STUDY 3.

SEASONAL UTILIZATION OF THE MAIN-STEM SITUK RIVER BY JUVENILE SALMONIDS

Rationale

Habitat in the main-stem Situk River will be heavily impacted by flooding. Knowledge of habitat utilization by juvenile salmonids in the main stem is important to determine potential losses from flooding and possible strategies for restoration.

Objectives

The objectives of this study were to determine the seasonal distribution, abundance, habitat use, and size of juvenile coho, sockeye, steelhead, and Dolly Varden in the main-stem Situk River. Similar data for chinook are presented in Study 4.

Summary of Results

The main-stem Situk River is an important summer rearing area for salmonids. In 1989 coho, steelhead, and Dolly Varden were common in the main stem from May through November, and sockeye were present from May to late July. In late November, coho and steelhead fry were still common, but parr, except Dolly Varden, were virtually absent. Fry often used channel edges with little cover; but parr primarily used willow edges and pools with abundant cover. Fish densities were higher in the upper river than in the lower river, probably because of warmer water and more abundant food near the Situk Lake outlet. The lower river is an important staging area for juvenile salmonids to acclimate to seawater while migrating to sea.

METHODS

Fish and habitat were sampled at two main-stem sites in the lower river and two main-stem sites in the upper river (Fig. 3.1) about every 2 weeks from 10 May to 22 September 1989 to estimate fish density and habitat use. We sampled these sites again on 30 November 1989 to determine fall-winter fish distribution but did not estimate fish density. At each site each sampling period except November, we sampled three habitat types (described in Study 2): three channel edges, one willow edge, and one debris pool. In November, we set baited minnow traps in willow edges (7 traps) and pools (15 traps) for 24 hours; channel edges were not seined because visual observations showed fish were absent. Habitat was measured during low flow and at low tide at lower river sites. Methods used to measure habitat, capture fish, and estimate fish density are in Study 2.

Each sampling period, a sample of fish of each species at each site was measured for FL and scaled to determine age (except Dolly Varden). Fry were separated from parr in the field by a predetermined cutoff size that increased seasonally from 50 to 75 mm. Age composition was determined by comparing scale ages with FL frequencies. Because assessment of fish and rearing habitat was the primary objective, migrating smolts were omitted from analysis.

RESULTS

Fish Abundance

Coho and steelhead fry densities (fish/100 m^2) were greater in the upper than in the lower river (Figs. 3.2, 3.3), whereas sockeye fry density was similar but low in both areas. Few Dolly Varden fry were caught, and data were omitted from analysis. Coho fry were caught from May through November, steelhead fry from late July through November, and sockeye fry from May through July. In the upper river, peak fry densities were 2,331 coho, 155 steelhead, and 13 sockeye; in the lower river, peak fry densities were 471 coho, 17 steelhead, and 14 sockeye. In November, twice as many fry were caught in the upper river as in the lower river (Table 3.1).

Parr densities were also usually greater in the upper river than in the lower river (Figs. 3.4, 3.5, 3.6). Coho, steelhead, and Dolly Varden parr were captured from May to November. In the upper river, peak densities were 281 coho, 82 steelhead, and 44 Dolly Varden; in the lower river, peak densities were 36 coho, 44 steelhead, and 35 Dolly Varden. Coho density peaked in the upper river in June and in the lower river in July; steelhead peaked in the upper river in August and in the lower river in June and July; and Dolly Varden peaked in the upper river in June and in the lower river in July. In November, parr were virtually absent, except Dolly Varden in the upper river (Table 3.1).

Habitat Utilization

Habitat characteristics differed among habitat types (Table 3.2). Average depth was greatest in debris pools (1.2 m) and least in channel edges (0.3 m). Average water velocity was greatest in willow edges (15 cm/s) and least in debris pools (10 cm/s). Cover was scarce in channel edges but was abundant in debris pools as large woody debris and in willow edges as overhanging vegetation and submerged roots.

Coho fry density differed significantly ($P < 0.05$; Friedman's test) among habitat types in the lower river but was similar ($P > 0.05$) among habitats in the upper river (Fig. 3.2). In the lower river, mean density was greater in willow edges (range, 0-471 coho) and debris pools (0-382) than in channel edges (0-82). In the upper river, mean density ranged from 2 to 1,442 in channel edges, 2 to 2,331 in willow edges, and 5 to 2,173 in debris pools. Density peaked earlier (May and June) in channel edges than in willow edges or debris pools (July). After July, density declined steadily in both the upper and lower river.

Densities of steelhead and sockeye fry were usually greatest in channel edges. Peak steelhead density was in channel edges in late July (upper river: 155 fish; lower river: 17 fish; Fig. 3.3). Peak sockeye density (14 fish) was in channel edges in late May, and few sockeye were in willow edges or debris pools.

Densities of coho, steelhead, and Dolly Varden parr differed significantly ($P < 0.05$; Friedman's test) among habitat types in both the upper and lower river. Parr densities were consistently greatest in willow edges or debris pools and least in channel edges (Figs. 3.4, 3.5, 3.6). In the upper river, peak densities of coho (281), steelhead (82), and Dolly Varden parr (44) were in willow edges. In the lower river, peak densities of coho (36) and Dolly Varden parr (35) were in debris pools, whereas peak steelhead density (44) was in willow edges.

Fish Size

Fry size of all species generally increased from May to September, but was similar in late September and November (Figs. 3.7, 3.8). An exception was coho in channel edges in the lower river where mean FL decreased sharply from 64 mm in late July to 39 mm in early August (Fig. 3.8). Monthly mean FL of fry (lower and upper river combined) increased from 36 to 64 mm for coho (May to November), 32 to 43 mm for sockeye (May to July), and 32 to 61 mm for steelhead (July to November).

Mean FL of fry within habitat types (combined sampling periods) was usually significantly ($P < 0.001$; *t*-test) greater in the lower than in the upper river (Table 3.3). The only exception was steelhead fry in channel edges; they were significantly ($P < 0.001$) larger in the upper than in the lower river. Among habitat types in both the lower and upper river, coho and steelhead fry were significantly ($P < 0.001$; *F*-test) larger in willow edges or debris pools than in channel edges.

Parr size also increased in most habitat types (Figs. 3.9, 3.10). Exceptions were steelhead parr in willow edges in the lower river and Dolly Varden parr in debris pools in the upper river. Mean FL of steelhead declined abruptly from 150 mm to 120 mm in mid-September, whereas mean FL of Dolly Varden decreased from 89 mm to 63 mm between late July and early September. Monthly mean FL (combined data for May to November) ranged from 60 to 87 mm for coho, 63 to 105 mm for steelhead, and 69 to 100 mm for Dolly Varden.

Within habitat types (combined sampling periods), coho, steelhead, and Dolly Varden parr were usually significantly ($P < 0.001$; *t*-test) larger in the lower than in the upper river (Table 3.4). An exception was that coho parr in willow edges were similar in size in the lower and upper river. In the lower river, coho, steelhead, and Dolly Varden parr were significantly ($P < 0.05$; *t*-test) larger in willow edges than in debris pools. In the upper river, steelhead parr were similar in size (90 mm) in both willow edges and debris pools. Mean FL of coho and Dolly Varden parr, however, differed significantly ($P < 0.001$; *F*-test) among habitat types in the upper river, with the smallest parr in channel edges.

Age Composition

The dominant age class in most sampling periods in both the upper and lower river was fry (Figs. 3.11, 3.12). All sockeye were fry, but nearly all Dolly Varden were parr. Coho parr were dominant (about 60%) only in debris pools in the lower river in May. Steelhead were 100% parr in May and June and 54-99% fry thereafter.

