



Observations on the life histories of the Columbia River chub and Columbia squawfish in western Montana  
by Cliff W Hill

A THESIS Submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of Master of Science in Fish and Wildlife Management  
Montana State University  
© Copyright by Cliff W Hill (1958)

**Abstract:**

The life histories of the Columbia River chub and the Columbia squawfish were studied during the summers of 1936 and 1937 in the drainage of the Big Blackfoot River, Montana. Both species occurred in certain lakes of the drainage, in the lower portion of the Big Blackfoot River and in one principal tributary. The Columbia squawfish also occurred in the upper portion of the Big Blackfoot River. Both species inhabited shallow, vegetated areas in lakes. Columbia squawfish were found in areas of relatively calm water in streams. The growth of Columbia River chub was studied by examining the scales from 300 fish. Specimens of this species up to nine years of age were collected. Growth of Columbia squawfish was based on examination of scales from 339 fish. Some individuals of this species attained an age of at least 15 years. Columbia River chub matured sexually at three to five years of age while Columbia squawfish matured at six to eight. Both species spawned in late May and early June while average water temperatures were 55-65° F. The stomach contents of 42 Columbia River chub and 83 Columbia squawfish were examined. Insects were the predominant item in the stomachs of both species. Fish were found in some Columbia squawfish stomachs.

OBSERVATIONS ON THE LIFE HISTORIES  
OF THE COLUMBIA RIVER CHUB AND COLUMBIA  
SQUAWFISH IN WESTERN MONTANA

by

CLIFF W. HILL, JR.

A THESIS

Submitted to the Graduate Faculty

in

partial fulfillment of the requirements

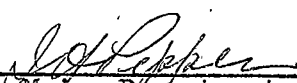
for the degree of

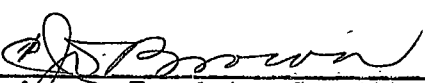
Master of Science in Fish and Wildlife Management

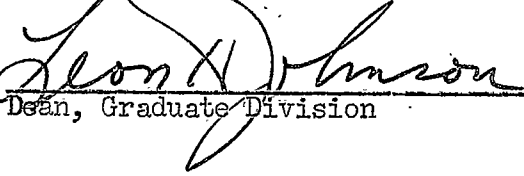
at

Montana State College

Approved:

  
Head, Major Department

  
Chairman, Examining Committee

  
Dean, Graduate Division

Bozeman, Montana  
May, 1958

6644

N 378  
H 5520  
cop. 2

109852

Table of Contents

	Page
Abstract . . . . .	3
Introduction . . . . .	4
Distribution and Habitat . . . . .	6
Growth . . . . .	10
Reproduction . . . . .	16
Food Habits . . . . .	24
Summary . . . . .	28
Literature Cited . . . . .	29

Abstract

The life histories of the Columbia River chub and the Columbia squawfish were studied during the summers of 1956 and 1957 in the drainage of the Big Blackfoot River, Montana. Both species occurred in certain lakes of the drainage, in the lower portion of the Big Blackfoot River and in one principal tributary. The Columbia squawfish also occurred in the upper portion of the Big Blackfoot River. Both species inhabited shallow, vegetated areas in lakes. Columbia squawfish were found in areas of relatively calm water in streams. The growth of Columbia River chub was studied by examining the scales from 300 fish. Specimens of this species up to nine years of age were collected. Growth of Columbia squawfish was based on examination of scales from 339 fish. Some individuals of this species attained an age of at least 15 years. Columbia River chub matured sexually at three to five years of age while Columbia squawfish matured at six to eight. Both species spawned in late May and early June while average water temperatures were 55-65° F. The stomach contents of 42 Columbia River chub and 83 Columbia squawfish were examined. Insects were the predominant item in the stomachs of both species. Fish were found in some Columbia squawfish stomachs.

### Introduction

The Columbia River chub (Mylocheilus caurinus) and the Columbia squawfish (Ptychocheilus oregonense) are abundant native fishes in the Columbia River drainage of western United States. Both grow to the size of many game fish but are little utilized as food and are generally classified as rough fish. They may compete with trout and salmon for food and space. In one area the Columbia squawfish was found to be an important predator on young sockeye salmon (Ricker, 1941; Foerster and Ricker, 1941). Both take bait readily and are considered a nuisance by anglers.

Until recently, little work was done on these fishes. In view of their abundance and widespread distribution in western Montana, a study of their habits and life histories was undertaken as a part of the fisheries management program for the area. The drainage of the Big Blackfoot River was selected for the present investigation, which was carried out during the summers of 1956 and 1957.

