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CULTURE OF 1976-BROOD SPRING CHINOOK SALMON, ONCORHYNCHUS TSHAWYTSCHA, FROM TWO BEHM CANAL STOCKS AT LITTLE PORT WALTER, BARANOF ISLAND, SOUTHEASTERN ALASKA

DECEMBER 1979

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CULTURE OF 1976-BROOD SPRING CHINOOK SALMON, *ONCORHYNCHUS TSHAWYTSCHA*, FROM TWO BEHM CANAL STOCKS AT LITTLE PORT WALTER, BARANOF ISLAND, SOUTHEASTERN ALASKA

by

William R. Heard, Alex C. Wertheimer, Roy M. Martin, and Bruce E. Short

December 1979

Northwest and Alaska Fisheries Center Auke Bay Laboratory
National Marine Fisheries Service, NOAA
P.O. Box 155, Auke Bay, AK 99821

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INTRODUCTION

In 1976, National Marine Fisheries Service (NMFS) and Alaska Department of Fish and Game (ADF&G) signed a Memorandum of Agreement to develop a brood stock of spring chinook salmon, Oncorhynchus tshawytscha, and to develop improved techniques for its artificial culture. In southeastern Alaska, natural populations are declining because of increased commercial and recreational fishing pressures. This cooperative agreement commits both funds and manpower of the NMFS Salmon Aquaculture Program in Alaska and ADF&G to research on spring chinook salmon. The NMFS aquaculture facility at Little Port Walter (LPW) on southern Baranof Island (Figure 1) is the site of most of the research.

During the study, at least three broods of spring chinook salmon will be transplanted to Little Port Walter. Results of this study will be used to 1) evaluate different culture strategies for producing smolts, 2) determine the effect of different culture strategies on ocean survival, and 3) determine ocean-migration patterns of cultured stocks and their contribution to various fisheries. If adult returns to LPW are adequate, we will use their eggs for chinook salmon enhancement programs in southeastern Alaska. This report deals only with the 1976 brood.

Initially, we intended to transplant only one chinook salmon stock to LPW; however, because of low numbers of spawners in the first stock, two

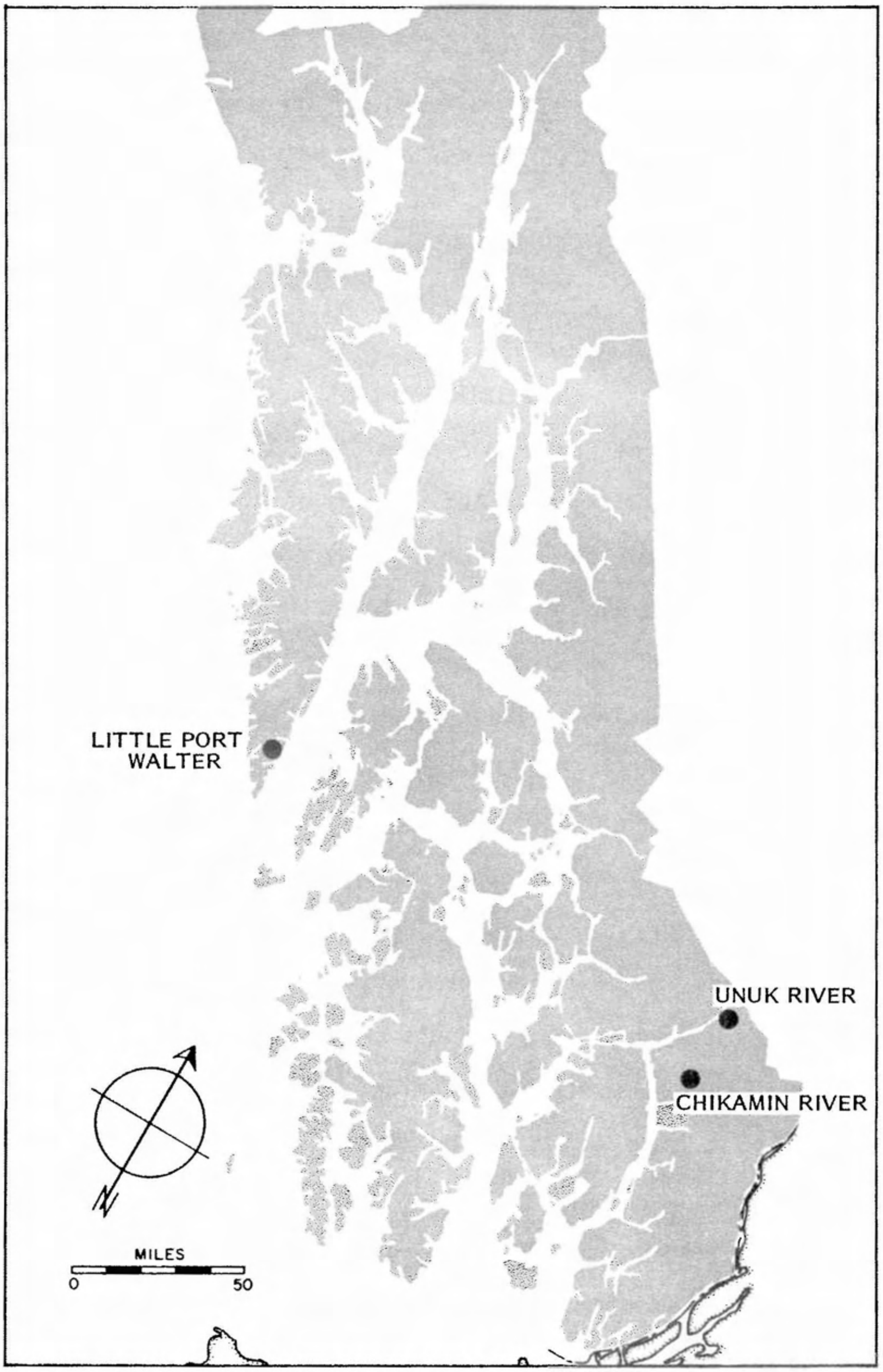

Figure 1.--Southeastern Alaska showing location of National Marine Fisheries Service Little Port Walter aquaculture station on Baranof Island and the source of two stocks of 1976-brood Behm Canal area spring chinook salmon.

stocks were transplanted to LPW in 1976. These stocks will be separated at least through the first filial (F-1) generation. Both stocks were incubated and reared separately and all groups of juveniles have a separate coded-wire tag. Any brood-stock developed with these fish will be of known origin.

National Marine Fisheries Service agreed to submit periodic reports to ADF&G on results and progress of the cooperative program. The first report (Heard and Wertheimer 1976) reviewed: 1) the collection of 1976-brood chinook salmon eggs from the Chickamin and Unuk Rivers in the Behm Canal area; 2) survival and incubation of these eggs through the advanced eyed stage; and 3) observations of the juveniles in the Chickamin River system. In this report, the second report, we 1) describe some culture strategies for spring chinook salmon, 2) document the continued culture of 1976-brood Chickamin River and Unuk River chinook salmon at LPW from eyed-egg stage through smolt stage, and 3) give data on the return of age-2_2 (1.0) adults in 1978 from 1976-brood releases at LPW.

CULTURE STRATEGIES AND PROCEDURES

Fall- or ocean-type chinook salmon runs produce juveniles that often begin the marine phase of growth during the first year of life. No runs of fall chinook salmon occur in Alaska. All Alaskan stocks are spring, or stream type, chinook salmon that have at least one freshwater annulus before estuarine and ocean growth begins (Rowland 1969; Kissner 1975; Kissner 1977). Although not precisely defined, the northernmost runs of fall chinook salmon presumably are along the northcentral coast of British Columbia. The environment north of this region may not support fall chinook salmon--an important factor in considering strategies for culture in Alaska.

For many reasons, spring chinook salmon have not been cultured as successfully as fall chinook salmon in North America. Spring chinook salmon tend to spawn farther inland and remain longer in freshwater, both as adults and juveniles; thus, their hatchery biology is more complex. Few natural populations of juvenile spring chinook salmon have been studied in detail. Two populations studied in detail are the population in the Wenatchee River, a mid-Columbia River tributary (French and Wahle 1959), and the population in the Yakima River (Major and Mighell 1969). Most spring chinook salmon hatcheries started after natural spawning and rearing habitat was threatened or destroyed. Many hatchery managers failed to consider the different biological requirements of different hatchery stocks or the influence of the hatchery environment on transplanted stocks. Only a few studies compare the effects of different hatchery practices on return rates of spring chinook salmon. Royal (1972 p. 140) summarizes hatchery practices in the Pacific northwest and concludes (p. 140) "...operations involving spring chinook salmon leave much to be desired if a successful hatchery program is to be evolved." Earlier in the same report (p. 136) he points out "It is imperative that the required operational procedures [for spring chinook salmon hatcheries] consistent with the natural life history be defined."

