

FEDERAL AID IN SPORT FISH RESTORATION

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Northern Cook Inlet Chinook
and Coho Salmon Enhancement

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The Sheep/Goose Creeks diversion dike satisfactorily dispersed water into both creeks in 1986 and 1987. The 1986 chinook salmon escapements into Sheep and Goose Creeks were estimated at a respective 1,285 and 600 fish, and the 1987 escapement estimates were 1,050 and 300 fish, respectively. Recovery of marked adult chinook salmon from the approximate 850 age-0.2 fish returning to the Willow Creek drainage indicates an estimated hatchery contribution of 71% (600 fish).

An estimated 32% of the coho salmon, *Oncorhynchus kisutch*, smolts in the Big Lake drainage migration were hatchery-produced. At Nancy Lake, an estimated 55% and 37% of the coho salmon smolts in the migration were from Fort Richardson and Big Lake Hatcheries, respectively.

Of the hatchery-produced coho salmon smolts released into the Cottonwood Lake drainage in 1981-1982, 0.7% survived, representing an estimated 23% contribution to the total return. Of those hatchery-produced fish returning to the Big Lake drainage from 1981 to 1986, the estimated survival and contribution are 0.7% and 26%, respectively. The estimated survival and contribution rates for the hatchery fish released into the Little Susitna River in 1986 are a respective 3% and 3% for smolts and 0.2% and 1% for fingerlings. The preliminary estimates of the number of hatchery-produced coho salmon returning to Cottonwood and Big Lakes and the Little Susitna River are 2,561, 6,776, and 15,369 fish, respectively.

KEY WORDS: Salmon enhancement, northern Cook Inlet, chinook salmon, *Oncorhynchus tshawytscha*, egg take, chinook salmon hatchery contribution, 1988 chinook salmon adult projections, coho salmon survivals, coho salmon, *O. kisutch*, hatchery contribution, 1987 coho salmon adult projections.

INTRODUCTION

Alaska's sport fishing population is a highly mobile group; the majority of them live in the Anchorage and Matanuska-Susitna River Valley areas. Correspondingly, the most intensely fished areas of the state are those within a 2-h drive from the major population centers; i.e., the Kenai Peninsula waters and Knik Arm and Susitna River tributaries that are accessible from the Parks Highway. In northern Cook Inlet, the most important chinook salmon, *Oncorhynchus tshawytscha*, fisheries occur in Willow Creek and the Little Susitna River; while the most important coho salmon, *O. kisutch*, fisheries occur on tributaries to the Knik Arm, including: (1) the Little Susitna River, which is second only to the Kenai River in angler-hours fished, (2) Cottonwood Creek drainage, (3) Big Lake drainage, and (4) tributaries to the Susitna River (Willow, Little Willow, Caswell, and Sheep Creeks).

While the number of commercial fishermen remains fairly static because of limited-entry laws, the sport-fishing effort has continued to increase with the increase in population, necessitating a species prioritization for hatchery-produced salmon. Sockeye salmon, *O. nerka*, pink salmon, *O. gorbuscha*, and chum salmon, *O. keta*, have been targeted for commercial use, and the less abundant chinook and coho salmon have been targeted for sport fishermen.

Sport-fishing effort in the Cook Inlet area has been increasing dramatically (Mills 1986). As the fishing pressure on Kenai Peninsula drainages has increased, there has been some shift in effort to the less-crowded northern Cook Inlet river systems. Also, increased public access to the key northern Cook Inlet river systems has provided more opportunities for sport fishing in the northern Cook Inlet area. With this increased fishing effort, however, has come increasingly restrictive management to maintain adequate spawner escapement. A number of systems have

been regulated for "weekend-only" sport fishing because the demand exceeds the availability of natural stocks.

Supplemental production of chinook and coho salmon by the Fisheries Rehabilitation, Enhancement and Development (FRED) Division of the Alaska Department of Fish and Game (ADF&G) is becoming an important tool for providing additional sport-fishing opportunities in northern Cook Inlet. Big Lake and Fort Richardson Hatcheries currently serve in augmenting the fishery by producing chinook and coho salmon fingerlings and smolts. Fingerlings, which are released in underutilized lakes connected to anadromous streams, take advantage of existing food supplies for juvenile development. The strategy of releasing smolts takes advantage of their ability to readily imprint to local surroundings; and because of their migratory nature, competition for food between introduced smolts and other juvenile salmonids is minimal. The returning adults from the fingerling and smolt releases will increase the number of fish available for sport fishermen; since these fish return to their respective imprinting sites, the collection of brood fish will be more efficient. This project will not only provide eggs for hatchery production of fingerlings and smolts, it will facilitate the collection of life-history information, which is necessary for the expansion of the enhancement program in northern Cook Inlet. Activities included in this project area: (1) collection of samples for disease screening of brood stocks, (2) determination of the location of spawning areas, (3) description of spawning-habitat characteristics, and (4) follow-up assessment of the contribution of stocked fish.

The chinook salmon study area consists of waters draining into Cook Inlet via Susitna River and Knik Arm (Figure 1). Enhancement efforts for chinook salmon are primarily directed toward road-system accessible waters, while studies to determine prospective brood stocks have no such limitation. Remote tributaries containing prospective brood stocks include (1)

Alexander Creek (west side lower Susitna River), (2) Lake Creek (Susitna River tributary via Yentna River), and (3) Prairie Creek (Susitna River tributary via Talkeetna River). Road-accessible tributaries containing potential chinook salmon brood stock are Willow, Sheep, and Montana Creeks (east side Susitna River tributaries) and Little Susitna River (Cook Inlet tributary via Knik Arm).

The coho salmon study area consists of three watersheds that drain into Knik Arm (Figure 1): (1) Big Lake watershed that drains via Fish Creek, (2) Cottonwood Lake watershed that drains via Cottonwood Creek, and (3) Little Susitna River that heads in Nancy Lake and the Talkeetna Mountains.

All five species of Pacific salmon return to the Big Lake watershed (approximately 176,486 hectares). Sockeye and coho salmon are the dominant species, and escapements have been monitored since 1936. Chinook, pink, and chum salmon have only minor representation. Commercial fishing for Big Lake sockeye and coho salmon occurs in Cook Inlet with drift and set nets. To protect sockeye salmon spawners in the watershed, sport fishing is prohibited; however, after the escapement goal of 50,000 sockeye salmon has been met, both commercial and personal-use fisheries may be opened by emergency order. Curtailment of recreational fishing for coho salmon prior to mid-August usually ensures that half of the coho salmon run escapes potential harvest in an intertidal sport fishery. Depending on run strength, this catch normally ranges from 150 to 500 fish. In 1987 the Fish Creek coho salmon sport fishery will not open unless an escapement of 1,000 coho salmon is achieved.

The Cottonwood Creek watershed (approximately 331 hectares) consists of numerous interconnected lakes that drain through Wasilla Lake and into Cottonwood Creek. Although all five species of Pacific salmon use the system, coho and sockeye salmon

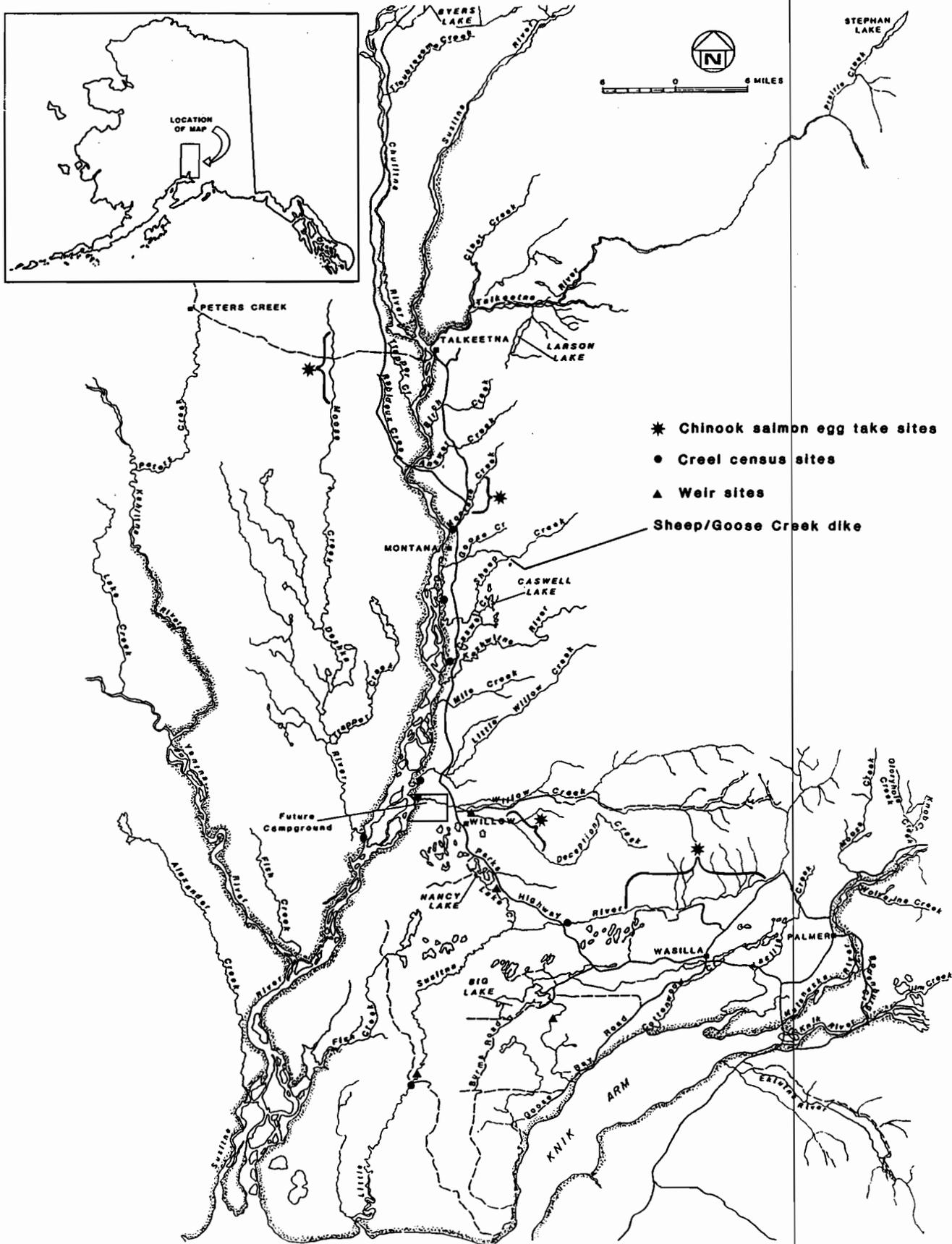


Figure 1. Northern Cook Inlet drainages, creel-census location, weir sites, and egg-take locations.

are predominant. During the 1970s, Sport Fish Division's annual index-area counts indicate the presence of only a few hundred sockeye and coho salmon spawners. Since then, the number of people in the Matanuska-Susitna Valleys has increased, access has become easier, numerous subdivisions have been built, and many road-related culverts have been placed within this system. Sport fishing for sockeye salmon is prohibited, but during mid-August through September, weekend openings allow fishing for coho salmon in the lower 6 km of Cottonwood Creek.

