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A Summary of Sport Fish Stocking Evaluations in Alaska, 1985-1989

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[1] Some of the data included in this report were collected under various jobs of Projects F-10-1 through F-10-5 of the Federal Aid in Fish Restoration Act (16 U.S.C. 777-777K).

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ABSTRACT

Stocking fish to enhance Alaskan sport fisheries dates back to 1917 when brook trout *Salvelinus fontinalis* were first introduced into southeast Alaska. Since then, individuals, federal agencies, and the state of Alaska have stocked numerous species of fish to enhance sport fisheries in most areas of the state. Stocking activities prior to 1985 are summarized in this report. More detailed evaluations, including estimates of cost per fish harvested, are discussed for fish stocked from 1985 through 1989.

During the five year reporting period from 1985 through 1989, 40,430,920 fish encompassing eight species were produced with Dingell Johnson/Wallop Breaux federal funds and other funding sources to benefit sport anglers. These fish were stocked in 1,348 locations in Alaskan waters. Fish were raised to four different sizes, depending upon the specific stocking program, prior to being released. Forty-eight percent of the fish produced were stocked into landlocked waters and 52-percent were stocked into anadromous systems or released directly into marine waters.

The estimated cost per fish harvested in sport fisheries (from 1985 through 1989) for species stocked in landlocked lakes was substantially lower than the estimated costs for anadromous stocking cohorts. In 82 percent of the 43 detailed evaluations of chinook salmon *Oncorhynchus tshawytscha*, coho salmon *Oncorhynchus kisutch*, rainbow trout *Oncorhynchus mykiss*, and Arctic grayling *Thymallus arcticus* harvested by sport anglers in landlocked lakes the average cost per fish was less than $10. In contrast, the cost per chinook and coho salmon resulting from anadromous releases and subsequently harvested by sport anglers ranged from $3.90 to $1,396.40 and the costs per steelhead *Oncorhynchus mykiss* caught in sport fisheries ranged from $185.48 to $717.00. Recommendations for future evaluation programs and stocking practices are presented.

KEY WORDS: Alaska, sport fisheries, stocking evaluations, estimated costs of stocked fish.

INTRODUCTION

Stocking fish to enhance Alaskan sport fisheries dates back to 1917 when brook trout *Salvelinus fontinalis* were first introduced into southeast Alaska. Since then, individuals, clubs, canneries, federal agencies, and the state of Alaska have stocked numerous species of fish to enhance sport fisheries in most areas of the state. The Alaska legislature created the Fisheries Rehabilitation, Enhancement, and Development (FRED) Division in 1971 to help reverse the major declines in salmon harvest and escapement. One focus of FRED Division activities was enhancement of commercial salmon fisheries. Sport anglers also shared in increased salmon harvests and other enhancement programs, such as stocking landlocked lakes that were specifically directed at developing and enhancing sport fisheries.

Prior to 1986, hatchery programs were primarily funded through state monies. However, the passage of the Wallop-Breaux amendment to the Federal Aid in Sport Fish Restoration Act (D-J/W-B) provided a significant increase in sport fish funding, some of which was transferred to FRED Division to cover the cost of programs that benefitted sport fisheries. Since fiscal year 1986 (FY86) over $1.0 million annually of D-J/W-B funding has been provided to FRED Division to partially fund their sport fish stocking programs. This money is primarily used to fund three hatcheries (Elmendorf, Ft. Richardson, and Clear) which are the primary producers of fish to be stocked for sport fishery enhancement. Smaller amounts of D-J/W-B funding are provided to other hatcheries for anadromous steelhead *Oncorhynchus mykiss*, coho salmon *O. kisutch*, and chinook salmon *O. tshawytscha* stocking programs. One of the major purposes of this report is to satisfy the requirement of the Federal Aid in Sport Fish Restoration program that enhancement programs be reviewed and evaluated every five years.

During the five year reporting period from 1985 through 1989, 40,430,920 fish encompassing eight species have been produced with D-J/W-B federal funds and other funding sources to benefit sport anglers (Table 1). These fish were stocked in 1,348 locations in Alaskan waters (Table 2). The fish were raised to four different sizes, depending upon the specific stocking program, prior to being released (Table 3). Forty-eight percent of the fish produced were stocked into landlocked waters (Table 4) and 52-percent were stocked into anadromous systems or were released directly into marine waters (Table 5).

The Division of Sport Fish, and in some cases FRED Division, conduct annual evaluations of various stocking programs through programs that estimate survival, abundance, and age and size structure of stocked fish, as well as estimate fishing effort and harvest levels from various enhanced fisheries. This information is used to modify existing procedures to improve benefits of the program. The goal of this report is to summarize results of past sport fish stocking efforts, evaluate the success of various enhancement techniques (area, size, species, etc.), and estimate the cost per survivor and cost per fish harvested in sport fisheries where the data were available to make the estimates.

METHODS

Numbers and locations of fish stocked during the last five years using D-J/W-B funding sources were obtained from a FRED Division data base of all fish stocked in the state. Those stocking records were cross checked by comparing with records kept in Division of Sport Fish regional offices. Historic summaries of

Table 1. Number of fish stocked by FRED Division for the enhancement of sport fisheries from 1985 through 1989.

Year	Chinook	Coho	Steelhead	Rainbow	Grayling	Sheefish	Arctic Char	Lake Trout	Total
SOUTHEAST:									
1985	0	181,744	204,486	0	0	0	0	0	386,230
1986	1,115,523	145,432	60,965	0	10,000	0	0	0	1,331,920
1987	215,031	348,650	101,740	0	0	0	0	0	665,421
1988	249,256	346,896	129,999	0	30,000	0	0	0	756,151
1989	337,000	346,265	108,431	0	30,000	0	0	0	821,696
COOK INLET:									
1985	1,654,345	660,460	35,196	1,213,666	534,414	0	0	0	4,098,081
1986	1,143,340	1,447,835	44,873	910,732	677,864	0	0	0	4,224,644
1987	683,877	730,191	0	3,232,851	443,098	0	0	0	5,090,017
1988	1,948,130	1,450,656	33,550	2,377,853	507,158	0	17,200	10,600	6,345,147
1989	2,109,675	1,902,264	0	3,207,019	376,598	0	11,670	27,259	7,634,485
ARCTIC/YUKON/KUSKOKWIM:									
1985	13,445	0	15,200	125,000	422,204	0	0	0	575,849
1986	36,800	0	0	216,587	326,124	0	0	0	579,511
1987	0	0	0	823,965	833,846	0	0	0	1,657,811
1988	56,015	522,708	0	756,609	1,352,292	60,000	42,791	43,176	2,833,591
1989	0	678,543	0	766,788	1,057,076	109,503	73,520	66,626	2,752,056
KODIAK/ALASKA PENINSULA:									
1985	0	0	0	9,893	115,000	0	0	0	124,893
1986	0	0	0	42,795	0	0	0	0	42,795
1987	0	0	0	55,600	70,000	0	0	0	125,600
1988	0	0	0	32,397	70,000	0	0	0	102,397
1989	114,400	0	0	58,225	110,000	0	0	0	282,625
TOTALS:									
1985	1,667,790	842,204	254,882	1,348,559	1,071,618	0	0	0	5,185,053
1986	2,295,663	1,593,267	105,838	1,170,114	1,013,988	0	0	0	6,178,870
1987	898,908	1,078,841	101,740	4,112,416	1,346,944	0	0	0	7,538,849
1988	2,253,401	2,320,260	163,549	3,166,859	1,959,450	60,000	59,991	53,776	10,037,286
1989	2,561,075	2,927,072	108,431	4,032,032	1,573,674	109,503	85,190	93,885	11,490,862
Total	9,676,837	8,761,644	734,440	13,829,980	6,965,674	169,503	145,181	147,661	40,430,920

Table 2. Number of waterbodies stocked by FRED Division for the enhancement of sport fisheries from 1985 through 1989.

Year	Chinook	Coho	Steelhead	Rainbow	Grayling	Sheefish	Arctic Char	Lake Trout	Total
SOUTHEAST:									
1985	0	3	5	0	0	0	0	0	8
1986	5	4	3	0	1	0	0	0	13
1987	4	5	4	0	0	0	0	0	13
1988	4	5	4	0	2	0	0	0	15
1989	5	4	4	0	2	0	0	0	15
SOUTHCENTRAL:									
1985	19	15	1	62	22	0	0	0	119
1986	18	19	1	88	34	0	0	0	160
1987	7	21	0	98	22	0	0	0	148
1988	27	19	6	116	29	0	2	1	200
1989	21	24	0	104	25	0	6	2	182
ARCTIC/YUKON/KUSKOKWIM:									
1985	6	0	1	2	31	0	0	0	40
1986	3	0	0	2	27	0	0	0	32
1987	0	0	0	5	26	0	0	0	31
1988	4	19	0	44	24	1	21	17	130
1989	0	22	0	52	28	1	22	20	145
KODIAK/ALASKA PENINSULA:									
1985	0	0	0	5	6	0	0	0	11
1986	0	0	0	20	0	0	0	0	20
1987	0	0	0	19	4	0	0	0	23
1988	0	0	0	15	4	0	0	0	19
1989	1	0	0	20	3	0	0	0	24
TOTALS:									
1985	25	18	7	69	59	0	0	0	178
1986	26	23	4	110	62	0	0	0	225
1987	11	26	4	122	52	0	0	0	215
1988	35	43	10	175	59	1	23	18	364
1989	27	50	4	176	58	1	28	22	366

Table 3. Number and size of fish stocked by FRED Division for the enhancement of sport fisheries from 1985 through 1989.

Year	Fry	Fingerling	Smolt	Subcatchable	Total
CHINOOK SALMON:					
1985	0	157,635	1,510,155	0	1,667,790
1986	911,000	72,622	1,312,041	0	2,295,663
1987	0	0	898,908	0	898,908
1988	0	72,615	2,180,786	0	2,253,401
1989	0	30,116	2,530,959	0	2,561,075
COHO SALMON:					
1985	35,564	459,934	346,706	0	842,204
1986	120,000	616,042	852,215	5,010	1,593,267
1987	104,000	104,279	870,562	0	1,078,841
1988	0	1,162,006	1,158,254	0	2,320,260
1989	164,567	1,383,671	1,378,834	0	2,927,072
STEELHEAD TROUT:					
1985	0	124,400	115,282	15,200	254,882
1986	0	0	105,838	0	105,838
1987	0	0	101,740	0	101,740
1988	0	90,392	73,157	0	163,549
1989	16,757	0	91,674	0	108,431
RAINBOW TROUT:					
1985	0	1,246,570	0	101,989	1,348,559
1986	0	1,007,908	0	162,206	1,170,114
1987	2,076,900	1,854,771	0	180,749	4,112,420
1988	600,000	2,182,821	0	384,038	3,166,859
1989	1,257,847	2,467,046	0	307,139	4,032,032
ARCTIC GRAYLING:					
1985	930,461	116,157	25,000	0	1,071,618
1986	774,332	239,656	0	0	1,013,988
1987	1,149,788	196,137	0	1,019	1,346,944
1988	1,861,506	96,808	0	1,136	1,959,450
1989	1,486,766	86,908	0	0	1,573,674
ARCTIC CHAR:					
1985	0	0	0	0	0
1986	0	0	0	0	0
1987	0	0	0	0	0
1988	0	39,970	0	20,021	59,991
1989	0	13,271	0	71,919	85,190
SHEEFISH:					
1985	0	0	0	0	0
1986	0	0	0	0	0
1987	0	0	0	0	0
1988	0	60,000	0	0	60,000
1989	0	109,503	0	0	109,503
LAKE TROUT:					
1985	0	0	0	0	0
1986	0	0	0	0	0
1987	0	0	0	0	0
1988	0	53,776	0	0	53,776
1989	0	63,309	0	30,576	93,885
TOTALS:					
1985	966,025	2,104,696	1,997,143	117,189	5,185,053
1986	1,805,332	1,936,228	2,270,094	167,216	6,178,870
1987	3,330,688	2,155,185	1,871,210	181,766	7,538,849
1988	2,461,506	3,758,388	3,412,197	405,195	10,037,286
1989	2,925,937	4,153,824	4,001,467	409,634	11,490,862

Table 4. Number of fish stocked into landlocked waters by FRED Division for enhancement of sport fisheries from 1985 through 1989.

Year	Chinook	Coho	Steelhead	Rainbow	Grayling	Sheefish	Arctic Char	Lake Trout	Total
SOUTHEAST									
1985	0	6,124	0	0	0	0	0	0	6,124
1986	0	5,010	0	0	10,000	0	0	0	15,010
1987	0	16,407	0	0	0	0	0	0	16,407
1988	0	8,182	0	0	30,000	0	0	0	38,182
1989	0	9,385	0	0	30,000	0	0	0	39,385
COOK INLET:									
1985	171,955	99,270	0	726,379	204,248	0	0	0	1,201,852
1986	43,032	207,123	0	817,511	364,455	0	0	0	1,432,121
1987	0	0	0	2,182,999	241,328	0	0	0	2,424,327
1988	117,534	350,298	33,550	1,789,382	249,158	0	17,200	10,600	2,567,722
1989	76,005	467,264	0	2,493,043	178,598	0	11,670	0	3,226,580
ARCTIC/YUKON/KUSKOKWIM:									
1985	13,445	0	15,200	125,000	397,976	0	0	0	551,621
1986	36,800	0	0	216,587	298,137	0	0	0	551,524
1987	0	0	0	811,470	815,807	0	0	0	1,627,277
1988	56,015	244,600	0	677,138	1,352,292	60,000	42,791	43,176	2,476,012
1989	0	493,055	0	697,580	1,057,076	109,503	73,520	66,626	2,497,360
KODIAK/ALASKA PENINSULA:									
1985	0	0	0	9,093	115,000	0	0	0	124,093
1986	0	0	0	41,997	0	0	0	0	41,997
1987	0	0	0	54,000	70,000	0	0	0	124,000
1988	0	0	0	30,797	70,000	0	0	0	100,797
1989	0	0	0	56,625	110,000	0	0	0	166,625
TOTALS:									
1985	185,400	105,394	15,200	860,472	717,224	0	0	0	1,883,690
1986	79,832	212,133	0	1,076,095	672,592	0	0	0	2,040,652
1987	0	16,407	0	3,048,469	1,127,135	0	0	0	4,192,011
1988	173,549	603,080	33,550	2,497,317	1,701,450	60,000	59,991	53,776	5,182,713
1989	76,005	969,704	0	3,247,248	1,375,674	109,503	85,190	66,626	5,929,950
Total	514,786	1,906,718	48,750	10,729,601	5,594,075	169,503	145,181	120,402	19,229,016

Table 5. Number of fish stocked into anadromous waters by FRED Division for the enhancement of sport fisheries from 1985 through 1989.

Year	Chinook	Coho	Steelhead	Rainbow	Grayling	Lake Trout	Total
SOUTHEAST:							
1985	0	175,620	204,486	0	0	0	380,106
1986	1,115,523	140,422	60,965	0	0	0	1,316,910
1987	215,031	332,243	101,740	0	0	0	649,014
1988	249,256	338,714	129,999	0	0	0	717,969
1989	337,000	336,880	108,431	0	0	0	782,311
COOK INLET:							
1985	1,482,390	561,190	35,196	487,287	330,166	0	2,896,229
1986	1,100,308	1,240,712	44,873	93,221	313,409	0	2,792,523
1987	683,877	730,191	0	1,049,852	201,770	0	2,665,690
1988	1,830,596	1,100,358	0	588,471	258,000	0	3,777,425
1989	2,033,670	1,435,000	0	713,976	198,000	27,259	4,407,905
ARCTIC/YUKON/KUSKOKWIM:							
1985	0	0	0	0	24,228	0	24,228
1986	0	0	0	0	27,987	0	27,987
1987	0	0	0	12,495	18,039	0	30,534
1988	0	278,108	0	79,471	0	0	357,579
1989	0	185,488	0	69,208	0	0	254,696
KODIAK/ALASKA PENINSULA:							
1985	0	0	0	800	0	0	800
1986	0	0	0	798	0	0	798
1987	0	0	0	1,600	0	0	1,600
1988	0	0	0	1,600	0	0	1,600
1989	114,400	0	0	1,600	0	0	116,000
TOTALS:							
1985	1,482,390	736,810	239,682	488,087	354,394	0	3,301,363
1986	2,215,831	1,381,134	105,838	94,019	351,396	0	4,148,218
1987	898,908	1,062,434	101,740	1,063,947	219,809	0	3,346,838
1988	2,079,852	1,717,180	129,999	669,542	288,000	0	4,884,573
1989	2,485,070	1,957,368	108,431	784,784	228,000	27,259	5,590,912
Total	9,162,051	6,854,926	685,690	3,100,379	1,441,599	27,259	21,271,904

stocking by species were compiled using files kept in area offices of the Division of Sport Fish.

After reviewing stocking records, detailed cost evaluations were performed for all D-J/W-B stocking lots, or cohorts of fish, for which all year classes had returned (for salmon), and for which abundance and harvest estimates were available. Harvest estimates were obtained from various on-site creel censuses and from the statewide harvest survey (Mills 1979-1989). Abundance estimates were obtained from department mark-recapture experiments, weir counts, and aerial surveys. During the past five years there were 14 anadromous chinook salmon stocking lots, three landlocked chinook salmon stocking lots, 11 anadromous and 11 landlocked coho salmon stocking lots, 2 steelhead stocking lots, 20 landlocked rainbow trout stocking lots, and 6 Arctic grayling *Thymallus arcticus* stocking lots from which the necessary information was available to perform detailed cost evaluations. Estimates of abundance to age 1 for three stocking cohorts of Arctic grayling (sac-fry, 4 g, and 6 g) and cost per survivor are also presented.

The Division of Sport Fish supervises all sport fish related activities (including stocking) throughout the state, which is divided into three major areas; Southeast, Southcentral, and Interior (Figure 1). Stocking evaluations are presented by species within each region.

Production Costs

Calculating actual production costs proved difficult. Total operating costs (all funding sources) for each hatchery that produced fish using D-J/W-B funds were obtained from the Alaska State Accounting System (AKSAS) reports for actual expenditures in a given fiscal year. The amount of D-J/W-B funding for each hatchery was known, but the actual amount of D-J/W-B funding used to produce an individual lot of fish was difficult to determine because: (1) in a given year each hatchery produced more than one lot of fish with the D-J/W-B money and it was difficult to accurately allocate the costs between different lots; (2) there was no straightforward way to allocate hatchery overhead costs (personnel, electricity, water systems, heat, etc.) between the D-J/W-B and other funding sources; and (3) if actual production costs for a given lot of fish were calculated, the estimated costs would vary from year to year solely based on the number of fish produced (due to economy of scale) which would make within and between year comparisons difficult to make.

Given these constraints, an index of actual costs was developed by mutual consent between personnel of FRED and Sport Fish Divisions to standardize cost estimates. The index of stocking cost (cost per fish) was the total operating expenses of a hatchery in a given fiscal year (all funding sources combined) divided by the total weight of all species of fish produced. The cost for a given lot of fish was the product of the cost per fish, the average weight of that lot of fish, and the number of fish stocked at a specific location. Drawbacks of this cost determination method and recommendations for future cost evaluations are reviewed in the discussion.

Detailed Cost Evaluations

For anadromous fish the cost per survivor was estimated by dividing the total estimated number of returning fish into the estimated production costs for a given stocking lot. When available, estimates of the commercial fishery

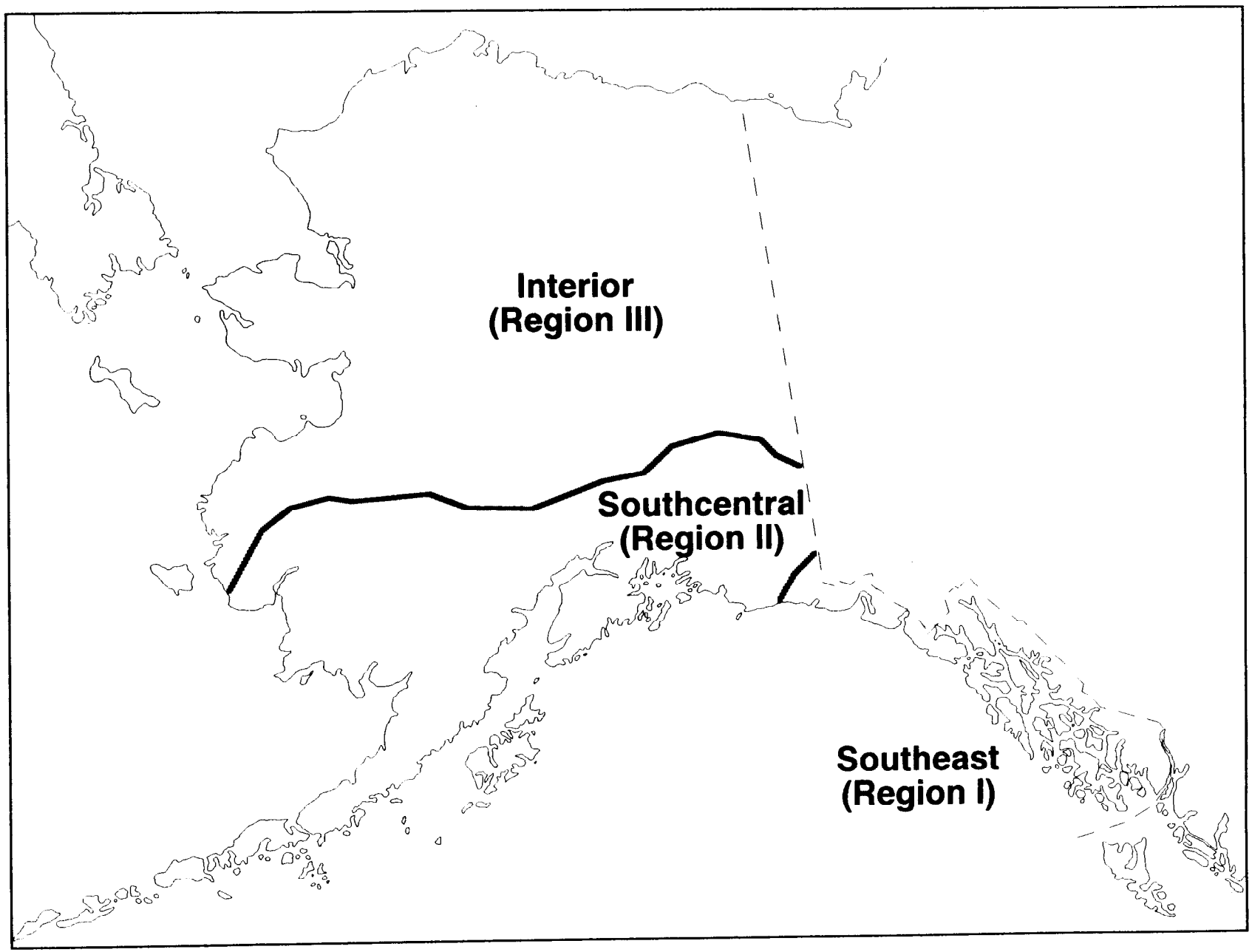

Figure 1. Division of Sport Fish regions; Southeast, Southcentral, and Interior.

exploitation rate were multiplied by the total estimated return to calculate total number of fish intercepted in the commercial fishery. Estimates of the number of fish harvested by sport anglers were obtained from on-site creel surveys or harvest estimates in the statewide harvest survey. Total cost per fish harvested was calculated by dividing the estimated harvest (sport and/or commercial) into the production costs of the particular stocking lot.

