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FEDERAL AID IN ANADROMOUS FISH CONSERVATION

Karluk Lake Sockeye Salmon
Investigations
Section C: Successful Rehabilitation
of Upper Thumb River
Sockeye Salmon Stock

by

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ABSTRACT

This report describes the sockeye salmon, *Oncorhynchus nerka*, rehabilitation work at Karluk Lake, Kodiak Island, Alaska during the period 1978 to 1987. The primary objective of this project is the rehabilitation of the early-run Upper Thumb River stock of Karluk by massive eyed-egg plants. A total of 85 million eggs were planted during this period. Pre-emergent fry survival results, from brood year 1979-1987, indicate survival of 41.7% from eyed-eggs planted to pre-emergent fry. The return of 20,000, 22,000, 28,800, 34,000, and 57,800 sockeye salmon spawners to the systems from 1983 to 1987, respectively, were the best recorded to the system since the 1920s and coincide with the returns from the egg-plant effort.

KEY WORDS: Karluk Lake, sockeye salmon, *Oncorhynchus nerka*, rehabilitation, eyed-egg plants, tagging.

INTRODUCTION

Karluk Lake, on the south end of Kodiak Island (Figure 1), at one time supported a sockeye salmon, *Oncorhynchus nerka*, run of greater magnitude relative to lake size, than any other sockeye