The Little Susitna River (approximately 72 km in length) supports a coho salmon run that has exceeded 35,000 fish (sport catch plus escapement) in recent years. No special freshwater management strategies have been required to ensure escapement.

OBJECTIVES

Chinook Salmon Enhancement and Biological Studies

1. Use a double weir arrangement on Deception Creek (tributary to Willow Creek) to enumerate spawners, hold brood fish, and serve as a mechanism for taking eggs and identifying marked fish. Use creel-census and carcass surveys to recover coded-wire-tagged fish and these results will be used to estimate contribution to the fishery. Incubate eggs at Fort Richardson Hatchery and release zero-age smolts in Willow, Sheep, and Montana Creeks in 1988.
2. Conduct pioneer egg take in Little Susitna River in July 1988. Incubate eggs at Fort Richardson Hatchery, and plant zero-age smolts in Little Susitna River in 1988.
3. Conduct egg take in the Deshka River in July 1987. Incubate eggs to the eyed stage at Fort Richardson Hatchery and then

transport them to Esther Hatchery in Prince William Sound. Raise fish to smolt stage and plant at selected locations in Prince William Sound; sport fishermen will be the primary beneficiaries.

4. Conduct disease screening at Alexander, Caswell, Sheep, Goose, and Montana Creeks. Pathology section personnel will conduct on-sight tissue analyses at Montana Creek.
5. Monitor Sheep and Goose Creek diversion dike for chinook salmon spawner distribution in both creeks.
6. Monitor escapement and location of spawners, which are potential brood sources for sport fish enhancement programs, in Prairie, Lake, and Alexander Creeks.

Coho Salmon Enhancement and Biological Studies

1. Evaluate the hatchery contribution to the smolt stage of fry planted into Fish Creek (Big Lake drainage) by Big Lake Hatchery staff. Determine the hatchery contribution to adult lifestage by recovery of coded-wire-tagged fish during the immigration and the egg take.
2. Evaluate the hatchery (Big Lake and Fort Richardson) contribution of smolts to Lake Creek, Nancy Lake, and Little Susitna River drainages. Determine hatchery contribution of adults by recovery of coded-wire-tagged fish during weir escapement counts, creel censuses, egg takes, and carcass surveys.
3. Collect tissue samples from coho salmon at Willow, Little Willow, and Lake Creeks and screen for diseases.

4. Take approximately 500,000 eggs at Little Susitna River, incubate at Fort Richardson Hatchery, and release as age-1.0 smolts in Nancy Lake.
5. Take approximately 1,000,000 eggs at Little Susitna River, incubate at Big Lake Hatchery, and release as fry into tributary lakes of the Little Susitna River; i.e., Delyndia, Butterfly, Horseshoe, Finger, and Nancy Lakes.
6. Take approximately 1,000,000 eggs at Fish Creek and Meadow Creek (Big Lake drainage), incubate at Big Lake Hatchery, and release fry into the Big Lake and Cottonwood Creek drainages and as smolts into Wasilla and Jim Creeks.
7. Take approximately 300,000 eggs at Cottonwood Creek (if spawners are available), incubate at Big Lake Hatchery, and release as fry into the Cottonwood Creek drainage.
8. Conduct aerial surveys for adult coho salmon escapement in the Little Susitna River and Willow Creek by helicopter.
9. Count coho salmon escapement at weir and recover marked fish in Fish Creek.
10. Conduct aerial surveys and assess beaver dams in road-system drainages and priority drainage of west side Susitna River tributaries to locate problem areas for fish passage.
11. Maintain equipment; i.e., smolt weir samplers, nets, out-board motors, and vehicle.

MATERIALS AND METHODS

Mark Recovery of Chinook Salmon

Marked adult chinook salmon were recovered at weirs and at Sport Fish Division creel-census locations (see Figure 1). Each marked fish was handled according to sampling instructions provided by ADF&G (1986) and forwarded to the lab for tag extraction, decoding, and identification.

Fish caught at weirs provided mark-recapture data, information about run timing and escapement, as well as samples to determine average sizes and ages. In addition, fish were collected for egg takes. At the Little Susitna River, Sport Fish Division personnel operated a weir to count the escapement of several species (Bartlett 1987).

A weir for collecting and counting adult chinook salmon, located at the mouth of Deception Creek (a tributary to Willow Creek), was operational from 6 July through 7 August (see Figure 1). The weirs at Deception Creek and Little Susitna River were designed specifically for those locations. Each weir was oriented so that fish would be directed into a holding box for sampling. The holding boxes were located in the main channel.

The Deception Creek weir was constructed of 1.8-m-long x 1.3-cm-diameter conduit inserted through holes 2.54 cm apart in 3.04-m-long, 5-cm x 5-cm x 4.7-mm aluminum angle. Weir sections were supported by tripods constructed from 2-m-long x 6.35-cm-diameter aluminum conduit. A live box was also constructed from aluminum angle and conduit materials; its dimensions were 2.45-m-long x 1.22-m-wide x 0.91-m-high. The floor and lids were of marine plywood painted light green.

The creel census for chinook salmon was operated by Sport Fish Division personnel at the confluences of Willow, Sheep, and Montana Creeks and the Deshka and Susitna Rivers (Bartlett 1987).

Estimation of hatchery contributions to the adult population was determined according to the formulas suggested by Kit Rawson (pers. comm., 1986):

$$\text{contribution estimation} = (m) (E1) (E2)$$

$$\text{variance of contribution estimation} = (m) (E1)^2 (E2)^2$$

$$\text{standard deviation of estimation} = \text{square root of}$$

$$[(m) (E1)^2 (E2)^2]$$

where:

E1 = number released/number marked

E2 = run size/number examined

m = number of marks recovered

Chinook Salmon Egg Takes

The Fish Culture Manual (ADF&G 1983) outlines the basic procedures for collection and spawning of fish; however, the actual collection techniques for brood fish varies both between and within the drainages. Except for the Deception Creek weir, the egg-take sites in northern Cook Inlet are remote (see Figure 1), and fish must be collected with nets. Collection of fish was done by hauling one floating, stretched gill net downstream toward a second barrier gill net. Gill nets consisted of #15 green nylon monofilament 9.1 m long by 1.8 m deep with 76-mm-square mesh netting; a vertical line at each end was tied to the float line, webbing, and lead line. The "poly" float line had a 38-mm diameter, eye loops were located on all four corners of the net, and 76- by 127-mm floats were spaced at 380-mm intervals. The single, lead-core line weighed 0.7 kg/m; lead and vertical lines were tied every 152 mm.

ining the proportion of hatchery-produced fish in the respective populations.

At Fish Creek, a tributary to Knik Arm of northern Cook Inlet and the outlet of Big Lake, smolts were individually hand-counted during the entire 18-h "day" (0200 to 2000 h) and 6-h night sampling periods; however, when the number of smolts dramatically increased, a biomass-sampling technique was used. Estimates were calculated by multiplying the average weight of subsamples of a known number of smolts (approximately 100 fish per subsample) by the mass weights of smolts captured/20 min.

Fish caught during the sampling periods were anesthetized in a solution of 2.3 g MS-222 and 3.0 g NaHCO₃ in 45.5 liters of water, counted, and examined for marks. Scale samples were collected from both marked and unmarked fish, and size measurements were recorded.

At Lake Creek, a tributary to the Little Susitna River and the outlet of Nancy Lake, the number of smolts was estimated from biomass samples between 2000 h to 0200 h; there was no sampling from 0200 h to 2000 h. Scale samples were collected from both marked and unmarked fish, and size measurements were recorded. The main intent was to document the proportion of the run that resulted from smolt and fingerling plants.

At Lake Creek, the number of smolts emigrating from 6 May to 30 June was estimated by sampling the night portion of the run. This emigration period was divided into 2-min periods for sampling purposes; 100% of the 2-min periods were selected, and all fish emigrating during these periods were counted. The sample was systematically selected (Cochran 1977); i.e., fish were enumerated during the first 2 min of each 20-min interval.

The calculations used to estimate the hatchery contribution to the smolt population were determined from the proportion of hatchery-produced smolts in the smolt catches based on the formulas:

$$T = (H/n1) (m3/n3)$$
$$C = (H/n1) (E/n3) (m3)$$
$$q = C/H$$

where:

- T = estimated proportion of hatchery-produced smolts in the emigrating smolt population
- C = estimated number of hatchery-produced smolts in the migration
- q = estimated survival of hatchery-produced fish to smolt stage
- H = number of hatchery-produced fish released
- n1 = number of marked fish released
- E = estimated number of smolts in migration
- n3 = number of smolts caught that were examined for marks
- m3 = number of marked smolts found

After the population size and the proportion of hatchery-produced smolts were estimated, the numbers of hatchery-produced smolts and their survival rates were calculated. All smolts were placed into a holding box immediately after enumeration to recover before they were released. During each sampling period, lengths (mm) and weights (g) from 20 fish were recorded, and seven scales from the "preferred area" were collected and mounted. In addition, all fish with clipped fins were measured and weighed, and scale samples were taken. Scales were placed on 7.62-cm x 2.54-cm microslides and covered by another slide. Ages of the smolts were determined from the scales by using a Microfiche reader, and age designations were recorded according to the European formula.

