SNAKE RIVER FALL CHINOOK SALMON BROOD-STOCK PROGRAM, 1985

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ABSTRACT

Efforts to establish a Snake River fall chinook salmon brood-stock program were terminated on 31 December 1985. The objective of the research program was the enhancement of upriver stocks through development of an egg bank. Eggs from fish held to maturity in seawater net-pens at the National Marine Fisheries Service's (NMFS) Manchester Marine Experimental Station, Manchester, Washington, were to be used to restore valuable salmon runs on the Snake River.

Since April 1982, when the first of four successive brood years was transferred to seawater net-pens, seawater survival to 4-year maturity has been severely compromised. The primary causes of mortality in Snake River fall chinook salmon were the sequential occurrences of bacterial kidney disease (BKD) after the first winter in seawater, losses of precocious males during the second year, and a new systemic pathogen (Rosette disease) responsible for significant losses during the final year before maturity. The NMFS and Battelle Marine Laboratories in Sequim, Washington, are investigating the pathogenesis and possible control of the Rosette disease.

Seawater entry trials with 0+ age and 1+ age fish showed that 0+ age Snake River fall chinook salmon do not easily adapt to seawater, and will either die or require up to 6 months to fully adapt. However, 1+ age smolts experience few problems at seawater entry; therefore, it is suggested that Snake River fall chinook salmon be released from hatcheries as 1+ smolting fish.

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INTRODUCTION

Snake River fall chinook salmon historically made significant contributions to ocean and lower Columbia River fisheries and are uniquely adapted to upper Snake River environmental conditions. In recent years, these stocks have become severely depressed, requiring extensive restoration by state and federal agencies. The objective of the Snake River fall chinook salmon brood-stock research program was to enhance upriver stocks by alternatives to traditional rear/release strategies. The National Marine Fisheries Service (NMFS) program utilizes captive brood-stock rearing concepts with fish reared to maturity in seawater net-pens. The NMFS brood-stock research program was intended to provide a stable egg bank of the Snake River stock. Eyed eggs or fry from Snake River fall chinook salmon stocks were provided to NMFS; fish were reared through their freshwater cycle and transferred to seawater net-pens. Throughout the production program, research was conducted in several critical areas: disease diagnosis and control, nutrition, acclimation to seawater, and spawning strategies.

A parallel program goal was to better understand the seawater phase of the life-cycle of chinook salmon. Captive rearing in seawater is a unique opportunity to document factors affecting growth and survival. Management models consider the seawater phase to be a "black box," with perhaps the greatest mortality occurring as predation on young fish. Once the fish reach 3-4 lb, it is assumed that survival to the adult will be good. NMFS research suggests that this may not be true. Our research has discovered unreported adult diseases which kill 90%+ of our brood stock between 3 years of age and maturity. Attempts to rear these fish to maturity were unsuccessful due to exorbitant losses from bacterial kidney disease (BKD) and marine diseases of

adult fish. NMFS researchers, in conjunction with the Battelle Marine Laboratories at Sequim, Washington, are describing these diseases and investigating methods of control.

Experiments since August 1983 were directed at understanding the source, occurrence, and pathogenesis of an infectious marine disease that killed most of the 1980- and 1981-brood Snake River chinook salmon during the year before maturation. This previously undocumented disease was also responsible for substantial losses in the 1982-brood fish during fall 1985.

BKD is recognized by Pacific Northwest fisheries biologists as a significant negative determinant of survival in chinook salmon stocks after release to the ocean. Mortality from BKD occurred in all Snake River fall chinook salmon transferred to marine net-pens at Manchester. NMFS continues research on pathogenesis of BKD and investigations of several chemotherapeutic measures of control.

MATERIALS AND METHODS

Freshwater Husbandry

Approximately 15,000 eggs or swim-up fry of Snake River fall chinook salmon were received from egg banks on the Snake and Columbia Rivers during early winter 1981, 1982, 1983, and 1984. Freshwater rearing was conducted at the Northwest and Alaska Fisheries Center (NWAFC), Seattle, Washington, or the NMFS experimental hatchery at the University of Washington's Big Beef Creek Fish Research Station, Seabeck, Washington. All water for incubation and rearing was either dechlorinated City of Seattle water or groundwater at Big Beef Creek. Fish that were of sufficient size and smoltification were transferred to the NMFS Marine Experimental Station at Manchester, Washington.