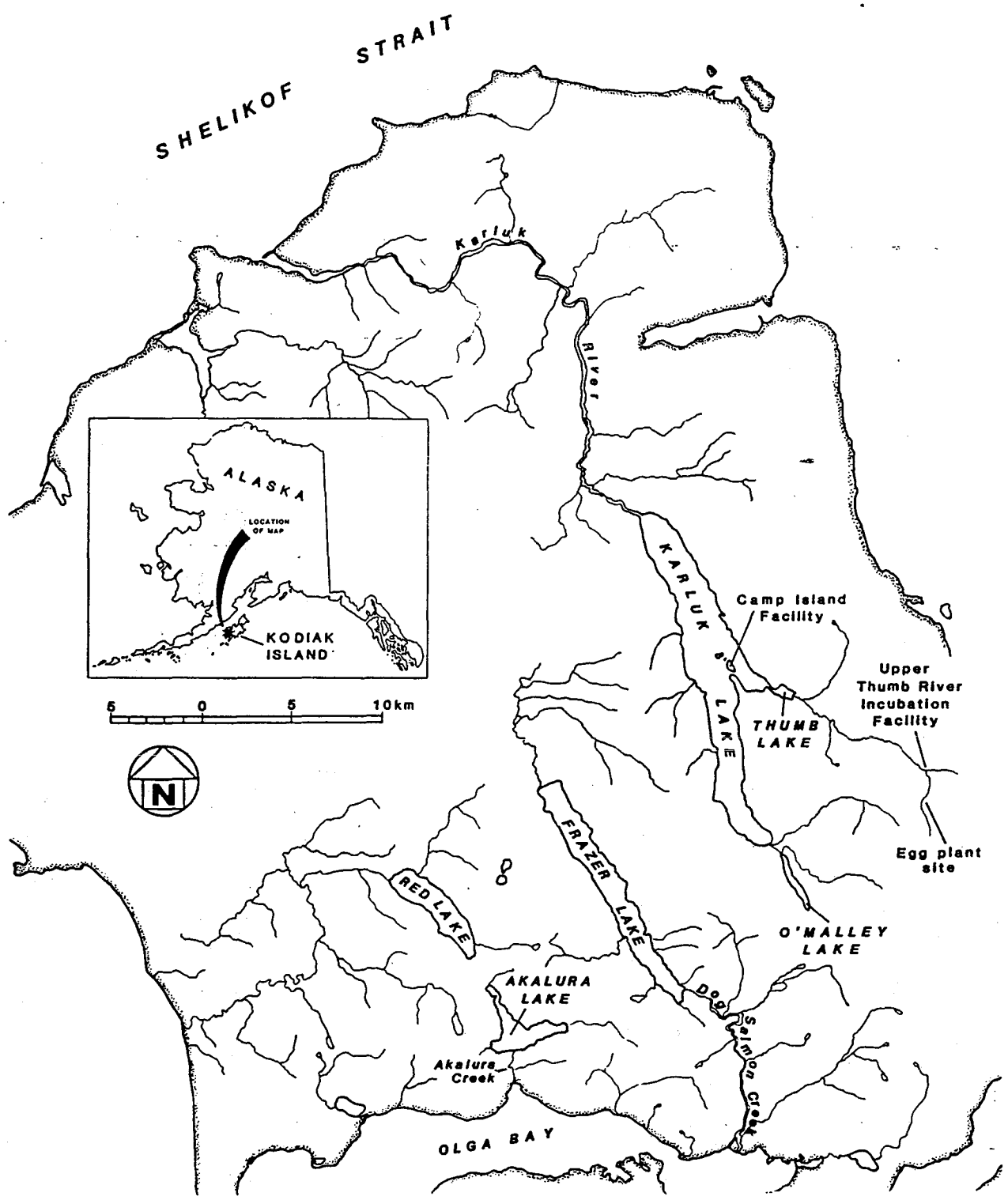

Figure 1. Karluk Lake, Alaska, showing major tributaries important for sockeye salmon spawning and rehabilitation facilities.

salmon-producing system in the world. In the early years of overexploitation, the runs ranged from 1 to 5 million fish. Recent (1978 to 1984) escapements have averaged only 330,000 sockeye salmon with the catch mainly incidental to a pink salmon, *Oncorhynchus gorbuscha*, fishery on the west side of Kodiak Island. However, in 1985, 1986, and 1987, there were over 1.1, 1.6, and 1.1 million returning sockeye salmon, respectively--numbers of fish not recorded since the 1930s (Table 1).

There are many theories advanced to explain the decline of the Karluk drainage sockeye salmon. Most stem from the belief that overfishing occurred that caused an upset in the life cycle of the fish. The U.S. Fish and Wildlife Service (USF&WS) has recently been studying the predator and competitor relationships. The Alaska Department of Fish and Game (ADF&G), Division of Fisheries Rehabilitation, Enhancement and Development (FRED) has been conducting prefertilization studies since 1978, and has been planting sockeye salmon eyed eggs since the 1978 brood year.

A small streamside facility was constructed in the spring of 1980 on Upper Thumb River, Karluk Lake, to "eye" sockeye salmon eggs for a rehabilitation project. This site was selected because historical records indicated Upper Thumb River, which was formerly a major producer, had become a minor producer of sockeye salmon relative to the other subpopulations of Karluk Lake.

The approach used to rehabilitate the Upper Thumb River component of the Karluk sockeye salmon population was to artificially incubate the eggs to the eyed stage to increase the green-to-eyed-egg survival that this technique provides; i.e., in excess of 80% compared to 13.6% for eggs spawned naturally (Drucker 1970).

In 1978, a new salmon egg-planting device (SEPD) was tested at Karluk Lake and compared with the conventional shovel method of planting eggs (White 1980). Both methods were tested in natural

Table 1. Average annual harvest and escapement of sockeye salmon, Karluk River, 1982 - 1987.[a/]

Years		Average escapement	Average catch	Average interception %	Average total run
1882	1890		1,326,397		
1891	1900		2,503,987		
1901	1910		2,205,012		
1911	1920		1,342,637		
1921	1930	1,182,125	974,198	45.6	2,136,323
1931	1940	972,238	799,054	45.1	1,771,292
1941	1950	656,200	487,351	42.6	1,143,551
1951	1960	403,150	146,135	26.6	549,285
1961	1970	389,445	219,939	36.1	609,384
1971	1980	338,662	107,030	24.0	445,692
1981		222,706	95,143	29.9	317,849
1982		164,407	146,755	47.2	311,162
1983		436,145	140,950	24.4	577,095
1984		420,268	258,375	38.1	678,643
1985		995,948	145,443	12.9	1,141,393
1986		887,171	762,717	46.2	1,649,888
1987		766,251	354,271	31.6	1,120,522

a/

Source: Barnaby, 1921-1936; U.S. Fish and Wildlife Service, weir reports and agent's reports, 1937-1956; ADF&G, Comm. Fish. Div., Area Annual Reports, 1957-1987.

streambeds with 465,000 eyed sockeye salmon eggs. The SEPD was 3.5-times faster and much easier to use than the shovel method. The eyed-egg-to-fry survival rate was 11.0% for the conventional method and 50.8% for the new egg planter.

