Alaska Fisheries Technical Report Number 74

Abundance and Run Timing of Adult Pacific Salmon and Dolly Varden in Frosty Creek, Izembek National Wildlife Refuge, Alaska, 2000-2002

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Key words: chum salmon, coho salmon, pink salmon, sockeye salmon, Dolly Varden, Frosty Creek, Izembek National Wildlife Refuge, fixed-picket weir

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June 2004

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The correct citation for this report is:

Cornum, K. K., K. S. Whitton, and M. P. Plumb. 2004. Abundance and run timing of adult Pacific salmon and Dolly Varden in Frosty Creek, Izembek National Wildlife Refuge, Alaska, 2000-2002. U.S. Fish and Wildlife Service, King Salmon Fish and Wildlife Field Office, Alaska Fisheries Technical Report Number 74, King Salmon, Alaska.

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Abstract.–From 2000 to 2002, a fixed picket weir was operated on Frosty Creek, Izembek National Wildlife Refuge, to assess the stock status of Pacific salmon and Dolly Varden *Salvelinus malma*. Chum salmon *Oncorhynchus keta* were the most abundant species with an annual escapement of about 30,000 to 40,000 fish per year. Dolly Varden were the second most abundant species at about 1,000 to 4,000 fish per year. Less than 1,300 sockeye *O. nerka*, pink *O. gorbuscha*, Chinook *O. tshawytscha* and coho *O. kisutch* salmon were counted through the weir each year. In 2000, the female chum salmon sex ratio was 32%, and increased to 48% in 2001 and 46% in 2002. Chum salmon age composition varied among years, with age-classes 0.3 and 0.4 the most abundant. The female coho salmon sex ratios were near 50% in all three years with age-class 2.1 the most abundant. The female sockeye salmon sex ratio varied from 31-48% and age-class 1.2 was the most abundant.

Introduction

The Alaska National Interest Lands Conservation Act (ANILCA) specifically mandated that fish populations and their habitats be conserved in their natural diversity within the Izembek National Wildlife Refuge (Refuge; USFWS 1994). The conservation of adult chum *Oncorhynchus keta*, coho *O. kisutch*, sockeye *O. nerka*, pink *O. gorbuscha*, and Chinook *O. tshawytscha* salmon stocks and resident species that are exploited in commercial, subsistence, or sport fisheries requires accurate monitoring of spawning escapements. Escapement goals for salmon are determined by the Alaska Department of Fish and Game (ADFG) based on aerial index counts, which are often imprecise (Minard et al. 1998). The more reliable escapement observations provided by a weir help fishery managers to determine salmon escapements necessary to utilize the available habitat and

also prevent the overexploitation of noncommercial species. Benefits to subsistence, sport, and commercial users are maximized when fish populations are healthy. Information on the fisheries resources of the Refuge is lacking for many drainages, increasing the likelihood of overexploitation. If escapement goals are not met, refuge fish populations could be adversely affected.

In addition to the recognition that decomposing salmon contribute to the nutrient cycle of the ecosystem, adult salmon are an important source of protein for brown bears *Ursus artctos* and other large predators (USFWS 1985). In the summer and fall, bears in the Refuge concentrate most noticeably at Frosty and Russell creeks and the Joshua Green River. Salmon carcasses are also important for scavengers and decomposers, and are necessary for nutrient cycling, which maintains aquatic habitats. Salmon fry are an important food source for fish, birds, and small mammals.

Information on human use and dependence upon Refuge resources is becoming more important as competition and conflict begins to develop between user groups for the same finite resources. Subsistence and sport fishing use and harvest of Refuge originating fish species are not well documented. Subsistence fishing occurs primarily off the Refuge, but it may impact some Refuge-originating stocks. Sport fishing on the Refuge occurs predominately in road accessible streams and lakes in the Cold Bay Area. During 1982-1983, sport fishing accounted for about 8% of all public use on the Refuge, and local residents accounted for approximately 95% of the sport fishing (USFWS 1985). At that time there were no commercial sport fishing guides operating on the Refuge. Fishing on the Refuge occurred primarily at Frosty Creek because it was accessible by road, and the species targeted by sport fishermen were coho, pink, and chum salmon and Dolly Varden *Salvelinus malma*. Non-local fishermen visit the Refuge for sport fishing opportunities, and this category of visitor-use is approaching the level of use by local residents. One of the prioritized tasks in the Fishery Management Plan for the Refuge is to conduct a creel survey to assess sport fishing use and harvest of anadromous and resident species in Frosty Creek (USFWS 1994). Documenting public use on Frosty Creek is important because of its proximity to Cold Bay coupled with its accessibility by road.

U.S. Fish and Wildlife Service personnel surveyed Frosty Creek and several other streams and lakes in 1985 and 1986 (Adams et al. 1993). The surveys characterized the fish populations and described physical and chemical parameters of the streams and lakes. Chum, coho, pink, and sockeye salmon and Dolly Varden were the only fish species captured in Frosty Creek. Therefore, the life history, run-timing, and escapement information collected during this study will supplement the existing information on anadromous and resident fish populations in Frosty Creek. Additional data are needed as a basis for preparing stock specific spawning escapement goals and to assess the impact of potential development or user conflicts. This study will allow managers to determine appropriate escapement levels for Pacific salmon and better characterize the Dolly Varden population found in Frosty Creek.

In 2000, the King Salmon Fish and Wildlife Field Office (KSFO) initiated a 3-year study on Frosty Creek to: (1) enumerate escapement of Pacific salmon and Dolly Varden in

Frosty Creek; (2) describe the run timing of Pacific salmon and Dolly Varden through the weir; (3) estimate the weekly age and sex composition of Pacific salmon such that simultaneous 90% confidence intervals have a maximum width of 0.20; (4) characterize current public use on Frosty Creek and Izembek National Wildlife Refuge land by conducting a general survey of visitors to the weir in 2000; (5) monitor discharge and water temperatures during weir operations.

Study Area

Frosty Creek, a second order stream, originates in the foothills of Frosty Peak volcano (elev. 2031 m) and flows north into Applegate Cove (Figure 1). Numerous small tributaries and ponds are included in the drainage basin, which is almost entirely located within the Refuge boundaries. Little hydrological information is available for Frosty Creek, although discharge and water quality (alkalinity, conductivity, and pH) parameters were sampled during the summers of 1985 and 1986 (Adams et al. 1993). Discharge ranged from 1.61-1.67 m^3/sec, alkalinity 13.6-15.7 mg/l, pH 6.7-7.0, and the conductivity was 27 S/cm. Frosty Creek is a clear water stream supporting spawning populations of chum, coho, pink, and sockeye salmon, as well as Dolly Varden.

The KSFO installed and operated a weir on Frosty Creek from 2000 to 2002. In 2000, a fixed picket weir was installed just down stream from the "first bridge" to facilitate the collection of public use information, (Latitude: N55º 10.102´ and Longitude: W162º 48.603´ Figure 1). This section of the creek is characterized by pools and riffles flowing over gravel and small and large cobble substrate. Alder, willow, and sedges dominate the riparian zone. In 2001 and 2002, the weir was moved downstream approximately 8 km from the original site and installed upstream of the creek mouth where it enters Applegate Cove (Latitude: N55º 11.672´ and Longitude: W162º 51.236´ Figure 1). This section of the creek is characterized by pools and glides flowing over sand, gravel, and small cobble substrate. Willow, grasses, and sedges dominate the riparian zone.

Methods

Weir Operation

The KSFO installed and operated a bi-directional weir on Frosty Creek from 2000 to 2002. The weir was constructed of 12-mm diameter electrical metal tubing (EMT) pickets separated by 19-mm lengths of polyvinyl chloride pipe (PVC). The picket spacing was set at 19 mm to allow capture of Dolly Varden. Three-millimeter diameter aircraft cable was used to string the pickets and PVC spacers together, and clamps were attached to the ends of the cables to create weir panels of varying heights (1.2-1.5 m) and lengths (3 m) to accommodate differences in channel depth and width. The weir panels were supported by fence posts and an 8-mm diameter galvanized aircraft cable stretched across the stream. The supporting cable was anchored to the stream banks using "dead men" buried parallel to the stream banks at a depth that allowed the cable to be suspended

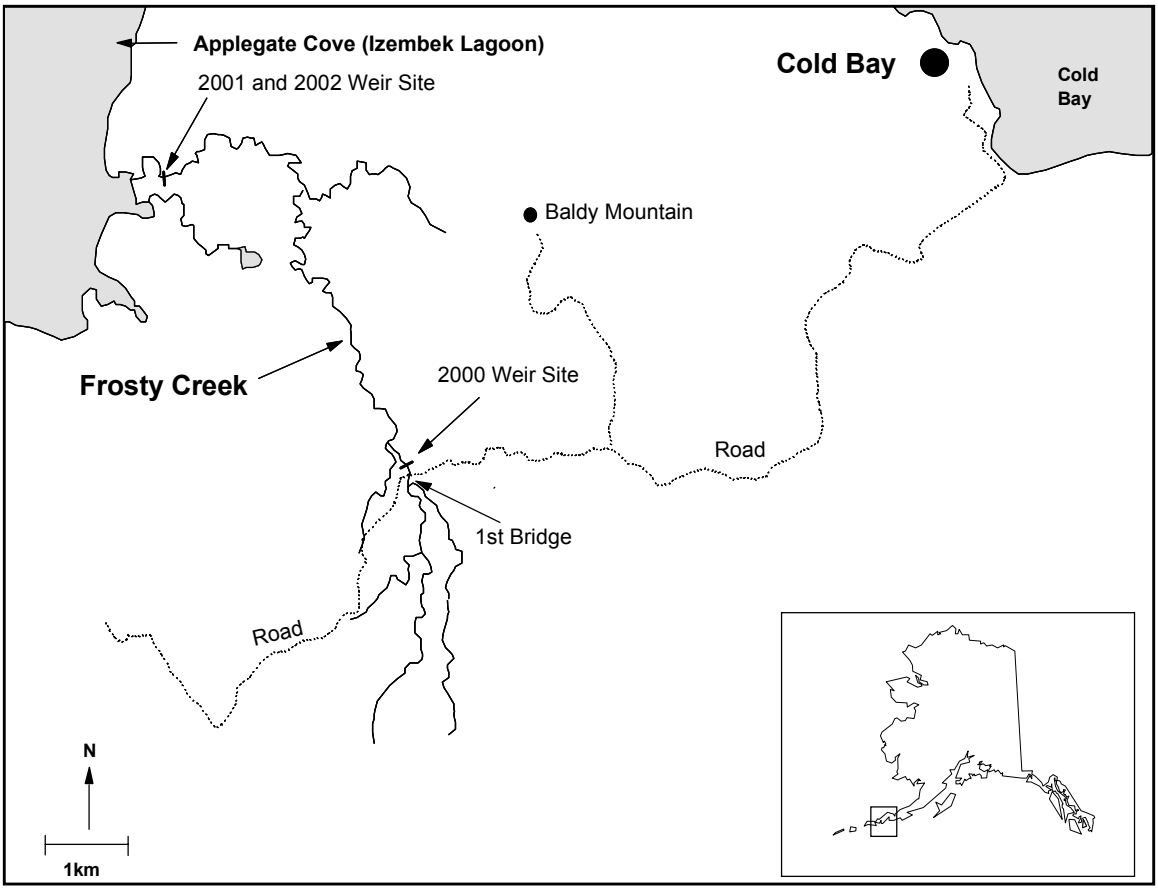

Figure 1. Map of Frosty Creek showing both weir sites, Izembek National Wildlife Refuge, Alaska, 2000-2002.

just above the water surface. Weir panels were hooked together and placed across the channel at an angle to direct upstream migrant fish to the upstream trap box and downstream migrant fish to the downstream trap box. The continuous panel was tilted downstream in relation to the streambed, to shunt debris to the water surface, and thereby maintaining free-flow of water through the pickets. The stream banks at each end of the weir were armored with sandbags to prevent erosion. The tops of the panels were wired to the supporting cable and the bottom ends of the pickets were pushed into the substrate. The entire weir was inspected, cleaned, and maintained daily to insure structural integrity.

Upstream and downstream migrant boxes were installed in the weir to capture salmon and Dolly Varden for weekly biological sampling. When fish were not being collected for sampling, the trap boxes were closed and fish were passed through an opening in the weir. During sampling, a dip-net was used to remove fish from the trap boxes at least once a day or more often as the number moving through the weir increased. Weekly samples of all Pacific salmon species were examined for gill-net marks, measured, sexed, and scales were extracted for age analysis. Scales were not collected from pink salmon. Salmon in excess of sampling needs were counted and identified as they were passed through an opening in the weir or upstream trap box. If possible, all Dolly Varden were

measured. Fish were not allowed to hold downstream of the weir. If this occurred, the trap box was closed and the counting panel opened to facilitate upstream passage.

To monitor stream discharge on Frosty Creek, water velocity was measured periodically over a range of stage heights. Stage heights were measured daily from a staff gauge. To estimate discharge, water velocity was measured with a Marsh-McBirney model 201 flow meter. The relationship between discharge and stage height was determined using linear regression. The relationship between the two variables was used to convert stage height readings to discharge for days when discharge was not measured. During all 3 years discharge and stage height measurements were taken near the weir sites.

In 2000, a Ryan Instruments thermograph (model RTM 2002-2) was installed at the weir to monitor water temperatures. It was replaced in 2001 and 2002 with a Hobo® thermograph (model number H08-001-02). Water temperature was recorded every 2 h and summarized as daily maximum, minimum, and mean.

Biological Data

Data on Pacific salmon age, sex, and length (ASL) were collected using a temporally stratified sampling design (Cochran 1977), with statistical weeks defining strata. All salmon were sampled weekly for ASL information, and to the extent logistically feasible, the sample was collected uniformly throughout each week (Sunday through Saturday). To avoid potential bias caused by the selection or capture of individual fish, all target species within the trap were included in the sample even if the target number for the species was exceeded. Non-target species were netted out of the trap box, tallied, and released upstream. Dolly Varden captured at the weir during sampling were measured to fork length (FL) and released.

Sub-sampled salmon were examined for gill net marks, measured from mid-eye to tail fork (MEF), sexed based on morphological characteristics and aged based on scale samples. Scales were not taken from pink salmon. The number of scale samples varied per species. One scale from chum and sockeye salmon and three scales from coho salmon were extracted from the preferred area on the left side of adult salmon (Jerald 1983). Scale samples were cleaned and mounted on gummed scale cards. In 2000 and 2001, KSFO made impressions of scales on cellulose acetate cards and aged the scales. Two readers independently aged the scales. Ages were compared and differences were resolved in conference. Scales were discarded from the analysis if the age could not be resolved in conference. In 2002, the ADFG office in Kodiak pressed and aged the scales. Salmon ages are reported according to the European method (Koo 1962), where the number on the left side of the decimal indicates the number of winters in fresh water and the number on the right side indicates the winter spent in salt water. In 2001, a sub-sample of scales was randomly selected from all scales collected (N=1,870). If a selected scale was unreadable, additional scales were randomly selected to meet the predetermined sample size of 79 scales per week.

Table 1. Maximum weekly sample size goals for chum, coho, and sockeye salmon from Frosty Creek, Izembek National Wildlife Refuge, 2000 to 2002.

Species	Number of Age Categories	Sample Size	Percent Unreadable	Adjusted Sample Size
Chum	4	121	10	135
Coho	4	121	10	135
Sockeye	4	121	10	135

Maximum weekly sample size goals were established for Pacific salmon so that simultaneous 90% interval estimates of age composition for each week have maximum widths of 0.20 (Bromaghin 1993) (Table 1). Sample sizes were increased to account for the expected number of unreadable scales. However, the derivation of maximum sample size goals was based on a multinomial sampling model (sampling with replacement or small samples relative to a large population). In 2000, the weir was installed about 8 km upstream of the mouth. Since historical escapement data were not available for this area, samples sizes for each species were based on an estimated escapement of 5,000 fish. The weekly sample size goal was expected to be a substantial fraction of the passage in some weeks; therefore, during weeks of low passage and the maximum sample size goal could not be practically obtained, about 10-20% of the weekly escapement was sampled. This was sufficient to describe the age composition and reduce the number of fish handled at the weir. For sample size determination, age categories were defined as the total age (fresh water and ocean age combined) for all salmon species (Table 1). In 2001 and 2002, the weir was relocated to a position upstream of the mouth and seasonal escapement for some species was expected to be much higher than at the 2000 weir location. However, during weeks of low passage a target sample size of about 20% of the weekly escapement was selected.

Walking Survey

In 2000, walking surveys were conducted downstream of the weir to estimate the abundance of salmon spawning below the weir. Surveys were conducted about once a week depending on weather conditions. Surveys were not conducted on windy or rainy days because these conditions made it difficult to observe salmon in the stream. Early in the season both observers counted fish from the same side of the stream. Beginning in late August, both sides of the stream were walked.

Escapement estimates were generated for Frosty Creek by extrapolating the individual stream counts using the trapezoidal approximation of the area-under-the-curve (AUC) model described by English et al. (1992) and Hilborn et al. (1999) approximated as

$$AUC = \sum_{i=2}^{n} (t_i - t_{i-1}) \frac{(x_i + x_{i-1})}{2},$$

where t_i is the day of the year and x_i is the number of salmon observed for the ith survey. Attempts were made to begin the surveys before any chum or coho salmon were present in the streams and to complete the final survey after all fish had died. When the first or last survey was not zero, the trapezoidal approximation fails (Hilborn et al. 1999), and the equations of Bue et al. (1998) were used to estimate AUC for the first and last survey periods. This method is unbiased for estimates of total season escapement, but can be biased if used for partial-season estimates (Hilborn et al. 1999). Since chum salmon were observed on the first survey, the AUC prior to the first survey (AUC_{first}) was estimated as

$$AUC_{first} = \frac{x_1 s}{2},$$

where s is the stream life. Since chum and coho salmon were observed on the last survey, AUC after the final survey (AUC_{last}) was estimated as

$$AUC_{last} = \frac{x_{last} s}{2}.$$

Total escapement ($\hat{E}$) was then estimated as

$$\hat{E} = \frac{AUC}{s} v,$$

where v is a correction for observer efficiency. Values used for stream life and observer efficiency were taken from a multi-year project investigating stream life and observer efficiencies using stream walking surveys for chum and coho salmon on the Alaska Peninsula (Hetrick and Nemeth 2003); 11.9 d was used for average stream life of chum salmon and 13.8 d was used for average stream life of coho salmon, and an average observer efficiency value of 0.74 was used.

Public Use Information

In 2000, visitors near the weir were opportunistically interviewed after they completed their activity to determine the following information:

1. Primary Purpose: (Hunting, fishing, other)
2. Secondary Purpose: (Hunting, fishing, other)
3. Subsistence/Sport
4. Resident/Non-Resident - State and City of residency
5. Guided/Unguided - Name of Guide or Lodge
6. Target species and number kept
7. How many in their party were fishing/hunting?
8. Hours/days spent on the refuge
9. Creel Survey: number fish harvested and released, and hours fished to estimate harvest and catch rates

Data Analysis

Characteristics of fish passing through the weir were estimated using standard stratified random sampling estimators (Cochran 1977). Within a given stratum m, the proportion of species i passing the weir that were of sex j and age k was estimated as

$$\hat{p}_{ijkm} = \frac{n_{ijkm}}{n_{i++m}},$$

where n_{ijkm} denotes the number of fish of species i, sex j, and age k sampled during stratum m and a subscript of "+" represents summation over all possible values of the corresponding variable, e.g., n_{i++m} denotes the total number of fish of species i sampled in stratum m. The variance of was estimated as

$$\hat{v}\left(\hat{p}_{ijkm}\right) = \left(1 - \frac{n_{i++m}}{N_{i++m}}\right) \frac{\hat{p}_{ijkm}\left(1 - \hat{p}_{ijkm}\right)}{n_{i++m} - 1},$$

where N_{i++m} denotes the total number of species i fish passing the weir in stratum m. The estimated number of fish of species i, sex j, and age k passing the weir in stratum m (N_{ijkm}) was

$$\hat{N}_{ijkm} = N_{i+m}\hat{P}_{ijkm},$$

with an estimated variance of

$$\hat{v}(\hat{N}_{ijkm}) = N_{i++m}^2 \hat{v}(\hat{p}_{ijkm}).$$

Estimates of proportions for the entire period of weir operation were computed as weighted sums of the stratum:

$$\hat{p}_{ijk} = \sum_m \left\{ \frac{N_{i++m}}{N_{i+++}} \right\} \hat{p}_{ijkm},$$

with an estimated variance of

$$\hat{v}\left(\hat{p}_{ijk}\right) = \sum_m \left(\frac{N_{i++m}}{N_{i+++}} \right)^2 \hat{v}\left(\hat{p}_{ijkm}\right).$$

The total number of fish species i and age k passing the weir during the entire period of operation was estimated as

$$\hat{N}_{ik} = \sum_m \hat{N}_{ikm},$$

with an estimated variance of

$$\hat{v}\left(\hat{N}_{ik}\right) = \sum_{m} \hat{v}\left(\hat{N}_{ikm}\right).$$

The mean length of fish species *i*, sex *j*, and age *k* sampled in stratum *m* was computed as

$$\bar{x}_{ijkm} = \frac{\sum x_{ijkm}}{n_{ijkm}},$$

with a sample variance of

$$\hat{v}\left(\bar{x}_{ijkm}\right) = \left(1 - \frac{n_{ijkm}}{\hat{N}_{ijkm}}\right) \frac{\sum \left(x_{ijkm} - \bar{x}_{ijkm}\right)^2}{n_{ijkm} - 1}.$$

The seasonal estimated mean length for species *i*, sex *j*, and age *k* was calculated as a weighted sum of the stratum means:

$$\hat{\bar{x}}_{ijk} = \sum_{m} \left(\frac{\hat{N}_{ijkm}}{\hat{N}_{ijk}}\right) \bar{x}_{ijkm}.$$

An approximate estimator of the variance of $\hat{\bar{x}}_{ijk}$ was obtained using the delta method (Seber 1982):

$$\hat{v}\left(\hat{\bar{x}}_{ijk}\right) = \sum_{m} \left\{ \hat{v}\left(\hat{N}_{ijkm}\right) \left[\frac{\bar{x}_{ijkm}}{\sum_{x} \hat{N}_{ijkx}} - \sum_{y} \frac{\hat{N}_{ijky}}{\left(\sum_{x} \hat{N}_{ijkx}\right)^2} \bar{x}_{ijky} \right]^2 + \left(\frac{\hat{N}_{ijkm}}{\sum_{x} \hat{N}_{ijkx}} \right)^2 s^2_{ijkm} \right\}.$$

Results

Weir Operation

In 2000, the weir was located just downstream from the "first bridge" and was operated 25 June through 23 October. Average daily water temperatures varied between 0.7 and 11.6 °C (Figure 2). Stream discharge during weir operation in 2000 varied between 0.61 and 5.18 m^3/sec (Figure 3). However, stream discharge was not measured at levels above 0.39 m (discharge = 3.2 m^3/sec); therefore, the relationship between water level and

discharge may not be valid at higher water levels (McMahon et al. 1996). Water levels during weir operation varied between 0.14 and 0.59 m.