Most chinook salmon runs in southeastern Alaska are on the mainland, usually in large glaciated rivers and in their tributaries such as the Alsek, Taku, Stikine, and Unuk Rivers. Nearly all the spawning grounds of spring chinook salmon in these rivers are in Canada. The only run in southeastern Alaska on an island is in the King Salmon River at the north end of Seymour Canal on Admiralty Island. This run is small; 100 to 300 fish spawn each year (Kissner 1975). There are reports of other small runs on islands in southeastern Alaska that were presumably fished out and are now extinct.

Development of brood stocks for experimental hatchery culture of chinook salmon in southeastern Alaska requires transplanting stocks because no existing or planned hatcheries are located on streams with natural runs. Brood stock should come from regions near the hatchery because these stocks have adapted to local conditions. By using stocks endemic to the region, potential adverse interactions between hatchery and wild fish should be minimized. Chinook salmon transplanted from mainland rivers to island streams or hatchery sites in southeastern Alaska will encounter freshwater environments, especially thermal regimes and growth conditions, vastly different from their origin. Other environmental features of mainland rivers that influence chinook salmon biology may be hard to simulate at island hatcheries. Two biological parameters that could be held constant between mainland rivers and island hatchery sites--age and time of migration of smolts--became key factors we initially considered in attempting to raise Behm Canal area fish on Baranof Island. These parameters will likely play an important part in successful chinook salmon hatcheries in the region.

We define time of migration as the time of entry of smolts into seawater. This definition is necessary to differentiate migration of smolts from emigration of juveniles from natal spawning areas (headwater tributary streams) into downstream freshwater areas. Emigration into the downstream freshwater areas can occur in mid- to late summer or in early fall (French and Wahle 1959; Royal 1972; Kissner 1977; Waite 1979). This seasonal emigration into downstream freshwater areas is apparently an important part of the biology of many spring chinook salmon stocks but could be erroneously interpreted as the behavior of fall chinook salmon by assuming the fish were emigrating out of the freshwater environment. Juvenile spring chinook salmon may overwinter downstream from tributary spawning grounds, but they usually do not migrate into the estuary until the following spring.

Because chinook salmon from natural populations in Alaska migrate to sea at age 1 or older, raising and releasing age-1 smolts in the hatchery and evaluating adult returns from these releases became one of the culture strategies we chose to study. In most previous hatchery culture in Alaska, spring chinook salmon were treated as fall chinook salmon and were released at age 0.

Spring chinook salmon smolts from the lower Taku River, about 10 km upstream from tidal influence, migrate to seawater from mid-April to mid-June (Meeham and Sineff 1962, p. 400); most of the smolts migrate in mid-May. In other areas of southeastern Alaska, most chinook salmon juveniles also migrate into seawater in May (Kissner 1977, p. 1, and pers. commun. 1979). Using these data, we defined mid-May--for purposes of experimental design--as the "normal" time for releasing spring chinook salmon smolts into estuaries in southeastern Alaska. Releases made in April are defined as "early" and those in June as "late."

Little Port Walter is a bay immediately adjacent to lower Chatham Strait and the Gulf of Alaska, and smolts can be released directly into an estuary. The marine setting of the LPW facilities, typical of many Alaskan hatchery and enhancement sites, could be beneficial because it minimizes problems associated with downstream migration of hatchery smolts. Potential advantages of chinook salmon hatcheries in estuarine or marine locations over hatcheries in upriver locations include less chance for residualism of smolts in rivers and adverse interactions between hatchery and wild fish (both juveniles and adults)--poorly understood phenomena of major concern (Wagner 1967. p. 30; Reimers and Loeffel 1967, p. 17; Royal 1972, pp. 122, 142). Releasing smolts directly into estuaries, however, will require accurate determination of controlable variables in the hatchery like age of smolts when released, time of their release, and size of smolts released--factors that may be site and stock specific--before successful adult returns will occur.

Our culture of spring chinook salmon at the LPW aquaculture facility followed procedures developed for coho salmon, Oncorhynchus kisutch, (Heard et al. 1977; Heard et al. 1978), except that volume-loading rates were usually kept below 0.5 pounds of fish per ft^3 (8.0 kg/m^3) and flow-loading rates below 5.0 pounds of fish per gpm (0.61 kg/liter per minute), especially during early rearing stages. These rates were often lower than rates used in coho salmon culture at LPW. Although not well documented, quality of smolts may be dependent on densities of fish and water-flow rates in the rearing environment. Low densities of fish and high flow rates in some spring chinook salmon hatcheries probably contribute to good smolt quality and high ocean return of adults (Hager page 137 in Shepherd and Ginetz [1978]; C. Hopley, pers. commun. 1979).

The time of spawning of spring chinook salmon and differences in thermal regimes in Behm Canal rivers and at LPW necessitated five stages in our culture of 1976-brood chinook salmon: egg-to-fry (August-December), overwinter fry rearing (December-29 March), fry to early fingerling (29 March-20 June), fingerling stage (20 June-19 August), and fingerling stage (19 August-7 June).

EGG-TO-FRY PERIOD (AUGUST-DECEMBER 1976)

Incubation

Eggs were incubated in standard Heath[1] incubators with stacked trays. Flow rates through the 16-tray units were 5 gpm (23 liter/min). Loading densities during the newly fertilized-egg stage ranged from 1 liter to 4 liters of eggs per tray; loading densities during eyed-egg and alevin stages were less than 1.5 liter per tray (~2,500 eggs or alevins per liter). Details of incubation through the advanced eyed-egg stage by stock and in some cases by individual females are documented elsewhere (Heard and Wertheimer 1976).

Survival

A total of 66,000 eggs were collected from the 1976-brood of stocks from Chickamin and Unuk Rivers, and 48,000 (72.7%) eggs survived from green eggs to the eyed-egg stage. Survival from eyed egg to initial feeding of fry was 97.5% (46,800) and from green egg to fry was 70.9%. Survival from egg to fry, differentiated by stock, is summarized in Table 1.

Table 1.--Survival from egg to fry of 1976-brood chinook salmon incubated at Little Port Walter.

	Numbers of eggs			Survival		
Stock	Collected (10^3)	Eyed stage (10^3)	Number of fry (10^3)	To eyed egg stage (%)	Eyed egg to fry stage (%)	Overall egg-to-fry (%)
Chickamin	27.8	21.8	20.6	78.4	94.5	74.1
Unuk	38.2	26.2	26.2	68.6	100.0	68.1
Totals	66.0	48.0	46.8	72.7	97.5	70.9

[1] Reference to trade names does not imply endorsement by National Marine Fisheries Service, NOAA.

To compare survival from green egg to eyed egg and to determine the incidence of malformed alevins, we collected two groups of eggs on 7 August: eggs from a single "shaker" female that was not fully ripe and eggs from two completely ripe females (Heard and Wertheimer 1976). Pooled milt from three males fertilized the two groups of eggs. Only 60.0% of the eggs from the "shaker" female survived to the eyed-egg stage; 95.4% of the eggs from the ripe females survived to the eyed-egg stage. In the "shaker" group, 5,711 eyed eggs produced 421 (7.4%) malformed alevins. In the ripe-female group, 5,827 eyed eggs produced 7 (0.1%) malformed alevins. Differences in survival and incidence of malformed alevins in these two groups of eggs emphasize the importance of maturity of females used for artificial spawning.

Temperature and Development

Incubation periods and the time of emergence of the chinook salmon incubated at LPW and their siblings incubated in their natal streams could not be compared for the 1976 brood. Initial incubation temperatures were only 1C° higher at LPW than temperatures of Chickamin River water on 5 and 7 August spawning dates (11°C vs. 10°C). However, temperatures at LPW throughout the egg-to-fry incubation period (Figure 2) probably averaged higher than in the natal Behm Canal rivers. Chinook salmon fry in the Taku River system are thought to emerge in April and May (Kissner 1977, p. 21), and it seems likely that Chickamin River and Unuk River fry also emerge at this time.