After the initial test, massive egg plants were undertaken from 1978 to 1986. Since the project's commencement, it has become one of the largest rehabilitation efforts in the State of Alaska and the largest eyed-egg planting operation to be conducted anywhere in the North Pacific.

This report is an update of a previous report that presented some preliminary information (White 1986b).

EGG TAKES, INCUBATION, AND EYED-EGG PLANT, 1978 TO 1986

Methods

Supplemental production of sockeye salmon in Upper Thumb River was accomplished primarily by taking eggs and milt from sockeye salmon returning to Upper and Lower Thumb Rivers. Eggs were taken by incision and fertilized in a plastic spawning bucket. From 1978 to 1980, 6 females and 2 or 3 males were used per bucket; and from 1981 to 1984, the gametes from 1 female and 2 to 3 males were stripped into individual containers. After 1980, each container of fertilized eggs was isolated until eggs were water-hardened and disinfected with a Betadine solution for 10 min. The disinfected eggs were consolidated and transported 2.75 km to the incubation facility. In 1978 and 1979, eggs were incubated at a facility on Devil's Creek on the U. S. Coast Guard base in Kodiak and at the Kitoi Bay Hatchery on Afognak Island. In 1980, an incubation facility was constructed on the East Fork of Upper Thumb River (White 1986b), and from 1980 on, all eggs were incubated at this site. Eggs were primarily incubated in

74-cm-diameter incubators. Flows were maintained at approximately 30 liters/min. Eggs were treated with Formalin at 1:1,000 to 1:600 concentration for 15 min every third day during the entire green-to-eyed-egg incubation stage. The eyed eggs were shocked and culled with a photoelectric egg picker and the numbers were estimated, primarily by volumetric displacement.

Eyed eggs were transported by backpack (0.5 km to 6.0 km) from the incubation facility to the planting sites above the first and second falls on the East and North Forks of Upper Thumb River (*See* Figure 1) in areas barren of natural spawners.

With the aid of the SEPD (White 1980; 1986b), most eggs were planted in areas where results from other pre-emergent sampling studies indicated the highest survival rates could be expected. The probe end of the device was driven approximately 30 cm into the streambed and eggs were hydraulically planted at the rate of approximately 455 eggs per probe planting site at a distance of 15 cm or more between each site. Each planting site was marked to facilitate subsequent evaluation.

Results

The egg takes at Thumb River from early-run sockeye salmon resulted in a total of 85,041,000 (Table 2) eyed eggs from early-run fish (Table 2). Green-to-eyed-egg survival averaged 84.0% and eggs were planted for nine years (Table 3). The egg-planting density averaged 1,377 eggs/m^2 during this period.

Discussion

Between 1978 and 1981, the egg takes averaged only 5.6 million eggs annually. This resulted from weak, natural returns to Upper Thumb River (10,000 fish or less) and project plans that called for using not more than 50% of the natural stock for egg-take purposes. In contrast to this, the annual egg takes from 1982 to

Table 2. Egg takes from the early-run (July to mid-August) sockeye salmon at Upper Thumb River, Karluk Lake, 1978-1986.