In 2001 and 2002, the weir was relocated to a site near the creek mouth. In 2001, the weir was operated from 1 July to 16 October. During the first two weeks of operation in 2001, the weir was not completely fish tight. In addition, on 17 July the weir was relocated to a better site approximately 90 m upstream. Due to the relocation, some fish may have been counted twice. On 12 September 2001 heavy rains caused water to spill over the weir; therefore, some fish may have gone upstream or downstream without being counted. In 2002, the weir was operated from 29 June through 7 October.

In 2001, stream discharge varied from 1.6 to 3.0 m^3/sec (Figure 3). However, stream discharge was not measured at levels above 0.47 m (discharge = 2.7 m^3/sec); therefore, the relationship between water level and discharge may not be valid at higher water levels. Water levels during weir operation varied between 0.34 and 0.51 m. Discharge was not measured in 2002 but water levels varied between 0.36 to 0.55 m. Peak discharge recorded at the U.S. Geological Survey (USGS) site near the "first bridge" occurred on the same day that the maximum water level was recorded at the weir (23 July; discharge = 4.13 m^3/sec) (Chad Smith, USGS, personal communication). In 2001, water temperatures varied from 0.2 to 15.2 °C, and in 2002 temperatures varied from 2.0 to14.8 °C (Figure 2).

Biological Data

Chum Salmon. Chum salmon were the most abundant species in Frosty Creek with an annual escapement of approximately 30,000 to 40,000 fish (Table 2; Appendices B, C, and D). In 2000, the walking survey counts ranged from 2 to 6,223 in Frosty Creek with an area under the curve (AUC) estimate of 29,875 chum salmon (Table 3, Appendix G). Approximately 10% of the run spawns above the "first bridge" weir site. Chum salmon were first captured at the upstream weir site the first week of July (Figure 4, Appendix B) At the mouth of Frosty Creek chum salmon were first observed in late June to early July with a peak migration approximately late July to mid-August (Figure 5, Appendices C and D). The chum salmon migration was complete by late September to early October. The sex composition was dominated by males early in the season but approached 50% for the entire run (Tables 4, 5, and 6). Four or five age groups were identified each year with age 0.3 and 0.4 chum salmon comprising the largest portion of the run (Table 7). Within the season, the peak run timing of age 0.4 chum salmon occurred early in the season while the age 0.3 peak run occurred in the middle of the migration (Tables 8, 9, and 10). The average length for male chum salmon was larger than females of the same age (Table 7). The length distribution was similar among years (Figure 6).

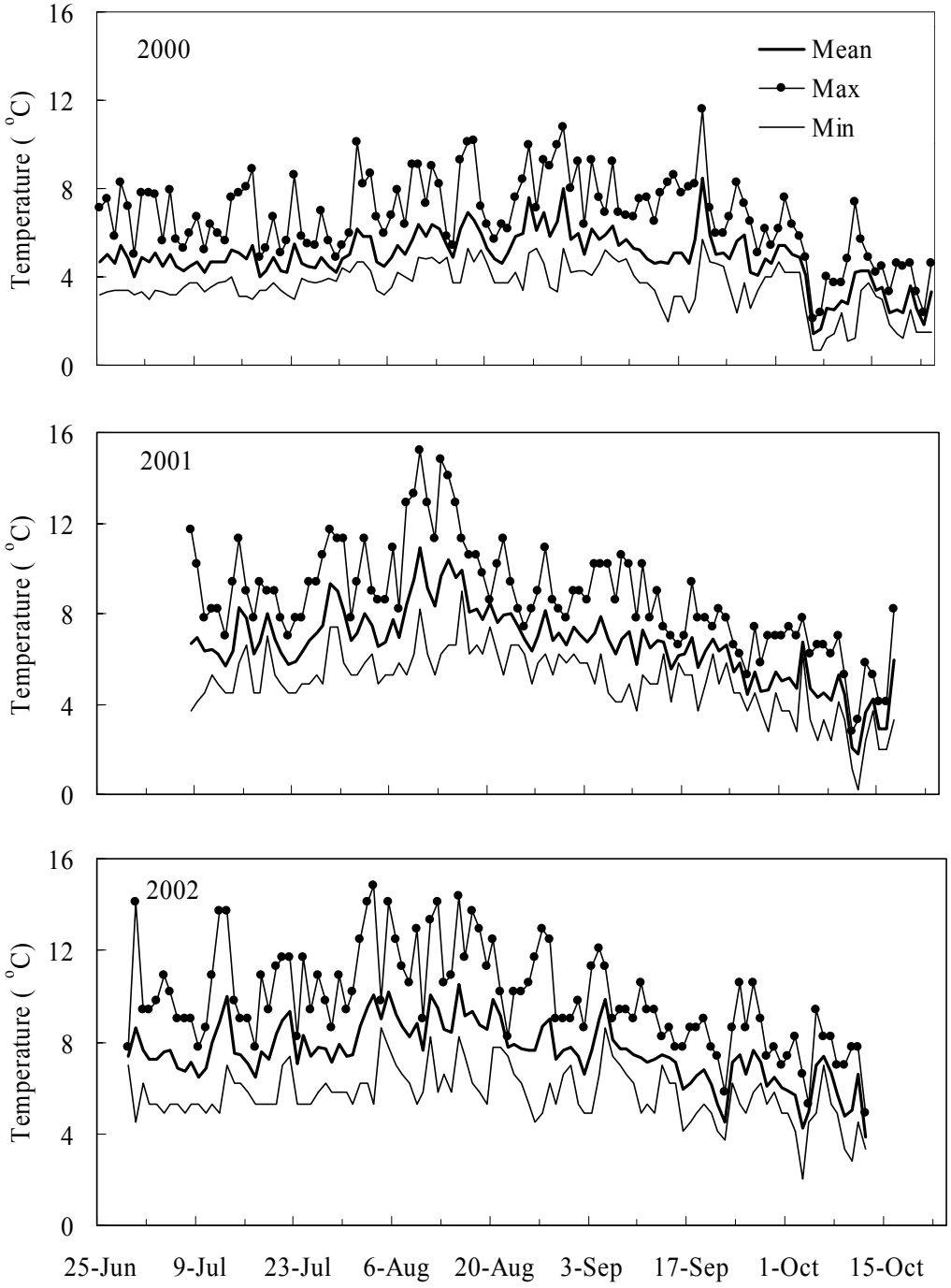

Figure 2. Maximum, mean, and minimum water temperatures in Frosty Creek for 2000 to 2002.

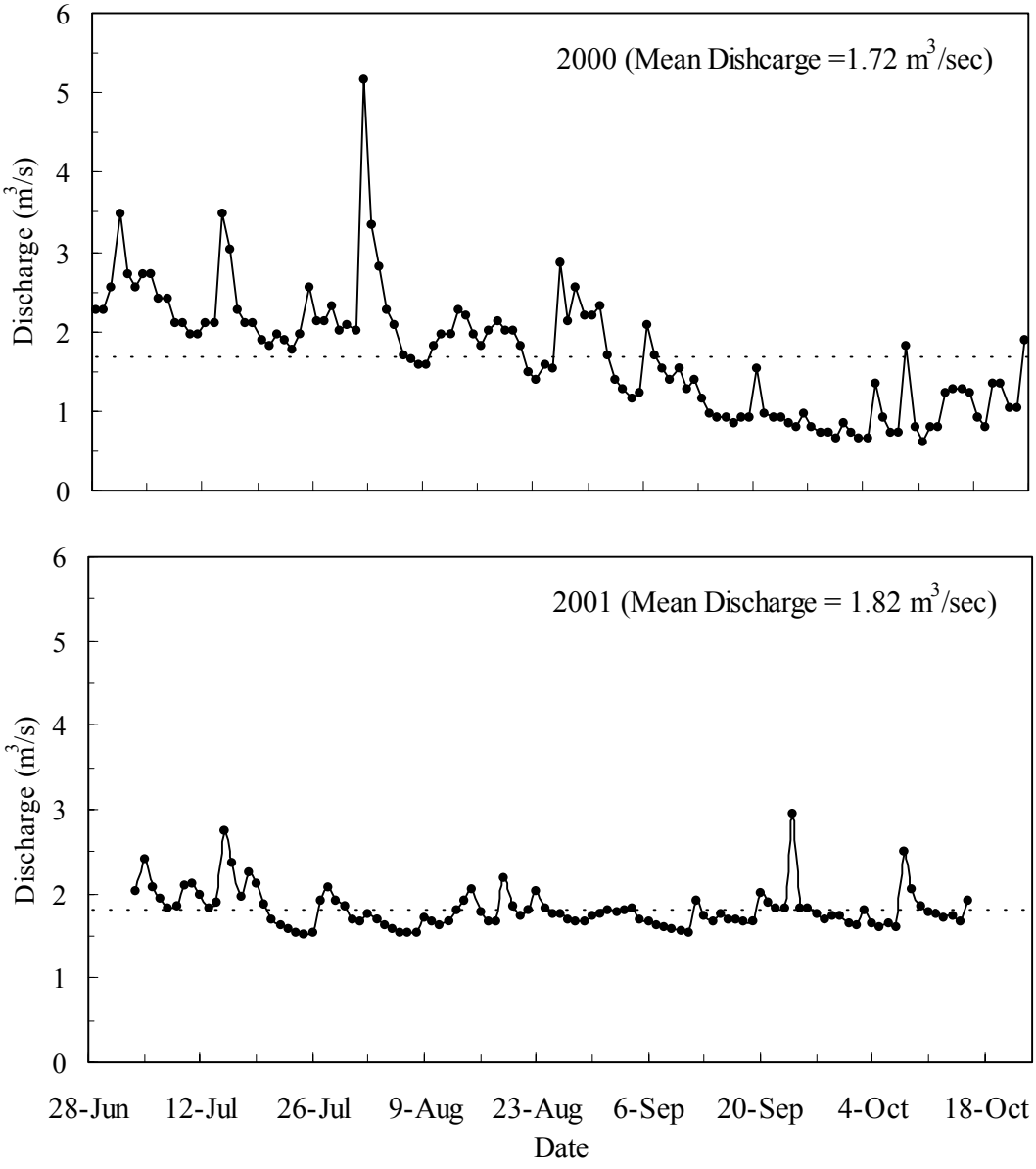

Figure 3. Estimated daily stream discharge (m^3/sec) near Frosty Creek weir, 2000 and 2001.

Table 2. Total escapement of chum, coho, pink, sockeye, and Chinook salmon and Dolly Varden through the Frosty Creek weir, 2000-2002.

	Escapement					
	Chum Salmon	Coho Salmon	Pink Salmon	Sockeye Salmon	Dolly Varden	Chinook Salmon
2000	2,739 29,875[a]	548 1,835[a]	56	55	1,321	7
2001	35,491	844	405	232	2,428	---
2002	42,194	733	1,250	1,276	4,074	---

[a] Area under the curve estimates from walking surveys in 2000.

Table 3. Numbers of chum salmon observed during walking surveys in Frosty Creek, 2000.

	Observed Count (Average)	
Survey Date	Chum Salmon	Coho Salmon
8 July 2000	694	0
16 July 2000	2,322	0
22 July 2000	3,396	0
31 July 2000	2,004	0
9 August 2000	3,060	0
17 August2000	3,075	0
24 August 2000	5,459	0
4 September 2000	6,223	84
14 September 2000	2,863	520
24 September 2000	397	766
2 October 2000	101	502
19 October 2000	2	544

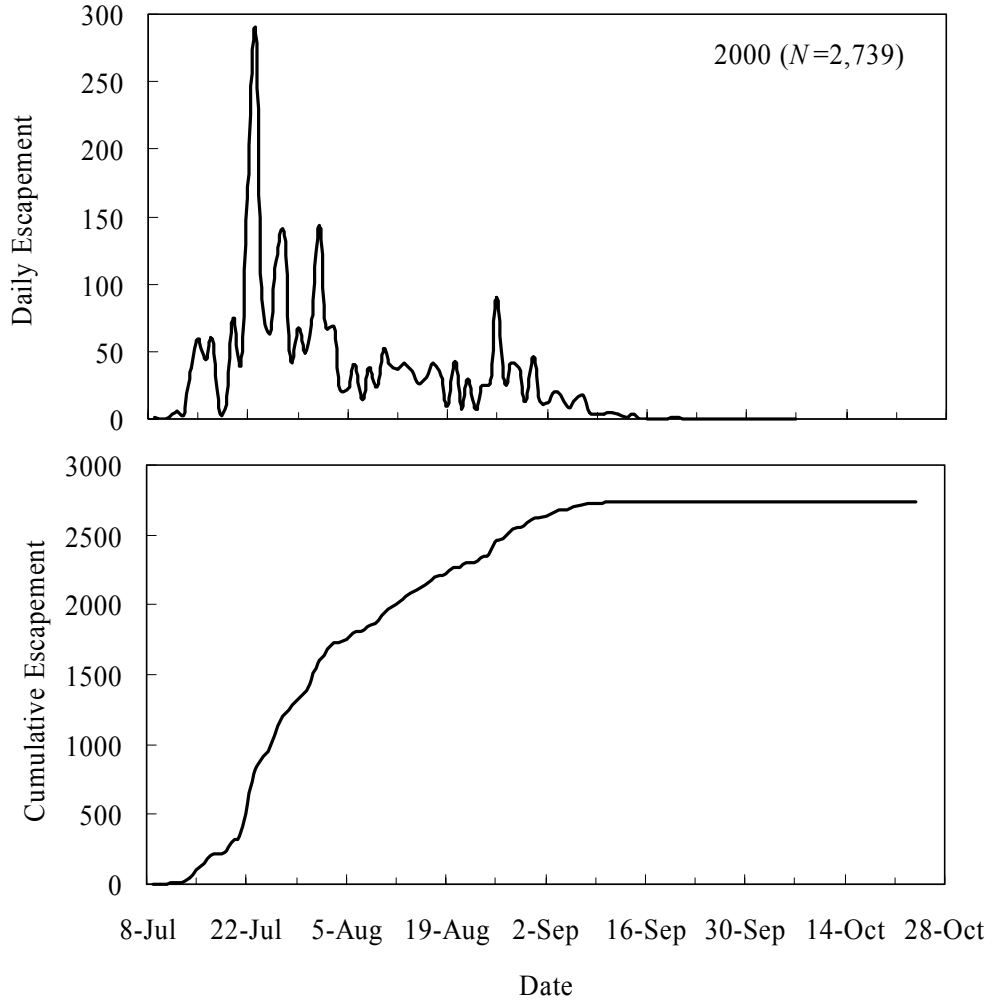

Figure 4. Daily and cumulative escapements of chum salmon counted at the Frosty Creek weir, 2000.

Table 4. Estimated sex composition and standard errors of Frosty Creek chum salmon escapement by stratum, 2000.

				Escapement						
	Sample			Percent			Number			
Stratum	*N*	Male	Female	Male	Female	SE	Male	Female	SE	Total
Jul 9 - Jul 22	486	351	135	72	28	0.4	365	140	2.0	505
Jul 23 - Jul 29	134	91	43	68	32	3.7	549	259	29.9	808
Jul 30 - Aug 5	44	26	18	59	41	7.1	262	181	31.5	443
Aug 6 - Aug 26	83	49	34	59	41	5.1	409	283	35.3	692
Aug 27 - Sep 20	57	27	30	47	53	6.0	138	153	17.4	291
Total	804	544	260	68	32	1.4	1,853	886	58.6	2,739

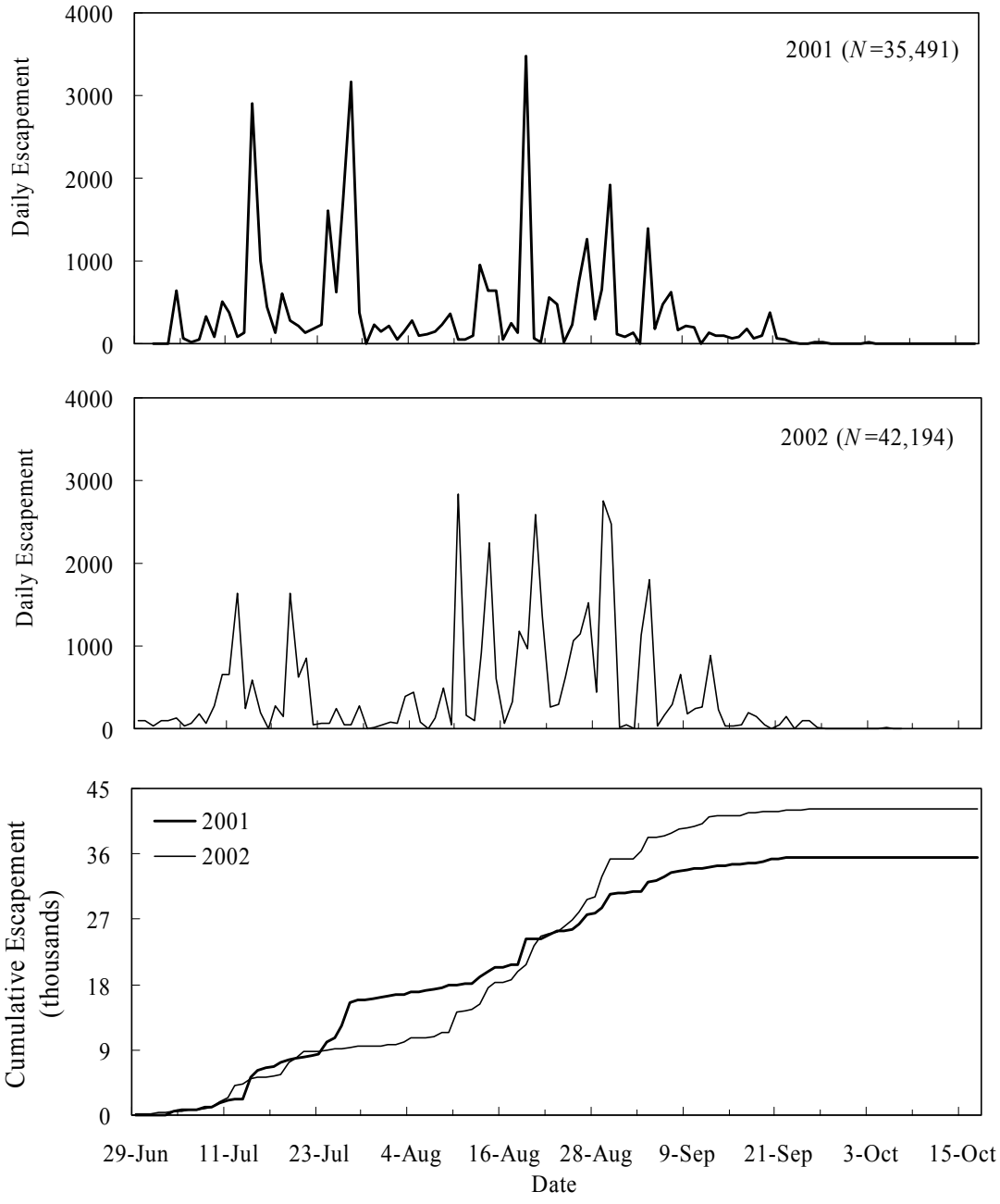

Figure 5. Daily and cumulative escapements of chum salmon counted at the Frosty Creek weir, 2001 and 2002.

Table 5. Estimated sex composition and standard errors of Frosty Creek chum salmon escapement by stratum, 2001.

Stratum	Sample			Escapement						
				Percent			Number			
	N	Male	Female	Male	Female	SE	Male	Female	SE	Total
Jul 1 - Jul 7	110	70	40	64	36	4.3	497	284	33.4	781
Jul 8 - Jul 14	159	95	64	60	40	3.8	2,629	1,771	168.5	4,400
Jul 15 - Jul 21	168	68	100	40	60	3.7	1,141	1,677	103.8	2,818
Jul 22 - Jul 28	185	97	88	52	48	3.6	4,144	3,760	287.6	7,904
Jul 29 - Aug 4	173	57	116	33	67	3.3	357	728	35.7	1,085
Aug 5 - Aug 11	135	67	68	50	50	4.0	513	520	41.6	1,033
Aug 12 - Aug 18	171	90	81	53	47	3.7	1,448	1,303	102.0	2,751
Aug 19 - Aug.25	181	89	92	49	51	3.7	2,374	2,454	176.5	4,828
Aug 26 - Sep 1	167	103	64	62	38	3.7	3,122	1,940	187.8	5,062
Sep 2 - Sep 8	163	85	78	52	48	3.8	1,555	1,426	113.8	2,981
Sep 9 - Sep 15	157	88	69	56	44	3.6	455	356	28.9	811
Sep 16 - Oct 17	94	31	63	33	67	4.6	342	695	48.2	1,037
Total	1,863	940	923	52	48	1.0	17,907	17,584	468.0	35,491

Table 6. Estimated sex composition and standard errors of Frosty Creek chum salmon escapement by stratum, 2002.