Marine Husbandry

Fish transferred to Manchester were acclimated to full-strength seawater (28 ppt) using intermediate salinities over several days. Brood stocks were held in 24- x 24- x 10-ft deep net-pens at densities of less than 0.5 lb/ft^3. Seawater temperatures ranged from 7° to 13° C during the year, and mean salinity was 28 ppt. Fish were fed pelleted rations, from several commercial manufacturers, supplemented with fresh-frozen herring, Clupea harengus, and whole krill, Euphausia pacifica. All fish were injected intraperitoneally with a vibrio bacterin/oxytetracycline mixture at 6- to 8-month intervals during their seawater residence. The salmon were also fed antibacterial drugs during epizootics of bacterial disease. Dead and moribund fish were removed from the population daily, weighed and measured, and necropsies performed.

Bacterial Kidney Disease Investigations

Snake River chinook salmon from the 1983 spawning were incubated and cultured at the Big Beef Creek Research Station. These fish were taken to seawater at different times and different locations to better understand the marine development of BKD. Approximately 6,000 fish were transferred to seawater net-pens at Manchester in early June 1984 as 0+ age fish at an average weight of 9.5 g. Approximately 1,300 more of the 1983 brood were transferred to marine net-pens in March 1985 as 1+ age smolts (Fig. 1). Another 150 of these fish were transferred as 2+ age smolts to a pumped-seawater facility (U.S. Fish and Wildlife Service, Marrowstone Island Research Station) on 26 February 1986.

The incidence of BKD-related mortality in these three separate lots of chinook salmon will be compared to a sample of 1983-brood fish retained on groundwater at the Big Beef Creek Research Station.

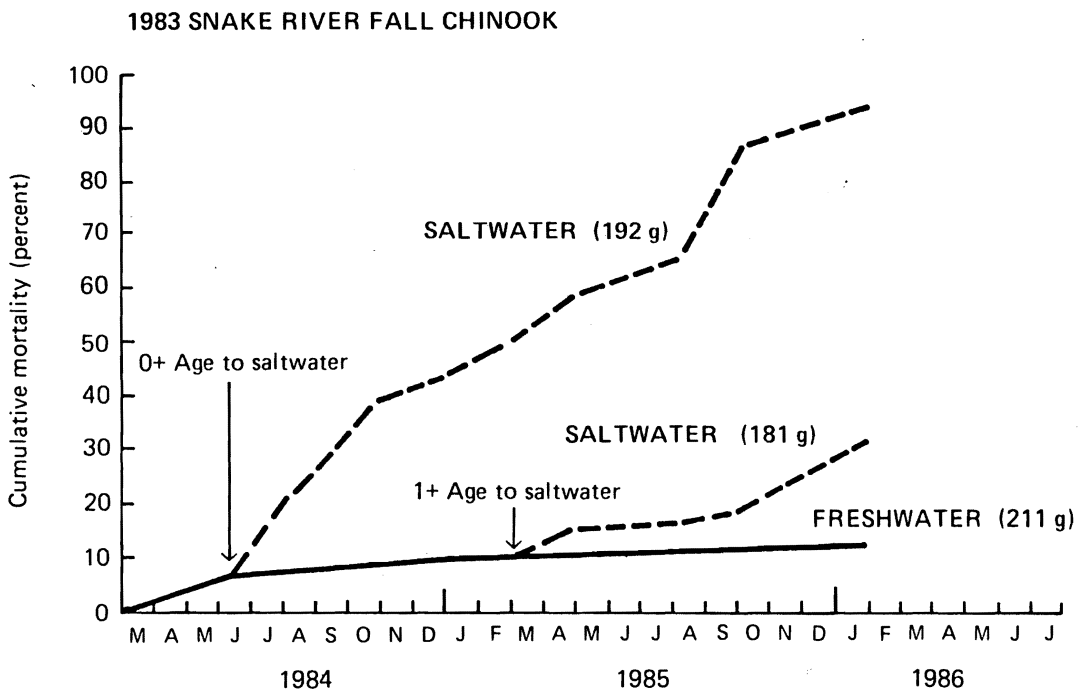

Figure 1.--Mortality of 1983-brood Snake River fall chinook salmon transferred to seawater net-pens at 0+ and 1+ years of age; losses were primarily from BKD.

