STUDY 2.

SUMMER DISTRIBUTION AND ABUNDANCE OF JUVENILE SALMONIDS IN THE SITUK RIVER

Rationale

Many juvenile salmonids rear in the flood zone. To determine the impacts of flooding on the salmonid stocks of the Situk River, the summer abundance and distribution of juveniles in the Situk River watershed needs to be determined.

Objectives

The objectives of this study were to determine distribution and abundance of juvenile salmonids inside and outside the flood zone of the Situk River.

Summary of Results

About 70% of the total juvenile salmonids in the Situk and Lost Rivers (excluding lakes) reared in the predicted flood zone in summers 1987-89: over 90% of sockeye, chinook, and Dolly Varden; 70% of coho; and 45% of steelhead. Coho salmon were the most abundant salmonid and were present in all study reaches, whereas chinook were present almost exclusively in the main-stem Situk River. Sockeye salmon were the least abundant and were primarily in the Old Situk River. Steelhead trout occurred in about 75% of the study reaches—40% reared in the West Fork. Dolly Varden were the second most abundant salmonid—about 90% reared in the Old Situk River.

METHODS

A stratified sampling design based on the USFS Channel Type Classification System (CTCS; Paustian 1992) was used to estimate fish populations in most areas of the Situk and Lost Rivers and partition fish populations between areas inside and outside the flood zone.

The CTCS defines "channel types" based on physical attributes, such as channel gradient, streambank incision and containment, and riparian plants. Channel types are grouped into "fluvial process groups" according to hydrologic, geomorphic, geologic, glacial, and tidal influences on fluvial erosion and deposition. Channel types are designated by a number preceded by two letters abbreviating the process group (e.g., FP3 for one type of floodplain channel). Phases of channel types are sometimes recognized, based on riparian vegetation, geomorphology, and other features, and are identified with a lower-case suffix (e.g., FP3a).

Most stream channels in the study area were of seven channel types: four floodplain channels (FP1, FP3, FP4, and FP5), two palustrian channels (PA1 and PA3), and one estuarine channel (ES4) (Fig. 2.1-2.7; Table 2.1). Two phases of the FP3, FP4, and FP5 channels were present but phases were combined for analysis. Because of the short lengths of ES4 channel, it was combined with the FP5 (river main stem) in the Situk River and with the FP1 (uplifted main-stem beach channel) in the Lost River for analysis.

Study sites were located in the Situk River, Lost River, Kunayosh Creek, and Seal Creek drainages (Fig. 2.1). A total of 47 sites were sampled but because of difficult logistics, only three sites were in Kunayosh and Seal Creeks, and these were not included in the analysis. The only riverine areas in the Situk and Lost Rivers not sampled were Mountain Stream (6 km long), and about 4 km of PA2 channel type in Tawah Creek. No lakes were sampled. Study sites in the Situk and Lost Rivers were selected to give a representative sample of habitat inside and outside the flood zone. Sites were sampled in random order to eliminate temporal bias. In each channel type we sampled five to seven reaches, each about 10 stream widths long. Each study site was sampled once during three summers from 1987 to 1989.

Habitat characteristics were measured in each study site mostly by methods described in Johnson and Heifetz (1985). Stream width, water velocity, and proportions of pools, riffles, and glides were measured for all channel types. LWD was counted and classified according to methods for verifying channel types (USFS 1990). Differences between channel types were tested with analysis of variance.

In all channel types except FP5, fish numbers were determined by the Petersen mark-recapture method (Ricker 1975). Study reaches were enclosed by blocking the upper and lower ends with seines. Fish for marking were collected with minnow traps baited with salmon roe, and after fish were removed from traps, more were collected with electroshocker and seine. This gear combination captured most fish species and sizes; however, steelhead fry were difficult to capture and their numbers were not estimated except in the channel edges of the FP5 channel type. Fish were marked by clipping a tip of the caudal fin and released. Following procedures of Peterson and Cederholm (1984), we waited 1 h before attempting recapture with electroshocker and seine. Estimated fish number was calculated from the formula

$$\hat{N} = \frac{(M+1)(C+1)}{(R+1)}, \tag{1}$$

where $\hat{N}$ is estimated fish number, M is the number of marked fish released, C is the number of fish examined for marks in the recapture sample, and R is the number of marked fish recaptured (Ricker 1975). Fish density was estimated by dividing $\hat{N}$ by the reach area.

In FP5 channels (main-stem Situk River), because of the large size of the stream, we estimated fish populations in individual habitat types instead of the stream reaches used for habitat measurements. We sampled three principal types of habitat: channel edges without cover (Fig. 2.8), willow edges (main-channel edge with dense overhanging vegetation and submerged roots) (Fig. 2.9), and debris pools (pools containing LWD) (Fig. 2.10). Other habitat in FP5 channels was mostly main-channel thalweg little utilized by rearing salmonids.

Because habitat types could not be isolated with block nets, we used the removal method (Zippin 1958) with repeated seining and trapping to estimate fish numbers within habitat types. At each channel-edge site, three separate 20-m sections, 50 m apart, were seined with a net (5.4 m long, 1.5 m deep, 6-mm mesh, with a pole at each end) pulled against the current parallel to shore (Fig. 2.11). Three passes with the pole seine were usually made per channel edge; if no fish were captured the first pass, no further seining was done. At each willow-edge site, a single section, 21-134 m long, was sampled with baited minnow traps set 3 m apart. At each pool site, a single pool, 195-735 m^2 was sampled with baited minnow traps set 3 m apart. The first trap was set 3 m upstream of the lower boundary to minimize attracting fish from downstream. Traps were fished three to five times for 30-50 minutes each time, depending on habitat size. Boundaries of the habitats were not blocked. We assumed immigration and emigration were negligible and probability of capture was constant during sampling.

For the removal population estimates, the maximum likelihood method (Saila et al. 1988) was used to estimate fish number ($\hat{N}$) and probability of capture ($\hat{q}$). Total catch was used instead of $\hat{N}$ if $\hat{q}$ was less than 0.20. Fish density in each habitat was computed by dividing the population estimate by the area sampled. Area of channel edges sampled was 74 m^2 at each seined section. Area of willow edge sampled was calculated from the average width of overhanging vegetation (measured at 3-m transects) times length (measured from the uppermost trap to 3 m downstream of the lowermost trap). Because fish were concentrated near LWD within pools, area of pools was measured as the length and width of the part of the pool containing LWD. At each habitat, water depth was measured at one-quarter, one-half, and three-quarters the distance across each transect and water velocity was measured at the same distance across the lower, middle, and upper transect.

At each study site, a random sample of fish of each species was scaled for ageing. Numbers of the different age groups of fish were not estimated separately.

The total number of juvenile salmonids in the Situk and Lost Rivers was estimated by extrapolating mean fish densities from the study sites to the total area of each channel type. All stream channels were typed and mapped on a U.S. Geological Survey topographic map (1:63,360) by the USFS, and length of each channel type was estimated with a measuring wheel. For each channel type except FP5, total number of fish ($\hat{N}_T$) was calculated by multiplying total area of the channel type (calculated from total length of the channel type times mean width of the study reaches) times the mean fish density in the study reaches. For the FP5 channel type, $\hat{N}_T$ was calculated by multiplying mean fish density in the study habitats times the total area of channel edge, willow edge, and pool habitats. These habitats were marked on aerial photos (1:15,840) during a boat survey of 80% of the FP5 channel type, and area of each was measured on the photos with calipers. The habitat area in the unsurveyed portion was extrapolated based on the area in the survey portion. Width of the FP5 channel type was measured at five locations during the survey. Total numbers of fish inside the flood zone was calculated by multiplying each channel type's $\hat{N}_T$ by the proportion of the channel type's length that was inside the flood zone, then summing for all channel types.

Variance of $\hat{N}_T$ for each channel type was estimated by the bootstrap method (Efron and Tibshirani 1986) with 1,000 replications. Each bootstrap replication for channel types other than FP5 involved randomly drawing from the study reaches (with replacement) a number of reaches equal to actual sample size (a reach could appear in a bootstrap replication more than once or not at all). For the FP5 channel type, each bootstrap replication involved randomly drawing from the study habitats (with replacement) 12 channel edge, 6 willow edge, and 6 debris pool sites (the actual sample sizes). The random drawing of sites accounted for variance between sites. For each site drawn, bootstrap statistics (denoted by asterisks) were calculated to account for variance in population estimates within sites.