All of the fry from eggs collected on the first spawning date (5 August) had absorbed their yolk by 29 and 30 November and were placed in rearing tanks at LPW. Fry at LPW emerged 5 to 6 months before wild fry probably emerged in their natal streams. Accumulated temperature units for different groups of 1976-brood incubated at LPW are given in Table 2.

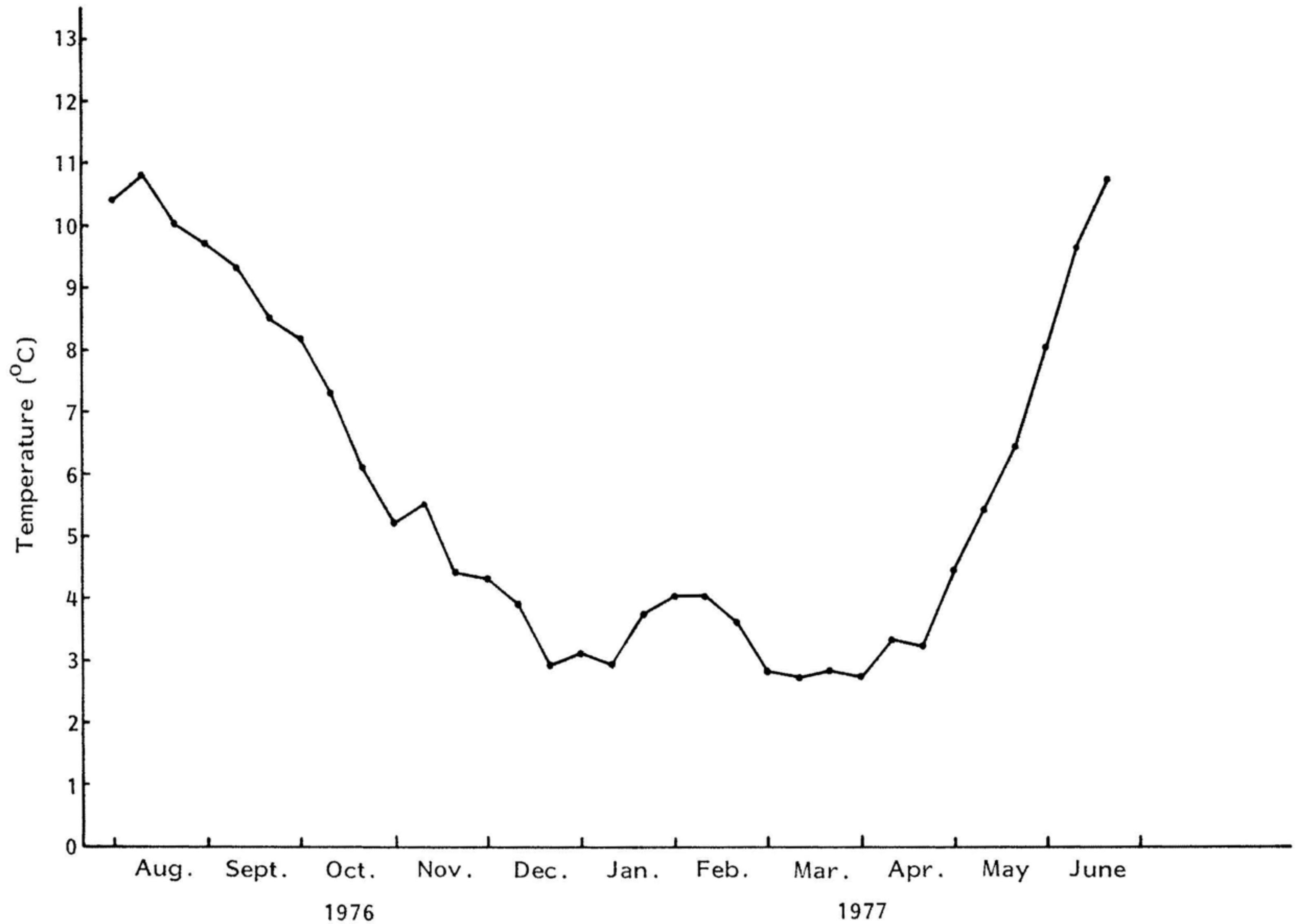

Figure 2.--Incubation and initial fry-rearing temperature regime for 1976-brood chinook salmon at Little Port Walter, July 1976-June 1977. Smoothed by 10-day average.

Table 2.--Accumulated temperature units (TU) between dates of spawning and initial feeding of fry for 1976-brood chinook salmon at Little Port Walter.

Stock	Date: Spawning	Date: Initial feeding	Accumulated TU (C°)
Chickamin	5 August	29-30 November	826 to 830
Chickamin	7 August	3 December	806
Unuk	18 August	13 December	850
Unuk	21 August	15-21 December	766 to 786

OVERWINTER FRY REARING (DECEMBER 1976 - 29 MARCH 1977)

Rearing Units

Chinook salmon fry were cultured during the overwinter period in four semicylindrical tanks. Each tank had an effective rearing volume of 55 ft^3 (1.6 m^3). These tanks, maintained inside the Little Port Walter dome facility (Heard et al. 1978, pp. 2, 15), had laminar, single-pass water flows. The ratio of fish to water flow (flow-loading rate) did not exceed 3.0 pounds/gpm (0.36 kg/liter per min). Fry from different stocks and spawning dates were maintained in separate rearing tanks (Table 3). Tanks 1 and 2 held Chickamin River fry from spawning dates of 7 and 5 August, respectively; and tanks 3 and 4 held Unuk River fry from spawning dates of 18 and 21 August, respectively.

Growth and Survival

We periodically weighed the fry and determined mean weights and growth rates of fry in each tank. Fry in tanks 1 and 2 were initially weighed on 11 December; fry in tanks 3 and 4 were initially weighed on 22 December. All four populations of fry were again weighed on 7 February and 29 March. We moved the fry to vertical raceways on 29 March.

Most daily growth rates ranged from 0.7% to 1.2% during the overwinter period, except in tank 4 where the growth rate was only 0.1% for the first part of the period (Table 3). Accumulated temperature (measured by temperature units) in tank 4 (from the 21 August spawning) was lower than accumulated temperature in other tanks (Table 2) and caused the fry in this tank to be less developed physiologically than fry in other tanks. Gain ratios (final weight/initial weight) for the overwinter period were 2.5 for both Chickamin groups and 2.0 and 1.6 for the two Unuk groups (Table 3).

Table 3.--Weights, numbers of fish, gain ratios, growth rates, and survival rates of four groups of 1976-brood spring chinook salmon (11 December 1976 through 29 March 1977).

			Mean weight		Population size		Growth		
Rearing tank	Stock	Sample date	Fish per pound	Grams per fish	Weight (lb)	Numbers (10^3)	Gain ratio[a]	Daily rate[b] (%)	Survival (%)
1	Chickamin	11 Dec	1072	0.42	9.0	9.6	--	--	--
		7 Feb	685	0.66	--	--	--	0.8	--
		29 Mar	424	1.07	22.5	9.5	2.5	1.0	98.9
2	Chickamin	11 Dec	1121	0.40	9.8	10.9	--	--	--
		7 Feb	725	0.63	--	--	--	0.7	--
		29 Mar	459	0.99	23.2	10.7	2.5	0.9	98.1
3	Unuk	22 Dec	1089	0.40	9.0	9.8	--	--	--
		7 Feb	794	0.57	--	--	--	0.7	--
		29 Mar	554	0.82	17.0	9.4	2.0	0.7	95.9
4	Unuk	22 Dec	1089	0.40	15.1	16.4	--	--	--
		7 Feb	1069	0.42	--	--	--	0.1	--
		29 Mar	700	0.65	22.3	15.6	1.6	1.2	95.1

[a] Gain ratio = $\dfrac{\text{mean weight, end of period}}{\text{mean weight, beginning of period}}$.

[b] Percent increase in body weight per day, derived from the equation: $\frac{1}{t_1} \ln \frac{w_1}{w_0} \times 100$, where w_1 is mean weight at the end of time period t_1, w_0 is mean weight at the beginning of time period t_1, and t_1 is the number of days between w_0 and w_1.