RESULTS AND DISCUSSION

The NMFS has reared four brood years of Snake River fall chinook salmon (1980, 1981, 1982, and 1983). Freshwater growth and survival were variable in the 1980, 1981, and 1982 broods. Since late 1982, the Big Beef Creek facility was operational, and both growth and survival have been excellent (Figs. 2 and 3). At Big Beef Creek, the fish were held in large (13-ft diameter) fiberglass tanks supplied with constant-temperature (10° C), pathogen-free groundwater, and fed by automatic feeders, allowing high growth to be maintained throughout the year.

Portions of all brood years were introduced into seawater as 0+ age and 1+ age fish. The 0+ age entries were not entirely successful; fish experienced osmoregulatory-related mortalities, and survivors required up to 6 months to fully adapt to seawater. However, 1+ age fish had few problems at seawater entry; in the future, all fish will be 1+ age before transfer to seawater. After fish fully adapted to seawater, growth was excellent.

1980 Brood

Seven females survived to maturity and spawned (fall 1984); however, only two of these produced viable eggs. Both of these fish were infected with the Rosette disease which resulted in 68% egg-mortality. Juveniles from these eggs have been examined for the Rosette disease; unless a non-recognizable (developmental) form is present, the disease is apparently not vertically transmitted. Approximately 500 of these fish have been transferred to