Stratum	Sample			Escapement						
				Percent			Number			
	N	Male	Female	Male	Female	SE	Male	Female	SE	Total
Jun 29 - Jul 6	122	78	44	64	36	3.9	421	238	26.0	659
Jul 7 - Jul 13	156	110	46	70	30	3.6	2,624	1,097	133.4	3,722
Jul 14 - Jul 20	161	91	90	50	50	3.6	1,751	1,732	126.3	3,483
Jul 21 - Jul 27	160	71	90	56	44	3.7	612	775	51.1	1,387
Jul 28 - Aug 3	160	76	84	48	52	3.6	425	470	32.1	895
Aug 4 - Aug 10	160	90	70	56	44	3.9	2,278	1,771	156.1	4,049
Aug 11 - Aug 17	165	86	79	52	48	3.8	2,313	2,125	169.9	4,438
Aug 18 - Aug 24	162	100	62	62	38	3.8	4,472	2,772	274.3	7,244
Aug 25 - Aug 31	161	81	80	50	50	3.6	4,744	4,686	370.0	9,430
Sep 1 - Sep 7	161	82	79	51	49	3.9	1,769	1,705	134.0	3,474
Sep 8 - Sep 14	158	77	81	49	51	3.9	1,209	1,272	95.8	2,481
Sep 15 - Sep 21	102	37	65	36	64	4.3	195	343	23.2	538
Sep 22 - Oct 7	93	38	55	41	59	4.5	161	233	17.6	394
Total	1,921	1,017	925	54	46	1.4	22,974	19,219	575.5	42,194

Table 7. Estimated length composition (mean, standard error, range, and sample size) of Frosty Creek chum salmon escapement by age and sex, 2000-2002. All lengths are mid-eye-to-fork of tail (mm).

	Males				Females				All Fish			
Age	*N*	Mean	SE	Range	*N*	Mean	SE	Range	*N*	Mean	SE	Range
						2000						
0.1	0	---	---	---	1	575	---	---	1	575	---	---
0.2	13	577	24.9	480-620	2	555	---	520-590	15	576	22.5	480-620
0.3	136	597	11.0	530-675	87	588	11.5	545-660	223	594	10.9	530-675
0.4	25	623	16.0	580-700	24	594	10.0	545-670	49	609	15.7	545-700
0.5	1	640	---	---	0	---	---	---		640	---	---
						2001[a]						
0.2	11	540	11.2	515-574	6	557	4.4	538-565	17	546	9.8	515-574
0.3	314	592	11.7	500-678	267	580	9.3	504-667	585	587	10.4	500-678
0.4	166	624	7.8	532-726	171	599	11.9	516-703	337	611	12.4	516-726
0.5	7	611	26.9	555-715	3	628	---	584-646	10	620	17.3	555-715
						2002[b]						
0.1	1	452	---	---	0	---	---	---	1	452	---	---
0.2	116	535	12.5	449-628	66	544	14.0	471-620	186	536	12.6	423-628
0.3	403	605	11.9	510-674	411	588	10.5	500-677	817	597	11.6	500-677
0.4	351	624	12.4	509-696	311	607	9.4	522-676	665	616	11.3	509-696
0.5	10	617	24.2	557-674	11	624	7.9	580-675	21	622	13.5	557-675
1.3	0	---	---	---	1	567	---	---	1	567	---	---

[a] All fish includes fish that were not identified as male or female (*N*=4).

[b] All fish includes fish that were not identified as male or female (*N*=10).

Table 8. Estimated age composition (percent and number) and standard errors of chum salmon by stratum in Frosty Creek, 2000.

					Age											
	Sample				0.2				0.3				0.4			
Strata	*N*	0.2	0.3	0.4	%	SE	No.	SE	%	SE	No.	SE	%	SE	No.	SE
1	19	1	17	1	5	5.2	27	26.1	90	7.1	452	35.8	5	5.2	27	26.1
2	105	6	82	16	6	2.1	46	17.2	78	3.8	631	30.6	15	3.3	123	26.6
3	43	4	32	7	9	4.3	41	18.9	75	6.4	330	28.3	16	5.4	72	24.0
4	51	1	36	13	2	1.9	13	13.1	71	6.2	488	42.9	25	5.9	176	41.0
5	73	3	58	12	4	2.0	12	5.9	80	4.1	231	12.0	16	3.8	47	11.0
Total[a]	291	15	225	49	5	1.4	139	39.2	78	2.6	2,132	70.8	16	2.2	446	61.4

[a] Sample sizes listed for age classes do not equal the total because ages 0.1 and 0.5 (*N*=2) were not included since they were <1% of the total sample.

Table 9. Estimated age composition (percent and number) and standard errors of chum salmon by stratum in Frosty Creek, 2001.

					Age											
	Sample				0.2				0.3				0.4			
Strata	*N*	0.2	0.3	0.4	%	SE	No.	SE	%	SE	No.	SE	%	SE	No.	SE
1	79	1	22	55	1	1.2	10	9.4	28	4.8	217	3706	70	4.9	544	38.6
2	80	0	20	57	0	0.0	0	0.0	25	4.8	1,100	212.4	71	5.0	3,135	222.0
3	79	0	38	41	0	0.0	0	0.0	48	5.6	1,355	157.2	52	5.6	1,463	157.2
4	79	0	45	33	0	0.0	0	0.0	57	5.6	4,502	440.9	42	5.6	3,302	439.2
5	79	1	49	26	1	1.2	14	13.2	62	5.3	673	57.4	33	5.1	357	55.6
6	79	0	48	30	0	0.0	0	0.0	61	5.3	628	54.9	38	5.3	392	54.6
7	79	0	53	26	0	0.0	0	0.0	67	5.2	1,846	144.2	33	5.2	905	144.3
8	79	5	58	16	6	2.7	306	132.0	73	5.0	3,545	239.5	20	4.5	978	217.9
9	79	2	63	14	3	1.8	128	89.3	80	4.5	4,037	228.5	18	4.3	897	217.2
10	79	2	57	20	3	1.8	75	52.3	72	5.0	2,151	149.3	25	4.9	755	144.8
11	79	3	65	10	4	2.0	31	16.7	82	4.1	667	33.3	13	3.6	103	29.0
12	79	3	67	9	4	2.1	39	21.6	85	3.9	879	40.5	11	3.5	118	35.9
Total	949[a]	17	585	337	2	0.5	603	170.7	61	1.8	21,600	653.7	36	1.8	12,948	642.6

[a] Sample sizes for listed age classes do not equal the total because age 0.5 (*N*=10) was not included since it was <1% of the total sample.

Table 10. Estimated age composition (percent and number) and standard errors of chum salmon by stratum in Frosty Creek, 2002.

						Age														
	Sample					0.2				0.3				0.4				0.5			
Strata	*N*	0.2	0.3	0.4	0.5	%	SE	No.	SE	%	SE	No.	SE	%	SE	No.	SE	%	SE	No.	SE
1	113	0	8	103	2	0	0.0	0	0.0	7	2.2	47	14.5	91	2.4	601	16.1	2	1.1	12	7.5
2	138	1	10	127	0	1	0.7	27	26.5	7	2.2	270	80.9	92	2.2	3,425	84.5	0	0.0	0	0.0
3	168	1	33	124	10	<1	0.6	21	20.2	20	3.0	684	104.5	74	3.3	2,571	115.6	6	1.8	207	62.2
4	141	2	54	82	3	<1	0.9	20	13.1	39	3.9	531	54.0	58	4.0	807	54.8	2	1.2	30	16.0
5	148	6	66	72	3	4	1.5	36	13.3	45	3.7	399	33.5	48	3.8	435	33.7	2	1.1	18	9.5
6	139	12	80	47	0	8	2.3	350	95.1	58	4.1	2,330	167.4	34	4.0	1,369	160.2	0	0.0	0	0.0
7	139	16	101	21	1	12	2.7	511	118.7	72	3.7	3,225	165.7	15	3.0	670	133.2	1	0.7	32	31.4
8	139	8	111	20	0	6	2.0	417	142.2	80	3.4	5,785	244.9	14	3.0	1,042	214.3	0	0.0	0	0.0
9	138	18	103	15	1	13	2.9	1,230	269.3	75	3.7	7,038	348.0	11	2.6	1,025	248.9	1	0.7	68	67.8
10	135	26	89	20	0	19	3.3	669	116.0	66	4.0	2,290	139.4	15	3.0	515	104.5	0	0.0	0	0.0
11	129	45	69	14	1	35	4.1	865	101.8	53	4.3	1,327	106.5	11	2.7	269	66.4	1	0.8	19	18.7
12	85	23	56	6	0	27	4.4	146	23.9	66	4.7	354	25.5	7	2.6	38	13.8	0	0.0	0	0.0
13	79	28	37	14	0	35	4.8	140	19.1	47	5.1	185	19.9	18	3.9	70	15.2	0	0.0	0	0.0
Total[a]	1,691	186	817	665	21	10	0.9	4,432	377.0	58	1.3	24,465	538.6	30	1.0	12,837	438.2	1	0.2	386	101.1

[a] Sample sizes for listed age classes do not equal the total because ages 0.1 and 1.3 (*N*=2) were not included since they were <1% of the total sample.

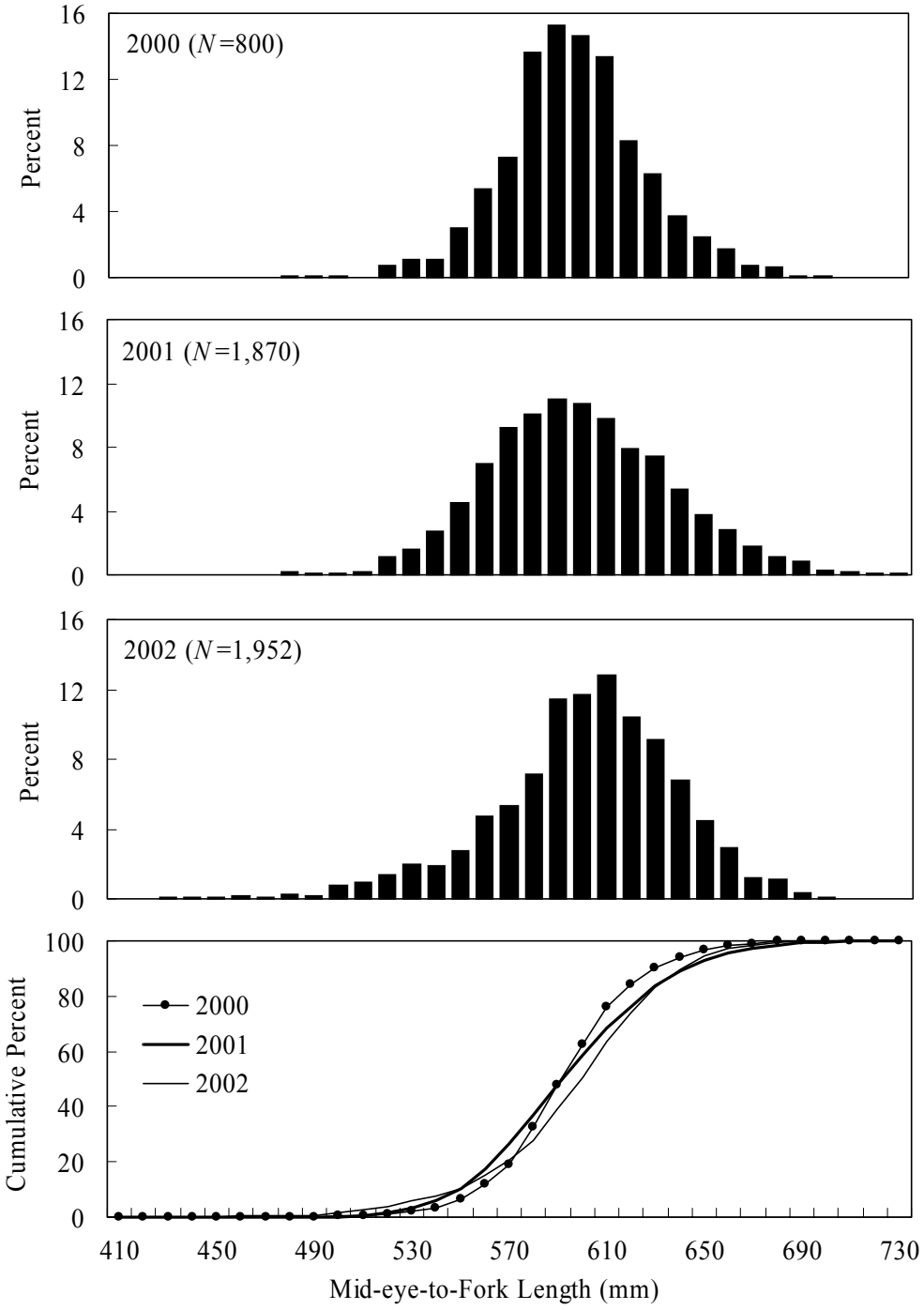

Figure 6. Length and cumulative length frequencies of chum salmon measured at the Frosty Creek weir, 2000-2002.

Coho Salmon. In 2000, the walking counts ranged from 0 to 766 with an AUC estimate of 1,835 fish (Table 3, Appendix G). The weir counts were less than 1000 fish annually (Table 2; Appendices B, C, and D). Coho salmon were first observed at the weir in mid-August (Figures 7 and 8). The peak daily escapement occurred in mid-September. Small numbers of coho salmon were migrating past the weir when it was removed. The sex composition for the entire season was not skewed (Table 11). Five to seven age groups were identified each year with age 2.1 and age 3.1 the dominant age classes (Table 12). In 2002, age 2.0 and 3.0 fish passed by the weir in greater numbers than in previous years. Fish lengths varied considerably between years (Figure 9). Male coho salmon lengths ranged from 308 to 690 mm and females ranged from 449 to 691 mm (Table 13). The mean length of female coho salmon was generally larger than the same aged males.

Pink Salmon. Escapement estimates ranged from 56 fish in 2000 to 1250 fish in 2002 (Table 2; Appendices B, C, and D). Pink salmon were first captured at the weir in mid-July with a peak daily escapement in mid to late August (Figures 10 and 11, Appendices B, C, and D). Pink Salmon were not observed passing the weir after mid- September. Females comprised 51%, 47%, and 47% of the run during 2000, 2001, and 2002, respectively. Lengths of male pink salmon ranged from 362 to 540 mm and females from 382 to 527 mm. Pink salmon lengths did not show much annual variation (Figure 12).

Sockeye salmon. Escapement estimates ranged from 55 fish in 2000 to 1276 fish in 2002 (Table 2; Appendices B, C, and D). Sockeye salmon were first captured at the weir in late June to early July with a peak daily escapement in mid to late July (Figures 13 and 14, Appendices B, C and D). The sockeye salmon migration began about a week later at the "first bridge" weir site with a peak migration occurring in late August. Females comprised 31%, 48%, and 39% of the run during 2000, 2001 and 2002, respectively. Five to six age groups were identified each year and 1.2 and 1.3 were the dominant age classes (Table 14). Male sockeye salmon lengths ranged from 418 to 630 mm and females from 420 to 590 mm (Table 14). Lengths of sockeye salmon were highly variable between years (Figure 15).

Dolly Varden. Dolly Varden were the second most abundant fish species found in Frosty Creek. Escapement estimates ranged from 1321 in 2000 to 4074 in 2002 (Table 2, Appendix E). Dolly Varden were first captured at the weir near the mouth of Frosty Creek in late June to early July and the peak daily escapement occurred during mid to late July (Figure 16; Appendix E). Dolly Varden were first captured at the "first bridge" weir site in late July and the peak daily escapement occurred in late August. Dolly Varden were observed at both weirs sites until the end of the sample season. Peak downstream movement occurred from late September to mid-October (Figure 17). More Dolly Varden were counted in the upstream traps than the downstream traps. The mean length for Dolly Varden captured in the upstream trap box was 405 mm, 401 mm, and 424mm while, in the downstream trap, the mean length was 448 mm, 417 mm, and 421 mm during 2000, 2001, and 2002 respectively. Lengths ranged between 180 to 600 mm and the distribution was highly variable among years (Figure 18).

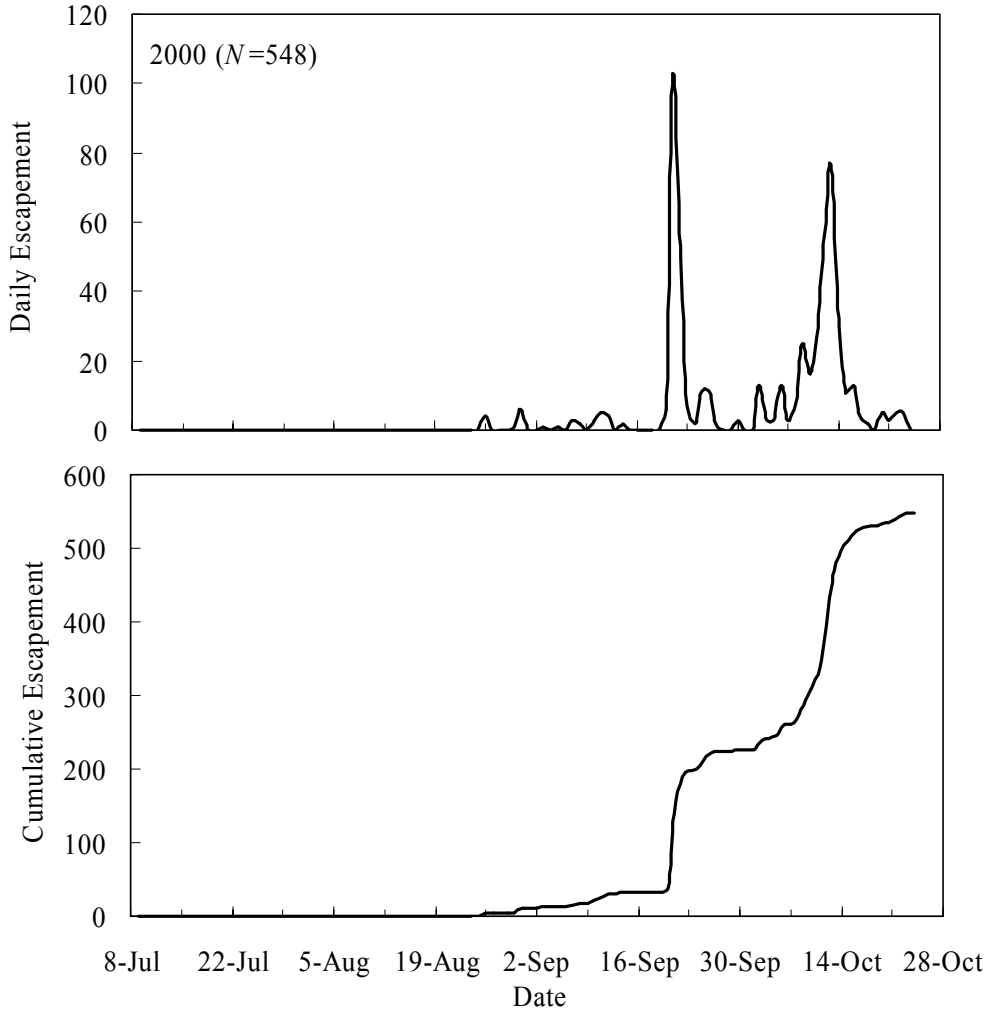

Figure 7. Daily and cumulative escapements of coho salmon counted at the Frosty Creek weir, 2000.

Table 11. Estimated sex composition and standard errors of Frosty Creek coho salmon escapement by stratum, 2000-2002.

				Estimated						
	Sample			Percent			Number			
Year	*N*	Male	Female	Male	Female	SE	Male	Female	SE	Total
2000	101	56	45	55	45	4.5	303	244	24.7	548
2001	34	16	18	47	53	8.5	397	447	17.8	844
2002	113	54	59	48	52	4.3	350	382	31.8	733

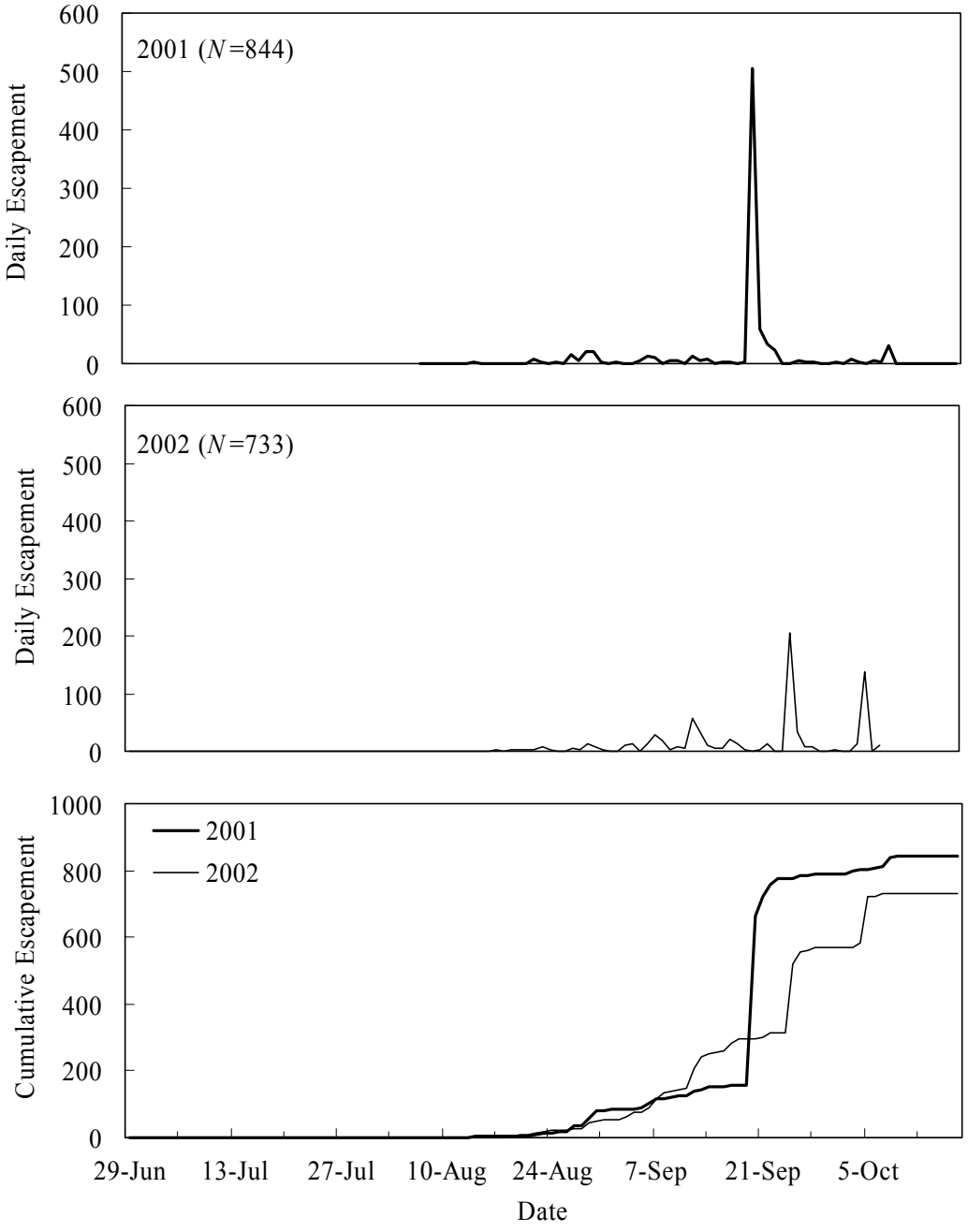

Figure 8. Daily and cumulative escapements of coho salmon counted at the Frosty Creek weir, 2001 and 2002.