To estimate variance of Petersen population estimates, we calculated fish number from the formula

$$\hat{N}^* = \frac{(M+1)(C+1)}{(R^*+1)}, \quad (2)$$

where $\hat{N}^*$ is the bootstrap population estimate, M is the number of marked fish released, C is the number of fish examined for marks in the recapture sample, and R^* is the bootstrap number of marked fish recaptured. R^* was resampled from the binomial ($\hat{N}$, $C/\hat{N}$). A bootstrap fish density was then calculated by dividing $\hat{N}^*$ by the area of the study reach. Average fish density in the bootstrap reaches was then multiplied by the total area of the channel type to obtain a bootstrap estimate of total fish number for the entire channel type ($\hat{N}_T$*).

To estimate variance of removal estimates in the three habitat types in the FP5 channels, we calculated bootstrap population estimates by Zippin's (1958) formula:

$$\hat{N}^* = \frac{T^*}{1-(1-\hat{q})^k} \; ; \qquad (3)$$

$\hat{N}$* is the bootstrap population estimate, T* is bootstrap total catch in all removals, $\hat{q}$ is probability of capture, and k is the number of removals (seine passes or trap sets). T* was calculated as

$$T^* = \sum_{i=1}^{k} U_i^* \, , \qquad (4)$$

where U^*_i is the bootstrap number of fish caught in removal i of k removals. For each habitat in the bootstrap sample, U^*_i was resampled k times from the binomial distribution (N^*_i, $\hat{q}$), where

$$N_i^* = \hat{N} - \sum_{i=1}^{k} U_{i-1}^* \qquad (5)$$

and

$$U_0^* = 0 \; . \qquad (6)$$

The bootstrap estimates $\hat{N}$* were then converted to densities by dividing by the habitat area sampled. Average density within a habitat type was multiplied by the total area of each habitat in the FP5 channel type and summed for the three habitat types to estimate $\hat{N}_T$* for the FP5 channel type.

Variance of the 1,000 bootstrap $\hat{N}_T$* for each channel type was used to estimate variance for the channel type's population estimate $\hat{N}_T$. This variance was multiplied by the proportion of the channel type's length that was inside the flood zone to obtain variance for the estimated populations rearing inside the flood zone. The variance estimates for all channel types were summed to obtain variance for total populations.

RESULTS

In summer, most fish of each species reared in one or two channel types and 70% reared in the flood zone (Tables 2.2, 2.3). Percentage of fish rearing in the flood zone was lower in the Lost River (59%) than in the Situk River watershed (72%). FP4 and PA3 channel types had the highest overall fish densities, and the FP1 channel type had the lowest density (Fig. 2.12; Appendix 2). The FP5 channel type, because of its large size, had the greatest number of fish (about 2 million, 40% of total), and the FP1 channel type had the fewest (139,000, 3% of total).

The total population estimate of coho was over twice as accurate as for the other species (Table 2.3). The total estimate of coho inside and outside the flood zone was ± 16%, whereas estimates for the other species ranged from ± 34% for steelhead to ± 46% for sockeye.

Coho salmon were present in all study reaches (Fig. 2.13) and were the most abundant salmonid, comprising 78% of the estimated population of all salmonids. Nearly 3 million coho (68% of the total coho population) reared in the flood zone (Tables 2.2, 2.3); 46% were in the FP5 channel type which makes up 54% of the stream area in the flood zone. Within each habitat type of the FP5 channel type, coho were the most abundant fish (mean, 519/100 m^2); coho density was greatest in willow edges (Table 2.4). Among all channel types, coho density was greatest in the PA3 channel type and least in the FP1 channel type (Fig. 2.12). The proportion of fry in the total coho catch was consistent between channel types, ranging from 36 to 100% and averaging about 80%.

Sockeye salmon were the least abundant salmonid (2% of the estimated population of all fish) and occurred in only about one-half the study reaches (Fig. 2.14). Of the sockeye that reared in the flood zone (88% of the total estimated sockeye population), 96% reared in PA3 and FP4 channels in Old Situk River (Table 2.3). Sockeye were the least abundant (mean, <1/100 m^2) fish in the FP5 channel type (Table 2.4). Most (81%) sockeye were fry.

Chinook salmon made up about 5% of the estimated total juvenile salmonid population (Table 2.3) and occurred almost exclusively in the Situk River main stem (FP5 channel type) (Fig. 2.15). Mean density of chinook in the habitat types of the FP5 channel type was 69/100 m^2 and was greatest in willow edges (Table 2.4). In other channel types, chinook were in only four reaches and their densities were low (mean, <1/100 m^2). About 176,000 chinook, 72% of the estimated total number in the Situk River watershed, reared in the flood zone (Tables 2.2, 2.3). No chinook were captured in the Lost River watershed. All chinook were fry.

Steelhead trout occurred in about 75% of the study reaches (Fig. 2.16) in all channel types except PA3 and made up 3% of the total estimated fish population (Table 2.3). About 40% of the total steelhead parr population was in the West Fork (FP4); density was 58 fish/100 m^2. Steelhead were present in all habitat types in the FP5 channel type but were most abundant (mean, 32/100 m^2) in willow edges (Table 2.4). A total of 45% of the estimated total steelhead population reared in the flood zone (Tables 2.2, 2.3).

Dolly Varden occurred in all but eight reaches (Fig. 2.17) and made up about 12% of the total estimated fish population (Table 2.3). Highest density was in the FP4 channel type of the Old Situk River (mean, 322/100 m^2) and was at least twelve times greater than in any other channel type (Fig. 2.12). In the FP5 channel type, Dolly Varden were most abundant in debris pools (mean, 17/100 m^2) and least abundant in channel edges (mean, <1/100 m^2) (Table 2.4). Of the 90% of the estimated total Dolly Varden population that reared in the flood zone (Tables 2.2, 2.3), 88% reared in Old Situk River. Age structure of Dolly Varden was not determined.

Channel types differed in habitat characteristics (Table 2.5; Appendix 3). Channel width differed significantly ($P < 0.001$; ANOVA) among channel types; FP5 channels were the widest, and PA1 channels were the narrowest. Discharge differed significantly ($P < 0.001$; ANOVA) among channel types; discharge was highest in FP5 channels and lowest in PA3 channels. LWD was most abundant (mean, 11.6 pieces/100 m^2) in FP5 channels and least abundant (means, 0.6 and 1.1 pieces/100 m^2, respectively) in PA3 and PA1 channels and differed significantly between channel types ($P < 0.07$; ANOVA). The scarcity of LWD in the PA channels was probably because of the lack of spruce or hemlock trees within their riparian zones. Percentage of pool habitat differed significantly ($P < 0.001$; ANOVA) between channel types; PA channels had the highest percentage of pools primarily because of low (<0.5%) gradient, and FP5 channels had the smallest percentage of pools. Most PA channels, because of the lack of LWD, had homogeneous habitat consisting of low velocity water with little variation in depth. Although PA channels had the lowest gradient, all channels had low gradient, usually less than 1%, reflecting the flat topography of the Yakutat Forelands. Depth differed significantly ($P > 0.07$; ANOVA) among channel types.

Most (57% of length and 69% of area) of the study area is within the flood zone (Table 2.6). The percentage of stream length of each channel that is in the flood zone ranges from 35% for the PA1 channel type to 100% for the PA3 channel type. All FP1 channel type is within the Lost River watershed, and all FP4 and FP5 channel types are within the Situk River watershed.

DISCUSSION

Estimates of the total number of juvenile salmonids rearing in the study area is plausible except for chinook. The estimated total number of chinook that reared in summer was high based on smolt production (Study 7) and average adult returns (Study 1). The high estimate was probably because more than 90% of chinook migrate from the Situk River as ocean-type fish. Most chinook rear their first 2-3 months in the upper 10 km of the Situk River and then begin a slow migration to the lower river before migrating to sea in late July and early August (Studies 4 and 7). Because of logistical difficulty in accessing the upper main-stem Situk River, sampling of the main stem was limited to the lower three-quarters of the river. When the main stem was sampled, most chinook had migrated from the upper river; therefore, estimates of chinook densities were disproportionately high, and the estimate of the total number of chinook in the main stem was skewed.