DISCUSSION

The main-stem Situk River provides important rearing habitat for juvenile salmonids. Channel edges are important nursery areas for newly emerged fry, particularly coho in May, June, and July; sockeye in May and June; and steelhead in July and August. Coho, steelhead, and Dolly Varden parr primarily used willow edges and debris pools—areas with abundant cover. Trapping in late November indicates that coho and steelhead fry use willow edges and debris pools in winter. Juvenile coho, steelhead, sockeye, and Dolly Varden occupied depth (0.3-1.5 m) and velocity (4-26 cm/s) ranges similar to those in other studies (Smith and Slaney 1980; Murphy et al. 1984; Thedinga et al. 1988; Bjornn and Reiser 1991).

Many coho and steelhead fry apparently moved from channel edges into willow edges and debris pools as they grew. As density of coho and steelhead fry decreased in channel edges, it increased in willow edges and debris pools. Other studies (Chapman and Bjornn 1969; Lister and Genoe 1970) have also shown that juvenile salmonids move from stream margins to areas of deeper, faster water as they grow.

Sockeye fry were not captured in the main stem after early July, and presumably migrated to the estuary. Many sockeye fry in the main stem were probably ocean type that originated from Old Situk River. Scale analysis shows that 94% of the sockeye escapement to Old Situk River (about 3,000 sockeye) have no freshwater annulus (Study 1). Number of ocean-type sockeye in the Situk estuary peaks in May and June, and most fish leave by late July (Study 5).

Coho was the most abundant species of fry in the main stem. This was expected, considering that coho escapement (25,000 adults)[17] is much higher than steelhead (5,000 adults; Schwan 1984) and chinook (2,000 adults; Bethers and Ingledue 1989), and most sockeye rear in lakes.

The greater densities of all species in the upper than in the lower river could be because of more suitable habitat upriver or because most spawning and wintering is in the upper watershed (Studies 1 and 6). Thus, as they emerge and disperse, more fry may occupy habitat close to the spawning areas in the upper river than farther downstream. Fry that are displaced by freshets (Scrivener and Anderson 1984; Sandercock 1991) or those unable to find and defend territories move to the lower river. This may explain why peak coho fry density was nearly three times greater in the upper than in the lower river. Similarly, parr migrating from wintering areas (tributaries and lakes) into the main stem may occupy nearby upriver areas first; some parr may eventually be displaced downstream as demands for space increase as fish grow (Sandercock 1991). Many parr may move downstream to staging areas as they begin to transform to smolts. Fish density may also have been greater in the upper than in the lower river because of greater food availability. Warmer water and abundance of seston in outlet flow from Situk Lake may provide more food in the upper main stem. Juvenile chinook, for example, grow to about 60 mm FL in the upper river by July before they migrate to the lower river, indicating favorable growth conditions (Study 4).

Density of fry, especially coho, declined from July to September. Mortality is a probable cause of the decline. Crone and Bond (1976) reported that mortality of coho was greatest (67-78%) in July and August of the first summer of life.

Fish density in the Situk River was generally higher than in other studies. In our study, however, density was estimated from specific habitats and not from an entire cross section of the river (this probably would have lowered our density estimates). In channel edges, coho fry density was higher (range, 0-1400 fish/100 m^2) and sockeye density lower (0-14 fish/100 m^2) in the Situk River than in the Taku River, Alaska (range, 0-5 coho/100 m^2, 17-40 sockeye/100 m^2; Thedinga et al. 1988). In pools, parr density was higher (0-280 coho/100 m^2 and 0-82 steelhead/100 m^2) in the Situk River than in an Oregon coastal stream (4-34 coho/100 m^2 and 13-24 steelhead/100 m^2; Hankin and Reeves 1988).

Seasonal differences in parr density between the lower and upper Situk River probably reflect migrations from wintering areas and subsequent migrations to the ocean. Coho and Dolly Varden parr were most abundant in the upper river from late May to late June, as they left wintering areas (e.g., Situk Lake) and moved into the main stem. Substantial numbers of coho, steelhead, and Dolly Varden parr reared in the lower river from late May to late July, but by

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early August, numbers had declined, as some parr probably transformed to smolts and migrated to sea. By late November, any remaining parr had probably moved upstream to wintering areas. In Porcupine Creek, Alaska, juvenile coho migrated upstream from the estuary to freshwater areas in fall (Murphy et al. 1984).

Seasonal changes in fish size reflect growth and migration. In the lower river, immigration of late-emerging fry (yolk sac visible) probably accounted for the decrease in length of coho fry in channel edges in early August. Similarly, immigration of small parr and emigration of large parr, possibly as smolts, probably accounts for the decrease in length of steelhead parr in willow edges (September) and Dolly Varden parr in debris pools (late July-September). The size increase in fry in our study (coho, 36 to 64 mm; sockeye, 32 to 43 mm; steelhead, 32 to 61 mm) is similar to that in Idaho and Alaska (Everest and Chapman 1972; Thedinga et al. 1988). The size increase in coho parr in our study (60 to 87 mm) was similar to that in Sashin Creek, Alaska (70 to 88 mm; Crone and Bond 1976). The size range of steelhead (44-197 mm) and Dolly Varden (47-190 mm) parr in the Situk River was similar to that of steelhead in Idaho (60-160 mm; Everest and Chapman 1972) and Dolly Varden in Hood Bay Creek, Alaska (51-137 mm; Blackett 1968).

The larger size of juvenile salmonids in the lower river compared to the upper river is similar to results of other studies. Juvenile coho were larger in lower than in upper reaches of Porcupine Creek (Koski and Kirchhofer 1984). Lower reaches of rivers often have abundant food because of estuarine influence (Levy and Northcote 1982; Koski and Kirchhofer 1984) and may promote faster growth.

The largest parr often occupied willow edges rather than debris pools. In both the lower and upper river, coho parr were 3-5 mm larger in willow edges than in debris pools. In the lower river, steelhead and Dolly Varden parr were 8-12 mm larger in willow edges than in debris pools. Water velocity was usually faster in willow edges (15 cm/s) than in debris pools (10 cm/s); thus, larger parr may have occupied willow edges for increased exposure to food organisms (Chapman and Bjornn 1969).

Table 3.1—Catch of juvenile salmonids in baited minnow traps set 24 hours in the upper and lower Situk River on 30 November 1989. Two willow edges and two debris pools were sampled in each river area. (DV = Dolly Varden).

	Fry		Parr		
	Coho	Steelhead	Coho	Steelhead	DV
Lower river					
Willow edges	78	123	0	1	1
Debris pools	63	54	0	0	0
Upper river					
Willow edges	122	95	1	2	36
Debris pools	247	173	0	1	27

Table 3.2—Summer habitat characteristics of study sites in the upper and lower Situk River, 1989. (P = pool with large woody debris; WE = willow edge; CE = channel edge). Values for channel edges are the means of three channel edges.

	Lower river						Upper river					
	Site 1			Site 2			Site 1			Site 2		
	P	WE	CE	P	WE	CE	P	WE	CE	P	WE	CE
Habitat area (m^2)	300.0	79.8	74.0	213.0	73.5	74.0	194.7	86.1	74.0	229.5	88.2	74.0
Mean depth (m)	1.2	0.8	0.4	1.5	1.0	0.3	1.1	1.2	0.3	0.8	0.6	0.3
Max. depth (m)	2.6	1.1	0.6	2.7	1.8	0.4	1.8	1.5	0.5	2.5	0.9	0.5
Mean width (m)	7.5	3.8	2.7	7.1	3.5	2.7	5.9	4.1	2.7	5.1	4.2	2.7
Water velocity (cm/s)	4	13	7	7	7	7	4	12	17	23	26	13
Pieces of large woody debris	8	0	0	25	0	0	9	0	0	14	0	0

Table 3.3—Fork length (mm) of coho, steelhead, and sockeye fry by habitat type (combined sampling periods) in the upper and lower Situk River, May-September and November 1989. Data are means ± standard error; sample size is in parentheses. A dash indicates no fish were captured.

