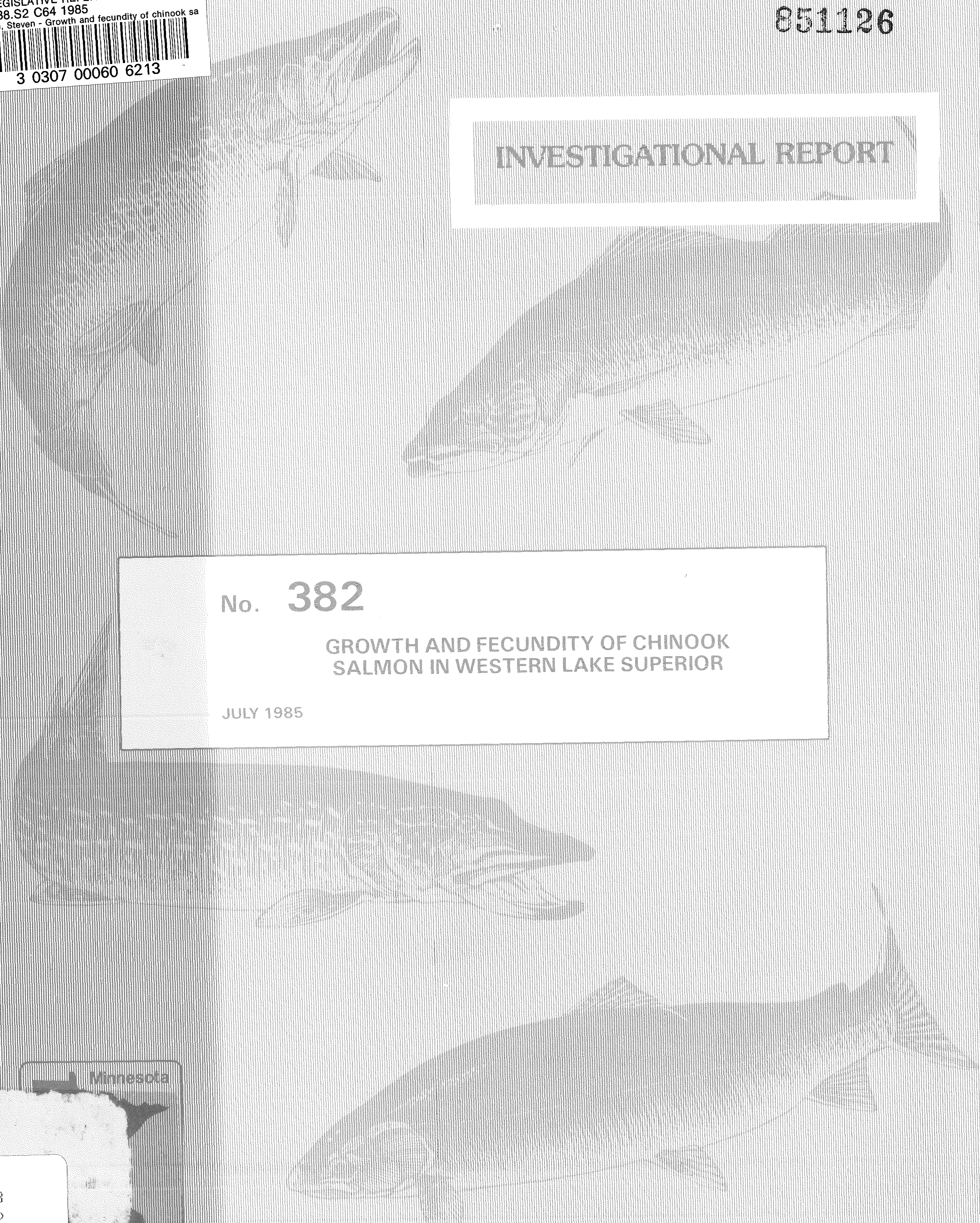

INVESTIGATIONAL REPORT

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GROWTH AND FECUNDITY OF CHINOOK SALMON IN WESTERN LAKE SUPERIOR

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GROWTH AND FECUNDITY OF CHINOOK SALMON IN WESTERN LAKE SUPERIOR[1]

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ABSTRACT

Life history data of fall and spring strain chinook (Oncorhynchus tshawytscha) stocked into Minnesota waters of Lake Superior since 1974 were evaluated to describe growth and fecundity. Growth rates of both strains were lower than West Coast and Lake Michigan chinook but comparable to that of chinook in eastern Lake Superior. Fall chinook salmon condition was similar to that observed in Lake Michigan. Sexual dimorphism in growth and condition was not observed. Spring chinook fecundity averaged 4,010 eggs/female while fall chinook averaged 3,703 eggs/female and 803 eggs/kg of gravid female.