The Big Blackfoot River and its tributaries drain portions of Lewis and Clark, Powell and Missoula counties in Montana. This drainage includes about 2,100 square miles and is bounded on the east and northeast by the Lewis Range, on the north and west by the Swan and Mission ranges and on the south by the Garnet Range. The highest point in the drainage is about 9,000 feet. The elevation of the Big Blackfoot River at its confluence with the Clark Fork, Columbia River is 3,300 feet. Most of the area is characterized by sharp relief and is vegetated by coniferous

forests. The average gradient of the Big Blackfoot River and its principal tributaries is approximately 11 feet per mile.

The Clearwater River is the largest tributary of the Big Blackfoot River. It occupies a narrow wooded valley 32 miles long lying north of the principal drainage. This river flows through eight lakes which make up a large part of the habitat suitable for the Columbia River chub and the Columbia squawfish. These lakes range from 25 to 1,200 acres in surface area. They are generally characterized by having abrupt shorelines and extensive depths (90 to 100 feet). The sharply inclined shoal areas have bottoms of gravel and rubble and those with gradual slopes have bottoms of sand or silt, sometimes covered with considerable debris and limited areas of vascular vegetation.

The water of the drainage is moderately soft (total alkalinity: 12 to 20 p.p.m.). The deeper lakes stratify thermally and chemically in summer but oxygen depletion is not severe.

The two minnows under consideration are among the most abundant fishes of the drainage. Other native fish present are: Redside shiner (Gila balteata), Longnose dace (Rhinichthys cataractae), Longnose sucker (Catostomus catostomus), Columbia large-scaled sucker (C. macrocheilus), Cutthroat trout (Salmo clarki), Dolly Varden (Salvelinus malma), Mountain whitefish (Coregonus williamsoni), Rocky Mountain sculpin (Cottus bairdi punctulatus). Introduced species include: Rainbow trout (Salmo gairdneri), Brown trout (S. trutta), Kokanee (Oncorhynchus nerka kennerlyi), Eastern Brook trout (Salvelinus fontinalis), Yellow perch

(Perca flavescens), Largemouth black bass (Micropterus salmoides), Pumpkinseed (Lepomis gibbosus). Three specimens indentified as hybrids between Columbia squawfish and Columbia River chub were collected during the study. Hybrids between these species were previously reported in Montana by Weisel (1953).

The writer wishes to thank Dr. C. J. D. Brown and Richard J. Graham, who directed the study and assisted in the preparation of the manuscript; Arthur N. Whitney, who suggested the problem and gave valuable help; other personnel of the Montana Fish and Game Department for assistance in the field; and my wife, Gail, for field assistance and encouragement. The Montana Fish and Game Department financed the field investigation under Federal Aid to Fisheries Restoration Project F-12-R. The writer was a graduate fellow of the National Science Foundation for a part of the period involved in the study.

#### Distribution and Habitat

Distribution. The distribution of the Columbia River chub and the Columbia squawfish within the Big Blackfoot River drainage was determined from collections made during the present study and from collections made by the Montana Fish and Game Department in 1954 (Fig. 1). The following sampling methods were used: lakes - gill netting; the Big Blackfoot River - dynamiting; the Clearwater River below Salmon Lake - angling; the Clearwater River above Rainy Lake - poisoning with rotenone; all other stream stations - electrical shocking. A number of small streams tributary to the Big Blackfoot River were sampled without collecting