Table 12. Estimated age composition (percent, percent standard error, estimated number, and standard error) of Frosty Creek coho salmon escapement, 2000-2002.

		Escapement			
Age	*N*	%	%SE	No.	SE
		2000			
1.1	7	6	6.9	41	13.7
2.0	1	2	1.6	6	5.6
2.1	68	72	6.0	395	23.4
2.2	1	2	1.6	6	5.6
3.0	1	3	2.4	5	4.8
3.1	16	15	5.1	94	19.6
		2001			
1.1	3	8	4.1	63	34.7
2.0	4	10	4.7	84	39.6
2.1	26	65	7.5	549	62.9
2.2	1	2	2.4	127	20.6
3.1	6	15	5.6	21	47.1
		2002			
1.1	11	9	2.5	70	18.4
2.0	8	7	2.2	51	15.9
2.1	62	53	4.3	395	31.3
2.2	1	1	0.8	6	5.8
3.0	5	4	1.7	32	12.7
3.1	28	24	3.7	177	26.8
4.1	1	1	0.8	6	5.8

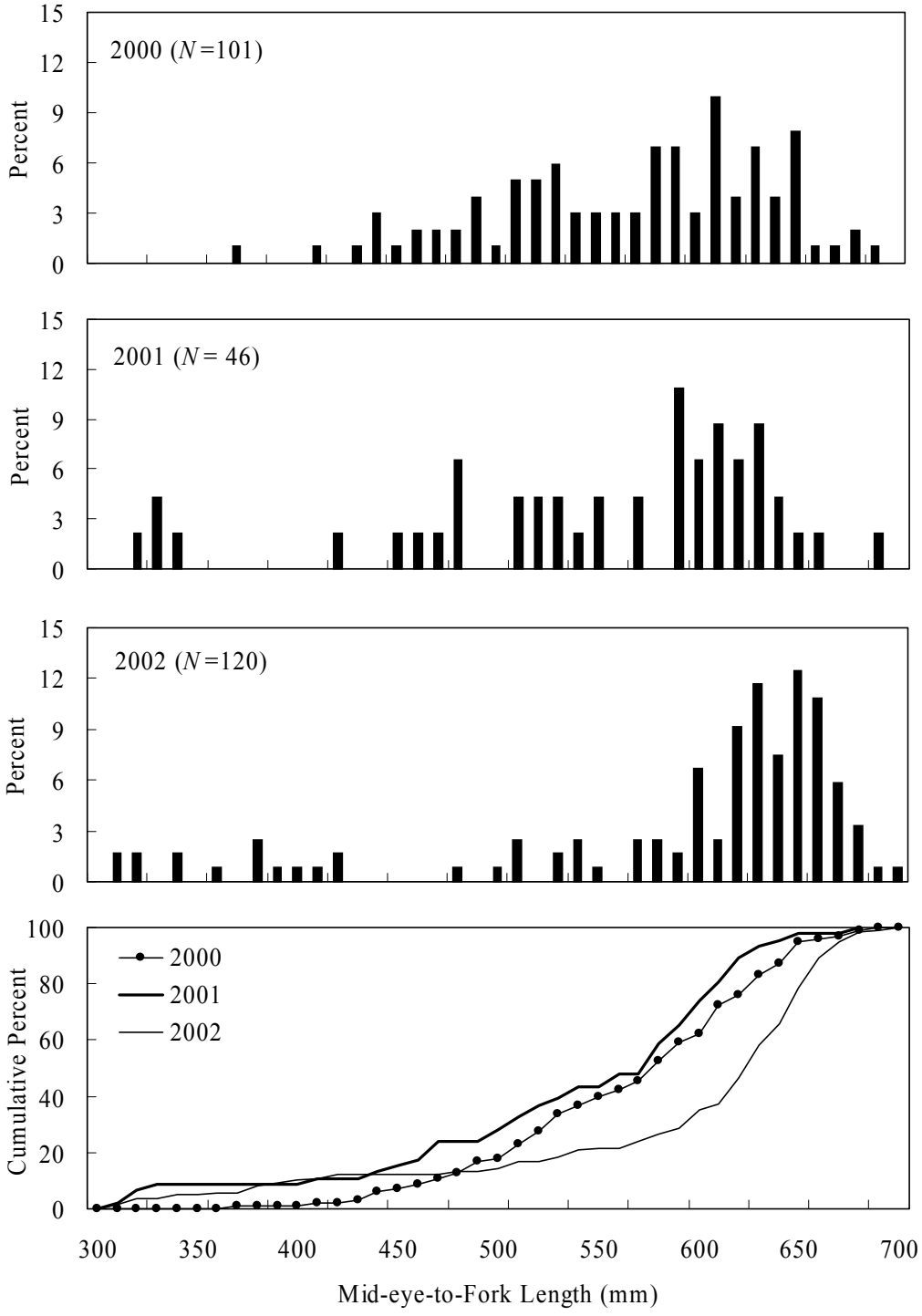

Figure 9. Length and cumulative length frequencies of coho salmon measured at the Frosty Creek weir, 2000-2002.

Table 13. Estimated length composition (mean, standard error, range, and sample size) of Frosty Creek coho salmon escapement by age and sex, 2000-2002.

	Age				
	1.1	2.0	2.1	3.0	3.1
			2000		
Females					
Mean Length	650	---	608		603
SE	---	---	36.6	---	31.9
Range	---	---	465-680	---	480-675
Sample Size	1	---	25		9
Males					
Mean Length	569	440	531	---	578
SE	53.6	---	58.2	--	61.3
Range	485-625	---	370-640	---	495-690
Sample Size	5	1	38	---	6
All Fish[a]					
Mean Length	583	440	562		583
SE	49.2	---	57.2	---	46.9
Range	485-650	---	370-680	---	435-690
Sample Size	6	1	63		16
			2001		
Females					
Mean Length	541	---	603	---	604
SE	80.3	---	63.2	---	12.07
Range	449-589	---	461-658	---	595-622
Sample Size	3	---	8	---	4
Males					
Mean Length	---	---	582	---	---
SE	---	---	52.5	---	---
Range	---	---	505-682	---	---
Sample Size	---	---	13	---	---
All Fish[a]					
Mean Length	541	---	562	---	604
SE	80.3	---	65.92	---	61.4
Range	449-589	---	461-682	---	595-622
Sample Size	3	---	26	---	6
			2002		
Females					
Mean Length	610	---	632	---	627
SE	15.1	---	31.7	---	42.5
Range	591-628	---	529-685	---	549-678
Sample Size	4	---	39	---	14
Males					
Mean Length	575	358	612	376	613
SE	63.5	39.7	44.7	30.7	38.7
Range	497-652	308-416	501-664	340-415	538-672
Sample Size	7	7	19	4	13
All Fish[a]					
Mean Length	588	351	621	378	621
SE	48.5	38.5	39.9	24.9	36.5
Range	497-652	301-416	480-685	340-415	538-678
Sample Size	11	8	62	5	28

[a] All fish includes fish not identified as male or female (N=14).

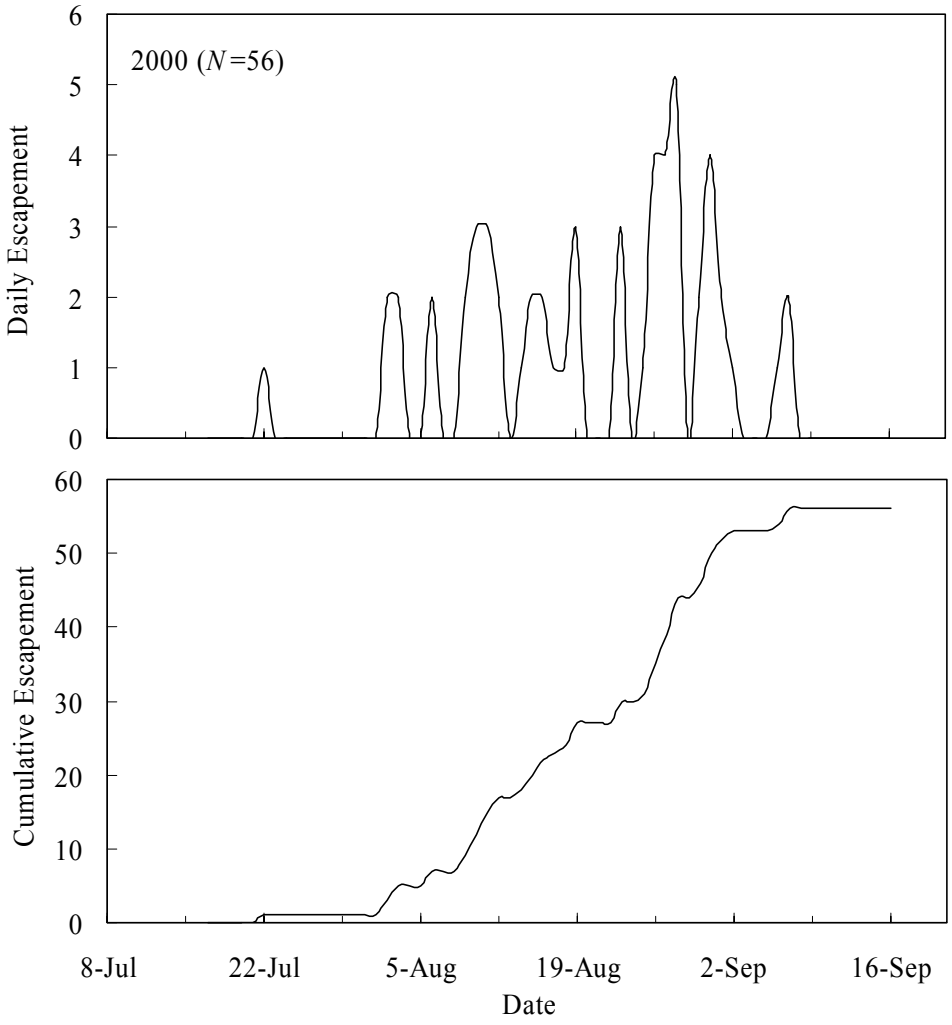

Figure 10. Daily and cumulative escapements of pink salmon counted at the Frosty Creek weir, 2000.

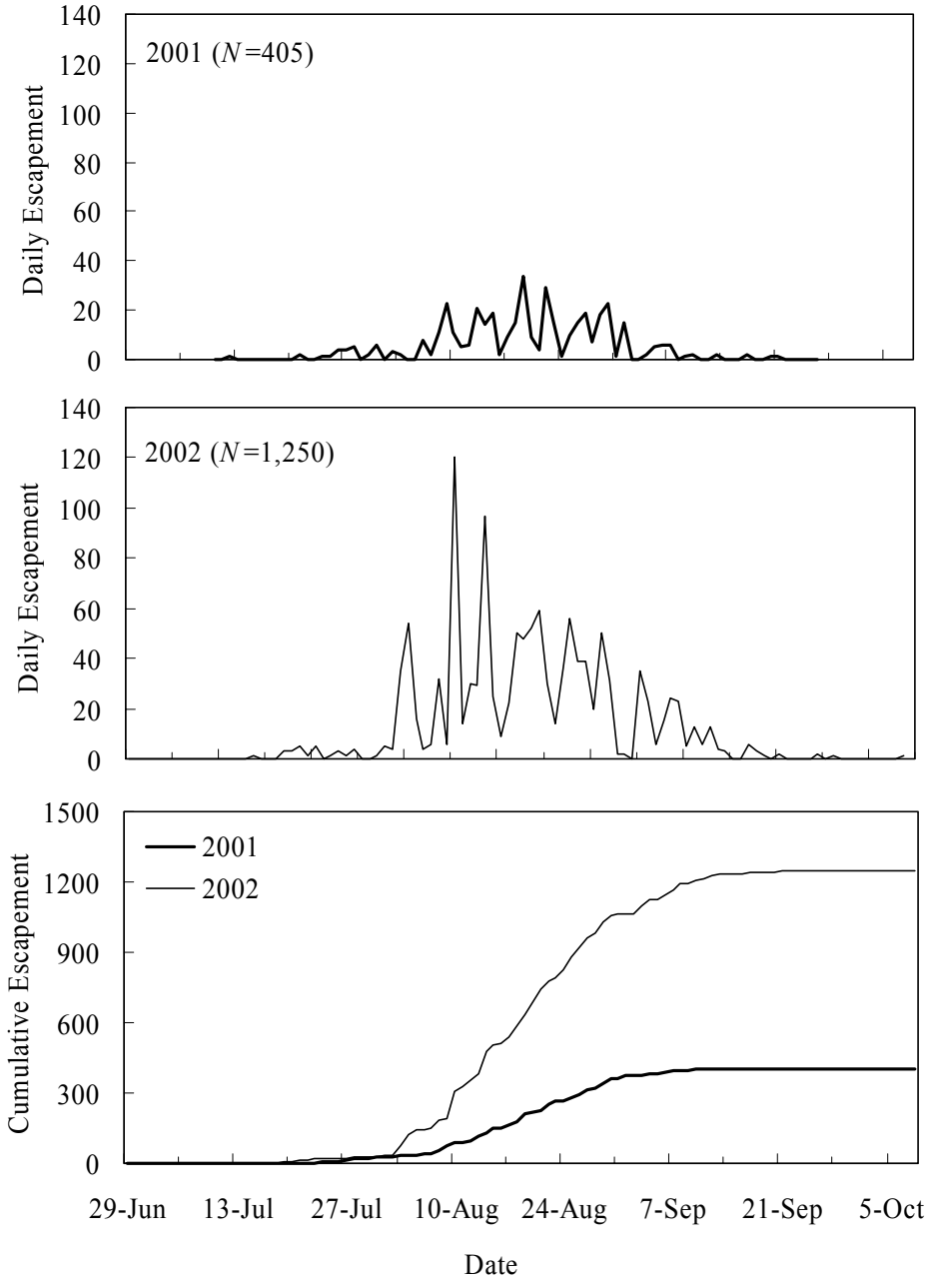

Figure 11. Daily and cumulative escapements of pink salmon counted at the Frosty Creek weir, 2001 and 2002.

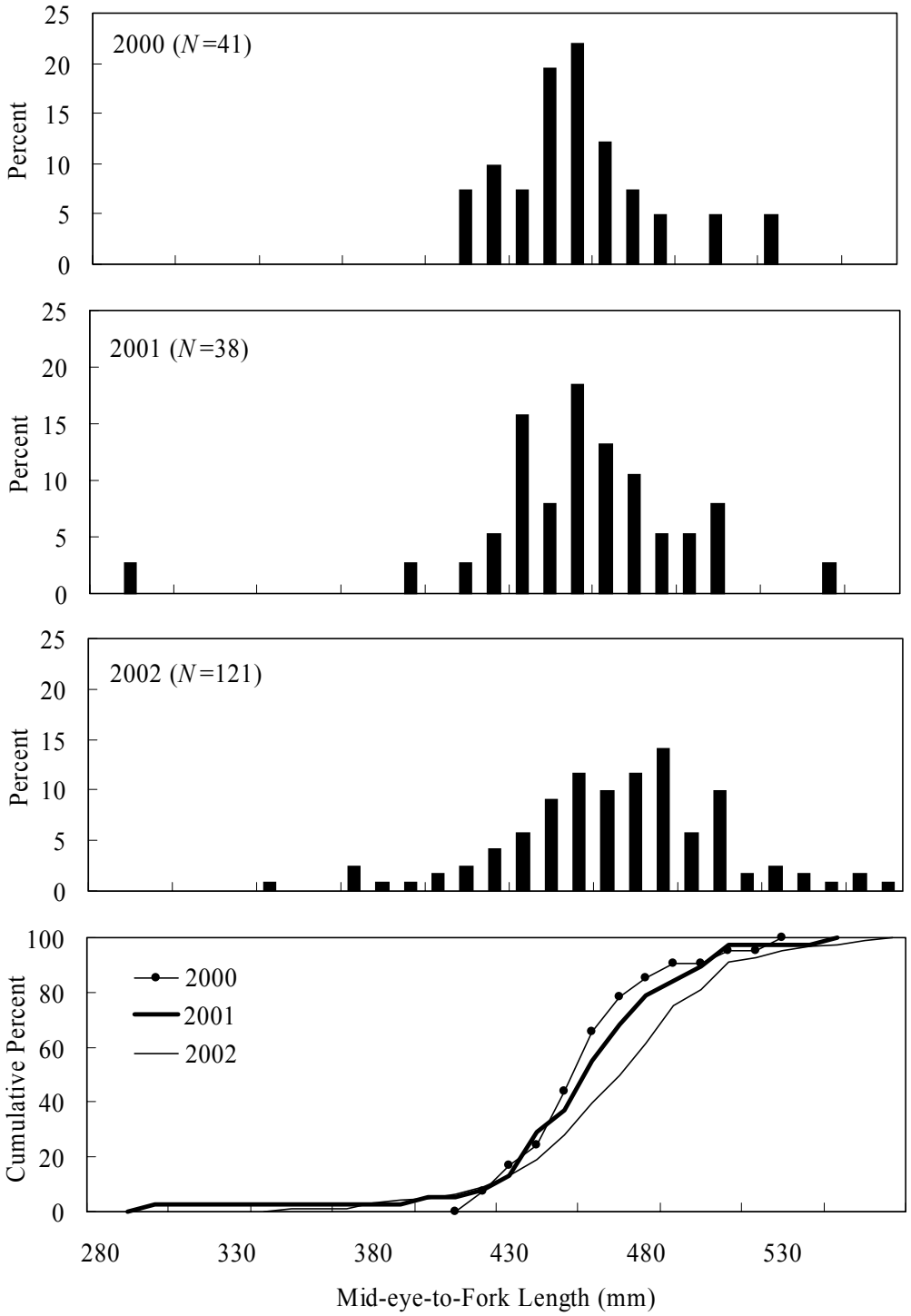

Figure 12. Length and cumulative length frequencies of pink salmon measured at the Frosty Creek weir, 2000-2002.

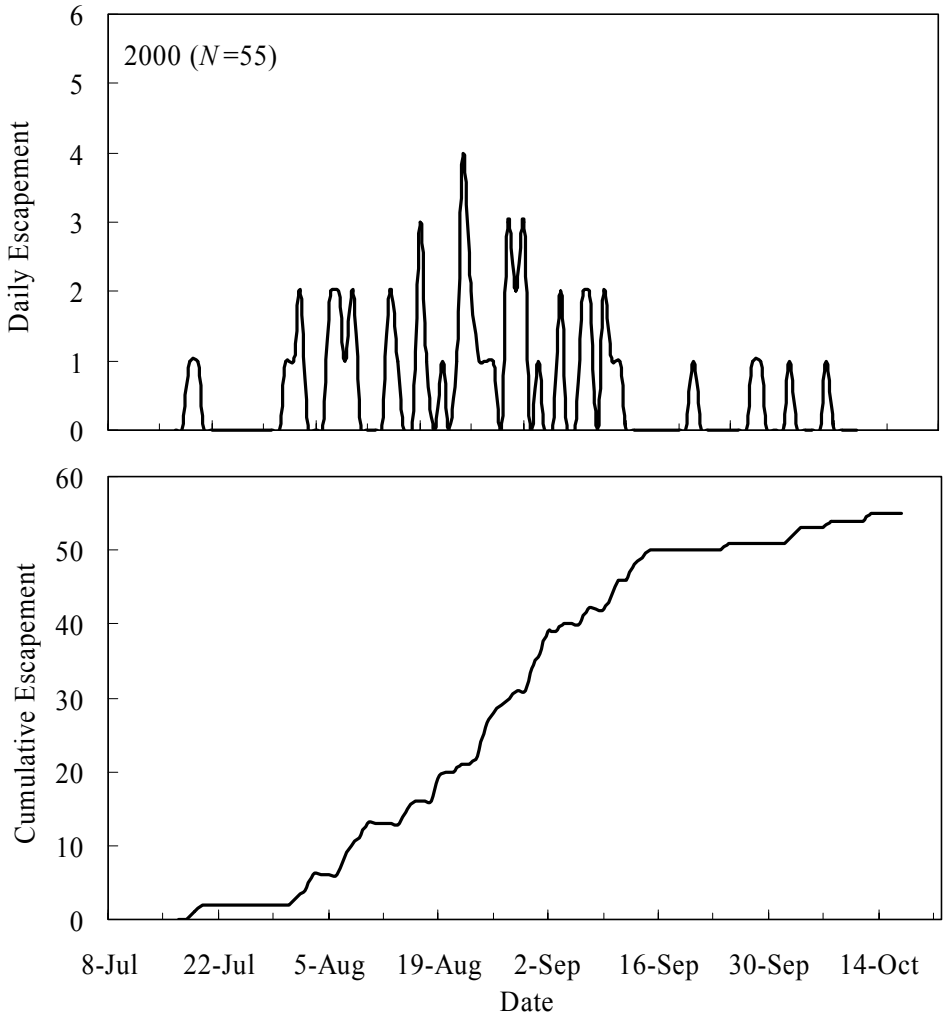

Figure 13. Daily and cumulative escapements of sockeye salmon counted at the Frosty Creek weir, 2000.