	Coho		Steelhead		Sockeye	
	Lower river	Upper river	Lower river	Upper river	Lower river	Upper river
Channel edges	50±0.6[a] (354)	39±0.2 (1637)	32±0.5 (94)	34±0.2[b] (614)	38±0.7[a] (132)	33±0.3 (123)
Willow edges	63±0.2[a] (1266)	53±0.3 (1637)	65±0.7[a] (108)	53±0.5 (319)	—	—
Debris pools	62±0.2[a] (1558)	52±0.3 (1921)	64±0.8[a] (102)	52±0.6 (329)	—	—

[a] Significantly ($P < 0.001$; t-test) larger in lower river than in upper river.

[b] Significantly ($P < 0.001$) larger in upper river than in lower river.

Table 3.4—Fork length (mm) of coho, steelhead, and Dolly Varden parr by habitat type (combined sampling periods) in the upper and lower Situk River, May-September and November 1989. Data are means ± standard error; sample size is in parentheses. A dash indicates no fish were captured.

	Coho		Steelhead		Dolly Varden	
	Lower river	Upper river	Lower river	Upper river	Lower river	Upper river
Channel edges	—	66±1.0 (120)	—	—	—	69±2.5 (14)
Willow edges	80±1.0 (128)	78±0.8 (274)	104±1.6* (183)	90±1.1 (316)	111±2.8* (57)	73±1.1 (151)
Debris pools	77±0.4* (466)	73±0.5 (671)	96±1.0* (494)	90±0.9 (595)	99±1.9* (203)	78±1.2 (221)

* Significantly larger ($P \leq 0.001$; t-test) in lower river than in upper river.

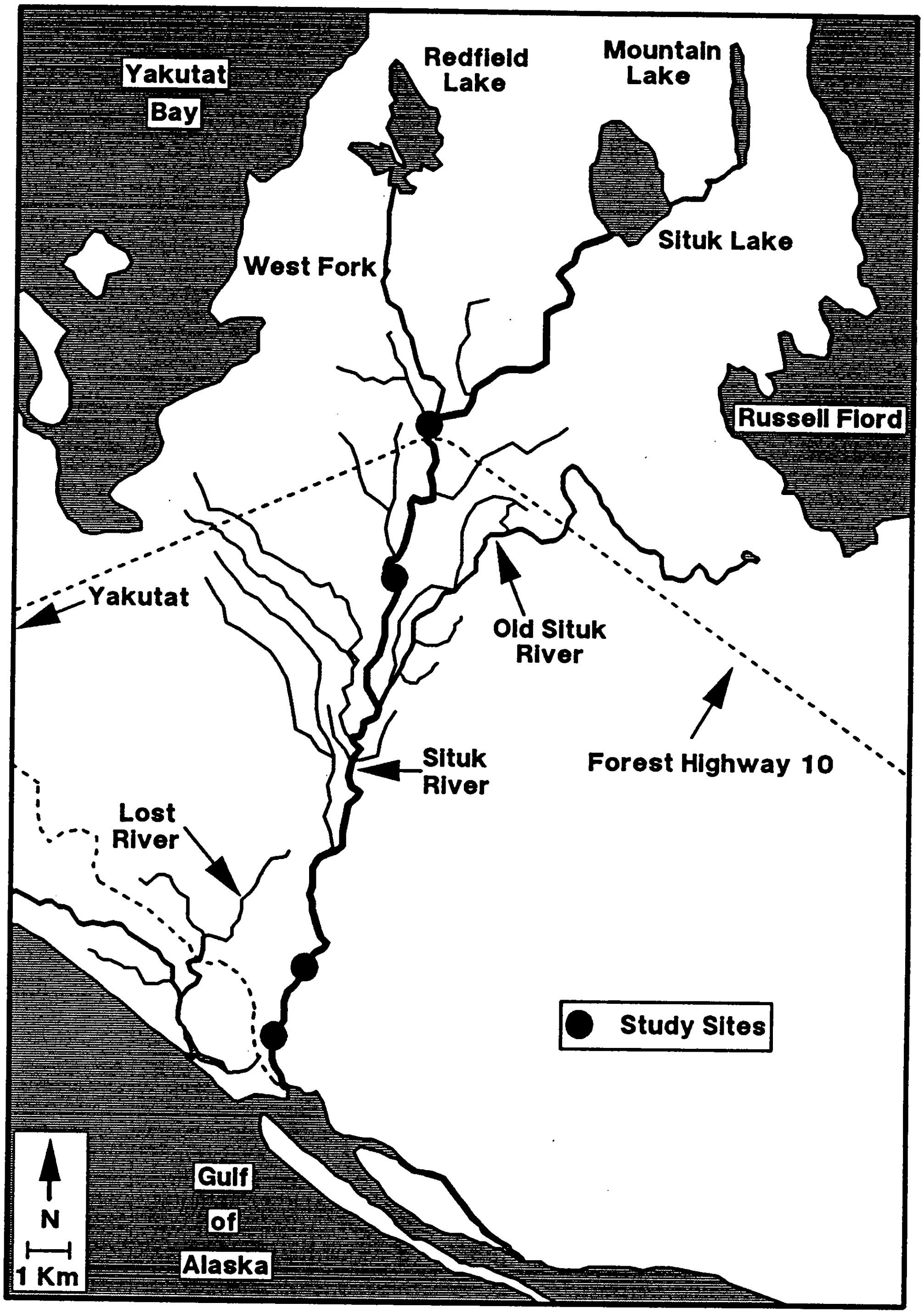

Figure 3.1—Sites sampled for juvenile salmonids in the upper and lower Situk River, May-September and November 1989.