Brood year	Brood source	Number of eggs taken	Fish spawned		Average fecundity	Survival to eyed-stage (%)	Number of live eggs	Incubation location
			Females	Males				
1978	Upper Thumb	3,071,000	1,030	525	2,982	84.1	2,583,000	Devil's Creek
1979	Upper Thumb	4,816,000	1,491	489	3,298	81.9	3,945,000	Devil's Creek
1980	Lower Thumb	4,115,000	1,563	925	2,679	73.8	3,038,000	Upper Thumb
1981	Lower Thumb	2,902,000	1,241	701	2,338	81.0	2,343,000	Upper Thumb
1982	Upper Thumb	11,190,000	4,888	1,404	2,282	82.0	9,206,000	Upper Thumb
1983	Lower Thumb	15,256,000	6,353	2,138	2,401	80.0	12,284,000	Upper Thumb
1984	Upper Thumb	15,475,000	6,452	3,324	2,399	85.8	13,207,000	Upper Thumb
1985	Upper Thumb	20,949,000	8,471	3,057	2,473	89.4	18,612,000	Uper Thumb
1986	Upper Thumb	23,443,000	9,259	3,804	2,532	84.6	19,823,000	Upper Thumb
Total		101,217,000	40,748	16,367			85,041,000	
Average					2,484	84.0		

Table 3. Eyed eggs from early-run sockeye salmon planted in Upper Thumb River, Karluk Lake, 1978 to 1986.

Brood year	Number of eggs planted	Area planted (m^2)	Mean density ($eggs/m^2$)	Average planting rate (excluding hauling time) (eggs/man-hour
1978	2,583,000	1,779	1,452	--
1979	1,449,000	600	2,121	--
1980	3,038,000	1,566	1,940	10,060
1981	2,344,000	1,037	2,260	13,000
1982	9,206,000	2,489	3,691	38,206
1983	12,284,000	5,017	2,448	18,869
1984	13,207,000	14,359	919	26,796
1985	18,612,000	27,850	668	46,488
1986	19,823,000	5,148	3,851	49,067
Total Average	82,546,000	59,925	1,377	28,926

1986 have averaged 17.3 million eggs. This is a direct result of strong returns of fish to Upper Thumb River, coinciding with the first returns from the initial rehabilitation effort in 1978-1980.

The average green-to-eyed-egg survival of 84.0% (range 73.8 to 88.8) was below the desired 90% survival level, but mortality is attributed to the additional handling stress associated with the transfer of eggs from the egg-take site to the incubation facility. In latter years, this amounted to a 0.5-hour backpack and, in former years, hour-long charter aircraft flights.

A total of 82.5 million early-run eggs have been planted over the nine-year period. I know of no other egg-plant operation of this magnitude in the North Pacific. From 1983 to 1986, there were so many eggs to plant that new planting areas had to be explored and evaluated. Most expansion took place in the upper stream area of Upper Thumb River. This area is so remote, 5-6 km from the incubation site, that it required up to 1.5 hours to backpack the eggs uphill to the egg-planting location.

EGG-PLANT-TO-FRY SURVIVAL

Background

The survival rates of planted eyed eggs were estimated by pre-emergent fry sampling and by marking-recapturing emergent fry. The two methods are somewhat redundant, but they ensured that an overall estimate would be made if one method failed to provide reliable data.

Methods

Mark-Recapture Fry Sampling:

The survival of the planted eyed eggs was estimated by empl a mark-and-recapture technique to estimate the total number fry produced. Each night, fry were caught in a fan trap (G 1977), marked by immersion in a Bismark brown Y solution (W and Verhoeven 1963), and released approximately 100 m upstr from the trap. The daily fry population estimate was based the ratio of individually counted marked to unmarked fish.

The daily and total population estimates were computed acco to the formula developed by Rawson (1984).

Pre-Emergent Fry Sampling:

Each spring from 1980 to 1987, pre-emergent sockeye salmon f were pumped out of the gravel at randomly selected sites in egg-planting location. Each planting site had been marked s could be relocated for an evaluation. Fry were collected in 0.1-m^2 cylindrical-shaped net with a circumference 1.12 m an hand-counted; similar to the method described by McNeil (196 The number of fry caught was divided by the number of eyed e planted to estimate the survival rate at each planting site.

Results

Mark-Recapture Fry Population Estimate:

Based on the mark-and-recapture fry population estimate, the average estimated survival from eyed-egg-to-emergent fry at U Thumb River during the 1978 to 1985 brood years was 40.3% wit range from 1.4% to 70.0% (Table 4).

Table 4. Numbers of fry produced and survival rates from eyed-eggs planted in Upper Thumb River from 1978-1985, estimated by marking and recapturing fry.