For fish stocked in landlocked lakes, the authors made the assumption that, except for chinook salmon, game fish were harvested in the sport fishery during a single year after stocking. Chinook salmon stocked as age 1 post-smolt were harvested late in the year they were stocked and the following year at age 2. For species other than chinook salmon, depending on the size and the time of stocking, fish were assumed to be captured the same year they were stocked, or the first or second year after stocking. Rainbow trout stocked as age 0 fingerlings (less than 10 g) were harvested the second year after stocking at age 2. Rainbow trout stocked as age 1 sub-catchables (greater than 10 g but less than 50 g) were harvested the following year after stocking at age 2. Rainbow trout stocked as age 1 large sub-catchables (greater than 50 g) were harvested the same year they were stocked. Coho salmon stocked as age 0 fingerlings were harvested the following year at age 1. Arctic grayling stocked as age 0 fry or age 0 fingerling were harvested the second year after stocking at age 2.

No estimate of precision of any of the above products was calculated because of the inability to estimate precision of the cost indices and because, in a number of cases, no variance estimate is presented for the harvest or escapement estimates. Sources of all estimates are cited in the appendices, and when available, variances of the harvest estimates are listed.

RESULTS

Chinook Salmon (Anadromous)

Southeast Historical Summary:

The stocking of hatchery-reared chinook salmon in Alaska was initiated by the Alaska Territorial Department of Fisheries in 1956, when eyed chinook salmon eggs, imported from Washington, were hatched at the Deer Mountain Hatchery and stocked in Ketchikan Creek (Alaska Fisheries Board and Alaska Department of Fisheries 1956). Sporadic releases of chinook salmon continued between 1956 and 1973.

The first hatchery release of chinook salmon in the Petersburg area occurred in 1973, when 1,140 fry (1972 Chignik River brood) were released into Crystal Creek (Petersburg area files). Eggs from a Carson River, Washington, stock were also incubated in Crystal Lake hatchery in 1972. Five subsequent Alaska brood sources were used at Crystal Lake Hatchery until the Andrews Creek (tributary to the Stikine River) stock was chosen as the brood source for chinook salmon eggs at the facility (Petersburg area files).

Beginning in the late 1970s, enhancement of chinook salmon was intensified due to depressed wild stocks, the onset of private non-profit hatcheries, and expanded Fisheries Rehabilitation, Enhancement and Development (FRED) and Division of Sport Fish budgets. During the period from 1978 until 1986, up to 500,000 chinook salmon were released each year. Experimental lots of age 0 and

1 smolt were released in over 20 different locations. Survival rates for age 0 smolt averaged 0.05 percent while the age 1 smolt achieved a 3.5 percent survival rate. The southeast Alaska 0 smolt program has since been terminated (Carol Denton, personal communication).

Chinook salmon were first stocked in the Juneau area in 1973 (Bethers 1974). A group of 155,078 Carson River, Washington, chinook salmon fry from Crystal Lake hatchery were stocked into Moose Lake to determine the feasibility of rearing smolts in ponds to improve the marine sport fishery around Juneau. In 1974, these pond-reared chinook salmon smolts (93,129) were released from Moose Lake into saltwater. At the same time, a group of 124,309 chinook salmon smolts reared at Crystal Lake hatchery were released from the Mendenhall rearing facility for comparison. The return rate of the pond-reared chinook salmon was nearly five times greater than returns from hatchery reared smolts (Bethers 1975, 1976, 1977, and 1978; Marriott 1979).

Southeast Evaluations (1985-1989):

In 1986, an intensive chinook salmon sport fishery enhancement program was initiated in the Juneau area with the release of approximately 204,500 chinook salmon smolts from Snettisham Hatchery. These fish were divided into seven experimental lots containing approximately 30,000 smolts per lot. All fish were marked with a coded wire tag and adipose fin clip. Each lot of fish had a different tag code. The chinook salmon smolts were released as follows: one lot in Montana Creek (freshwater release), one lot released in saltwater at Sheep Creek, two lots released at Fish Creek (one lot in freshwater and one lot held for two weeks in a saltwater rearing pen), and three lots at Auke Creek (one lot in freshwater, one lot held for two weeks in a saltwater rearing pen which had a plastic skirt around it, with Auke Creek water piped into it, and one lot held for two weeks in a saltwater rearing pen without a plastic skirt). All lots held in saltwater rearing pens were fed for two weeks prior to release (Josephson 1986 and 1987).

The adult returns of the 1986 release occurred from 1988 through 1990. The estimated harvest of chinook salmon stocked as smolts in 1986 in the commercial fisheries and to the local marine sport fishery was 576 and 603 fish, respectively (Suchanek 1989; Suchanek and Bingham 1990a and 1990b; unpublished data). The estimated total harvest of 1,179 chinook salmon represents a 0.6 percent harvest rate of the smolts released in 1986. Chinook salmon released at remote stocking sites in Juneau apparently survive and contribute better to local sport fisheries than do smolts released at Snettisham hatchery.

Additional releases of chinook salmon in the Juneau area have occurred each year since 1986. All fish were reared at Snettisham Hatchery and released into area streams. In 1987, 214,848 chinook salmon smolts were released, and in 1988 and 1989, 249,556 and 348,000 chinook salmon smolts were released, respectively (Josephson 1988 and 1989).

During the mid-1980s, additional enhancement of chinook salmon in the Ketchikan area was initiated. Both private and state hatcheries expanded their involvement with this species. In 1989, nearly 2.5 million chinook salmon smolts were released in the Ketchikan area (Neets Bay, Whitman Lake, Deer Mountain, and Tamgass Creek hatchery management plans). The results of these massive releases have been encouraging. Dockside sampling has indicated hatchery contributions

ranging from five percent to 45 percent of the chinook salmon sport harvest in the Ketchikan area (Suchanek 1988-1990).

Southcentral Historical Summary:

Since 1958, several Alaska strains of chinook salmon, plus chinook salmon from Oregon, have been stocked in Southcentral. The first hatchery-reared chinook salmon using an Alaskan brood source in Southcentral were stocked in 1964. Eggs for this release were obtained from Ship Creek in 1963 and were incubated at Fire Lake Hatchery. The resulting fingerlings were marked and released through the Ft. Richardson cooling ponds into Ship Creek (Gretz 1964).

Chinook salmon smolts were released in Ship Creek in Anchorage from 1964 through 1980, and again in 1984 and 1985 (Gretz 1964; Kubik 1965-1973; Miller 1990). From 1965-1967, both Ship Creek and Oregon stock were used; Ship Creek provided the brood source for all other years with the exception of 1973 (Chignik), and 1980 and 1984 (Crooked Creek) (Miller 1990). Non-Alaskan stocks have had unsuccessful returns, while local stocks, although better, were erratic during the earlier years because of differences in fish sizes, and numbers released (Kubik 1972). Through 1973, returns of chinook salmon to Ship Creek never exceeded 0.1 percent despite repeated introductions of Ship Creek stock (Redick 1974). Documentation of returns has occurred annually during the course of the program (McMullen and Kissel 1980, 1981, 1982; McMullen et. all 1983; McMullen and Hansen 1984; Hansen 1985 and 1986). Since 1985, chinook salmon smolts (from Ship Creek brood stock) have been released annually into Ship Creek. The reach of Ship Creek below the Chugach power plant dam was opened to sport fishing for chinook salmon beginning in 1987 and a significant fishery has developed.

A chinook salmon run was created at Frazer Lake on Kodiak Island from the stocking of 160,000 fry over a four year period beginning in 1966. The first naturally produced chinook salmon returned in 1976 (Van Hulle and Murray 1977; Blackett 1979).

Lake Rose Tead was stocked with Chignik stock chinook salmon fingerlings (1976-1985) and Rose Tead stock (1982-1985) (Van Hulle and Murray 1978-1981; Murray 1982-1986). Observed adult returns were low. From 1976 through 1985 (1976-1979 plants) only 154 adults returned (0.07 percent). An additional 163 adults from subsequent plants have been observed. Because of these low returns, Murray (1986) recommended that the program be discontinued.

Since 1975, nearly 2.5 million chinook salmon smolts have been released in Crooked Creek on the Kenai Peninsula. Ocean survival of age 0 accelerated-reared smolts released in Crooked Creek during the spring was significantly less than that of age 1 smolts (age 0 averaged 2.5 percent; age 1 averaged 7.3 percent). Resulting adult returns have been used to develop a chinook salmon sport fishery on the Kasilof River and serve as broodstock for numerous other chinook salmon stocking programs throughout southcentral Alaska. The harvest of chinook salmon in the Kasilof River sport fishery during 1978-1988 averaged nearly 4,000 fish. In recent years, annual harvests of 7,000 to 11,000 fish in the Kasilof River fishery rivaled harvest of the early-run Kenai River chinook salmon sport fishery. Over 66 percent of the chinook salmon returning to Crooked Creek during the last seven years resulted from the release of hatchery smolts (Kyle and Litchfield 1989).

Since 1979, a saltwater rearing facility at Halibut Cove in the Homer area has been used primarily as an imprinting and release site for Crooked Creek chinook

smolts. The average survival rate has been 2.3 percent, ranging from 0.3 to 6.1 percent. Over 1.1 million chinook salmon smolts have been stocked since 1979 (Dudiak 1987a; Dudiak and Boyle 1988; Dudiak et al. 1987a, 1987b). Adult chinook salmon returns from smolt releases at Homer Spit, a roadside fishery accessible to a large number of anglers, have generated intensive fishing effort and a positive public response. Survival rates have equaled or exceeded those of the Halibut Cove Lagoon project (Dudiak 1987b; Dudiak and Boyle 1988; Dudiak et. al. 1987a, 1988).

Ship Creek and Crooked Creek brood chinook salmon smolts were released into Box Canyon Creek from 1976 through 1979 and again in 1983. These introductions failed to establish a significant adult return (McHenry 1977-1986). There has been no formal evaluation of adult returns from chinook salmon smolts released at three locations in Resurrection Bay since 1984, but a viable beach and boat sport fishery has resulted since the first return of three-ocean adults in 1987.

Crooked Creek chinook salmon fingerlings and smolts were stocked in the Six Mile Creek drainage on the Kenai Peninsula beginning in 1984 in an attempt to establish a viable sport fishery. There has been no formal evaluation of this program and the sport fishery has not developed. Stocking has been discontinued.

Program development and anadromous fish stocking in the Matanuska-Susitna Valleys have followed guidelines set forth in the "Cook Inlet Regional Salmon Enhancement Plan 1981-2000" (Alaska Department of Fish and Game 1982), and the "Plan for Supplemental Production of Salmon and Steelhead for Cook Inlet Recreational Fisheries 1981" (Alaska Department of Fish and Game 1982). Chinook salmon for potential brood stock have been screened for diseases at Willow, Prairie, Lake, Montana, and Alexander Creeks and Deshka and Little Susitna Rivers (Chlupach 1987).

Chinook salmon were stocked in the Big Lake drainage in 1976, but no evaluation was performed. Willow Creek chinook salmon smolts were released into Willow Creek in 1985. Five point six percent of those fish were marked with coded wire tags. Returns will be monitored through the sport fishery and at the Deception Creek weir (Chlupach 1987).

In an effort to create a terminal fishery, Crooked Creek chinook salmon smolts from Elmendorf Hatchery were released in Passage Canal near Whittier in 1981, and from 1983 through 1986 (Kubik and Delaney 1980; Kubik 1981; Hepler and Kubik 1982; McDaniel 1982; Delaney and Hepler 1983; Delaney et al. 1987; Miller 1990). Evaluations of these releases have been conducted sporadically since the start of stocking efforts (McMullen and Kissel 1982; McMullen et al. 1983; McMullen and Hansen 1984; Hansen 1985, 1986). Other stocking efforts in Prince William Sound include Susitna River drainage chinook salmon smolts stocked in Anderson Bay in Valdez Arm, in 1985 and 1986, and chinook salmon fingerlings stocked in two lakes near Granite Bay on Ester Island in 1986 (Delaney et al. 1987).

Southcentral Evaluations (1985-1989):

In 1982, the Alaska Department of Fish and Game expanded its enhancement program by releasing chinook salmon in Lowell Creek, Thumb's Cove, Seward Lagoon, and Box Canyon. In 1986 and 1987, an estimated 488 (Conrad et al. 1987) and 764 (Vincent-Lang et al. 1988b) chinook salmon were harvested in the sport fisheries in Resurrection Bay. The releases of chinook salmon smolts into Seward Lagoon and Thumb's Cove have contributed the most fish to these sport fisheries. These

releases have resulted in a more diversified fishery in Resurrection Bay which begins about one month earlier than the established sport fishery for coho salmon (Vincent-Lang et al. 1988a).

An estimated 3,400 chinook salmon returned to Halibut Cove Lagoon in 1988, of which an estimated 2,050 were harvested by sport anglers (Dudiak and Boyle 1988). In 1989, an estimated 1,600 chinook salmon were harvested out of a 3,010 fish return. The return of age 4-ocean chinook salmon completed the cycle of returns for the 1985 smolt release. The total estimated survival rate for the 1985 returns was 2.9 percent (Dudiak and Boyle 1989).

An estimated 3,300 chinook salmon were harvested at Homer Spit in 1987, the first year all four age classes were represented. Age class contributions were: 3 percent (age 0.1); 25 percent (age 0.2); 57 percent (age 0.3); and 15 percent (age 0.4) (Dudiak and Boyle 1988). In 1989, an estimated 3,000 chinook salmon were harvested. Total survival from the 1985 smolt release is estimated at 2.9 percent, slightly higher than the 2.3 percent survival rate of the 1984 release group (Dudiak and Boyle 1989).

Chinook salmon smolts were first released in Seldovia Bay in 1987. An estimated 1,000 age 0.1 "jacks" returned in 1988 which generated a considerable amount of fishing effort (Dudiak and Boyle 1988). In 1989, the chinook salmon return to Seldovia Bay was estimated at 950 fish; 400 age 0.1 and 550 age 0.2 (Dudiak and Boyle 1989).

Chinook salmon smolts (Willow Creek origin) were released into Willow Creek in 1985 (5.6 percent marked), 1986 (14.7 percent marked), 1988 (10.4 percent marked), and 1989 (8.4 percent marked). Willow Creek smolts were also stocked in Sheep Creek in 1988 (no marks) and 1989 (9.7 percent marked), and in Montana Creek in 1988 (16.3 percent marked) and 1989 (11 percent marked).
Three groups of smolts were released into Deception Creek (tributary to Willow Creek) in 1985; 14 g age 0 smolts from brood year 1984 were stocked on 10 June and 20 June, and 18 g age 1 smolts from brood year 1983 were stocked on 13 June. An estimated 39 percent of the adult chinook returns to the Deception Creek weir, 1986-1989, were from the 1985 release groups of hatchery smolts. The proportional contribution of smolts was not statistically different between the two lots of 14 g smolts released on 10 and 20 June 1985, but both of these had significantly greater contribution than the 18 g smolts released on 13 June. Recommendations are to continue to release hatchery-produced chinook salmon into selected northern Cook Inlet drainages and to evaluate rearing and release strategies for chinook smolts to improve the survival rate and contribution of returning adults (Chlupach 1987-1989).

In 1988, 528 chinook salmon from the sport fishery at Willow Creek were examined, of which 8 were observed to have a missing adipose fin. Based on this, the estimated contribution of hatchery-produced chinook salmon to the Willow Creek harvest during 1988, was 578 fish or 26.8 percent of the 2,160 chinook harvested (Hepler et al. 1989).

In 1989, 1,005 chinook salmon from the sport fishery at Willow Creek were examined, of which 16 were observed to have a missing adipose fin. These 16 fish represented an estimated 609 chinook from the 10 June 1985 release of 14 g smolts, 320 chinook from the 20 June 1985 release of 14 g smolts, and 22 chinook from the May 1986 release of 12.2 g smolts into Willow Creek, for a total hatchery contribution of 951 fish or 37 percent of the 2,570 chinook harvested

in 1989. In the Deshka River creel census, 997 chinook salmon were examined. One fish had a missing adipose fin. It was from the 20 June 1985 Willow Creek smolt release. The estimated hatchery contribution was 138 fish or 2.7 percent of the 5,036 chinook salmon harvested in 1989. One of 312 chinook salmon examined at Montana Creek (representing a hatchery contribution of 58 fish), and one of 855 chinook salmon examined at Sheep Creek (representing a hatchery contribution of 23 fish), were from the 1988 release of Willow Creek hatchery smolts into Montana Creek (Sweet and Webster in preparation).

Cost Estimates:

Since 1985, data were available to estimate costs from 14 stocking lots of anadromous chinook salmon (Table 6). In Southeast, cost per fish harvested in the sport fishery ranged from $42.78 for Auke Creek smolts stocked in 1986 to $1,396.40 for smolts stocked in Montana Creek in 1986. In Southcentral, cost per fish harvested in the sport fishery ranged from $11.62 for smolts stocked at Homer Spit in 1985 to $50.88 for age 1 smolts stocked in Crooked Creek in 1984.

Chinook Salmon (Landlocked)

Southcentral Historical Summary:

Chinook salmon fingerlings (2 g) stocked in 1984, in a Southcentral landlocked lake containing age 2 stocked coho salmon, yielded an age 0 catch rate of 0.4 chinook salmon per hour versus a coho salmon catch rate of 4.1 fish/hour (Williams and Potterville 1985). Chinook salmon (2 g and 7 g) were stocked in three lakes and with 2 g coho salmon in four other lakes. Experimental gill net catch rates for chinook salmon ranged from zero to 1.6 fish/hour and averaged 0.3 fish/hour for all lakes. Coho salmon catch rates ranged from 0.7 to 7.8 fish/hour and averaging 4.3 fish/hour. Survival estimates of chinook salmon ranged from 1 to 17 percent and averaged 7 percent in lakes stocked only with chinook salmon, and averaged less than one percent in lakes stocked with both chinook and coho salmon. In three of seven lakes, chinook salmon were large enough to enter the winter fishery at age 0 (Havens 1985 and 1986).

Chinook salmon fingerlings (14 g) stocked in several landlocked lakes provided good winter fisheries for age 0 fish which averaged 23 mm longer than coho salmon stocked at a similar size. Most chinook salmon were probably harvested at age 0 since experimental gill netting indicated few fish remained at age 1 (Bentz 1982, 1983; Wallace and Hammarstrom 1982, 1983).

Survival of chinook salmon fingerlings (17 g) was estimated three months after stocking in two Southcentral landlocked lakes. Estimated survival was 29 percent in one lake (stocked only with chinook salmon). Too few fish were captured to estimate survival in the second lake stocked with both chinook salmon and sub-catchable rainbow trout. However, chinook salmon at age 0 were large enough to enter the winter fishery (Hepler and Bowden 1986).

Southcentral Evaluations (1985-1989):

Relative survival to age 0 of coho salmon stocked at 3.5 g was significantly greater than that of chinook salmon stocked at 13 - 14 g in Memory, Rocky, and Victor Lakes in 1985. Absolute survival of age 0 coho salmon in Johnson Lake (85 percent) was greater than was survival of chinook salmon (50 percent). Mean length of chinook salmon was significantly greater than that of coho salmon in

Table 6. Estimated costs of hatchery produced anadromous chinook salmon harvested in sport and commercial fisheries from 1985 through 1989.

Stocking Cohort Release Year and Size	Estimated Cost Per Fish: Total Return	Fish Harvested By Sport Anglers	All Fish Harvested
Southeast:			
Montana Creek			
1986 Smolt (8.4 g)	---	$1,396.40	$581.83
Fish Creek			
1986 Smolt (7.5 g) Direct Release	---	$1,347.40	$280.71
1986 Smolt (8.4 g) Held, Fed, and Imprinted	---	$81.19	$46.40
Auke Creek			
1986 Smolt (8.0 g) Direct Release	---	$79.90	$57.91
1986 Smolt (9.0 g) Held and Fed	---	$42.78	$28.36
1986 Smolt (9.1 g) Held, Fed, and Imprinted	---	$79.38	$36.81
Sheep Creek			
1986 Smolt (7.7 g)	---	$47.17	$17.49
All 1986 Juneau Area Releases Only Production Costs Included	---	$82.54	$42.22
All 1986 Juneau Area Releases All Costs Included	---	$530.68	$271.42
Southcentral:			
Homer Spit			
1985 Smolt (16.0 g)	$10.61	$11.62	a
Crooked Creek			
1983 Age 0+ Smolt (10.2 g)	$21.86	$32.27	a
1983 Age 1+ Smolt (18.2 g)	$13.81	$22.78	a
1984 Age 0+ Smolt (17.4 g)	$10.25	$13.30	a
1984 Age 1+ Smolt (20.7 g)	$26.63	$50.88	a

[a] The estimated harvest of hatchery produced anadromous chinook salmon intercepted in commercial fisheries was zero.

all four lakes, however, coho salmon were approximately 25 percent smaller than chinook salmon at the time of stocking. The third and final year of coho salmon and chinook salmon fingerlings comparisons of relative survival and growth in landlocked Matanuska-Susitna Valley lakes occurred in 1986. Because of the poor long-term survival, stocking of chinook salmon to create landlocked salmon fisheries was discontinued.

A total of 24,846 chinook salmon post-smolts were stocked in three Anchorage lakes in 1986 to enhance the winter ice fishery. No chinook salmon were available in 1987, but stocking was expanded to 13 Anchorage lakes where 92,789 fish were stocked in 1988. The Alaska Statewide Sport Fisheries Harvest Survey (Mills 1987-1989) reported harvests of landlocked salmon from Anchorage area lakes of 749 in 1986, 2,263 in 1987, and 4,364 in 1988.

Interior Evaluations (1985-1989):

Fingerling chinook salmon were stocked in landlocked lakes as part of the Department of Fish and Game's effort to increase the diversity of sport species and fishing opportunities. The brood sources for chinook salmon stocked in Interior lakes were Clear Creek, near Nenana, and Crooked Creek, near Anchorage. Chinook salmon fingerlings were first stocked in lakes in 1985 as an experiment to evaluate the rate of survival and growth (Doxey 1987). In two lakes the rate of survival to age 1 was about 30 percent (Doxey 1988). Mean length at age 1 was about 170 mm. By age 2, mean length was about 250 mm.

The rate of survival of chinook salmon beyond age 2 was very low (less than 5 percent). During mark-recapture experiments, several hundred age 2 chinook salmon were marked in the spring but none were recaptured in the fall (Doxey 1989). However, in 1989, 4 male chinook salmon were captured in Little Harding Lake in the fall. These fish were in spawning condition.

Chinook salmon were dropped from the Interior lake stocking program in 1989 because of the low rate of survival after age 2.

Cost Estimates:

Since 1985, data were available to estimate costs from three stocking lots of chinook salmon post-smolt in southcentral Alaska lakes (Table 7). Cost per fish harvested in the sport fishery ranged from $1.96 to $14.87.

Coho Salmon (Anadromous)

Southeast Historical Summary:

The stocking of hatchery reared coho salmon in Alaska was initiated by the Alaska Territorial Department of Fisheries in 1955 when coho salmon eggs imported from Washington, and Alaskan coho salmon eggs taken from Buschmann Creek, were incubated in Ketchikan Hatchery and released as fry at several southeastern Alaska locations (Alaska Fisheries Board and Alaska Department of Fisheries 1954). Federal fisheries officials experimented with various brood sources, sizes of releases, and locations hoping to improve production of this species. Following statehood in 1959, various divisions of ADF&G continued enhancement of this species in various locations and numbers up to the late 1970s. The successes of these introductions were never adequately monitored but some were

Table 7. Estimated costs of hatchery produced chinook salmon stocked into landlocked lakes and harvested in sport fisheries from 1985 through 1989.

Stocking Cohort Release Year and Size	Estimated Cost Per Fish Harvested By Sport Anglers
Southcentral:	
Beach Lake	
1988 Post-Smolt (69.6 g)	$14.87
Green Lake	
1988 Post-Smolt (74.0 g)	$3.76
Fish Lake	
1988 Post-Smolt (75.6 g)	$1.96

successful, based on the current presence of this species in some areas that historically lacked coho salmon stocks (Ketchikan area files).