The observed overwinter growth may have been greater than we could usually expect at Little Port Walter because the winter of 1976-77 was uncommonly mild and resulted in higher than normal water temperatures. Freshwater temperatures were often above 3.0°C in 1976-77 (Figure 2) although usually during this period freshwater temperatures rarely exceed 3.0°C and are often below 2.0°C (see figure 11 in Heard et al. 1977).

The number of fry in each population was estimated from en masse weights at the beginning and end of the overwinter period (Table 3), and survival ranged from 95.1% to 98.9% in the four tanks and averaged about 97% overall.

Fish Health and Drug Therapy

We recorded the number of dead fry removed from each tank during the overwinter period. Deaths in tanks 1, 2, 3, and 4 were 104, 288, 381, and 859, respectively. The mortality rate was highest during early January. Samples of dead fish examined by the fish pathology staff of ADF&G failed to reveal any particular causative pathogens. These losses may have been related to congenital problems associated with the initial rearing of fry at low temperatures.

Distressed fish often swam erratically, spiralling and fluttering downward until they reached the bottom of the tank. This behavior may have been part of a fright response, which began when an observer first approached or bumped the tank. Tests for whirling disease, Myxosoma cerebralis, were negative.

We administered two standard 10-day antibiotic treatments of oxytetracycline (Wood 1974, p. 7): the first in January to avoid bacterial complications; the second in March to minimize effects of stress associated with transferring and handling fish. Effectiveness may have been minimal because of low water temperatures, low feeding rates, or low intake of the antibiotic.

FRY-TO-EARLY FINGERLING (29 MARCH - 20 JUNE 1977)

Rearing Units

On 29 March, after weighing the fish, we moved them from indoor rearing tanks to outside vertical raceways (see figures 4 and 5 in Heard and Martin 1979) floating in the LPW estuary. The rearing volume of the raceways was about 600 ft^3 (17.0 m^3). Fry from the same stock but with different spawning dates were combined and the two stocks were held in separate raceways. Freshwater flowed through each raceway at a rate of 100 gpm (378 liter/min). In the raceway with fry from the Chickamin stock, the maximum water flow-loading rate was 3.1 pounds/gpm (0.38 kg/liter per min) and the maximum volume-loading rate was 0.5 pound/ft^3 (8.0 kg/m^3); in the raceway with fry from the Unuk stock, these rates were 3.3 pounds/gpm (0.39 kg/liter per min) and 0.6 pounds/ft^3 (9.6 kg/m^3), respectively.

A wire-mesh fence 2 ft (0.6 m) in height with an electrically charged wire along the top was installed around the float frames that supported the vertical raceways. In past studies, similar arrangements were reasonably effective in keeping mammalian predators out of raceways.

Growth and Survival

Increasing temperatures (Figure 2) and photoperiod were accompanied by increased growth during this culture period. Daily growth rates were 2.3% and 2.6% and gain ratios were 7.3% and 9.0% for Chickamin and Unuk stock raceways, respectively. Survival was similar, 95.5% and 96.0%, in both raceways during the period (Table 4).

Fish Health and Drug Therapy

The low but steady attrition in both raceways during this period (29 March to 20 June) was primarily a continuation of the losses that occurred

Table 4.--Weights, lengths, numbers of fish, gain ratios, growth rates, and survival rates of two stocks of 1976-brood spring chinook salmon raised in vertical raceways (29 March through 23 June 1977).

		Mean weight		Mean	Population size		Growth		
Stock	Sample date	Fish per pound	Grams per fish	fork-length (mm)	Weight (lb)	Numbers (10^3)	Gain ratio	Daily rate (%)	Survival (%)
Chickamin	29 Mar	442	1.0	45.7	46	20.2	--	--	--
	20 Jun	62	7.3	83.5	310	19.3	7.3	2.3	95.5
Unuk	29 Mar	636	0.7	41.1	39	25.0	--	--	--
	23 Jun	72	6.3	80.4	334	24.0	9.0	2.6	96.0

during the overwinter period. No particular causative pathogen was implicated. The peculiar spiraling behavior evident at the beginning of the period was gone by early June. A standard 10-day oxytetracycline treatment was given to fry in both raceways in mid-June prior to transferring fish.

FINGERLING STAGE (20 JUNE - 19 AUGUST 1977)

Rearing Units

On 20 June, we divided the Chickamin population into nearly equal numbers and placed them into two vertical raceways designated VR-1 and VR-2. On 23 June, the Unuk population was divided equally into three vertical raceways designated VR-3, VR-4, and VR-6. At the beginning of the fingerling stage, single-pass water flows of 100 gpm (378 liter/min) were maintained in all five raceways. Freshwater was used in VR-1, VR-4, and VR-6; seawater (8-10$^{o}/_{oo}$ salinity) was used in VR-2 and VR-3. A venturi mixing device (Heard and Salter 1978) provided seawater flows of stable, intermediate salinity. After flow-loading rates in the two Chickamin raceways, VR-1 and VR-2, reached 6.3 and 5.7 pounds/gpm (0.76 and 0.68 kg/liter per min), respectively, on 8 August, we increased flows to 150 gpm (568 liter/min). Volume-loading rates at the end of the period ranged from 0.9 to 1.3 pounds/ft^3 (14.4 to 20.8 kg/m^3) in the five raceways (Table 5).

Growth and Survival

Daily growth rates were similar in the five raceways and ranged from 2.6% to 2.9% during this period (Table 6). Gain ratios ranged from 4.9 to 5.3. In this period, the feeding rate of about 4% of body weight per day apparently limited growth. Food conversion factors were approximately 1:1.4 to 1:1.5. Growth rates were higher than they should have been to keep flow-loading rates and volume-loading rates within predetermined limits. Growth of fry in the intermediate salinity raceways (VR-2 and VR-3) was similar to growth of fry in freshwater raceways although temperatures were consistently higher in the freshwater raceways during this period (Figure 3).

Table 5.--Flow-load and volume-load densities in five populations of 1976-brood spring chinook salmon during three time periods between 20 June and 21 August 1977. (Metric units in parentheses.)

Rearing unit[a]	Flow load pounds per gpm (kg/l per min.)			Volume load pounds per cubic foot (kg/m^3)		
	20-23 June	8 August	19-21 August	20-23 June	8 August	19-21 August
VR-1	1.6 (0.19)	6.3 (0.76)	5.2 (0.62)	0.26 (4.2)	1.04 (16.8)	1.30 (20.8)
VR-2	1.5 (0.18)	5.7 (0.68)	5.0 (0.60)	0.26 (4.2)	0.95 (15.2)	1.26 (20.2)
VR-3	1.1 (0.13)	4.1 (0.50)	5.8 (0.70)	0.19 (3.0)	0.69 (11.1)	0.98 (15.6)
VR-4	1.1 (0.13)	-- --	5.9 (0.71)	0.19 (3.0)	-- --	0.98 (15.6)
VR-6	1.1 (0.13)	3.9 (0.47)	5.4 (0.65)	0.19 (3.0)	0.65 (10.5)	0.90 (14.4)

[a] VR-1 and VR-2 Chickamin fish; all others Unuk fish.

Table 6.--Weights, lengths, numbers of fish, gain ratios, growth rates, and survival rates of five populations of 1976-brood spring chinook salmon (20 June through 19 August 1977).

Rearing unit[a]	Sample date	Mean weight: fish per pound	Mean weight: grams per fish	Mean fork-length (mm)	Population size: Pounds	Population size: Number	Growth: Gain ratio	Growth: Daily rate (%)	Survival (%)
VR-1	20 Jun	62.1	7.3	83.5	156	9,705	--	--	--
	8 Aug	15.4	29.5	131.7	--	--	--	--	--
	19 Aug	12.6	36.0	140.9	777	9,689	4.9	2.7	99.8
VR-2	20 Jun	62.1	7.3	83.5	154	9,537	--	--	--
	8 Aug	16.8	27.0	127.9	--	--	--	--	--
	20 Aug	12.7	35.7	--	754	9,575	4.9	2.6	100.4
VR-3	23 Jun	71.9	6.3	80.4	112	8,017	--	--	--
	8 Aug	19.3	23.5	119.4	--	--	--	--	--
	20 Aug	13.7	33.1	--	584	8,000	5.3	2.9	99.8
VR-4	23 Jun	71.9	6.3	80.4	111	7,981	--	--	--
	21 Aug	13.5	33.6	--	591	7,977	5.3	2.8	99.9
VR-6	23 Jun	71.9	6.3	80.4	111	7,995	--	--	--
	8 Aug	20.3	22.3	118.8	--	--	--	--	--
	21 Aug	14.8	30.6	--	537	7,945	4.9	2.7	99.4

[a] VR-1 and VR-2 contained Chickamin fish; all others contained Unuk fish.