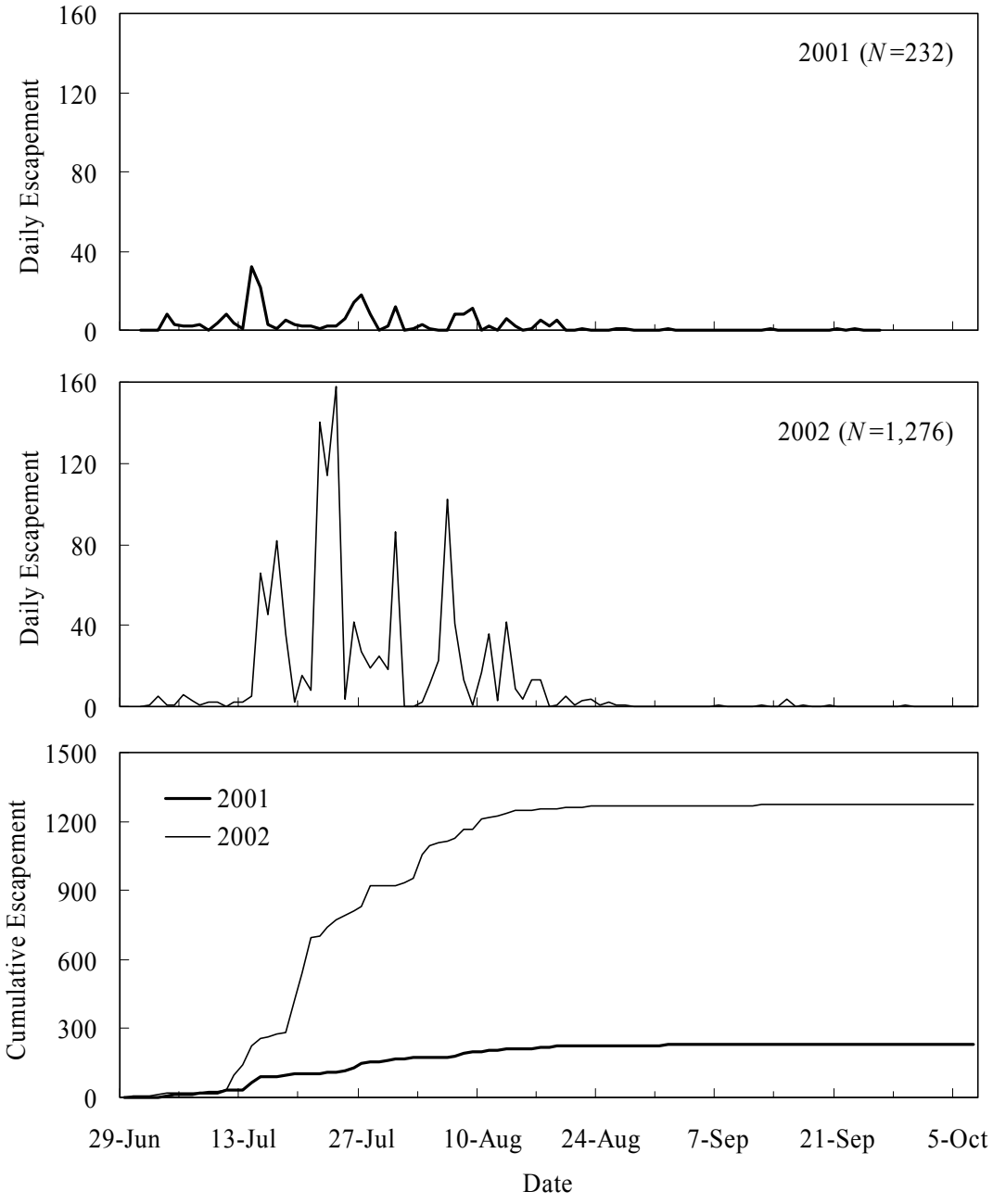

Figure 14. Daily and cumulative escapements of sockeye salmon counted at the Frosty Creek weir, 2001 and 2002**.**

Table 14. Estimated length composition (mean, standard error, range, and sample size) of Frosty Creek sockeye salmon escapement by age and sex, 2000-2002. All lengths are mid-eye-to-fork of tail (mm).

	Males				Females				All Fish[a]			
Age	*N*	Mean	SE	Range	*N*	Mean	SE	Range	*N*	Mean	SE	Range
						2000						
0.3	2	585	7.1	580-598	1	580	---	---	3	583	4.3	580-590
1.1	1	385	---	---	0	---	---	---	1	385	---	---
1.2	1	555	---	---	0	---	---	---	1	555	---	---
1.3	4	596	26.9	565-630	5	551	27.4	505-590	9	571	28.9	505-630
2.2	1	445	---	---	0	---	---	---	1	445	---	---
2.3	7	558	60.6	430-610	3	548	26.7	525-590	10	555	18.4	430-610
ALL	22	558	13.4	430-630	10	561	12.6	505-635	32	559	9.9	385-635
						2001						
1.2	1	600	---	---	3	528	37.4	487-561	8	509	57.3	412-600
1.3	4	574	32.3	528-604	3	545	26.3	524-575	8	564	29.2	524-604
2.1	0	---	---	---	0	---	---	---	1	451	---	---
2.2	1	515	---	---	0	---	---	---	2	515	0.7	514-515
2.3	0	---	---	---	1	520	---	---	1	520	---	---
ALL	13	554	41.4	470-604	12	496	27.9	487-580	32	518	47.6	412-604
						2002[b]						
1.2	29	506	30.0	418-592	29	497	23.0	420-568	63	501	23.7	418-592
1.3	12	587	15.1	531-614	8	555	23.4	520-580	20	573	22.3	520-614
2.2	3	434	---	418-485	3	468	6.0	462-480	6	445	6.9	418-485
2.3	2	573	7.8	567-578	---	---	---	---	2	573	7.7	567-578
ALL	49	518	9.5	418-614	40	495	6.4	420-580	95	505	5.9	418-614

[a] All fish includes fish which were not identified as male or female.

[b] Ages 0.3 and 1.1 were not included as they were <3% (*N*=4) of the total sample.

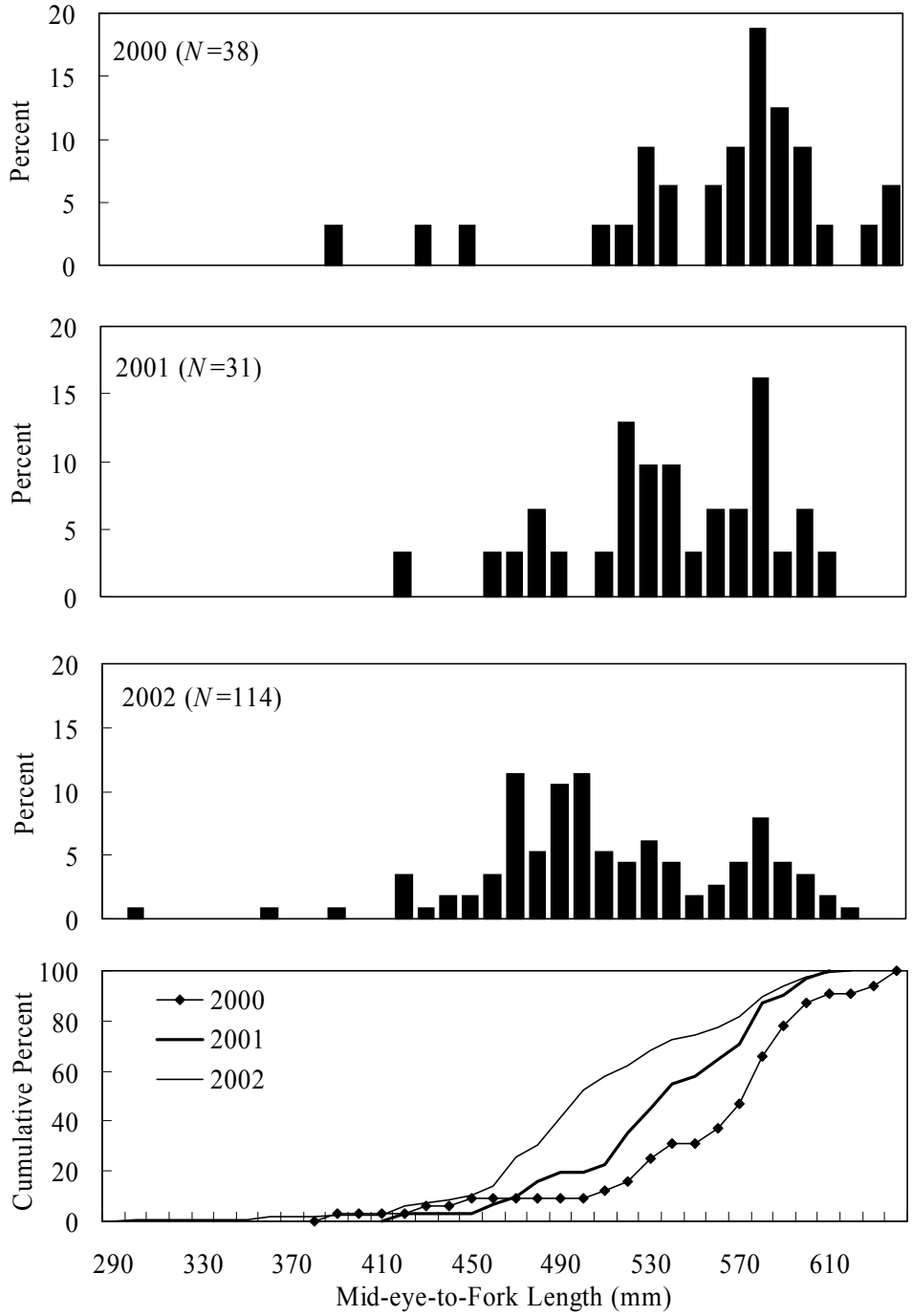

Figure 15. Length and cumulative length frequencies of sockeye salmon measured at the Frosty Creek weir, 2000-2002.

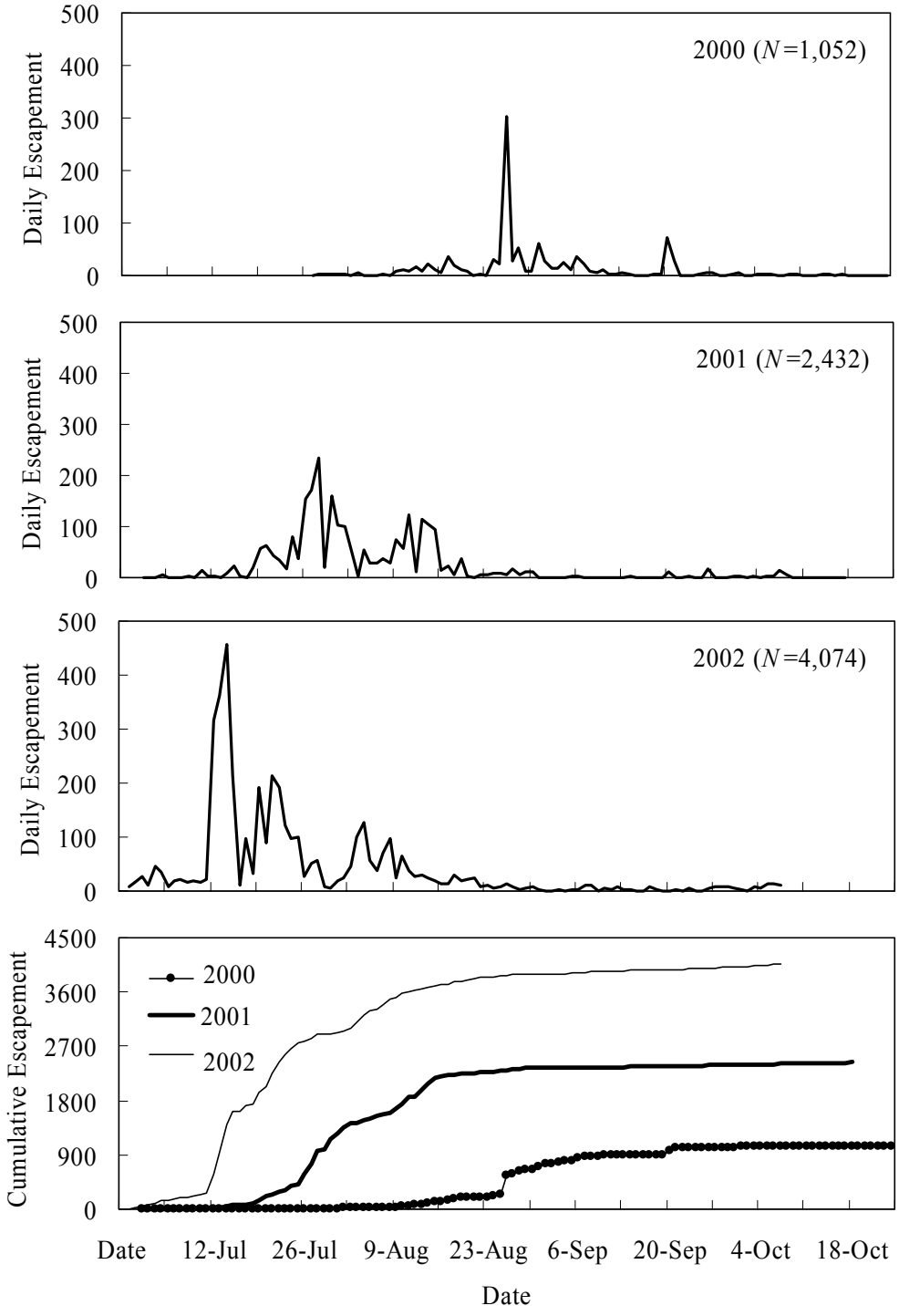

Figure 16. Daily and cumulative counts of Dolly Varden captured in the upstream migrant trap box at the Frosty Creek weir, 2000-2002.

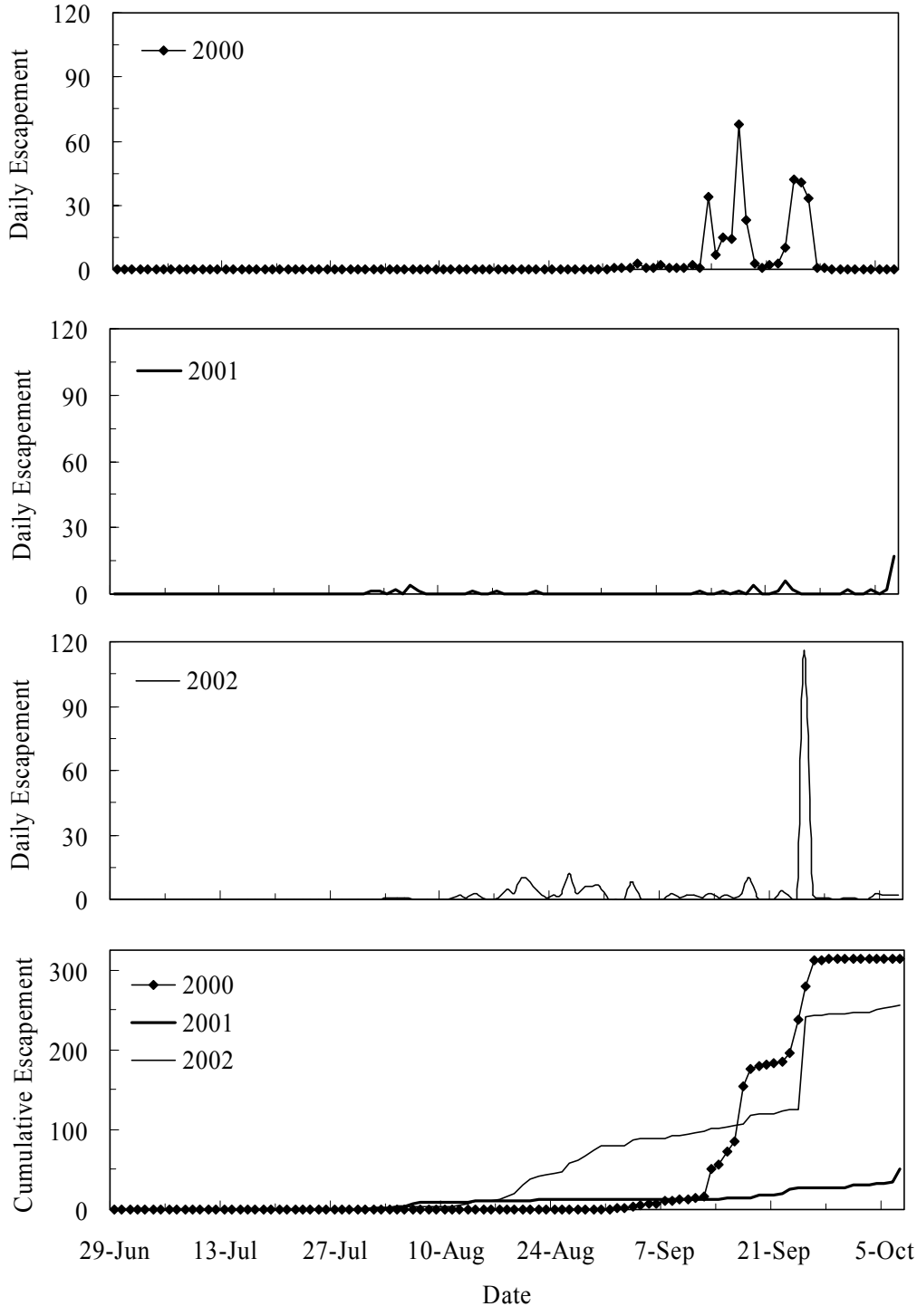

Figure 17. Daily and cumulative escapement for Dolly Varden captured in the downstream migrant box at the Frosty Creek weir, 2000-2002.

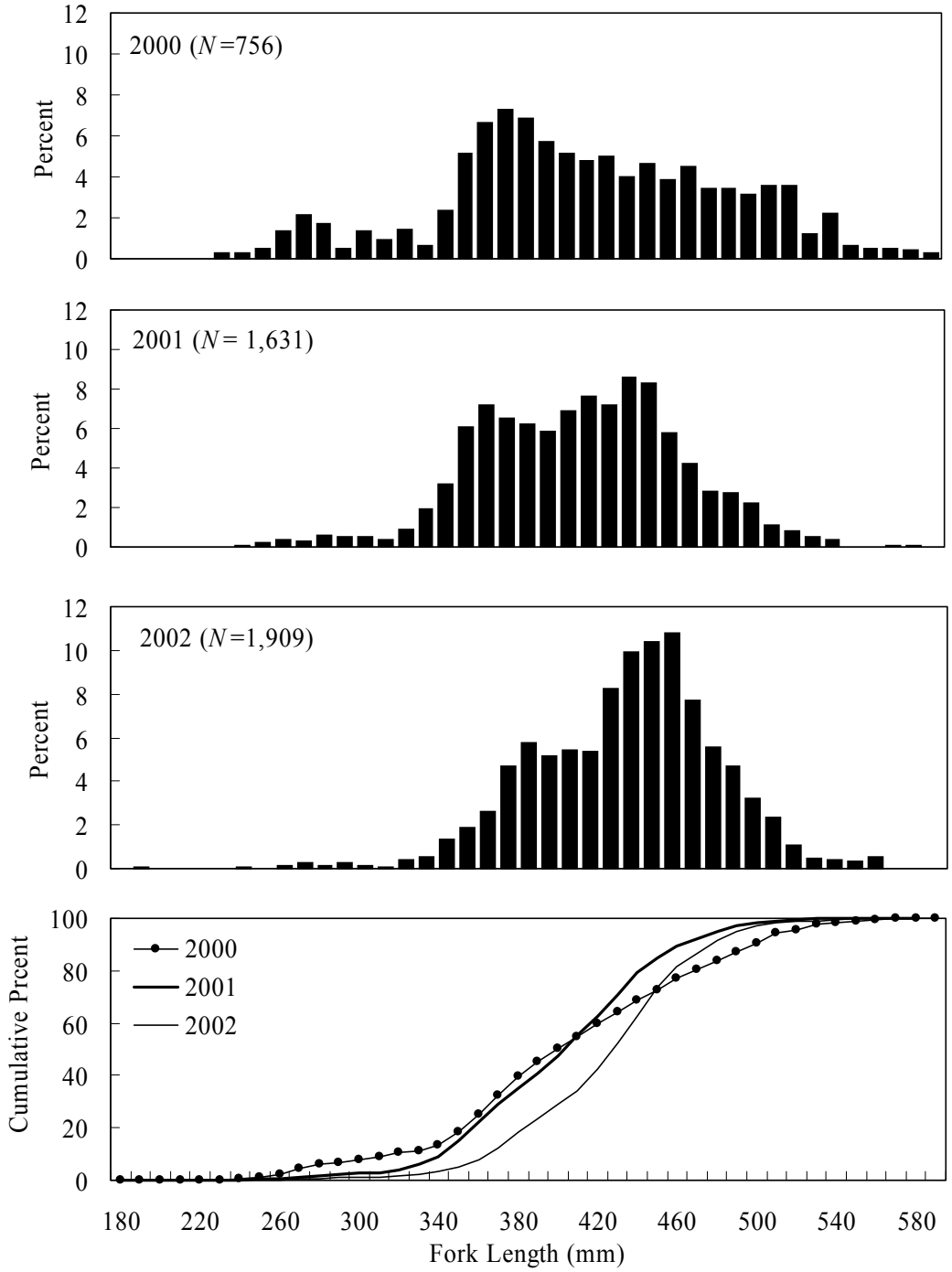

Figure 18. Length and cumulative length frequencies of Dolly Varden measured at the Frosty Creek weir, 2000-2002.

Public Use Information

In 2000, 36 groups visiting the Izembek National Wildlife Refuge were interviewed at the Frosty Creek weir from 8 July to 22 October (Table 15; Appendix F). The primary purpose for visiting the area was fishing for 15 groups, hunting for11 groups, and sightseeing for 5 groups. Only seven groups indicated a secondary purpose for visiting the Frosty Creek area. Dolly Varden were the primary target species for fishermen at Frosty Creek. Anglers reported a harvest of 67 Dolly Varden, 1 coho and 2 sockeye salmon. Eight groups of fishermen interviewed on Frosty Creek were targeting more that one species of fish (Dolly Varden and coho salmon, *N*=6) or also hunting (ptarmigan, *N*=2). The target species for all groups hunting in the Frosty Creek area were ptarmigan and waterfowl. The known harvest for two groups was 31 ptarmigan. Twenty-nine groups visiting the area were not guided, one group was guided, and one group had unknown guide status. The residence of nine groups was the contiguous 48 states, four were from the Cold Bay, two were from other locations in Alaska, one group was from Holland, and 15 groups were of unknown residence.

Interviewed fishing groups spent 97 hours at Frosty Creek, with an average of 7.5 hours per group (Table 16). Interviewed hunting groups spent 99 hours in the Frosty Creek area, with an average of 9.9 hours per group. Three interviewed groups spent a total of 9 hours sight seeing in the area. The total expanded time (hours*group size) was 215 hours for people fishing on Frosty Creek and 245 hours for people hunting in the Frosty Creek area. The total time spent in Frosty Creek area by all visitors was 475 hours.