The first documented coho salmon enhancement efforts by ADF&G in northern Southeast occurred in 1973 when the Mendenhall Lakes pond rearing project began near Juneau. Dredge Lake was stocked with 139,896 coho salmon fry and Norton Lake received 125,000 coho salmon fry from Mendenhall Ponds. The introduced fish were Blind Slough stocks reared at Crystal Lake Hatchery (Bethers 1974 and 1975). In 1974, 81,425 coho salmon smolts (30.7 percent fry-to-smolt survival rate) emigrated from Norton and Dredge Lakes (Bethers 1975). These smolts achieved a 10.5 percent survival rate to returning adults. In subsequent years, rearing coho salmon experienced poor survival at the Mendenhall facility because of avian predation and overcrowding in the rearing lakes (Bethers 1976, 1977, and 1978; Marriott 1978).

Salmon Creek and Sheep Creek on the Juneau road system are excellent spawning streams and support large runs of pink and chum salmon, but lack adequate rearing habitat for coho salmon. These streams were stocked with coho salmon smolts in 1975 and 1976. Neither stream had a pond or suitable area for releasing smolts and consequently, coho salmon smolts were apparently swept out of the streams soon after stocking.

Marriott (1976) reported that the total return from 12,793 coho salmon smolts released at Salmon Creek in 1975 was 25 adults in 1976 (0.2 percent survival). A total return of 6 adult coho salmon was realized from 15,264 coho salmon smolts released into Sheep Creek in 1975 (0.04 percent survival). The 1976 releases of coho salmon smolt into Salmon and Sheep Creeks were not evaluated. However, no significant sport fisheries resulted.

In the early 1980s, the Northern Southeast Regional Aquaculture Association (NSRAA) began taking coho salmon eggs from several Juneau area streams to develop a coho salmon enhancement program at their Salmon Creek Hatchery. The eggs were incubated in the hatchery building and later reared in raceways at the south end of Twin Lakes with water from Salmon Creek circulated through the rearing pens.

A substantial return of adult coho salmon to Salmon Creek in 1984 generated considerable sport fishing effort. An even larger return developed in 1985, and sport fishing effort developed throughout the northern end of Gastineau Channel as well as at the mouth of Salmon Creek. The fishery was extremely popular. The returning coho salmon also made an impressive contribution to the local marine boat sport fishery. However, by this time, NSRAA had determined the marine area adjacent to and near the Salmon Creek hatchery was poorly suited for fish holding and the prosecution of terminal fishing operations for cost recovery. Therefore, the facility was closed.

Southeast Evaluations (1985-1989):

Beginning in the late 1970s, additional coho salmon enhancement was undertaken at various locations, primarily in the Ketchikan area, with mixed results (Neets Bay, Deer Mountain, Whitman Lake, and Klawock Hatchery Management Plans 1976-1989). The results of these introductions is well documented in both commercial catch statistics and dockside creel census monitoring reports (Suchanek 1986-1989 and Siedleman 1976-1988). Returns from these enhancement projects have resulted in sport catches in the Ketchikan area being comprised of up to 50 percent hatchery fish (Suchanek 1987-1989).

The Division of Sport Fish became directly involved in coho salmon enhancement in the Ketchikan area in 1987 with the onset of the summer-run coho salmon project at Deer Mountain Hatchery. Although the funding source for this project has changed recently, the division was directly involved in planning for releases approaching 200,000 summer-run coho salmon at Ketchikan Creek, Ward Creek, Bold Island, Margaret Lake, and Reflection Lake (Deer Mountain Hatchery Management Plan 1988-1990).

The results of the summer-run coho salmon program are just beginning to materialize. In 1989, several hundred summer-run coho salmon returned to Ward Creek and Ketchikan Creek, but due to the lack of an on-site creel census, information on angler harvest for these locations is lacking. Through dockside interviews, it was determined that over 200 of these fish were caught by sport fishermen in saltwater (Suchanek, 1990). Commercial delivery tickets documented well over 800 fish harvested (Carol Denton, personal communication - FRED Division). The combination of these two harvest levels with estimates of escapement indicates an overall survival rate of over 7 percent.

In 1985, 20,225 coho salmon smolts from Snettisham Hatchery were released into Dredge Lake. The fish averaged 104 mm fork length and most of the fish outmigrated in the spring of 1985 after spending some time in the Dredge Lake and Mendenhall Ponds system.

In 1986, 6.6 percent of the coho salmon smolts released into Dredge Lake returned as adults, as compared to 1.3 percent for coho salmon smolts from the same egg-take that were released at Snettisham Hatchery (Van Hulle memo 11/7/86). The total coho salmon return from the 1985 Dredge Lake release was 1,374 fish for a 6.8 percent survival rate.

Because of the high survival and the popularity of the sport fishery created by the NSRAA releases of lake-reared coho salmon into Salmon Creek in the early 1980s, local sport anglers urged the Department of Fish and Game to continue stocking Salmon Creek with coho salmon. Considerable debate ensued over whether to hold and feed the smolts prior to release, versus just releasing them directly into the creek. In 1986 and 1987, coho salmon from Snettisham Hatchery were released directly into Salmon Creek (no lake rearing). A total of 124,422 coho salmon smolts were released in 1986 and 1987. Only 48 adult coho salmon returned from these two releases (0.04 percent survival) (Ron Josephson, unpublished data).

In 1987, an additional 106,000 coho salmon smolts from Snettisham Hatchery were stocked at Fish Creek and Dredge Lake. These fish averaged only 5.2 g per fish and were far from smolt condition. It is evident that many of the small juvenile coho salmon were forced to remain in freshwater for an additional year prior to smolting (Suchanek 1989). Only an estimated 499 adult coho salmon were harvested in sport and commercial fisheries (the sport harvest was 65 fish and the commercial harvest was 434 fish); a 0.5 percent harvest rate (Suchanek and Bingham 1990a and 1990b; unpublished data).

In 1988, 200,000 coho salmon smolts from Snettisham Hatchery were released at three locations on the Juneau road system (Fish Creek, Sheep Creek, and Dredge Lake). These smolt releases contributed 450 adult coho salmon to Juneau area sport fisheries while 4,888 fish were intercepted in commercial fisheries (Suchanek and Bingham 1990a and 1990b; unpublished data). The estimated total

harvest of 5,338 coho salmon represents a 2.7 percent harvest rate of the smolts released in 1988.

In 1989, 160,806 coho salmon smolts from Snettisham Hatchery were released in the Juneau area. Two groups of two-year-old smolts were released in 1989. In the fall of 1989, 1,837 "jacks" from the 1989 spring releases were harvested (Suchanek 1990). The 1990 adult returns from the two-year-old smolts have not been fully evaluated at this time.

Southcentral Historical Summary:

Coho salmon eggs obtained from Fish, Bear, and Dairy Creeks, and the Swanson River were incubated at Fire Lake Hatchery to determine the suitability of these stocks for use in the sport fish management program. These fry were released into Upper Fire Lake north of Anchorage (Gretz 1963). A mark/recapture estimate of coho salmon out-migrants at Fire Lake indicated better survival to smolt size for fry released into Lower Fire Lake than for those fish released into Upper Fire Lake (Gretz 1964; Wallis 1967, 1969).

Coho salmon smolts, from eggs obtained in Oregon, were released into Ship Creek in 1968 (Kubik 1973; Miller 1990). Coho salmon smolts were released annually in Ship Creek from 1969 to 1976 and again in 1978, although coho salmon eggs from an additional eight brood stock sites ranging from Washington to Kodiak were used (Miller 1990). Returns of adult coho salmon from Ship Creek releases achieved a 1 percent return rate only once through 1972 (Redick 1973). Evaluations of returns of Ship Creek Hatchery reared coho salmon were conducted incidental to the stocking program (Kubik 1970-1973; McMullen and Kissel 1980). Annual releases of coho salmon smolt have occurred since 1987 and a significant sport fishery for these fish has recently developed. Other systems in the Anchorage area that have been stocked with coho salmon include Chester Creek (1971 and 1982) and Ingram Creek (1985) (Miller 1990). The Ingram Creek stocking program has continued annually since 1985 (Schmidt 1988).

Resurrection Bay supported a small commercial fishery for coho salmon during the 1950s. This fishery gave way to the start of the Seward Silver Salmon Derby in 1956. A program to evaluate this fishery began in 1959 (Dunn 1961). A coho salmon enhancement program by rehabilitation and subsequent stocking of Bear Lake was initiated in 1962 (Logan 1962).

From 1963 to 1966, coho salmon fingerlings stocked in Bear Lake were predominantly from Swanson River stock although Bear, Dairy, and Ketchikan Creeks brood sources were also used (Logan 1963-1966). Coho salmon stocks from Big Creek and Eagle Creek Hatcheries in Oregon were used from 1966 to 1969. Between 1967 and 1974, Ship Creek stock and coho salmon from three separate Kodiak Island sources were planted in Resurrection Bay drainages (Logan 1967-1969; McHenry 1970-1974). McHenry (1971) recommended discontinuing the use of non-Alaska coho salmon stocks as the few adults that did return to Resurrection Bay arrived in January, long after the sport fishery was completed. Since 1975, only Seward Lagoon and Bear Lake brood stocks have been used (McHenry 1975-1986; Vincent-Lang 1987).

Most sport fishing effort on Resurrection Bay coho salmon takes place in a marine boat fishery because the local streams have been closed to salmon fishing since 1960. Stocked coho salmon provided 21.7 percent of the harvest during the years 1962-1986 and of that, Seward Lagoon enhancement has provided over 50 percent of

the hatchery reared coho salmon harvest (Vincent-Lang 1987; Vincent-Lang et al. 1988).

Quartz Creek coho salmon fry and smolts were stocked in Grant Lake from 1983 to 1986 to provide coho salmon to commercial, sport, and personal use fisheries in Cook Inlet and the Kenai River drainage. Fry to adult returns to the Grant Creek weir were 0.19 percent and smolt to adult returns were 0.49 percent (Marcuson 1989). He concluded that the cost/benefit ratio was unacceptably low based upon escapement estimates. However, it should be noted that the number of fish harvested and returns to other portions of the Kenai system are unknown.

In the fall of 1982, a coho salmon egg take was conducted at the outlet of Lower Russian Lake. The Pathology Section of FRED Division documented a high incidence of bacterial kidney disease (BKD) and Flagg (1982) recommended that this stock be deleted as a potential brood source.

Outside of Resurrection Bay, Crooked Creek has been the only coho salmon brood source used on the Kenai Peninsula since the last Quartz Creek egg take in 1984. Kasilof Hatchery is located on the banks of Crooked Creek, where coho salmon were selected as a brood stock (Gary Kyle, FRED Division, personal communication). Enhancement of the Crooked Creek coho salmon sport fishery began with a fry plant in 1982, followed by annual smolt releases beginning in 1983. Neither a formal creel census nor a return evaluation has been conducted. A successful sport fishery has been established with an annual harvest of just over 350 fish from 1981 to 1983. The average coho salmon harvest from 1984 to 1988 increased to over 2,000 fish annually (Mills 1982-1989).

Crooked Creek strain coho salmon fingerlings were stocked in three separate locations in the Six Mile Creek drainage beginning in 1983 in an attempt to establish a sport fishery. There was no formal evaluation of this program, but no significant sport fishery developed, and the stocking has been discontinued.

An experimental coho salmon fry plant into Mission Lake on Kodiak Island in 1973, produced an active sport fishery. The minimum spawning escapement was 35 adults during September and October of 1975 (Van Hulle and Murray 1976). Coho salmon stocked in Mission Lake on 23 June 1976 at 1.1 g were in pre-smolt condition (mean length 93 mm) after 3 months of lake residency (Van Hulle and Murray 1977).

Eleven Kodiak area lakes were stocked in 1984 to provide anadromous coho salmon (Murray 1985). Buskin River coho salmon fingerlings, marked and stocked in Lake Genevieve in 1983, returned an estimated 181 age 1.1 adults through the Buskin River weir in 1985 (Murray 1984-1986).

Program development and anadromous fish stocking in the Matanuska-Susitna Valleys follow guidelines set forth in the "Cook Inlet Regional Salmon Enhancement Plan 1981-2000" (Alaska Department of Fish and Game 1982) and "Plan for Supplemental Production of Salmon and Steelhead for Cook Inlet Recreational Fisheries 1981" (Alaska Department of Fish and Game 1981). Coho salmon for potential brood stocks have been disease screened at Fish, Cottonwood, Caswell, Sunshine, Rabideaux, Birch, Clear, Willow, and Horseshoe Creeks and Deshka and Little Susitna Rivers (Chlupach 1987).

The Alaska Department of Fish and Game Big Lake Hatchery was completed in 1976. Coho salmon fingerling releases into the Big Lake drainage were initiated in

1976, and coho salmon have been stocked annually since that date. A portion of the coho salmon released were fin-clipped through 1981, and, since 1982, coded-wire-tags have been used. Survival of stocked fingerlings to out-migrating smolts have been estimated annually. Of the hatchery-produced fish returning to the Big Lake drainage from 1981 to 1986, the estimated survival was 0.7 percent, and contribution to the total escapement was 26 percent (Chlupach 1985, 1987; McMullen and Kissel 1980-1982; McMullen et al. 1983; McMullen and Hansen 1984; Hansen 1985, 1986).

Coho salmon fingerlings were first released into the Cottonwood Creek drainage in 1978, with a portion of the fish marked before release. Coho salmon have been stocked annually since that date. Evaluation of hatchery fingerling survival to out-migrating smolt was estimated in 1980 and 1981. Of the hatchery-produced fish returning to the Cottonwood Creek drainage in 1981-1982, the estimated survival was 0.7 percent and contribution to the total escapement was 23 percent (Bentz 1982, 1983; Chlupach 1985, 1987).

Coho salmon fingerlings were first released into the Little Susitna River drainage in 1982; additional releases of smolt began in 1985. Beginning in 1983, a portion of the coho salmon released were marked. In 1986, an estimated 6.6 percent to 10.2 percent of the adult coho salmon harvested by sport anglers were hatchery-produced (Bentz 1987; Chlupach 1987).

Coho salmon fingerling and smolt releases in Prince William Sound were initiated in 1978. The first smolt release was in Whittier Harbor to provide a terminal sport fishery in Passage Canal. Evaluations of the survival of various stocking strategies and enumeration of the adult returns from these stocking efforts have occurred sporadically since stocking was initiated (McMullen and Kissel 1980-1983; Hepler and Kubik 1982; McDaniel 1982; Delaney and Hepler 1983; McMullen et al. 1983; McMullen and Hansen 1984; Hansen 1985, 1986; Delaney et al. 1987; Miller 1990). Creel surveys revealed 11.2 percent and 11.4 percent of harvested coho salmon were marked returns from the 1978 and 1979 smolt releases (Kubik and Delaney 1980; Kubik 1981).

Other coho salmon stocking efforts have been with fry and fingerlings stocked in 18 Mile Creek in 1983, 1985, and 1986; fry and fingerlings stocked in Culross Lake from 1984 to 1986; fingerlings stocked in Surprise Cove Lakes from 1985 to 1987 (Delaney et al. 1987); and smolts stocked in Wells Passage in 1986 and 1987. A terminal sport fishery has been created at Flemming Spit in Cordova through the annual stocking of coho salmon smolt beginning in 1987.

Southcentral Evaluations (1985-1989):

In 1987, the Resurrection Bay boat fishery harvested an estimated 22,402 coho salmon, while the beach fishery harvested an estimated 1,545 coho salmon. Hatchery coho salmon from the 1986 smolt emigration of 1984 and 1985 Bear Lake fingerlings, the 1986 Seward Lagoon smolt release, and the 1986 Box Canyon Creek smolt release comprised approximately 40 percent of the boat harvest. In the beach fishery, fish from these releases comprised more than three-quarters of the harvest. Total estimated hatchery contribution for the 1987 fisheries was 43 percent. As measured by percentage of smolt contributing to the harvest, the Seward Lagoon stocking was the most efficient (8.0 percent) followed by Box Canyon (6.0 percent) and Bear Lake (3.9 percent) (Vincent-Lang et al. 1988b).

Between 1 July and 14 September, 1988, the Resurrection Bay boat fishery harvested an estimated 9,809 coho salmon while the beach fishery harvested an estimated 4,718 coho salmon between 13 August and 27 September. Hatchery coho salmon from the 1985 and 1986 Bear Lake fingerling, the 1987 Seward Lagoon smolt release, and the 1987 Box Canyon Creek smolt release comprised approximately 43 percent of the boat harvest and 81 percent of the beach harvest. Total estimated hatchery contribution to the recreational harvest was 56 percent. As measured by percentage of smolt contributing to the harvest, the Seward Lagoon stocking was the most efficient (6.3 percent) followed by Box Canyon (5.8 percent) and Bear Lake (0.8 percent) (Carlon and Vincent-Lang 1989b). The estimated marine survival rate (1988 harvest and escapement) from the 1987 Bear Lake coho salmon smolt emigration of 80,182 fish was 3.5 percent. The majority of these smolts were from the 1985 and 1986 Bear Lake fingerling introductions (Carlon and Vincent-Lang 1989a).

In 1988 nearly 75 percent of the total return of coho salmon to Crooked Creek were hatchery-produced, and an estimated 1,000 sport-caught coho salmon were hatchery fish (Kyle 1988). In 1989, an estimated 55 percent of the total return of coho salmon to Crooked Creek were hatchery-produced, and an estimated 1,100 sport-caught coho salmon were hatchery fish (Kyle et al. 1989).

Caribou and Seldovia Lakes have been stocked with coho salmon annually since 1984. Estimated 1987 adult coho salmon returns were 1,500 and 800, respectively, for Caribou and Seldovia Lakes (Dudiak and Boyle 1988). Estimated 1988 adult coho salmon returns were 3,400 and 1,000, respectively, for Caribou and Seldovia Lakes (Dudiak and Boyle 1989). The salmon stocking program on the Homer spit has created an extremely popular, family-oriented fishery. In 1989, an estimated 2,500 coho salmon were harvested by anglers (Holland 1989b).

During May and June, 1985, an estimated 91 percent of coho salmon smolt migrating through the Fish Creek weir were hatchery-produced (Chlupach 1985). In 1986 the adult contribution of hatchery-produced coho salmon was determined twice during the adult return based upon the examination of marked fish. At the adult weir on Fish Creek, an estimated 81 percent of the escapement was of hatchery origin. Upstream at the egg-take weir on Meadow Creek, the hatchery component was estimated to be 86 percent (Chlupach 1987).

During May and June, 1986, an estimated 36 percent of the coho salmon smolt migrating through the Fish Creek smolt weir were hatchery-produced (Chlupach 1986). The coho salmon escapement into the Big Lake drainage from 9 July to 27 August 1987 was 3,871 fish. Heads were collected from nine marked fish of 1,500 coho salmon examined for clipped adipose fins at the Fish Creek adult weir, giving an estimated hatchery contribution of 56 percent or 2,168 fish (Chlupach 1988).

During May and June, 1987, an estimated 32 percent of coho salmon smolt migrating through the Fish Creek smolt weir were hatchery-produced, indicating a survival rate (stocked fingerlings to age 2.0 outmigrating smolt) of 2.9 percent (Chlupach 1987). The estimated contribution of hatchery fish through the Fish Creek adult weir in 1988 was 713 or 33 percent of the 2,162 coho salmon escapement: 21 percent were from the 1985 fingerling release and 11 percent were from the 1986 fingerling release (Chlupach 1989).

During May and June, 1988, an estimated 55,019 fish (44.1 percent) of the 124,724 coho salmon smolt migrating through the Fish Creek smolt weir were

hatchery-produced. These hatchery fish were comprised of 0.9 percent of the fingerlings released in 1986, 1.5 percent of the fingerlings stocked in 1987, 2.8 percent of the pre-smolts released in 1987, and 4.8 percent of the smolts stocked earlier in 1988 (Chlupach 1988). Preliminary estimates of the contribution of hatchery-produced adult coho salmon through the Fish Creek weir in 1989 was 34.1 percent of the coho salmon escapement. From this data, 19.4 percent were from the 1986 fingerling release, 4.5 percent were from the 1987 fingerling release, 9.6 percent were from the 1987 pre-smolt release, and 0.6 percent were from the 1988 smolt release. A portion of the estimated number of hatchery-produced age 1 coho salmon migrating through the Fish Creek weir may actually be fish that will reside in freshwater for an additional year before smolting. This may explain the difference between the estimated percent of hatchery-produced outmigrants and the adult returns (Chlupach, ADF&G, FRED Division, pers. comm.).

In 1987, the minimum estimated contribution of hatchery-produced coho salmon to the sport harvest in the Little Susitna River was 3,460 fish (26.2 percent of the total coho salmon harvest). The 1986 smolt release into Nancy Lake (tributary to the Little Susitna River) contributed 3,453 coho salmon, and straying coho salmon from the 1986 Eklutna PNP Hatchery smolt release contributed 7 fish. Although present in the return, no coho salmon with coded-wire tags from the 1983 fingerling release were recovered in the sport fishery, probably due to a combination of low abundance and the low marking rate of the initial release (Bartlett and Conrad 1988). At the egg-take site on Nancy Lake Creek, an estimated 52.4 percent of returning coho salmon adults were from the 1986 smolt release, and 15.5 percent were from the 1984 fingerling release. Although stocking numbers were similar (497,323 smolts and 436,216 fingerlings), an estimated 863 adults were from the smolt release, and 256 were from the fingerling release: about 3.4 times as many smolts as fingerlings (Chlupach 1988).

In 1987, an estimated 92 percent of the coho salmon smolt sampled as they migrated through the Nancy Lake weir (tributary to the Little Susitna River) were hatchery-produced fish: 55 percent from Little Susitna River origin smolt released into Nancy Lake from Ft. Richardson Hatchery in 1987, and 37 percent from fingerlings released from Big Lake Hatchery in 1985 (Chlupach 1987). In 1988, based on tag decoding information from coho salmon examined at the Nancy Lake Creek egg-take site, 96 percent of the adults were from the 1987 Nancy Lake smolt release (Chlupach 1989). The minimum estimated contribution of hatchery-produced coho salmon to the sport harvest in the Little Susitna River in 1988 was 6,468 fish (51 percent of total coho salmon harvest). An estimated 22 percent of the escapement of 21,438 coho salmon past the weir were hatchery fish (Bartlett and Vincent-Lang 1989).

In 1989, the minimum estimated contribution of hatchery-produced coho salmon to the sport harvest in the Little Susitna River through the Burma Road, was 10,331 fish (75.1 percent of the total coho salmon harvest). Of the 50 decodable tags recovered, 49 were from the 1988 Nancy Lake smolt release, and one was from the 1987 Nancy Lake smolt release. The estimated contribution of hatchery-produced coho salmon to the sport harvest in the Little Susitna River through Miller's Landing was 329 fish (82.3 percent), all from the 1988 Nancy Lake smolt release. An estimated 46 percent of the escapement of 15,855 coho salmon past the weir were hatchery fish. Based on tag decoding information obtained from fish caught in the sport fishery, it is probable that these coho salmon originated from the 1988 Nancy Lake smolt release (Bartlett in preparation).

In 1988, an estimated 3,000 adult coho salmon were harvested from Kodiak area stocked lakes (White 1988). In 1989, an estimated 2,000 adult coho salmon were harvested from Kodiak area stocked lakes (White 1989).

In 1988, Cordova sport fishermen harvested an estimated 5,000 coho salmon returning from a FRED Division coho salmon smolt release (Holland 1989a). In 1989, Prince William Sound sport fishermen harvested an estimated 4,000 coho salmon returning from FRED Division coho salmon smolt releases (Holland 1989b).