Adult Studies Coho Salmon

Eggs from coho salmon were incubated at Big Lake and Fort Richardson Hatcheries. After hatching and rearing to the fingerling stage at Big Lake Hatchery or the smolt stage at Fort Richardson Hatchery, the juvenile fish were transported to selected locations. To evaluate their survival to the adult stage, fish from both facilities were marked by excising the adipose fin and inserting a CWT. Marking procedures were conducted in accordance with the procedures described by Moberly et al. (1977). The number of fish to mark and the required number to recover was determined by FRED biometrics staff (Region II). Usually, the mark-recovery plan was designed for the smolt or adult life stage.

Coded-wire tagged fish were recovered at weirs, Sport Fish Division creel-census sites, or egg-take locations. Heads or snouts from marked fish were forwarded to the FRED Division Tag Lab for tag extraction, decoding, and identification.

Fish caught at weirs provided mark-recapture data, information about run timing and escapement, and size and age data. In addition, fish were collected for subsequent egg takes.

From 1984 to 1986, a weir for adult coho salmon, located approximately 1.6 km downstream from the outlet of Big Lake in Fish Creek, was fished from early July through late August or mid-September. Big Lake Hatchery personnel operated the hatchery weir for coho salmon brood-stock collection on Meadow Creek, upstream from Big Lake. The operation and design of the Meadow Creek weir was described by Clevenger (1986). On the Little Susitna River, Sport Fish Division personnel operated a weir to count the escapement of several species (Bartlett 1987).

The weirs for Cottonwood, Meadow, and Fish Creeks were designed specifically for each location. The Cottonwood and Fish Creek

weirs were oriented to direct fish into a holding box until they could be sampled. The holding boxes were located in the main channel, because most fish migrated through the deepest part of the creek.

During most years, an in-water viewing device was used to examine the ventral fins in addition to handling the fish. This method employed a glass-bottomed box to see through the surface film of the water and a light-colored plate on the substrate to increase the contrast between the background and the subject. The device was located just above the opening of the weir where the fish paused briefly and flared their fins before proceeding into the holding box. The observer looked down from above to determine if both ventral fins were present.

Creel censuses for coho salmon were conducted by Sport Fish Division personnel at Houston, the Burma Road, and the Ship Creek (Anchorage) boat landing to recover coded-wire tags from marked fish caught in the Little Susitna River (Bentz 1986; Bartlett 1987). Estimation of hatchery contributions to the adult populations was determined with the same methods listed under the section covering mark recovery of chinook salmon.

Monitoring coho salmon returns to spawning grounds on the Little Susitna River and Willow Creek was done by foot and helicopter surveys. Holding areas adjacent to spawning beds were determined by helicopter. Maturation stage was determined on spawning grounds by test-netting with floating gill-net capture techniques used in remote egg takes. Information gathered about Little Susitna River coho salmon brood stock was used for in-season egg-take purposes. Escapement counts at Fish Creek were also used to determine the number of adults available for egg takes if brood stock did not appear in the holding area at the Meadow Creek weir at Big Lake Hatchery. The Willow Creek brood stock was evaluated for potential egg takes for a future project. In July and August

aerial surveys were flown to identify beaver dams that restricted adult migration to spawning grounds. Blockages were removed.

RESULTS

Mark Recovery of Chinook Salmon

Chinook salmon eggs have been taken from selected drainages of northern Cook Inlet since 1983 (Table 1). During 1986 studies of returning adults were implemented to assess the results of releases.

Chinook salmon smolts were first released into Deception Creek (tributary to Willow Creek) in 1985; of 534,389 released, 30,275 fish were marked. The average year-class composition of the Willow Creek chinook salmon stock has been (1) age 1.2, 15%; (2) age 1.3, 21%; and (3) age 1.4, 64%. Typically, no age-1.1 "jacks" have been observed either because sport fishermen are not required to log their catch or because they are released. Scale reading of 223 chinook salmon caught at Deception Creek weir in 1986 indicated the following age composition: (1) age 0.1 and 1.1 fish, 7%; (2) age-1.2 fish, 15%; (3) age-1.3 fish, 26%; and (4) age-1.4 fish, 52%.

Marked chinook salmon from the 1985 release have been recovered at Deception Creek in 1986 at ages 0.1 and 1.1 and in 1987 at ages 0.2 and 1.2. Of the 121 "jack"-size chinook salmon aged in 1986, five were marked with excised adipose fins; one fish was age 1.1 and the remaining fish were age 0.1. Approximately 72% of the "jack" population in Deception Creek was of hatchery origin. In 1987, 692 age-0.2 and 1.2 fish were examined for marks; 28 marks were noted. Heads from 14 marked fish were collected and forwarded to the FRED Division Tag Lab for tag

Table 1. Fort Richardson Hatchery chinook and coho salmon production for northern Cook Inlet.

Species	Brood year	Eggs incubated		Fish released					Dominant return year
		Origin	Number	Year	Location	Lifestage	Total number	Number marked	
Chinook	1983	Willow Creek	307,000	1985	Willow Creek	smolt	101,256	8,152	1989
Coho	1983	Little Susitna R.	56,000	1985	Little Susitna R.	smolt	54,000	12,000	1986
Chinook	1984	Willow Creek	759,000	1985	Willow Creek	smolt	433,133	22,123	1989
					Prince Wlm. Snd.	smolt	147,106	18,454	1989
Coho	1984	Little Susitna R.	594,000	1986	Little Susitna R.	smolt	474,106	23,217	1987
Chinook	1985	Willow Creek	377,000	1986	Willow Creek	smolt	325,304	28,188	1990
Chinook	1985	Deshka River	458,200	1986	Prince Wlm Snd.	smolt			
Coho	1985	Little Susitna R.	552,000	1987	Little Susitna R.	smolt	247,843	20,187	1990
Coho	1985	Caswell Creek	60,000	1987	Caswell Creek		31,767	0	1988
Coho	1986	Little Susitna R.	549,700	1988	Little Susitna R.	smolt			
Chinook	1987	Willow Creek	600,000 ^{a/}						
Chinook	1987	Deshka River	250,000 ^{a/}						

^{a/} Preliminary estimate

extraction and reading. From foot surveys, an estimated 850 chinook salmon in the Willow Creek drainage were of age 0.2 or 1.2. An estimated 607 (range: 583-631) age-0.2 or 1.2 chinook salmon were of hatchery origin. Approximately 0.11% of the smolts planted returned to the stream as adults in these age classes. During a Sport Fish Division creel census, two heads from age-0.1 or 0.2 marked fish were collected. Other fish may have been caught in various unmonitored fisheries.

Chinook Salmon Egg Takes

A fish transport permit to enhance the Montana, Sheep, and Willow Creek drainages with chinook salmon originating from one Willow Creek egg take was approved. The Deception Creek weirs were installed on 7 July. Within a week, enough fish (110-130 females) to take approximately 1 million eggs were being held. The weir survived a flood; the water rose 45 cm (1.5 ft). At a later date, however, site personnel were unable to prevent four inebriated men from pulling out weir pickets faster than they could be replaced. Consequently, the entire brood stock moved upstream.

Rain during 24-27 July and from 31 July to 7 August resulted in flash flooding of the Little Susitna and Deshka Rivers, Willow, Sheep, and Montana Creeks. The collection of chinook salmon eggs was constrained by the high-water conditions.

Over a 2-week period at Willow Creek, collection of chinook salmon brood stock in a 5-7-km reach (see Figure 1) yielded an estimated 600,000 eggs. Eggs were transported to Fort Richardson Hatchery for incubation and rearing (Wall 1987). No chinook salmon eggs could be collected from Little Susitna River. An estimated 300,000 chinook salmon eggs were collected from the Deshka River and transported to Fort Richardson Hatchery. Later, the eggs will be divided for use by Esther Hatchery and programs designed for Valdez Arm of Prince William Sound.

Disease History of Chinook Salmon

Northern Cook Inlet disease histories from current and prospective brood sources are presented in Table 2. Targeted for chinook salmon disease screening in 1986 was Alexander Creek, which is a lower "west-side" Susitna River tributary. Pathological findings indicate a low presence of viral agents and no other pathogens present, making this potential source of chinook salmon suitable for brood-stock use.

Chinook Salmon Escapement at Sheep/Goose Creek Dike

On 18 July 1987, both Sheep and Goose Creeks were surveyed by floating and walking from the water-diversion dike to the Parks Highway. Approximately 400 and 1,050 chinook salmon were observed in Goose and Sheep Creeks, respectively. Based on schooling behavior and distribution of fish, we estimated that peak spawning would occur between 20 and 27 July.

Prior to the 100-year flood in fall 1986 (Chlupach 1986), Sheep Creek Slough, which passes by the mouth of Goose Creek, was gradually being isolated from the Susitna River and dewatered. This appeared to be the result of a log jam. After the flood, the size of the log jam increased, and even less water flows into this slough. The Goose Creek flow is unaffected, but with less flow in the slough, the water level in the mouth of Goose Creek is no longer as high. All flows are adequate, however, so there is no impedence to chinook salmon migration through the slough or up Goose Creek.

Escapement Monitoring at Remote Locations

Chinook salmon within Alexander, Lake, and Prairie Creeks and drainages (see Figure 1) have been surveyed to determine the best

Table 2. Summary of disease history of salmon stocks in northern Cook Inlet.

