaska, 1990, 1991 and 1992.

clear of debris, the weir surfaced with little damage and prohibited upstream passage of fish.

The weir stayed above the water surface at higher water flows (2.0 m) after pickets were lengthened and resistance boards were enlarged. Weir panels were submerged for a total of 393 hours in 1991 during two high water events (Figure 6). The weir was also partially submerged during lower water levels on two occasions in September when high winds resulted in leaf matter accumulating on the weir.

In 1992, a series of high water events submerged the weir during four periods from late May to early July (Figure 6). Weir panels were submerged for a total of 505 hours. The chronic high water conditions washed a considerable amount of gravel and cobble on top of the weir which kept the weir from surfacing immediately after water levels receded.

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, which allowed for better passage of fish and increased our ability to obtain sampling objectives.

The weir was able to pass large amounts of debris, including several trees over 1 m in diameter. Debris and fish carcasses were removed from the weir by walking across each panel until it partially submerged and allowing the current to wash the debris downstream.

Biological Data

Seven species of anadromous salmonids returned to the Uganik River in 1990, 1991 and 1992. Escapement counts were obtained on sockeye, pink, chum, coho and chinook salmon, steelhead and Dolly Varden char.

Sockeye salmon.-A total of 65,551 sockeye salmon were counted between June 25 and September 20, 1990 (Appendix 1). Immediately after the weir became fish tight on June 25, fish began to congregate downstream of the weir. Peak escapement counts occurred the first week of July (Figure 7), decreased soon after, and by mid-August less than 100 sockeye salmon passed through the weir daily.

An aerial survey on June 27, 1990, conducted by the Department, indicated an index of 35,000 sockeye salmon in Uganik Lake two days after the weir was installed. Subtracting the weir escapement obtained on June 25 and 26 from the aerial survey count, resulted in an estimated total of 32,206 sockeye salmon entering the Uganik River before weir installation. Combining the aerial and weir counts resulted in an estimated total escapement of approximately 97,757 sockeye salmon in 1990 (Table 3).

A total of 79,295 sockeye salmon were counted between May 25 and October 7, 1991 (Appendix 2). Two escapement peaks occurred, one in

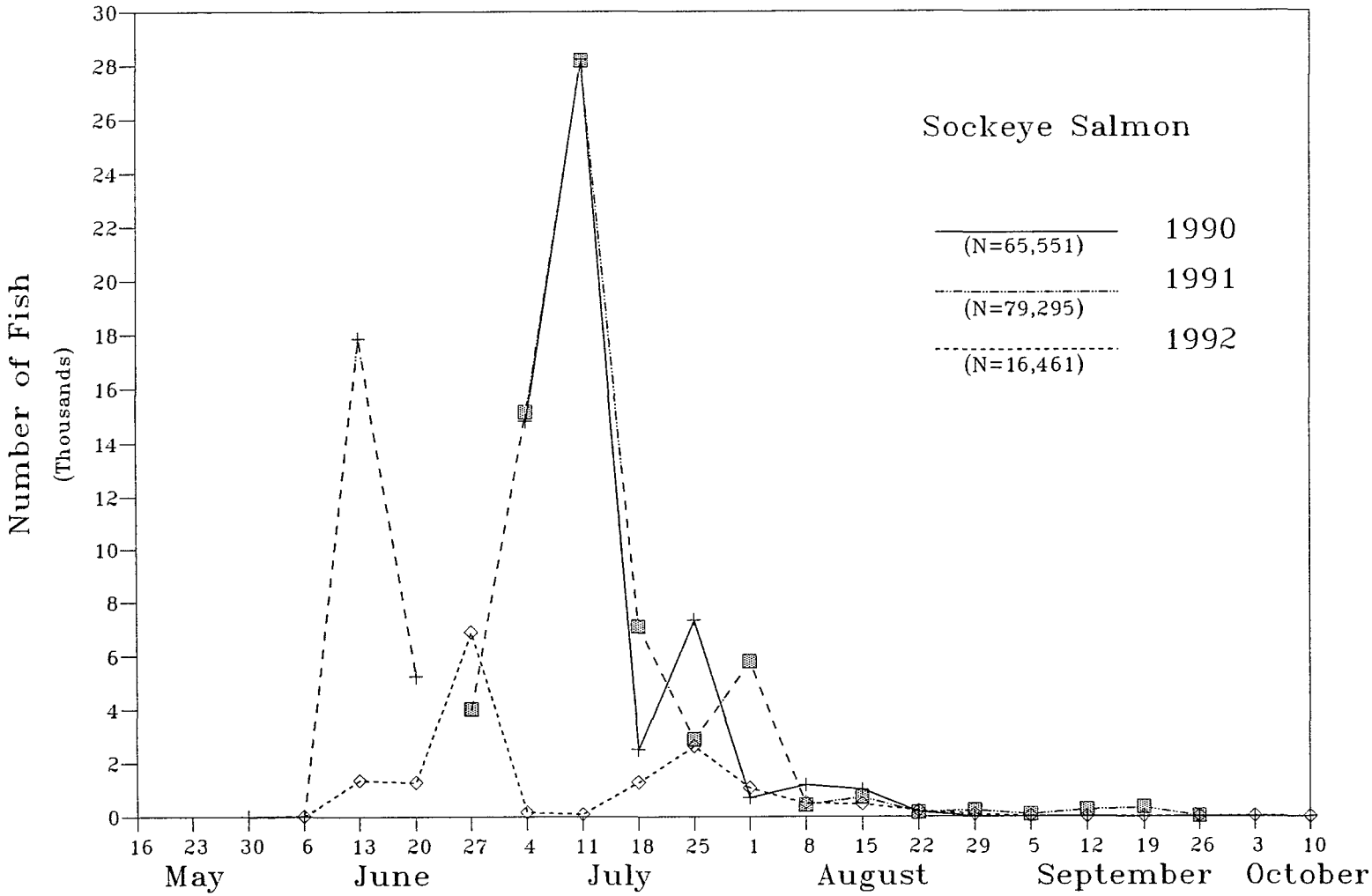

FIGURE 7.—Weekly escapement of sockeye salmon in the Uganik River, Alaska, 1990, 1991 and 1992.

mid-June and another in early July (Figure 7). A high water event June 19-29, 1991, submerged several weir panels for a total of 223 hours

TABLE 3.-Uganik River weir counts 1990, 1991 and 1992.

Species	1990	1991	1992	Mean
Sockeye	65,551[a]	79,295[a]	16,461[a]	N/A
	97,756[b]	89,295[b]	72,896[b]	86,649[b]
Pink	77,015	185,414	117,515	126,648
Chum	2,560	11,823	11,771	8,718
Coho	5,261	11,704	9,927	8,964
Char	18,159	69,564	60,880	49,534

[a] incomplete count
[b] estimated by aerial survey and over the weir escapement

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 resulted in an estimated total escapement of 89,295 sockeye salmon for 1991.

A total of 16,461 sockeye salmon were counted between June 1 and October 8, 1992 (Appendix 3). Several high water events in June prohibited accurate counts during the peak of migration. An aerial survey indicated an index of 25,000 fish above the weir on July 29. Expanding the index count with a 2.8:1 factor developed in 1991, produced an estimated escapement of 70,000 fish prior to this date. Combined with weir counts after July 29 (2,896 fish), the estimated escapement of sockeye salmon was 72,896 in 1992. This was similar to AUC methodology which estimated 81,400 spawning sockeye salmon in the Uganik River system in 1992.

Eight age groups of sockeye salmon were identified in 1990, six in 1991, and 12 in 1992. The dominant age groups were 1.3 and 2.3 (Table 4). 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 1992, age 2.3 was predominant for both males and females and age composition did not differ significantly by sex ($P>0.50$). In 1990 and 1992, 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), 533 mm (N=748), and 517 mm (N=625) in length, and 2,583 g, 2,336 g and 2,380 g in weight in 1990, 1991 and 1992, respectively.

TABLE 4.—Age, length, and weight composition of sockeye salmon sampled at the Uganik River weir, Alaska, 1990, 1991 and 1992.

	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	44.3	530		2,625		456	55.7	534		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	

TABLE 4.—(Continued).