The fish population estimates had relatively wide confidence limits for all species. This is reasonable considering that study sites were sampled during a three month period in three different summers. Juvenile fish density changes annually and seasonally based on the number and success of spawning adults, the effects of protracted emergence of fry, mortality, migration, and environmental conditions. Escapement of adults to the Situk River was relatively constant during the study but egg survival is unknown. Coho fry emergence begins in April and continues for several months (Study 1). Chinook migrate from upriver rearing habitat to the lower river in summer; thus, depending on the location and time of sampling, density of chinook could vary drastically.

Because most of the population of each species reared in specific channel types, flooding will affect each species differently. Flooding will inundate the entire Old Situk River and thus, in summer, affect the rearing habitat of most Dolly Varden and riverine sockeye, whereas West Fork is upstream of the flood zone and will provide refuge for many rearing steelhead. Nearly all chinook rear in the main-stem Situk River both inside and outside the flood zone (Study 4). Coho flourish throughout the Situk and Lost River watersheds, especially in PA channels which are predominately in the flood zone.

Coho density in the Situk River was much higher than reported for other rivers in Southeast Alaska. Mean coho densities in FP3, FP4, and FP5 channel types in the Situk River ranged from 176 to 278 fish/100 m^2 but ranged from only 8 to 35 fish/100 m^2 in other streams in Southeast Alaska[11] (Table H.1). In the FP4 channel type of Porcupine Creek (Murphy et al. 1984), coho densities ranged from 27 to 76 fish/100 m^2; in a combination of six FP3 and FP4 channels throughout Southeast Alaska (Murphy et al. 1986), coho densities in streams in old-growth and logged watersheds ranged from 75 to 178 fish/100 m^2.

Dolly Varden density in the Situk River was similar to other streams in Southeast Alaska. For 37 streams in Southeast Alaska[11], mean Dolly Varden densities in FP3, FP4, and FP5 channel types were 34, 29, and 19 fish/100 m^2 compared to mean densities of 17, 170, and 1 fish/100 m^2 in the Situk River.

Most juveniles, with the exception of sockeye, rear within the study area. Most sockeye in the Situk River watershed rear in Situk, Mountain, and Redfield Lakes[12] and in the Lost River watershed rear in Summit Lake. Coho, steelhead, chinook, and Dolly Varden, however, generally prefer riverine habitat, thus, few fish of these species probably rear in the lakes. Results of this study are therefore relevant to all juveniles except lake-type sockeye.

Table 2.1—Characteristics of channel types in the Situk River and adjacent watersheds as defined by the Channel Type Classification System (adapted from Paustian 1992).

Channel type	Stream gradient (%)	Incision depth (m)	Bank-full width (m)	Bank-full depth (cm)	Dominant substrate	Riparian vegetation	Adjacent[a] landform
FP1f[b]	0.5-1	<2	12-23	60-90	Sand and fine gravel	Alder/willow, Sitka spruce/ Devils club	Glacial outwash floodplain Forested
FP1s[c]	<0.5	<2	11-22	100-160	Sand and fine gravel	Alder/willow, willow/sedge	Beach and dune landforms Non-forested
FP3f	1	1	4-7	30-40	Sand and fine gravel	Sitka spruce/devil's club Sitka spruce/*Vaccinium*/devil's club	Forested flat lowland Floodplain
FP3s	1	1	4-7	30-40	Sand and fine gravel	Alder/salmonberry Alder/willow	Non-forested flat lowland Floodplain
FP4f	0.5-1.5	0.3-2	12-23	60-90	Gravel and cobble	Sitka spruce/cottonwood/willow Sitka spruce/devil's club/*Vaccinium*	Glacial outwash floodplain Forested
FP4s	<0.5	0.3-2	12-23	60-90	Sand and gravel	Willow/sedge, alder/willow, and cottonwood/alder	Glacial outwash floodplain Non-forested
FP5f	0.5-1	<2	21-34	60-90	Gravel	Sitka spruce/cottonwood/alder/ devil's club, cottonwood/alder	Glacial outwash floodplain Forested
FP5s	0.5-1	<2	21-34	60-90	Sand and gravel	Alder/willow/salmonberry *Myrica gale*/willow	Glacial outwash floodplain Non-forested
PA1	<0.5	<1	3-4.5	40-70	Silt, sand, fine organics	*Equisetum*/sedge, willow/sedge *Myrica gale*/willow	Glacial outwash plain Non-forested
PA3	<0.5	<1	7-14	60-80	Organics, sand, and silt	*Equisetum*/sedge, willow/sedge Willow/alder, Sitka spruce, Cottonwood	Braided glacial outwash plain, cut-off slough

[a]Glacial outwash floodplain refers to channels created by past glaciers.

[b]Foreland outwash forested phase.

[c]Foreland outwash shrub phase.

Table 2.2—Percentage of juveniles that rear inside and outside the predicted flood zone of the Situk and Lost Rivers in summer. Values do not include Situk, Mountain, and Redfield Lakes and Mountain stream in the Situk River watershed, and Tawah Creek watershed upstream of the predicted flood zone in the Lost River watershed.

	Coho	Sockeye	Chinook	Steelhead	Dolly Varden
			Situk River		
% Inside	69	89	72	37	92
% Outside	31	11	28	63	8
			Lost River		
% Inside	59	55	0	58	52
% Outside	41	45	0	42	48
			Situk and Lost Rivers		
% Inside	68	88	72	45	90
% Outside	32	12	28	55	10

Table 2.3—Comparison of estimated number of juvenile salmonids by channel type rearing inside and outside the flood zone of the Situk and Lost Rivers in summer (80% confidence intervals are in parentheses).

	Inside flood zone		Outside flood zone		Total	
	$\hat{N}$	80% CI	$\hat{N}$	80% CI	$\hat{N}$	80% CI
			Coho			
FP1	104,355	(82,262-126,448)	30,071	(18,211-41,931)	134,426	(109,351-159,501)
FP3	235,707	(175,867-295,547)	169,762	(118,978-220,546)	405,469	(326,985-483,953)
FP4	268,502	(107,403-429,601)	300,113	(129,794-470,432)	568,615	(334,177-803,053)
FP5	1,293,468	(927,233-1,659,704)	503,016	(274,627-731,404)	1,796,484	(1,364,871-2,228,097)
PA1	176,211	(47,255-305,167)	324,579	(149,561-499,597)	500,790	(283,394-718,186)
PA3	707,733	(322,678-1,092,788)	0	(0-0)	707,733	(322,678-1,092,788)
TOTAL	2,785,976	(2,212,350-3,359,603)	1,327,541	(989,132-1,665,949)	4,113,517	(3,447,508-4,779,526)
			Sockeye			
FP1	509	(120-898)	147	(0-356)	656	(214-1,098)
FP3	466	(0-1,062)	143	(0-473)	609	(0-1,290)
FP4	34,159	(14,860-53,458)	8,291	(0-17,799)	42,450	(20,936-63,964)
FP5	530	(157-903)	206	(0-439)	736	(297-1,175)
PA1	1,508	(0-3,558)	2,907	(61-5,753)	4,415	(908-7,922)
PA3	48,071	(9,726-86,416)	0	(0-0)	48,071	(9,726-86,416)
TOTAL	85,243	(42,258-128,227)	11,694	(1,759-21,629)	96,937	(52,819-141,055)
			Chinook			
FP1	0	(0-0)	0	(0-0)	0	(0-0)
FP3	174	(63-285)	11	(0-39)	185	(71-299)
FP4	16	(0-119)	77	(0-304)	93	(0-342)
FP5	176,263	(101,867-250,659)	68,547	(22,153-114,941)	244,810	(157,133-332,487)
PA1	268	(0-1,057)	498	(0-1,574)	766	(0-2,100)
PA3	0	(0-0)	0	(0-0)	0	(0-0)
TOTAL	176,721	(102,321-251,122)	69,133	(22,726-115,540)	245,854	(158,167-333,541)
			Steelhead			
FP1	2,969	(0-5,955)	857	(0-2,461)	3,826	(436-7,216)
FP3	5,056	(0-13,617)	4,550	(0-12,672)	9,606	(0-21,407)
FP4	10,168	(0-28,113)	44,711	(7,082-82,340)	54,879	(13,190-96,568)
FP5	38,596	(27,720-49,473)	15,010	(8,227-21,793)	53,606	(40,788-66,424)
PA1	5,642	(0-12,356)	10,392	(1,281-19,503)	16,034	(4,716-27,352)
PA3	0	(0-0)	0	(0-0)	0	(0-0)
TOTAL	62,431	(38,607-86,256)	75,520	(35,351-115,689)	137,951	(91,248-184,654)
			Dolly Varden			
FP1	34	(0-97)	10	(0-44)	44	(0-115)
FP3	15,304	(0-37,905)	15,515	(0-38,272)	30,819	(0-62,892)
FP4	511,584	(238,658-784,510)	14,025	(0-59,215)	525,609	(248,967-802,251)
FP5	17,034	(11,247-22,822)	6,625	(3,015-10,234)	23,659	(16,838-30,480)
PA1	17,304	(0-38,279)	31,874	(3,406-60,342)	49,178	(13,817-84,539)
PA3	24,562	(4,819-44,305)	0	(0-0)	24,562	(4,819-44,305)
TOTAL	585,822	(310,391-861,254)	68,049	(9,882-126,216)	653,871	(372,364-935,378)