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INTRODUCTION

Chinook salmon (Oncorhynchus tshawytscha) is an important component of the Lake Superior fish community. The states of Michigan, Minnesota and Wisconsin have stocked over 7.3 million chinook salmon since 1967, including approximately 900,000 in 1983 (Great Lakes Fishery Commission Memorandum, 29 January 1985). The Minnesota Department of Natural Resources began stocking chinook salmon in 1974 to diversify angling opportunities in western Lake Superior. Spring strain chinook were stocked from 1974-1978 and fall strain chinook since 1979 (Close et al. 1984).

Management of chinook in Minnesota waters of Lake Superior requires knowledge of life history and sport fishery parameters. Growth, longevity, survival and fecundity of chinook in eastern Lake Superior have been reported by Rybicki (1973), Berg (1978) and Patriarche (1981). Similar information is limited for the more recently introduced western Lake Superior stocks. Close et al. (1984) described longevity, survival, food habits and catchability of chinook in Minnesota waters of Lake Superior. This report supplements Close et al. (1984) and describes growth, condition and fecundity of chinook in western Lake Superior.

MATERIALS AND METHODS

Chinook salmon were collected from three sources to obtain growth and condition data. Most chinook were captured in the French River weir or seined from the river immediately downstream of the weir. Chinook taken incidentally in lake trout (Salvelinus namaycush) test nets and those observed during the Lake Superior creel census were also sampled. Data collected from each fish included total length (mm), weight (g) and sex. Scale samples were retained for age determination.

Five chinook cohorts were evaluated during the study. Spring strain chinook were planted in 1974 and 1976-1978. The 1974 year-class was obtained from Rapid River Hatchery, Idaho and the other spring chinook cohorts from Cowlitz Hatchery, Washington. Eggs for the 1979 fall chinook cohort were obtained from the Little Manistee River weir, Michigan. The original source of fall chinook stocked into the upper Great Lakes was the Toutle River, Washington.

Growth patterns were determined for each strain and sex. Back-calculated lengths at age (from scale annuli) were used to calculate Ford growth equations from weighted Walford regressions (Lagler 1956). A von Bertalanffy equation was calculated for fall strain chinook (Ricker 1975). Length-weight regressions were calculated to determine condition. Slopes and elevations of Walford and length-weight regressions were compared statistically at an alpha level of 0.05 by analysis of covariance (Snedecor and Cochran 1967).

Chinook salmon fecundity and hatching data were obtained from 1979-1982 French River Hatchery records. Records included length and weight of each female stripped, number of females stripped each day, total daily egg take and egg eye-up and hatching success. Average number of eggs per female and eggs/kg were calculated.

RESULTS

Growth rates of male and female spring chinook were similar. Ford growth equations were:

Females: $L_{t+1} = 136 + 1.19\ L_t$ $\quad R = +0.90$

Males: $L_{t+1} = 147 + 1.13\ L_t$ $\quad R = +0.90$

Slopes and intercepts of the regressions were not significantly different. Ford growth coefficients (k) were 1.19 for female and 1.13 for male spring chinook. Maximum theoretical lengths ($L\infty$) were not calculated because k was greater than 1.0 in both cases.