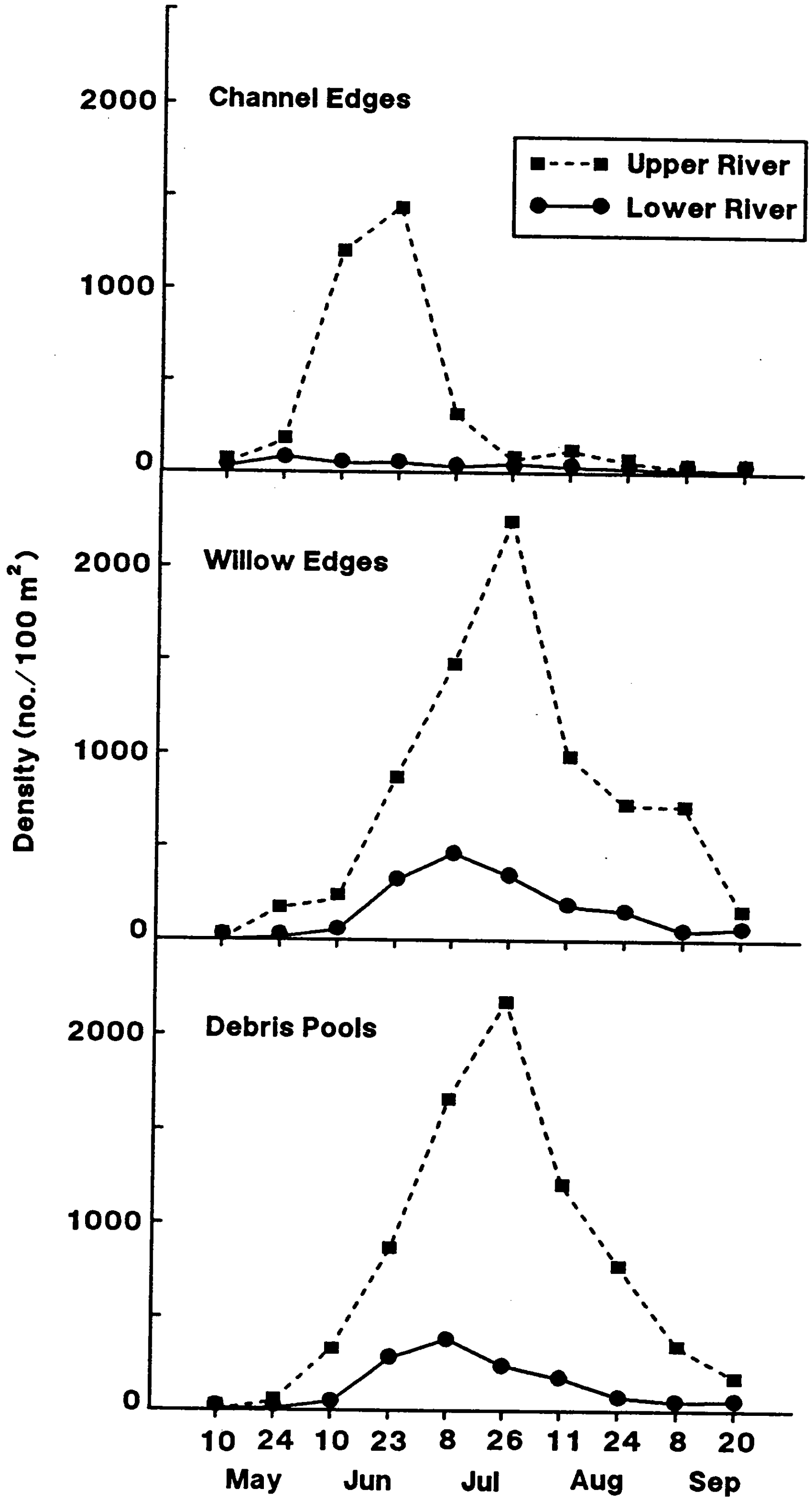

Figure 3.2—Mean density of coho fry by habitat type in the upper and lower Situk River, 1989.

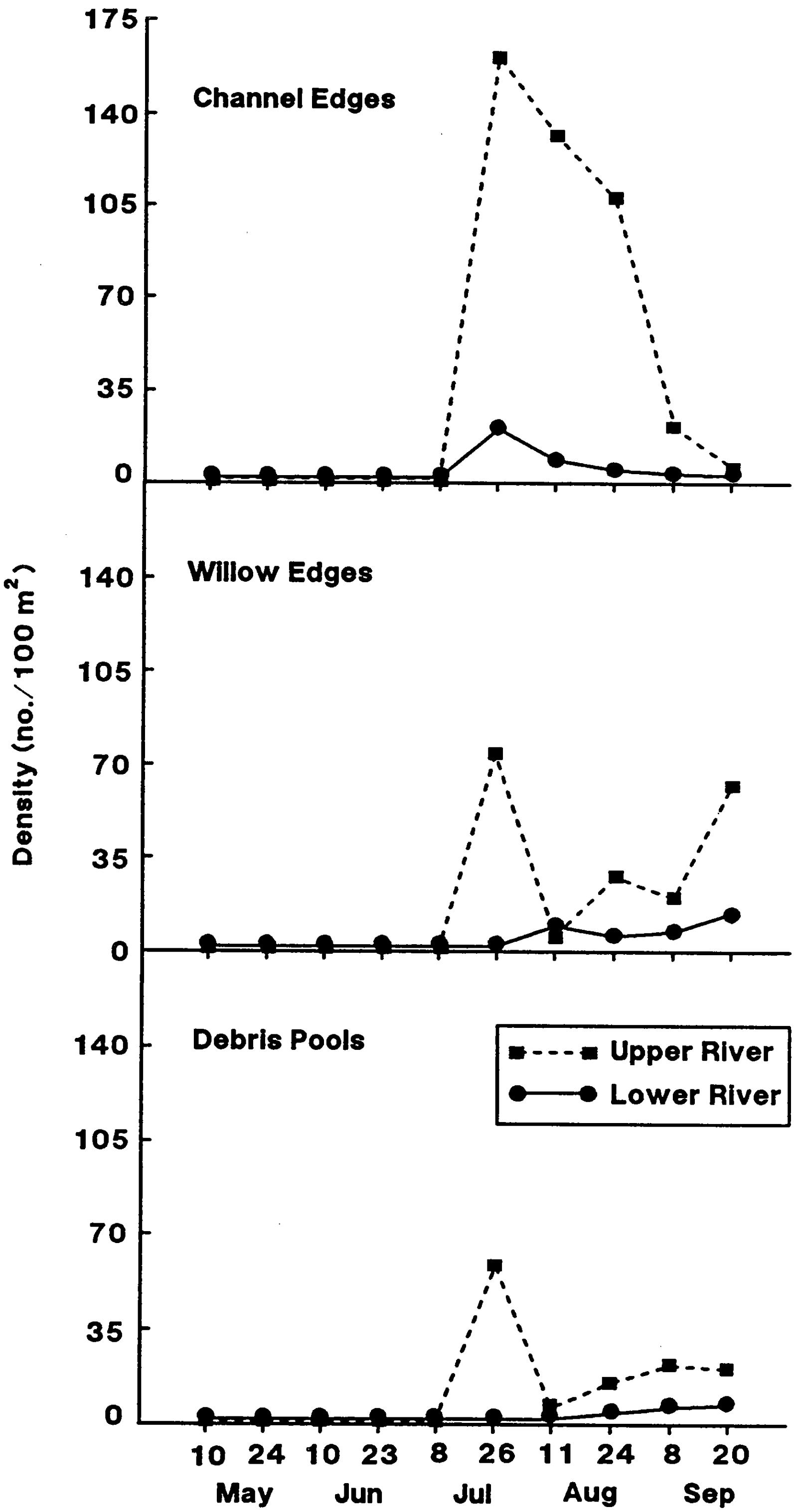

Figure 3.3—Mean density of steelhead fry by habitat type in the upper and lower Situk River, 1989.