Table 2.4—Mean density (no./100 m^2) of salmonids in three habitat types of the FP5 channel type in the Situk River. Standard error is in parentheses.

	Channel edge	Willow edge	Debris pool
Coho	161 (424)	986 (559)	766 (789)
Sockeye	1 (2)	<1 (<1)	<1 (<1)
Chinook	<1 (<1)	134 (124)	114 (158)
Steelhead	<1 (<1)	32 (19)	24 (13)
Dolly Varden	<1 (<1)	10 (9)	17 (26)

Table 2.5—Mean physical characteristics of channel types and habitat types in the FP5 channel type in the Situk and Lost Rivers, 1987-89. Ranges are in parentheses.

	FP1	FP3	FP4	FP5	FP5			PA1	PA3
					Debris pool	Willow edge	Channel edge		
No. Sites	5	7	6	4	6	6	12	7	5
Discharge (m^3/s)	0.59 (0.46-0.72)	0.15 (0.01-0.60)	0.56 (0.29-1.69)	2.8 (1.9-5.7)	1.47 (0.14-5.41)	1.44 (0.16-6.02)	0.11 (0.08-0.14)	0.06 (0.01-0.33)	0.04 (0.01-0.15)
% Pool	34.1 (0.0-61.9)	50.3 (31.2-95.2)	50.2 (25.4-66.6)	13.9 (7.4-25.9)	100 (100.0-100.0)	33.3 (0.0-100.0)	20.8 (0.0-33.3)	79.8 (8.1-100.0)	98.7 (96.3-100.0)
Average width (m)	10.14 (5.3-14.6)	5.43 (2.4-8.6)	14.6 (7.4-22.4)	28.3 (22.8-32.5)	6.7 (4.8-9.8)	4.0 (3.1-5.9)	3.7 (3.7-3.7)	2.6 (1.3-4.2)	9.4 (3.6-15.2)
Average depth (cm)	45.1 (28.5-59.2)	25.3 (9.2-48.2)	29.4 (17.9-41.0)	35.6 (30.7-47.2)	92.6 (46.0-153.0)	97.2 (62.0-125.8)	29.8 (26.3-35.7)	30.6 (14.2-49.7)	30.1 (11.3-61.8)
LWD* (No./100 m)	4.3 (0.0-18.8)	9.1 (0.0-26.8)	7.5 (0.0-28.7)	11.6 (2.5-30.9)	65.8 (20.0-142.7)	0.12 (0.0-0.7)	2.5 (0.0-5.0)	1.1 (0.0-3.9)	0.6 (0.0-2.7)

*Large woody debris >1 m long and >10 cm diameter.

Table 2.6—Length and area of each channel type inside and outside the predicted flood zone of the Situk and Lost River watersheds. Values do not include Situk, Mountain, and Redfield Lakes and Mountain Stream in the Situk River watershed, and the Tawah Creek watershed upstream of the predicted flood zone in the Lost River watershed.

	Inside flood zone		Outside flood zone	
Channel type	Length (m)	Area (m^2)	Length (m)	Area (m^2)
		Situk River		
FP3	12,878	70,854	12,229	55,583
FP4	8,528[a]	158,877	7,401[b]	77,488
FP5	24,336	689,682	9,654	273,594
PA1	4,830	12,558	23,667	61,534
PA3	18,664	175,442	0	0
		Lost River		
FP1	8,367	84,841	2,415	24,488
FP3	7,244	39,879	3,620	19,958
PA1	19,549	50,827	21,239	55,221

[a]Old Situk River.

[b]West Fork.

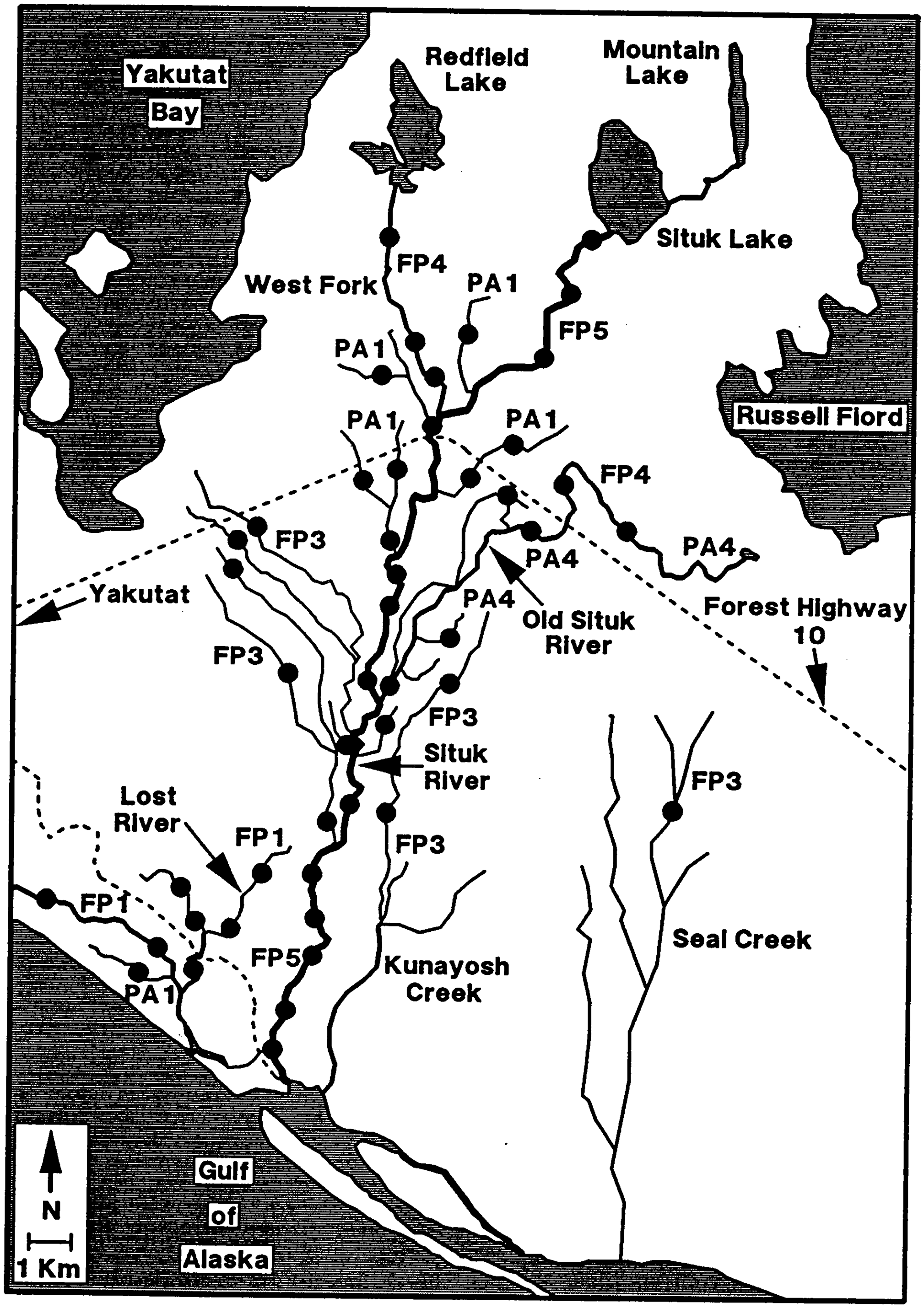

Figure 2.1—Location of study sites (solid circle) and channel types (two capital letters followed by a number) on Situk River and adjacent watersheds.