Species	Brood stock	Lifestage	Sampling location	Disease Organism									
				IHN		BKD		Furunculosis		Pseudomonas			
				Number positive	Number samples	Number positive	Number samples	Number positive	Number samples	Number positive	Number samples		
Sockeye	Fish Creek	adult	Big Lake Hatchery	174	310								
Sockeye	Fish Creek	adult	Fish Creek	22	64								
Sockeye	Fish Creek	fry	Big Lake Hatchery	2	74	0	10	0	10				
Sockeye	Larson Lake	adult	Larson Lake	8	70								
Coho	Fish Creek	fry	Big Lake Hatchery	4	30	0	10	2	22	2	12		
Coho	Fish Creek	adult	Fish Creek			0	100	0					
Coho	Fish Creek	fry	Eklutna Hatchery			0	20	0	20				
Coho	Cottonwood Creek	smolt	Cottonwood Creek			0	55						
Coho	Little Susitna R.	adult	Little Susitna River			0	64						
Coho	Deshka River	adult	Deshka River			0	65	2	65				
Coho	Caswell Creek	adult	Caswell Creek			0	64	0	64				
Coho	Sunshine Creek	fry	Sunshine Creek			0	62	0	62				
Coho	Rabideaux Creek	fry	Rabideaux Creek			0	100	0	100				
Coho	Rabideaux Creek	fry	Rabideaux Creek			0	55	0	55				
Coho	Birch Creek	fry	Birch Creek			0	60	0	60				
Coho	Clear Creek	adult	Clear Creek			0	55	0	55				
Coho	Willow Creek	adult	Willow Creek			0	59	1	59				
Coho	Horseshoe Creek	adult	Horseshoe Creek			0	28	0	28				
Chinook	Willow Creek	adult	Willow Creek	0	61	0	63	0	63				
Chinook	Prairie Creek	adult	Prairie Creek	0	66	0	94	52	94				
Chinook	Deshka River	adult	Deshka River	0	100	0	63	0	63				
Chinook	Lake Creek	adult	Lake Creek	0	70	0	83	48	83				
Chinook	Montana Creek	adult	Montana Creek	0	54	0	91	26	96				
Chinook	Little Susitna R.	adult	Little Susitna River	0	76	0	67	5	67				
Chinook	Alexander Creek	adult	Alexander Creek	2	63	0	76	0	76				
Pink	Willow Creek	adult	Willow Creek			0	20						
Chum	Willow Creek	adult	Willow Creek			0	60						
Chum	Little Susitna R.	adult	Little Susitna River			0	60						

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tactical areas for potential egg takes, areas of best spawner concentration, and approximate spawning times. Judging from fish distributions and fish movement toward spawning areas, peak spawner availabilities were estimated as 15-22 July in Alexander Creek, 27 July-4 August in Lake Creek, and 27 July-4 August in Prairie Creek.

Juvenile Coho Salmon Studies

Coho salmon have been planted in selected drainages of northern Cook Inlet since 1976 (Tables 1 and 3). During 1987 studies to estimate the coho salmon smolt population in the Big Lake drainage commenced 6 May and ended 30 June. An estimated 95,075 coho salmon smolts migrated through Fish Creek weir. Of 31,877 fish observed, 95 had excised adipose fins. An estimated 30,424 age-2.0 smolts were of hatchery origin. Hatchery-produced smolts comprised 32% of the migrants, and the estimated survival rate from stocked fingerlings to age-2.0 smolts was 2.9%.

Of 610 readable scales, 15% were from age-1.0 smolts, 82% were from age-2.0 smolts, and 3% were from age-3.0 smolts. Mean lengths and weights for age-1.0, 2.0, and 3.0 smolts were 108 mm and 13 g, 128 mm and 19 g, and 151 mm and 35 g, respectively. No marked age-1.0 or age-3.0 smolts were found among fish used for scale samples, but marked age-2.0 smolts averaged 130 mm and 20 g.

Coho salmon smolts and fingerlings were planted in Nancy Lake, which drains into the Little Susitna River via Lake Creek. Smolts were planted in May 1987 and fingerlings in May 1985. A smolt weir was operated over a 10-day period during the expected peak migration. The night-time sampling was conducted between 2000 hr and 0200 h for 2 min every 20 min. The primary purpose was to determine the hatchery contribution resulting from fingerling and smolt releases.

Table 3. Big Lake Hatchery coho salmon production, 1977-1987.

Brood year	Eggs incubated		Fry released					Dominant return year
	Drainage	Number	Year	Location	Size (g)	Number	Number marked	
1976	Big Lake	79,983	1977	Big Lake	0.28	40,673	23,852	1980
1977	Big Lake	589,623	1978	Big Lake	0.70	101,081	40,959	1981
1977	Big Lake		1978	Cottonwood Lake	0.80	317,694	32,064	1981
1978	Big Lake	842,238	1979	Big Lake	0.49	383,295	20,218	1982
			1979	Cottonwood Lake	0.54	246,762	19,992	1982
1979	Big Lake	927,708	1980	Big Lake	0.64	99,736	0	1983
			1980	Big Lake	0.38	351,151	22,337	1983
			1980	Cottonwood Lake	0.63	154,991	15,000	1983
			1980	Cottonwood Lake	0.49	155,004	15,000	1983
1980	Big Lake	543,081	1981	Big Lake	0.46	118,071	13,072	1984
			1981	Cottonwood Lake	0.78	179,117	18,450	1984
			1981	Cottonwood Lake	0.45	181,658	18,500	1984
1981	Big Lake	1,242,993	1982	Big Lake	0.41	585,548	23,085	1985
1981	Little Susitna	3,113	1982	Cottonwood Lake	0.45	364,911	86,850	1985
			1982	Little Susitna	0.40	2,950	0	1985
1982	Big Lake	2,782,857	1983	Big Lake	0.45	1,612,337	21,607	1986
1982	Cottonwood Lake	232,332	1983	Cottonwood Lake	0.45	368,022	21,917	1986
1982	Little Susitna	500,775	1983	Little Susitna	0.57	216,508	20,835	1986
1983	Big Lake	1,664,295	1984	Big Lake	0.76	986,552	10,000	1987
1983	Cottonwood Lake	25,796	1984	Cottonwood Lake	0.91	372,318	10,000	1987
1983	Little Susitna	547,214	1984	Little Susitna	0.91	426,216	10,000	1987
1984	Big Lake	3,082,000	1985	Big Lake	0.30	1,053,000	10,000	1988
	Cottonwood Lake	35,000	1985	Cottonwood Lake	0.30	336,000	10,000	1988
	Little Susitna	1,350,000	1985	Little Susitna	0.30	1,225,000	10,000	1988
1985	Big Lake	2,620,000	1986	Big Lake	1.0	2,355,000	15,000	1989
	Cottonwood Lake	0	1986	Cottonwood Lake	1.0	316,000	10,000	1989
	Little Susitna	364,000	1986	Little Susitna	1.0	316,270	0	1989
1986	Big Lake	2,900,000	1987	Big Lake				
	Little Susitna	15,000						

A total of 20,817 fish was examined for marks; 976 were marked, and scale samples were collected from 206 of these fish. An estimated 92% of the population sampled were hatchery-produced fish: 55% from smolts released from Fort Richardson Hatchery and 37% from fingerlings released from Big Lake Hatchery.

Adult Coho Salmon Studies

Mark Recovery:

Coho salmon have been planted into selected drainages of northern Cook Inlet since 1976 (Tables 1 and 3). During 1980-1986, adult fish studies were implemented to assess the results of these releases. For 1987, however, only early in-season mark-recovery results are currently available. Mark recovery for the 1987 return will be completed by mid-October 1987 and reported in its entirety in the FY 1988 annual report.

A weir at Cottonwood Creek was fished from 14 July through 7 September 1981 and 20 July through 6 September 1982. A total of 2,436 and 764 fish in 1981 and 1982, respectively, were enumerated. In both years, weir operations were limited because of monetary restrictions; however, on 6 September 1982, an estimated 1,300 fish were holding in pools between the intertidal area and the weir. Consequently, the estimated run strength was 2,064 fish (Appendix 1). Most of the fish had moved upstream by 15 September. In 1981 when no additional fish were observed holding in pools between the weir and intertidal area, the weir was removed (Appendix 2).

During 1981, 2,436 fish were examined at the weir, and 67 marked fish were observed. An estimated 683 (range: 521-803) fish (28%) were of hatchery origin (Table 4). Approximately 0.21% of the planted fingerlings returned to the stream as adults; others died or were caught in various fisheries.

Table 4. Estimated adult coho salmon hatchery contribution in northern Cook Inlet, 1980-1986.

Drainage	Year	Dates of weir operation	Total escape	Percent thru weir at end	Number of Fish			Range		Percent hatchery produced	Percent survival to stream	Release stage
					Examined	Marked	Hatchery produced	Low	High			
Cottonwood Lake	1981	14 July-7 Sept	2,436	100	2,436	67	683	521	803	28	0.21	fingerling
Cottonwood Lake	1982	20 July-6 Sept	2,064	37	764	11	376	348	386	18	0.15	fingerling
Big Lake	1980	16 July-1 Sept	8,924	100	8,924	441	752	725	779	8	1.85	fingerling
Big Lake	1981	9 July-7 Sept	2,382	100	2,382	72	178	165	191	7	0.18	fingerling
Big Lake	1982	18 July-8 Sept	5,201	58	3,001	66	2,136	2,116	2,210	42	0.56	fingerling
Big Lake	1983	15 July-31 Aug	2,342	44	1,037	8	365	346	384	16	0.08	fingerling
Big Lake	1984	18 July-19 Sept	4,510	64	2,880	9	128	117	139	3	0.11	fingerling
Big Lake	1985	25 July-30 Aug	5,089	29	1,499	15	1,289	1,253	1,325	25	0.22	fingerling
Big Lake	1986	14 July-26 Aug	2,166	37	816	9	1,746	1,704	1,788	81	0.11	fingerling
Little Susitna R.	1986	17 July-8 Sept	6,999	100	4,359	35	79	33	125	1	0.04	fingerling
Little Susitna R.	1986						367	302	432	3	0.68	smolt

In 1982, 764 fish were examined at the weir, and 11 marked fish were observed. An estimated 367 (range: 348-386) fish (18%) were of hatchery origin. Approximately 0.15% returned to the stream as adults; others died or were caught in various fisheries.