Cost Estimates:

Since 1985, data were available to estimate costs from 11 stocking lots of anadromous coho salmon (Table 8). In Southeast, cost per fish harvested in the sport fishery ranged from $45.21 for smolt stocked in Dredge Lake in 1987 to $453.83 for smolt stocked in Fish Creek in 1987. In Southcentral, cost per fish harvested in the sport fishery ranged from $3.90 for smolt stocked at Seward Lagoon in 1987 to $61.54 for smolt stocked in the Little Susitna River in 1987.

Coho Salmon (Landlocked)

Southeast Historical Summary:

Landlocked coho salmon were first stocked into the Juneau area in 1974, when 976 sub-smolts from the Mendenhall Lakes rearing facility were released into Marshall Ponds in the Mendenhall Valley. These fish were known to have survived, however, harvest studies were not conducted.

Landlocked coho salmon were stocked into Twin Lakes in 1982, and have been stocked annually through 1989 (Josephson 1987, 1988, and 1989). In 1982, juvenile coho salmon were brought from the Little Port Walter Hatchery. In subsequent years, juvenile coho salmon were transplanted from Snettisham Hatchery. Coho salmon slated for release into Twin Lakes were held in the hatchery for an additional year and released into Twin Lakes as age 2 sub-catchables, ranging from 20 to 25 cm (Neimark 1984; Schmidt and Bethers 1985). No harvest or survival evaluations were performed on the fish stocked from 1985 through 1989.

Southcentral Historical Summary:

Stocking of hatchery reared coho salmon in Southcentral began in 1958, when eggs obtained from Ward Cove Creek (Ketchikan) were incubated at Fire Lake Hatchery and were stocked as fry or fingerlings in four landlocked Anchorage/Matanuska Valley lakes and one Fairbanks area lake (Alaska Fisheries Board and Alaska Department of Fisheries 1958). Since 1958, at least 12 Alaska strains of coho salmon, along with coho salmon from Washington and Oregon hatcheries, have been stocked in Southcentral lakes.

Survival of fish stocked in Southcentral landlocked lakes was confirmed through experimental netting and angler catches (McGinnis 1963-1966; Redick 1967). Seven population estimates performed on stocked fingerling coho salmon revealed that survival at age 1 ranged from 31 to 50 percent and averaged 40 percent (Chlupach 1978, Murray and Van Hulle 1980, 1981; Murray 1982).

A significant portion of male coho salmon mature at age 2 and die one year earlier than females (Redick 1970). Comparison of a Kodiak versus Green River,

Table 8. Estimated costs of hatchery produced anadromous coho salmon harvested in sport and commercial fisheries from 1985 through 1989.

Stocking Cohort Release Year and Size	Estimated Cost Per Fish: Total Return	Fish Harvested By Sport Anglers	All Fish Harvested
Southeast:			
Salmon Creek			
1987 Smolt (3.5 g)	___	a	$926.60
Fish Creek			
1987 Smolt (7.8 g)	---	$453.83	$55.57
1988 Smolt (12.3 g)	---	$54.72	$6.32
Dredge Lake			
1987 Smolt (3.4 g)	---	$45.21	$5.97
1988 Smolt (6.8 g)	---	$78.85	$5.80
Sheep Creek			
1988 Smolt (10.9 g)	---	$67.04	$4.92
Southcentral:			
Little Susitna River			
1987 Smolt (19.1 g)	$18.83	$61.54	$23.36
1985 Emergent Fry (0.3 g)	$31.80	a	$63.55
Seward Lagoon			
1986 Smolt (21.9 g)	---	$8.19	b
1987 Smolt (21.3 g)	---	$3.90	b
Lowell Creek			
1987 Smolt (27.2 g)	---	$5.39	b

[a] The estimated harvest of hatchery produced anadromous coho salmon by sport anglers was zero.

[b] The estimated harvest of hatchery produced anadromous coho salmon intercepted in commercial fisheries was zero.

Washington, strain of coho salmon fingerlings, stocked at the same time, size, and density, indicated the Kodiak strain was significantly larger at age 1. However, 29 percent of the Kodiak fish were mature males, whereas, only 2 percent of the Washington fish were mature (Kalb 1975).

ADF&G staff have concluded that coho salmon fry should be stocked in lakes that are easily accessible in winter because coho salmon only reach harvestable size at age 1, after 18 months of lake residency. Subsequently, they produce high winter-time angler catch rates. Catch rates of age 1 coho salmon that are acceptable to winter anglers have resulted only from stocking densities of at least 494 to 1,235 fish per surface hectare (Redick 1970). Coho salmon exhibit larger size at age 1 when stocked at densities of 494 to 741 per hectare than at densities greater than 1,112 per hectare (Engel 1971; Hammarstrom 1977; Murray and Van Hulle 1981). Coho salmon stocked in early summer exhibited better relative survival than coho salmon of similar size that were stocked in the fall (Engel 1973). Coho salmon stocked as fingerlings (2 - 7 g) at 247 to 494 fish per hectare are larger by winter at age 0 and produce better catch rates than fry (>1 g) stocked at higher densities (Watsjold 1981).

Evaluations of growth and survival of rainbow trout and coho salmon fingerlings stocked in the same lake and coho salmon in lakes previously stocked with rainbow trout were conducted in the 1960s and 1970s. Experimental gillnet catches and angler catch rates indicate slower growth for coho salmon than for rainbow trout (Andrews 1960; Van Wyhe 1962; Redick 1970; Engel 1971; Watsjold 1976; Chlupach 1978).

Evaluations of chinook and coho salmon fingerlings (15 g) stocked in lakes previously stocked with just coho salmon indicate higher experimental gillnet catches, higher angler catch rates, and more rapid growth for chinook salmon. However, by age 1 most chinook salmon had either been harvested or had died (Bentz 1982). Two gram coho salmon were stocked in the same lake with 2 g and then 7 g chinook salmon (in successive years). Catch rates were significantly higher for coho salmon. Although the few chinook salmon captured were large enough to enter the winter fishery at age 0, none were captured the following year at age 1. Estimated coho salmon survival in four lakes ranged from 32 to 65 percent and averaged 51 percent, while survival of 7 g chinook salmon was less than 1 percent (Havens 1985, 1986).

Southcentral Evaluations (1985-1989):

Relative survival for coho salmon stocked as 3.5 g fingerlings was significantly greater than that of chinook salmon stocked as 13 to 14 g fingerlings in Memory, Rocky, and Victor Lakes in 1985. Absolute survival of age 0 coho salmon in Johnson Lake (85 percent) was greater than chinook salmon survival (50 percent). Mean length of chinook salmon was significantly greater than that of coho salmon in all four lakes. However, coho salmon were approximately 25 percent smaller than chinook salmon at the time of stocking. The third and final year of coho salmon and chinook salmon fingerling comparisons of relative survival and growth in landlocked lakes in the Matanuska-Susitna Valley occurred in 1986. The conclusion of these studies was that no more chinook salmon fingerlings would be stocked in an attempt to create landlocked salmon fisheries. Instead, research would be continued in hatcheries to accelerate growth of coho salmon to be stocked in landlocked lakes at age 0 following ice-out (Havens et al. 1987).

Two Matanuska/Susitna Valley lakes were experimentally stocked in 1986 with coho salmon fingerlings and rainbow trout or Arctic grayling fingerlings. In Wolf Lake, Arctic grayling that had been stocked at 4.6 g had an estimated survival at age 1 of 2.5 percent, while coho salmon stocked at 1.4 g had an estimated survival to age 1 of 9.9 percent. Based on these results it was recommended that stocking Arctic grayling be discontinued but that coho salmon stocking continue on an annual basis. In Echo Lake, rainbow trout stocked as 3.0 g fingerlings had an estimated survival to age 1 of 12.1 percent, while coho salmon stocked at 3.5 g had an estimated survival to age 1 of 13.0 percent. The mean length of age 1 coho salmon in Echo Lake from a single species introduction in 1983 was 246 mm. The mean length of age 1 coho salmon was 222 (1985) and 204 mm (1986) after being stocked at equal densities with chinook salmon in 1984 and 1985, respectively. In all three cases, the mean length of age 1 coho salmon was greater than the mean length of 185 mm attained by the coho salmon stocked with rainbow trout in 1986. Although it appears that a dual stocking of rainbow trout and coho salmon may limit first year fish growth, 80 percent of the salmon were larger than 165 mm and would be available for harvest in the winter fishery. It was recommended that Echo Lake continue to be stocked annually with coho salmon at a density of 494 fish per surface hectare and stocked with rainbow trout triennially at 247 fish per surface hectare (Havens 1988).

Coho salmon of Little Susitna River origin were stocked at a size of 3.7 g from a warm-water hatchery in four Matanuska/Susitna Valley landlocked lakes in June, 1988, and at 1.1 to 1.3 g from a cold-water hatchery in four other lakes in July, 1988, for comparison of mean length (at age 0 and age 1) and survival at age 0. In September, 1988, estimated survival of coho salmon stocked at 3.7 g ranged from 48 to 90 percent and averaged 60 percent, while mean lengths ranged from 109 to 126 mm and averaged 118 mm. Mean lengths at age 1 in May, 1989, ranged from 124 to 150 mm and averaged 139 mm. Estimated survival of coho salmon stocked at 1.1 to 1.3 g ranged from 24 to 36 percent and averaged 32 percent, while mean lengths at age 0 ranged from 78 to 89 mm and averaged 82 mm. Mean lengths at age 1 ranged from 115 to 129 mm and averaged 118 mm. Based on these results, it was recommended that coho salmon be stocked in landlocked lakes soon after ice-out at as large a size as can be produced at warm-water hatcheries (Havens in prep.)

Interior Historical Summary:

To increase fishing opportunities and species diversity, coho salmon have been stocked in lakes along the road system in interior Alaska since 1958 (McKirdy 1962). Coho salmon stocked in interior Alaska lakes usually reach catchable size (220 to 260 mm) 22 to 24 months after stocking (summarized by Peckham 1980). In some lakes, the mean lengths of coho salmon were 223 to 281 mm 14 to 16 months after stocking. For comparison, Arctic grayling and rainbow trout were about 130 mm 14 months after stocking (Doxey 1989; Skaugstad 1989).

A comparison of stocking densities for fingerling coho salmon showed the rate of growth and the capture rate in gill nets was usually highest when 250 to 490 fingerlings were stocked per surface hectare (Peckham 1981). Mean lengths at age 2 ranged from 216 to 357 mm when stocking densities were less than 490 per surface hectare. In comparison, when fingerlings were stocked at 990 per surface hectare, the mean length by age 4 was only 238 mm.

From 1968 through 1979, there was an attempt to establish a coho salmon fishery in Harding Lake because prior introductions of lake trout *Salvelinus namaycush* and rainbow trout failed to produce a sport fishery (summarized by Hallberg

1980). To establish a fishery, sac fry, fingerlings, and lake reared smolt were stocked into Harding Lake. However, the rate of survival was very low. Only a few coho salmon were caught by anglers and no fishery developed. A few large coho salmon (up to 672 mm and 5 kg), that had been stocked as fingerlings or that were lake-reared smolt were captured in gill nets (Kramer 1977, 1978).

A study was initiated in 1972 to evaluate the rates of survival and growth of hatchery-reared fingerlings and lake-reared smolt that were stocked into Harding Lake (Kramer 1977). Smolts stocked into Harding Lake were first stocked in small lakes as fingerlings. The following year these fish were captured and stocked into Harding Lake as smolts. Based on the number of fish caught in gill nets, the rate of survival of coho salmon stocked as fingerlings and as smolts was very low.

A comparison of growth of landlocked coho salmon from different brood sources showed that coho salmon from Seward Lagoon brood stock were larger at age 1 (Peckham 1980). Mean length of coho salmon from Seward Lagoon brood stock was 215 mm compared to mean lengths ranging from 132 to 187 mm for coho salmon from other sources. Coho salmon stocked in the Interior have been obtained from about a dozen different stocks in Southcentral and the Interior.

Cost Estimates:

Since 1985, data were available to estimate costs from 11 stocking lots of coho salmon fingerling in Southcentral and Interior lakes (Table 9). In Southcentral the cost per fish harvested in six sport fisheries ranged from $0.89 to $12.86. In Interior the cost per fish harvested in five sport fisheries ranged from $1.44 to $4.74.

Sockeye Salmon (Anadromous)

Southeast Historical Summary:

Although sockeye salmon *Oncorhynchus nerka* were stocked in northern southeast Alaska in the 1920s and 1930s, the first recent sockeye salmon enhancement effort occurred in 1974. In 1974 and 1975, sockeye salmon eggs were taken from fish spawning in Lake Creek, the largest spawning tributary to Auke Lake (near Juneau). Eggs were hatched in Auke Creek Hatchery and the resultant fry were released back into Auke Lake for natural rearing and smoltification. This stocking produced a 65 percent fry to smolt survival rate for fry released at 1.0 g per fish and a 24 percent fry to smolt survival rate for fry released at 0.4 g (Taylor 1984).

Southeast Evaluations (1985-1989):

In the late 1970s and early 1980s the Auke Lake sockeye salmon population declined significantly. Beginning in 1986, the Division of Sport Fish, in cooperation with the National Marine Fisheries Service's Auke Bay Lab, duplicated the 1974 enhancement technique to restore the sockeye salmon population in Auke Lake.

From 1986 through 1989, over 500,000 sockeye salmon eggs were collected at Auke Lake and nearly 205,000 sockeye salmon fry were placed in various experimental groups to determine the most effective techniques for increasing smolt production in the Auke Lake system (Bethers 1985 and 1990). Although it is too early to

Table 9. Estimated costs of hatchery produced coho salmon stocked into landlocked lakes and harvested in sport fisheries from 1985 through 1989.

Stocking Cohort Release Year and Size	Estimated Cost Per Fish Harvested By Sport Anglers
Southcentral:	
Bear Paw Lake	
1986-1987 Fingerling	$1.78
Christiansen Lake	
1987-1988 Fingerling	$5.76
Finger Lake	
1985-1988 Fingerling	$0.89
Loon Lake	
1986-1988 Fingerling	$12.19
Prator Lake	
1986-1988 Fingerling	$3.95
Wolf Lake	
1987-1988 Fingerling	$12.86
Interior:	
Birch Lake	
1984-1988 Fingerling	$1.59
Quartz Lake	
1984-1988 Fingerling	$1.44
Chena Lake	
1984-1988 Fingerling	$1.47
Roadside Ponds	
1984-1988 Fingerling	$3.74
Dune Lake	
1987 Fingerling	$1.49

calculate the total smolt production from specific release lots or adult return rates, it is apparent that enhancement efforts have significantly increased the number of sockeye salmon smolts emigrating from Auke Lake. Twenty-five, one-ocean sockeye salmon from enhancement efforts returned to Auke Lake in 1989. Adult returns from enhancement efforts will continue through 1996. Although the number of adult sockeye salmon returning to Auke Lake is increasing, the harvest by sport anglers remains very low. Because of the limited benefits to sport anglers, ADF&G has terminated participation in this enhancement project.

Sockeye Salmon (Landlocked)

Interior Evaluations (1985-1989):

Sockeye salmon were first introduced into Harding Lake in May and June of 1988, when 500,000 sac-fry from the Gulkana River Incubation Facility were stocked. Another 500,000 sac-fry were stocked in 1989. ADF&G's intent in stocking sockeye salmon into Harding Lake was to introduce a game fish that would occupy the pelagic zone and provide recreational fishing opportunity.

Tow nets were used to capture juvenile sockeye salmon to estimate abundance and growth. The estimated abundance of juvenile sockeye salmon (age 0), by October 1988 was 25,500 (Clark and Doxey 1988). The rate of survival was five percent for the first four months. In general, the survival rate of sockeye salmon is about eight percent from the time the population migrates into a lake after emergence, to the time of their seaward migration as smolts, typically one to three years later. Therefore, it appears that survival of sockeye salmon stocked into Harding Lake is lower than what could be expected in typical lakes that support sockeye salmon.

In October 1989 both age 0 and age 1 juvenile sockeye salmon were captured (Clark 1991). Mean fork length of sockeye salmon was 72 mm, four months after stocking, and was 102 mm, 16 months after stocking. Reported mean fork lengths of age 0 sockeye salmon, sampled from late August to early October for populations in a series of eight lakes located in the Bristol Bay and Cook Inlet areas of Alaska, ranged from 35 to 70 mm. Growth of age 0 sockeye salmon in Harding Lake was slightly faster than that reported for several native stocks of Alaska sockeye salmon.

Steelhead

Southeast Historical Summary:

The US Forest Service incubated and reared 450,000 steelhead fry in the Ward Creek Hatchery (Ketchikan) and released them in Ward Creek and Ward Lake in 1937 (Petersburg area files). In 1939 the US Forest Service in conjunction with the US Navy transplanted 50,000 eyed-eggs from Sashin Lake to Blue Lake, near Sitka (Tate 1939). Steelhead stocking first occurred in northern southeast Alaska in 1941 when Peterson Creek and Windfall Lake near Juneau were stocked.

Peterson Creek is reported to have historically had a small steelhead run, however, the stream was stocked annually from 1961 through 1968. Peterson Creek received nearly 135,000 steelhead from Pleasant Bay stock and "a remote southeast Alaska lake" (Juneau area files). Peterson Creek currently has an annual steelhead return of approximately 200 steelhead (Harding et al. 1989). It is not

known what portion of the steelhead currently residing in Peterson Creek are descendants of the stocked fish.

No additional steelhead stocking occurred in southeast Alaska until after Crystal Lake Hatchery was built in 1972. Crystal Lake Hatchery acquired its first steelhead broodstock from Petersburg Creek in 1974. Approximately 169,500 steelhead "smolts", averaging 24.4 g (136 mm), were produced at the hatchery between 1974 and 1984, almost all of which were stocked in the immediate Petersburg area (Petersburg area files).

Montana Creek was stocked with 6,600 steelhead smolt from Crystal Lake Hatchery in 1986. This introduction was not evaluated, and only one steelhead is reported to have been caught in Montana Creek.

Steelhead enhancement began in the Ketchikan area in 1980 as a mitigation effort (after a major chlorine spill) in Ward Creek by the Ketchikan Pulp Company. Additionally, enhancement of the Klawock River and Ketchikan Creek began in 1980. All three sites have seen enhancement at various levels and all have used various brood sources since that date. During the last ten years, from 27,000 to 30,000 smolt or parr, averaging from just under 5 g to over 65 g have been stocked (Ketchikan area files).

Southeast Evaluations (1985-1989):

The Division of Sport Fish organized and conducted the Alaska Steelhead Workshop in Anchorage on 25 and 26 February, 1985. One of the workshop's primary objectives was to determine the optimum size for steelhead smolt to be released from hatcheries in Alaska. A length of 170 to 180 mm was determined to be the desired size for hatchery-reared steelhead smolt, based on hatchery steelhead programs in Oregon and Washington and from limited data on the size of wild steelhead smolt in Alaska (Van Hulle 1985). Based on results in Oregon and Washington, a smolt-to-adult survival goal was set at five percent. To date, these standards have not been achieved in Southeast Alaska hatcheries.

For the period 1984 through 1989, approximately 485,000 steelhead eggs were collected for incubation and rearing in Crystal Lake Hatchery, which has or will result in the release of 178,200 smolt. Egg-to-smolt survival for steelhead in the Crystal Lake Hatchery has averaged 36.7 percent (Petersburg area files). The average weight of those smolt released to date (1985-1988) was 9.3 g. This equated to an average length of 98.6 mm, substantially less than the 170 to 180 mm desired size. Consequently, mechanical and cultural changes have been implemented at Crystal Lake Hatchery in an effort to produce age 2 steelhead smolt to achieve the desired size (Zorich pers. comm.).

Steelhead eggs were taken annually from 1983 through 1987 from Peterson Creek on the Juneau road system. The objective of the program was to produce steelhead smolt at Snettisham Hatchery for release into Montana Creek. The overall success of the program was low due to the limited brood stock, the extended rearing time needed to produce smolt at Snettisham Hatchery, and various disease problems in the hatchery. In 1987, 27,372 steelhead smolt were transplanted to Montana Creek from Klawock Hatchery. Only 20 to 30 percent of the steelhead in the shipment were actually smolts; the remainder were small fish which probably averaged under 100 mm (Bethers personal comm.). A similar transfer was attempted in 1988, however all the fish died in the tanks while in transit.

In total, Montana Creek received 32,165 steelhead smolt from State hatcheries from 1986 through 1987 (Josephson 1989). In 1989, a creel census on Montana Creek estimated a catch of 16 hatchery produced steelhead in the sport fishery. Although additional steelhead were observed in the stream, the overall return from enhancement efforts in 1989 was poor (Suchanek 1990). Additional returns of adult steelhead are expected through 1991.

During the period 1985 through 1989, both the Klawock River and Ward Creek were enhanced annually with 20,000 to 30,000 steelhead smolt of various sizes. The resulting returns have been evaluated via on-site creel census projects. Results have been mixed. Contributions to the Klawock River were noted to approach 50 percent of the angler's creel (Freeman and Hoffman 1988), while only 10 to 20 percent of the angler's catch in Ward Creek was of hatchery origin (Hubartt 1988 and 1989). Again, the best results from these enhancement efforts occurred when steelhead smolt averaging 45 grams and 170 to 180 mm in length were released (Ketchikan area files). Future D-J/W-B steelhead enhancement in the Ketchikan area will be limited to the Klawock River and Ketchikan Creek. The goal of these programs will be to evaluate time and size of release.

Southcentral Historical Summary:

The stocking of hatchery reared steelhead in southcentral Alaska was initiated by the Kodiak Conservation Club and the U.S. Fish and Wildlife Service in 1953. Steelhead eggs from Karluk River stock were hatched at the Kodiak Conservation Club Hatchery and stocked as fry into the Buskin River and numerous lakes ranging from Kodiak to Glennallen (Allin 1953; Alaska Fisheries Board and Alaska Department of Fisheries 1956). The stocking of hatchery reared steelhead was expanded by the U.S. Fish and Wildlife Service and the Alaska Territorial Department of Fisheries in 1954, when steelhead eggs obtained through the Kodiak Conservation Club were incubated in hatcheries located in Kodiak and Anchorage and released as fry into southcentral Alaska lakes and streams (Alaska Fisheries Board and Alaska Department of Fisheries 1954; Allin 1954; Whitesel 1957).

Approximately 25 creeks, open-drainage lakes, or landlocked lakes in the Anchorage area and 40 Kodiak area waters were stocked with steelhead fry by the U.S. Fish and Wildlife Service in 1953 and 1954. By 1956, successful fisheries were established in six Anchorage area lakes and seven Kodiak area lakes while an additional five Anchorage lakes and 16 Kodiak area lakes had some survival from the fry plants (Whitesel 1957). Three Kodiak area lakes stocked with steelhead fry in 1958 produced successful sport fisheries (Sexsmith 1962).

Steelhead eggs from the Kodiak Hatchery were planted in Campbell Creek and the Little Susitna River in July 1956. The Little Susitna River "nests" examined in early September, 1956 indicated the eggs had hatched and by 1 October most young were out of the gravel. Hatching success appeared to be 80 to 90 percent (Whitesel 1957). There was no observation of survival from 1956, 1958, or 1959 steelhead fry introductions in Robe Lake (Valdez), which supports Dolly Varden *Salvelinus malma* and large numbers of salmon (Williams 1964).

Three southcentral Alaska lakes were stocked with both fin clipped rainbow and steelhead fingerlings in October 1956. Gillnetting, one year later, indicated the domesticated rainbow trout broodstock fingerlings had exhibited a faster rate of growth and somewhat better survival as compared to Karluk River steelhead (Alaska Fisheries Board and Alaska Department of Fisheries 1958).