	Females						Males					
			Length (mm)		Weight (g)				Length (mm)		Weight (g)	
Age	N	%	Mean	SE	Mean	SE	N	%	Mean	SE	Mean	SE
						1992						
0.2	0	0	0	0	0	0	2	0.3	420	0	1,650	24
1.1	0	0	0	0	0	0	4	0.6	318	34	1,025	17
0.3	1	0.2	570	-	2,950	-	0	0	0	0	0	-
1.2	9	1.4	457	9	1,800	19	43	6.9	437	7	1,800	11
2.1	0	0	0	-	0	-	3	0.5	338	7	1,150	16
1.3	55	8.8	534	4	2,725	11	39	6.2	573	5	2,750	9
2.2	34	5.4	467	5	1,925	9	99	15.8	443	5	1,800	12
1.4	3	0.5	540	26	2,775	22	1	0.2	620	-	3,225	-
2.3	171	27.4	532	2	2,550	7	154	24.6	576	2	2,700	6
3.2	3	0.5	450	3	1,675	16	1	0.2	375	-	1,450	-
2.4	0	0	0	-	-	-	2	0.3	600	5	3,500	30
3.3	0	0	0	-	-	-	1	0.2	565	-	2,550	-
Total	276	44.2	521	2	2,478		349	55.7	514	4	2,303	

Pink salmon.-In 1990, a total of 77,015 pink salmon were counted through the weir and the escapement timing was bimodal (Figure 8). Pink salmon were first observed at the weir on June 27. Substantial numbers (>100/day) did not appear until the second week in July. Peak escapement occurred in mid-August. By early September fewer than 100 pink salmon were being passed daily.

In 1991, a total of 185,414 pink salmon were counted through the weir and the escapement timing was bimodal. Pink salmon were first observed at the weir on July 5. Substantial numbers began to appear in mid-July (Figure 8). Two escapement peaks occurred, one in mid-August and another the last week of August. By late September fewer than 100 pink salmon were being passed daily.

In 1992, a total of 117,515 pink salmon were counted through the weir and three escapement peaks were observed. Escapement timing was similar to 1990 and 1991. Escapement peaks were observed in early, mid and late August (Figure 8).

Aerial surveys observed an estimated 55,000, 63,590 and 51,840 pink salmon spawning below the weir site in 1990, 1991 and 1992, respectively (Table 5). Combining the aerial survey estimates with counts obtained at the weir, the total spawning escapement in the Uganik River for pink salmon was estimated to be 132,015, 249,004 and 169,355 fish in 1990, 1991 and 1992, respectively.

TABLE 5.-Aerial survey estimates of pink and chum salmon spawning below the weir for the Uganik River, Alaska, 1990, 1991 and 1992[a].

Year	Pink salmon	Combined with weir escapement	Chum salmon	Combined with weir escapement
1990	55,000	132,015	8,000	10,560
1991	63,590	249,004	10,000	21,823
1992	51,840	169,355	17,980	29,751
Mean	56,810	183,458	11,993	20,711

[a] Data source: U.S. Fish and Wildlife Service, Kodiak, Alaska.

The percentage of males (52% and 53%) was similar to females ($P > 0.50$) in 1990 and 1991, respectively. Males were more predominant (59%) than females ($P < .005$) in 1992. Female pink salmon averaged 461 mm (N=363), 470 mm (N=433), and 471 mm (N=460) in length and 1,600 g, 1,604 g, and 1,550 g in weight in 1990, 1991 and 1992, respectively (Table 6). Male pink salmon were smaller than females, averaging 453 mm, 466 mm,

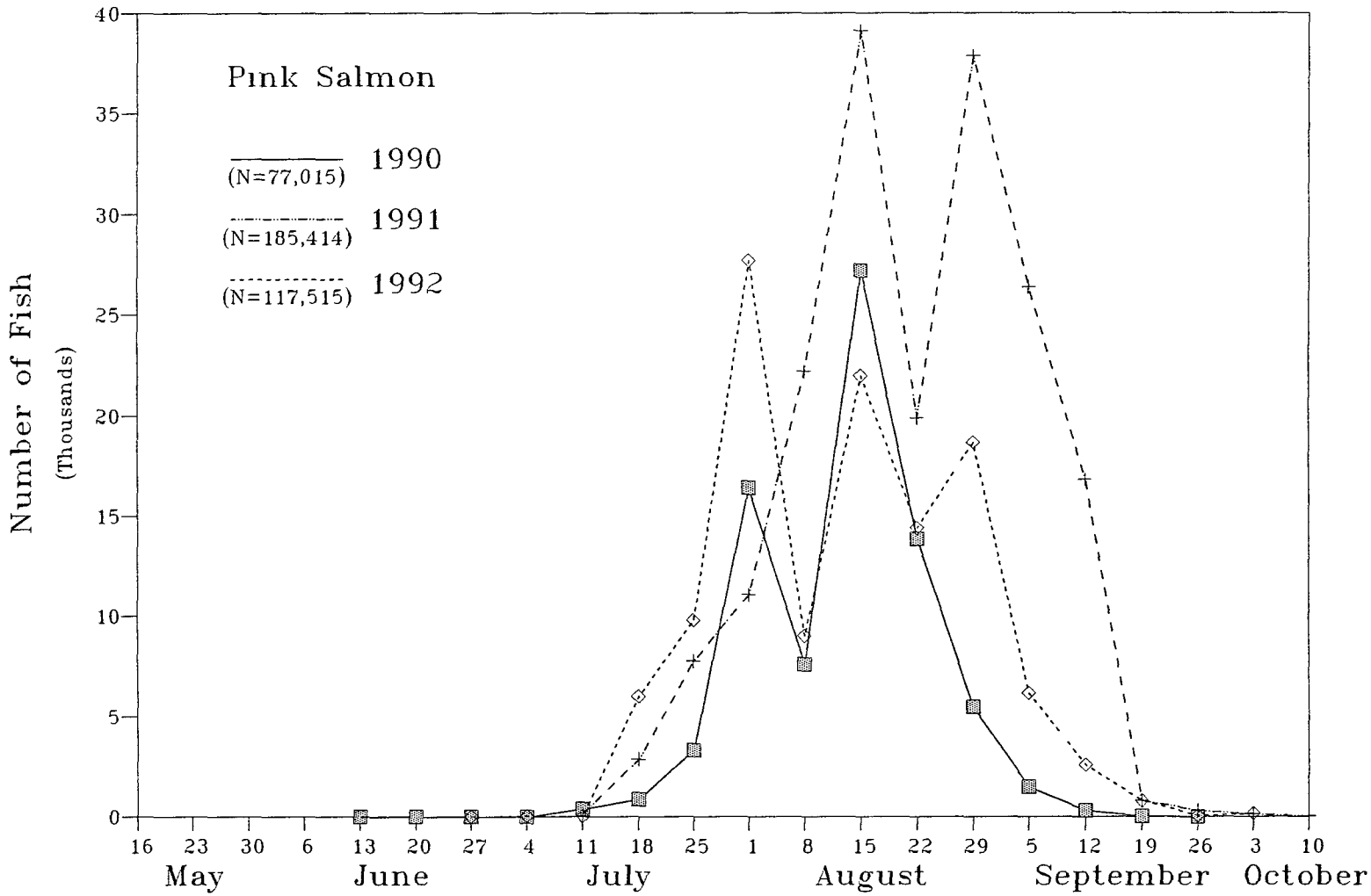

FIGURE 8.—Weekly escapement of pink salmon in the Uganik River, Alaska, 1990, 1991 and 1992.

and 458 mm in length and 1,575 g, 1,550 g, and 1,559 g in weight in 1990, 1991, and 1992, respectively.

TABLE 6.-Length and weight composition of pink salmon sampled at the Uganik River weir, Alaska, 1990, 1991 and 1992.

	Female						Male					
			Length (mm)		Weight (g)				Length (mm)		Weight (g)	
Year	*N*	%	Mean	SE	Mean	SE	*N*	%	Mean	SE	Mean	SE
1990	363	48.0	461	4	1,600	16	393	52.0	453	6	1,575	6
1991	433	47.0	470	3	1,604	11	488	53.0	466	3	1,550	9
1992	460	40.9	471	3	1,550	12	662	59.1	458	2	1,559	6

Chum salmon.-A total of 2,560 chum salmon were passed through the weir between June 27 and September 20, 1990. The escapement 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 9).

In 1991, a total of 11,823 chum salmon were passed through the weir July 3 to October 6 and the escapement timing was trimodal. A daily escapement of 13-556 fish was passed from mid-July through mid-September with escapement peaks occurring in late July, mid-August and early September (Figure 9).

In 1992, a total of 11,771 chum salmon passed through the weir between July 1 and October 6. A bimodal escapement was observed with escapement peaks in early and mid-August (Figure 9). Escapement timing was similar to 1990 and 1991.

Aerial surveys observed an estimated 8,000, 10,000 and 17,980 chum salmon spawning below the weir site in 1990, 1991 and 1992, respectively (Table 5). Combining the aerial survey estimates with counts obtained at the weir, the total spawning escapement in the Uganik River for chum salmon was estimated to be 10,560, 21,823 and 29,751 fish in 1990, 1991 and 1992, respectively.