Brood year	Sample year	Number of eyed eggs planted	Estimated number of fry	95% Confidence interval		Mean survival (%)
				Upper	Lower	
1978	1979	2,583,000	724,000	----	----	28.0
1979	1980	1,449,000	21,000	24,000	20,000	1.4a/
1980	1981	3,038,000	663,000	705,000	622,000	21.8
1981	1982	2,344,000	1,643,000	1,689,000	1,597,000	70.0
1982	1983	9,206,000	2,715,000	3,164,000	2,055,000	29.5
1983	1984	12,284,000	4,811,000	5,154,000	4,469,000	39.1
1984	1985	13,207,000	5,704,000	5,559,000	5,849,000	43.0
1985	1986	18,612,000	8,970,000	8,882,000	9,066,000	48.2
Total		62,723,000	25,251,000			
Average				----	----	40.3

a/ Low survival attributed to planting technique and floods in October and November, 1979.

Pre-Emergent Fry Sampling:

Based on the pre-emergent fry sampling technique, the average estimated survival from eyed-egg-to-emergent fry at Upper Thumb River during the 1979-1986 brood years was 41.7% (range 1.4% to 61.3%) (Table 5).

Discussion

Fry-trap fishing time was lost each year from 1979-1983 because of high-water conditions. There were 5, 1, 2, 3, and 1 days of fishing time lost in 1979, 1980, 1981, 1982, and 1983, respectively. There was no estimate of the numbers of fry migrating during these high-water periods. Fry trapping from 1984 to 1986 was exceptional because no fishing time was lost during high-water periods.

Between 1979 and 1986, the estimated number of fry based on the pre-emergent sampling exceeded the estimate based on the fry mark-and-recapture technique by an average of 1,014,000 fry (Table 6). Overall, the pre-emergent estimate technique appears to be more reliable because flooding has not affected the results.

The pre-emergent sampling technique has also been useful in identifying survivals within specific planting areas. Many streambed areas have been avoided after the sampling indicated low survival--apparently because of unsuitable streambed conditions. The highest mortality or loss of eggs and fry appears to be caused by flooding, which shifts streambed gravel. Longer and more severe floods result in greater mortality. Water-discharge records in Upper Thumb River (USGS 1976 to 1983), indicated flood conditions with a mean discharge of 2.068 m^3/second recorded for a 17-day period in October and a 10-day period in November 1979. The pre-emergent index after this flood was 5.5 fry/dig, the poorest pre-emergent survival data recorded.

Table 5. Numbers of fry produced and survival rates of eyed-eggs planted in Upper Thumb River from 1979-1986, estimated from pre-emergent sampling.

Brood year	Sample year	Number of eyed eggs planted	Estimated number of pre-emergent fry	Number of samples	Number of fry/sample	Mean % survival
1979	1980	1,449,000	20,000	80	5	1.4a/
1980	1981	3,038,000	1,013,000	47	120	33.3
1981	1982	2,344,000	1,437,000	43	279	61.3
1982	1983	9,206,000	4,483,000	123	221	48.7
1983	1984	12,307,000	4,797,000	73	177	39.0
1984	1985	13,207,000	6,728,000	125	215	51.0
1985	1986	18,612,000	7,063,000	124	184	38.0
1986	1987	19,823,000	7,832,000	86	204	39.5
Total		79,963,000	33,373,000	701		
Average					175	41.7

a/ Low survival due to floods in October and November, 1979.

Table 6. Numbers of fry surviving from eyed eggs planted in Upper Thumb River, Karluk Lake from 1978-1985 estimated by sampling pre-emergent fry and by mark and recapture of fry.