All coho salmon caught in Cottonwood Creek had spent 1 year in the ocean (Table 5). Most coho salmon spend 2 years rearing in fresh water; only a small proportion of them spend 1 year in fresh water.

From 1980 through 1986, weir operations began in early July and usually extended into early September. In 1980 and 1981 the weir was located between the Knik Arm-Goose Bay Road and the inter-tidal area. Because of vandalism and harassment of personnel, the weir was moved in 1982 to a site approximately 14.5 km upstream (about 1.6 km from Big Lake outlet). Escapement counts for the latter site indicate approximately 45% (range: 29%-64%) of the fish have passed the weir by the end of August (Appendices 3-9).

Annual escapement of coho salmon into the Big Lake drainage has fluctuated greatly (Table 6). Some of the fluctuation is, apparently, an artifact of the enumeration times and methods; but it appears that run sizes since 1970 have been smaller than during earlier years, possibly because data were rarely collected later than early August.

Since 1982 hatchery-produced fish have made an important contribution to the escapement of coho salmon into Fish Creek (Table 4). In 1986 the adult contribution of hatchery-produced coho salmon was determined twice during the adult return: (1) at the enumeration weir on Fish Creek and (2) at the egg-take weir on Meadow Creek. At the Fish Creek weir, 816 fish were examined, and nine fish were marked. An estimated 1,746 (range: 1,704-1,788) fish (81%) were of hatchery origin. At the egg-take site on Meadow Creek, 2,005 fish were examined, and 23 marks were

Table 5. Percent age composition of adult coho salmon, Cottonwood Creek, 1981 through 1982.

Year	Age class ^{a/}								Adult escapement
	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	
1981	23	0	0	72	0	0	5	0	2,436
1982	16	0	0	83	0	0	1	0	2,064

^{a/} Sample size for age composition was no less than 10% proportionately sampled for the duration of the return.

Table 6. Coho salmon escapement into Fish Creek, Big Lake watershed, 1936 through 1986.

Year	Dates	Methods	Total number coho salmon	5-year mean
1936	7/15-8/11	Weir		
1937	7/21-8/09	Weir	489	
1938	7/10-8/08	Weir	19,417	
1939	7/11-8/12	Weir	2,764	
1940	7/04-8/12	Weir	16,546	
1941	7/04-8/09	Weir	9,720	9,787
1942-1948	No actual counts conducted			
1949	7/09-8/17	Weir	1,642	
1950	7/09-8/17	Weir	1,042	
1951	7/04-8/16	Weir	1,953	
1952	7/12-8/09	Weir	277	
1953	7/11-8/05	Weir	71	
1954	7/13-8/09	Weir	1,057	
1955	7/08-8/08	Weir	4,417	
1956	7/08-7/31	Weir	22	1,169
1957	7/12-8/25	Weir	15,630	
1958	7/04-7/28	Weir	592	
1959	7/10-8/02	Counting Screen		
1960	7/04-7/31	Counting Screen		
1961	7/04-7/31	Counting Screen		
1962	7/04-7/31	Counting Screen		
1963	7/04-8/01	Counting Screen	1,814	
1964	7/04-7/31	Counting Screen		
1965	7/04-8/08	Counting Screen	792	
1966	7/05-7/31	Counting Screen		
1967	7/03-7/31	Counting Screen	984	
1968	7/01-7/31	Counting Screen	2,088	
1969	7/04-9/02	Weir	4,253	
1970	7/04-8/08	Weir	1,048	
1971	7/03-8/07	Weir	583	1,791
1972	7/02-9/08	Weir	709	
1973	7/01-9/06	Weir	210	
1974	7/07-9/06	Weir	1,154	
1975	7/03-9/11	Weir	1,601	
1976	7/05-9/10	Weir	765	888
1977	7/05-8/15	Weir	970	
1978	7/03-9/30	Weir	3,121	
1979	7/05-8/30	Weir	3,000	
1980	7/04-9/01	Weir	8,832	
1981	7/09-9/07	Weir	2,261	3,637
1982	7/12-9/08	Weir	5,201	
1983	7/05-8/30	Weir	2,342	
1984	6/29-9/19	Weir	4,510	
1985	7/25-8/30	Weir	5,089	
1986	7/14-8/26	Weir	2,166	

observed; and estimated 1,854 (range: 1,486-2,240) fish (86%) were of hatchery origin.

Typically, 75% of the adult coho salmon returning to Fish Creek are age 2.1 (Table 7). Other important age classes include ages 1.1 and 3.1. Coho salmon from Fish Creek rarely remain in the ocean for 2 years.

In 1986 marked adult coho salmon were caught in the Little Susitna River drainage. At the Sport Fish Division weir on the lower river and from the creel censuses at Burma Road, Houston, and the Ship Creek boat launching ramps, a total of 4,359 fish was examined. Heads from 35 marked fish were collected for extraction of coded-wire tags; of these, 21 tags were extracted. The estimated adult contribution from coho salmon released as smolts was 367 fish (range: 302-432), while that from those released as fingerlings was 79 fish (range: 33-125). Thus an estimated 10.2% of the adult coho salmon caught in the Little Susitna River were hatchery-produced.

Egg Takes

Coho salmon egg takes in 1987 are scheduled in northern Cook Inlet from approximately 7 September to 10 October. The goal is to take 875,000 eggs, incubate and rear them at Fort Richardson Hatchery, and release resulting smolts. Another 2-3 million eggs are planned for incubation at Big Lake Hatchery for release as fingerlings, presmolts, and smolts.

In 1988 approximately 300,000 and 150,000 smolts from Fort Richardson Hatchery are scheduled for release in the Little Susitna River and Caswell Creek drainages, respectively. Another 210,000 smolts from a northern Cook Inlet brood source will be distributed for enhancement projects in Homer and Cordova. Production from Big Lake Hatchery will include releases for Big

Table 7. Percent age composition of adult coho salmon, Fish Creek, 1973 through 1986.

Year	Age class ^{a/}								Adult escapement
	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	
1973	0	0	0	100	0	0	0	0	210
1974	8	0	0	81	0	0	11	0	1,154
1975	0	0	0	83	0	0	17	0	1,601
1976	13	0	0	83	2	0	2	0	765
1977	14	0	0	79	2	0	6	0	970
1978	4	0	0	94	1	0	1	0	3,121
1979	2	0	0	95	1	0	2	0	3,000
1980	7	0	0	80	0	0	13	0	8,832
1981	11	0	0	76	0	0	12	0	2,261
1982	2	0	0	97	0	0	1	0	5,201
1983	17	0	0	76	0	0	7	0	2,342
1984	17	0	0	77	0	0	6	0	4,510
1985	2	0	0	50	0	0	48	0	5,089
1986	10	0	0	72	0	0	18	0	2,166

^{a/} Sample size for age composition was no less than 10% proportionately sampled for the duration of the return.

Lake and Cottonwood Lake drainages, Wasilla Creek, Rabbit Slough, and Jim Creek.

Disease History

Northern Cook Inlet coho salmon disease histories from current and prospective brood-stock sources are presented in Table 2. In 1986 tissue samples from coho salmon were collected at Willow and Horseshoe Creeks. From 59 Willow Creek samples, no pathogens were noted that would prevent their future use as a brood source for the Willow Creek drainage. Also, no pathogens were detected from 28 samples collected at Horseshoe Creek; however, the sample size is incomplete and more are scheduled for collection in fall 1987. This brood stock, if "clean", may be used for possible enhancement efforts at Byers Lake.

Escapement Monitoring

In September 1987, coho salmon escapement surveys will be coordinated with Sport Fish Division. Streams will be monitored from helicopter; particular attention will be paid to fish distributions, concentrations in riffles and deeper reaches, and behavior as they move toward spawning areas.

DISCUSSION

FRED Division efforts in the northern Cook Inlet area are designed to augment existing chinook and coho salmon runs. These efforts have followed the sequence of programs according to the fish species and drainage prioritization presented in an ADF&G report (1981).

Assessment of hatchery returns of adult chinook and coho salmon in northern Cook Inlet depends on coordination of a variety of

information collection systems, including (1) several Sport Fish Division creel-census projects, (2) FRED Division escapement weirs and egg takes, and (3) ground and aerial escapement surveys. With the careful coordination and intense efforts of personnel from both Sport Fish and FRED Divisions, these programs are becoming successful in rehabilitating salmon runs and increasing sport fishermen harvests.

Chinook Salmon

Chinook salmon sport fishery enhancement has been limited to the Willow Creek drainage where smolts have been stocked. Eggs have also been taken from the Deshka River for incubation and rearing. These juveniles, however, have been used as donors to support or create sport fisheries in Prince William Sound. In 1987 two additional egg takes for chinook salmon in northern Cook Inlet were scheduled: Little Susitna River and Montana Creek. High-water conditions prevented the desired goals from being met; however, smolts resulting from approximately 600,000 eggs will be apportioned for releases into Willow, Sheep, and Montana Creeks. This allows for a more comprehensive enhancement effort to road-accessible Susitna River tributaries. There does not appear to be any solution to deal with flood-water situations where gathering brood stocks are concerned, but considering the annual people-related problems when holding chinook salmon brood stock at Deception Creek, an alternate upstream site is being explored.