Four age groups were identified for chum salmon. The dominant age group was 0.3 followed by 0.4 and 0.5 (Table 7). Age composition differed significantly between males and females ($P<0.05$, $P<0.01$ and $P<0.05$) in 1990, 1991 and 1992, respectively. Age 0.3 predominated for females and age 0.4 for males. In 1990, the percentage of males (52%)

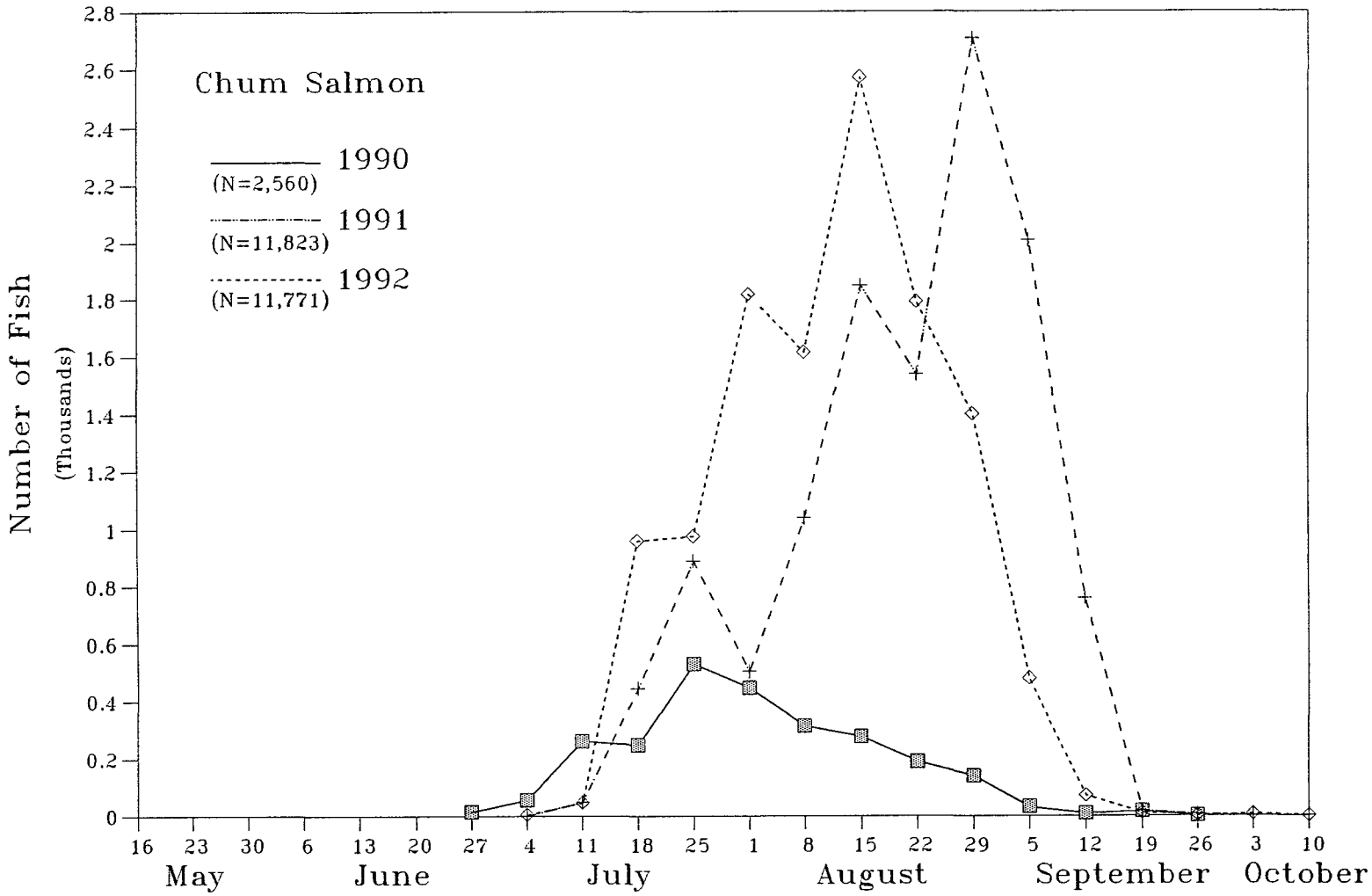

FIGURE 9.—Weekly escapement of chum salmon in the Uganik River, Alaska, 1990, 1991 and 1992.

TABLE 7.—Age, length, and weight composition of chum salmon sampled at the Uganik River weir, Alaska, 1990, 1991 and 1992.

	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	
						1992						
0.2	1	0.3	430	-	2,975	-	7	2.3	490	16	3,025	30
0.3	82	27	580	4	3,425	11	76	24.8	595	3	3,400	14
0.4	38	12	610	5	4,050	15	89	29.1	623	3	4,225	11
0.5	4	1.3	631	11	4,975	22	9	2.9	625	9	5,350	22
Total	125	40.6	590		3,661		181	59.1	606		3,888	

was similar to females (P>0.50). However, in 1991 and 1992, the percentage of males (57% and 59%) differed significantly from the percentage of females (P<.005 and P<.005), respectively. Chum salmon averaged 602 mm (*N*=256), 595 mm (*N*=224), and 600 mm (*N*=306) in length and 3,601 g, 3,693 g and 3,795 g in weight in 1990, 1991 and 1992, respectively.

Coho salmon-A total of 5,261 coho salmon were counted in 1990. Coho salmon first appeared at the weir on August 18. This was followed by a low escapement for three weeks until a peak number (>2,500) was passed on September 12 (Figure 10). Coho salmon passing through the weir declined steadily until the weir was disassembled on October 12.

A total of 11,704 coho salmon were counted in 1991. Coho salmon first appeared at the weir on August 14. This was followed by a low escapement for two weeks until a peak number (1,173) was passed on September 11 (Figure 10). Coho salmon were passed through the weir until October 7.

In 1992, a total of 9,927 coho salmon were counted through the weir. The first coho salmon appeared at the weir on August 12. Two escapement peaks were observed, one in mid-September and another in early October (Figure 10).

Five age groups of coho salmon were identified in 1990 and 1992, and three in 1991. The dominant age group was 2.1 for males and females (Table 8). The percentage of males (63% and 64%) differed significantly from the percentage of females (P<.005) in 1990 and 1992, respectively In 1991, the percentage of males (49%) was similar to the percentage of females (P>0.50). Coho salmon averaged 601 mm (*N*=123), 628 mm (*N*=210), and 625 mm (*N*=126) in length and 3,122 g, 3,479 g and 3,502 g in weight in 1990, 1991 and 1992, respectively.

Chinook salmon.-Six chinook salmon were observed in the Uganik River in 1990, one in 1991, and five in 1992. The majority (67%) of these fish were passed in July, with the earliest observed in late June and the last fish observed in mid-August.

Other species.-A total of 18,159 Dolly Varden were passed through the weir in 1990. Dolly Varden were present at the weir during construction and a bimodal escapement pattern was observed with an early peak in mid-July and another in early August (Figure 11). In 1991, a total of 69,564 Dolly Varden were passed through the weir. A bimodal escapement was also observed in 1991 with an early peak the last week of July and a later peak in mid-August. A total of 60,890 Dolly Varden were counted in 1992. Two escapement peaks were observed, one in late July and another in late August.

In addition to the upstream movement of Dolly Varden, some downstream passage was observed in 1991 and 1992. A total of 18,523 Dolly Varden were passed downstream between May 19 and June 7, 1991. In 1992, 28,775 Dolly Varden were passed downstream between May 17 and June 6. However,