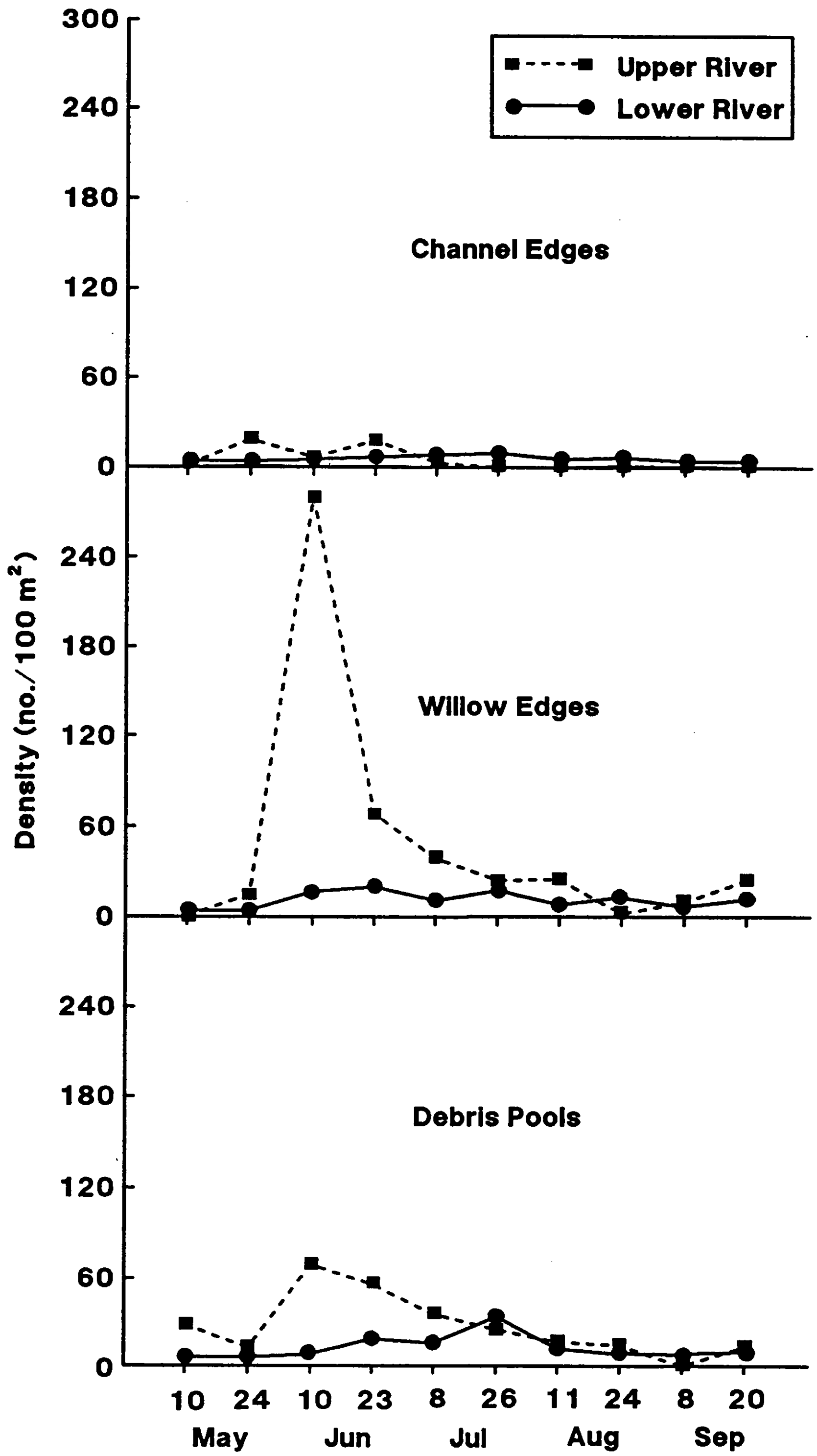

Figure 3.4—Mean density of coho parr by habitat type in the upper and lower Situk River, 1989.

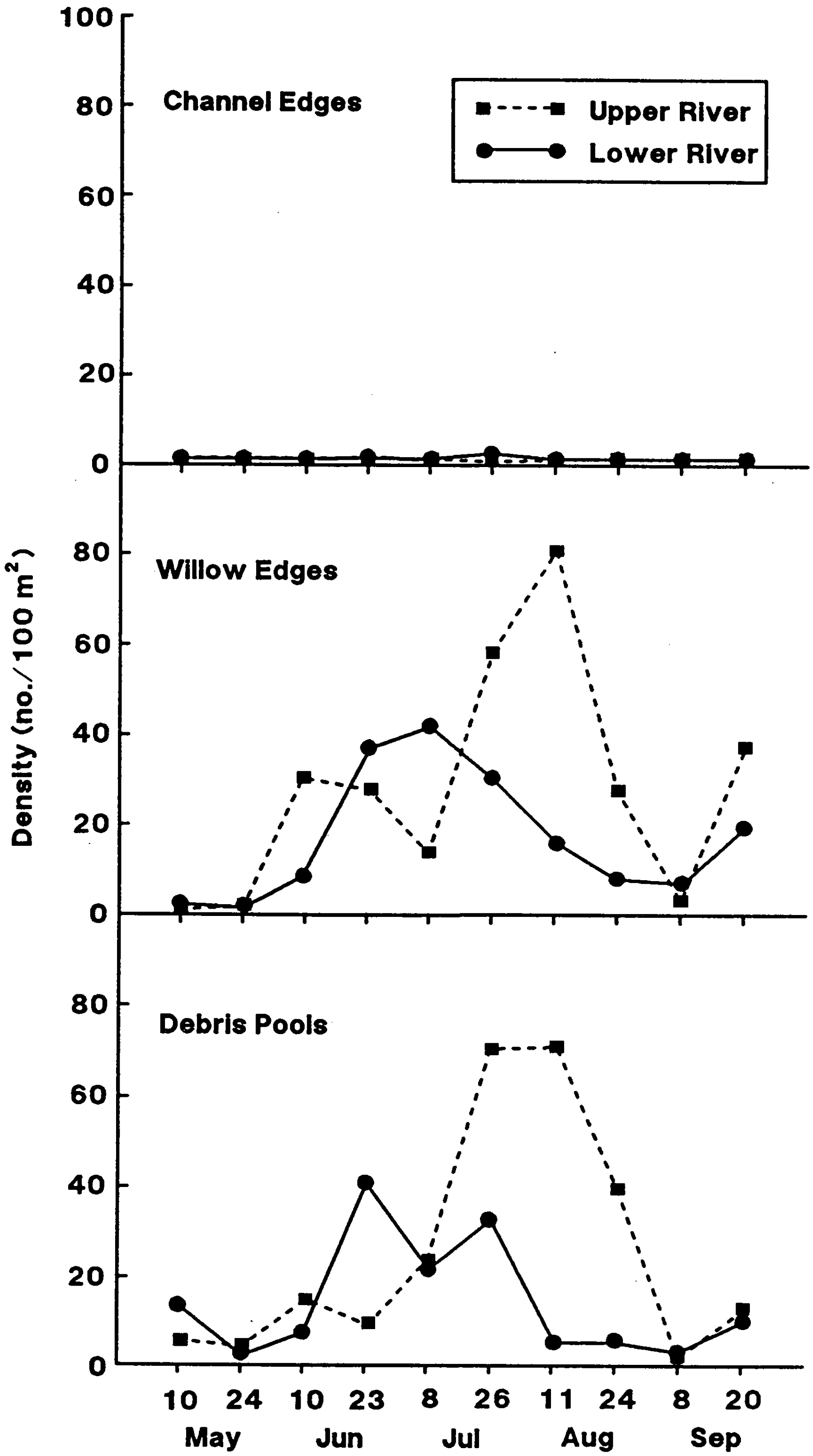

Figure 3.5—Mean density of steelhead parr by habitat type in the upper and lower Situk River, 1989.