Brood year	Brood year	Estimated number of fry		Difference (pre-emergent minus the mark-recapture)
		Mark-recpature	Pre-emergent sampling	
1978	1979	724,000	----	----
1979	1980	21,000	20,000	-1,000
1980	1981	663,000	1,013,000	+350,000
1981	1982	1,643,000	1,437,000	-206,000
1982	1983	2,715,000	4,483,000	+1,768,000
1983	1984	4,811,000	4,797,000	-14,000
1984	1985	5,704,000	6,728,000	+1,024,000
1985	1986	8,970,000	7,063,000	-1,907,000
Total Difference:				+1,014,000

In 1980, after a six-day flood in October, the pre-emergence index was 120 fry/dig, which is slightly below the five-year average of 136 fry/dig. In 1981, there were only three flood days between October and November and the pre-emergence index was 279 fry/dig, the highest pre-emergent density recorded in the study period. In 1979, the worst year, the flood damage was apparent because of a lack of not only live fry but also dead fry and eggs as well. There was also physical evidence of streambed erosion, and a portion of the egg-planting area was covered with gravel and became part of a new streambank. The displaced fry were assumed to be dead; however, some of the eggs or fry that were washed out of the egg-planting area may have survived unrecorded.

The estimated average annual egg-to-fry survival of naturally spawned sockeye salmon in the Karluk system was 29.4% (range: 19.0% to 42.8%) from 1964 to 1967 (Drucker 1970). In our study, the eyed-egg-to-fry survival was 41.7% (range: 1.4% to 61.3%) (*See* Table 5). Canadian spawning channels egg-to-fry survivals for sockeye salmon in 1983 averaged 46.3% (range 32.6% to 80.4%) at Upper Pitt, Weaver Creek, Gates Creek, and Nadina River (INPFC 1984). At Jones Creek, annual egg-to-fry survival of pink salmon was 37.7% (range: 8.5% to 79.1%) over a 15-year study period (Frazer and Fedorenko 1983). The egg-to-fry survival rates of the Upper Thumb River egg-plant operation are within the range of survivals reported for the Canadian spawning channels (INPFC, 1984; Frazer and Fedorenko 1983) and higher than those reported for both potential and actual egg deposition from natural spawners in the eight-year study at Grassy Point Creek, Karluk Lake (Drucker 1970).

The pattern of fry emergence was similar to that reported for Karluk Lake (Drucker 1970). Migration was nocturnal. As the season progressed and daylight increased, the period of fry emergence shifted to later in the evening. The emergence period lasted from mid-March until mid-June with the peak periods

occurring between the first week of April to the last week of May, depending upon floods or freshets, which apparently trigg bursts of emergence.

FRY-MARKING INVESTIGATIONS

Background

In 1979, 1981, 1984, and 1985, sockeye salmon fry from eggs tha had been planted in Upper Thumb River were marked so returning adults could be identified. In 1979 and 1981, sockeye salmon f were marked by removal of their adipose and left-ventral fins. In 1984 and 1985, fish were tagged with a "half-length" (0.5 mm coded-wire tag (HLCWT). Fry that were used for the marking project were from eggs planted above a barrier falls in an area barren to natural spawning sockeye salmon.

Methods

Fry from the egg plant were marked by the removal of a fin in a manner described by Bams (1972) and Moberly et al. (1977). The HLCWT program was conducted in a manner described by Rawson et al. (1988), except the adipose fin was not excised. A quality-control program was conducted during the entire project to ensu that only valid marks were recorded for each lot. Marked fry were released in the evening or at night when the natural migration occurred.

Adult sockeye salmon brood fish returning during the July 1983 1986 egg takes were inspected to determine if they had been marked as fry at Upper Thumb River. Because there were multipl age groups of sockeye salmon with the same mark, each sockeye salmon that was inspected was aged to determine brood year of t marked and unmarked fish from otolith samples.

Results

The fry-marking program from 1978 to 1985 is summarized in Table 7. In four years, a total of 356,300 sockeye salmon fry was marked.

A total of 43,827 adult sockeye salmon brood fish was inspected for marks from 1983 through 1985 (Table 8). From these, 591 marked fish were found.

Discussion

Returns of marked fish from the 1979 brood year were substantially less than those from the 1980 brood year. Adults from the 1980 brood year contributed over half of the 2.7 million Karluk Lake sockeye salmon that returned in 1985 and 1986. Consequently, the survival of 1980 brood year-marked fish was greater than that of the 1978 group. The overall 1.3% survival of marked fish to returning adult is within the range of the 1% to 2% survivals expected.