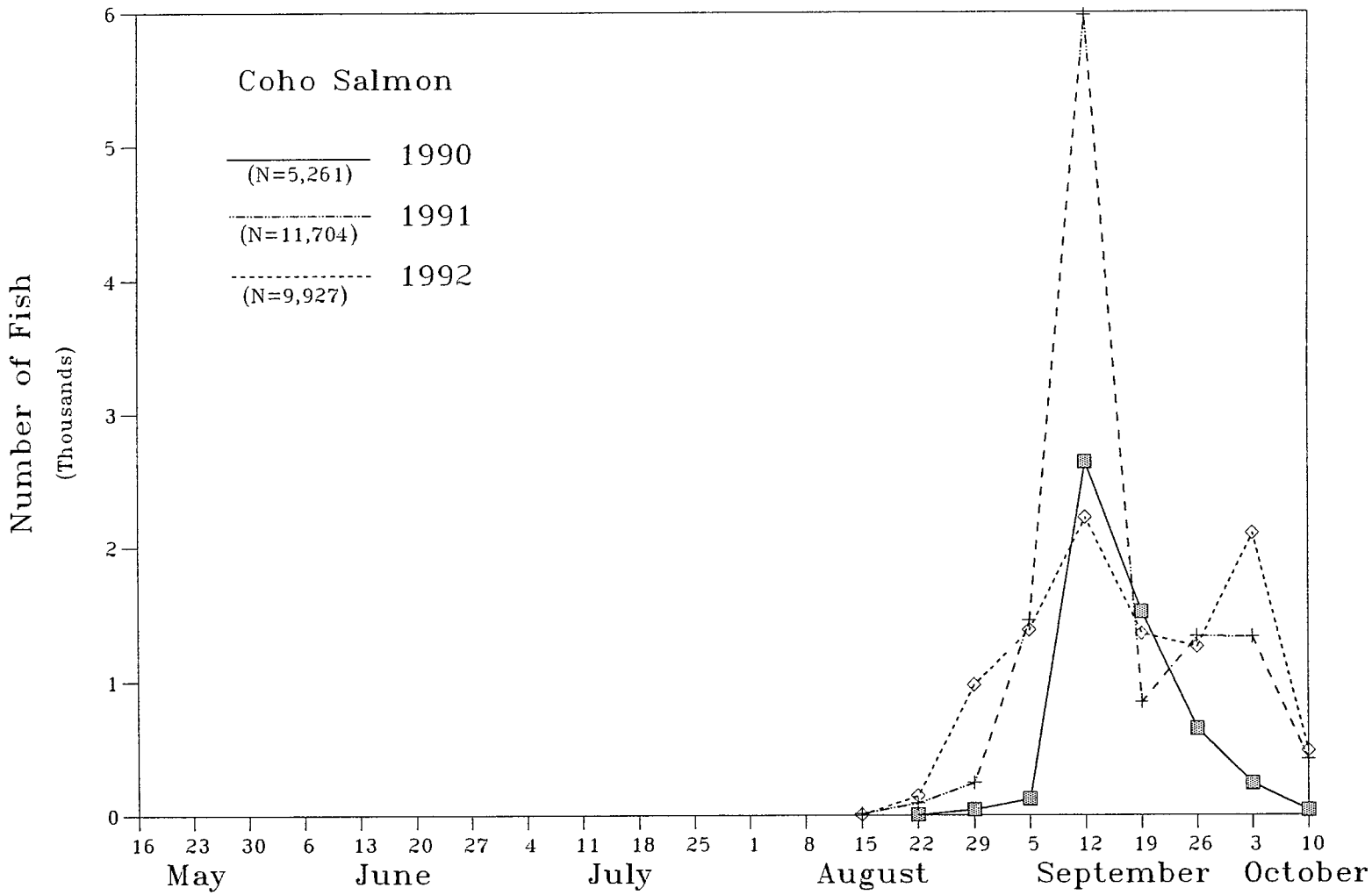

FIGURE 10.—Weekly escapement of coho salmon in the Uganik River, Alaska, 1990, 1991 and 1992.

TABLE 8.—Age, length, and weight composition of coho salmon sampled at the Uganik River weir, Alaska, 1990, 1991 and 1992.

	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	20	9.5	614	9	2,075	40	15	7.2	599	12	3,325	15
2.1	85	40.5	634	4	3,425	19	83	39.5	635	5	3,775	11
3.1	3	1.4	602	38	3,600	32	4	1.9	562	28	4,275	21
Total	108	51.4	629	4	3,450		102	48.6	626	3	3,825	
1992												
1.1	6	4.7	595	27	3,350	19	5	4.0	649	12	3,575	33
2.0	0	-	0	-	-	-	4	3.1	376	9	800	20
2.1	39	31.0	655	7	3,700	11	65	51.6	628	9	3,600	9
3.0	0	-	0	-	-	-	1	0.8	360	-	750	-
3.1	1	0.8	620	-	3,475	-	5	4.0	628	47	3,500	14
Total	46	36.5	647	7	3,650		80	63.5	613	11	3,417	

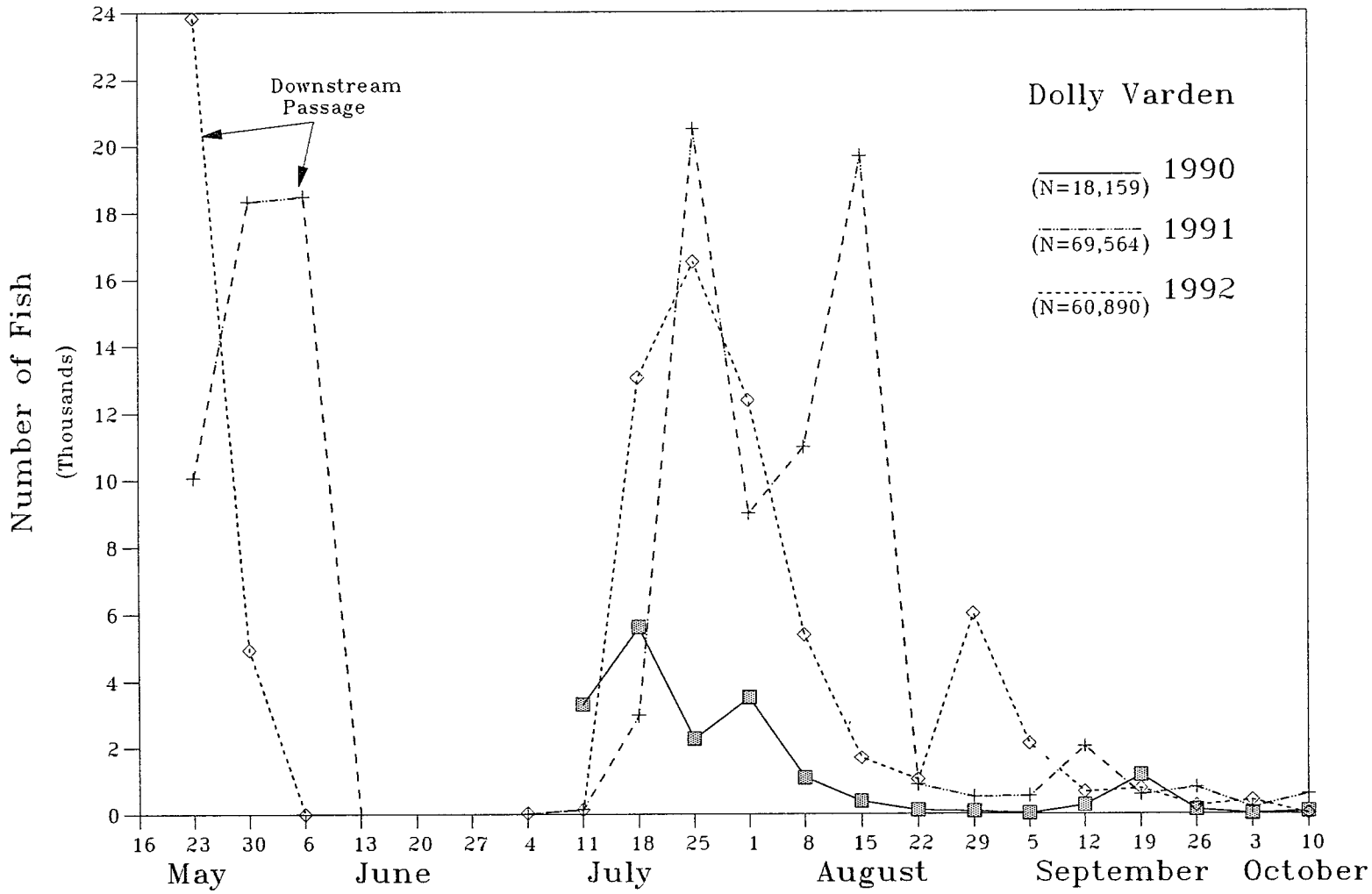

FIGURE 11.—Weekly escapement of Dolly Varden in the Uganik River, Alaska, 1990, 1991 and 1992.

high water conditions prevented complete counts of downstream migrating Dolly Varden after May 24.

One adult steelhead was counted upstream through the weir in 1990, two in 1991, and three were observed in 1992. These fish were passed in September and October. Four steelhead were also passed downstream through the weir in 1992. No downstream migration was observed in 1990 or 1991.

Discussion

Weir

The resistance board weir worked effectively in 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 high and low water levels. However, extreme high water conditions during the peak of sockeye salmon migration in 1992 precluded us from obtaining accurate escapement counts on this species.

Increasing picket length and the size of the resistance boards allowed the weir to stay above the water surface during higher water levels than in 1990. However, the high water events during June in 1991 and 1992 required estimates of undetected sockeye salmon escapement during periods that the weir was submerged.

Placement of the counting chute into deeper water in 1991 and 1992 helped facilitate passage of fish during low water levels which may have delayed fish passage in 1990. The earlier weir installation dates in 1991 and 1992 provided information on early returning sockeye salmon and outmigrating Dolly Varden and steelhead that was not collected in 1990

In contrast to standard picket weirs, the resistance board weir lends itself to rivers and streams otherwise considered not weirable due to fluctuating water levels and high debris loads. However, high water levels associated with increased water velocities can submerge weir panels and result in undetected fish passage. The advantage of the resistance board weir is the ability to prohibit fish passage soon after water levels recede and debris is removed, whereas the conventional picket weirs may have to be re-installed, repaired or removed for the remainder of the season.