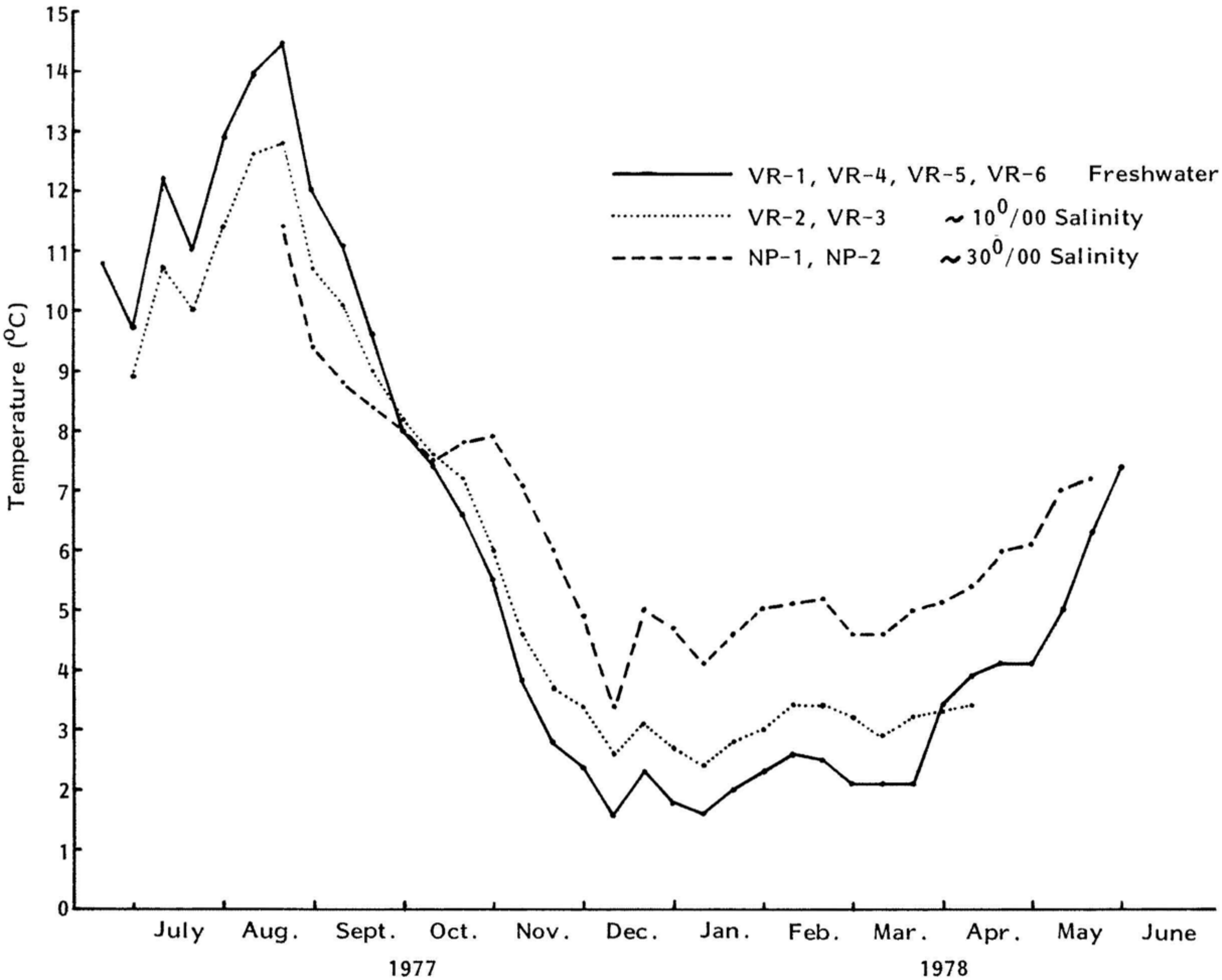

Figure 3.--Temperature regimes in various culture modes at Little Port Walter during fingerling-to-smolt culture of 1976-brood chinook salmon. All groups smoothed by 10-day moving average.

More than 99% of the fry survived during this period (Table 6). The survival exceeding 100% in VR-2 is an artifact of the en masse weighing procedure for estimating population numbers.

Fish Health and Drug Therapy

The high survival rates indicated that the fish were healthy. Mean weights in all populations exceeded 30 g per fish by the end of this period. The fish developed a silvery smolt-like appearance with deciduous scales and no visible parr marks. Fewer than 100 fish died during this period, and most of these fish died after jumping out of the raceways. This loss was eliminated after plywood barriers were installed around the tops of the raceways.

All five populations were given a 10-day oxytetracycline antibiotic treatment in mid-August just prior to transferring and handling fish at the end of the period.

Late Summer Release of Age-0 Smolts

Because one of our primary goals was to evaluate age-1 smolts, we did not initially plan to make age-0 releases of 1976-brood fish. However, it was apparent by midsummer that adjustments were necessary because the fish were larger and more numerous than we had planned. After considering several options, we decided: 1) to mark and release one group of age-0 Chickamin fingerlings in August; 2) to divide all the remaining fish scheduled for age-1 release into eight nearly equal-sized groups; 3) to overwinter two of the eight groups in net pens (one group from each of the two stocks).

On 19 August, we marked 5,055 Chickamin fingerlings from VR-1 by excising the adipose fin and tagging them with coded-wire tags (ad + cwt). Half of the tags were coded 16/4; the other half, 16/5. The marked fish were placed in a 12 ft x 12 ft x 12 ft with 1/4-inch mesh (3.7 m x 3.7 m x

3.7 m with 6.4 mm mesh) holding net in the LPW estuary for 48 h. One fish died. The fish weighed an average of 36.0 g, were silvery and smolt-like in appearance, showed no distress symptoms in adapting to seawater, and fed well in the holding net during the evening of 19 August (day of handling, anesthetizing, and tagging). On 21 August, 5,054 fish were released into Little Port Walter at 2300 h. We did not test for prerelease tag-shedding in these fish.

FINGERLING TO AGE 1 SMOLT STAGE (19 AUGUST 1977 - 7 JUNE 1978)

Rearing Units

We established three new groups (one group from Chickamin stock and two groups from Unuk stock) at the beginning of this period: two of the groups were transferred to net pens suspended in the LPW estuary; the other group was put into a vertical raceway with freshwater. On 20 August, approximately 4,800 Chickamin fish were transferred from intermediate salinity raceway, VR-2, into the net pens. These fish became the Chickamin net-pen group (designated NP-1). One group from Unuk stock, the Unuk net-pen group (designated NP-2), was established 21 August and was estimated to be 4,800 fish: 3,200 fish were from intermediate salinity raceway VR-3 and 1,600 fish were from freshwater raceway VR-4. The other group of Unuk stock, an estimated 4,828 fish, was placed in a freshwater raceway, VR-5, on 21 August and was made up of 1,609 fish from VR-4 and 3,219 fish from VR-6. After all the fish were transferred, estimated numbers of fish in the three Chickamin groups (VR-1, VR-2, and NP-1) and in the five Unuk groups (VR-3, VR-4, VR-5, VR-6, and NP-2) ranged from 4,633 to 4,828 fish (Table 7).

The net pens, suspended in the LPW estuary, were 12 ft x 25 ft x 12 ft with 1/4-inch mesh (3.7 m x 7.6 m x 3.7 m with 6.4 mm mesh). Rearing depth of net pens, however, was only about 9 ft (3 m) because the aluminum frame supporting the net was raised about 3 ft (1 m) above the water to keep predators out. Rearing volume of the net pens was about 2,700 ft^3 (76.5 m^3).

All raceways had a water flow of 100 gpm (378 liter/min) throughout late summer, fall, and winter. Water in VR-1, VR-4, VR-5, and VR-6 was fresh; seawater in VR-2 and VR-3 had a salinity of 8-10$^{o}/_{oo}$. Flow-loading rates

Table 7.--Comparisons of weights, lengths, numbers of fish, gain ratios, growth rates, and survival rates in eight populations of 1976-brood spring chinook salmon between 19 August 1977 and 6 June 1978.