The approach of marking sockeye salmon fry in 1984 and 1985 with a HLCWT with no adipose-fin clip was intended to avoid the problem of fin regeneration (Loren Flagg[1], personal communication; Hauser and Howe 1985) and obtain a lifelong tag that would possibly aid in following the fish from juvenile to smolt and smolt-to-adult return. This is the first time that sockeye salmon fry have been tagged without the removal of an adipose fin for external identification. Adults will be inspected by passing them through a quality-control device for tag detection from 1988 to 1991.

[1] 312 Tyee Street, Soldotna, Alaska 99669

Table 7. Sockeye salmon fry marked at Upper Thumb River, Karluk Lake, 1979 to 1985.

Brood year	Release year	Mark type	Number fry marked	Number unmarked fry released
1978	1979	Adipose + left ventral	27,700	691,000
1980	1981	Adipose + left ventral	70,600	942,400
1983	1984	Half-length coded-wire tag	117,000	4,683,000
1984	1985	Half-length coded-wire tag	141,000	5,562,000

Table 8. Revcovery of marked Upper Thumb River, Karluk Lake sockeye salmon, 1983-1986.

Brood year	Fry examined				Adults examined			
	Marked		Unmarked		Marked		Unmarked	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1978	27,700	1.9	1,406,300	98.9	31	0.2	19,869	99.8
1980	70,600	6.1	1,092,400	93.9	560	2.3	23,367	97.6
Total	98,300	3.8	2,498,700	96.2	591	1.3	43,236	98.7

ADULT RETURNS

Background

Numbers of adult sockeye salmon that return to Upper Thumb River and other Karluk Lake tributaries have been monitored since 1971 when rehabilitation planning efforts began. Initially, these surveys were made to document areas that needed rehabilitation and, subsequently, to witness changes in the population size in conjunction with the rehabilitation effort. Fish have been aged at Upper Thumb River since 1978 to ascertain survival by brood year. This information, along with the fry population estimates, provides data on survival for each brood year.

Methods

The escapement of sockeye salmon to Upper Thumb River and other tributaries was estimated by foot surveys made every week during the peak spawning periods. Numbers of live fish and carcasses were recorded. The numbers from the peak survey and total numbers of brood fish used in the egg takes were summed to determine the total adult return to Upper Thumb River.

The commercial fisheries harvest of sockeye salmon that originated from the eggs planted in Upper Thumb River was estimated from the commercial catch data and the Karluk Lake escapement counts. The commercial catch of sockeye salmon from Karluk Lake was estimated by the ADF&G, Commercial Fisheries Division (Manthey 1983), and the total escapement into Karluk Lake was counted at the weir at the outlet of the lake. I assumed that the proportion of fish from Upper Thumb River in the commercial catch was the same as the proportion of the escapement count for Upper Thumb River in the total escapement for Karluk Lake.

The age composition of adults returning to Upper Thumb River was determined by reading the otoliths of fish used in the egg takes, except in 1987 when the otoliths were taken from spawned-out fish.

Results

The returns of adult sockeye salmon into Upper Thumb River of 20,000, 22,000, 28,800, 34,000, and 57,800 in 1983 through 1987, respectively, were the highest recorded since the 1920s (Gilbert and Rich 1927) and coincide with expected returns from the initial rehabilitation efforts from 1978 to 1982.

Tables 9 and 10 depict the age composition of the adult returns to Upper Thumb River and the relationship with fry population. The survival from fry to returning adult (including the estimated catch) ranged from 1.4 to 5.8 for the 1978-1981 brood years.

Discussion

Although there has been a dramatic increase in early-run adult returns to Upper Thumb River, there has also been a population increase throughout the entire Karluk Lake system. The rate of increase, however, for the Upper Thumb River has exceeded that of other spawning populations in the lake system. There were 15.4 and 6.0 returns per spawner for the 1980 and 1981 brood years, respectively, at Upper Thumb River, while other Karluk systems show 3.5 and 4.9 returns per spawner, respectively, for early run of the brood years. The increase at Upper Thumb River is attributed to the success of the egg-plant project.