Historically, the Karluk River had been used as a source of steelhead-rainbow eggs to rear for the stocking of Kodiak lakes and streams. However, this source cost more than did eggs and fry from other sources. Imported domestic rainbow trout fry replaced the local brood stock for Kodiak lakes in 1961 (Sexsmith 1962).

A review of lake stocking records in the ADF&G offices in Palmer and Kodiak indicated both hatchery reared Karluk River steelhead and imported domesticated rainbow trout broodstock fry and fingerlings were stocked in Southcentral lakes from 1953 through 1959. Between 1960 and 1984 only hatchery reared rainbow trout were stocked.

Anchor River steelhead smolt were introduced in landlocked Bridge Creek Reservoir in 1985, and in Crooked Creek and Campbell Creek in 1985 and 1986 (Miller 1990). No steelhead were observed at a weir operated on Campbell Creek in 1986, while in 1987 three steelhead were observed. Because a significant steelhead fishery did not develop, the program in Campbell Creek was discontinued (Kent Roth pers. comm.).

Southcentral Evaluations (1985-1989):

Bridge Creek Reservoir was stocked with Anchor River steelhead smolt in 1985, fingerlings in 1987, and again with smolt in 1988. No harvest data are available but reports indicate fishing has been good (Dudiak and Boyle 1988). In 1989, an estimated 60 steelhead were caught in Crooked Creek. These fish were stocked as smolt in 1985 and 1986 (Kyle et al. 1989).

Cost Estimates:

Data were available to estimate cost per fish harvested for two stocking lots of steelhead; Crystal Creek in 1983 and 1984 (Table 10). The cost per fish returning was similar in both years, $64.59 in 1983 and $67.22 in 1984. However, the cost to the creel was much less in 1983 than in 1984, $185.48 and $717.00, respectively.

Rainbow Trout

Southeast Historical Summary:

The USFS stocked rainbow trout into a number of lakes on Baranof Island and Chichagof Island during the 1930s. These fish originated from steelhead that had been transplanted into Sashin Lake from Sashin Creek. Details of these stocking activities are summarized in Schmidt (1981).

ADF&G initiated a rainbow trout stocking program in 1965. Brood sources included Ennis, Montana; Winthrop, Washington; Willamette, Oregon; Winther, Wisconsin; Mt. Whitney, California; Oakridge, Oregon and an Alaska/Ennis strain. Specific stocking data and subsequent test netting evaluations are summarized by Schmidt (1978).

Over 176,000 rainbow trout were stocked into ten lakes in northern southeast Alaska from 1959 through 1974. Most were never evaluated, however some are known to have provided sport fishing opportunity for a few seasons after they were stocked.

Table 10. Estimated costs of hatchery produced anadromous steelhead harvested in sport and commercial fisheries from 1985 through 1989.

Stocking Cohort Release Year and Size	Estimated Cost Per Fish: Total Return	Estimated Cost Per Fish: Fish Harvested By Sport Anglers	Estimated Cost Per Fish: All Fish Harvested
Southeast:			
Crystal Creek			
1983 Smolt (47.4 g)	$64.59	$185.48	a
1984 Smolt (29.0 g)	$67.22	$717.00	a

[a] No estimates of the number of hatchery produced steelhead harvested in commercial fisheries were available.

Enhancement of rainbow trout in the Ketchikan area by the Division of Sport Fish began in 1961 and continued through 1972. During this period, 57 different lakes were stocked with fertilized rainbow trout eggs, eyed eggs, fry, or fingerlings (Ketchikan area files). Although very little evaluation work was conducted to determine the relative success of these stocking activities, many self sustaining rainbow trout populations developed and are documented as ancillary information in other reports (Siedelman 1974-1987). Rainbow trout also appear in the Ketchikan area of the Statewide Harvest Surveys (Mills 1978-1988). Enhancement of this species has not occurred in the Ketchikan area since 1972.

Southcentral Historical Summary:

The stocking of hatchery reared rainbow trout in southcentral Alaska was initiated by the Alaska Territorial Department of Fisheries in 1952. Steelhead eggs from Karluk Lake on Kodiak Island, and rainbow trout eggs imported from Idaho, Montana, Oregon, or Washington were incubated in Alaska hatcheries and stocked in lakes as fry, fingerlings, sub-catchables, or catchables.

Imported strains experienced poor survival ranging from zero to 25 percent and averaged 8 percent when stocked as fingerlings (Redick 1971, 1972; Watsjold 1973; Kalb 1974, 1975; Chlupach 1976, 1977, 1978). Low survival rates and the risk of possible importation of nonindigenous disease organisms led to a decision to develop and use Alaska brood stocks.

Three strains of rainbow trout were initially selected for evaluation of survival and growth: an Alaska-produced Ennis (Montana) strain, a native Alaska rainbow trout strain from Swanson River on the Kenai Peninsula, and a native rainbow trout strain from Talarik Creek in Bristol Bay. Ennis rainbow trout were chosen for evaluation because the strain's extensive cultural background accommodated comparative studies between native Alaska and domestic brood programs. Swanson River rainbow trout were selected because they exhibited a lake rearing background and a possibly greater tolerance to stickleback *Gasterosteus sp.* competition, while Talarik rainbow trout were chosen primarily for their large size and long life span.

Egg takes of native Alaskan rainbow trout began at Talarik Creek on the Alaska Peninsula and at the Swanson River on the Kenai Peninsula in 1974. Comparative survival evaluations between wild Swanson and Talarik fingerlings were initiated in 1974. The first Ennis fingerlings from Alaska brood stocks were stocked in 1975, while the Swanson and Talarik fingerlings resulting from hatchery brood stocks were stocked in 1977.

Extensive evaluations of the various rainbow trout strains were conducted from 1974 through 1979 (Havens 1980; Hammerstrom 1981; Van Hulle and Murray 1981; Williams and Potterville 1981). Swanson River rainbow trout exhibited significantly greater survival in 16 out of 17 experiments when stocked sympatrically in lakes with Ennis and Talarik rainbow trout of the same size. Based on the results of these tests, the Swanson River strain of rainbow trout was selected as the broodstock for Alaska's lake stocking program in 1980. All Ennis and Talarik broodstock and progeny were phased out by 1981. However, evaluations between other strains of native Alaskan rainbow trout stocks continued.

Evaluations of rainbow trout stocks from the Kitoi River on Afognak Island and Big Lake in the Matanuska Valley in comparison with Swanson River rainbow trout

were initiated in 1984 and 1985, respectively (Havens 1986; Murray 1986; Havens et al. 1987; Havens 1988). Swanson River rainbow trout were significantly more abundant than Kitoi River rainbows in six of the seven experiments, and were larger in every evaluation. Swanson River rainbow trout were compared with Big Lake fish in nine lakes. Swanson River fish exhibited greater survival in eight lakes, while the mean length of the two strains was almost equal for age 1 fish.

Swanson River rainbow trout were ultimately selected as the broodstock for ADF&G's statewide lake stocking program. The only exception was that Big Lake fish were used for stocking in the Big Lake drainage. The stocking density was standardized at 494 1-gram fish per surface hectare.

Southcentral Evaluations (1985-1989):

A creel survey conducted in 1986 on three Anchorage area lakes stocked with large sub-catchable rainbow trout immediately after ice-out indicated angler participation and rainbow trout harvest were highest during the three weeks following stocking. Dramatic declines in effort, catch rates, and harvest occurred by late June (Havens et al. 1987). Recommendations for annual rainbow trout stocking for each Anchorage lake were to stock 60 percent of the trout shortly after ice-out in May and the remaining 40 percent during the third week in June.

Comparisons of relative survival of rainbow trout released directly from a hatchery truck to survival of rainbow trout air-dropped from a Cessna 188 Agtruck were performed in 1986 and 1987. In Matanuska Lake, survival to age 1 of truck-released fish was significantly greater ($P < 0.05$) than that for air-dropped fish (Havens et al. 1987). There was not a significant difference in survival to age 1 between the two stocking methods in South Rolly Lake (Havens 1988). It was recommended that the air-drop stocking method be continued for remote lakes not directly accessible to hatchery tank trucks.

Evaluations were begun in 1988 to compare survival and growth of rainbow trout fingerlings stocked at various densities. Preliminary data for the density experiments (Havens in prep.) indicate survival to age 1 averaged 30 percent for fish stocked at 247 fish per hectare, 26 percent (494 fish/hectare), 8 percent (988 fish/hectare), 10 percent (1,977 fish/hectare) and 15 percent (2,470 fish/hectare). It was recommended that evaluations of stocking density be continued for at least two more years to determine the effects of annual fingerlings releases on subsequent rainbow trout survival and growth.

Evaluations were begun in 1988 to compare initial survival, growth, and longevity between triploid (sterile) and diploid (normal) rainbow trout. Preliminary data for the triploid versus diploid experiments (Havens in prep.) indicate no significant difference in survival to age 1 between the two stocking groups. Only 37 percent of the group of triploid rainbow trout stocked in 1988 were actually triploids. In 1989, all fish stocked were triploids (Carmen Olito pers. comm.).

Interior Historical Summary:

The Alaska Game Commission and the Alaska Department of Fish and Game have stocked hatchery reared rainbow trout in interior Alaska since 1939. In 1939, the US Forest Service supplied the Alaska Game Commission with rainbow trout adults, fingerlings, and eggs for stocking in Harding Lake. The fate of these

fish is not known. Since 1952, hatchery reared rainbow trout have been stocked annually in various Interior lakes. Evaluations of these early introductions were usually limited to monitoring the growth of various cohorts based on catches in gill nets. To determine if a sport fishery for rainbow trout could be established in a stream, fingerlings were stocked in the Salcha River in 1952. No rainbow trout are known to have been caught by anglers and rainbow trout were not stocked again in the Salcha River.

A study was initiated in 1979 to evaluate the Swanson and Ennis strains of rainbow trout. The rate of growth to age 1 was slower for the Swanson strain (Swanson: 184 mm vs Ennis: 225 mm). However, the rate of survival was much higher for the Swanson strain (Swanson: 0.55 vs Ennis: 0.22). These results agreed with those found in southcentral Alaska and the Swanson strain was selected for future enhancement programs.

Interior Evaluations (1985-1989):

To reduce the cost of development and maintenance of sport fisheries for rainbow trout, different methods of stocking rainbow trout in lakes were evaluated from 1985 through 1989. The rate of survival was compared between age 1 rainbow trout that were stocked as age 0 fingerlings (approximately 2 g), and small age 1 sub-catchables (about 20 g; Doxey 1986, 1988, and 1989). In August 1988, the rate of survival of fingerlings to age 1 was about 19 percent and the rate of survival of sub-catchables was about 28 percent. Mean length of fish stocked as fingerlings was 186 mm at age 1 in September. Mean length of fish stocked as sub-catchables was 194 mm. Sub-catchable rainbow trout are now stocked in Birch and Quartz Lakes. Fingerlings are still stocked in Quartz Lake, Chena Lake, and in small natural lakes and gravel pits.

An experiment was initiated in 1988 to evaluate the rates of survival and growth of sub-catchable rainbow trout that were stocked in early spring while lakes were covered with ice (Doxey 1989). Rainbow trout have traditionally been stocked after lakes were clear of ice. If successful, this method would reduce hatchery rearing time by one to two months which would reduce costs. This would also free hatchery space for other projects. Preliminary results indicate that rates of growth were about the same for rainbow trout stocked in ice free versus ice covered Birch Lake. However, the mortality rate was 57 percent for rainbow trout stocked through the ice in March until they reached catchable size (180 mm). In comparison, the mortality rate of the cohort stocked into open water in May was only 42 percent until they reached catchable size.

Many small lakes along the road system of Interior Alaska are stocked with rainbow trout. Harvest estimates for 1988 (Mills 1989) showed that 12,500 rainbow trout were harvested in these small lakes. The majority of the harvest of rainbow trout in the Interior occurs in three lakes that support large fisheries. Rainbow trout harvest in 1989 in Quartz Lake was 25,200, Birch Lake was 18,400 and Chena Lake was 9,900.

In small lakes, the rate of survival to age 1 for rainbow trout that were stocked as age 0 fingerlings ranged from 14 percent to 82 percent. These fish were stocked at 50 mm and were about 130 mm at age 1. The length at age 1 is about the same for fingerling Arctic grayling that were stocked in small lakes.

The rates of survival and growth are currently being evaluated for age 1 rainbow trout that were stocked as age 0 fingerlings in lakes that have Arctic char

Salvelinus alpinus, Arctic grayling, lake trout, coho salmon, or various combinations of these species. The purpose of this experiment is to determine if combinations of sport species can be stocked sympatrically to increase the diversity and number of fish available to the public (Skaugstad in prep).

In 1986, rainbow trout were stocked in Piledriver Slough, a spring-fed stream near Fairbanks. The purpose was to determine if a stream fishery for rainbow trout could be established along the road system. Evaluation of the rainbow trout fishery in Piledriver Slough has been by creel census. In 1988, there was more fishing effort spent in Piledriver Slough (24,400 days fished) than for any other water body in interior Alaska, except the Chena River (25,900 days fished). In 1988, 12,300 rainbow trout were harvested in Piledriver Slough and approximately 36,000 rainbow trout were caught and released.

Cost Estimates:

Since 1985, data were available to estimate costs to the creel from 20 lots of rainbow trout stocked in Southcentral and Interior waters (Table 11). In Southcentral the cost per rainbow trout stocked as large sub-catchables and harvested in seven sport fisheries ranged from $1.67 to $7.81. Rainbow trout stocked as fingerling and harvested in seven sport fisheries cost from $0.61 to $6.92 per fish. In Interior waters the cost per rainbow trout stocked as large sub-catchables and harvested in two sport fisheries ranged from $4.05 to $4.45 while the cost per fish stocked as fingerling ranged from $1.51 to $190.96. The cost per fish harvested from two lakes where they were stocked as both fingerling and sub-catchables ranged from
$2.17 to $3.58.

Arctic Grayling

Southeast Historical Summary:

Arctic grayling are not endemic to southeast Alaska, but were stocked in approximately 40 lakes throughout the region between 1920 and 1972. Age at stocking ranged from eyed-egg to adult. The earliest introductions were transplanted from McDonald Lake in British Columbia (Juneau area files). Subsequent stockings were conducted with eggs taken from Tolsona Lake near Glennallen and reared at the Fire Lake Hatchery (Petersburg and Ketchikan area files).

Although no specific evaluations were conducted to determine survival and growth rates, 17 lakes throughout the region are known to contain reproducing populations of Arctic grayling (Schwan 1984). Fourteen of these lakes are located in the southern portion of Southeast. Details of these stocking activities were summarized by Ericksen (1987), Schmidt (1978), and Siedelman (1972-1979).

Southcentral Historical Summary:

The stocking of hatchery reared Arctic grayling in southcentral Alaska was initiated by ADF&G in 1961 when Arctic grayling eggs taken from Bear and Mud Creeks (Glennallen area) were incubated at Fire Lake Hatchery and stocked as fry in three barren landlocked lakes in the Glennallen area (Van Wyhe 1962). Since the inception of the stocking program, Arctic grayling eggs have been obtained from several wild stocks in the Glennallen/Delta Junction area. The primary

Table 11. Estimated costs of hatchery produced rainbow trout harvested in sport fisheries from 1985 through 1989.

Stocking Cohort Release Year and Size	Estimated Cost Per Fish Harvested By Sport Anglers
Southcentral:	
Beach Lake	
1986-1989 Large Sub-Catchables	$5.35
Triangle Lake	
1985-1989 Large Sub-Catchables	$1.87
Lower Fire Lake	
1985-1989 Large Sub-Catchables	$2.73
Hillberg Lake	
1985-1989 Large Sub-Catchables	$1.67
Delong Lake	
1986-1989 Large Sub-Catchables	$7.81
Campbell Point Lake	
1986, 1988-1989 Large Sub-Catchables	$7.19
Lucille Lake	
1986-1989 Large Sub-Catchables	$5.62
Tigger Lake	
1985-1987 Fingerling	$0.61
Wishbone Lake	
1985-1986 Fingerling	$6.92
Seymour Lake	
1985-1987 Fingerling	$6.15
South Rolly Lake	
1985-1987 Fingerling	$2.30
Reed Lake	
1985-1987 Fingerling	$0.96
Big No Luck Lake	
1985-1987 Fingerling	$3.27
Walby Lake	
1985-1987 Fingerling	$2.53

-continued-

Table 11. (Page 2 of 2.)

Stocking Cohort Release Year and Size	Estimated Cost Per Fish Harvested By Sport Anglers
Interior:	
Birch Lake	
1984-1989 Fingerling, Sub-Catchables, and Large Sub Catchables	$3.58
Chena Lake	
1985-1989 Large Sub-Catchables	$4.45
Piledriver Slough	
1987-1989 Large Sub-Catchables	$4.05
Quartz Lake	
1984-1988 Fingerling and Sub-Catchables	$2.17
Harding Lake	
1986-1987 Fingerling	$190.96
Roadside Ponds	
1983-1987 Fingerling	$1.51

sources, Tolsona Lake or Moose Lake, are annually stocked with hatchery reared fry to supplement natural production.

Since 1980, Clear Hatchery has been the sole producer of Arctic grayling for stocking Southcentral lakes. In 1983 the first successful hatchery rearing of Arctic grayling to fingerlings size using a commercially prepared diet was accomplished at Clear Hatchery (Dave Parks, Clear Hatchery Manager, pers. comm.).

Success of new fisheries based upon hatchery reared Arctic grayling fry stocked in Southcentral has been quite variable. Only in barren lakes, lakes chemically treated to remove sticklebacks, or lakes naturally lacking stickleback populations but containing other native or stocked game fish species, have successful Arctic grayling fisheries been produced by stocking fry (Van Wyhe 1963; Sexsmith 1964; Marriot 1965, 1967, 1968; Williams 1968, 1971; Redick 1970; Van Hulle 1970; Van Hulle and Murray 1972, 1976, 1980, 1981; Engel 1973; Murray 1982-1986; Williams and Potterville 1984). Stocking Arctic grayling fry has often produced fishable populations and on occasion, natural reproduction has been observed in landlocked lakes susceptible to low winter dissolved oxygen concentrations where the stocking of other fish species failed (Williams 1971, 1972, 1974, 1976; Redick 1972, 1973; Van Hulle and Murray 1975).

Survival to age 0 of Arctic grayling stocked as fry in a barren Southcentral lake stocked for two consecutive years was 1.9 percent and 2.2 percent. A comparison between Arctic grayling stocked as fry at a density of 1,645 per surface hectare and fingerlings at 548 per surface hectare, in a stickleback-free lake, indicated fingerlings survival to age 1 was 59 percent while too few fish from the fry introduction were captured to provide an estimate (Havens 1985, 1986). Survival of Arctic grayling stocked as fingerlings in a lake containing whitefish, burbot, and stocked rainbow trout, was 18 percent at age 1 (Williams and Potterville 1986).

To maintain fishable populations in stickleback-free lakes, Arctic grayling fry are stocked annually or biennially at 1,645 to 2,740 per surface hectare or with a combination of fry (600 per hectare) and fingerlings (548 per hectare). Lakes containing sticklebacks are normally stocked with fingerlings at 548 per hectare.

Southcentral Evaluations (1985-1989):

Four Matanuska/Susitna Valley lakes were stocked with Arctic grayling for experimental purposes in 1985. Sliver Lake and Wolf Lake containing populations of threespine sticklebacks *Gasterosteus aculeatus* were stocked with 1.24 g Arctic grayling fingerlings. Arctic grayling survival to age 1 was 10 percent in Sliver Lake and 1 percent in Wolf Lake. Two additional lakes devoid of threespine sticklebacks were stocked with two size groups of Arctic grayling (0.017 g fry and 1.24 g fingerlings). In these lakes relative survival from stocking to age 1 was significantly greater for Arctic grayling stocked as fingerlings than was survival for fish stocked as sac-fry (Havens 1987).

Two Matanuska/Susitna Valley lakes were experimentally stocked in 1986 with Arctic grayling fingerlings and rainbow trout or coho salmon fingerlings. In Wolf Lake, Arctic grayling that had been stocked at 4.6 g had an estimated survival rate at age 1 of 2.5 percent, while coho salmon stocked at 1.4 g had an estimated survival rate to age 1 of 9.9 percent. In Sliver Lake, Arctic grayling stocked at 6.4 g had an estimated survival rate to age 1 of 0.9 percent,

while rainbow trout stocked at 2.3 g had an estimated survival rate to age 1 of 6.2 percent.

Interior Historical Summary:

Hatchery reared Arctic grayling were first stocked in interior Alaska in 1965 in 12 lakes near Fairbanks and Delta Junction (Heckart and Roguski 1966; Roguski and Tack 1970). Some of these lakes were marginal or not suited to other sport species such as rainbow trout and landlocked coho salmon because levels of dissolved oxygen were less than 1 ppm during the winter. Arctic grayling survived in these lakes and provided new sport fisheries where none existed before.

Arctic grayling fry were stocked in the Delta Clearwater River in 1974 and 1975 to evaluate the feasibility of supplementing natural production (Peckham 1975; Pearse 1976). Although Arctic grayling are present in the Delta Clearwater River during the summer, the river is not used for spawning and few juveniles (age 0 through age 2) are present. Three to four months after the fry were stocked, no survivors were captured with electrofishing gear, beach seines, or traps. No fry have subsequently been stocked in a river in interior Alaska.

From 1975 through 1986, hatchery and lake reared Arctic grayling fingerlings were stocked in the Delta Clearwater River and they were stocked in the Chena River in 1984 (Holmes 1984, 1985; Holmes et al. 1986; Pearse 1976; Peckham 1977, 1978, 1979, 1980, 1984; Peckham and Ridder 1979; Ridder 1980, 1981, 1982, 1983, 1984, 1985; Skaugstad and Ridder 1987). These fish were captured in later years with fyke nets, electrofishing gear, and by anglers. In the 1989 creel survey of the Delta Clearwater River, stocked Arctic grayling comprised 17 percent of the harvest in 4 of 10 age classes. For age 4 fish, over 50 percent of the Arctic grayling harvested were stocked fish.

From 1975 through 1987, experiments were conducted to estimate the number of sac-fry that could be stocked in small lakes in the spring and removed as fingerlings for subsequent stocking in rivers in the fall (Holmes 1984, 1985; Holmes et al. 1986; Pearse 1976; Peckham 1977, 1978, 1979, 1980, 1984; Peckham and Ridder 1979; Ridder 1980, 1981, 1982, 1983, 1984, 1985; Skaugstad and Ridder 1987). Estimates of minimum rates of survival ranged from 5 to 34 percent. The range and average length of the age 0 pond reared fish when stocked into rivers was equivalent to the lengths of age 1 or age 2 wild fish (110 and 140 mm). Rearing Arctic grayling in small lakes to produce fingerlings was terminated because fingerlings can be produced for less cost at Clear Hatchery.

Before 1983, only sac-fry were produced by hatcheries. Since then, techniques were developed at Clear hatchery to rear large numbers of Arctic grayling to fingerling size. The rearing technique has been continuously improved and Arctic grayling can now be reared to adults for brood stock. This technology has resulted in increased survival of stocked fish (because they can be stocked at a larger size) and a decrease in the cost of collecting eggs (because eggs can be collected from brood stock kept at Clear Hatchery).

Over the years, Arctic grayling eggs have been collected from more than six different sources. Presently, while Clear Hatchery is developing a brood stock, eggs are collected from Arctic grayling that spawn in Our Creek (Moose Lake) near Glennallen.