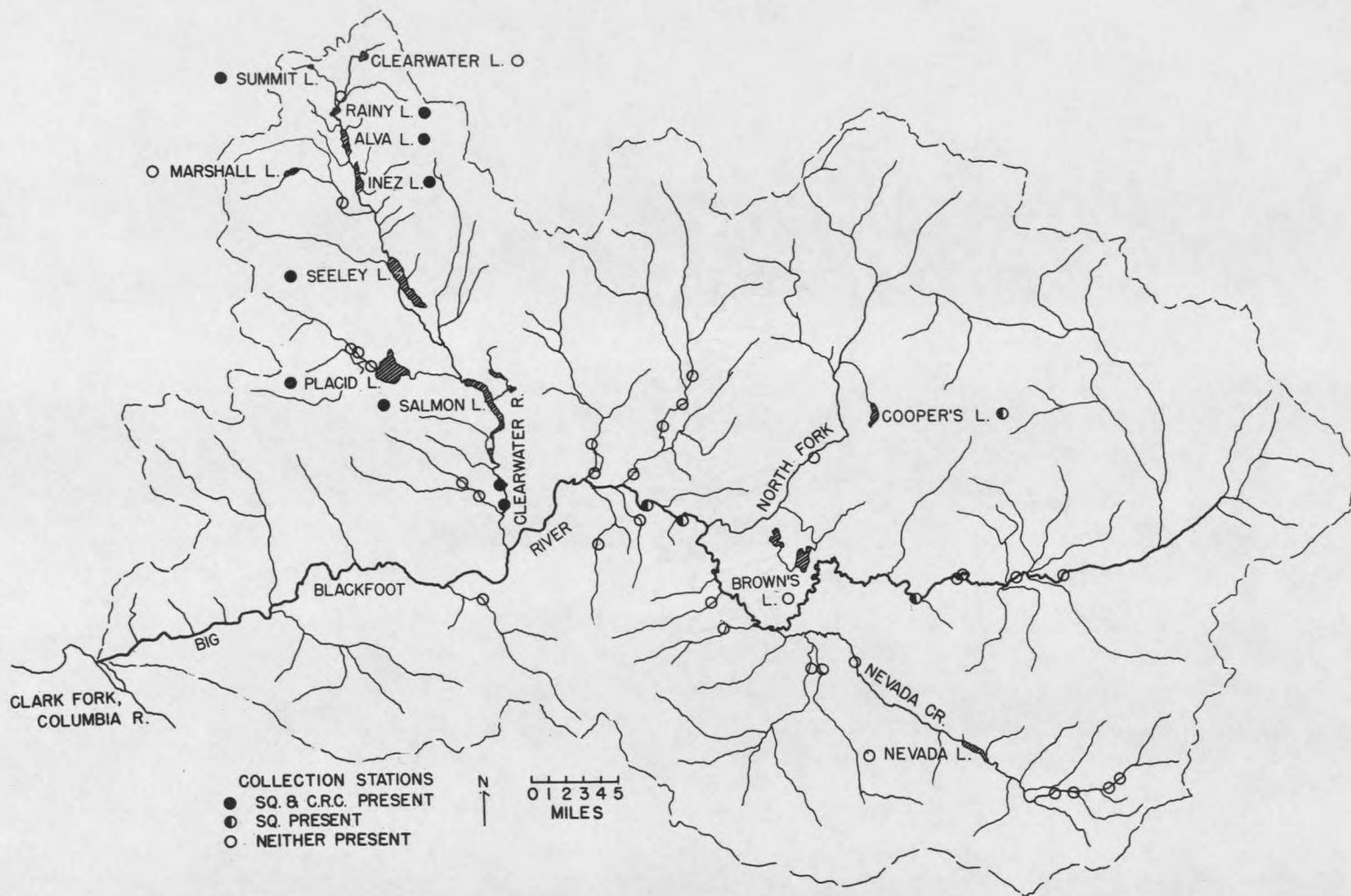


Figure 1. Map of the Big Blackfoot River drainage, showing collection stations and occurrence of the Columbia River chub and Columbia squawfish.



either species. Other small streams with steep gradients were not sampled. No recent collections were made on the Big Blackfoot River below the mouth of the Clearwater River, although records from 1948 are available for this area. Recent creel census records also show that both Columbia River chub and Columbia squawfish are present there.

The Columbia River chub was found to be abundant in certain lakes of the Clearwater River drainage. They occurred in small numbers in the broad, slow areas of the Clearwater River below Salmon Lake and in the Big Blackfoot River below the mouth of the Clearwater River.

Columbia squawfish were present in the same lakes of the Clearwater River drainage. This species was also present in Cooper's Lake, which has an outlet intermittently flowing into the North Fork, Big Blackfoot River. It was not found in this latter river. The fish from Cooper's Lake were more darkly pigmented than those found in the Clearwater drainage and in the Big Blackfoot River. Columbia squawfish were common in the lower Clearwater River and in the Big Blackfoot River below the mouth of the Clearwater River. They were also found in the Big Blackfoot River upstream to a point about two miles above the mouth of Arrastra Creek. Collections made at stations in the upper portion of this river contained only large fish (those above Arrastra Creek were 11.3 - 15.7 inches in length\*). Searches for young of the year at several stations on the Big Blackfoot River disclosed none more than 15 miles upstream from the mouth

\* ALL length measurements used in this report are total lengths; maximum length from tip of snout to the longest part of the caudal fin.

of the Clearwater River. Evidently little or no successful reproduction occurred in the upper portion of the range of this species.

Habitat. In lakes, both Columbia River chub and Columbia squawfish were found to occur almost exclusively in the shallow areas during summer. Few fish were captured in nets set at depths greater than 20 feet. Both species inhabited areas where submerged vegetation was present, except during the spawning period. At that time fish were captured in open areas as well as in vegetated areas. In Seeley Lake during late March, 1957, when ice cover was present, fish of both species were captured in gill nets set in vegetation at depths of eight feet or less but not at greater depths. These fish quite possibly remained in shallow vegetated areas during the period of ice cover.