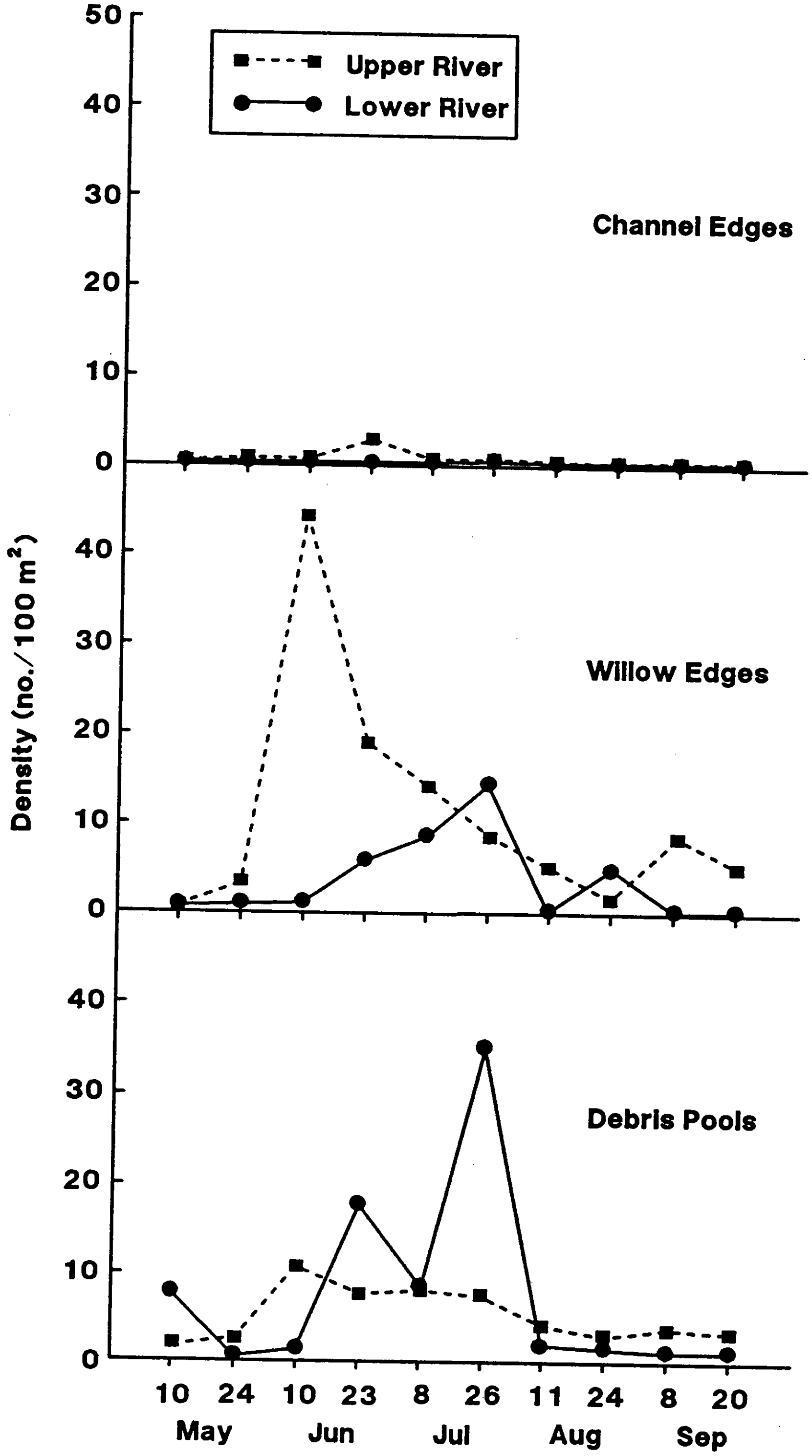

Figure 3.6—Mean density of Dolly Varden parr by habitat type in the upper and lower Situk River, 1989.

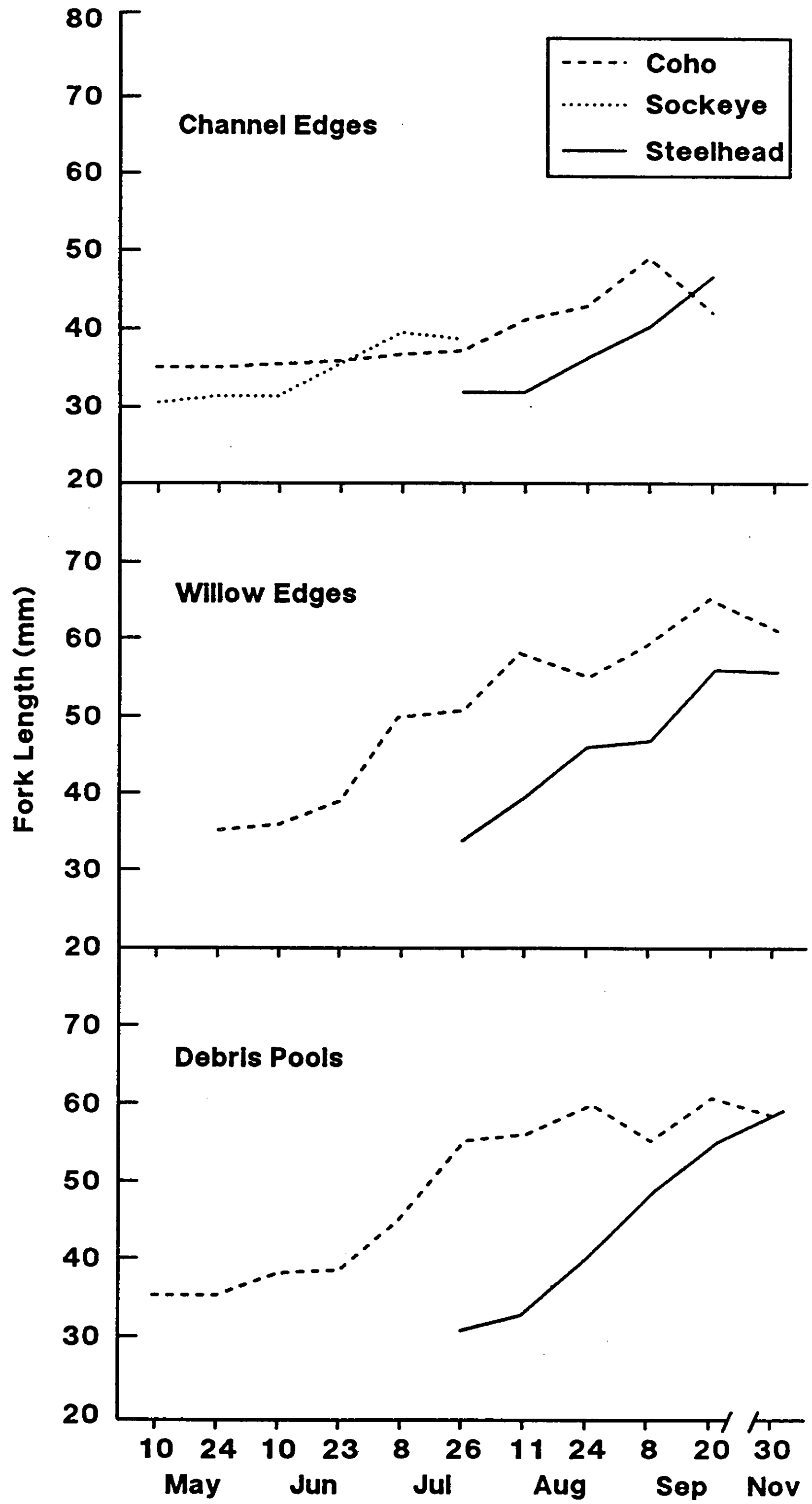

Figure 3.7—Mean fork length of fry by habitat type in the upper Situk River, 1989. Each data point represents at least seven fish.