Biological Data

Sockeye salmon.-Escapement timing observed at the weir in 1990 and 1991 was similar to weir counts in 1928-1931 for sockeye salmon (U.S. Department of Interior 1968). Years in which the weir has been installed by early June (1929, 1930, 1932, 1991 and 1992) show a bimodal escapement of sockeye salmon and an early escapement peak occurring in mid-June. 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 a 10-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. Weir counts in 1992 indicated sockeye salmon numbers were also building in June until high water events limited escapement counts during peak migration and precluded any accurate estimates of escapement timing and abundance.

Sockeye salmon escapement in 1990 was 10% 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 for the Inner Uganik Bay (Figure 12) was over 100% greater in 1990 than in 1991, indicating that the run strength was greater in 1990 than in 1991 (Table 9).

The sockeye salmon weir count in 1992 was down by over 75% when compared to counts in 1990 and 1991. Given the similar escapement in 1992 of other species, when compared to previous years, it is possible that the reduced escapement of sockeye salmon in 1992 was due to several factors and may have included a number of undetected sockeye salmon passing during high water events, increased commercial harvest and/or a naturally low return of fish to the system.

Sockeye salmon escapement into the Uganik River occurs from early June through August. Peak escapement occurs the last week of June and the first week of July with over 90% of the run passed by late July. Given this escapement timing, the majority of Uganik River sockeye salmon are available to the commercial fishery prior to August 1 and the majority of harvest beyond August 1 is attributed to other stocks (Holmes and Monkiewicz 1988).

Uganik River stocks of salmon are commercially harvested during June and July in the Central and Inner Uganik Bay Sections of the Northwest Kodiak commercial fishing district. These sections are divided into several statistical areas of which areas 25313 and 25312 are in closest proximity to the Uganik River (Figure 12). Harvests in these two areas are primarily made up of Uganik River stocks although some mixed-stock harvest does occur (Holmes and Monkiewicz 1988). Additional harvest of Uganik River stocks also occurs in several other outlying areas but these are highly mixed-stock harvests with the contribution of Uganik River stocks unknown.

Sockeye salmon harvest has remained at record levels since 1990 in area 25313 but has declined in area 25312. The majority of the recent high harvest levels in area 25313 may be attributed to other stocks as over 50% of the harvest in this area had occurred after August 1 in 1990, 1991 and 1992 (Figure 13). The majority (>90%) of the sockeye salmon harvest in area 25312 occurs before August 1 which is when Uganik River sockeye salmon are present based on weir escapement counts.

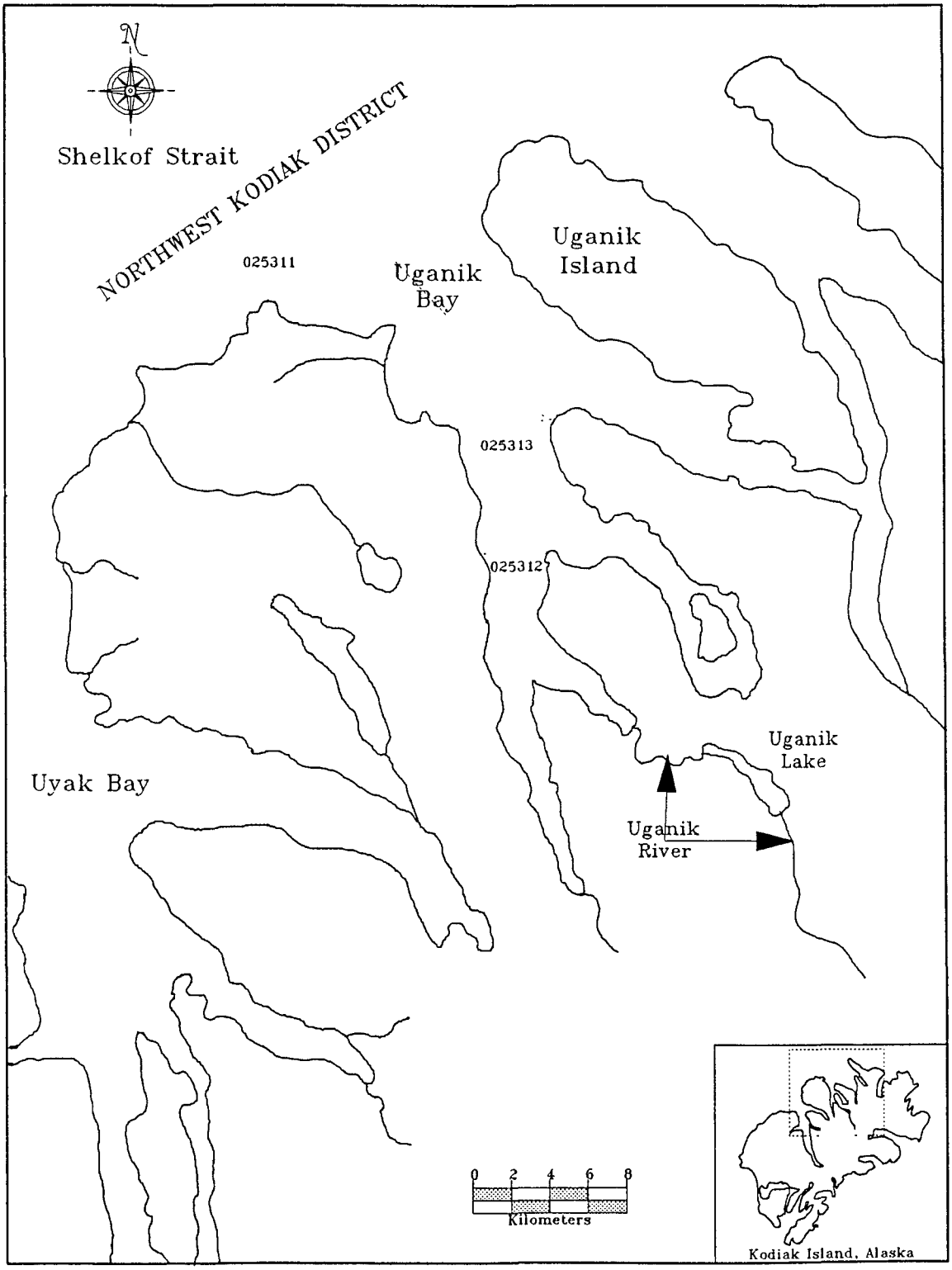

FIGURE 12.-The Uganik Bay commercial fishery section (statistical areas 025312, 025313 and 025311) of the Northwest Kodiak District, Alaska.

TABLE 9.-Commercial salmon harvest in the Northwest Kodiak District, statistical area 025312, Kodiak, Alaska, 1990, 1991 and 1992[a].

Date	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
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
8/17	532	647	118	38
Totals	12,989	9,831	2,365	127
		1992		
6/10	121	0	10	0
6/11	2,005	0	46	0
6/15	62	0	0	0
6/16	352	0	5	0
6/17	113	0	0	0
6/23	62	7	7	0
9/11	202	0	0	28
Totals	6,142	7	68	28

[a] Data source: Alaska Department of Fish and Game, Division of Commercial Fisheries, Kodiak, Alaska