Discussion

Escapement

Salmon runs in Frosty Creek began in late June and continued into October. Chum salmon, the most abundant species in the drainage, were the first fish to enter the creek in June and continued into early October. The chum salmon run was bimodal. The early run began in late June to early July and ended in late July to early August. The late run began mid-August and continued through early to mid-October. Based on the run timing observed in 2000, it appears that fish in the early run may spawn higher in the drainage. A bimodal chum salmon run was also observed in the Joshua Green River and has been documented in other systems (Salo 1991; Whitton and Eaton 2001).

The combined number of other Pacific salmon species made up less than 10% of the total salmon run. The pink and sockeye salmon run began slightly later than the chum salmon run in early July but continued about the same duration and exhibited a single peak in mid-August. The pink salmon run in Frosty Creek exhibited strong even year run strength similar to other Alaska Peninsula stocks (Heard 1991). Information on run abundance for pink salmon in the Joshua Green River shows a similar pattern (Whitton and Eaton 2001). The sockeye salmon run in Frosty Creek began slightly later than the Mortensens Creek run which began late June and continued through early September (Whitton 2002). Coho salmon were the last fish to begin their migration in mid-August

Table 15. Summary of the 2000 public use information collected at the Frosty Creek weir. Some groups had multiple targets species (*N*=8) and/or residence (*N*=1).

Category	Number of Groups
Primary Purpose	
Hunting	11
Fishing	15
Site seeing	5
Secondary Purpose	
Hunting	2
Fishing	3
Site seeing	2
Hunting Target Species	
Ptarmigan	10
Waterfowl	3
Fishing Target Species	
Dolly Varden	9
Coho Salmon	6
Unknown or Other	6
Guide Status	
Guided	1
Not Guided	29
Unknown	1
Reason for Visit	
Sport	27
Subsistence	0
Other	4
Residence	
Cold Bay	4
Other Alaska (King Salmon, Anchorage, Kenai)	2
Contiguous 48 States (MO, AZ, NV, NC, FL, NJ, CA, WI, and PA)	9
International (Holland)	1
Unknown	15

Table 16. Summary of the 2000 public use information collected at the Frosty Creek weir by primary purpose.

	Primary Purpose for Visit			
	Hunting	Fishing	Other	All
Groups Interviewed (N)	11	15	5	31
Complete Surveys	4	7	3	14
Incomplete Surveys	7	8	2	17
Time Spent in Activity[a]				
Total Time for all Groups (hrs)	99	97	9	205
Average Time Per Group (hrs)	9.9	7.5	3	7.9
SD	13.9	13.6	1.0	8.1
Range (hrs)	1-36	1-48	2-4	1-48
N	10	13	3	26
Group Information				
Total Number of People)	25	47	11	83
Average Group Size (hrs)	2.5	3.1	2.2	2.8
SD	1.0	1.6	1.1	1.4
Range (hrs)	1-4	1-6	1-4	1-6
N	10	15	5	30
*Expanded Time (time*group size) (hrs)*	245	215	15	475

and continued past weir removal in mid-October. Coho salmon run timing was similar to other creeks and rivers in the area (Sandercock 1991; Whitton and Eaton 2001).

Dolly Varden were the second most abundant fish species in Frosty Creek. The upstream migration coincided with the salmon runs. Peak migration of Dolly Varden varied from mid-July to late August, which is similar to both the Joshua Green River and to Moffet Springs Creek (Whitton and Eaton 2001). While Dolly Varden were still being captured in the upstream weir in October, downstream migration dominated the weir counts toward the end of the sampling season. In September and October, some of the downstream migrant Dolly Varden appeared to be spawned out based on coloration and body condition. Dolly Varden redds were observed while conducting walking surveys. It appears there may be two distinct spawning locations for Dolly Varden in Frosty Creek. The first location is in the headwaters where substrate consists of coarse gravel to large cobble, and the second location is downstream of the bridge where the substrate is primarily gravel.

Overall, it appears that the weir provided accurate estimates of Pacific salmon and Dolly Varden escapement in Frosty Creek. Chum salmon were observed at the weir the first few days after the weir was installed, thus we may not have counted some fish. However, because it was early in the run it is unlikely that a large number of fish were not counted. A small number of fish migrated through the weir a couple of days before it was removed; therefore, we may have missed some coho salmon. In 2001, the weir was not fish tight during the first 2 weeks of operation because high winds prevented the transport of additional weir materials by boat. In 2000, the weir preformed well until high water and debris damaged it in mid-October. Based on salmon run timing, the weir still provided complete estimates of salmon escapement above the first bridge. The weir was designed to capture fish greater than 200 mm; therefore, Dolly Varden should have been captured at the weir if they were present.

Area under the curve estimates of adult chum salmon and coho salmon on Frosty Creek in 2000 should be considered minimum estimates. Peak salmon abundance coincides with peak bear abundance. On some surveys, bears prevented the sampling crews from counting fish in dense vegetation areas. In addition, sampling was concluded before the end of the coho salmon run. The survey frequency should be adequate to provide good AUC estimates. Hetrick and Nemeth (2003) recommended survey intervals equal to the expected residence time specific to the species and survey period (i.e., early or late in the season) for maximum logistical efficiency. Surveys were planned at 7 d intervals for Frosty Creek in 2000 based on a mean chum salmon residence time of 11.7 d and mean coho salmon residence time of 13.8 d (Hetrick and Nemeth 2003). To improve AUC estimates, residence time for chum and coho salmon should be estimated specifically for Frosty Creek.

In most years, aerial counts appear to provide reasonable estimates of chum salmon escapement in Frosty Creek. Aerial surveys conducted by ADFG in 2001 estimated a total escapement for chum salmon of 38,600 compared to the weir count of 35,482 and

the aerial count flown in 2002 was 37,500 compared to the weir count of 42,194 (Arnie Shaul, ADFG, personal communication). The aerial surveys flown in 2000 under estimated the total escapement by about 20,000 chum salmon. The aerial survey estimate was 9,000 chum salmon, while the AUC estimate was 29,875. The aerial estimate was not comparable to weir counts from 2000 since the surveys ended at the weir. The weir counts showed that approximately 10 % of the chum salmon run spawns above the aerial survey area.

Frosty Creek is a unique system given that it is only about 16 km in length and had a chum salmon escapement greater than 35,000 fish for two of the three years the weir was operated. Overall, it appears that the escapement numbers for chum salmon have increased since counts began in 1960. Historical chum salmon escapement data from the ADFG indicate that the average estimated total escapement was 18,570 for the previous 40 years (Arnie Shaul, ADFG personal communication). In 2002, the total escapement was the third highest since 1960. However, it is also possible, that the methods used to estimate escapement from aerial counts underestimates the actual escapement. There is limited escapement data for sockeye salmon in Frosty Creek; however, the average yearly estimated escapement since 1987 was 77 fish per season. In 2001 and 2002 escapement at the weir was greater than 230 sockeye salmon. There is no historical escapement data for pink or coho salmon in Frosty Creek. Surveys are not conducted late enough in the season to get a complete count for coho salmon (Arnie Shaul, ADFG personal communication).

Based on the weir counts and AUC estimates during 2000-2002, it appears that Frosty Creek supports a fairly small population of coho salmon; therefore, an increase in sport fishing on Frosty Creek could impact the population. At current use levels, the coho population is sustainable. However, either the population abundance or the sport fishery should be monitored to prevent over-harvest.

Biological Data

The age composition of salmon sampled in Frosty Creek was similar to other populations but did exhibit some interesting differences. For coho salmon, age 2.1 was the most abundant age class for all 3 years, followed by age 3.1. In the Joshua Green River, age 1.1 or 2.1 would be the most abundant age-class. There was a higher percentage of age 3.1 coho salmon in Frosty Creek (15-25%) than other Alaskan systems, where age 3.1 is usually less than 5% of the run (Sandercock et al. 1991). Although not abundant, age classes 2.0 and 3.0 were observed at the Frosty Creek weir. Both age classes were found in the Joshua Green River, but in fewer numbers (Whitton and Eaton 2001). Scale patterns indicate slow growth during the first freshwater year, increased growth during the second year, and in some cases a delay in migration until the third year in fresh water (Matt Foster, ADFG, personal communication).

The most abundant age-class for sockeye salmon was 1.2 followed by age 1.3, which is similar to what was found in the McLees Lake and the Joshua Green River sockeye salmon (Palmer 2003; Whitton and Eaton 2001). Age 0.3 and 0.4 chum salmon were the most abundant age classes at Frosty Creek. Age 0.3 and 0.4 chum salmon also dominated

the run in Joshua Green River (Whitton and Eaton 2001), as well as other chum salmon runs within Alaska (Salo 1991).

Public Use

A survey was conducted in 2000 to characterize public use in the Frosty Creek area. Sport fishing on Izembek Refuge occurs mainly in road accessibly streams and lakes in the Cold Bay area. Hunting and fishing were the primary activities with anglers targeting Dolly Varden and coho salmon. Compared to Russell and Mortensens creeks, the harvest of coho salmon was minor (Whitton 2002). Hunters were primarily targeting ptarmigan. Waterfowl hunters parked their vehicle and walked to Izembek Lagoon to hunt.

The survey only covered a portion of the total use for the area because people exited the survey area before they could be interviewed. During the ptarmigan season, a number of vehicles passed by this area to hunt further up the road. This area would provide a good site to stop and interview hunters for future surveys.

Acknowledgements

We wish to thank the many people who helped with field work and data entry: Mark Nelson, David Leer, Jason Stolarski, Frank Preston, Starr Nicely, Emily Loose, Andy Dux, Adam Peterson, Kevin Sims, Kevin Taft, Andy Selle, Jeremy Carlson, John Meyer, Alexander Potter, Benjamin Feldman, Michael Harrington, and Julie Teskie. We also thank the staff at the Izembek National Wildlife Refuge for logistical support.

Literature Cited

Adams, F. J., B. Mahoney, and S. Lanigan. 1993. Fishery survey of lakes and streams on Izembek and Alaska Peninsula National Wildlife Refuges, 1985 and 1986. U.S. Fish and Wildlife Service, Fisheries Technical Report 20, King Salmon, Alaska.

Bromaghin, J. F. 1993. Sample size determination for interval estimation of multinomial probabilities. The American Statistician 47:203-206.

Bue, B. G., S. M. Fried, S. Sharr, D. G. Sharps, J. A. Wilcock, and H. J. Geiger. 1998. Estimating salmon escapement using area-under-the-curve, aerial observer efficiency, and stream-life estimates: the Prince William Sound pink salmon example. North Pacific Anadromous Fish Commission Bulletin 1:240-250.

Cochran, W. G. 1977. Sampling Techniques, 3rd edition. John Wiley & Sons, New York.

English, K. K., R. C. Bocking, and J. R. Irvine. 1992. A robust procedure for estimating salmon escapement based on the area-under-the-curve method. Canadian Journal of Fisheries and Aquatic Sciences 49:1982-1989.

Heard, W.R. 1991. Life history of pink salmon *Oncorhynchus gorbuscha*. Pages 120-230 *in* C. Groot and L. Margolis, editors. Pacific salmon life histories. UBC Press, Vancouver, British Columbia.

Hetrick, N. J., and M. J. Nemeth. 2003. Survey of coho salmon runs on the Pacific Coast of the Alaska Peninsula and Becharof National Wildlife Refuges, 1994 with estimates of escapement for two small streams in 1995 and 1996. U. S. Fish and Wildlife Service, King Salmon Fish and Wildlife Field Office, Alaska Fisheries Technical Report 63, King Salmon, Alaska.

Hilborn, R., B. G. Bue, and S. Sharr. 1999. Estimating spawning escapements from periodic counts: a comparison of method. Canadian Journal of Fisheries and Aquatic Sciences 56:888-896.

Jerald, A. 1983. Age determination. Pages 301-324 in L. A. Nielsen and D. L. Johnson, editors. Fisheries techniques. American Fisheries Society, Bethesda, Maryland.

Koo, T. S. Y. 1962. Age determination in salmon. Pages 301-324 in T.S. Y. Koo, editor. Studies of Alaska red salmon. University of Washington Press, Seattle, Washington.

McMahon, T. E., A. V. Zale, and D. J. Orth. 1996. Aquatic Habitat Measurements. Pages 83-120. in B. R. Murphy and D. W. Wills, editors. Fisheries Techniques, 2 edition. American Fisheries Society, Bethesda, Maryland.

Minard, R. E., D. O. Dunaway, and M. J. Jaenicke. 1998. Area management report for the recreational fisheries of the Southwest Alaska sportfish management area, 1997. Alaska Department of Fish and Game, Fishery Management Report No. 98-3, Anchorage, Alaska.

Palmer, D. E., 2003. Estimation of the sockeye salmon escapement into Mclees Lake, Unalaska Island, Alaska, 2002. U.S. Fish and Wildlife Service, Kenai Fish and Wildlife Field Office, Kenai, AK. Alaska Fisheries Data Series 2003-4.

Salo, E. O. 1991. Life history of chum salmon (*Oncorhynchus keta*). Pages 231-310 *in* C. Groot and L. Margolis, editors. Pacific salmon life histories. University of British Columbia Press, Vancouver, British Columbia.

Sandercock, F.K. 1991 Life history of coho salmon (*Oncorhynchus kisutch*). Pages 231-310 *in* C. Groot and L. Margolis, editors. Pacific salmon life histories. University of British Columbia Press, Vancouver, British Columbia.

Seber, G. A. F. 1982. The estimation of animal abundance and related parameters, 2nd edition. Maxmillan, New York.

USFWS (U.S. Fish and Wildlife Service). 1985. Izembek National Wildlife Refuge final comprehensive plan and environmental impact statement and wilderness review. U.S. Department of the Interior, Fish and Wildlife Service, Anchorage, Alaska

USFWS. 1994. Izembek National Wildlife Refuge fishery management plan fiscal years 1994-1998, King Salmon, Alaska.

Whitton, K. S. 2002. Estimation of sockeye and coho salmon escapement in Mortensens Creek, Izembek National Wildlife Refuge, 2001. U.S. Fish and Wildlife Service, King Salmon Fishery Resources office, King Salmon, AK. Alaska Fisheries Data Series 2002-3.

Whitton, K. S. and D. M. Eaton. 2001. Joshua Green salmon stock assessment and resident fish species survey, Izembek National Wildlife Refuge, Alaska 1994-1996. U.S. Fish and Wildlife Service, King Salmon Fishery Resources office, King Salmon, AK. Alaska Fisheries Data Series 2001-3.

Appendix A. – Strata (time periods) used for analysis of Frosty Creek chum, sockeye and coho salmon biological data, 2000-2002.

Strata	Chum	Sockeye	Coho
		2000	
1	July 9 to July 22	July 19 to October 13	August 26 to September 23
2	July 23 to July 29	----	September 24 to October 24
3	July 30 to August 5	----	----
4	August 6 to August 26	----	----
5	August 27 to September 20	----	----
		2001	
1	July 1 to July 7	July 4 to September 23	August 11 to October 17
2	July 8 to July 14	----	----
3	July 15 to July 21	----	----
4	July 22 to July 28	----	----
5	July 29 to August 4	----	----
6	August 5 to August 11	----	----
7	August 12 to August 18	----	----
8	August 19 to August 25	----	----
9	August 26 to September 1	----	----
10	September 2 to September 8	----	----
11	September 9 to September 16	----	----
12	September 17 to October 17	----	----
		2002	
1	June 29 to July 6	June 20 to July 27	August 23 to October 7
2	July 7 to July 13	July 28 to August 3	----
3	July 14 to July 20	August 4 to October 7	----
4	July 21 to July 27	----	----
5	July 28 to August 3	----	----
6	August 4 to August 10	----	----
7	August 11 to August 17	----	----
8	August 18 to August 24	----	----
9	August 25 to August 31	----	----
10	September 1 to September 7	----	----
11	September 8 to September 14	----	----
12	September 15 to September 21	----	----
13	September 22 to October 7	----	----

Appendix B. – Daily counts, cumulative counts (Cum.), and cumulative percent (Cum. %) of sockeye, coho, pink, and chum salmon escapement through the Frosty Creek weir, 2000.

	Chum Salmon			Coho Salmon			Sockeye Salmon			Pink Salmon		
Date	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %
Jul 9	1	1	0.04	0	0	0.00	0	0	0.00	0	0	0.00
Jul 10	0	1	0.04	0	0	0.00	0	0	0.00	0	0	0.00
Jul 11	1	2	0.07	0	0	0.00	0	0	0.00	0	0	0.00
Jul 12	6	2	0.30	0	0	0.00	0	0	0.00	0	0	0.00
Jul 13	2	10	0.37	0	0	0.00	0	0	0.00	0	0	0.00
Jul 14	38	48	1.75	0	0	0.00	0	0	0.00	0	0	0.00
Jul 15	59	107	3.91	0	0	0.00	0	0	0.00	0	0	0.00
Jul 16	44	151	5.51	0	0	0.00	0	0	0.00	0	0	0.00
Jul 17	59	210	7.67	0	0	0.00	0	0	0.00	0	0	0.00
Jul 18	3	213	7.78	0	0	0.00	0	0	0.00	0	0	0.00
Jul 19	11	224	8.18	0	0	0.00	1	1	1.81	0	0	0.00
Jul 20	75	299	10.92	0	0	0.00	1	2	3.63	0	0	0.00
Jul 21	42	341	12.45	0	0	0.00	0	2	3.63	0	0	0.00
Jul 22	164	505	18.44	0	0	0.00	0	2	3.63	1	1	1.79
Jul 23	289	794	28.99	0	0	0.00	0	2	3.63	0	1	1.79
Jul 24	89	883	32.24	0	0	0.00	0	2	3.63	0	1	1.79
Jul 25	63	946	34.54	0	0	0.00	0	2	3.63	0	1	1.79
Jul 26	117	1,063	38.81	0	0	0.00	0	2	3.63	0	1	1.79
Jul 27	139	1,202	43.88	0	0	0.00	0	2	3.63	0	1	1.79
Jul 28	44	1,246	45.49	0	0	0.00	0	2	3.63	0	1	1.79
Jul 29	67	1,313	47.94	0	0	0.00	0	2	3.63	0	1	1.79
Jul 30	49	1,362	49.73	0	0	0.00	0	2	3.63	0	1	1.79
Jul 31	70	1,432	52.28	0	0	0.00	0	2	3.63	0	1	1.78

Appendix B. – Continued.

	Chum Salmon			Coho Salmon			Sockeye Salmon			Pink Salmon		
Date	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %
Aug 1	143	1,575	57.50	0	0	0.00	1	3	5.45	0	1	1.78
Aug 2	68	1,643	59.98	0	0	0.00	1	4	7.27	2	3	5.36
Aug 3	69	1,712	62.50	0	0	0.00	2	6	10.90	2	5	8.92
Aug 4	21	1,733	63.27	0	0	0.00	0	6	10.90	0	5	8.92
Aug 5	23	1,756	64.11	0	0	0.00	0	6	10.90	0	5	8.92
Aug 6	40	1,796	65.57	0	0	0.00	0	6	10.90	2	7	12.50
Aug 7	14	1,810	66.08	0	0	0.00	2	8	14.54	0	7	12.50
Aug 8	38	1,848	67.47	0	0	0.00	2	10	18.18	0	7	12.50
Aug 9	24	1,872	68.35	0	0	0.00	1	11	20.00	2	9	16.07
Aug 10	52	1,924	70.24	0	0	0.00	2	13	23.64	3	12	21.43
Aug 11	40	1,964	71.71	0	0	0.00	0	13	23.64	3	15	26.78
Aug 12	37	2,001	73.06	0	0	0.00	0	13	23.64	2	17	30.36
Aug 13	42	2,043	74.59	0	0	0.00	0	13	23.64	0	17	30.36
Aug 14	36	2,079	75.90	0	0	0.00	0	13	23.64	1	18	32.14
Aug 15	26	2,105	76.85	0	0	0.00	2	15	27.27	2	20	35.71
Aug 16	31	2,136	77.98	0	0	0.00	1	16	29.09	2	22	39.29
Aug 17	42	2,178	79.52	0	0	0.00	0	16	29.09	1	23	41.07
Aug 18	32	2,210	80.69	0	0	0.00	0	16	29.09	1	24	42.86
Aug 19	10	2,220	81.05	0	0	0.00	3	19	34.54	3	27	48.21
Aug 20	43	2,263	82.62	0	0	0.00	1	20	36.36	0	27	48.21
Aug 21	7	2,270	82.88	0	0	0.00	0	20	36.36	0	27	48.21
Aug 22	30	2,300	83.97	0	0	0.00	1	21	38.18	0	27	48.21
Aug 23	7	2,307	84.23	0	0	0.00	0	21	38.18	3	30	53.57
Aug 24	25	2,332	85.14	0	0	0.00	1	22	40.00	0	30	53.57
Aug 25	26	2,358	86.09	0	0	0.00	4	26	47.27	1	31	55.36

Appendix B. – Continued.

	Chum Salmon			Coho Salmon			Sockeye Salmon			Pink Salmon		
Date	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %
Aug 26	90	2,448	89.37	4	4	0.73	2	28	50.90	4	35	62.50
Aug 27	26	2,474	90.32	0	4	0.73	1	29	52.72	4	39	69.64
Aug 28	41	2,515	91.82	0	4	0.73	1	30	54.55	5	44	78.57
Aug 29	38	2,553	93.21	0	4	0.73	1	31	56.36	0	44	78.57
Aug 30	13	2,566	93.68	1	5	0.91	0	31	56.36	2	46	82.14
Aug 31	46	2,612	95.36	6	11	2.01	3	34	61.82	4	50	89.29
Sep 1	13	2,625	95.84	0	11	2.01	2	36	65.45	2	52	92.85
Sep 2	12	2,637	96.28	0	11	2.01	3	39	70.90	1	53	94.64
Sep 3	20	2,657	97.01	1	12	2.19	0	39	70.90	0	53	94.64
Sep 4	18	2,675	97.66	0	12	2.19	1	40	72.73	0	53	94.64
Sep 5	8	2,683	97.96	1	13	2.37	0	40	72.73	0	53	94.64
Sep 6	14	2,697	98.47	0	13	2.37	0	40	72.73	1	54	96.42
Sep 7	18	2,715	99.12	3	16	2.92	2	42	76.36	2	56	100.00
Sep 8	5	2,720	99.31	2	18	3.28	0	42	76.36	0	56	100.00
Sep 9	3	2,723	99.42	0	18	3.28	0	42	76.36	0	56	100.00
Sep 10	3	2,726	99.52	3	21	3.83	2	44	80.00	0	56	100.00
Sep 11	5	2,731	99.71	5	26	4.74	2	46	83.64	0	56	100.00
Sep 12	3	2,734	99.81	4	30	5.47	0	46	83.64	0	56	100.00
Sep 13	1	2,735	99.85	0	30	5.47	2	48	87.27	0	56	100.00
Sep 14	3	2,738	99.96	2	32	5.84	1	49	89.10	0	56	100.00
Sep 15	0	2,738	99.96	0	32	5.84	1	50	90.90	0	56	100.00
Sep 16	0	2,738	99.96	0	32	5.84	0	50	90.90	0	56	100.00
Sep 17	0	2,738	99.96	0	32	5.84	0	50	90.90	0	56	100.00
Sep 18	0	2,738	99.96	0	32	5.84	0	50	90.90	0	56	100.00
Sep 19	0	2,738	99.96	0	32	5.84	0	50	90.90	0	56	100.00

Appendix B. – Continued.