Different stocking densities were compared to optimize the rate of survival of stocked age 0 Arctic grayling in summer rearing ponds (Jennings 1983). No correlation was found between stocking density and rate of survival over the range of densities tested (800 to 9,600 sac-fry/hectare). Evidence suggested that the high rate of mortality within a month of stocking was associated with specific food requirements at the time of first feeding, sac fry mobility and fitness, and predation by invertebrates.

Interior Evaluations (1985-1989):

To reduce the cost of developing and maintaining enhanced Arctic grayling sport fisheries, different methods of stocking Arctic grayling in lakes were evaluated from 1986 through 1989. The rate of survival, cost per survivor, and growth were compared for age 1 Arctic grayling that were stocked at age 0 as sac-fry, 4 g, and 6 g fingerlings (Skaugstad 1988, 1989). The average cost per survivor was lowest for fish that were stocked as 4 g fingerlings. As a result of this experiment, 4 g fingerlings are now used for enhancement of the lakes along the road system in interior Alaska. However, when a lake has no other fish species or a large number of fish must be transported by aircraft, sac-fry are stocked.

Cost Estimates:

Cost per fish surviving to age 1 for Arctic grayling stocked in Interior Alaska was calculated for three size lots of fish stocked (Table 12). Cost per survivor ranged from $0.21 for 6-g fingerlings to $1.58 for sac fry. Since 1985, data were available to estimate costs from six stocking lots of Arctic grayling in Southcentral and Interior lakes (Table 13). In Southcentral the cost per Arctic grayling harvested ranged from $1.94 to $12.98. In Interior the cost per Arctic grayling harvested in two sport fisheries ranged from $1.49 to $84.01.

Brook Trout

Southeast Historical Summary:

All brook trout were stocked in Alaska prior to statehood. From 1917 to 1953, Eastern brook trout were stocked by local residents into at least 14 streams and lakes in the Juneau and Skagway areas. Many other small streams were also stocked, however, the specific locations were not documented. In 1920, the US Forest Service successfully transplanted 50,000 fry into four lakes in the Skagway area (Petersburg area files). An estimated 50,000 eyed eggs were shipped from Colorado to Skagway in November of 1939 (Kimmerich 1939; Edwards 1940). Approximately 35 lakes in southeast Alaska, most of them in southern Southeast, were stocked with brook trout fry incubated and reared at Yes Bay Hatchery during 1931 and 1932 (Petersburg area files).

The only evaluation information available on the success or failure of the brook trout stocking program is that 17 lakes throughout the region still have populations of brook trout (Schwan 1984). No subsequent enhancement efforts involving brook trout in southeast Alaska have been conducted.

Table 12. Estimated costs of hatchery produced Arctic grayling surviving to age 1 stocked in landlocked lakes in interior Alaska from 1985 through 1989.

Stocking Cohort	Estimated Cost Per Fish Surviving To Age 1
Sac Fry	$1.58
4-Gram Fingerling	$0.24
6-Gram Fingerling	$0.21

Table 13. Estimated costs of hatchery produced Arctic grayling stocked into landlocked lakes and harvested in sport fisheries from 1985 through 1989.

Stocking Cohort Release Year and Size	Estimated Cost Per Fish Harvested By Sport Anglers
Southcentral:	
Lower Fire Lake	
1986-1987 Fingerling	$7.00
Farmer Lake	
1987 Fingerling	$12.98
Long Lake	
1986-1987 Fry and Fingerling	$10.37
Meirs Lake	
1986-1987 Fry and Fingerling	$1.94
Interior:	
Dune Lake	
1987 Fingerling	$1.49
Harding Lake	
1986-1987 Fingerling	$84.01

Dolly Varden

Southeast Historical Summary:

Dolly Varden were first stocked in southeast Alaska in 1918, when sportsmen at the new Port Walter Cannery transported an unknown number of 100 to 200 mm fish in buckets to Osprey Lake (Petersburg area files). Similar transplants occurred in 1929.

According to information contained in the Ketchikan office files, Dolly Varden were stocked in Shinaku Lake on Prince of Wales Island in 1970. No evaluation of this stocking activity was conducted although fishing reports indicate it was a successful introduction.

Dolly Varden were stocked at Twin Lakes (in Juneau) on June 22, 1984. These fish (1,895) were survivors of a Dolly Varden rearing study conducted at Snettisham Hatchery. The Dolly Varden were 1981 brood from Crescent Lake, near Snettisham Hatchery, and averaged 171 mm when released into Twin Lakes (Bethers 1985). A creel census was not conducted at Twin Lakes in 1984, however, the Dolly Varden were documented to contribute to the summer and winter sport fisheries at Twin Lakes through 1985.

Cutthroat Trout

Southeast Historical Summary:

The first cutthroat trout *Oncorhynchus clarki* enhancement efforts were similar to those described for Dolly Varden with sportsmen at Port Walter beginning stocking efforts in the 1910s. They continued stocking cutthroat trout eyed-eggs and catchables into various lakes in the early 1930s (Petersburg area files). The US Forest Service also stocked fingerlings and catchable size cutthroat trout into a number of lakes in Southeast from 1922 through 1966 (Petersburg area files; Chipperfield 1938).

Cutthroat trout enhancement activities by ADF&G were restricted to stocking one lake on Prince of Wales Island in 1964 (Ketchikan area files) and transferring adult cutthroat trout into Mendenhall Ponds from nearby Shelter Lake on Shelter Island (Douglas area files).

Southeast Evaluations (1985-1989):

Cutthroat trout enhancement was conducted at Auke Lake (near Juneau) from 1983 through 1987 in cooperation with the National Marine Fisheries Service's Auke Creek Hatchery. Cutthroat trout eggs were collected from wild cutthroat trout captured in the Auke Creek weir. Eggs were hatched in the Auke Creek Hatchery and then stocked into Auke Lake for natural rearing. This treatment increased the number of cutthroat trout in Auke Lake available to the sport fishery. The number of outmigrant cutthroat trout captured in the Auke Creek weir also increased (Bethers 1987). The majority of the cutthroat trout caught in Auke Lake have been taken during the winter ice fishery. There have been no substantial creel sampling programs conducted on this fishery, however in the 1988 winter fishery, from 40 to 50 percent of the cutthroat trout caught bore fin clips identifying them with the 1983 to 1987 enhancement program (Bethers, pers. comm.).

Arctic Char

Interior Evaluations (1985-1989):

In 1985, eggs were collected from Arctic char in Amiloyak Lake (in the Brooks Range) and reared at Clear Hatchery. These fish were stocked in Trap Lake in the Kantishna River drainage. In 1986, eggs were obtained from Arctic char captured at Icy Creek, in the Wood River system of Bristol Bay and reared at Clear Hatchery. These fish were stocked in lakes along the road system of interior and southcentral Alaska as part of ADF&G's effort to increase the diversity of sport species and the opportunities for fishing.

In 1988, a study was initiated to evaluate the rate of survival and growth at age 1 Arctic char stocked in lakes with various combinations of other species. In 11 of 17 lakes stocked with Arctic char, the rate of survival to age 1 ranged from 0.11 to 0.41. The rate of survival was lowest, or zero, when Arctic char were stocked in small shallow lakes near Fairbanks. Survival rates were highest when Arctic char were stocked in alpine lakes near Delta Junction. Preliminary results suggest that the rate of survival may be dependent more on temperature than on the presence of other fish species. During the summer, the temperature in these lakes may exceed the thermal tolerance of Arctic char (Skaugstad in prep). In small lakes, mean length of age 1, 2, and 3 Arctic char, captured in 1989, were about 130, 225, and 280 mm (Doxey 1988; Skaugstad in prep).

To create a sport fishery in Harding Lake, three sizes of hatchery reared Arctic char (45 g, 122 g, and 740 g) were stocked in 1988 and 1989. The sizes of these fish when stocked were based on constraints at Clear Hatchery. When the biomass of Arctic char approached the maximum capacity of a raceway, one half of the fish were stocked. This procedure optimized production at Clear Hatchery by keeping the raceways near maximum capacity during rearing.

A creel census conducted at Harding Lake during the summer in 1989 found that no Arctic char were caught by the anglers who were interviewed. A few anglers reported catching Arctic char during periods when personnel from ADF&G were not present. In December 1989, biologists found that Arctic char could be caught during the winter. The public was informed of locations and lures that produced the best catches. A fishery ensued. Preliminary results from the winter creel census showed that 51 percent of the Arctic char in the harvest had been stocked at 740 g, 42 percent had been stocked at 122 g, and seven percent had been stocked at 45 g. The proportion of each size group in the harvest was inverse to the proportion of each size group that was stocked. The introduction of Arctic char in Harding Lake has quickly produced a successful and popular winter fishery where little fishing occurred previously. Continued evaluation is ongiong.

Lake Trout

Interior Historical Summary:

In 1939 and 1940, "about a dozen" lake trout from an unknown source were stocked into Harding Lake by the U.S. Fish and Wildlife Service (Metsker 1963). The lake trout reproduced in Harding Lake, but in 1963, the population was small (determined by catch rates in gill nets and by anglers) and did not support a significant fishery.

In 1963, ADF&G transported 252 lake trout (length ranged from 173 to 813 mm) to Harding Lake from Two Bit and Boulder Lakes in the Alaska Range. The transplant was considered a success. In 1964 lake trout were captured in shoal areas in spawning condition (Heckart 1965). In June 1965, an additional 235 adult lake trout (254 to 508 mm; ages 8 to 10) were transplanted from Monte Lake in the Robertson River drainage of the Alaska Range. In December 1965, 88,000 eyed eggs from Susitna Lake (Williams 1966) were stocked into Harding Lake (Heckart and Roguski 1966).

The age of lake trout captured in gill nets in 1978, 1979, 1984, and 1985 ranged from age 2 to over age 35. Fork lengths ranged from 110 to 846 mm. The presence of young lake trout indicated that some spawning occurred. The lake trout population is apparently still small, since very few lake trout are captured by anglers or are caught in experimental gill nets.

Interior Evaluations (1985-1989):

Since 1987, as part of ADF&G's effort to increase the number and diversity of sport fish available to anglers, eggs have been collected from lake trout in Paxson Lake. These eggs have been incubated and the fry reared to fingerling size at Clear Hatchery and subsequently stocked into numerous lakes near Fairbanks and Delta Junction. Fingerling lake trout have also been stocked into Paxson Lake and a roadside lake near the Glenn Highway.

In 1988, a study was initiated to evaluate the rate of survival and growth of age 1 lake trout that were stocked in lakes along with various combinations of other species. Of 14 lakes stocked in 1988, lake trout were captured in fyke nets and gill nets in only two lakes in 1989 (Skaugstad in prep). The rate of survival was lowest when lake trout were stocked in small shallow lakes. Preliminary results suggest that the rate of survival may be dependent on temperature. During the summer the temperature in these lakes may exceed the thermal tolerance of lake trout (Skaugstad in prep). Mean fork length of lake trout at age 1 was 130 mm. This is high compared to mean lengths of natural populations of age 1 lake trout (55 to 131 mm) and is likely the result of accelerated growth in the hatchery before stocking, warmer lake water, or both.

Sheefish

Interior Historical Summary:

The goal of the sheefish *Stenodus leucichthys* enhancement program was to increase and diversify angling opportunities along the road system in interior Alaska. It was hoped that the predacious sheefish would feed on non-sport species, such as lake chub *Couesius plumbeus* and longnose suckers *Catostomus catostomus* that are abundant in several lakes in interior Alaska.

Sheefish eggs were first collected in Alaska in 1967 and fry were stocked in 1968. Since then, eggs have been collected from more than a half-dozen Alaskan brood sources. Sheefish fry and fingerlings have been stocked in several lakes near Fairbanks and Delta Junction and in the Chatanika River (Summarized by Alt 1987; Alt and Parks unpublished; Hallberg et al. 1986).

At Clear hatchery, incubation and rearing techniques were developed to rear large numbers of sheefish to fingerlings size. The rearing technique was further improved and sheefish were reared to adult size and kept for brood stock.

In general, most stocking attempts failed completely and no stocked sheefish survived to catchable size. The rate of survival was greater for sheefish that were stocked in lakes that contained no other fish species (Alt 1980, 1981; Alt and Parks unpublished). However, sheefish usually grew to a larger size in lakes with forage species.

Almost all of the sheefish harvested by anglers came from Four Mile Lake near Tok. The size of fish caught by anglers ranged from 0.2 to 4.3 kg. Some natural reproduction from stocked fish occurred in Four Mile Lake. In 1980, three sheefish captured in gill nets were progeny from sheefish that were stocked in 1969. Large sheefish have also been occasionally caught by anglers in a few other lakes. However, in total, anglers have harvested very few stocked sheefish.

Interior Evaluations (1985-1989):

Fingerling sheefish reared at Clear Hatchery were stocked into the Chatanika River in 1985 to enhance a population of indigenous sheefish. No stocked fingerlings were captured in beach seines in mid-June or September, 1985. The fate of these fish is not known. Sheefish were dropped from the stocking program because the overall rate of survival to a catchable size was very low and the return to the creel was virtually nil. Evaluations were summarized by Alt (1987).

DISCUSSION

Although over 40.4 million fish were stocked in 1,348 locations during the 1985 through 1989 federal aid contract period, complete information needed for cost analyses was available for only a few stocking cohorts. Rainbow trout and Arctic grayling comprised approximately fifty percent of all fish stocked from 1985 through 1989. Extensive evaluations to optimize stocking density, stocking size, survival rates and other important parameters have been conducted during the past 20 years for these two species. However, during the 1985 through 1989 period only 26 detailed cost evaluations could be conducted because specific harvest information was lacking for most stocking cohorts.

The production costs that were developed by FRED Division and used in this report are a weight related index of the total operating costs of a hatchery divided by the total production weight for all species in the hatchery. This provided an estimated cost per gram of biomass produced. To calculate the production costs for each stocking cohort, the actual number of fish released was multiplied by the average weight of the fish and then multiplied by the cost per gram for that specific hatchery during that year. The most obvious flaws with this method are 1) it does not consider differences in culture methodology and growth between species; and 2) the average cost per gram of biomass produced at a specific hatchery could vary greatly from year to year depending on the total weight of all fish raised at the hatchery. In addition, these cost estimates do not include other costs associated with conducting enhancement programs including: capital improvement costs, special projects costs, FRED Division administrative overhead costs, or costs incurred by the Division of Sport Fish to evaluate enhancement projects. This method also does not take into account funding source. It includes all forms of funding including D-J/W-B funds, general funds, fish and game funds, and U.S./Canada Treaty monies.

Such methodology was utilized because it was the most realistic way to accomplish the project within the time and resources available. Because of the relatively small number of detailed cost evaluations and the difficulties with the method used to calculate actual production costs, the cost per fish data presented in the detailed cost evaluations (Appendix A) should not be considered the "actual" cost of providing enhanced fish to the creel, nor should these cost figures be used to make detailed comparisons between species. However, the cost figures presented in this report do provide a general index of the costs of conducting sport fishery enhancement programs and these data provide insights into how and where future evaluation efforts should be conducted.

An example of the drawbacks inherent in the method used to calculate actual production costs is illustrated in the summary of the seven detailed cost evaluations for chinook salmon in the Juneau area (Table 6; Appendix A, anadromous chinook salmon, No. 8). Using the cost procedures described in the methods section, the estimated cost to produce 204,523 chinook salmon smolt at Snettisham Hatchery was $49,773. Based upon this production cost, the estimated cost per stocked chinook salmon harvested in the Juneau sport fisheries was $82.54. The cost estimate of $82.54 per fish assumes no cost to produce the 576 chinook salmon into the commercial fishery. It also assumes no benefit for the recreational fishery other than consumptive harvest. Cost of produced chinook salmon to the combined sport and commercial fisheries was $42.22 per fish. The Division of Sport Fish actually provided $325,000 for the production of chinook and coho salmon at Snettisham Hatchery. The estimated cost for producing the coho salmon smolts was $5,000. The seven groups of chinook salmon stocked in the Juneau area comprised all of the chinook salmon produced at Snettisham. Thus, by subtraction, the actual funding provided to produce the same 204,523 chinook salmon smolts was $320,000 and the estimated cost per fish harvested in the sport and commercial fisheries increased to $530.68 and $271.42, respectively.

Despite the drawbacks with calculating the costs associated with the production of fish stocked over the past five years, some conclusions can be drawn. The estimated cost per fish harvested in sport fisheries for species stocked in landlocked lakes was substantially lower than the estimated costs for anadromous stocking cohorts. In 82 percent of the detailed evaluations of chinook salmon, coho salmon, rainbow trout and Arctic grayling harvested by sport anglers in landlocked lakes the average cost per fish was less than $10. (Tables 7, 9, 11 and 13). The estimated costs to produce sub-catchable (age 1) Arctic grayling ranged from $0.21 to $1.58 (Table 12).

The estimated cost for coho and chinook salmon stocked in anadromous waters and subsequently harvested by sport anglers ranged from $3.90 to $453.83, and $11.62 to $1,396.40 per fish, respectively (Tables 6 and 8). The costs for steelhead harvested in sport fisheries ranged from $185.48 to $717.00 per fish (Table 10). The high costs per fish for several of the coho and chinook salmon stocking groups (Montana and Fish Creek chinook salmon and Salmon Creek coho salmon) may have resulted from high mortality rates caused by releasing undersized smolts into streams lacking adequate rearing habitat.

The number of anadromous salmon intercepted in commercial fisheries also influenced the cost per fish in sport fisheries. Commercial fisheries harvested 5,322 hatchery produced coho salmon from five stocking groups released near Juneau (Fish Creek, Sheep Creek, and Dredge Lake), while sport anglers harvested 515 fish from these five stocking cohorts and the cost per fish in the sport fisheries ranged from $45.21 to $453.83.

Three cohorts of coho salmon stocked into streams near Seward (Seward Lagoon and Lowell Creek) were evaluated. The hatchery production costs for these fish averaged $0.39 per fish (fish ranged in weight from 21.3 to 27.2 g), while the average cost per fish for five groups of coho salmon stocked in the Juneau area was $0.10 (fish ranged in weight from 3.4 to 12.3 g). There was no known commercial interception of coho salmon stocked in the Seward area, and the resulting cost per fish harvested in the Resurrection Bay sport fisheries was much lower ($3.90 to $8.19 per fish) than was the case in Southeast (Table 8).

The survival rate of coho salmon stocked in the Little Susitna River as emergent fry and smolts was 0.1 percent and 7.0 percent, respectively. The cost per fish for the total adult return was $31.80 for emergent fry and $18.83 for smolt releases (Table 8). Based on these evaluations, emergent coho salmon fry will no longer be stocked in the Little Susitna River. All future coho salmon releases will be smolt.

Evaluations of survival rate, cost per survivor, and growth were conducted for Arctic grayling stocked as sac-fry, 4 g, and 6 g fingerlings in Interior lakes (Table 11). The average cost per survivor was about the same for fish that were stocked at 4 or 6 g. However, because 4 g fish exhibited faster growth in the wild and because stocking fish at a smaller size freed hatchery space for other projects, 4 g is the desired size at which to stock Arctic grayling. Sac-fry are stocked if the lake to be stocked has no other fish species present or if the lake is located in a remote area and the fish must be transported by aircraft.

Stocking evaluations during the 1985-1989 reporting period were primarily focused on objectives related to life stage (i.e. stocked as eggs, fry, fingerling or smolt) survival rates, proportional contribution to both sport and commercial harvest rates, or numbers of fish counted at a weir or in a stream. In many cases, a stocking project was deemed successful if the stocked fish exhibited survival rates equal to or exceeding published life stage survival assumptions or if a measurable return of adult fish was identified.

As the Division of Sport Fish begins a new five-year stocking contract period we should focus future stocking evaluation projects on specific fishing and fishing opportunity related goals and objectives rather than continue using survival related goals. Recreational fisheries enhancement objectives should be constructed in recreational terms. These fishery objectives should be clear and concise; produce a specific amount of fish that will be available for harvest by recreational anglers at a specific place and time that will in turn increase angler participation by some specific amount and minimize costs. Release timing, survival rates, and size of fish at release should remain as fish cultural concerns, but they should be secondary to the fishery objectives.

SUMMARY AND CONCLUSIONS

1. During the five year reporting period, 1985 through 1989, 40,430,920 fish encompassing 8 species have been produced with D-J/W-B federal funds and other funding sources to benefit sport anglers. These fish were stocked in 1,348 locations in Alaskan waters. The fish were raised to different sizes depending upon the specific stocking program prior to being released. Forty-eight percent of the fish produced were stocked into landlocked waters and 52 percent were stocked into anadromous systems or released directly into marine waters.

2. The estimates of cost per fish presented in this report should not be considered the "actual" cost of providing enhanced fish to the sport creel. Differences between actual and estimated costs are presented in the discussion section. The cost estimates do furnish a general index of the costs involved in sport fishing enhancement programs and provide insight as to where and how future evaluation efforts should be concentrated.

3. The estimated cost per fish harvested in sport fisheries for rainbow trout and coho salmon released into landlocked waters ranged from $0.38 to $1.19 and the estimated cost for Arctic grayling that survived to age 1 ranged from $0.21 to $1.58. In contrast, the cost per chinook and coho salmon resulting from anadromous releases and subsequently harvested by sport anglers ranged from $3.90 to $1,396.40 and the production costs for steelhead caught in sport fisheries ranged from $185.48 to $717.00.

4. The large variations in cost per fish harvested for anadromous releases may be due to the size of fish when released and the lack of adequate rearing habitat at certain release sites. The number of fish intercepted in commercial fisheries influenced the cost of creeled fish in sport fisheries. In southeast Alaska, commercial fishermen harvested ten times more coho salmon than sport anglers and the cost per fish in the sport fisheries ranged from $45.21 to $453.83 when production costs and benefits were all attributed to the sport fishery. There was little to no commercial interception of coho salmon returning to Resurrection Bay in southcentral Alaska and the cost per fish in these sport fisheries ranged from $3.90 to $8.19. Inferred, actual, and assigned benefits and costs greatly influence these estimates of cost of creeled fish in the sport fishery.

5. Several stocking programs have become more cost effective during the past five years because stocking evaluations were implemented. A coho salmon emergent fry stocking program was discontinued in favor of stocking smolts in the Little Susitna River because evaluation results demonstrated that the cost per returning adult stocked as emergent fry was nearly three times the cost per adult stocked as smolt. Cost per survivor evaluations for Arctic grayling identified 4 g fingerlings as the most economical size for release into most landlocked waters.

RECOMMENDATIONS

1. Sport Fish and FRED Division staff should work cooperatively to develop a new evaluation format that focuses on sport fishing opportunity and harvest goals and objectives. This new format should be used on all future sport fish stocking evaluation projects.

2. Specific stocking criteria including size and number of fish, release timing, and release location criteria that will ensure optimum sport fishery benefits (opportunity and harvest) should be established. Production stocking programs should not be initiated unless these stocking requirements can be achieved.

3. Experimental stocking programs involving new stocking techniques or utilizing different species of fish in new release locations should not be initiated unless a stocking evaluation program has been developed.

4. Complete evaluation programs that include estimates of increased sport fishing effort and harvest and other sport fishing benefits should be concentrated on a small number of releases rather than conducting portions of a total evaluation program on a large number of releases.

5. Stocking programs intended to benefit sport fisheries that involve releases of anadromous species should be designed to minimize commercial interception. If this is not possible, funding sources other than D-J/W-B monies should be used to produce the fish.

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APPENDIX A

DETAILED COST EVALUATIONS

Appendix A. Detailed cost evaluations.