Figure 2.2—FP1 channel type on the Lost River.

Figure 2.3—FP3 channel type in the Situk River watershed.

Figure 2.4—FP4 channel type in the Situk River watershed.

Figure 2.5—FP5 channel type in the main-stem Situk River.

Figure 2.6—PA1 channel type in the Situk River watershed.

Figure 2.7—PA3 channel type in Old Situk River.

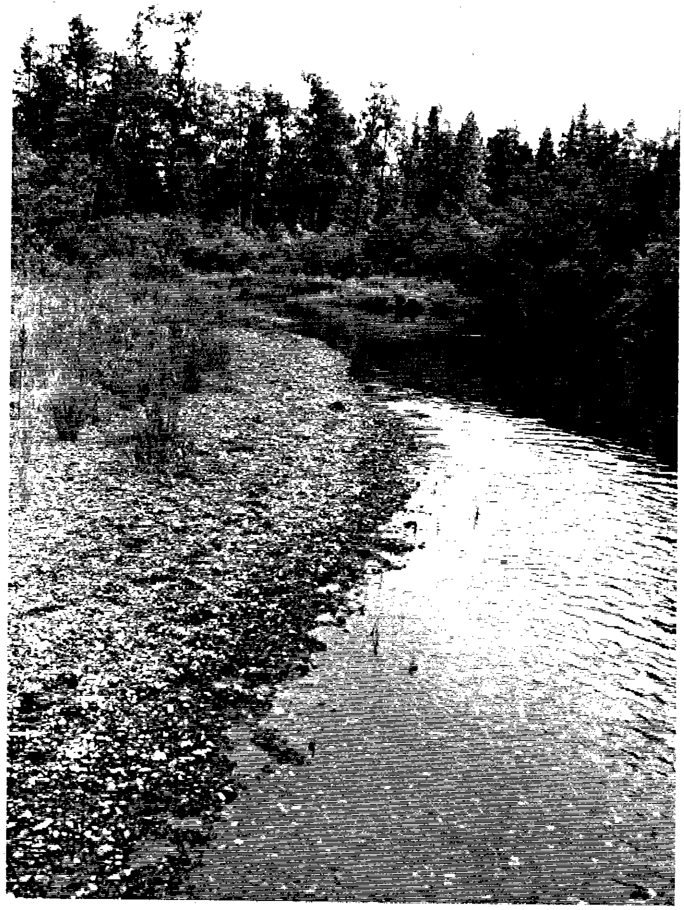

Figure 2.8—Channel edge habitat on the main-stem Situk River.

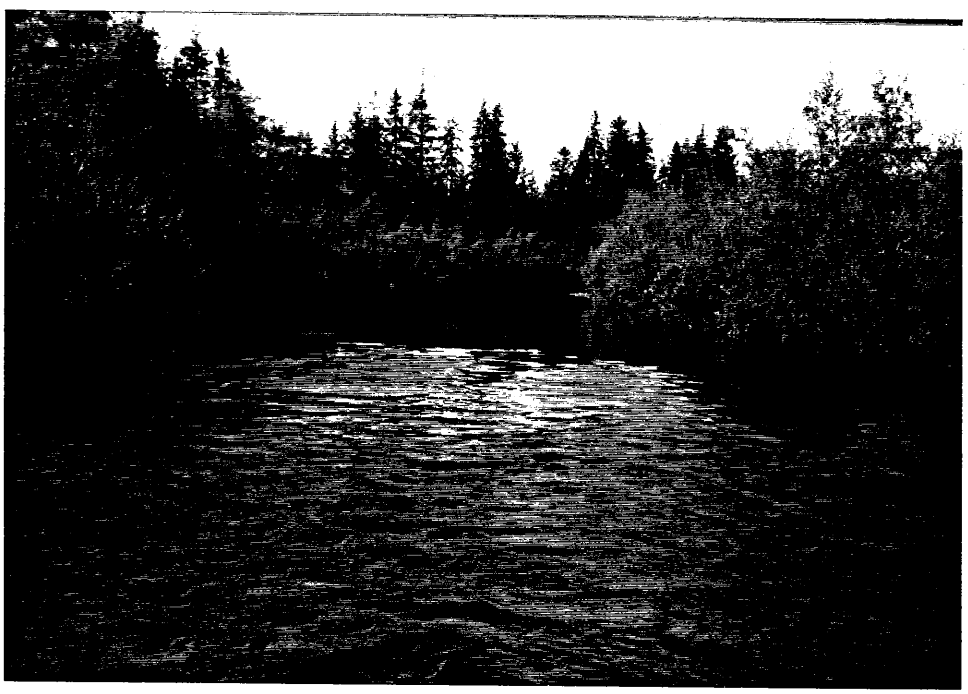

Figure 2.9—Willow edge habitat on the main-stem Situk River.

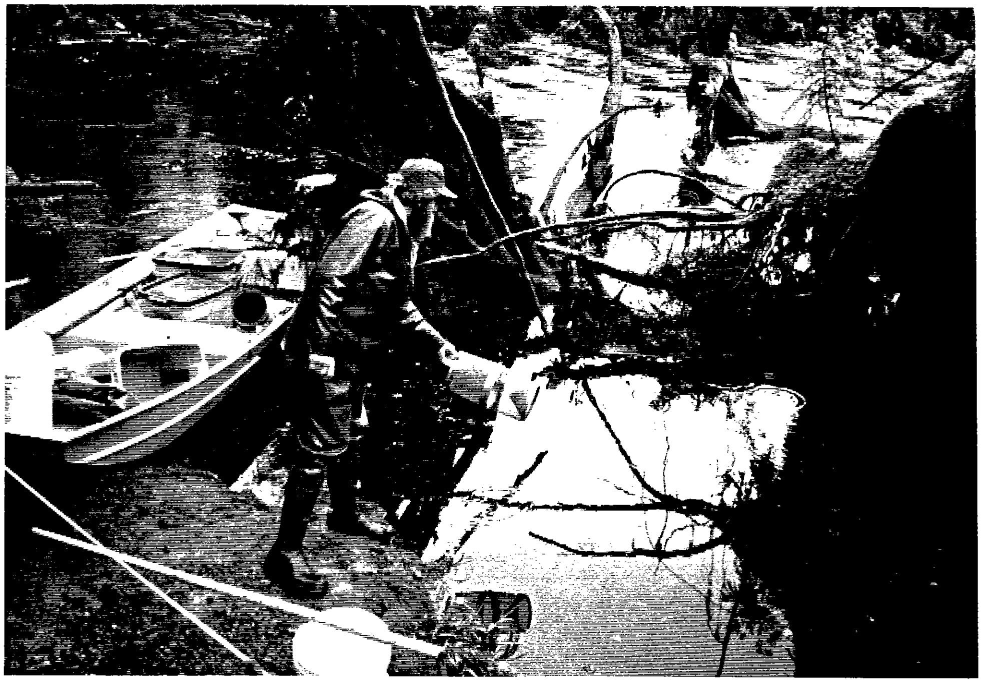

Figure 2.10—Debris pool habitat on the main-stem Situk River.