	Chum Salmon			Coho Salmon			Sockeye Salmon			Pink Salmon		
Date	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %
Sep 20	1	2,739	100.00	6	38	6.93	0	50	90.90	0	56	100.00
Sep 21	0	2,739	100.00	102	140	25.55	0	50	90.90	0	56	100.00
Sep 22	0	2,739	100.00	50	190	34.67	0	50	90.90	0	56	100.00
Sep 23	0	2,739	100.00	7	197	35.95	0	50	90.90	0	56	100.00
Sep 24	0	2,739	100.00	2	199	36.31	0	50	90.90	0	56	100.00
Sep 25	0	2,739	100.00	11	210	38.32	1	51	92.73	0	56	100.00
Sep 26	0	2,739	100.00	11	221	40.33	0	51	92.73	0	56	100.00
Sep 27	0	2,739	100.00	2	223	40.69	0	51	92.73	0	56	100.00
Sep 28	0	2,739	100.00	0	223	40.69	0	51	92.73	0	56	100.00
Sep 29	0	2,739	100.00	0	223	40.69	0	51	92.73	0	56	100.00
Sep 30	0	2,739	100.00	3	226	41.24	0	51	92.73	0	56	100.00
Oct 1	0	2,739	100.00	0	226	41.24	0	51	92.73	0	56	100.00
Oct 2	0	2,739	100.00	0	226	41.24	0	51	92.73	0	56	100.00
Oct 3	0	2,739	100.00	13	239	43.61	1	52	94.55	0	56	100.00
Oct 4	0	2,739	100.00	3	242	44.16	1	53	96.36	0	56	100.00
Oct 5	0	2,739	100.00	3	245	44.71	0	53	96.36	0	56	100.00
Oct 6	0	2,739	100.00	13	258	47.08	0	53	96.36	0	56	100.00
Oct 7	0	2,739	100.00	3	261	47.62	0	53	96.36	0	56	100.00
Oct 8	0	2,739	100.00	8	269	49.08	1	54	98.18	0	56	100.00
Oct 9	0	2,739	100.00	25	294	53.64	0	54	98.18	0	56	100.00
Oct 10	0	2,739	100.00	16	310	56.57	0	54	98.18	0	56	100.00
Oct 11	0	2,739	100.00	27	337	61.49	0	54	98.18	0	56	100.00
Oct 12	0	2,739	100.00	57	394	71.89	0	54	98.18	0	56	100.00
Oct 13	0	2,739	100.00	76	470	85.77	1	55	100.00	0	56	100.00
Oct 14	0	2,739	100.00	30	500	91.24	0	55	100.00	0	56	100.00

Appendix B. – Continued.

	Chum Salmon			Coho Salmon			Sockeye Salmon			Pink Salmon		
Date	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %
Oct 15	0	2,739	100.00	11	511	93.25	0	55	100.00	0	56	100.00
Oct 16	0	2,739	100.00	13	524	95.62	0	55	100.00	0	56	100.00
Oct 17	0	2,739	100.00	4	528	96.35	0	55	100.00	0	56	100.00
Oct 18	0	2,739	100.00	2	530	96.71	0	55	100.00	0	56	100.00
Oct 19	0	2,739	100.00	0	530	96.71	0	55	100.00	0	56	100.00
Oct 20	0	2,739	100.00	5	535	97.62	0	55	100.00	0	56	100.00
Oct 21	0	2,739	100.00	3	538	98.18	0	55	100.00	0	56	100.00
Oct 22	0	2,739	100.00	5	543	99.09	0	55	100.00	0	56	100.00
Oct 23	0	2,739	100.00	5	548	100.00	0	55	100.00	0	56	100.00
Total	2,739	2,739	100.00	548	548	100.00	55	55	100.00	56	56	100.00

Appendix C. – Daily counts, cumulative counts (Cum.), and cumulative percent (Cum. %) of chum, coho, sockeye, and pink salmon escapement through the Frosty Creek weir, 2001.

	Chum Salmon			Coho Salmon			Sockeye Salmon			Pink Salmon		
Date	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %
Jul 1	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
Jul 2	7	7	0.02	0	0	0.00	0	0	0.00	0	0	0.00
Jul 3	2	9	0.03	0	0	0.00	0	0	0.00	0	0	0.00
Jul 4	635	644	1.81	0	0	0.00	8	8	3.44	0	0	0.00
Jul 5	73	717	2.02	0	0	0.00	3	11	4.74	0	0	0.00
Jul 6	20	737	2.07	0	0	0.00	2	13	5.60	0	0	0.00
Jul 7	44	781	2.20	0	0	0.00	2	15	6.47	0	0	0.00
Jul 8	326	1,107	3.12	0	0	0.00	3	18	7.75	0	0	0.00
Jul 9	88	1,195	3.37	0	0	0.00	0	18	7.75	0	0	0.00
Jul 10	511	1,706	4.81	0	0	0.00	4	22	9.48	0	0	0.00
Jul 11	370	2,076	5.85	0	0	0.00	8	30	12.93	0	0	0.00
Jul 12	74	2,150	6.06	0	0	0.00	4	34	14.66	1	1	0.25
Jul 13	130	2,280	6.42	0	0	0.00	1	35	15.01	0	1	0.25
Jul 14	2,901	5,181	14.60	0	0	0.00	32	67	28.88	0	1	0.25
Jul 15	1,005	6,186	17.43	0	0	0.00	22	89	38.36	0	1	0.25
Jul 16	438	6,624	18.66	0	0	0.00	3	92	39.65	0	1	0.25
Jul 17	136	6,760	19.05	0	0	0.00	1	93	40.08	0	1	0.25
Jul 18	607	7,367	20.76	0	0	0.00	5	98	42.24	0	1	0.25
Jul 19	286	7,653	21.56	0	0	0.00	3	101	43.53	0	1	0.25
Jul 20	218	7,871	22.18	0	0	0.00	2	103	44.39	0	1	0.25
Jul 21	128	7,999	22.54	0	0	0.00	2	105	45.26	2	3	0.74
Jul 22	176	8,175	23.03	0	0	0.00	1	106	45.69	2	3	0.74
Jul 23	228	8,403	23.68	0	0	0.00	2	108	46.55	2	3	0.74

Appendix C. – Continued.

	Chum Salmon			Coho Salmon			Sockeye Salmon			Pink Salmon		
Date	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %
Jul 24	1,601	10,004	28.19	0	0	0.00	2	110	47.41	1	4	0.99
Jul 25	620	10,624	29.93	0	0	0.00	6	116	50.00	1	5	1.23
Jul 26	1,733	12,357	34.81	0	0	0.00	14	103	56.03	4	9	2.22
Jul 27	3,170	15,527	43.75	0	0	0.00	18	148	63.79	4	13	3.21
Jul 28	376	15,903	44.81	0	0	0.00	8	156	67.24	5	18	4.44
Jul 29	0	15,903	44.81	0	0	0.00	0	156	67.24	0	18	4.44
Jul 30	233	16,136	45.47	0	0	0.00	2	158	68.10	2	20	4.94
Jul 31	155	16,291	45.90	0	0	0.00	12	170	73.28	6	26	6.42
Aug 1	219	16,510	46.52	0	0	0.00	0	170	73.28	0	26	6.42
Aug 2	52	16,562	46.66	0	0	0.00	1	171	73.71	3	29	7.16
Aug 3	141	16,703	47.06	0	0	0.00	3	174	75.00	2	31	7.65
Aug 4	285	16,988	47.86	0	0	0.00	1	175	75.43	0	31	7.65
Aug 5	94	17,082	48.13	0	0	0.00	0	175	75.43	0	31	7.65
Aug 6	113	17,194	48.45	0	0	0.00	0	175	75.43	8	39	9.63
Aug 7	142	17,336	48.84	0	0	0.00	8	183	78.88	2	41	10.12
Aug 8	227	17,563	49.49	0	0	0.00	8	191	82.33	11	52	12.94
Aug 9	360	17,923	50.50	0	0	0.00	11	202	87.07	23	75	18.52
Aug 10	47	17,970	50.63	0	0	0.00	0	202	87.07	11	86	21.23
Aug 11	51	18,021	50.78	1	1	0.12	2	204	87.93	5	91	22.47
Aug 12	96	18,117	51.04	0	1	0.12	0	204	87.93	6	97	23.95
Aug 13	952	19,069	53.73	0	1	0.12	6	210	90.52	21	118	29.14
Aug 14	640	19,709	55.53	2	3	0.36	2	212	91.38	14	132	32.59
Aug 15	634	20,343	57.32	0	3	0.36	0	212	91.38	19	151	37.29
Aug 16	50	20,393	57.46	0	3	0.36	1	213	91.81	2	153	37.77
Aug 17	242	20,635	58.14	0	3	0.36	5	218	93.97	9	162	40.00

Appendix C. – Continued.

	Chum Salmon			Coho Salmon			Sockeye Salmon			Pink Salmon		
Date	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %
Aug 18	137	20,772	58.53	0	3	0.36	2	220	94.83	15	177	43.70
Aug 19	3,469	24,241	63.30	0	3	0.36	5	225	96.98	34	211	52.09
Aug 20	61	24,302	68.47	0	3	0.36	0	225	96.98	9	220	54.32
Aug 21	20	24,322	68.53	0	3	0.36	0	225	96.98	4	224	55.31
Aug 22	552	24,874	70.09	8	11	1.30	1	226	97.41	29	253	62.46
Aug 23	476	25,350	71.43	3	14	1.65	0	226	97.41	15	268	66.17
Aug 24	18	25,368	71.48	0	14	1.65	0	226	97.41	1	269	66.42
Aug 25	232	25,600	72.13	3	17	2.01	0	226	97.41	10	279	68.88
Aug 26	752	26,352	74.25	1	18	2.13	1	227	97.84	15	294	72.59
Aug 27	1,260	27,612	77.80	16	34	4.03	1	228	98.28	19	313	77.28
Aug 28	294	27,906	78.63	4	38	4.50	0	228	98.28	7	320	79.01
Aug 29	649	28,555	80.46	21	59	6.99	0	228	98.28	18	338	83.46
Aug 30	1,925	30,480	85.88	21	80	9.48	0	228	98.28	23	361	89.14
Aug 31	107	30,587	86.18	2	82	9.71	0	228	98.28	1	362	89.38
Sep 1	75	30,662	86.39	1	83	9.83	1	229	98.71	15	377	93.09
Sep 2	137	30,799	86.78	3	86	10.19	0	229	98.71	0	377	93.09
Sep 3	1	30,800	86.78	0	86	10.19	0	229	98.71	0	377	93.09
Sep 4	1,398	32,198	90.72	1	87	10.31	0	229	98.71	2	379	93.58
Sep 5	186	32,384	91.25	4	91	10.78	0	229	98.71	5	384	94.81
Sep 6	478	32,862	92.59	13	104	12.32	0	229	98.71	6	390	96.29
Sep 7	621	33,483	94.34	11	115	13.63	0	229	98.71	6	396	97.77
Sep 8	161	33,644	94.80	0	115	13.63	0	229	98.71	0	396	97.77
Sep 9	218	33,862	95.41	4	119	14.09	0	229	98.71	1	397	98.02
Sep 10	192	34,054	95.95	6	125	14.81	0	229	98.71	2	399	98.52
Sep 11	6	34,060	95.97	1	126	14.93	0	229	98.71	0	399	98.52

Appendix C. – Continued.

	Chum Salmon			Coho Salmon			Sockeye Salmon			Pink Salmon		
Date	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %
Sep 12	129	34,189	96.33	12	138	16.35	0	229	98.71	0	399	98.52
Sep 13	106	34,292	96.63	5	143	16.94	1	230	99.14	2	401	99.01
Sep 14	96	34,391	96.90	8	151	17.89	0	230	99.14	0	401	99.01
Sep 15	64	34,455	97.08	0	151	17.89	0	230	99.14	0	401	99.01
Sep 16	85	34,540	97.32	2	153	18.13	0	230	99.14	0	401	99.01
Sep 17	186	34,726	97.84	3	156	18.48	0	230	99.14	2	403	99.51
Sep 18	64	34,790	98.02	0	156	18.48	0	230	99.14	0	403	99.51
Sep 19	103	34,893	98.32	2	158	18.72	0	230	99.14	0	403	99.51
Sep 20	379	35,272	99.38	504	662	78.43	0	230	99.14	1	404	99.75
Sep 21	69	35,341	99.57	60	722	85.55	1	231	99.57	0	405	100.00
Sep 22	52	35,393	99.72	34	756	89.57	0	231	99.57	0	405	100.00
Sep 23	17	35,410	99.77	22	778	92.18	0	232	100.00	0	405	100.00
Sep 24	1	35,411	99.77	0	778	92.18	0	232	100.00	0	405	100.00
Sep 25	1	35,412	99.77	0	778	92.18	0	232	100.00	0	405	100.00
Sep 26	16	35,428	99.82	5	783	92.77	0	232	100.00	0	405	100.00
Sep 27	16	35,444	99.86	2	785	93.01	0	232	100.00	0	405	100.00
Sep 28	4	35,448	99.88	2	787	93.25	0	232	100.00	0	405	100.00
Sep 29	6	35,454	99.89	1	788	93.36	0	232	100.00	0	405	100.00
Sep 30	1	35,455	99.89	0	788	93.36	0	232	100.00	0	405	100.00
Oct 1	8	35,463	99.92	2	790	93.60	0	232	100.00	0	405	100.00
Oct 2	2	35,465	99.93	0	790	93.60	0	232	100.00	0	405	100.00
Oct 3	20	35,485	99.98	8	798	94.55	0	232	100.00	0	405	100.00
Oct 4	0	35,485	99.98	3	801	94.91	0	232	100.00	0	405	100.00
Oct 5	0	35,485	99.98	1	802	95.02	0	232	100.00	0	405	100.00
Oct 6	0	35,485	99.98	6	808	95.73	0	232	100.00	0	405	100.00

Appendix C. – Continued.

	Chum Salmon			Coho Salmon			Sockeye Salmon			Pink Salmon		
Date	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %
Oct 7	1	35,486	99.99	2	810	95.97	0	232	100.00	0	405	100.00
Oct 8	4	35,490	99.99	30	840	99.52	0	232	100.00	0	405	100.00
Oct 9	0	35,490	99.99	1	841	99.65	0	232	100.00	0	405	100.00
Oct 10	0	35,490	99.99	1	842	99.76	0	232	100.00	0	405	100.00
Oct 11	0	35,490	99.99	0	842	99.76	0	232	100.00	0	405	100.00
Oct 12	0	35,490	99.99	0	842	99.76	0	232	100.00	0	405	100.00
Oct 13	0	35,491	100.00	1	843	99.88	0	232	100.00	0	405	100.00
Oct 14	0	35,491	100.00	0	843	99.88	0	232	100.00	0	405	100.00
Oct 15	0	35,491	100.00	0	843	99.88	0	232	100.00	0	405	100.00
Oct 16	0	35,491	100.00	1	844	100.00	0	232	100.00	0	405	100.00
Total	35,491	35.491	100.00	844	844	100.00	232	232	100.00	405	405	100.00

Appendix D. – Daily counts, cumulative counts (Cum.), and cumulative percent (Cum. %) of chum, coho, sockeye, and pink salmon escapement through the Frosty Creek weir, 2002.

	Chum Salmon			Coho Salmon			Sockeye Salmon			Pink Salmon		
Date	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %
Jun 29	96	96	0.23	0	0	0.00	1	1	0.08	0	0	0.00
Jun 30	91	187	0.44	0	0	0.00	5	6	0.47	0	0	0.00
Jul 1	35	222	0.53	0	0	0.00	1	7	0.55	0	0	0.00
Jul 2	100	322	0.76	0	0	0.00	1	8	0.63	0	0	0.00
Jul 3	100	422	1.00	0	0	0.00	6	14	1.02	0	0	0.00
Jul 4	139	561	1.33	0	0	0.00	3	17	1.33	0	0	0.00
Jul 5	28	589	1.39	0	0	0.00	1	18	1.41	0	0	0.00
Jul 6	70	569	1.56	0	0	0.00	2	20	1.57	0	0	0.00
Jul 7	174	833	1.97	0	0	0.00	2	22	1.72	0	0	0.00
Jul 8	66	899	2.13	0	0	0.00	0	22	1.72	0	0	0.00
Jul 9	284	1,183	2.80	0	0	0.00	2	24	1.88	0	0	0.00
Jul 10	661	1,844	4.37	0	0	0.00	2	26	2.04	0	0	0.00
Jul 11	656	2,500	5.93	0	0	0.00	5	31	2.43	0	0	0.00
Jul 12	1,636	4,136	9.80	0	0	0.00	66	97	7.60	0	0	0.00
Jul 13	245	4,381	10.38	0	0	0.00	45	142	11.13	0	0	0.00
Jul 14	592	4,973	11.79	0	0	0.00	82	224	17.55	0	0	0.00
Jul 15	200	5,173	12.26	0	0	0.00	36	260	20.38	1	1	0.08
Jul 16	2	5,175	12.26	0	0	0.00	2	262	20.53	0	1	0.08
Jul 17	275	5,450	12.92	0	0	0.00	15	277	21.71	0	1	0.08
Jul 18	154	5,604	13.28	0	0	0.00	8	285	22.34	0	1	0.08
Jul 19	1,634	7,238	17.15	0	0	0.00	140	425	33.30	3	4	0.32
Jul 20	626	7,864	18.64	0	0	0.00	114	539	42.24	3	7	0.56

Appendix D. – Continued.

	Chum Salmon			Coho Salmon			Sockeye Salmon			Pink Salmon		
Date	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %
Jul 21	848	8,712	20.65	0	0	0.00	158	697	54.63	5	12	0.96
Jul 22	51	8,763	20.77	0	0	0.00	4	701	54.94	1	13	1.04
Jul 23	69	8,832	20.93	0	0	0.00	42	743	58.23	5	18	1.44
Jul 24	72	8,904	21.10	0	0	0.00	27	770	60.35	0	18	1.44
Jul 25	250	9,154	21.70	0	0	0.00	19	789	61.83	1	19	1.52
Jul 26	47	9,201	21.81	0	0	0.00	25	814	63.79	3	22	1.76
Jul 27	50	9,251	21.92	0	0	0.00	18	832	65.20	1	23	1.84
Jul 28	278	9,529	22.58	0	0	0.00	86	918	71.94	4	27	2.16
Jul 29	0	9,529	22.58	0	0	0.00	0	918	71.94	0	27	2.16
Jul 30	13	9,542	22.61	0	0	0.00	0	918	71.94	0	27	2.16
Jul 31	54	9,596	22.74	0	0	0.00	2	920	72.10	1	28	2.24
Aug 1	78	9,674	22.93	0	0	0.00	11	931	72.96	5	33	2.64
Aug 2	71	9,745	23.09	0	0	0.00	23	954	74.76	4	37	2.98
Aug 3	401	10,146	24.05	0	0	0.00	102	1,056	82.76	35	72	5.76
Aug 4	438	10,584	25.08	0	0	0.00	41	1,097	85.97	54	126	10.08
Aug 5	88	10,672	25.29	0	0	0.00	13	1,110	86.99	16	142	11.36
Aug 6	2	10,674	25.30	0	0	0.00	1	1,111	87.07	4	146	11.68
Aug 7	132	10,806	25.61	0	0	0.00	17	1,128	88.40	6	152	12.16
Aug 8	498	11,304	26.79	0	0	0.00	36	1,164	91.22	32	184	14.72
Aug 9	51	11,355	26.91	0	0	0.00	3	1,167	91.46	6	190	15.20
Aug 10	2,840	14,095	33.64	0	0	0.00	42	1,209	94.75	120	310	24.80
Aug 11	172	14,367	34.05	0	0	0.00	9	1,218	95.45	14	324	25.92
Aug 12	105	14,472	34.30	0	0	0.00	4	1,221	95.77	30	354	28.32

Appendix D. – Continued.

	Chum Salmon			Coho Salmon			Sockeye Salmon			Pink Salmon		
Date	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %
Aug 13	913	15,385	36.46	0	0	0.00	13	1,235	96.79	29	383	30.64
Aug 14	2,250	17,635	41.79	0	0	0.00	13	1,248	97.81	97	480	38.40
Aug 15	606	18,241	43.23	0	0	0.00	0	1,248	97.81	25	505	40.40
Aug 16	64	18,305	43.38	0	0	0.00	1	1,249	97.88	9	514	41.12
Aug 17	328	18,633	44.16	2	2	0.27	5	1,254	98.28	22	536	42.88
Aug 18	1,174	19,807	46.94	0	2	0.27	1	1,255	98.35	50	586	46.88
Aug 19	961	20,768	49.22	3	5	0.68	3	1,258	98.59	48	634	50.72
Aug 20	2,582	23,350	55.34	2	7	0.95	4	1,262	98.90	52	686	54.88
Aug 21	1,360	24,710	58.56	3	10	1.36	1	1,263	98.98	59	745	59.60
Aug 22	256	24,966	59.17	2	12	1.63	2	1,265	99.14	30	775	62.00
Aug 23	293	25,259	59.86	7	19	2.59	1	1,266	99.22	14	789	63.12
Aug 24	618	25,877	61.33	2	21	2.86	1	1,267	99.29	36	825	66.00
Aug 25	1,068	26,845	63.86	0	21	2.86	0	1,267	99.29	56	881	70.48
Aug 26	1,151	28,096	66.59	0	21	2.86	0	1,267	99.29	39	920	73.60
Aug 27	1,522	29,618	70.19	6	27	3.68	0	1,267	99.29	39	959	76.72
Aug 28	446	30,064	71.25	2	29	3.96	0	1,267	99.29	20	979	78.32
Aug 29	2,747	32,811	77.76	14	43	5.87	0	1,267	99.29	50	1,029	82.32
Aug 30	2,477	35,288	83.63	7	50	6.82	0	1,267	99.29	31	1,060	84.80
Aug 31	19	35,307	83.68	2	52	7.09	0	1,297	99.29	2	1,062	84.96
Sep 1	41	35,348	83.77	0	52	7.09	0	1,267	99.29	2	1,064	85.12
Sep 2	6	35,354	83.79	1	53	7.23	0	1,267	99.29	0	1,064	85.12
Sep 3	1,123	36,477	86.45	11	64	8.73	0	1,267	99.29	35	1,099	87.92

Appendix D. – Continued.