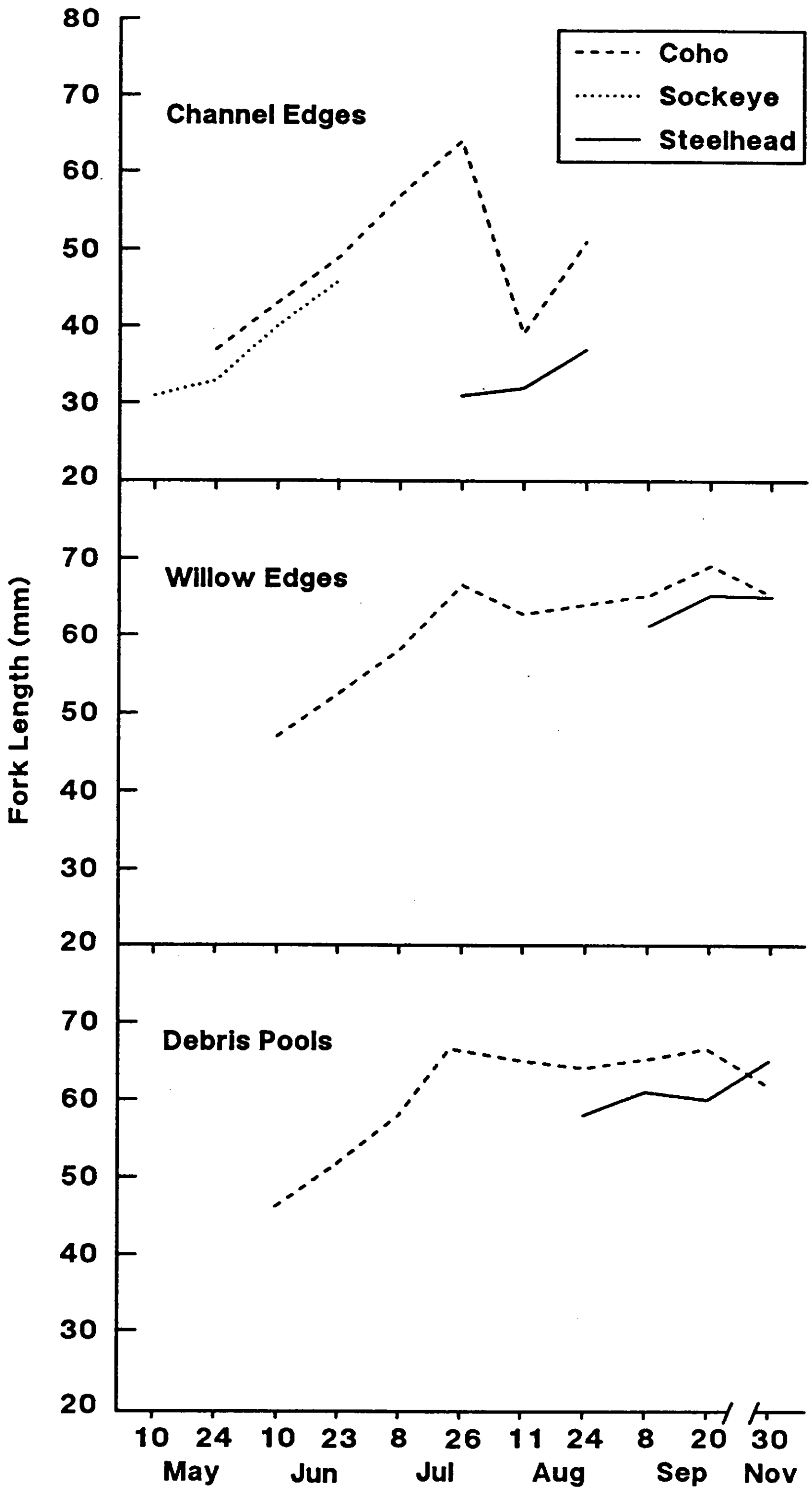

Figure 3.8—Mean fork length of fry by habitat type in the lower Situk River, 1989. Each data point represents at least seven fish.

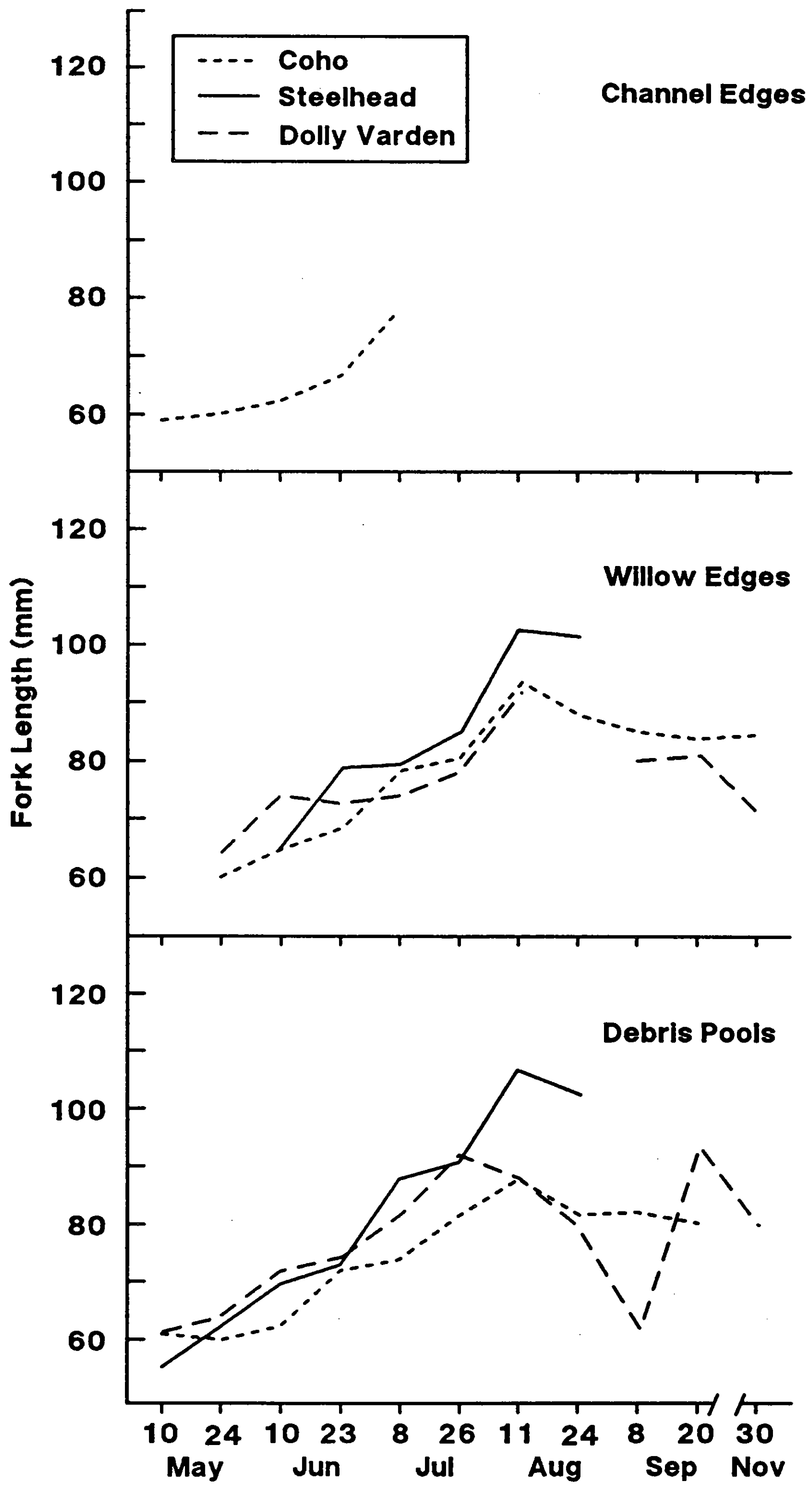

Figure 3.9—Mean fork length of parr by habitat type in the upper Situk River, 1989. Each data point represents at least seven fish.

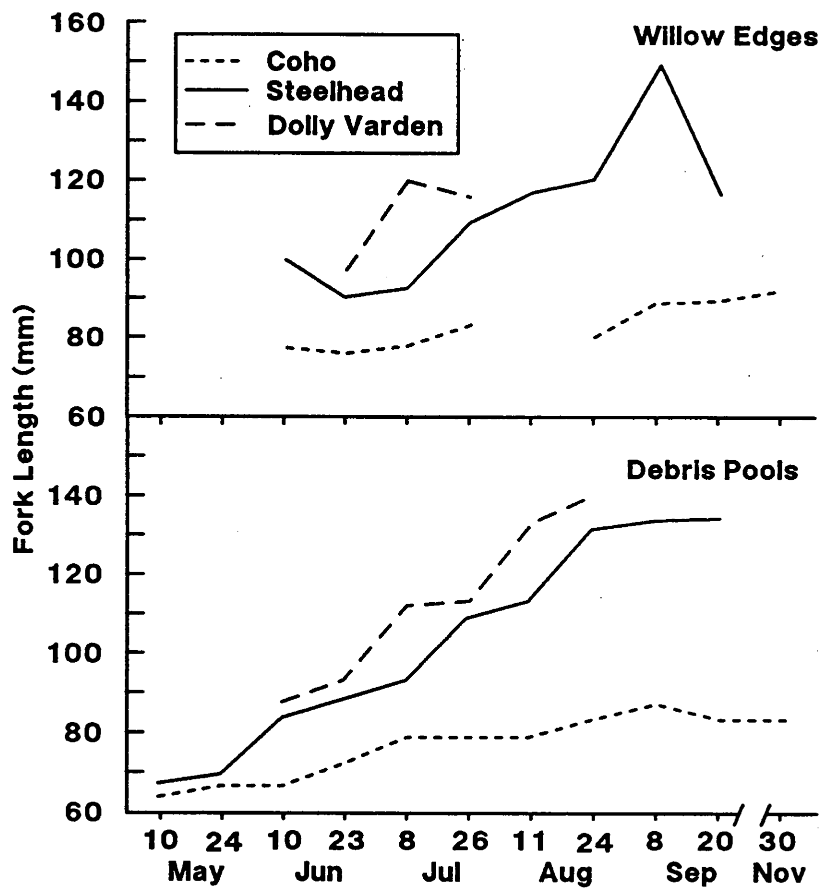

Figure 3.10—Mean fork length of parr by habitat type in the lower Situk River, 1989. Each data point represents at least seven fish.