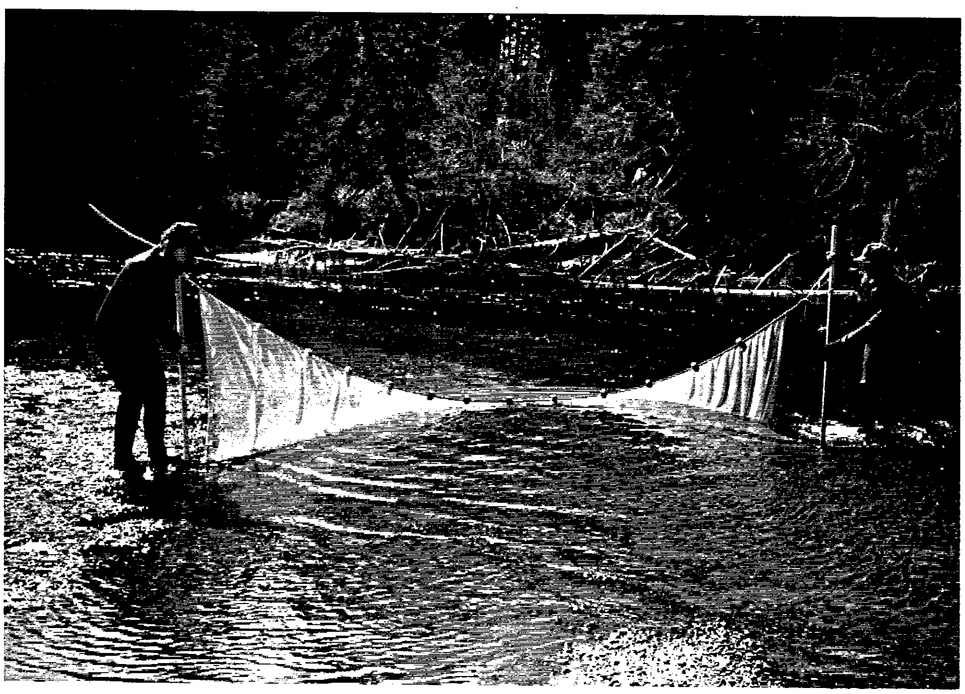

Figure 2.11—Sampling a channel edge with a pole seine on the main-stem Situk River.

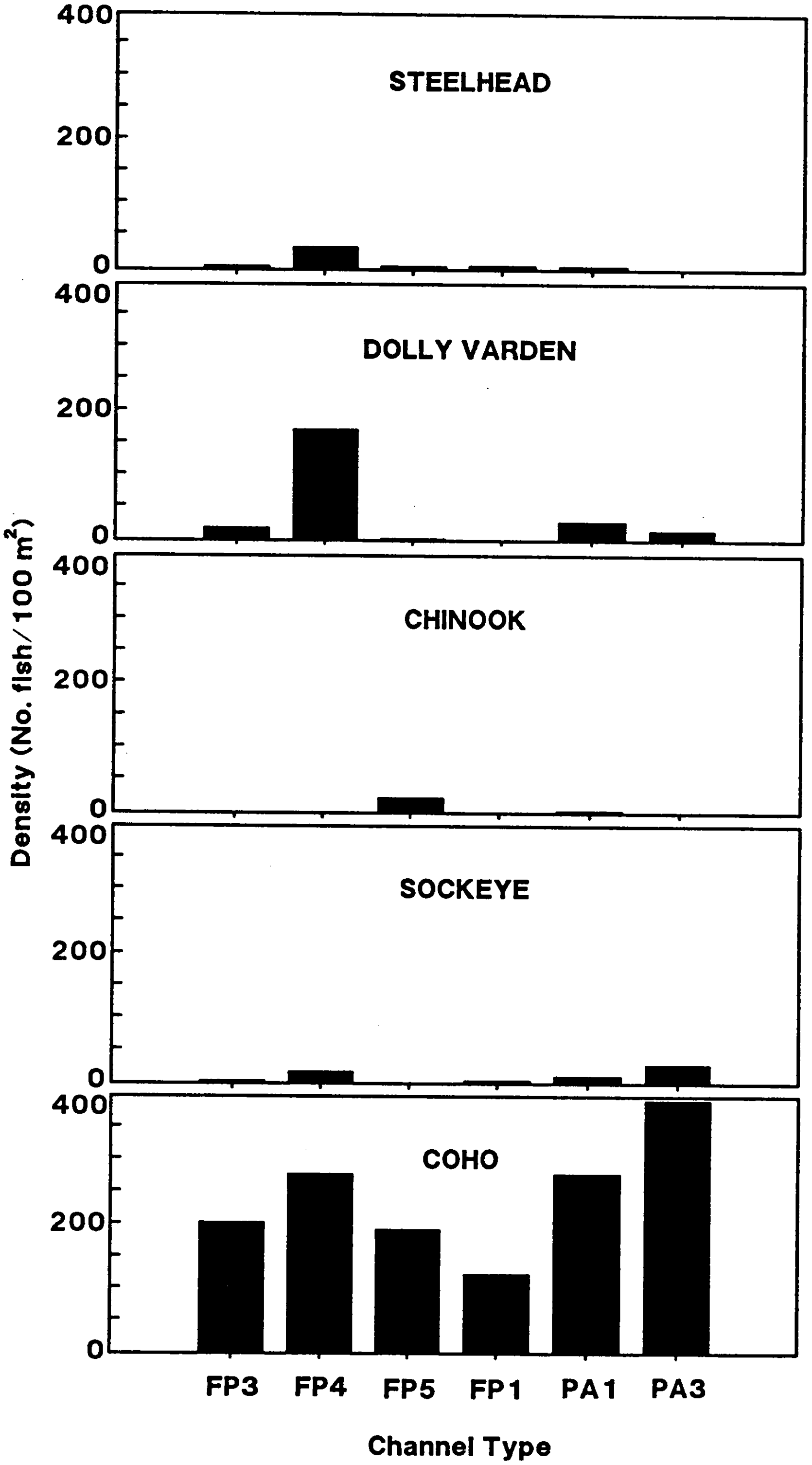

Figure 2.12—Mean density (no./100 m^2) of juvenile salmonids in summer by channel type in the Situk River and Lost River.

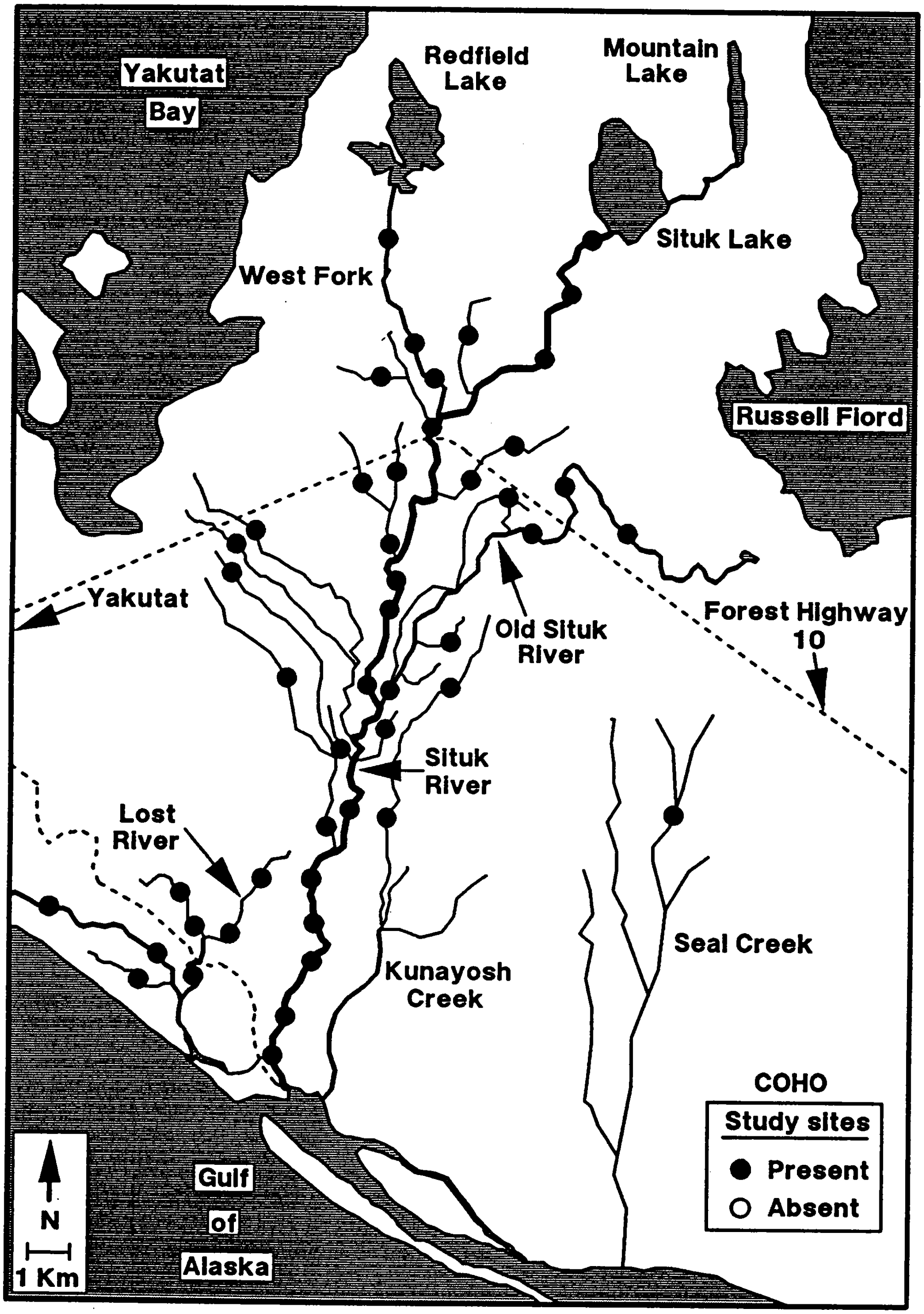

Figure 2.13—Location of study sites where juvenile coho salmon were captured.