ANADROMOUS CHINOOK SALMON

SOUTHEAST:

1. SIZE STOCKED: AGE 1+ SMOLT (8.4 GRAM) DIRECT RELEASE

NUMBER STOCKED: 28,335

BROOD STOCK: CRYSTAL CREEK

HATCHERY WHERE REARED: SNETTISHAM

RELEASE SITE AND YEAR: MONTANA CREEK-1986

PRODUCTION COSTS: $6,982

FISH HARVESTED IN SPORT FISHERY[2]: 5 (0.02% HARVEST RATE) (SUCHANEK AND BINGHAM 1990a AND 1990b AND UNPUBLISHED DATA)

COST/FISH TO THE CREEL: $1,396.40

FISH HARVESTED IN THE COMMERCIAL FISHERIES: 7 (F.R.E.D. DIVISION TAG LAB, UNPUBLISHED DATA)

COST/ALL FISH HARVESTED: $581.83

TOTAL RETURN: NO ESCAPEMENT DATA AVAILABLE

2. SIZE STOCKED: AGE 1+ SMOLT (7.5 GRAM) DIRECT RELEASE

NUMBER STOCKED: 30,620

BROOD STOCK: CRYSTAL CREEK

HATCHERY WHERE REARED: SNETTISHAM

RELEASE SITE AND YEAR: FISH CREEK-1986

PRODUCTION COSTS: $6,737

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[2]Notes on sport and commercial harvest estimates:

A. The 1990 sport and commercial harvest estimates are preliminary, but should not change substantially.

B. There may be additional returns (probably very few) from the 1986 releases in 1991 as age 1.5 fish.

C. There were no roadside creel surveys in 1988 directed at chinook salmon recoveries.

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FISH HARVESTED IN SPORT FISHERY[2]: 5 (0.02% HARVEST RATE) (SUCHANEK AND BINGHAM 1990a AND 1990b AND UNPUBLISHED DATA)

COST/FISH TO THE CREEL: $1,347.40

FISH HARVESTED IN THE COMMERCIAL FISHERIES: 19 (F.R.E.D. DIVISION TAG LAB, UNPUBLISHED DATA)

COST/ALL FISH HARVESTED: $280.71

TOTAL RETURN: NO ESCAPEMENT DATA AVAILABLE

3. SIZE STOCKED: AGE 1+ SMOLT (8.0 GRAM) DIRECT RELEASE

NUMBER STOCKED: 26,896

BROOD STOCK: CRYSTAL CREEK

HATCHERY WHERE REARED: SNETTISHAM

RELEASE SITE AND YEAR: AUKE CREEK-1986

PRODUCTION COSTS: $6,312

FISH HARVESTED IN SPORT FISHERY[2]: 79 (0.3% HARVEST RATE) (SUCHANEK AND BINGHAM 1990a AND 1990b AND UNPUBLISHED DATA)

COST/FISH TO THE CREEL: $79.90

FISH HARVESTED IN THE COMMERCIAL FISHERIES: 30 (F.R.E.D. DIVISION TAG LAB, UNPUBLISHED DATA)

COST/ALL FISH HARVESTED: $57.91

TOTAL RETURN: NO ESCAPEMENT DATA AVAILABLE

4. SIZE STOCKED: AGE 1+ SMOLT (9.0 GRAM) HELD AND FED

NUMBER STOCKED: 29,003

BROOD STOCK: CRYSTAL CREEK

HATCHERY WHERE REARED: SNETTISHAM

-continued-

RELEASE SITE AND YEAR: AUKE CREEK-1986

PRODUCTION COSTS: $7,657

FISH HARVESTED IN SPORT FISHERY[2]: 179 (0.6% HARVEST RATE) (SUCHANEK AND BINGHAM 1990a AND 1990b AND UNPUBLISHED DATA)

COST/FISH TO THE CREEL: $42.78

FISH HARVESTED IN THE COMMERCIAL FISHERIES: 91 (F.R.E.D. DIVISION TAG LAB, UNPUBLISHED DATA)

COST/ALL FISH HARVESTED: $28.36

TOTAL RETURN: NO ESCAPEMENT DATA AVAILABLE

5. SIZE STOCKED: AGE 1+ SMOLT (8.4 GRAM) HELD, FED, AND IMPRINTED

NUMBER STOCKED: 29,652

BROOD STOCK: CRYSTAL CREEK

HATCHERY WHERE REARED: SNETTISHAM

RELEASE SITE AND YEAR: FISH CREEK-1986

PRODUCTION COSTS: $7,307

FISH HARVESTED IN SPORT FISHERY[2]: 90 (0.3% HARVEST RATE) (SUCHANEK AND BINGHAM 1990a AND 1990b AND UNPUBLISHED DATA)

COST/FISH TO THE CREEL: $81.19

FISH HARVESTED IN THE COMMERCIAL FISHERIES: 66 (F.R.E.D. DIVISION TAG LAB, UNPUBLISHED DATA)

COST/ALL FISH HARVESTED: $46.40

TOTAL RETURN: NO ESCAPEMENT DATA AVAILABLE

6. SIZE STOCKED: AGE 1+ SMOLT (9.1 GRAM) HELD, FED, AND IMPRINTED

NUMBER STOCKED: 29,737

-continued-

BROOD STOCK: CRYSTAL CREEK

HATCHERY WHERE REARED: SNETTISHAM

RELEASE SITE AND YEAR: AUKE CREEK-1986

PRODUCTION COSTS: $7,938

FISH HARVESTED IN SPORT FISHERY[2]: 100 (0.3% HARVEST RATE) (SUCHANEK AND BINGHAM 1990a AND 1990b AND UNPUBLISHED DATA)

COST/FISH TO THE CREEL: $79.38

FISH HARVESTED IN THE COMMERCIAL FISHERIES: 117 (F.R.E.D. DIVISION TAG LAB, UNPUBLISHED DATA)

COST/ALL FISH HARVESTED: $36.81

TOTAL RETURN: NO ESCAPEMENT DATA AVAILABLE

7. SIZE STOCKED: AGE 1+ SMOLT (7.7 GRAM) HELD, FED, AND IMPRINTED

NUMBER STOCKED: 30,280

BROOD STOCK: CRYSTAL CREEK

HATCHERY WHERE REARED: SNETTISHAM

RELEASE SITE AND YEAR: SHEEP CREEK-1986

PRODUCTION COSTS: $6,840

FISH HARVESTED IN SPORT FISHERY[2]: 145 (0.5% HARVEST RATE) (SUCHANEK AND BINGHAM 1990a AND 1990b AND UNPUBLISHED DATA)

COST/FISH TO THE CREEL: $47.17

FISH HARVESTED IN THE COMMERCIAL FISHERIES: 246 (F.R.E.D. DIVISION TAG LAB, UNPUBLISHED DATA)

COST/ALL FISH HARVESTED: $17.49

TOTAL RETURN: NO ESCAPEMENT DATA AVAILABLE

-continued-

8. SIZE STOCKED: AGE 1+ SMOLT (ALL KING SALMON STOCKED IN THE JUNEAU AREA IN 1986.)

NUMBER STOCKED: 204,523

BROOD STOCK: CRYSTAL CREEK

HATCHERY WHERE REARED: SNETTISHAM

RELEASE SITE AND YEAR: JUNEAU AREA-1986

PRODUCTION COSTS: $49,773

FISH HARVESTED IN SPORT FISHERY[2]: 603 (0.3% HARVEST RATE) (SUCHANEK AND BINGHAM 1990a AND 1990b AND UNPUBLISHED DATA)

COST/FISH TO THE CREEL: $82.54

FISH HARVESTED IN THE COMMERCIAL FISHERIES: 576 (F.R.E.D. DIVISION TAG LAB, UNPUBLISHED DATA)

COST/ALL FISH HARVESTED: $42.22

TOTAL RETURN: NO ESCAPEMENT DATA AVAILABLE

9. SIZE STOCKED: AGE 1+ SMOLT (ALL KING SALMON STOCKED IN THE JUNEAU AREA IN 1986.)

NUMBER STOCKED: 204,523

BROOD STOCK: CRYSTAL CREEK

HATCHERY WHERE REARED: SNETTISHAM

RELEASE SITE AND YEAR: JUNEAU AREA-1986

PRODUCTION COSTS: $320,000 (DIVISION OF SPORT FISH PAID F.R.E.D. DIVISION $325,000 FOR THE CHINOOK AND COHO SALMON PRODUCTION AT SNETTISHAM IN 1986. COHO PRODUCTION WAS 20,000 SMOLT. COSTS FOR COHO SALMON PRODUCTION PER FISH WERE ASSUMED TO BE IDENTICAL TO COSTS FOR CHINOOK SALMON PER FISH PRODUCTION COSTS. TOTAL COSTS FOR 20,000 COHO IS $4,867.)

FISH HARVESTED IN SPORT FISHERY: 603 (0.3% HARVEST RATE) (SUCHANEK AND BINGHAM 1990a AND 1990b AND UNPUBLISHED DATA)

-continued-

COST/FISH TO THE CREEL: $530.68

FISH HARVESTED IN THE COMMERCIAL FISHERIES: 576 (F.R.E.D. DIVISION TAG LAB, UNPUBLISHED DATA)

COST/ALL FISH HARVESTED: $271.42

TOTAL RETURN: NO ESCAPEMENT DATA AVAILABLE

SOUTHCENTRAL:

1. SIZE STOCKED: SMOLT (16.0 GRAM)

NUMBER STOCKED: 152,200

BROOD STOCK: CROOKED CREEK

HATCHERY WHERE REARED: ELMENDORF

RELEASE SITE AND YEAR: HOMER SPIT-1985

PRODUCTION COSTS: $46,485

TOTAL RETURN: 4,370 (2.9% SURVIVAL RATE)

COST/FISH (TOTAL RETURN): $10.61

FISH HARVESTED IN SPORT FISHERY: 4,000 (2.6% HARVEST RATE) (DUDIAK, PERS. COMM)

COST/FISH TO THE CREEL: $11.62

FISH HARVESTED IN THE COMMERCIAL FISHERIES: 0 (DUDIAK, PERS. COMM.)

COST/ALL FISH HARVESTED: $11.62

2. SIZE STOCKED: AGE 0+ SMOLT (10.19 GRAM)

NUMBER STOCKED: 211,179

BROOD STOCK: CROOKED CREEK

HATCHERY WHERE REARED: ELMENDORF

RELEASE SITE AND YEAR: CROOKED CREEK-1983

-continued-

PRODUCTION COSTS: $84,932

TOTAL RETURN: 3,885 (1.8% SURVIVAL RATE) (KYLE AND LITCHFIELD 1989)

COST/FISH (TOTAL RETURN): $21.86

FISH HARVESTED IN SPORT FISHERY: 2,632 (1.2% HARVEST RATE) (KYLE AND LITCHFIELD 1989)

COST/FISH TO THE CREEL: $32.27

FISH HARVESTED IN THE COMMERCIAL FISHERIES: 0 (KYLE, PERS. COMM.)

COST/ALL FISH HARVESTED: $32.27

3. SIZE STOCKED: AGE 0+ SMOLT (17.43 GRAM)

NUMBER STOCKED: 195,531

BROOD STOCK: CROOKED CREEK

HATCHERY WHERE REARED: ELMENDORF

RELEASE SITE AND YEAR: CROOKED CREEK-1984

PRODUCTION COSTS: $53,747

TOTAL RETURN: 5,244 (2.7% SURVIVAL RATE) (KYLE AND LITCHFIELD 1989)

COST/FISH (TOTAL RETURN): $10.25

FISH HARVESTED IN SPORT FISHERY: 4,041 (2.1% HARVEST RATE) (KYLE AND LITCHFIELD 1989)

COST/FISH TO THE CREEL: $13.30

FISH HARVESTED IN THE COMMERCIAL FISHERIES: 0 (KYLE, PERS. COMM.)

COST/ALL FISH HARVESTED: $13.30

4. SIZE STOCKED: AGE 1+ SMOLT (18.16 GRAM)

NUMBER STOCKED: 53,741

BROOD STOCK: CROOKED CREEK

HATCHERY WHERE REARED: CROOKED CREEK

-continued-

RELEASE SITE AND YEAR: CROOKED CREEK-1983

PRODUCTION COSTS: $73,974

TOTAL RETURN: 5,357 (10.0% SURVIVAL RATE) (KYLE AND LITCHFIELD 1989)

COST/FISH (TOTAL RETURN): $13.81

FISH HARVESTED IN SPORT FISHERY: 3,248 (6.0% HARVEST RATE) (KYLE AND LITCHFIELD 1989)

COST/FISH TO THE CREEL: $22.78

FISH HARVESTED IN THE COMMERCIAL FISHERIES: 0 (KYLE, PERS. COMM.)

COST/ALL FISH HARVESTED: $22.78

5. SIZE STOCKED: AGE 1+ SMOLT (20.66 GRAM)

NUMBER STOCKED: 67,800

BROOD STOCK: CROOKED CREEK

HATCHERY WHERE REARED: CROOKED CREEK

RELEASE SITE AND YEAR: CROOKED CREEK-1984

PRODUCTION COSTS: $94,490

TOTAL RETURN: 3,548 (5.2% SURVIVAL RATE) (KYLE AND LITCHFIELD 1989)

COST/FISH (TOTAL RETURN): $26.63

FISH HARVESTED IN SPORT FISHERY: 1,857 (2.7% HARVEST RATE) (KYLE AND LITCHFIELD 1989)

COST/FISH TO THE CREEL: $50.88

FISH HARVESTED IN THE COMMERCIAL FISHERIES: 0 (KYLE, PERS. COMM.)

COST/ALL FISH HARVESTED: $50.88

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LANDLOCKED CHINOOK SALMON (ALL HARVEST ESTIMATES WERE GENERATED FROM STATEWIDE HARVEST SURVEY DATA, MILLS 1989 AND 1990)

SOUTHCENTRAL:

1. BEACH LAKE (POST-SMOLT)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1988	3,227	69.6 GRAM	FT. RICHARDSON	$4,208	124
1989	0				159
	3,227			$4,208	283

COST/FISH TO THE CREEL: $14.87 (8.7% HARVEST RATE)

2. GREEN LAKE (POST-SMOLT)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1988	3,580	74.0 GRAM	FT. RICHARDSON	$4,963	1,114
1989	0				206
	3,580			$4,963	1,320

COST/FISH TO THE CREEL: $3.76 (36.9% HARVEST RATE)

3. FISH LAKE (POST-SMOLT)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1988	604	75.6 GRAM	FT. RICHARDSON	$855	248
1989	0				188
	604			$855	436

COST/FISH TO THE CREEL: $1.96 (72.2% HARVEST RATE)

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ANADROMOUS COHO SALMON

SOUTHEAST:

1. SIZE STOCKED: SMOLT (3.46 GRAM)

NUMBER STOCKED: 101,000

BROOD STOCK: SPEEL LAKE

HATCHERY WHERE REARED: SNETTISHAM

RELEASE SITE AND YEAR: SALMON CREEK-1987

PRODUCTION COSTS: $4,633

FISH HARVESTED IN SPORT FISHERY: 0, (SUCHANEK AND BINGHAM 1989)

COST/FISH TO THE CREEL: N.A.

FISH HARVESTED IN THE COMMERCIAL FISHERIES: 5 (F.R.E.D. DIVISION TAG LAB, UNPUBLISHED DATA)

COST/ALL FISH HARVESTED: $926.60

TOTAL RETURN: NO ESCAPEMENT DATA AVAILABLE

2. SIZE STOCKED: SMOLT (7.75 GRAM)

NUMBER STOCKED: 53,000

BROOD STOCK: SPEEL LAKE

HATCHERY WHERE REARED: SNETTISHAM

RELEASE SITE AND YEAR: FISH CREEK-1987

PRODUCTION COSTS: $5,446

FISH HARVESTED IN SPORT FISHERY: 12 (0.02% HARVEST RATE) (SUCHANEK AND BINGHAM 1989)

COST/FISH TO THE CREEL: $453.83

FISH HARVESTED IN THE COMMERCIAL FISHERIES: 86 (F.R.E.D. DIVISION TAG LAB, UNPUBLISHED DATA)

COST/ALL FISH HARVESTED: $55.57

TOTAL RETURN: NO ESCAPEMENT DATA AVAILABLE

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3. SIZE STOCKED: SMOLT (3.41 GRAM)

NUMBER STOCKED: 53,000

BROOD STOCK: SPEEL LAKE

HATCHERY WHERE REARED: SNETTISHAM

RELEASE SITE AND YEAR: DREDGE LAKE-1987

PRODUCTION COSTS: $2,396

FISH HARVESTED IN SPORT FISHERY: 53 (0.1% HARVEST RATE) (SUCHANEK AND BINGHAM 1989)

COST/FISH TO THE CREEL: $45.21

FISH HARVESTED IN THE COMMERCIAL FISHERIES: 348 (F.R.E.D. DIVISION TAG LAB, UNPUBLISHED DATA)

COST/ALL FISH HARVESTED: $5.97

TOTAL RETURN: NO ESCAPEMENT DATA AVAILABLE

4. SIZE STOCKED: SMOLT (12.3 GRAM)

NUMBER STOCKED: 50,000

BROOD STOCK: SPEEL LAKE

HATCHERY WHERE REARED: SNETTISHAM

RELEASE SITE AND YEAR: FISH CREEK-1988

PRODUCTION COSTS: $8,700

FISH HARVESTED IN SPORT FISHERY: 159 (0.3% HARVEST RATE) (SUCHANEK AND BINGHAM 1990a AND 1990b)

COST/FISH TO THE CREEL: $54.72

FISH HARVESTED IN THE COMMERCIAL FISHERIES: 1,217 (F.R.E.D. DIVISION TAG LAB, UNPUBLISHED DATA)

COST/ALL FISH HARVESTED: $6.32
TOTAL RETURN: NO ESCAPEMENT DATA AVAILABLE

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5. SIZE STOCKED: SMOLT (10.9 GRAM)

NUMBER STOCKED: 100,000

BROOD STOCK: SPEEL LAKE

HATCHERY WHERE REARED: SNETTISHAM

RELEASE SITE AND YEAR: SHEEP CREEK-1988

PRODUCTION COSTS: $15,419

FISH HARVESTED IN SPORT FISHERY: 230 (0.2% HARVEST RATE) (SUCHANEK AND BINGHAM 1990a AND 1990b)

COST/FISH TO THE CREEL: $67.04

FISH HARVESTED IN THE COMMERCIAL FISHERIES: 2,903 (F.R.E.D. DIVISION TAG LAB, UNPUBLISHED DATA)

COST/ALL FISH HARVESTED: $4.92

TOTAL RETURN: NO ESCAPEMENT DATA AVAILABLE

6. SIZE STOCKED: SMOLT (6.8 GRAM)

NUMBER STOCKED: 50,000

BROOD STOCK: SPEEL LAKE

HATCHERY WHERE REARED: SNETTISHAM

RELEASE SITE AND YEAR: DREDGE LAKE-1988

PRODUCTION COSTS: $4,810

FISH HARVESTED IN SPORT FISHERY: 61 (0.1% HARVEST RATE) (SUCHANEK AND BINGHAM 1990a AND 1990b)

COST/FISH TO THE CREEL: $78.85

FISH HARVESTED IN THE COMMERCIAL FISHERIES: 768 (F.R.E.D. DIVISION TAG LAB, UNPUBLISHED DATA)

COST/ALL FISH HARVESTED: $5.80

TOTAL RETURN: NO ESCAPEMENT DATA AVAILABLE

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SOUTHCENTRAL:

1. SIZE STOCKED: SMOLT (19.1 GRAM)

NUMBER STOCKED: 302,055

BROOD STOCK: LITTLE SUSITNA RIVER

HATCHERY WHERE REARED: FT. RICHARDSON

RELEASE SITE AND YEAR: LITTLE SUSITNA RIVER-1987

PRODUCTION COSTS: $398,072

TOTAL RETURN: 21,144 (7.0% SURVIVAL RATE) TOTAL RETURN IS BASED ON TAG RETURNS IN THE SPORT FISHERY, AT THE WEIR, AND EGG TAKE SITES (CHLUPACH, PERS. COMM.). A COMMERCIAL HARVEST OF 50% OF THE TOTAL RUN IS ASSUMED (CHLUPACH 1989).

COST/FISH (TOTAL RETURN): $18.83

FISH HARVESTED IN SPORT FISHERY: 6,468 (SE = 571.9) (2.1% HARVEST RATE) (BARTLETT AND VINCENT-LANG 1989)

COST/FISH TO THE CREEL: $61.54

FISH HARVESTED IN THE COMMERCIAL FISHERIES: 10,572 (CHLUPACH PERS. COMM.)

COST/ALL FISH HARVESTED:$23.36

2. SIZE STOCKED: EMERGENT FRY (0.3 GRAM)

NUMBER STOCKED: 1,225,000

BROOD STOCK: LITTLE SUSITNA RIVER

HATCHERY WHERE REARED: BIG LAKE

RELEASE SITE AND YEAR: LITTLE SUSITNA RIVER-1985

PRODUCTION COSTS: $38,954

TOTAL RETURN: 1,225 (0.1% SURVIVAL RATE) TOTAL RETURN IS BASED ON TAG RETURNS IN THE SPORT FISHERY, AT THE WEIR, AND EGG TAKE SITES (CHLUPACH, PERS. COMM). A COMMERCIAL HARVEST OF 50% OF THE TOTAL RUN IS ASSUMED (CHLUPACH 1989).

COST/FISH (TOTAL RETURN): $31.80

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FISH HARVESTED IN SPORT FISHERY: 0, NO ADULTS TAGGED AS FINGERLING WERE OBSERVED IN THE SPORT HARVEST DURING CREEL SURVEY. ALL TAGGED FISH WERE FROM THE SMOLT RELEASE. (CHLUPACH PERS. COMM.)

COST/FISH TO THE CREEL: N.A.

FISH HARVESTED IN THE COMMERCIAL FISHERIES: 613 (CHLUPACH PERS. COMM.)

COST/ALL FISH HARVESTED: $63.55

3. SIZE STOCKED: SMOLT (21.9 GRAM)

NUMBER STOCKED: 51,544

BROOD STOCK: BEAR LAKE

HATCHERY WHERE REARED: ELMENDORF

RELEASE SITE AND YEAR: SEWARD LAGOON-1986

PRODUCTION COSTS: $33,889

FISH HARVESTED IN SPORT FISHERY: 4,138 (8.1% HARVEST RATE) (SE = 424) (VINCENT-LANG, ET AL. 1988)

COST/FISH TO THE CREEL: $8.19

FISH HARVESTED IN THE COMMERCIAL FISHERIES: 0 (VINCENT-LANG, PERS. COMM.)

COST/ALL FISH HARVESTED: $8.19

TOTAL RETURN: NO ESCAPEMENT DATA AVAILABLE

4. SIZE STOCKED: SMOLT (21.3 GRAM)

NUMBER STOCKED: 65,514

BROOD STOCK: BEAR LAKE

HATCHERY WHERE REARED: ELMENDORF

RELEASE SITE AND YEAR: SEWARD LAGOON-1987

PRODUCTION COSTS: $16,101

-continued-

FISH HARVESTED IN SPORT FISHERY: 4,124 (6.3% HARVEST RATE) (SE = 417) (VINCENT-LANG AND CARLON 1989)

COST/FISH TO THE CREEL: $3.90

FISH HARVESTED IN THE COMMERCIAL FISHERIES: 0 (VINCENT-LANG, PERS. COMM.)

COST/ALL FISH HARVESTED: $3.90

TOTAL RETURN: NO ESCAPEMENT DATA AVAILABLE

5. SIZE STOCKED: SMOLT (27.2 GRAM)

NUMBER STOCKED: 57,232

BROOD STOCK: BEAR LAKE

HATCHERY WHERE REARED: ELMENDORF

RELEASE SITE AND YEAR: LOWELL CREEK (SEWARD)-1987

PRODUCTION COSTS: $17,937

FISH HARVESTED IN SPORT FISHERY: 3,328 (5.8% HARVEST RATE)(SE = 357) (VINCENT-LANG AND CARLON 1989)

COST/FISH TO THE CREEL: $5.39

FISH HARVESTED IN THE COMMERCIAL FISHERIES: 0 (VINCENT-LANG, PERS. COMM.)