At Willow Creek, hatchery-origin, age-0.1 chinook salmon "jacks" and age-1.2 and 0.2 chinook salmon returned in 1986 and 1987, respectively. Of those fish that migrated past the Deception Creek weir in 1986, approximately 11% were age zero; in 1987 about 23% were age-1.2 and 0.2 fish. In 1986 and 1987 an estimated 72% and 71%, respectively, were hatchery-produced fish. Combining the estimated numbers of hatchery-produced chinook salmon from the sport fishery and the weir, the approximate estimated survival rate was 0.15%. An estimated 35 age-1.2 and

0.2 fish were harvested. It should be noted, however, that because of their size, one and two "ocean"-age fish are often not kept by anglers; so age-class composition computed from creel-census data may be misleading. With the stock composition of age-1.2, 1.3, and 1.4 chinook salmon in Willow Creek averaging 13%, 19%, and 57%, respectively, the greatest contribution will be in 1989. Some returning adult chinook salmon may be intercepted by various fisheries, but the hatchery-produced fish should be intercepted at the same rate as all Willow Creek chinook salmon.

Coho Salmon

The most popular sport fisheries for coho salmon on road-system streams in northern Cook Inlet are the Knik Arm tributaries of Jim Creek, Rabbit Slough, Cottonwood Creek, Fish Creek, and the Little Susitna River. Of these, only Jim Creek and the Little Susitna River area open 7 days each week. The Little Susitna River is the most intensive of all Knik Arm coho salmon fisheries. Angling effort on tributaries on the east side of the Susitna River (accessible by the Parks Highway) is distributed among Willow Creek, Little Willow, Caswell, Sheep, Goose, and Montana Creeks; all of these are open to coho salmon fishing every day of the week. Coho salmon enhancement projects in northern Cook Inlet are presently geared for the Little Susitna River, Cottonwood Creek, and Fish Creek, which drain into the Knik Arm, and Caswell Creek, which drains into the Susitna River. Other supplemental Knik Arm coho salmon releases into Rabbit Slough and Jim Creek have been scheduled to begin in either 1 or 2 years, depending on the number of juveniles resulting from last year's egg takes. Presently, the Fish Creek coho salmon brood stock is being developed as the donor stock for Knik Arm tributaries, except the Little Susitna River where the in-system brood stock is being used. Along the Parks Highway, the Caswell Creek enhancement project for coho salmon has been hampered by poor escapement or inaccessible brood stock. As a contingency,

however, an egg take from the Willow Creek brood stock is scheduled for next year. If the Willow Creek brood stock develops as hoped, this source could become a universal donor for east-side Susitna River tributaries from Willow Creek to Montana Creek.

Because hatchery-produced coho salmon released as smolts survive much better than those released as fingerlings and because it is often difficult to achieve egg-take goals for coho salmon, it may be appropriate to expand smolt production of Knik Arm drainages. If this can be achieved at Big Lake Hatchery, a higher percentage of adult coho salmon will be available to anglers from the limited number of available eggs. Smolts from a pilot production program have been scheduled for release into Jim Creek and Rabbit Slough. In addition, an experimental release of presmolts is scheduled for the Big Lake drainage. These fish will be released in October at nearly smolt size. These fish should require minimal rearing in the lake before emigrating the following spring. Ultimately, the intent is to obtain the greatest efficiency (i.e., adults) from the available number of eggs.

Juvenile Coho Salmon

During 1987, approximately 1.3 million smolts migrated from Big Lake. Of these, 1.2 million were sockeye salmon and 100,000 were coho salmon. There is some evidence to suggest that the large numbers of sockeye salmon smolts may be suppressing the number of coho salmon smolts. One indicator is the low survival of hatchery-produced coho salmon fingerlings to smolt (approximately 2.9%). Hatchery-produced smolts, however, comprised 32% of the migrants.

At Nancy Lake an estimated 92% of the population sampled were hatchery-produced fish: 55% from smolts released from Fort Richardson Hatchery and 37% from fingerlings released from Big Lake Hatchery.

Adult Coho Salmon

Coho salmon returning to the Cottonwood Lake drainage were examined for marks at the escapement weir in 1981 and 1982; the estimated hatchery contribution to the stream was 28% and 18%, respectively, of the total escapement. This amounted to an estimated contribution of 1,000 fish over 2 years. Subsequent assessment of hatchery contribution was discontinued because of changes in project priority and funding allocations, but enhancement has continued. The drainage is annually supplemented with approximately 400,000 coho salmon fingerlings.

In the Big Lake drainage, hatchery contribution from 1980-1986 ranged from an estimated 3% to 81%: a total of about 21,352 fish or an estimated average annual contribution of 3,050 fish per year. There is, however, no apparent correlation between the numbers of juvenile coho salmon stocked and their survival to adult or the numbers of juvenile sockeye salmon stocked and the survival of juvenile coho salmon to adult (Table 8).

Both coho salmon smolts and fingerlings have been released into Nancy Lake, which drains into the Little Susitna River. The fingerling release in 1983 was approximately 230,000 fish, while the smolt release in 1985 was about 54,000 fish. With this release strategy, the fish would return as adults in the same year. Adults from fish released as fingerlings accounted for about 1% of the return, while those from fish released as smolts accounted for about 10% of the total return: an estimated total of 1,938 fish. Based on creel-census results, the Little Susitna River is the second-highest-fished stream in the state. Subsequent smolt releases of 400,000 to 500,000 fish annually could considerably increase the number of returning adults by up to 4,000 to 5,000 fish.

Table 8. Coefficient of determination between number of sockeye/ coho salmon fingerlings stocked and percent survival to adult for coho salmon in the Big Lake drainage, 1980-1986.

Species	Coefficient of Determination ^{a/}			
	Linear regression	Exponential curve	Logarithmic curve	Power curve
Sockeye	0.18	0.16	0.09	0.24
Coho	0.15	0.16	0.36	0.28

^{a/} Coefficient of determination values close to 1.00 indicate a better fit (the regression coefficients define the generated curve) than values close to zero.

One of the largest problems confronting fishery management and enhancement staffs is the forecasting of adult returns. Through mark-recovery work and the knowledge that commercial and sport fisheries managers have for their area stocks, survival estimates may be calculated (Table 9). The forecasted returns of hatchery-produced coho salmon for Cottonwood Lake, Big Lake, and Little Susitna River drainages in 1987 are presented in Table 10. The average estimated survival rate from 1980-1986 for coho salmon fingerlings released into the Big Lake drainage is 1.43%. Because the estimated survival rate of 5.96% for fish returning in 1980 is atypical, the most appropriate value is 0.68%—the average from 1981-1986. Preliminary results in 1987 at the Little Susitna River indicate that approximately 40% or more of the sport catch is from hatchery-produced fish.

Thus far, coho salmon smolt and fingerling enhancement programs are making a positive contribution to the adult return. Since the major and potential donor brood stocks have been screened for disease, implementation of a more comprehensive program is now possible (Chlupach 1985). In the northern Cook Inlet area, all the major tributaries to Knik Arm (Jim Creek, Rabbit Slough, Cottonwood Creek, Fish Creek, and Little Susitna River) will be supplemented with coho salmon fingerlings or smolts. The development of a universal east-side Susitna River tributary coho salmon brood stock is anticipated for smolt releases into drainages from Willow Creek to Montana Creek.

CONCLUSIONS

Sport fishing opportunities have been increased in the northern Cook Inlet area through supplemental production of chinook and coho salmon, as evidenced by the following facts:

Table 9. Survival rates of hatchery-released coho salmon in northern Cook Inlet^{a/}.

Drainage	Return year	Total stream escape	Estimated percentage of adults				Est. No. of adults from hatchery	Total % surv to adult	Release stage
			Commercial harvest	Sport harvest	Escape-ment	Hatchery-produced			
Cottonwood Lake	1981	2,436	55	18	27	28	2,529	0.79	fingerling
Cottonwood Lake	1982	2,064	55	18	27	18	1,359	0.55	fingerling
Big Lake	1980	8,924	55	14	31	8	2,425	5.96	fingerling
Big Lake	1981	2,382	55	14	31	7	574	0.57	fingerling
Big Lake	1982	5,201	55	14	31	42	6,977	1.82	fingerling
Big Lake	1983	2,342	55	14	31	16	1,177	0.26	fingerling
Big Lake	1984	4,510	55	14	31	3	412	0.35	fingerling
Big Lake	1985	5,089	55	14	31	25	4,158	0.71	fingerling
Big Lake	1986	2,166	55	14	31	81	5,629	0.35	fingerling
Little Susitna R.	1986	6,999	55	22	23	1	343	0.16	fingerling
			55	22	23	3	1,595	2.95	smolt

a/ Comments:

1. Commercial fisheries interception -

Range: 50-60 percent interception of all returning adults

Personal conversation 16 April 1987 with Paul Ruesch, Area Biologist - Soldotna, Commercial Fisheries Division

2. Sport fisheries interception -

Range: 30-50 percent interception of adults returning to Cottonwood Creek, after commercial interception.

Range: 20-30 percent interception of adults returning to Fish Creek, after commercial interception.

Range: 30-60 percent interception of adults returning to Little Susitna River, after commercial interception.

Personal conversation 16 April 1987 with Larry Engel, Area Biologist-Palmer, Sport Fish Division.

3. Total survival = harvest plus escapement.

Table 10. Forecasted hatchery contribution of adult coho salmon in 1987 to Cottonwood Creek, Big Lake, and Little Susitna River drainages.

Drainage	Number of fish stocked	Release stage	Average surv (%) to adult	Forecasted		number of fish	
				Total	Commercial harvest	Sport harvest	Escapement
Cottonwood Lake	382,318	fingerling	0.67	2,561	1,408	461	691
Big Lake	996,552	fingerling	0.68	6,776	3,726	948	2,100
Little Susitna R.	639,288	fingerling	0.16	1,022	562	225	235
Little Susitna R.	577,448	smolt	2.95	17,034	9,369	3,747	3,918

1. An estimated 25% of the Willow Creek chinook salmon returns though two age-classes of fish were of hatchery origin. Returns of these fish forecast significant returns of hatchery-produced chinook salmon in future years.
2. Hatchery-produced coho salmon from fingerling and smolt releases indicate contribution levels of better than 26% in the Big Lake drainage. Smolt studies at Nancy Lake show a greater contribution from smolt releases than from fingerling releases.
3. The release of over 400,000 coho salmon smolts at Nancy Lake (a tributary to the Little Susitna River) is materializing into a significant portion of the sport catch in 1987. Preliminary creel-census figures indicate an estimated 40% or greater contribution to the fishery.