Rearing unit[a]	Sample date	Mean weight: fish per pound	Mean weight: grams per fish	Mean fork-length (mm)	Population size: Pounds	Population size: Number	Growth: Gain ratio	Growth: Daily rate (%)	Survival (%)
VR-1	19 Aug	12.6	36.0	140.9	368	4,633	--	--	--
	10 May	7.1	64.2	176.4	632	4,491	1.8	--	96.9
VR-2	20 Aug	12.7	35.7	--	376	4,775	--	--	--
	22 Oct	7.6	59.7	--	--	--	--	0.8	--
	13 April	6.3	72.2	179.1	725	4,570	1.9	0.1	95.7
VR-3	20 Aug	13.7	33.1	--	350	4,800	--	--	--
	12 Apr	7.1	63.9	172.8	641	4,554	1.9	--	94.9
VR-4	20 Aug	13.5	33.6	--	353	4,768	--	--	--
	9 May	7.0	64.7	173.1	642	4,491	2.0	--	94.1
VR-5	21 Aug	14.3	31.7	--	338	4,828	--	--	--
	11 Apr	7.0	64.8	173.0	706	4,938	2.0	--	102.3
VR-6	21 Aug	14.8	30.6	--	319	4,726	--	--	--
	14 Apr	6.8	66.5	173.8	632	4,298	2.2	--	90.9
	6 Jun	5.5	82.8	187.7	764	4,201	1.2	0.4	--
NP-1	20 Aug	12.7	35.7	--	378	4,800	--	--	--
	11 May	5.4	84.6	195.0	815	4,400	2.4	--	91.7
NP-2	21 Aug	13.6	33.4	--	354	4,800	--	--	--
	12 May	7.0	64.5	175.8	632	4,426	1.9	--	92.2

[a] VR-1, VR-2, and NP-1 contained Chickamin fish; all others Unuk fish.

(7.2 pounds/gpm, 0.87 kg/liter per min) and volume-loading rates (1.2 pounds/ft^3, 19.4 kg/m^3) in the raceways were maximum in April just prior to the first age 1 smolt releases. After the "early" age 1 smolts were released from VR-2, VR-3, and VR-5, available water and raceway space were redistributed. We increased flows in VR-1 and VR-4 to 140 gpm (530 liter/min). The population in VR-6 was equally divided into two groups and placed in raceways VR-6A and VR-6B, which had a water flow of 100 gpm (378 liter/min). Fish in VR-6 were marked with coded-wire tags on 14 April as they were moved into VR-6A and VR-6B.

In May, the highest volume-loading rates in the net pens (0.30 pound/ft^3 [4.8 kg/m^3] and 0.23 pounds/ft^3 [3.8 kg/m^3]) occurred just prior to tagging and release of the smolts (Table 8). No flow-loading rates were determined for the net pens because of the large number of variables, such as location relative to tidal currents, amplitude of tides, size of mesh opening, and amount of fouling on the nets (Huguenin and Ansuini 1978, pp. 152-157).

The mesh nets of both pens were replaced with clean 3/8-inch (9.5 mm) mesh nets on 13 February, 13 April, and 10 May. The fouled net was enclosed in a clean net, and the fish were slowly herded into the clean net without excessive crowding or handling. The procedure was similar to one described by Kennedy (1975).

Growth and Survival

During the fingerling to age-1 smolt-rearing period, 19 August 1977-7 June 1978, decreased feeding rates and low winter water temperatures reduced growth. Feeding rates, based on percentage of body weight fed per day, ranged from 4.0% during the early part of the period to 1.0-1.5% in the latter part. We sampled only one group, VR-2, to measure growth over the

Table 8.--Flow load and volume load densities in eight populations of 1976-brood chinook salmon during four time periods between 19 August 1977 and 6 June 1978. (Metric units in parentheses.)

Rearing unit[a]	Flow load pounds per gpm (kg/l per min)				Volume load pounds per cubic foot (kg/m³)			
	19-21 Aug	9-14 Apr	9-12 May	6 Jun	19-21 Aug	9-14 Apr	9-12 May	6 Jun
VR-1	3.7 (0.44)	6.3 (0.76)	4.2 (0.51)	--	0.61 (9.8)	1.05 (16.9)	1.05 (16.9)	--
VR-2	3.8 (0.45)	7.2 (0.87)	--	--	0.63 (10.1)	1.21 (19.4)	--	--
VR-3	3.5 (0.42)	6.4 (0.77)	--	--	0.58 (9.4)	1.07 (17.2)	--	--
VR-4	3.5 (0.42)	6.4 (0.77)	4.3 (0.51)	--	0.59 (9.4)	1.07 (17.2)	1.07 (17.2)	--
VR-5	3.4 (0.41)	7.1 (0.85)	--	--	0.56 (9.0)	1.18 (18.9)	--	--
VR-6	3.2 (0.38)	6.3 (0.76)	--	3.8 (0.45)	0.53 (8.5)	1.05 (16.9)	--	0.64 (10.1)
NP-1	--	--	--	--	0.14 (2.2)	--	0.30 (4.8)	--
NP-2	--	--	--	--	0.13 (2.1)	--	0.23 (3.8)	--

[a] VR-1, VR-2, and NP-1 contained Chickamin fish; all others Unuk fish.

early part of the period because a moderately severe "fin rot" developed in the raceways in September. Fish in VR-2 had a daily growth rate of 0.8% and a 70% weight increase in the 63-day interval, 20 August to 22 October (Table 7). After 22 October, most feeding rates were further reduced to 0.5% of the fish weight in all raceways and remained at 0.5% for the remainder of the period. In VR-6, the one exception, the feeding rate was increased to 0.7% during late April and May. During the 173-day overwinter period from 22 October to 13 April, the daily growth rate in VR-2 was 0.1% at feeding rates of 0.5% of body weight per day (Table 7). In VR-6 after the population was split into two raceways and the feeding rate was increased to 0.7% of body weight per day (14 April to 6 June), daily growth rate increased to 0.4%. Gain ratios of the eight groups throughout the period ranged from 1.8 in VR-1 to 2.4 in NP-1 (Table 7). There were no consistent differences in growth between stocks or culture treatments.

Survival rates in the raceways, based on estimated numbers at the start of the period and on counts of fish in each population at the end of the period, ranged from 90.9% to 102.3% (Table 7). Survival in freshwater raceways (90.9-102.3%, mean 96.0%) was similar to survival in 8-10‰ saline raceways (94.9-95.7%, mean 95.3%). Survival rates of the two stocks in raceways were also similar: Chickamin stock in VR-1 and VR-2 had an average survival of 96.3%; Unuk stock in VR-3, VR-4, VR-5, and VR-6 had an average survival of 95.6%. We believe the wide range of survival values of the Unuk stock was primarily due to a low bias in estimating the initial numbers and, possibly, some differential losses to predators.

Unuk stock may actually have survived better than Chickamin stock. A total of 320 dead fish were removed from Chickamin raceways VR-1 and VR-2; less than 80 dead fish were removed from Unuk stock raceways VR-3, VR-4, VR-5, and VR-6 (Table 9). Procedures for observing, removing, and recording dead fish were the same for both stocks. Records of dead fish may more accurately reflect differences in survival among stocks than en masse estimates. Discrepancies in numbers of fish in these two procedures are reviewed in Table 10.

Table 9.--Monthly summary of numbers of dead fish in eight groups of 1976-brood spring chinook salmon (October 1977 through May 1978).

Rearing unit[a]	Number of dead fish								
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Total
VR-1	13	19	2	15	8	18	34	6	115
VR-2	8	32	43	78	25	9	10	--	205
VR-3	6	6	1	0	2	1	3	--	19
VR-4	2	0	4	2	1	2	0	0	11
VR-5	1	2	2	0	1	0	4	--	10
VR-6	10	2	0	0	1	1	4	--	18
NP-1	29	16	45	5	23	46	33	14	211
NP-2	173	41	50	29	26	32	17	9	377

[a] VR-1, VR-2, and NP-1 contained Chickamin fish; all others Unuk fish.