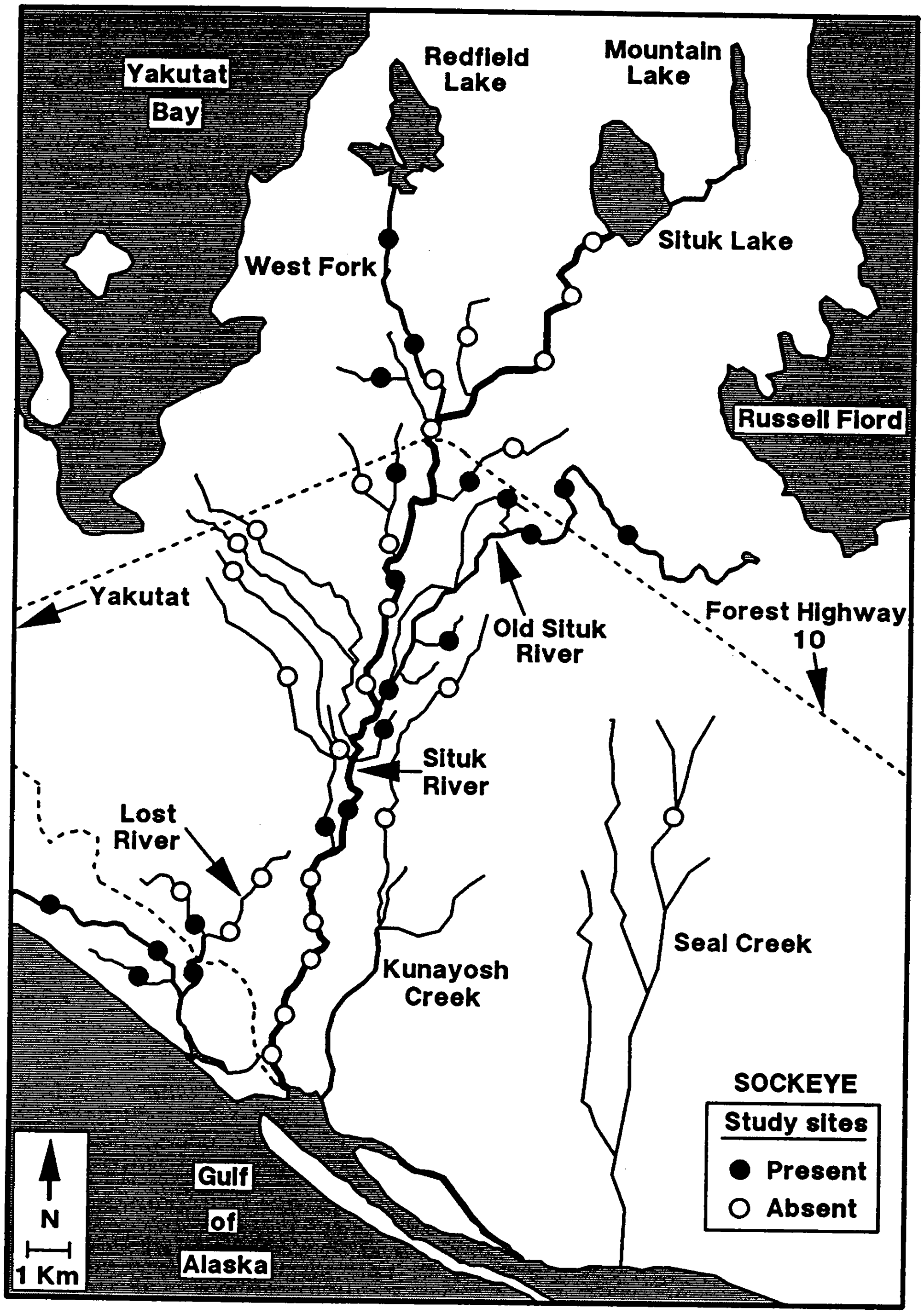

Figure 2.14—Location of study sites where juvenile sockeye salmon were captured.

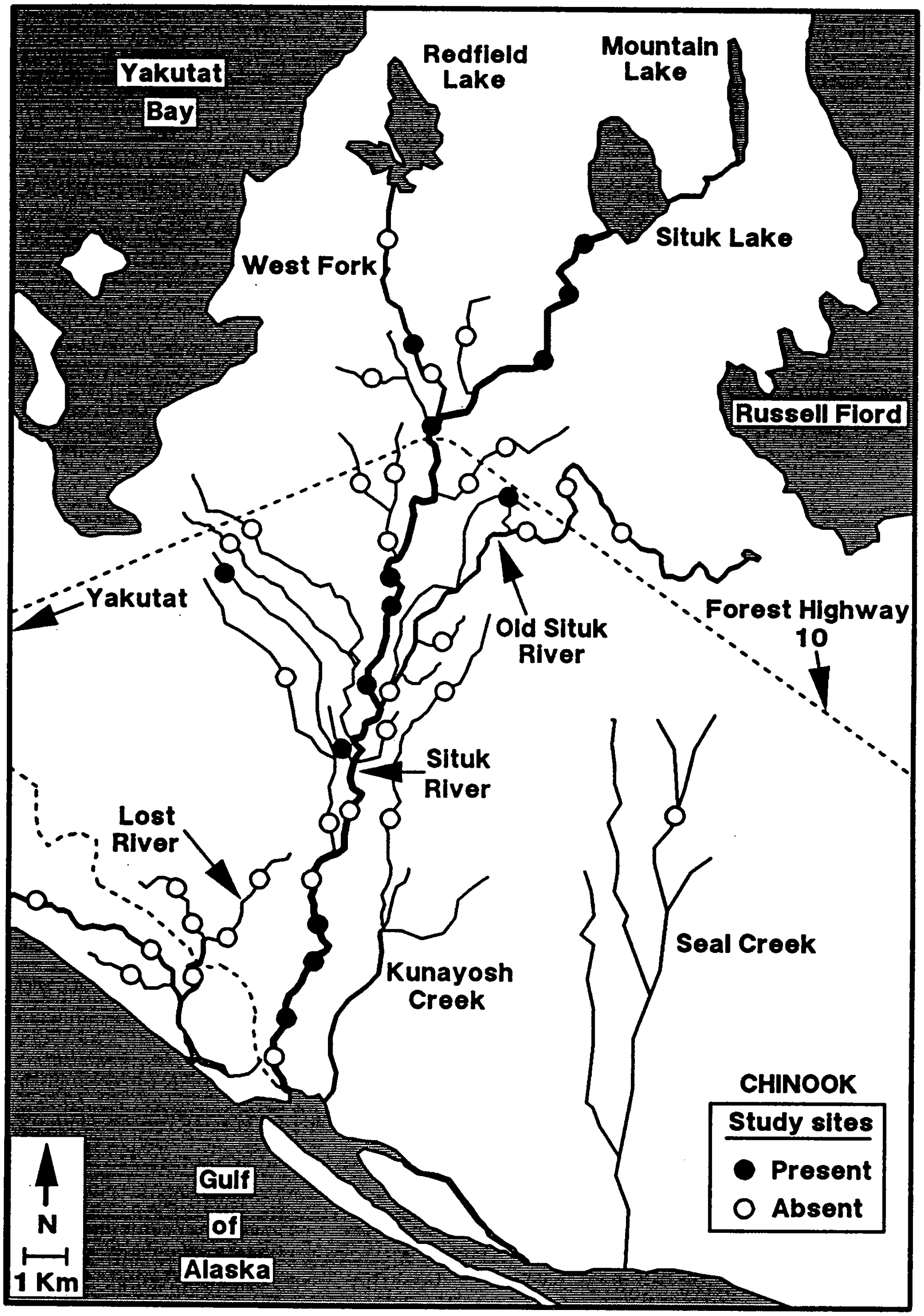

Figure 2.15—Location of study sites where juvenile chinook salmon were captured.