To broaden and improve enhancement opportunities, additional information was collected during 1987 about the relative abundance, distribution, and run timing of chinook and coho salmon. Tissue samples from candidate brood stocks for priority drainages is nearly complete; however, collection of samples from other watersheds continues for possible future enhancement programs.

RECOMMENDATIONS

Chinook Salmon

1. Continue to take chinook salmon eggs from Willow Creek and stock smolts in Willow, Sheep, and Montana Creeks.

2. Continue to mark smolts released into Willow Creek to assess their survival and contribution as adults to the sport fishery.
3. Continue operations to recover marked adults at a weir and during the creel census at Willow Creek to assess adult contribution.
4. Continue the egg take at Deshka River to support enhancement programs outside northern Cook Inlet.
5. Utilize Fort Richardson Hatchery to incubate eggs and rear fingerlings to the smolt stage.
6. Begin a Little Susitna River enhancement project based on smolt releases.
7. Continue brood-stock screening of chinook salmon stocks for new enhancement projects.
8. Continue to determine spawning escapement and spawning locations of chinook salmon in Montana, Prairie, and Lake Creeks as potential donors for future enhancement programs.
9. Initiate Clear Creek chinook salmon investigations to determine spawner distribution, run timing, and disease history.

Coho Salmon

1. Continue coho salmon egg takes from the Little Susitna River, Big Lake, and Cottonwood Lake drainages to raise fingerlings for release from Big Lake Hatchery.
2. Continue coho salmon egg takes from the Little Susitna River and Caswell Lake drainages to incubate and rear to the smolt

stage for release from Fort Richardson and Big Lake Hatcheries.

3. Continue coded-wire tagging juvenile coho salmon prior to the releases from Fort Richardson and Big Lake Hatcheries.
4. Continue assessment of hatchery-produced fish contribution to the Big Lake and Little Susitna River smolt populations by operating the Fish and Lake Creek weirs.
5. Continue to determine the escapement and distribution of spawning fish in the Little Susitna River, Big Lake, Cottonwood Lake, and Caswell Lake drainages.
6. Continue to collect tissue samples for disease histories from tributaries to Yentna, Susitna, Talkeetna, and Chulitna Rivers.
7. Continue to recover marked adult fish at the Fish Creek weir to assess hatchery contribution.
8. Determine the feasibility of producing 30,000 to 60,000 smolts and 400,000 to 500,000 presmolts annually at Big Lake Hatchery for release in Knik Arm tributaries.
9. Investigate Jim Creek and Rabbit Slough drainages to select optimal and accessible smolt-release sites.
10. Continue to develop new or improved fish collection and egg-transport techniques.

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Appendix 1. Cottonwood Creek daily and cumulative counts for coho salmon, 1982.

Date	Number of jacks in daily	Daily	Cumulative	Number of Marks	Percent of Enumeration	Percent of Expanded Enumeration
JULY 20		1	1		0	0
21		0	1		0	0
22		1	2		0	0
23		0	2		0	0
24		2	4		0	0
25		1	5		0	0
26		2	7		1	0
27		4	11		1	0
28		19	30		4	1
29		3	33		4	2
30	1	49	82		11	4
31		29	111		14	5
AUG 1		22	133	1	17	6
2		38	171		22	8
3		66	237		31	11
4		43	280	1	37	14
5		5	285		37	14
6		7	292	1	38	14
7		12	304		40	15
8		1	305		40	15
9		0	305		40	15
10		1	306		40	15
11		12	318		40	15
12		37	355	2	46	17
13		2	357		47	17
14		18	375		49	18
15		3	378		49	18
16		0	378		49	18
17		4	382		50	18
18		0	382		50	18
19		4	386		50	19
20		6	392		51	19
21		7	399		52	19
22		2	401		52	19
23		8	409		53	20
24		3	412		54	20
25		8	420		55	20
26		8	428		56	21
27		8	436		57	21
28		24	460		60	22
29		24	484		63	23
30	2	101	585	3	77	28
31		24	609		80	29
SEP 1	1	17	626		82	30
2		22	648		85	31
3	3	103	751	3	98	36
4	1	5	756		99	37
5		0	756		99	37
6		8	764		100	37
Totals	8		2,064 ^{a/}	11 ^{b/}		

^{a/} Cottonwood Creek was walked from weir site to Sport Fish closure marker on 9/7/82. There were an additional 1,300 coho present, cumulative count adjusted to this addition.

^{b/} Actual number per 764 fish observed through weir.

Appendix 2. Cottonwood Creek daily and cumulative counts for coho salmon, 1981.

Date	Number of jacks in daily	Daily	Cumulative	Number of Marks	Percent of Enumeration
JULY 14		1	1		0
15		4	5		0
16		1	6		0
17		1	7		0
18		0	7		0
19	1	1	8		0
20		2	10		0
21		2	12		0
22		9	21		1
23		21	42		2
24		34	76		3
25		21	97		4
26	2	13	110		4
27	6	47	157		6
28	1	24	181		7
29		49	230		9
30		38	268		11
31	2	43	311	1	13
AUG 1		13	324		13
2		18	342		14
3	1	22	364		15
4	1	26	390		16
5		31	421		17
6	1	25	446	1	18
7	1	35	481		20
8	2	15	496	5	20
9	3	78	574	3	24
10	1	76	650	3	27
11	1	33	683	3	28
12	4	28	711	2	29
13	6	445	1,156	10	47
14	2	56	1,212		50
15	3	54	1,266	2	52
16	3	210	1,476	5	61
17	4	47	1,523	3	62
18	2	3	1,526		63
19	7	58	1,584	3	65
20	11	168	1,752	6	72
21	5	39	1,791	1	73
22	12	18	1,809		74
23	5	71	1,880	4	77
24	4	41	1,921	2	79
25	10	51	1,972	1	81
26	11	40	2,012	1	83
27	8	46	2,058		84
28	11	55	2,113	2	87
29	2	44	2,157	3	89
30	8	57	2,214	4	91
31	4	43	2,257		93
SEPT 1	3	26	2,283		94
2	4	40	2,323	1	95
3	3	39	2,362		97
4	2	30	2,392	1	98
5	4	8	2,400		98
6	4	30	2,430	2	100
7	1	6	2,436	2	100
Totals	166		2,436	69	

Appendix 3. Fish Creek daily and cumulative counts for coho salmon, 1980.

Date	Number of jacks in daily	Daily	Cumulative	Number of Marks	Percent of Enumeration
JULY 16	1	2	2		0
17	1	2	4		0
18		25	29	2	0
19		64	93	3	1
20		52	145	2	2
21		47	192	3	2
22		72	264	3	3
23	4	234	498	11	6
24		337	835	13	9
25	3	556	1,391	27	16
26	52	716	2,107	33	24
27	20	363	2,470	15	28
28	37	960	3,430	38	38
29	8	223	3,653	12	41
30	12	196	3,849	8	44
31	17	239	4,088	10	46
AUG 1	14	281	4,369	11	49
2	7	212	4,581	11	51
3	8	233	4,814	12	54
4	7	306	5,120	14	57
5	17	150	5,270	18	59
6	10	186	5,456	18	61
7	9	242	5,698	15	64
8	4	75	5,773	5	65
9	2	215	5,988	14	67
10	5	146	6,134	7	69
11	7	93	6,227	4	70
12	9	180	6,407	7	72
13	2	92	6,499	3	73
14	4	149	6,648	4	74
15	3	214	6,862	14	77
16	4	255	7,117	13	80
17	7	90	7,207	3	81
18	14	142	7,349	7	82
19	12	215	7,564	13	85
20	8	205	7,769	13	87
21	8	312	8,081	12	90
22	8	249	8,330	14	93
23	11	85	8,415	3	94
24	6	81	8,496	3	95
25	8	160	8,656	6	97
26	7	76	8,732	5	98
27	3	47	8,779	3	98
28	7	28	8,807	2	99
29	6	47	8,854	3	99
30	0	16	8,870	1	99
31	2	31	8,901	2	99
SEP 1	3	23	8,924	1	100
Totals	377		8,924 ^{a/}	441	

^{a/} Weir at Knik-Goose Bay Road Escapement enumeration is considered a final count.

Appendix 4. Fish Creek daily and cumulative counts for coho salmon, 1981.

Date	Number of jacks in daily	Daily	Cumulative	Number of Marks	Percent of Enumeration
JULY 9					
10					
11		19	19		1
12		8	27		1
13		4	31		1
14		13	44		2
15		8	52		2
16		22	74		3
17		1	75		3
18	3	11	86		4
19	1	18	104		4
20		9	113	1	5
21		2	115		5
22		37	152		6
23		12	164		7
24	1	34	198	1	8
25		42	240		10
26		131	371	2	16
27		8	379	1	16
28	2	88	467	2	20
29		17	484		20
30	5	196	680	7	28
31	1	54	734		31
AUG 1	2	60	794	3	33
2	2	45	839	1	35
3	1	99	938		39
4		82	1,020		43
5		8	1,028		43
6		25	1,053	1	44
7	2	88	1,141	1	48
8	2	28	1,169	2	49
9	6	183	1,352	8	57
10		66	1,418	8	59
11		30	1,448	1	61
12	1	45	1,493	1	63
13		80	1,573	1	66
14		6	1,579		66
15		3	1,582		66
16	3	64	1,646	1	69
17		78	1,724	2	72
18		16	1,740	2	73
19	2	82	1,822		76
20		0	1,822		76
21		0	1,822		76
22		5	1,827		77
23		1	1,828		77
24		0	1,828		77
25		6	1,834		77
26	2	60	1,894	3	79
27		57	1,951	6	82
28	2	22	1,973	1	83
29		24	1,997	1	84
30		74	2,071	3	87
31	2	43	2,114	3	89
SEP 1	2	77	2,191	7	92
2		37	2,228	1	93
3		49	2,277	1	96
4		37	2,314		97
5		54	2,368		99
6		5	2,373		99
7		9	2,882		100
Totals	42		2,382 ^{a/}	72	

^{a/} Weir located at Knik-Goose Bay Road. Escapement enumeration is considered a final count.