Estimated survivals of the two stocks in the two net pens were similar: 91.7% and 92.2% (Table 7). Overwinter survival of the chinook salmon fingerlings was similar to overwinter survival of coho salmon fingerlings in net pens at Little Port Walter (Heard et al. [see footnotes 4, 5]; Tables 5 and 7) suggesting both chinook salmon and coho salmon are adaptable to this type of culture. The discrepancy between estimated and recorded numbers of dead fish in NP-1 (Table 10) is normal because marine amphipods often destroy carcasses in net pens before the carcasses can be removed and counted. The fact that there was almost no difference in the numbers of counted fish and estimated number of dead fish in NP-2 (Table 10) strengthens our belief that the original number of fish estimated to be in the Unuk stock was too low.

Table 10.--Discrepancies in the recorded and estimated numbers of dead fish in eight groups of 1976-brood spring chinook salmon (late summer 1977 through spring 1978).

Rearing unit[a]	Recorded	Estimated[b]	Discrepancy
VR-1	115	142	-27
VR-2	205	205	0[c]
VR-3	19	241	-222
VR-4	11	277	-266
VR-5	10	110	+120
VR-6[d]	15	428	-413
NP-1	211	400	-189
NP-2	377	374	+3

[a] VR-1, VR-2, and NP-1 contained Chickamin fish; all others Unuk fish.

[b] from population estimates made by en masse weighing procedures at beginning and end of period.

[c] due to method of population estimates.

[d] over the period 20 August 1977 to 14 April 1978.

Some fish were lost to mammalian and avian predators during the overwinter period. A large, dead, male otter, Lutra canadensis, discovered in NP-2 on 30 January was unable to climb out of the net after entering over the top of the predator fence. Its stomach held four or five salmonids and a large amount of shellfish and non-salmonid fish remains. Net covers were put over the net pens, and no further otter predation was recorded.

On 1 June, a small female mink, Mustela vison, was seen leaving VR-6A with a fish in its mouth. The animal was trapped and removed. The mink had entered the fenced raceway through several small holes between the raceways and the support floats. The holes were closed. We found a second mink--a large, drowned male--in VR-6A on 5 June. When these fish were counted and checked for tag retention on 6 June, 91 fish were missing from the population, all from VR-6A.

Problems with bird predators, principally kingfishers, Megaceryle alcyon, were generally minor after troublesome individuals were removed.

Fish Health and Drug Therapy

In September, fins--particularly caudal fins and to a lesser extent dorsal fins--developed "fin rot" in the six raceways. In the most extreme cases, the entire caudal fin eroded away. Fish began dying in October, and most of the dead fish removed from the raceways (Table 9) were infected with this ailment. The ADF&G pathology laboratory reported that the affected areas were heavily infected with myxobacteria, pseudomonad bacteria, and infested with the ciliate protozoan Costia. However, no single pathogen was the primary causative agent. Handling fish is one of the main causes of "tail rot" or "fin rot" disease (Wood 1974, p. 56). General crowding in the raceways when volume-loading and flow-loading rates were high in August and the subsequent transferring and subdivision of the groups when water temperatures were highest (Figure 3), probably caused "fin rot" to develop. "Fin rot" was most severe in the two Chickamin raceways VR-1 and VR-2 (Table 9) and more severe in VR-2, an intermediate saline raceway, than in VR-1, a freshwater raceway. VR-1 and VR-2 also had the highest volume-loading and flow-loading rates prior to handling in August (Table 5).

In October, before lowering the feeding rate, we gave all groups a 10-day treatment of oxytetracycline-medicated food. No effect on the infection was noted. In January we gave raceways a flow-through Formalin treatment (1:12,000) to control Costia (Wood 1974, p. 34). After this treatment, no Costia were found on infected fish, but "fin rot" was not alleviated. During the spring period, prior to handling and marking before release of age-1 smolts we again gave all groups another 10-day oxytetracycline treatment.

In the net pens, "fin rot" did not appear until November. Pathological examination of infected fish in the net pens revealed the marine bacterium Vibrio in kidney smear cultures, in addition to most of the other organisms found in infected fish in the raceways. Excluding October, the numbers of dead fish removed from the net pens varied relatively little from month to month throughout the period (Table 9). In October, most of the dead fish removed from the net pens were killed when flood currents from Sashin Creek broke tie-down lines and partially collapsed the nets.

MARKING AND RELEASE OF AGE-1 SMOLTS

Eight groups of age-1 smolts were marked with distinctive coded-wire tags, held in net pens for 36 h (prerelease holding period), and released into the LPW estuary between 12 April and 7 June 1978. We observed behavioral responses of each group to the 30°/₀₀ seawater and recorded initial tagging and handling losses during the holding period. Table 11 summarizes the parent stocks, identifying codes, dates of release, numbers and size of fish, and culture treatments for each group.

Rationale for analytical comparisons of the releases falls into the following categories:

1) To determine effects of time of release on marine survival, we will compare the three groups with the same parent stock and culture treatment. The Unuk stock in freshwater raceways was released early (fish in VR-4 were released 12 April), at the normal time (fish in VR-5 were released 10 May), and late (fish in VR-6 were released 7 June).

2) To determine the effects of stock origin on marine survival, we will compare three paired groups from the two stocks with the same culture treatment that were released at the same time: a) fish reared in intermediate salinity water and released early (Chickamin stock in VR-2 were released 14 April, and Unuk stock in VR-3 were released 13 April); b) fish cultured in freshwater and released at the normal time (Chickamin stock in VR-1 were released 11 May, and Unuk stock in VR-5 were released 10 May); and c) fish cultured in the net pens released at the normal time (Chickamin stock in NP-1 were released 12 May, and Unuk stock in NP-2 were released 13 May).

Table 11.--Summary of 1976-brood spring chinook salmon releases at Little Port Walter.

Rearing unit	Code group[a]	Release date	Number released[b]	Mean weight (g)	Treatment[c]
VR-1	C-4	21 Aug 1977	2,517	36.0	Late summer, age 0, freshwater
VR-1	C-5	21 Aug 1977	2,517	36.0	Late summer, age 0, freshwater
VR-4	U-10	12 Apr 1978	4,918	64.8	Early, age 1, freshwater
VR-3	U-11	13 Apr 1978	4,536	63.9	Early, age 1, OW 8°/oo saline
VR-2	C-12	14 April 1978	4,552	72.2	Early, age 1, OW 8°/oo saline
VR-1	C-13	11 May 1978	4,472	64.2	Normal, age 1, freshwater
NP-1	C-14	12 May 1978	4,373	84.6	Normal, age 1, OW 30°/oo saline
NP-2	U-15	13 May 1978	4,408	64.5	Normal, age 1, OW 30°/oo saline
VR-5	U-16	10 May 1978	4,462	64.7	Normal, age 1, freshwater
VR-6	U-17	7 Jun 1978	4,184	82.8	Late, age 1, freshwater

[a] C and U prefixes indicate Chickamin and Unuk fish; number is the data 2 identification for the binary-coded wire tags used on each group.

[b] Includes all corrections for post tagging-prerelease deaths and estimates for a prerelease tag-shedding rate of 0.004; see text.

[c] Includes brief information on timing, age, and culture history. OW = overwinter; arbitrary assignments of timing for age 1 categories include: early--April, normal--May, late--June.

3) To determine the effects of different culture treatments on marine survival, we will compare two groups with the same parent stock released at the same time: a) fish raised in raceways with freshwater and water of intermediate salinity (Unuk stock in VR-4 were released 12 April, and Unuk stock in VR-3 were released 13 April); and b) fish raised in raceways with freshwater and in net pens with seawater (Unuk stock in VR-4 were released 10 May, Unuk stock in NP-2 were released 13 May, Chickamin stock in VR-1 were released 11 May, and Chickamin stock in NP-1 were released 12 May).

Tag- and Scale-Shedding Rates

We determined the rate coded-wire tags were shed during the prerelease holding period for only one of the eight groups to minimize effects of repeated handling. The group checked for tag shedding (Unuk stock in VR-6) was tagged 14 April and examined for tags 53 days later. Only 18 of 4,201 fish lost their tags (shedding rate 0.004). This shedding rate was assumed for all 1976-brood chinook salmon released at LPW (Table 11) because all groups were marked and handled similarly.

During tagging, we frequently checked tag placement by killing a few fish and dissecting out tags. We also periodically changed head-mold sizes on the tag injector to fit different-sized fish.