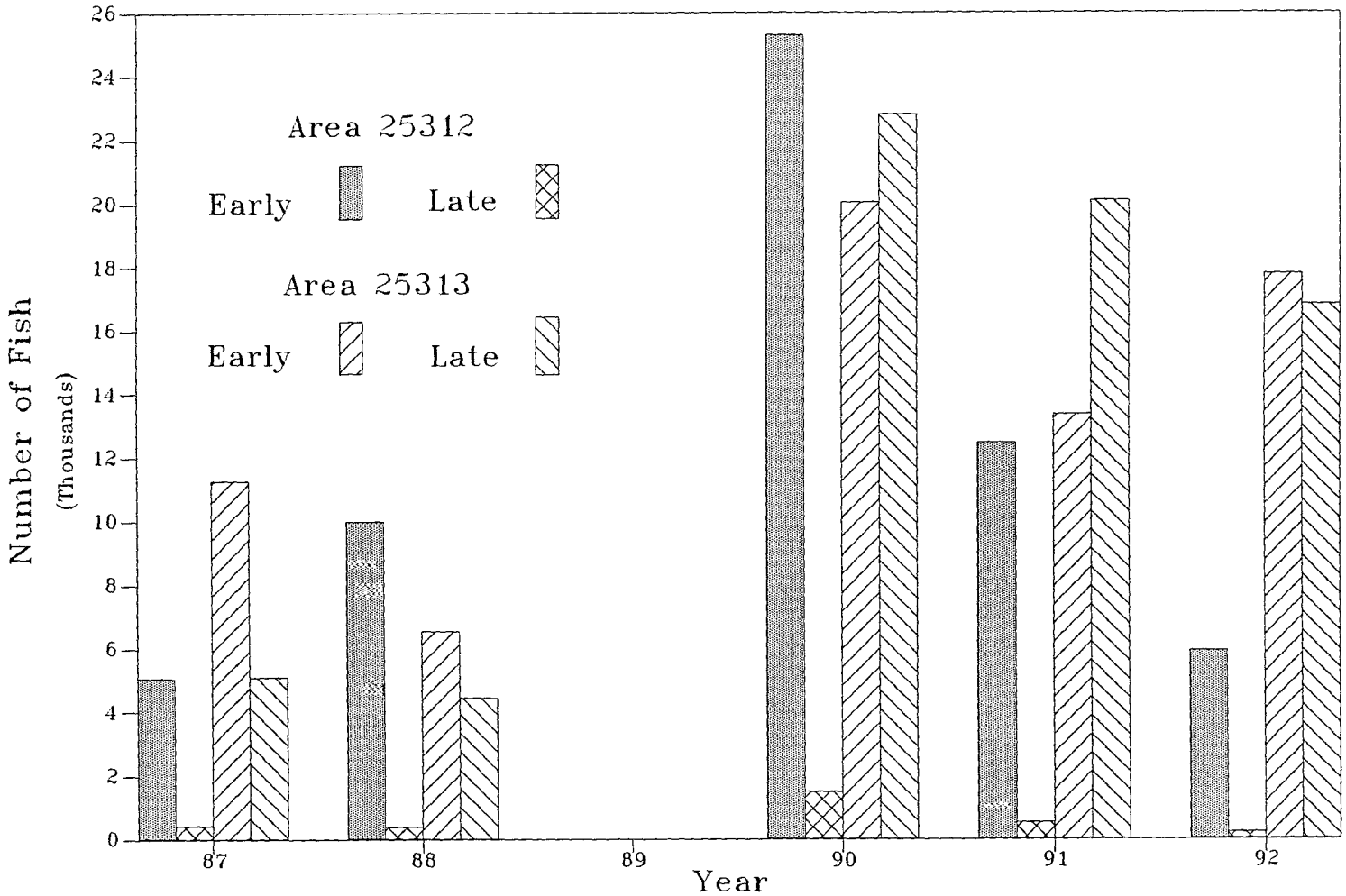

FIGURE 13.—Sockeye salmon harvest in the Northwest Kodiak District (statistical areas 25312 and 25313). Data source: Alaska Department of Fish and Game, Division of Commercial Fisheries, Kodiak, Alaska.

Harvest in area 25312 has declined since 1990 which can partially be attributed to a decline in the amount of time the fishery has been open (Table 9).

Total harvest of sockeye salmon in the Central and Inner Uganik Bay sections of the Northwest Kodiak District was not abnormally high in 1992 when compared to previous years, although a record level was harvested in area 25311. Area 25311 is a cape fishery and consists of a mixed stock harvest of which only a small percentage is apportioned to the Uganik River stock (Holmes and Monkiewicz 1988). Therefore, it does not appear that an increased interception of Uganik River stock in the commercial fishery is responsible for the reduced escapement of sockeye salmon observed in 1992.

Aerial surveys indicate a substantial number of fish escaped over the weir undetected into the system in 1992. A survey on July 29, 1992 resulted in an index count of 25,000 sockeye salmon which was similar to an index count of 29,100 fish on July 19, 1991 (Chatto 1992). Expanding the 1992 aerial index count resulted in an estimated escapement of 70,000 sockeye salmon prior to July 29, and resulted in a total estimated escapement of 72,896 sockeye salmon in 1992.

To further substantiate undetected escapement past the weir in 1992, the Refuge conducted five aerial surveys with both fixed and rotary wing aircraft (Chatto 1992). Counts from the additional surveys were used to estimate a total escapement of 81,400 sockeye salmon using AUC methodology (Johnson and Barrett 1988; Perrin and Irvine 1990). The AUC estimate is comparable to the estimated escapement of 72,896 fish using weir counts and the expanded aerial survey count.

Weir counts on other major sockeye salmon systems near the Uganik River did not experience decreased escapements in 1992 (Alaska Department of Fish and Game 1992b). The Karluk and Ayakulik rivers, two of the largest sockeye salmon systems on the west side of Kodiak Island, reported average escapements in 1992. This could possibly rule out environmental factors which could have affected run strength in local river systems.

Available data do not show any substantial increase in total commercial fishery harvest or any dramatic aberration that would indicate an extremely high or low return to the Uganik River. Also, escapement in nearby rivers does not indicate a natural low return of sockeye salmon in the geographical area. The above information supports the assumption that there was a significant amount of undetected sockeye salmon escapement past the weir during high water periods in 1992.

Pink salmon.-A bimodal entry pattern was evident for pink salmon in 1990 and 1991, and a trimodal pattern was observed in 1992. Escapement peaks occurred in early, mid, and late August. In previous years of weir operation (1928, 1929, 1930, and 1931) a single escapement peak was reported.

Pink salmon abundance was over 525% greater than earlier weir counts but was similar to historical aerial survey counts. However, substantial spawning of pink and chum salmon occurred below the weir. Combined estimates of spawners below the weir with escapement counts obtained at the weir resulted in a 69% increase over the earlier aerial survey counts.

Pink salmon harvest in the Inner Uganik Bay section ranged from less than 100 fish to over 86,000 fish during weir operations. Harvest levels were the greatest in 1990 (86,765 fish) while escapement (77,015 fish) was the lowest recorded during the three years of weir operation. The peak escapement timing of pink salmon occurs simultaneously with the commercial fishery in Uganik Bay and a high degree of exploitation on this species is expected.

Chum salmon.-Chum salmon escapement timing was similar for all three years of operation, with the exception of 1990 when a weak escapement was observed. Chum salmon are present in the system for approximately three months, with the first fish appearing in late June and the peak of migration occurring in late August. This escapement timing is similar to that observed during earlier weir operations and is comparable to pink salmon resulting in a high degree of overlap between these two species.

Chum salmon abundance was over 60% greater than earlier weir counts and over 90% greater than that estimated by historical aerial surveys when estimates of fish spawning below the weir were combined with weir counts.

Chum salmon harvest in the Inner Uganik Bay section ranged from less than 100 fish to over 19,000 fish during weir operations. The 1990 commercial harvest of 19,453 chum salmon resulted in the lowest escapement (2,560 fish) recorded at the weir during the three years of operation. Peak escapement of chum salmon occurs simultaneously with the commercial fishery in Uganik Bay. As with pink salmon, a high degree of exploitation is expected with this species.

Coho salmon.-Coho salmon escapement timing was later in 1990, 1991 and 1992, than that reported by the earlier weir counts. The recent escapement data show the majority of coho salmon passage occurs in September while the earlier weir information shows most escapement occurring in August.

Our data on coho salmon run timing are the only complete escapement data available as the earlier weir on the Uganik River was removed in late August or early September. Peak coho salmon escapement in 1990, 1991 and 1992 occurred the second week in September, later than the weir has previously been operated. In 1992, a second peak was also observed in early October.

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. Coho salmon were observed concentrating 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 the counting chute was moved into deeper water and water levels began to rise.

Coho salmon abundance was 560% greater than historical weir counts and was over 250% greater than historical aerial surveys. However, the earlier weir was not operational for the duration of the coho migration which resulted in an incomplete count of this species and can partially account for the increase in abundance that we observed.

Harvest of coho salmon in the Inner Uganik Bay section was less than 400 fish each year during weir operations. The escapement timing of this species, which peaks in mid-September, occurred after the majority of the commercial harvest takes place in Uganik Bay resulting in minimal exploitation of this species.

Chinook salmon.-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 1991).

Other species.-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 the Karluk and Ayakulik rivers on Kodiak Island between mid-May and early June with adults returning in the fall as early as September (Chatto 1987).

The entry pattern of Dolly Varden appears to coincide with peak escapement of other species. The 1990, 1991 and 1992 escapement peaks were comparable to increases in chum and 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 freshwater environments throughout the summer and fall 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 observed escapement pattern for Dolly Varden may only be valid for larger adults. Picket spacing allowed smaller fish (<300 mm) to move freely through the weir at any location. Thus, total escapement figures are conservative for upstream migrating Dolly Varden.

Management Implications

The escapement numbers of all species during the 1990, 1991 and 1992 weir operation, with the exception of chum salmon in 1990, were above that recorded by weir counts over 60 years ago. Sockeye, pink, and coho salmon counts averaged approximately six times greater than that observed in 1928-1932, indicating either an increase in production and escapement of these species or changes in commercial fishery management strategies allowing for greater in-river escapement.

Total escapement numbers should be considered conservative for all species as the weir was partially submerged during periods that each species was present. Attempts to enumerate fish during high water conditions were difficult due to water turbidity and flow going over the weir. However, escapement over the weir was observed and actual counts were added to the daily escapement. On several occasions, (1991 and 1992), evening fish concentrations below the weir were present above the weir the following morning indicating that fish were able to pass over the weir during high water events. When water levels receded, weir inspections did not identify any holes or scouring under the weir which would have allowed fish to pass through or under the weir undetected.