Appendix 5. Fish Creek daily and cumulative counts for coho salmon, 1982.

Date	Number of jacks in daily	Daily	Cumulative	Number of Marks	Percent of Enumeration	Percent of Expanded Enumeration
JULY 18		1	1		0	0
19		0	1		0	0
20		3	4	1	0	0
21		27	31	1	1	0
22		45	76		2	1
23		9	85		3	2
24	1	54	139	3	5	3
25		38	177	3	6	3
26	1	75	252	5	8	5
27	1	41	293	6	10	6
28		42	335	1	11	6
29		17	352		12	7
30		85	437	6	15	8
31		0	437		15	8
AUG 1	1	1	438		15	8
2		23	461		15	9
3		17	478	1	16	9
4		4	482		16	9
5		10	492		16	9
6	1	24	516		17	10
7		9	525	1	17	10
8		5	530		18	10
9		0	530		18	10
10		2	532		18	10
11	1	109	641	2	21	12
12		4	645		21	12
13		11	656		22	13
14		39	695		23	13
15		47	742	1	25	14
16		38	780	1	26	15
17	1	33	813	2	27	16
18	1	25	838		28	16
19		3	841		28	16
20		28	869	1	29	17
21		18	887		30	17
22		17	904		30	17
23		20	924	2	31	18
24		10	934	1	31	18
25	1	83	1017	3	34	19
26	1	183	1200	2	40	23
27		27	1227		41	24
28		32	1259	2	42	24
29	1	41	1300	3	43	25
30	3	702	2002	10	67	38
31	1	788	2790	7	93	54
SEP 1	1	26	2816		94	54
2		4	2820		94	54
3		2	2822		94	54
4		31	2853		95	55
5	1	22	2875		96	55
6		33	2908	1	97	56
7	1	41	2949		98	57
8	—	52	3001	—	100	58
Totals	17		5201 ^{a/}	66 ^{b/}		

^{a/} Fish Creek was walked and floated to Tyonek power line on 9/9/82. There were an additional 2,200 coho present, cumulative count adjusted to this addition.

^{b/} Actual number per 3,001 fish observed through weir.

Appendix 6. Fish Creek daily and cumulative counts for coho salmon, 1983.

Date	Number of jacks in daily	Daily	Cumulative	Number of Marks	Percent of Enumeration	Percent of Expanded Enumeration
JULY 15						
16		4	4		0	0
17		2	6		0	0
18		5	11		1	0
19		3	14		1	1
20		0	14		1	1
21		4	18		2	1
22		11	29		3	1
23		9	38		4	2
24		2	40		4	2
25		26	66		6	3
26		26	92		9	4
27		20	112	1	11	5
28		11	123		12	5
29		1	124	1	12	5
30		2	126		12	5
31		3	129		12	5
AUG 1	1	20	149		14	6
2		14	163		16	7
3		6	169		16	7
4		10	179		17	8
5		15	194		19	8
6		4	198		19	8
7		7	205		20	9
8		0	205		20	9
9		5	210		20	9
10		53	263		25	11
11		35	298	1	29	13
12		0	298		29	13
13		6	304		29	13
14		7	311		30	13
15		22	333		32	14
16		16	349		34	15
17		8	357		34	15
18		23	380		37	16
19		25	405		39	17
20		4	409		39	17
21		34	443		43	19
22	2	17	460		44	20
23		69	529	1	51	23
24	2	103	632		61	27
25	1	117	749	2	72	32
26		61	810		78	35
27		67	877		85	37
28	1	102	979		94	42
29		16	995		96	42
30	1	42	1,037	2	100	44
31						
Totals	8		2,342 ^{a/}	8		

^{a/} Fish Creek was walked and floated to Tyonek power line on 8/31/83. There were an additional 1,305 coho present, cumulative count adjusted to this addition.

Appendix 7. Fish Creek daily and cumulative counts for coho salmon, 1984.

Date	Number of jacks in daily	Daily	Cumulative	Number of Marks	Percent of Enumeration	Percent of Expanded Enumeration
JULY 18	0	1	1		0	
19	0	7	8		0	
20	0	2	10		0	
21	0	0	10		0	
22	0	0	10		0	
23	0	46	56		2	1
24	0	59	115		4	3
25	0	61	176		6	4
26	0	41	217		7	5
27	0	93	310		11	7
28	0	42	352		12	8
29	0	9	361		12	8
30	0	12	373		13	8
31	0	134	507	2	17	11
AUG 1	0	74	581		20	13
2	0	35	616		21	14
3	0	27	643		22	14
4	0	7	650		22	14
5	0	0	650		22	14
6	0	12	662		23	15
7	1	35	697		24	15
8	0	18	715		25	16
9	0	8	723		25	16
10	0	1	724		25	16
11	0	6	730		25	16
12	0	2	732		25	16
13	1	7	739		25	16
14	1	13	752		26	17
15	0	32	784		27	17
16	0	33	817		28	18
17	0	3	820		28	18
18	0	5	825		28	18
19	0	5	830		29	18
20	0	1	831		29	18
21	1	6	837		29	18
22	0	3	840		29	19
23	0	13	853		29	19
24	0	201	1,054	3	36	23
25	0	330	1,384	3	48	31
26	0	186	1,570	1	54	35
27	0	37	1,607		56	36
28	0	10	1,617		56	36
29	0	16	1,633		57	36
30	0	16	1,649		57	36
31	0	10	1,659		57	37
SEP 1	0	22	1,681		58	37
2	0	3	1,684		58	37
3	0	15	1,699		59	38
4	0	40	1,739		60	38
5	0	42	1,781		62	39
6	2	81	1,862		64	41
7	4	54	1,916		66	42
8	5	80	1,996		69	44
9	3	51	2,047		71	45
10	14	160	2,207		76	49
11	1	54	2,261		78	50
12	3	63	2,324		81	51
13	1	95	2,419		84	54
14	1	138	2,557		89	57
15	3	101	2,658		92	59
16	3	58	2,716		94	60
17	2	71	2,787		97	62
18	3	83	2,870		99	64
19	0	10	2,880		100	64
Totals	49		4,510 ^{a/}	9 ^{b/}		

^{a/} Fish Creek was walked and floated to Tyonek power line on 9/20/84. There were an additional 1,630 coho present, cumulative count adjusted to this addition.

^{b/} Actual number per 2,880 fish observed through weir.

Appendix 8. Fish Creek daily and cumulative counts for coho salmon, 1985.

Date	Number of jacks in daily	Daily	Cumulative	Number of Marks	Percent of Enumeration	Percent of Expanded Enumeration
JULY 25	1	42	42		3	0
26		51	93		6	2
27		37	130		9	2
28		127	257	5	17	5
29		63	320	3	21	6
30		44	364	1	24	7
31	1	50	414	1	28	8
AUG 1		38	452		30	9
2		13	465		31	9
3	1	43	508		34	10
4		11	519		35	10
5		28	547		36	11
6		28	575		38	11
7	2	154	729		48	14
8		6	735		49	14
9		0	735		49	14
10		6	741		49	14
11		0	741		49	14
12		42	783		52	15
13	3	385	1,168	3	78	23
14		44	1,212		81	24
15		9	1,221		81	24
16		0	1,221		81	24
17		7	1,228		82	24
18		8	1,236		82	24
19		11	1,247		83	24
20		0	1,247		83	24
21		22	1,269		84	25
22		32	1,301	1	87	25
23	1	51	1,352	1	90	26
24		5	1,357		90	26
25		11	1,368		91	27
26	1	29	1,397		93	27
27	1	56	1,453		97	28
28		11	1,464		97	29
29	1	35	1,499		100	29
30						
Totals	12		5,089 ^{a/}	15 ^{b/}		

^{a/} Fish Creek was walked and floated to Tyonek power line on 8/30/87. There were an additional 3,590 coho present, cumulative count adjusted to this addition.

^{b/} Actual number per 1,499 fish observed through weir.

Appendix 9. Fish Creek daily and cumulative counts for coho salmon, 1986.

Date	Number of jacks in daily	Daily	Cumulative	Number of Marks	Percent of Enumeration	Percent of Expanded Enumeration
JULY 14		1	1		0	0
15		0			0	0
16		2	3		0	0
17		7	10		1	0
18		10	20		2	1
19		11	31		4	1
20	2	24	55		7	3
21		22	77		9	4
22		8	85		10	4
23	3	42	127		15	6
24		31	158		19	7
25		37	195		24	9
26	1	45	240		29	11
27		3	243		30	11
28		15	258	1	31	12
29	1	22	280		34	13
30		17	297		36	14
31	1	16	313		38	14
AUG 1	2	27	340		42	16
2	1	10	350		43	16
3		23	373		45	17
4	2	20	393		48	18
5		17	410	1	50	19
6		7	417		51	19
7		16	433		53	20
8		12	445		54	20
9		3	448		54	21
10		1	449		55	21
11		100	549		67	25
12		23	572	2	70	26
13	10	94	666	4	81	31
14	4	22	688		84	32
15		5	693		85	32
16	1	13	706		86	33
17		1	707		86	33
18		3	710		87	33
19		3	713		87	33
20		20	733		90	34
21	1	4	737		90	34
22	3	9	746		91	34
23		6	752		92	35
24	3	59	811		99	37
25		2	813	1	99	37
26		3	816		100	37
Totals	35		2,166 ^{a/}	9 ^{b/}		

^{a/} Fish Creek was walked and floated to Tyonek power line on 8/27/86. There were an additional 1,350 coho present, cumulative count adjusted to this addition.

^{b/} Actual number per 816 fish observed through weir.