We did not quantify scale shedding beyond a generalized ranking among the three basic culture treatments. During tagging, scales on fish raised in freshwater raceways were least deciduous; scales on fish raised in seawater net pens were the most deciduous; and those on fish raised in 8°/₀₀ saline water were intermediate in deciduousness during handling and tagging.

Responses to Seawater after Tagging

The number of deaths and behavior of the smolts in seawater holding nets provided a crude bioassay of the effects of handling and the osmoregulatory capability of the fish. We relate few dead fish and a rapid resumption of prehandling behavior--especially feeding and schooling responses--to a quick recovery from handling and tagging stress. No more than two fish from any one of the nine groups died during the prerelease holding period (Table 12), and we assume stress was minimal. Three groups released early (April) did not respond to food after tagging on the day of

Table 12.--Numbers of dead fish removed from saltwater net in nine populations of 1976-brood spring chinook salmon during a 36 h to 48 h prerelease holding period at Little Port Walter.

Population unit[a]	Culture treatment	Date into prerelease net	Dead fish removed
VR-1	freshwater	19 Aug	1
VR-1	freshwater	10 May	1
VR-2	8-10°/oo	13 Apr	0
VR-3	8-10°/oo	12 Apr	0
VR-4	freshwater	9 May	1
VR-5	freshwater	11 Apr	2
NP-1	30°/oo	11 May	2
NP-2	30°/oo	12 May	0
VR-6[b]	freshwater	6 Jun	0

[a] VR-1, VR-2, and NP-1 contained Chickamin fish; all others Unuk fish.

[b] Tagged 14 April and returned to a freshwater raceway. Individual fish were checked for tag shedding and transferred to saltwater holding net on 6 June.

tagging; however, these fish did feed the next day, but their behavior was still somewhat depressed. Another group tagged at the same time and retained in freshwater (VR-6) fed normally after tagging on the same day; therefore, stress in the first group was probably related to seawater exposure and not tagging. All groups tagged during the normal release period (May) and late release periods (June) fed in the seawater holding nets after tagging on the day of tagging; their feeding indicated rapid osmotic adjustment. In May, groups raised in net pens fed more vigorously immediately after tagging than groups raised in freshwater raceways suggesting more complete osmotic adjustment due to previous seawater experience.

SURVIVAL FROM FRY TO SMOLT

Although not the most important factor in overall performance, one measure of success of culture programs that produce smolts is survival from fry to smolt. During this study, 41,104 chinook salmon smolts were released at LPW--87.8% of the fry survived to the smolt stage.

RETURNS OF AGE-2_2 (1.0) ADULTS (MINI-JACKS)

During July and August 1978, several maturing male chinook salmon weighing from 150 g to 600 g were caught by sport fishermen in the LPW estuary near the mouth of Sashin Creek. These fish originated from age-1 smolts released earlier during the year. By late August, mature males of a similar size with free-flowing milt were migrating past Sashin Creek weir at the head of tidewater. Many were collected in a trap at the weir; however, due to their small size, some escaped through the trap into the stream where they were subsequently collected with pole spears. These chinook salmon "mini-jacks," which matured during the same year of entry into the marine environment without remaining overwinter and producing an ocean annulus, had the same biological pattern as coho salmon jacks. Spring chinook salmon jacks usually have at least one ocean annulus and return at age 3_2 (1.1) or 4_2 (1.2).

One hundred "mini-jacks" returned from seven of the eight groups of age-1 smolts released (Table 13); no "mini-jacks" were recovered from the age-0 smolts released in August 1977. The Unuk stock produced more "mini-jacks" than the Chickamin stock. More Unuk "mini-jacks" were recovered from groups released at the normal time or late than from groups released early (Table 13). The large size of the smolts released--from 64 g to 82 g in mean weight--15 to 20 times larger than wild age-1 smolts in southeastern Alaska--likely influenced the return of "mini-jacks" at LPW from the 1976-brood releases. Findings at the Cowlitz Hatchery in Washington have correlated high return rates of spring chinook salmon "mini-jacks" to large size of smolts--in this case from 90 g to 120 g at release (C. Hopley, pers. commun. 1979).

Table 13.--Summary of age-2_2 (1.0) adult[a], "mini-jacks," recoveries of 1976-brood spring chinook salmon released as age-1 smolts in 1978 at Little Port Walter.

	Release				Recoveries			
							Total	
Code group[b]	Date	Weight (g)	Number	Treatment[c]	Little Port Walter estuary	Sashin Creek	Number	Survival (%)
U-10	12 Apr	64.8	4,918	Early, freshwater	0	2	2	0.04
U-11	13 Apr	63.9	4,536	Early, overwinter, 8°/oo	6	1	7	0.15
C-12	14 Apr	72.2	4,552	Early, overwinter, 8°/oo	0	1	1	0.02
C-13	11 May	64.2	4,472	Normal, freshwater	0	3	3	0.07
C-14	12 May	84.6	4,373	Normal, overwinter, 30°/oo	0	0	0	--
U-15	13 May	64.5	4,408	Normal, overwinter, 30°/oo	10	8	18	0.41
U-16	10 May	64.7	4,462	Normal, freshwater	15	7	23[d]	0.52
U-17	7 Jun	82.8	4,184	Late, freshwater	38	8	46	1.10

[a] Only sexually mature fish or those in advanced stage of maturity. Two other fish recovered away from Little Port Walter area are discussed in text. "Mini-jacks" have a total age of 2 yr, having been released during their second year and maturing after 2-4 months at sea. They have one freshwater annulus and no ocean annulus and are recorded as 1.0 under the European system of age designation.

[b] C and U prefixes indicate Chickamin and Unuk fish; number is the data 2 identification for the binary-coded wire tags used on each group.

[c] Includes brief information on time of release, and culture history: Early = April; normal = May; late = June.

[d] One U-16 fish was recovered at Osprey Creek weir about 2 km from Little Port Walter.

In addition to the 100 "mini-jacks" recovered at LPW in 1978, one immature male (U-15) (see Table 11) was caught by a commercial troller at Port Herbert 10 km north of LPW, and one fish of unknown sex or maturity (C-13) was recovered from a commercial fish packing scow 100-150 km north of LPW in Chatham Strait.

CONCLUSIONS

A cooperative research program was initiated in 1976 between the National Marine Fisheries Service and the Alaska Department of Fish and Game to study the culture of transplanted stocks of spring chinook salmon at LPW. The research is intended to eventually define the best available technology for the culture of these fish in southeastern Alaska and, if possible, to develop brood stocks for use in enhancement programs.

Two 1976-brood Behm Canal stocks transplanted to LPW on Baranof Island resulted in overall survivals of 70.9% from green-egg to fry stage and 87.8% from fry to released-smolt stage. Nine separate groups with a total of 41,104 smolts were released; the groups included four groups of Chickamin stock and five groups of Unuk stock. All groups were differentially marked with coded-wire tags.

The transplanted fish were cultured through five temporal phases determined partly by biological factors and partly by available facilities. Because seasonal water-temperature regimes at LPW are warmer than those in the natal streams, egg development was accelerated, which required ponding and initially feeding the fry during the winter. Subsequent growth was greater than anticipated, and after considering waterflow, fish density, and rearing-facility constraints, we released one group of age-0 smolts in August 1977. Initial plans had called for releasing all smolts (as age-1 fish) at the same time wild spring chinook salmon smolts in southeastern Alaska migrated into seawater (April-June), and eight groups were released at LPW at this time in 1978.

Fry, fingerlings, and smolts were raised in a variety of culture treatments that included freshwater tanks, freshwater and intermediate-salinity floating raceways, and seawater net pens. Growth and survival of each group of fry were measured during each temporal phase of their culture.

Mature "mini-jacks" from age-1 smolts returned to LPW in 1978, 2-4 months after they were released in the estuary. The large size (64-85 g) of smolts at release probably influenced the occurrence of these precocious fish. Some mini-jacks returned from seven of the eight groups of age-1 smolts released.

Future returns of older-age adults to LPW from the 1976-brood releases and recoveries of these fish in various fisheries will be documented and subsequently reported.

ACKNOWLEDGMENTS

We thank Jim Hendricks, Dick Crone, P. Jo Short, Roger Vallion, Randy Riddell, Peggy Wertheimer, and Al Didier for assistance during diverse field work associated with this study.

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