	Chum Salmon			Coho Salmon			Sockeye Salmon			Pink Salmon		
Date	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %
Sep 4	1,807	38,284	90.73	12	76	10.37	1	1,286	99.37	23	1,122	89.76
Sep 5	30	38,314	90.80	0	76	10.37	0	1,268	99.37	6	1,128	90.24
Sep 6	170	38,484	91.21	13	89	12.14	0	1,268	99.37	15	1,143	91.44
Sep 7	297	38,781	91.91	28	117	15.96	0	1,268	99.37	24	1,167	93.36
Sep 8	650	39,431	93.45	17	134	18.28	0	1,268	99.37	23	1,190	95.20
Sep 9	185	39,616	93.89	3	137	18.69	1	1,269	99.45	5	1,195	95.60
Sep 10	247	39,863	94.48	7	144	19.65	0	1,269	99.45	13	1,208	96.64
Sep 11	255	40,118	95.08	5	149	20.33	0	1,269	99.45	6	1,214	97.12
Sep 12	878	40,996	97.16	57	206	28.10	4	1,273	99.76	13	1,227	98.16
Sep 13	235	41,231	97.72	35	241	32.88	0	1,273	99.76	4	1,231	98.48
Sep 14	31	41,262	97.79	11	252	34.38	1	1,274	99.84	3	1,234	98.72
Sep 15	35	41,297	97.87	5	257	35.06	0	1,274	99.84	0	1,234	98.72
Sep 16	55	41,352	98.00	5	262	35.74	0	1,274	99.84	0	1,234	98.72
Sep 17	204	41,556	98.49	21	283	38.61	1	1,275	99.92	6	1,240	99.20
Sep 18	151	41,707	98.85	12	295	40.25	0	1,275	99.92	3	1,243	99.44
Sep 19	44	41,751	98.95	3	298	40.65	0	1,275	99.92	1	1,244	99.52
Sep 20	6	41,757	98.96	0	298	40.65	0	1,275	99.92	0	1,244	99.52
Sep 21	43	41,800	99.07	2	300	40.93	0	1,275	99.92	2	1,246	99.68
Sep 22	143	41,943	99.41	13	313	42.70	0	1,275	99.92	0	1,246	99.68
Sep 23	4	41,947	99.41	1	314	42.84	0	1,275	99.92	0	1,246	99.68
Sep 24	92	42,039	99.63	1	315	42.97	0	1,275	99.92	0	1,246	99.68
Sep 25	103	42,142	99.88	206	521	71.08	0	1,275	99.92	0	1,246	99.68

Appendix D. – Continued.

	Chum Salmon			Coho Salmon			Sockeye Salmon			Pink Salmon		
Date	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %	Daily	Cum.	Cum. %
Sep 26	23	42,165	99.93	33	554	75.58	1	1,276	100.00	2	1,248	99.84
Sep 27	5	42,170	99.94	8	562	76.67	0	1,276	100.00	0	1,248	99.84
Sep 28	3	42,173	99.50	7	569	77.62	0	1,276	100.00	1	1,249	99.92
Sep 29	0	42,173	99.50	0	569	77.62	0	1,276	100.00	0	1,249	99.92
Sep 30	0	42,173	99.50	0	569	77.62	0	1,276	100.00	0	1,249	99.92
Oct 1	2	42,175	99.95	2	571	77.90	0	1276	100.00	0	1,249	99.92
Oct 2	0	42,175	99.95	0	571	77.90	0	1,276	100.00	0	1,249	99.92
Oct 3	1	42,176	99.96	0	571	77.90	0	1,276	100.00	0	1,249	99.92
Oct 4	8	41,184	99.98	13	584	79.67	0	1,276	100.00	0	1,249	99.92
Oct 5	9	42,193	99.99	138	722	98.50	0	1,276	100.00	0	1,249	99.92
Oct 6	0	42,193	99.99	0	722	98.50	0	1,276	100.00	0	1,249	99.92
Oct 7	1	42,194	100.00	11	733	100.00	0	1,276	100.00	1	1,250	100.00
Total	42,194	42,194	100.00	733	733	100.00	1,276	1,276	100.00	1,250	1,250	100.00

Appendix E. – Daily counts, cumulative counts (Cum.), and cumulative percent (Cum. %) of Dolly Varden escapement through the Frosty Creek weir, 2000, 2001 and 2002.

	2000				2001				2002			
	Upstream			Downstream[a]	Upstream			Downstream	Upstream			Downstream
Date	Daily	Cum	Cum%	Daily	Daily	Cum	Cum%	Daily	Daily	Cum	Cum%	Daily
Jun 29	0	0	0.00	0	0	0	0.00	0	9	9	0.22	0
Jun 30	0	0	0.00	0	0	0	0.00	0	16	25	0.61	0
Jul 1	0	0	0.00	0	0	0	0.00	0	26	51	1.25	0
Jul 2	0	0	0.00	0	0	0	0.00	0	11	62	1.52	0
Jul 3	0	0	0.00	0	0	0	0.00	0	45	107	2.62	0
Jul 4	0	0	0.00	0	5	5	0.21	0	35	142	3.48	0
Jul 5	0	0	0.00	0	0	5	0.21	0	8	150	3.68	0
Jul 6	0	0	0.00	0	0	5	0.21	0	18	168	4.12	0
Jul 7	0	0	0.00	0	0	5	0.21	0	21	189	4.64	0
Jul 8	0	0	0.00	0	2	7	0.28	0	15	204	5.00	0
Jul 9	0	0	0.00	0	1	8	0.33	0	20	224	5.50	0
Jul 10	0	0	0.00	0	15	23	0.95	0	15	239	5.86	0
Jul 11	0	0	0.00	0	4	27	1.11	0	21	260	6.38	0
Jul 12	0	0	0.00	0	4	31	1.28	0	316	576	14.14	0
Jul 13	0	0	0.00	0	0	31	1.28	0	361	937	22.99	0
Jul 14	0	0	0.00	0	10	41	1.69	0	458	1,395	34.24	0
Jul 15	0	0	0.00	0	23	64	2.64	0	214	1,609	39.49	0
Jul 16	0	0	0.00	0	4	68	2.80	0	12	1,621	39.79	0
Jul 17	0	0	0.00	0	1	69	2.84	0	96	1,717	42.15	0

Appendix E. – Continued.

	2000				2001				2002			
	Upstream			Downstream[a]	Upstream			Downstream	Upstream			Downstream
Date	Daily	Cum	Cum%	Daily	Daily	Cum	Cum%	Daily	Daily	Cum	Cum%	Daily
Jul 18	0	0	0.00	0	20	89	3.66	0	33	1,750	42.95	0
Jul 19	0	0	0.00	0	56	145	5.97	0	193	1,943	47.69	0
Jul 20	0	0	0.00	0	63	208	8.57	0	89	2,032	49.87	0
Jul 21	0	0	0.00	0	44	252	10.38	0	214	2,246	55.13	0
Jul 22	0	0	0.00	0	34	286	11.78	0	191	2,437	59.81	0
Jul 23	0	0	0.00	0	18	304	12.52	0	122	2,559	62.81	0
Jul 24	0	0	0.00	0	80	384	15.82	0	96	2,655	65.16	0
Jul 25	0	0	0.00	0	36	420	17.29	0	101	2,756	67.64	0
Jul 26	0	0	0.00	0	154	574	23.64	0	28	2,784	68.34	0
Jul 27	0	0	0.00	0	171	745	30.68	0	51	2,835	69.58	0
Jul 28	3	3	0.29	0	238	979	40.32	0	57	2,892	70.98	0
Jul 29	2	5	0.48	0	21	1,000	41.19	0	9	2,901	71.20	0
Jul 30	4	9	0.86	0	160	1,160	47.78	0	6	2,907	71.35	0
Jul 31	2	11	1.05	0	104	1,264	52.06	0	18	2,925	71.79	0
Aug 1	3	14	1.33	0	100	1,364	56.18	0	25	2,950	72.41	0
Aug 2	1	15	1.42	0	58	1,422	58.56	0	45	2,995	73.51	0
Aug 3	5	20	1.90	0	3	1,425	58.69	0	101	3,096	75.99	1
Aug 4	0	20	1.90	0	53	1,478	60.87	0	128	3,224	79.14	1
Aug 5	1	21	1.99	0	29	1,507	62.07	0	56	3,280	80.51	1
Aug 6	0	21	1.99	0	30	1,537	63.30	0	38	3,318	81.44	0

Appendix E. – Continued.

	2000				2001				2002			
	Upstream			Downstream[a]	Upstream			Downstream	Upstream			Downstream
Date	Daily	Cum	Cum%	Daily	Daily	Cum	Cum%	Daily	Daily	Cum	Cum%	Daily
Aug 7	2	23	2.19	0	36	1,573	64.78	0	69	3,387	83.14	0
Aug 8	1	24	2.28	0	29	1,602	65.98	0	97	3,484	85.51	0
Aug 9	7	31	2.95	0	73	1,675	68.98	0	23	3,507	86.08	0
Aug 10	12	43	4.09	0	56	1,731	71.29	0	64	3,571	87.65	0
Aug 11	8	51	4.85	0	124	1,855	76.40	0	37	3,608	88.56	1
Aug 12	16	67	6.37	0	11	1,866	76.85	0	26	3,634	89.20	2
Aug 13	9	76	7.22	0	113	1,979	81.51	0	29	3,663	89.91	1
Aug 14	23	99	9.41	0	104	2,083	85.79	0	25	3,688	90.52	3
Aug 15	12	111	10.55	0	95	2,178	89.70	0	20	3,708	91.01	1
Aug 16	5	116	11.03	0	15	2,193	90.32	0	13	3,721	91.33	0
Aug 17	37	153	14.54	0	23	2,216	91.27	0	14	3,735	91.68	1
Aug 18	19	172	16.35	0	5	2,221	91.47	0	29	3,764	92.39	5
Aug 19	11	183	17.40	0	36	2,257	92.96	0	20	3,784	92.88	3
Aug 20	8	191	18.16	0	4	2,261	93.12	0	22	3,806	93.42	10
Aug 21	1	192	18.25	0	0	2,261	93.12	0	25	3,831	94.03	8
Aug 22	2	194	18.44	0	7	2,268	93.41	1	8	3,839	94.23	4
Aug 23	1	195	18.54	0	7	2,275	93.70	1	11	3,850	94.50	1
Aug 24	31	226	21.48	0	10	2,285	94.11	0	6	3,856	94.64	2
Aug 25	23	249	23.67	0	8	2,293	94.44	2	8	3,864	94.84	2
Aug 26	303	552	52.47	1	7	2,300	94.73	1	13	3,877	95.16	12

Appendix E. – Continued.

	2000				2001				2002			
	Upstream			Downstream[a]	Upstream			Downstream	Upstream			Downstream
Date	Daily	Cum	Cum%	Daily	Daily	Cum	Cum%	Daily	Daily	Cum	Cum%	Daily
Aug 27	28	580	55.13	0	18	2,318	95.47	0	7	3,884	95.33	3
Aug 28	54	634	60.27	0	6	2,324	95.72	0	2	3,886	95.38	6
Aug 29	8	642	61.03	1	11	2,335	96.17	0	6	3,892	95.53	6
Aug 30	8	650	61.78	0	11	2,346	96.62	0	9	3,901	95.75	6
Aug 31	62	712	67.68	1	0	2,346	96.62	0	2	3,903	95.80	0
Sep 1	28	740	70.34	0	0	2,346	96.62	0	0	3,903	95.80	0
Sep 2	14	754	71.67	0	0	2,346	96.62	0	0	3,903	95.80	0
Sep 3	13	767	72.91	0	0	2,346	96.62	0	2	3,905	95.85	8
Sep 4	26	793	75.38	0	0	2,346	96.62	1	1	3,906	95.87	1
Sep 5	10	803	76.33	0	2	2,348	96.71	0	3	3,909	95.94	0
Sep 6	35	838	79.66	3	2	2,350	96.78	0	2	3,911	95.99	0
Sep 7	23	861	81.84	0	1	2,351	96.82	0	10	3,921	96.24	0
Sep 8	9	870	82.70	1	0	2,351	96.82	0	11	3,932	96.51	3
Sep 9	6	876	83.27	0	1	2,352	96.86	0	1	3,933	96.53	1
Sep 10	11	887	84.31	0	1	2,353	96.91	0	5	3,938	96.66	2
Sep 11	2	889	84.50	0	0	2,353	96.91	0	4	3,942	96.76	2
Sep 12	3	892	84.79	0	1	2,354	96.95	0	8	3,950	96.96	1
Sep 13	5	897	85.27	0	1	2,355	96.99	0	3	3,953	97.03	3
Sep 14	2	899	85.45	0	4	2,359	97.16	0	4	3,957	97.13	1
Sep 15	0	899	85.45	0	1	2,360	97.19	0	1	3,958	97.15	2

Appendix E. – Continued.

	2000				2001				2002			
	Upstream			Downstream[a]	Upstream			Downstream	Upstream			Downstream
Date	Daily	Cum	Cum%	Daily	Daily	Cum	Cum%	Daily	Daily	Cum	Cum%	Daily
Sep 16	0	899	85.45	1	0	2,360	97.19	0	0	3,958	97.15	1
Sep 17	1	900	85.55	2	0	2,360	97.19	0	9	3,967	97.37	3
Sep 18	4	904	85.93	0	0	2,360	97.19	0	4	3,971	97.47	10
Sep 19	3	907	86.22	0	1	2,361	97.24	0	1	3,972	97.50	1
Sep 20	71	978	92.97	1	11	2,372	97.69	0	0	3,972	97.50	0
Sep 21	29	1,007	95.72	0	1	2,373	97.73	0	4	3,976	97.59	0
Sep 22	0	1,007	95.72	0	1	2,374	97.77	0	0	3,976	97.59	4
Sep 23	1	1,008	95.81	0	3	2,377	97.90	0	5	3,981	97.72	2
Sep 24	0	1,008	95.81	0	3	2,377	97.90	0	1	3,982	97.74	0
Sep 25	2	1,010	96.01	0	3	2,377	97.90	0	0	3,982	97.74	116
Sep 26	5	1,015	96.48	0	16	2,393	98.56	0	6	3,988	97.89	2
Sep 27	6	1,021	97.05	0	16	2,393	98.56	0	9	3,997	98.11	1
Sep 28	0	1,021	97.05	0	16	2,393	98.56	0	8	4,005	98.30	1
Sep 29	0	1,021	97.05	1	16	2,393	98.56	0	7	4,012	98.47	0
Sep 30	2	1,023	97.24	0	2	2,395	98.64	0	5	4,017	98.60	1
Oct 1	6	1,029	97.81	0	3	2,398	98.76	1	3	4,020	98.67	1
Oct 2	1	1,030	97.91	0	3	2,398	98.76	0	0	4,020	98.67	0
Oct 3	1	1,031	98.00	1	4	2,402	98.93	4	9	4,029	98.89	0
Oct 4	2	1,033	98.19	0	1	2,403	98.97	0	6	4,035	99.04	3
Oct 5	2	1,035	98.38	2	2	2,405	99.05	0	14	4,049	99.38	2

Appendix E. – Continued.

	2000				2001				2002			
	Upstream			Downstream[a]	Upstream			Downstream	Upstream			Downstream
Date	Daily	Cum	Cum%	Daily	Daily	Cum	Cum%	Daily	Daily	Cum	Cum%	Daily
Oct 6	3	1,038	98.67	0	2	2,407	99.14	1	14	4,063	99.73	2
Oct 7	0	1,038	98.67	2	15	2,422	99.75	2	11	4,074	100.00	2
Oct 8	0	1,038	98.67	0	5	2,427	99.96	0	0	4,074	100.00	0
Oct 9	2	1,040	98.85	34	5	2,427	99.96	0	0	4,074	100.00	0
Oct 10	3	1,043	99.14	7	5	2,427	99.96	0	0	4,074	100.00	0
Oct 11	0	1,043	99.14	15	5	2,427	99.96	0	0	4,074	100.00	0
Oct 12	0	1,043	99.14	14	5	2,427	99.96	0	0	4,074	100.00	0
Oct 13	1	1,044	99.14	68	5	2,427	99.96	0	0	4,074	100.00	0
Oct 14	2	1,046	99.43	23	5	2,427	99.96	0	0	4,074	100.00	0
Oct 15	2	1,048	99.62	3	5	2,427	99.96	0	0	4,074	100.00	0
Oct 16	0	1,048	99.62	1	0	2,428	100.00	2	0	4,074	100.00	0
Oct 17	2	1,050	99.80	2	0	2,428	100.00	0	0	4,074	100.00	0
Oct 18	0	1,050	99.80	0	0	2,428	100.00	0	0	4,074	100.00	0
Oct 19	0	1,050	99.80	10	0	2,428	100.00	0	0	4,074	100.00	0
Oct 20	1	1,051	99.90	42	0	2,428	100.00	0	0	4,074	100.00	0
Oct 21	0	1,051	99.90	32	0	2,428	100.00	0	0	4,074	100.00	0
Oct 22	1	1,052	100.00	1	0	2,428	100.00	0	0	4,074	100.00	0
Total	1,052	1,052	100.00	269	2,428	2,428	100.00	17	4,074	4,074	100.00	256

[a]Dolly Varden migrating downstream appeared to be spawned out.

Appendix F. – Public use information near the Frosty Creek weir, including date, primary and secondary activity, reason (sport or subsistence), guide status (yes or no), time (hrs/days), target species, and residence, 2000.

Date	Primary	Secondary	Reason	Guided	Group Size	Time (hrs/days)	Target Sp.	Residence
Jul 8	Fishing	Unknown	Sport	N	2	1.0 hr	? (chum)	Unknown
Aug 19	Sight See.	None	N/A	N	2	—	Bears	Cold Bay, AK
Aug 19	Hunting	None	Sport	N	2	3.0	Ptarmigan	Cold Bay/MO
Aug 26	Sight See.	None	Photo	N	2	2.0	Frosty/Weir	Unknown
Aug 27	Sight See.	None	N/A	N	1	3.0	N/A	Cold Bay, AK
Aug 28	Sight See.	Fishing	Sport	N	4	—	—	Phoenix, AZ
Aug 31	Fishing	None	Sport	N	4	2	Dolly Varden	Reno, NV
Aug 31	Fishing	None	Sport	N	1	1	?	?
Sep 4	Fishing	Hunting	Sport	N	6	?	Dolly/Ptarm.	?
Sep 4	Fishing	None	Sport	N	3	3	Dolly Varden	Holland
Sep 7	Fishing	Hunting	Sport	N?	6	?	Fish/Ptarm.	NC, FL, NJ, CA
Sep 9	Fishing	None	Sport	Y	4	3	Dolly Varden	?
Sep 11	Sight See.	Other	None	N	2	4	None	Cold Bay, AK
Sep 15	Fishing	None	Sport	N	2	2	Dolly/Coho	EauClaire, WI
Sep 17	Fishing	None	Sport	N	2	3	Dolly/Coho	EauClaire, WI
Sep 18	Fishing	None	Sport	N	2	3	Dolly/Coho	EauClaire, WI
Sep 19	Fishing	None	Sport	N	2	3	Dolly/Coho	EauClaire, WI
Sep 21	Hunting	Fishing	Sport	N	2	8	Ptarmigan	California
Sep 23	Fishing	None	Sport	N	5	1	—	Pennsylvania
Sep 25	Fishing	None	Sport	N	4	3	Dolly Varden	?
Sep 29	Hunting	Fishing	Sport	N	2	3 days	Waterfowl	Anchorage, AK
Sep 29	Hunting	None	Sport	N	3	3 days	Waterfowl	King/Kenai

Appendix F. – Continued.

Date	Primary	Secondary	Reason	Guided	Group Size	Time (hrs/days)	Target Sp.	Residence
Oct 3	Hunting	None	Sport	N	2	1	Ptarmigan	?
Oct 3	Fishing	?	Sport	N	2	1day	Coho/Other	?
Oct 3	Fishing	?	Sport	N	2	2 days	Coho/Other	?
Oct 9	Hunting	None	Sport	N	4	4	Waterfowl	?
Oct 10	Hunting	None	Sport	N	1	2	Ptarmigan	?
Oct 12	Hunting	None	Sport	N	?	?	Ptarmigan	?
Oct 15	Hunting	None	Sport	N	4	2	Ptarmigan	?
Oct 15	Hunting	None	Sport	N	2	6	Ptarmigan	?
Oct 22	Hunting	None	Sport	N	3	1.0	Ptarmigan	?

Appendix G. – Numbers of chum, sockeye, pink and coho salmon observed during walking surveys from the weir downstream to the mouth of Frosty Creek, 2000.

Date	Chum	Sockeye	Pink	Coho
July 8, 2000	694	0	0	0
July 16, 2000	2,322	1	0	0
July 22, 2000	3,396	11	146	0
July 31, 2000	2,004	44	17	0
Aug. 9, 2000	3,030	76	27	0
Aug. 17, 2000	3,060	44	93	0
Aug. 24, 2000	5,459	0	0	0
Sep. 4, 2000	6,223	0	0	84
Sep. 14, 2000	2,863	0	0	520
Sep. 24, 2000	397	0	0	766
Oct. 2, 2000	101	0	0	502
Oct. 19, 2000	2	0	0	544
TOTALS	29,551	176	283	2,416