From 1985 to 1987, the 1980 brood year made a very strong contribution. Survivals of 5.8% from fry to returning adults are higher than the expected 1% to 2%. The survival of fry from the 1980 brood year appears to have been enhanced by the high zooplankton densities reported for that period (White 1986a).

Table 9. Estimated numbers and age composition of adult sockeye salmon returning to Upper Thumb River, Karluk Lake, 1978-1987.

Year	Sample size	Number of fish			Age comparison (years since broodyear)							
					4		5		6		7	
		Escapement	Catch	Total	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1978	54	11,675	606	12,275	0	0.0	9,096	74.1	2,725	22.2	454	3.7
1979	75	7,323	468	7,791	0	0.0	1,971	25.3	5,617	72.1	203	2.6
1980	158	4,345	444	4,789	848	17.7	2,481	51.8	1,432	29.9	29	0.6
1981	154	4,168	560	4,728	189	4.0	2,265	47.9	2,000	42.3	279	5.8
1982	80	12,979	1,667	14,646	190	1.3	7,865	53.7	6,225	42.5	366	2.5
1983	308	19,616	1,144	20,760	1,474	7.1	13,743	66.2	5,543	26.7	0	0.0
1984	200	21,776	2,325	24,101	1,325	5.5	8,917	37.0	12,653	52.5	1,205	5.0
1985	371	28,865	1,690	30,555	886	2.9	24,047	78.7	4,888	16.0	733	2.4
1986	268	34,149	11,872	46,021	3,221	0.7	11,689	25.4	33,135	72.0	874	1.9
1987	240	57,820	8,243	66,043	792	1.2	43,192	65.4	12,680	19.2	9,378	14.2

Table 10. Upper Thumb River, Karluk Lake sockeye salmon run by broodyear and fry population estimate data with overall survival from fry to adult.[a]

Brood Year	Brood Year Population Size	(Catch & Escape) Return Year Run Size	Age Group 4	5	6	7	Brood Year Fry Population	Fry to Adult % Survival
1978	11,675	22,322	190	13,743	12,653	733	1,434,000	1.9%
1979	7,323	16,155	1,474	8,917	4,888	874	601,000	2.7%
1980	4,345	67,885	1,325	24,047	33,235	9,378	1,163,000	5.8%
1981	4,168	25,255[b]	886	11,689	12,680	--	1,764,000	1.4%
1982	12,979	--	3,221	43,192	--	--	3,070,000	

[a] 1978-1981 data, 4,962,000 fry returned as 136,617 adults or mean survival of 2.7%

[b] 7-year olds not included

SUMMARY

The objective of the Karluk Lake sockeye salmon rehabilitation project was to plant massive numbers of eyed sockeye salmon eggs in the underutilized streambed of Upper Thumb River and thus increase the returns of adult fish to that system. The project proceeded on the fundamental assumption that the survival rate from green egg to fry would be greater through hatchery incubation and egg planting than through natural production.

The project has been successful because massive numbers of eggs have been seeded annually into the Upper Thumb River streambed since 1978. The subsequent increases in numbers of fry from the egg plant resulted in returns of 20,000 to 58,000 adult sockeye salmon to Upper Thumb River between 1983 and 1987. These were the highest returns to that system since the 1920s, and this represents more than a four-fold increase in the escapement over the pre-rehabilitation levels.

Other early-run systems experienced less than a two-fold increase. The 13.5 return per spawner for the 1980 brood year at Upper Thumb River was higher than other early-run systems which had a 3.5 return per spawner.

The project has become one of the largest rehabilitation efforts in the State of Alaska and is the largest egg-planting effort to be conducted anywhere in the North Pacific. Returns projected from 1988 to 1991 are expected to reach and exceed the goals of rehabilitating the system--allowing for a moderate early-run fishery.

After more than fifty years of decline, the Karluk Lake sockeye salmon run is on the increase. The annual sockeye salmon catch and escapement has exceeded one million fish from 1985 to 1987; a record not achieved since the 1930s. The value of the 1986 and

1987 Karluk Lake sockeye salmon catch exceeded $5 million and $3 million, respectively.

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