Visual observations and aerial surveys indicate a substantial number of fish spawn below the weir. When aerial survey counts of pink and chum salmon below the weir are combined with weir counts, a much larger total escapement is obtained and is more comparable to aerial survey counts from previous years. Aerial survey estimates of salmon spawning below the weir in 1990, 1991 and 1992, ranged from 55,000 to 63,590 pink salmon and 8,000 to 17,980 chum salmon, respectively.

In the past, aerial survey index counts have been used to estimate escapement levels into the Uganik River. Aerial surveys conducted by the Refuge and the Department in 1958-1967 and 1976-1989 have observed fewer sockeye, coho, pink and chum salmon than recorded at the weir in 1990, 1991 and 1992. However, many of the previous 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 possible 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 expensive 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 cannot

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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References

Alaska Department of Fish and Game. 1993. Westward region commercial salmon reports to the State Board of Fisheries. Alaska Department of Fish and Game, Division of Commercial Fisheries, Kodiak, AK.

_____. 1992a. Kodiak management area 1991/92 commercial salmon fishery. Alaska Department of Fish and Game, Division of Commercial Fisheries, Kodiak, AK.

_____. 1992b. Westward region salmon weir counts, 1984-1992. Alaska Department of Fish and Game, Division of Commercial Fisheries, Kodiak, AK.

_____. 1991. Kodiak management area 1990 annual weir reports. Alaska Department of Fish and Game, Division of Commercial Fisheries, Kodiak, AK.

Armstrong, R.H. 1965. Some feeding habits of the anadromous dolly varden *Salvelinus malma* (Walbaum) in southeastern Alaska. Alaska Department of Fish and Game. Informational Leaflet 51: 1-27, Anchorage, AK.

Armstrong, R.H. and J.E. Morrow. 1980. The dolly varden char *Salvelinus malma*. Pages 99-140 *in* E.K. Balon, editor. Charrs, salmonid fishes of the genus Salvelinus (Perspectives invertebrate science; v.1). Dr. W. Junk by publishers, The Hague, The Netherlands.

Bartlett, L. 1988. Resistance-board weirs, tips, suggestions and observations. Alaska Department of Fish and Game, Division of Sport Fisheries. Anchorage, AK.

Bevan, D.E. 1961. Variability in aerial counts of spawning salmon. Journal of the Fisheries Research Board of Canada 18(3): 337-348.

Chatto, T. 1992. 1992 Uganik River sockeye salmon escapement evaluation, Kodiak National Wildlife Refuge (Preliminary September 29, 1992) memo, Kodiak National Wildlife Refuge, Kodiak, AK.

_____. 1987. Instream movements and distribution of fall run steelhead in the Karluk River 1982-1984. U.S. Fish and Wildlife Service, Kodiak National Wildlife Refuge, Kodiak, AK.

Holmes, P.B. 1990. Kodiak management area salmon catch and escapement statistics, 1987. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Informational Report: 91-14, Kodiak, AK.

_____. 1990. Kodiak management area salmon catch and escapement statistics, 1986. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Fishery Report 90-04. Kodiak, AK.

_____. 1988. Salmon catch and escapement statistics, Kodiak Management Area. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Informational Report: 4K88-37. Kodiak, AK.

Holmes, P.B. and B.E. Monkiewicz. 1988. Catch and escapement statistics for Kodiak Management Area sockeye and coho salmon, 1985. Alaska Department of Fish and Game, Commercial Fish Division Technical Report 88-09, Kodiak, AK.

Johnson, B.A. and B.M. Barrett. 1988. Estimation of salmon escapement based on stream survey data: a geometric approach. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report: 4K88-35, Kodiak, AK.

Kodiak Regional Planning Team. 1992. Kodiak regional comprehensive salmon plan 1982-2002, phase 2 revision. Kodiak Regional Planning Team, Kodiak, AK.

Koo, T.S.Y. 1962. Age designation in salmon. Pages 37-48 *in* T.S.Y. Koo, editor. Studies of Alaska Red Salmon. University of Washington Press, Seattle, WA.

Mills, M.J. 1991. Harvest, catch, and participation in Alaska sport fisheries during 1990. Alaska Department of Fish and Game, Division of Sport Fisheries, Fishery Data Series Number 91-58. Anchorage, AK.

Morrow, J.E. 1980. The freshwater fishes of Alaska. Alaska Northwest Publishing Company. Anchorage, AK.

Mosher, K.H. 1968. Photographic atlas of sockeye salmon scales. U.S. Fish and Wildlife Service, Bureau of Commercial Fisheries, Fishery Bulletin 2: 243-274.

Neilson, J.D. and G.H. Geen. 1981. Enumeration of spawning salmon from spawner residence time and aerial counts. Transactions of the American Fisheries Society 110:554-556.

Perrin, C.J. and J.R. Irvine. 1990. A review of survey life estimates as they apply to the area-under-the-curve method for estimating the spawning escapement of Pacific salmon. Canadian Technical Report of Fisheries Science No. 1733, Department of Fisheries and Oceans, Nanaimo, British Columbia.

Reed, R.J. 1967. Observation of fishes associated with spawning salmon. Transactions of the American Fisheries Society 96: 62-67.

Schneiderhan, D.J. 1987. Kuskokwim area salmon escapement aerial survey manual. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage, AK.

U.S. Department of Interior. 1968. Stream catalog of Kodiak District of Alaska. U.S. Fish and Wildlife Service, Bureau of Commercial Fisheries Report Number 10, Washington, D.C.

U.S. Fish and Wildlife Service. 1987. Kodiak National Wildlife Refuge, final comprehensive conservation plan, wilderness review and environmental impact statement. U.S. Department of Interior, Fish and Wildlife Service, Anchorage, AK.

_____. 1990. Fishery management plan for the Kodiak National Wildlife Refuge. U.S. Fish and Wildlife Service, Kodiak National Wildlife Refuge, Kodiak, AK.

_____. 1992. Kodiak National Wildlife Refuge public use management plan and environmental assessment for public use regulations, final report. U.S. Department of Interior, Fish and Wildlife Service, Kodiak, AK.

U.S. Geological Survey. 1951-1978. Annual stream discharge report. U.S. Geological Survey, Division of Water Resources, Anchorage, AK.

Zar, J.H. 1984. Biostatistical analysis, second edition. Prentice and Hall, Englewood Cliffs, N.J.

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

Date	Sockeye salmon	Pink salmon	Chum salmon	Coho salmon	Chinook salmon	Dolly Varden	Steelhead
6/25	1,012	0	0	0	0	-	0
6/26	1,782	0	0	0	0	-	0
6/27	1,227	3	15	0	0	-	0
6/28	1,647	0	4	0	0	-	0
6/29	1,896	0	3	0	0	-	0
6/30	3,287	0	2	0	0	-	0
7/1	2,592	0	1	0	0	-	0
7/2	4,150	0	26	0	0	-	0
7/3	1,576	0	21	0	0	-	0
7/4[a]	-	-	-	-	-	-	-
7/5	2,279	0	54	0	0	-	0
7/6	3,514	14	46	0	0	-	0
7/7	6,179	18	32	0	0	-	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
8/5	51	744	48	0	0	142	0

APPENDIX 1.-(Continued).

Date	Sockeye salmon	Pink salmon	Chum salmon	Coho salmon	Chinook salmon	Dolly Varden	Steelhead
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
9/17[b]	300	27	10	1,207	0	379	0
9/18	1	0	1	3	0	30	0

APPENDIX 1.-(Continued).

Date	Sockeye salmon	Pink salmon	Chum salmon	Coho salmon	Chinook salmon	Dolly Varden	Steelhead
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] - 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, 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]	-	-	-	-	-	-	-
6/20[a]	-	-	-	-	-	-	-
6/21[a]	-	-	-	-	-	-	-
6/22[a]	-	-	-	-	-	-	-
6/23[a]	-	-	-	-	-	-	-
6/24[a]	-	-	-	-	-	-	-
6/25[a]	-	-	-	-	-	-	-
6/26[a]	-	-	-	-	-	-	-
6/27[a]	-	-	-	-	-	-	-
6/28[a]	-	-	-	-	-	-	-
6/29[a]	-	-	-	-	-	-	-
6/30	7,474	0	0	0	0	0	0

APPENDIX 2.-(Continued).

Date	Sockeye salmon	Pink salmon	Chum salmon	Coho salmon	Chinook salmon	Dolly Varden	Steelhead
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
8/12	36	2,779	206	0	0	3,021	0
8/13	19	1,164	99	0	0	322	0

APPENDIX 2.-(Continued).