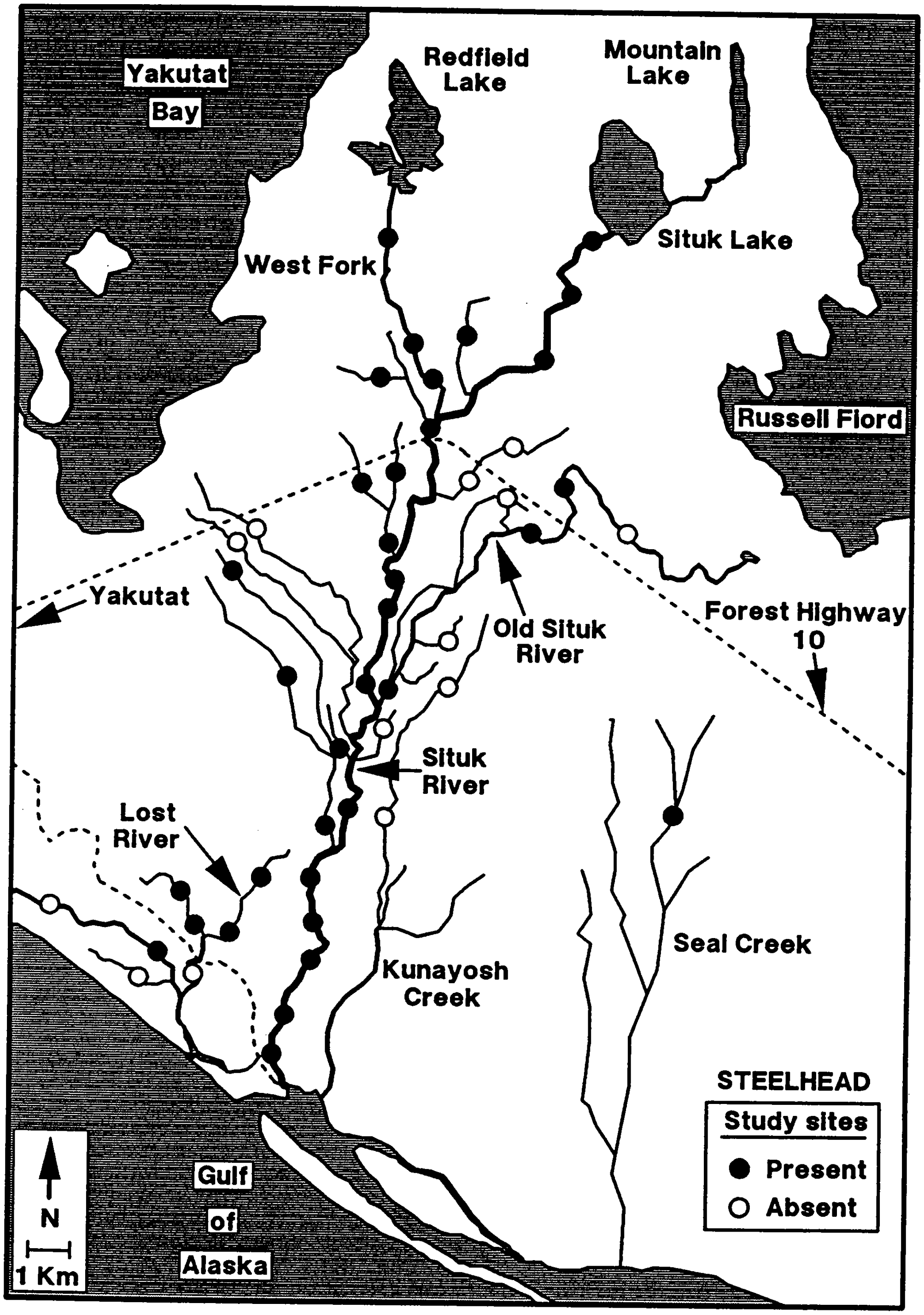

Figure 2.16—Location of study sites where juvenile steelhead were captured.

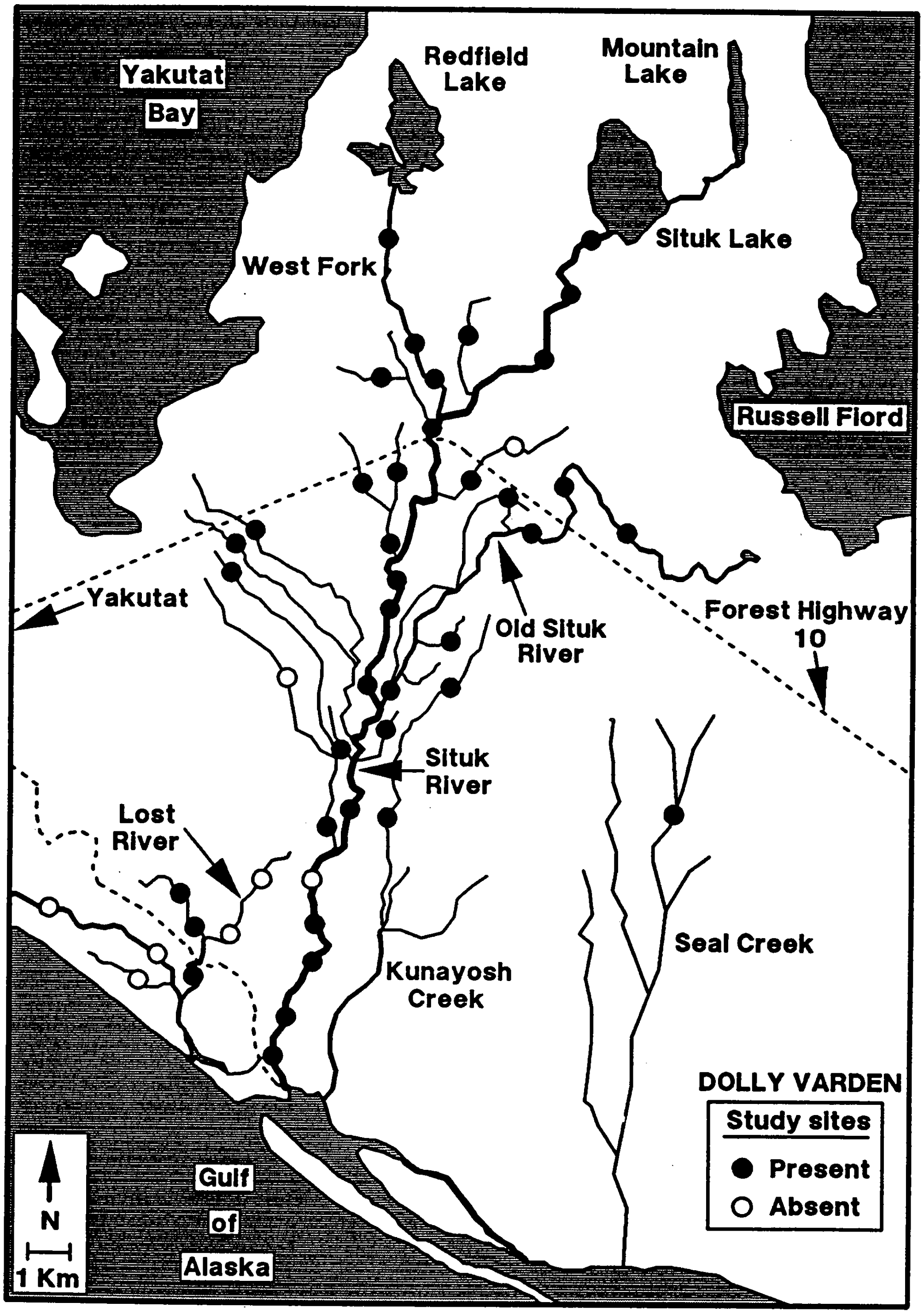

Figure 2.17—Location of study sites where juvenile Dolly Varden were captured.