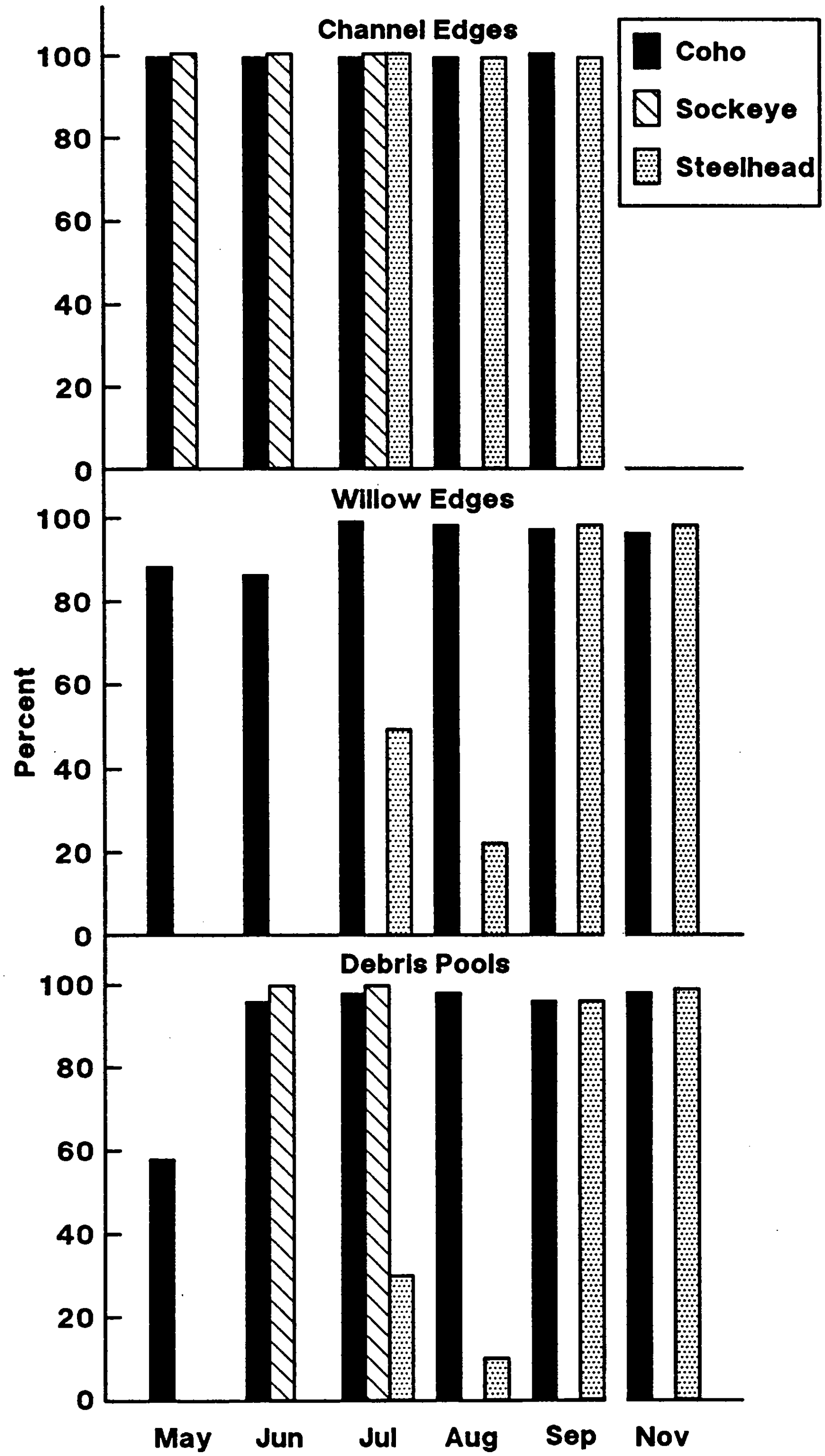

Figure 3.11—Percentage of fry by habitat type in the upper Situk River, 1989.

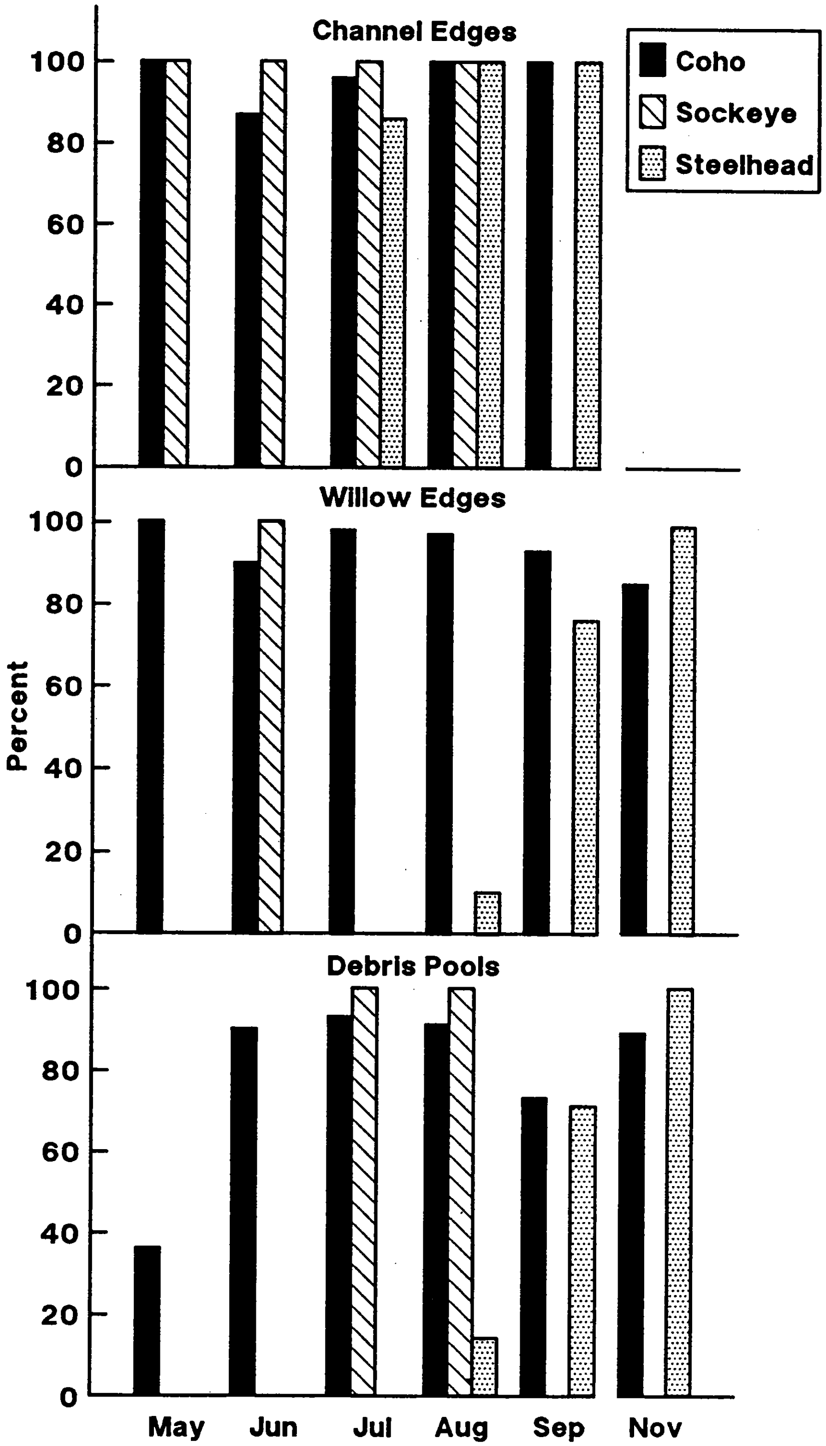

Figure 3.12—Percentage of fry by habitat type in the lower Situk River, 1989.