COST/ALL FISH HARVESTED: $5.39

TOTAL RETURN: NO ESCAPEMENT DATA AVAILABLE

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LANDLOCKED COHO SALMON (ALL HARVEST ESTIMATES WERE GENERATED FROM STATEWIDE HARVEST SURVEY DATA, MILLS 1985-1990)

SOUTHCENTRAL:

1. BEAR PAW LAKE (FINGERLING)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1987	4,500	1.1 GRAM	TRAIL LAKE	$555	0
1988	8,980	3.7 GRAM	FT. RICHARDSON	$622	218
1989	0				445
	13,480			$1,177	663

COST/FISH TO THE CREEL: $1.78 (4.9% HARVEST RATE)

2. CHRISTIANSEN LAKE (FINGERLING)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1987	35,800	1.1 GRAM	TRAIL LAKE	$4,416	0
1988	37,143	3.7 GRAM	ELMENDORF	$1,812	546
1989	0				536
	72,943			$6,228	1,082

COST/FISH TO THE CREEL: $5.76 (1.5% HARVEST RATE)

3. FINGER LAKE (FINGERLING)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1985	71,900	3.0 GRAM	ELMENDORF	$4,105	0
1986	72,215	3.5 GRAM	ELMENDORF	$7,588	6,244
1987	72,400	1.0 GRAM	TRAIL LAKE	$8,118	8,439
1988	145,433	3.8 GRAM	ELMENDORF	$7,286	11,896
1989	0				3,805
	361,948			$27,097	30,384

COST/FISH TO THE CREEL: $0.89 (8.4% HARVEST RATE)

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4. LOON LAKE (FINGERLING)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1986	21,600	3.5 GRAM	ELMENDORF	$2,270	0
1987	10,800	1.1 GRAM	TRAIL LAKE	$1,332	272
1988	21,575	3.7 GRAM	FT. RICHARDSON	$1,495	55
1989	0				91
	53,975			$5,097	418

COST/FISH TO THE CREEL: $12.19 (0.8% HARVEST RATE)

5. PRATOR LAKE (FINGERLING)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1986	19,845	3.5 GRAM	ELMENDORF	$2,085	0
1987	9,800	1.1 GRAM	TRAIL LAKE	$1,209	417
1988	19,838	1.3 GRAM	BIG LAKE	$758	109
1989	0				499
	49,483			$4,052	1,025

COST/FISH TO THE CREEL: $3.95 (2.1% HARVEST RATE)

6. WOLF LAKE (FINGERLING)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1987	12,400	1.0 GRAM	TRAIL LAKE	$1,390	0
1988	12,400	1.3 GRAM	BIG LAKE	$474	0
1989	0				145
	24,800			$1,864	145

COST/FISH TO THE CREEL: $12.86 (0.6% HARVEST RATE)

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INTERIOR:

1. BIRCH LAKE (FINGERLING)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1984	50,000	3.8 GRAM	CLEAR	$10,022	0
1985	55,539	3.7 GRAM	CLEAR	$12,092	4,672
1986	40,000	4.0 GRAM	CLEAR	$6,666	4,950
1987	40,000	4.9 GRAM	CLEAR	$7,293	6,719
1988	40,000	3.3 GRAM	CLEAR	$6,782	5,548
1989	0				4,982
	225,539			$42,855	26,871

COST/FISH TO THE CREEL: $1.59 (11.9% HARVEST RATE)

2. QUARTZ LAKE (FINGERLING)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1984	6,000	3.8 GRAM	CLEAR	$1,203	0
	60,350	4.3 GRAM	CLEAR	$13,963	0
	62,568	1.8 GRAM	ELMENDORF	$1,806	0
	26,800	1.9 GRAM	ELMENDORF	$803	0
1985	149,976	3.5 GRAM	CLEAR	$31,225	26,312
1986	168,500	4.0 GRAM	CLEAR	$28,082	16,613
1987	168,489	3.5 GRAM	CLEAR	$22,168	15,449
1988	150,000	3.4 GRAM	CLEAR	$25,892	19,009
1989	0				9,593
	792,683			$125,142	86,976

COST/FISH TO THE CREEL: $1.44 (11.0% HARVEST RATE)

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3. CHENA LAKE (FINGERLING)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1984	30,000	3.8 GRAM	CLEAR	$6,013	0
1985	30,000	3.7 GRAM	CLEAR	$6,531	9,485
1986	30,000	3.8 GRAM	CLEAR	$4,811	1,778
1987	30,000	5.2 GRAM	CLEAR	$5,875	1,398
1988	15,000	3.4 GRAM	CLEAR	$2,589	2,401
1989	0				2,468
	135,000			$25,819	17,530

COST/FISH TO THE CREEL: $1.47 (13.0% HARVEST RATE)

4. ROADSIDE PONDS (FINGERLING)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1984	28,000	3.8 GRAM	CLEAR	$5,612	0
1985	38,461	4.0 GRAM	CLEAR	$9,151	573
1986	26,500	4.0 GRAM	CLEAR	$4,417	720
1987	66,400	5.0 GRAM	CLEAR	$12,480	3,000
1988	39,600	3.3 GRAM	CLEAR	$6,654	5,384
1989	0				561
	198,961			$38,314	10,238

COST/FISH TO THE CREEL: $3.74 (5.1% HARVEST RATE)

5. DUNE LAKE (FINGERLING)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1987	20,000	2.0 GRAM	CLEAR	$1,504	0
1988	0				1,010
	20,000			$1,504	1,010

COST/FISH TO THE CREEL: $1.49 (5.1% HARVEST RATE)

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STEELHEAD
SOUTHEAST:

1. SIZE STOCKED: SMOLT (47.39 GRAM)

   NUMBER STOCKED: 10,026

   BROOD STOCK: CRYSTAL CREEK

   HATCHERY WHERE REARED: CRYSTAL LAKE

   RELEASE SITE AND YEAR: CRYSTAL CREEK (PETERSBURG)-1983

   PRODUCTION COSTS: $21,701

   TOTAL RETURN: 336 (3.4% SURVIVAL RATE) (FRED DIV.)

   COST/FISH (TOTAL RETURN): $64.59

   FISH HARVESTED IN THE SPORT FISHERY: 117 (1.2% HARVEST RATE) (FRED DIV.)

   COST/FISH TO THE CREEL: $185.48

   FISH HARVESTED IN THE COMMERCIAL FISHERIES: NO ESTIMATE AVAILABLE

   COST/ALL FISH HARVESTED: $185.48

2. SIZE STOCKED: SMOLT (29 GRAM)

   NUMBER STOCKED: 3,322

   BROOD STOCK: CRYSTAL CREEK

   HATCHERY WHERE REARED: CRYSTAL LAKE

   RELEASE SITE AND YEAR: CRYSTAL CREEK (PETERSBURG)-1984

   PRODUCTION COSTS: $2,151

   TOTAL RETURN: 32 (1.0% SURVIVAL RATE) (FRED DIV.)

   COST/FISH (TOTAL RETURN): $67.22

   FISH HARVESTED IN THE SPORT FISHERY: 3 (0.1% HARVEST RATE) (FRED DIV.)

   COST/FISH TO THE CREEL: $717.00

   FISH HARVESTED IN THE COMMERCIAL FISHERIES: NO DATA AVAILABLE

   COST/ALL FISH HARVESTED: $717.00

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RAINBOW TROUT (ALL HARVEST ESTIMATES WERE GENERATED FROM STATEWIDE HARVEST SURVEY DATA, 1984-1990)

SOUTHCENTRAL:

1. BEACH LAKE (CATCHABLES)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1986	2,485	55.6 GRAM	FT. RICHARDSON	$3,461	882
1987	4,810	133.5 GRAM	SHIP CREEK	$7,409	1,884
1988	5,298	93.4 GRAM	FT. RICHARDSON	$9,270	637
1989	6,583	97.2 GRAM	FT. RICHARDSON	$9,585	2,148
	19,176			$29,725	5,551

COST/FISH TO THE CREEL: $5.35 (29.0% HARVEST RATE)

2. TRIANGLE LAKE (CATCHABLES)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1985	964	56.8 GRAM	FT. RICHARDSON	$1,055	555
1986	1,988	55.6 GRAM	FT. RICHARDSON	$2,769	905
1987	579	131.6 GRAM	SHIP CREEK	$879	1,058
1988	808	90.0 GRAM	SHIP CREEK	$959	182
1989	1,256	86.0 GRAM	FT. RICHARDSON	$1,618	1,201
	5,595			$7,280	3,901

COST/FISH TO THE CREEL: $1.87 (69.7% HARVEST RATE)

3. LOWER FIRE LAKE (CATCHABLES)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1985	4,976	56.8 GRAM	FT. RICHARDSON	$5,447	2,324
1986	2,461	75.5 GRAM	FT. RICHARDSON	$4,655	1,687
1987	4,740	131.5 GRAM	SHIP CREEK	$7,192	1,602
1988	5,018	75.3 GRAM	FT. RICHARDSON	$7,079	4,675
1989	6,618	92.8 GRAM	FT. RICHARDSON	$9,200	1,989
	23,813			$33,573	12,277

COST/FISH TO THE CREEL: $2.73 (51.6% HARVEST RATE)

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4. HILLBERG LAKE (CATCHABLES)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1985	3,121	62.0 GRAM	FT. RICHARDSON	$3,729	1,838
1986	995	75.5 GRAM	FT. RICHARDSON	$1,882	1,239
1987	1,199	111.7 GRAM	SHIP CREEK	$1,545	1,107
1988	1,414	90.0 GRAM	FT. RICHARDSON	$2,384	1,328
1989	1,510	87.0 GRAM	FT. RICHARDSON	$1,968	1,323
	8,239			$11,508	6,889

COST/FISH TO THE CREEL: $1.67 (83.6% HARVEST RATE)

5. DELONG LAKE (CATCHABLES)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1986	5,900	81.0 GRAM	FT. RICHARDSON	$11,973	369
1987	7,228	137.3 GRAM	SHIP CREEK	$11,451	1,068
1988	11,689	86.6 GRAM	FT. RICHARDSON	$18,964	
	4,143	61.0 GRAM	FT. RICHARDSON	$4,735	2,365
1989	12,118	84.2 GRAM	FT. RICHARDSON	$15,285	4,193
	41,078			$62,408	7,995

COST/FISH TO THE CREEL: $7.81 (19.5% HARVEST RATE)

6. CAMPBELL POINT LAKE (CATCHABLES)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1986	2,606	81.0 GRAM	FT. RICHARDSON	$5,288	793
1988	4,988	99.6 GRAM	FT. RICHARDSON	$9,309	1,746
1989	4,998	96.5 GRAM	FT. RICHARDSON	$7,225	497
	12,592			$21,820	3,036

COST/FISH TO THE CREEL: $7.19 (24.1% HARVEST RATE)

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7. LUCILLE LAKE (CATCHABLES)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1986	19,878	40.0 GRAM	FT. RICHARDSON	$19,920	168
1987	15,609	109.0 GRAM	ELMENDORF	$19,631	3,379
1988	20,254	69.0 GRAM	FT. RICHARDSON	$26,181	8,495
1989	11,000	39.0 GRAM	FT. RICHARDSON	$6,427	792
	66,741			$72,159	12,834

COST/FISH TO THE CREEL: $5.62 (19.2% HARVEST RATE)

8. TIGGER LAKE (FINGERLING)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1985	6,398	2.5 GRAM	FT. RICHARDSON	$308	0
1986	3,780	2.7 GRAM	FT. RICHARDSON	$256	0
1987	1,897	1.3 GRAM	FT. RICHARDSON	$170	417
1988	0				782
1989	0				0
	12,075			$734	1,199

COST/FISH TO THE CREEL: $0.61 (9.9% HARVEST RATE)

9. WISHBONE LAKE (FINGERLING)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1985	10,050	2.1 GRAM	FT. RICHARDSON	$407	0
1986	12,112	2.4 GRAM	FT. RICHARDSON	$728	0
1987	0				146
1988	0				18
	22,162			$1,135	164

COST/FISH TO THE CREEL: $6.92 (0.7% HARVEST RATE)

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10. SEYMOUR LAKE (FINGERLING)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1985	69,253	2.5 GRAM	FT. RICHARDSON	$3,336	0
1986	45,817	2.7 GRAM	FT. RICHARDSON	$3,099	0
1987	45,800	2.3 GRAM	FT. RICHARDSON	$7,268	165
1988	0				1,619
1989	0				445
	160,870			$13,703	2,229

COST/FISH TO THE CREEL: $6.15 (1.4% HARVEST RATE)

11. SOUTH ROLLY LAKE (FINGERLING)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1985	21,600	2.6 GRAM	FT. RICHARDSON	$1,082	0
1986	10,785	2.7 GRAM	FT. RICHARDSON	$730	0
1987	10,800	1.8 GRAM	FT. RICHARDSON	$1,341	291
1988	0				564
1989	0				518
	43,185			$3,153	1,373

COST/FISH TO THE CREEL: $2.30 (3.2% HARVEST RATE)

12. REED LAKE (FINGERLING)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1985	8,180	2.5 GRAM	FT. RICHARDSON	$394	0
1986	3,894	2.3 GRAM	FT. RICHARDSON	$224	0
1987	5,850	1.3 GRAM	FT. RICHARDSON	$525	68
1988	0				691
1989	0				436
	17,924			$1,143	1,195

COST/FISH TO THE CREEL: $0.96 (6.7% HARVEST RATE)

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13. BIG NO LUCK LAKE (FINGERLING)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1985	13,600	2.6 GRAM	FT. RICHARDSON	$681	0
1986	13,721	2.7 GRAM	FT. RICHARDSON	$928	0
1987	6,812	2.3 GRAM	FT. RICHARDSON	$1,081	87
1988	0				255
1989	0				481
	34,133			$2,690	823

COST/FISH TO THE CREEL: $3.27 (2.4% HARVEST RATE)

14. WALBY LAKE (FINGERLING)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1985	29,313	2.3 GRAM	FT. RICHARDSON	$1,299	0
1986	10,730	2.3 GRAM	FT. RICHARDSON	$618	0
1987	5,434	1.3 GRAM	FT. RICHARDSON	$487	350
1988	0				273
1989	0				327
	45,477			$2,404	950

COST/FISH TO THE CREEL: $2.53 (2.1% HARVEST RATE)

INTERIOR:

1. BIRCH LAKE (FINGERLING, SUBCATCHABLES, AND CATCHABLES)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1984	263,498	1.7 GRAM	ELMENDORF	$7,231	0
	6,465	2.8 GRAM	ELMENDORF	$283	0
1986	83,368	20.0 GRAM	CLEAR	$69,996	8,723
1987	34,039	25.0 GRAM	CLEAR	$31,989	9,981
1988	54,723	27.0 GRAM	CLEAR	$75,233	18,390
1989	4,045	112.0 GRAM	FT. RICHARDSON	$6,787	16,420
	446,138			$191,519	53,514

COST/FISH TO THE CREEL: $3.58 (12.0% HARVEST RATE)

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2. CHENA LAKE (CATCHABLES)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1985	15,200	56.7 GRAM	FT. RICHARDSON	$21,592	9,660
1986	14,702	56.4 GRAM	FT. RICHARDSON	$15,979	
	14,400	79.4 GRAM	FT. RICHARDSON	$22,034	7,001
1987	22,512	113.0 GRAM	ELMENDORF	$29,351	
	2,890	151.0 GRAM	ELMENDORF	$5,035	5,220
1988	22,020	95.0 GRAM	FT. RICHARDSON	$39,190	
	7,858	90.0 GRAM	FT. RICHARDSON	$13,249	
	4,429	63.0 GRAM	FT. RICHARDSON	$5,227	9,877
1989	7,935	78.5 GRAM	FT. RICHARDSON	$9,331	
	12,238	96.0 GRAM	FT. RICHARDSON	$17,600	
	10,308	103.0 GRAM	FT. RICHARDSON	$15,905	11,968
	134,492			$194,493	43,726

COST/FISH TO THE CREEL: $4.45 (32.51% HARVEST RATE)

3. HARDING LAKE (FINGERLING)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1986	117,215	3.3 GRAM	FT. RICHARDSON	$9,808	
	22,748	3.6 GRAM	FT. RICHARDSON	$2,063	
	47,522	4.5 GRAM	FT. RICHARDSON	$5,298	0
1987	544,200	0.2 GRAM	FT. RICHARDSON	$5,632	
	584,083	2.5 GRAM	FT. RICHARDSON	$100,753	0
1988					191
1989					456
	1,315,768			$123,554	647

COST/FISH TO THE CREEL: $190.96 (0.05% HARVEST RATE)

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4. PILEDRIVER SLOUGH (CATCHABLES)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1987	4,091	110.0 GRAM	ELMENDORF	$5,192	
	8,404	154.0 GRAM	ELMENDORF	$8,404	4,346
1988	9,417	89.7 GRAM	FT. RICHARDSON	$15,825	
	11,059	90.0 GRAM	FT. RICHARDSON	$18,646	
	2,188	65.0 GRAM	FT. RICHARDSON	$2,664	
	3,880	135.0 GRAM	FT. RICHARDSON	$9,813	12,296
1989	11,845	96.0 GRAM	FT. RICHARDSON	$17,034	
	13,810	101.0 GRAM	FT. RICHARDSON	$20,895	7,689
	64,694			$98,473	24,331

COST/FISH TO THE CREEL: $4.05 (37.6% HARVEST RATE)

5. ROADSIDE PONDS (FINGERLING)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1983	30,000	1.9 GRAM	ELMENDORF	$2,250	0
1984	1,950	1.1 GRAM	ELMENDORF	$34	
	79,477	2.2 GRAM	ELMENDORF	$2,758	0
1985	269,400	2.0 GRAM	FT. RICHARDSON	$10,384	1,358
1986	81,800	1.5 GRAM	CLEAR	$5,151	
	1,000	2.1 GRAM	CLEAR	$88	768
1987	165,800	2.0 GRAM	CLEAR	$12,465	
	20,041	2.3 GRAM	FT. RICHARDSON	$3,180	2,053
1988	0				12,498
1989	0				7,365
	649,468			$36,310	24,042

COST/FISH TO THE CREEL: $1.51 (3.7% HARVEST RATE)

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6. QUARTZ LAKE (FINGERLING AND SUBCATCHABLES)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1984	273,567	1.8 GRAM	ELMENDORF	$7,551	0
1985	100,000	0.9 GRAM	ELMENDORF	$1,770	
	287,376	1.7 GRAM	CLEAR	$29,061	0
1986	329,865	1.6 GRAM	CLEAR	$22,156	14,778
1987	10,000	28.0 GRAM	CLEAR	$10,525	
	101,795	2.2 GRAM	CLEAR	$8,533	
	227,917	2.4 GRAM	FT. RICHARDSON	$37,742	10,106
1988	41,627	24.0 GRAM	CLEAR	$50,870	25,175
1989	0				27,356
	1,372,147			$168,208	77,415

COST/FISH TO THE CREEL: $2.17 (5.6% HARVEST RATE)

ARCTIC GRAYLING (ALL HARVEST ESTIMATES WERE GENERATED FROM STATEWIDE HARVEST SURVEY DATA, MILLS 1987-1990)

SOUTHCENTRAL:

1. LOWER FIRE LAKE (FINGERLING)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1986	20,000	4.6 GRAM	CLEAR	$3,862	0
1987	20,000	3.1 GRAM	CLEAR	$2,331	0
1988	0				819
1989	0				66
	40,000			$6,193	885

COST/FISH TO THE CREEL: $7.00 (2.2% HARVEST RATE)

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2. LONG LAKE (FRY AND FINGERLING)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1986	63,600	0.02 GRAM	CLEAR	$48	
	6,000	6.4 GRAM	CLEAR	$1,612	0
1987	60,000	0.02 GRAM	CLEAR	$41	0
1988	0				91
1989	0				73
	129,600			$1,701	164

COST/FISH TO THE CREEL: $10.37 (0.1% HARVEST RATE)

3. MEIRS LAKE (FRY AND FINGERLING)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1986	33,600	0.02 GRAM	CLEAR	$25	0
	3,375	5.3 GRAM	CLEAR	$751	0
1987	0				0
1988	0				400
1989	0				0
	36,975			$776	400

COST/FISH TO THE CREEL: $1.94 (1.1% HARVEST RATE)

4. FARMER LAKE (FINGERLING)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1987	4,200	3.7 GRAM	CLEAR	$584	0
1988	0				0
1989	0				45
	4,200			$584	45

COST/FISH TO THE CREEL: $12.98 (1.1% HARVEST RATE)

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INTERIOR:

1. SIZE STOCKED: SAC FRY

   BROOD STOCK: MOOSE LAKE

   HATCHERY WHERE REARED: CLEAR

   RELEASE SITE AND YEAR: 28 LAKES NEAR FAIRBANKS, GLENNALLEN, AND PALMER AREAS-1986 AND 1987

   PRODUCTION COSTS (1986)[3]: $16,550 ($0.02 PER FISH; SKAUGSTAD 1989)

   FISH HARVESTED IN SPORT FISHERY[4]: NOT AVAILABLE

   COST/SURVIVOR AT AGE 1+: $1.58 (SE = 0.18) (SKAUGSTAD,1989)

2. SIZE STOCKED: 4-GRAM FINGERLING

   BROOD STOCK: MOOSE LAKE

   HATCHERY WHERE REARED: CLEAR

   RELEASE SITE AND YEAR: 30 LAKES NEAR FAIRBANKS, GLENNALLEN, AND PALMER AREAS-1986 AND 1987

   PRODUCTION COSTS (1986)[3]: $23,040 ($0.12 PER FISH; SKAUGSTAD 1989)

   FISH HARVESTED IN SPORT FISHERY[4]: NOT AVAILABLE

   COST/SURVIVOR AT AGE 1+: $0.24 (SE = 0.02) (SKAUGSTAD,1989)

3. SIZE STOCKED: 6-GRAM FINGERLING

   BROOD STOCK: MOOSE LAKE

   HATCHERY WHERE REARED: CLEAR

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[3]Production costs for Arctic grayling include all associated costs. Production costs for all other species were for hatchery operating costs only and do not include capital improvement projects, special projects, or any administrative overhead costs.

[4]Harvest estimates for Arctic grayling stocked in Interior lakes are not available. The cost evaluations for Arctic grayling are based on cost per fish that survived to age 1+.

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RELEASE SITE AND YEAR: 11 LAKES NEAR FAIRBANKS, GLENNALLEN, AND PALMER AREAS-1986 AND 1987

PRODUCTION COSTS (1986)[3]: $27,080 ($0.14 PER FISH; SKAUGSTAD 1989)

FISH HARVESTED IN SPORT FISHERY[4]: NOT AVAILABLE

COST/SURVIVOR AT AGE 1+: $0.21 (SE = 0.01) (SKAUGSTAD,1989)

4. DUNE LAKE (FINGERLING)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1987	5,000	4.7 GRAM	CLEAR	$878	0
1988	0				0
1989	0				591
	5,000			$878	591

COST/FISH TO THE CREEL: $1.49 (11.8% HARVEST RATE)

5. HARDING LAKE (FRY AND FINGERLING)

YEAR	NUMBER STOCKED	SIZE	HATCHERY	TOTAL COST	FISH HARVESTED
1986	60,653	1.9 GRAM	CLEAR	$4,711	0
	18,759	2.1 GRAM	CLEAR	$1,685	79
1987	640,000	0.01 GRAM	CLEAR	$241	0
1988	0				0
1989	0				0
	719,412			$6,637	79

COST/FISH TO THE CREEL: $84.01 (0.01% HARVEST RATE)