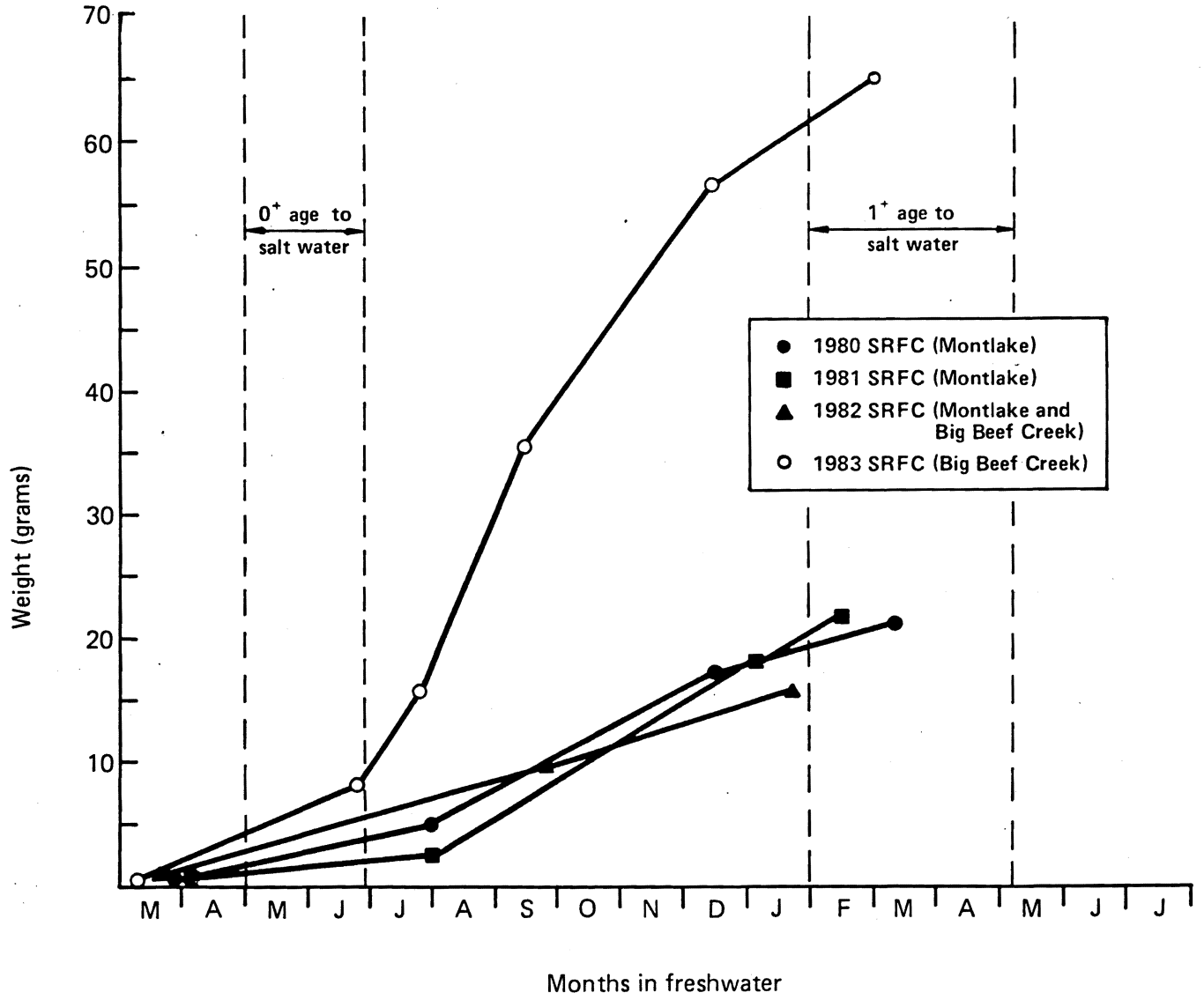

Figure 2.--Growth of four successive Snake River fall chinook salmon brood years in freshwater facilities at Montlake (dechlorinated City of Seattle water) and Big Beef Creek (groundwater).