Growth patterns of the 1979 fall strain cohort did not differ significantly between the sexes. Ford equations determined from Walford regressions were as follows:

Females: $L_{t+1} = 276 + 0.76\ L_t$ $R = +0.88$

Males: $L_{t+1} = 282 + 0.74\ L_t$ $R = +0.84$

Growth coefficients were 0.76 for female and 0.74 for male fall chinook. Maximum theoretical length was estimated at 1,140 mm for females and 1,095 mm for males. An additional Ford equation was developed for fall chinook (sexes combined) using $L(\infty)$ and k values derived from a von Bertalanffy growth curve:

von Bertalanffy: $L_t = 3{,}750\ (1-e^{-0.057\ (t+0.21)})$

Ford: $L_{t+1} = 225 + 0.94\ L_t$ $R = +0.93$

The length-weight relationship of female spring chinook was not calculated due to insufficient data. The length-weight relationship of male spring chinook was:

$\mathrm{Ln}\ W = -12.67 + 3.18\ \mathrm{Ln}\ L$ $R = +0.96$.

Length-weight regressions of male and female fall chinook were similar:

Females: $\mathrm{Ln}\ W = -11.78 + 3.04\ \mathrm{Ln}\ L$ $R = +0.98$

Males: $\mathrm{Ln}\ W = -12.70 + 3.18\ \mathrm{Ln}\ L$ $R = +0.97$

Neither slopes nor elevations of the regressions were significantly different.

Fecundity was determined for spring and fall chinook (Table 1). Spring chinook females averaged 4,010 eggs/female (n = 8) and fall chinook averaged 3,703 eggs/female and 804 eggs/kg of gravid female (n = 39). Hatching success of eggs reared at French River during 1980-82 ranged from 60 to 81% and averaged 72%. Survival from fertilization to eye-up in 1982 was 78% (French River Hatchery File Data).

Table 1. Fecundity of chinook salmon captured at French River, 1980-1982. Confidence intervals (95%) for mean total length ($\overline{TL}$) and weight ($\overline{W}$) at capture are included.

Strain	No.	$\overline{TL}$(mm)	$\overline{W}$(g)	Eggs per female	Eggs/kg
Spring	8	791 ± 14	[a]	4,010	[a]
Fall	39	762 ± 19	4,606 ± 363	3,703	804

[a] Unavailable

DISCUSSION

Chinook salmon growth in western Lake Superior is slower than reported elsewhere. Spring chinook from the Willamette River system (Oregon) attained lengths of 635 mm at age 3 and 777 mm at age 4 (Mattson 1963) which were greater than the back-calculated lengths of 590 mm and 690 mm, respectively, for spring chinook in Minnesota waters of Lake Superior. Fall chinook grew more slowly in Lake Superior than in the Columbia River system (Young and Robinson 1974) or Lakes Huron and Michigan (Patriarche 1981). Growth after age 1, however, was similar to that of fall chinook in eastern Lake Superior (Berg 1978). Growth rates of Minnesota's fall chinook are considered preliminary since inclusion of growth data to age 4 is necessary for reliability of the Walford and von Bertalanffy curves.

Condition of Minnesota chinook was lower than west coast fish. Willamette River spring chinook were substantially heavier than Minnesota-caught fish (Mattson 1963). Length-weight relationships of fall chinook captured in Lake Michigan, however, were similar to those of other Lake Superior salmon (Patriarche 1981).

Neither chinook strain exhibited sexual dimorphism in growth rate and fall chinook did not exhibit sex-specific length-weight relationships. These findings agree with Berg (1978) who found no sex-specific differences in growth or age at maturity for Lake Superior chinook. Young and Robinson (1974) found no consistent sexual dimorphism in average weight at age of Columbia River chinook spawners.

Fecundity of fall chinook was slightly higher than the 610-620 eggs/kg average for Lake Michigan females (Rybicki 1973; Hay 1984) but substantially lower than that of west coast fish (Healey and Heard 1984). The number of eggs per female may underestimate total egg production because eggs not expelled by air injection were excluded from fecundity calculations. Egg retention after stripping was estimated to be less than 20% (D. Bathel, MN Dept. Nat. Res., personal communication 1985) while egg retention in nature can be substantial. Stauffer (1976) reported egg retention ranging from 12%-39% for coho salmon (Oncorynchus kisutch) in Michigan tributaries of Lakes Michigan and Superior. More extensive fecundity data for fall chinook are needed, including eggs/female, eggs/kg and average egg diameter.

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