Date	Sockeye salmon	Pink salmon	Chum salmon	Coho salmon	Chinook salmon	Dolly Varden	Steelhead
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]	-	-	-	-	-	-	-
9/15[a]	-	-	-	-	-	-	-
9/16[a]	-	-	-	-	-	-	-
9/17[a]	-	-	-	-	-	-	-
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]	-	-	-	-	-	-	-
9/24[a]	-	-	-	-	-	-	-
9/25	1	20	0	293	0	90	0
9/26	0	45	0	254	0	203	0

APPENDIX 2.-(Continued).

Date	Sockeye salmon	Pink salmon	Chum salmon	Coho salmon	Chinook salmon	Dolly Varden	Steelhead
9/27	2	46	1	177	0	279	0
9/28	0	13	0	180	0	198	0
9/29[a]	-	-	-	-	-	-	-
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

APPENDIX 3.-Total daily weir count of anadromous fish species, Uganik River, Alaska, 1992.

Date	Sockeye salmon	Pink salmon	Chum salmon	Coho salmon	Chinook salmon	Dolly Varden	Steelhead
5/12	0	0	0	0	0	0	0
5/13	0	0	0	0	0	0	0
5/14	0	0	0	0	0	0	0
5/15	0	0	0	0	0	0	0
5/16	0	0	0	0	0	0	0
5/17	0	0	0	0	0	0	0
5/18	0	0	0	0	0	0	0
5/19	0	0	0	0	0	0	0
5/20	0	0	0	0	0	0	0
5/21	0	0	0	0	0	0	0
5/22	0	0	0	0	0	0	0
5/23	0	0	0	0	0	0	0
5/24	0	0	0	0	0	0	0
5/25	0	0	0	0	0	0	0
5/26	0	0	0	0	0	0	0
5/27	0	0	0	0	0	0	0
5/28	0	0	0	0	0	0	0
5/29	0	0	0	0	0	0	0
5/30	0	0	0	0	0	0	0
5/31	0	0	0	0	0	0	0
6/01	16	0	0	0	0	0	0
6/02[a]	19	-	-	-	-	-	-
6/03[a]	-	-	-	-	-	-	-
6/04[a]	-	-	-	-	-	-	-
6/05[a]	-	-	-	-	-	-	-
6/06[a]	-	-	-	-	-	-	-
6/07[a]	-	-	-	-	-	-	-
6/08[a]	-	-	-	-	-	-	-
6/09	71	0	0	0	0	0	0
6/10	727	0	0	0	0	0	0
6/11	569	0	0	0	0	0	0
6/12[a]	-	-	-	-	-	-	-
6/13[a]	-	-	-	-	-	-	-
6/14[a]	-	-	-	-	-	-	-
6/15[a]	-	-	-	-	-	-	-
6/16	278	0	0	0	0	0	0
6/17	143	0	0	0	0	0	0
6/18	572	0	0	0	0	0	0
6/19	90	0	0	0	0	0	0
6/20	212	0	0	0	0	0	0
6/21	2,042	0	0	0	0	0	0
6/22	2,943	0	0	0	0	0	0
6/23	1,152	0	0	0	1	0	0

APPENDIX 3.-(Continued).

Date	Sockeye salmon	Pink salmon	Chum salmon	Coho salmon	Chinook salmon	Dolly Varden	Steelhead
6/24	582	0	0	0	0	0	0
6/25	11	0	0	0	0	0	0
6/26	66	1	0	0	0	0	0
6/27	89	0	0	0	1	0	0
6/28[a]	-	-	-	-	-	-	-
6/29[a]	-	-	-	-	-	-	-
6/30[a]	-	-	-	-	-	-	-
7/01	79	14	2	0	0	6	0
7/02	21	2	1	0	0	4	0
7/03	32	0	1	0	0	13	0
7/04	41	6	2	0	0	16	0
7/05	12	1	8	0	0	3	0
7/06	16	4	7	0	1	4	0
7/07	22	7	1	0	0	5	0
7/08	37	5	5	0	0	19	0
7/09	3	1	2	0	0	12	0
7/10	10	5	18	0	0	67	0
7/11	5	4	8	0	0	31	0
7/12	31	104	37	0	0	683	0
7/13	25	50	63	0	0	295	0
7/14	135	293	207	0	1	1,762	0
7/15	448	635	226	0	0	4,817	0
7/16	91	625	130	0	0	998	0
7/17	372	2,853	168	0	0	3,114	0
7/18	198	1,461	128	0	0	1,388	0
7/19	382	927	101	0	0	2,769	0
7/20	427	1,064	98	0	0	1,614	0
7/21	667	2,317	176	0	0	4,543	0
7/22	978	3,411	223	0	0	6,335	0
7/23	4	550	68	0	0	102	0
7/24	12	404	57	0	0	193	0
7/25	177	1,092	252	0	1	971	0
7/26	103	1,841	138	0	0	1,143	0
7/27	85	2,237	192	0	0	971	0
7/28	549	11,052	419	0	0	3,974	0
7/29	206	3,278	249	0	0	2,941	0
7/30	15	1,395	148	0	0	305	0
7/31	75	6,452	480	0	0	2,172	0
8/01	54	1,456	193	0	0	874	0
8/02	49	848	156	0	0	746	0
8/03	129	3,019	404	0	0	2,237	0
8/04	119	1,956	254	0	0	1,611	0
8/05	33	345	64	0	0	169	0

APPENDIX 3.-(Continued).

Date	Sockeye salmon	Pink salmon	Chum salmon	Coho salmon	Chinook salmon	Dolly Varden	Steelhead
8/06	23	630	151	0	0	171	0
8/07	128	1,074	308	0	0	253	0
8/08	49	1,128	279	0	0	205	0
8/09	113	1,912	492	0	0	257	0
8/10	70	2,756	378	0	0	370	0
8/11	60	2,987	249	0	0	132	0
8/12	88	4,303	372	1	0	163	0
8/13	35	3,063	226	0	0	140	0
8/14	27	2,358	341	0	0	102	0
8/15	103	4,600	514	6	0	538	0
8/16	21	2,516	235	2	0	134	0
8/17	25	1,544	209	11	0	193	0
8/18	24	1,853	289	12	0	150	0
8/19	40	1,713	282	36	0	161	0
8/20	77	3,392	339	44	0	250	0
8/21	25	1,769	248	18	0	88	0
8/22	24	1,626	189	26	0	74	0
8/23	25	2,835	230	21	0	143	0
8/24	20	1,451	172	51	0	482	0
8/25	16	1,816	182	63	0	424	0
8/26	14	1,421	122	170	0	681	0
8/27	9	2,693	138	175	0	319	0
8/28	26	5,035	286	283	0	2,581	0
8/29	12	3,417	270	210	0	1,366	0
8/30	17	2,345	200	137	0	1,355	0
8/31	5	247	12	8	0	70	0
9/01	4	654	56	73	0	102	0
9/02	7	770	68	556	0	172	0
9/03	1	250	31	15	0	23	0
9/04	11	1,033	82	471	0	251	0
9/05	7	887	33	118	0	151	0
9/06	5	470	15	111	0	41	0
9/07	5	457	18	159	0	134	0
9/08	6	507	12	856	0	69	0
9/09	6	497	11	526	0	71	0
9/10	6	212	5	228	0	47	1
9/11	6	300	5	305	0	302	0
9/12	1	152	8	37	0	12	0
9/13	8	222	3	232	0	147	0
9/14	7	169	2	141	0	112	0
9/15	4	142	5	341	0	83	0
9/16	2	119	1	141	0	305	0
9/17	1	76	1	118	0	76	0
9/18	3	61	1	229	0	38	0

APPENDIX 3.-(Continued).

Date	Sockeye salmon	Pink salmon	Chum salmon	Coho salmon	Chinook salmon	Dolly Varden	Steelhead
9/19	2	24	0	150	0	25	0
9/20	1	14	1	232	0	57	0
9/21	1	11	0	62	0	12	0
9/22	5	8	0	130	0	47	0
9/23	7	6	0	124	0	20	0
9/24	10	5	0	238	0	22	0
9/25	8	9	1	281	0	20	0
9/26	8	76	3	191	0	79	0
9/27	13	142	5	265	0	135	1
9/28	8	27	0	363	0	108	0
9/29	1	11	2	528	0	50	1
9/30	0	4	0	153	0	23	0
10/01	1	0	0	365	0	32	0
10/02	0	0	1	263	0	51	0
10/03	0	0	0	167	0	35	0
10/04	0	0	0	133	0	112	0
10/05	0	1	0	145	0	74	0
10/06	0	0	1	136	0	68	0
10/07	2	0	0	20	0	63	0
10/08	4	0	0	50	0	12	0
10/09	0	0	0	0	0	0	0
10/10	0	0	0	0	0	0	0
Total	16,461	117,515	11,771	9,927	5	60,890	3

[a] - No counts, weir submerged