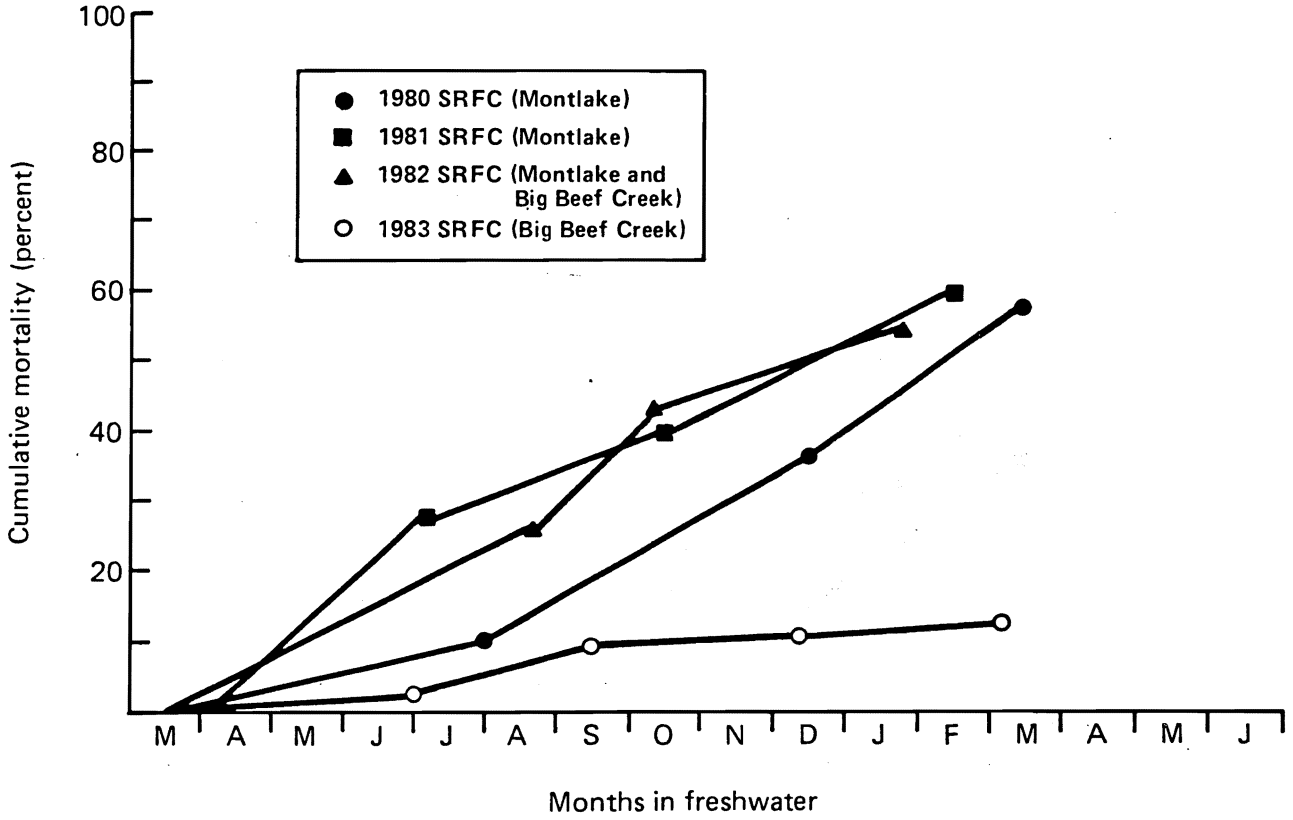

Figure 3.--Mortality of four successive Snake River fall chinook salmon brood years in freshwater facilities at Montlake (dechlorinated City of Seattle water) and Big Beef Creek (groundwater).

seawater net-pens, and 500 remain in fresh water at Battelle Marine Laboratories. These fish will remain under surveillance for signs of Rosette disease.

1981 Brood

Survival and growth in the 1981 brood fish were nearly identical to survival and growth in the 1980 brood fish. Attempts to control the Rosette disease with injections of oxytetracycline were unsuccessful. Four females from this brood stock matured during fall 1985 and were spawned at Manchester. These females were infected with the Rosette agent, and none of the eggs survived.

1982 Brood

By January 1986, the survival and growth of 1982 Snake River fall chinook salmon were similar to survival and growth of 1980- and 1981-brood years in 1984 and 1985, respectively. The Rosette agent was first isolated from these fish in August 1986 after approximately 16 months seawater residence. During 1985, the 1982-brood fish were given either injections of antibiotics or oral erythromycin treatments in attempts to control BKD and/or Rosette disease. These treatments were ineffective against either disease.

In February 1986, NMFS held in seawater net-pens 740 fish from the 1982 brood.

1983 Brood

Approximately 6,000 of the 1983 brood were transferred to seawater in early June 1984. These fish showed poor survival due to osmoregulatory difficulties and BKD; only approximately 5% of the original number remain. A small number of this brood year were brought to marine net-pens in September 1984 at approximately 35 g. None of these fish survived seawater transfer.

Approximately 1,300 of these fish were also transferred to marine net-pens in March 1985, as 1+ smolts at approximately 62 g; survival after 1 year was 70%. Losses to date have been primarily due to BKD. However, the Rosette agent was isolated from this group in March 1986, 4 months before the usual time of seawater residence that the Rosette agent is observed. Attempts to control BKD by visible-light irradiation of a subsample of these fish during late freshwater rearing was not successful. Groups that were irradiated with cool-white and pink lights succumbed to BKD at the same rate as the non-treated controls. Fish that were retained at Big Beef Creek were analyzed for BKD using fluorescent antibody techniques, and no evidence of the disease was observed. Also, 150 of the non-irradiated fish that were transferred to seawater facilities at Marrowstone Island in February of this year are not yet experiencing BKD-mortality.

In February 1986, NMFS held in seawater net-pens 1,646 fish from the 1983 brood.

SUMMARY AND CONCLUSIONS

1. Results of NMFS seawater acclimation trials suggest that Snake River fall chinook salmon should be released from hatcheries as 1+ smolting fish.

2. Maintaining chinook salmon to maturity in marine net-pens affords a unique opportunity to observe growth and survival during an otherwise inaccessible life cycle phase.

3. Our investigations showed that many factors affect marine survival of chinook salmon. Marine mortalities first occur during the osmoregulatory adaptation to seawater. During the first winter in seawater, Snake River fall chinook salmon mortality increases markedly due to BKD. Losses to this

disease may continue for up to 6 months, and mortality can exceed 25%. During fall the following year, chinook salmon are infected with previously undocumented diseases. We have identified a pathogen responsible for catastrophic losses (95+%) of 3-4 year-old fish in seawater. Other serious adult diseases (e.g., an infectious anemia) were observed in captive spring chinook salmon at the Manchester Marine Experimental Station. A better understanding of these diseases may provide insight on problems of high-seas survival.

4. During March 1986, the majority of the 1982 and 1983 brood at Manchester will be disposed of in a manner acceptable to the Washington Department of Fisheries and the Bonneville Power Administration (BPA). Approximately 400 fish from each of these two brood years will be retained in marine net-pens to continue investigations on BKD and adult diseases expected during the next 2 years.

5. Work continues on the final report to BPA due September 1986.

ACKNOWLEDGMENTS

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