Young of the year Columbia River chub and Columbia squawfish captured in lakes before July 8, 1957 were found in water less than one foot deep along rubble or gravel shores. After August 1, these fish were found in nearby areas of submerged vegetation at depths less than three feet.

Columbia squawfish in the Big Blackfoot River were captured in large pools (8-12 feet deep and up to 100 feet long). In the Clearwater River they were taken in pools and in other areas of low gradient. Groups of fish less than six inches in length were also observed in riffle areas of the latter river, where they were concentrated in the shelter of the boulders along the river's edge. Young of the year were found in protected places near shore and in backwaters of the Big Blackfoot River and the Clearwater River.

### Growth

Methods. Young-of-the-year fish were collected with a dip net until mid-August, but at that time the fish were able to evade this net. A seine was used for subsequent collections in lakes.

The growth of older fish in certain lakes was determined by examining scales from fish captured in gill nets. The nets used were 125 feet long with 25 foot sections of  $3/4$ , 1,  $1\frac{1}{4}$ ,  $1\frac{1}{2}$  and 2 inch square mesh. The largest mesh was of a size capable of capturing fish larger than any encountered during the study. Some young age groups were not vulnerable to the nets and were not collected. Scales were taken from each fish in the area between the base of the dorsal fin and the lateral line. Measurements of scale radii were made with the aid of a scale projector. Total lengths at formation of annuli were calculated with a nomograph. A linear relationship between scale radius and body length was assumed.

A length-frequency distribution was also used for evaluating the growth of Columbia squawfish in the Clearwater River. Fish used were captured by seining and angling.

Columbia River chub. Young-of-the-year Columbia River chub from Placid Lake attained an average length of 2.2 inches by September 12, 1957 (Table I).

Scales of 300 fish collected during 1956 were used for determining the growth of Columbia River chub in Placid Lake. Collection periods were mid-June and late August and early September. The youngest fish in the sample were two years old. Age class II was not represented in the June collections but had attained a size vulnerable to the  $3/4$  inch gill

Table I. Growth of young-of-the-year Columbia River chub and Columbia squawfish in Placid Lake, 1957.

Date	Columbia River chub			Columbia squawfish		
	Av.	Range	No.	Av.	Range	No.
Aug. 6	1.2	1.1-1.3	15	1.4	1.3-1.5	12
Aug. 16	1.5	1.4-1.7	7	1.7	1.6-1.7	5
Sept. 12	2.2	2.0-2.4	30	2.1	1.6-2.4	15

net mesh by late August. Scales from young-of-the-year fish were examined in order to evaluate growth in the first summer and to aid in locating the first annulus. The scales of young fish (2.0-2.2 inches in length) collected in September had 9-12 circuli.

The average size of female Columbia River chub was greater than that of males. This resulted from greater longevity and from a slightly faster growth rate in females (Table II). The average calculated length of females was 0.2 inches greater than males at five years and 0.7 inches greater at seven years, the oldest group in which males were represented. The oldest female in the sample (13.5 inches in length) was aged at nine years. Several males (10.4-11.1 inches in length) were aged at seven years.

Columbia squawfish. Young-of-the-year of this species from Placid Lake attained an average length of 2.1 inches by September 12, 1957 (Table I). Columbia squawfish collected in the Clearwater River below Salmon Lake were considerably smaller than those taken from Placid Lake at comparable times. On August 3, 1957, fifteen fish averaged 0.9 inches in length (range: 0.8-1.0) and on August 21, eight fish averaged 1.2

Table II. Calculated growth of Columbia River chub in Placid Lake.

Age Class	Sample size				Average length at annulus formation								
	I*	M	F	T	1	2	3	4	5	6	7	8	9
II	6			6	2.4	4.6							
III	76	18		94	2.6	4.8	7.0						
IV	10	8	6	24	2.7	4.8	6.9	8.6					
V	1	41	9	51	2.7	4.7	6.7	8.5	9.8				
VI		23	31	54	2.6	4.5	6.5	8.3	9.6	10.7			
VII		6	53	59	2.6	4.4	6.4	8.1	9.5	10.5	11.4		
VIII			11	11	2.7	4.5	6.4	8.3	9.8	10.9	11.7	12.6	
IX			1	1	3.1	4.5	6.7	8.7	9.8	11.3	12.0	12.7	13.5
Average	93	96	111	300	2.6	4.6	6.7	8.3	9.6	10.6	11.5	12.6	13.5

\* I: immature; M: male; F: female; T: total.

inches in length (range 1.1-1.5). Growth of young in the Big Blackfoot River was similar to that in the Clearwater River.

A length-frequency distribution was made from 127 Columbia squawfish collected in the Clearwater River below Salmon Lake (Fig. 2). Fish 1.9-4.3 inches in length were collected by seining on July 17, 1956 and fish

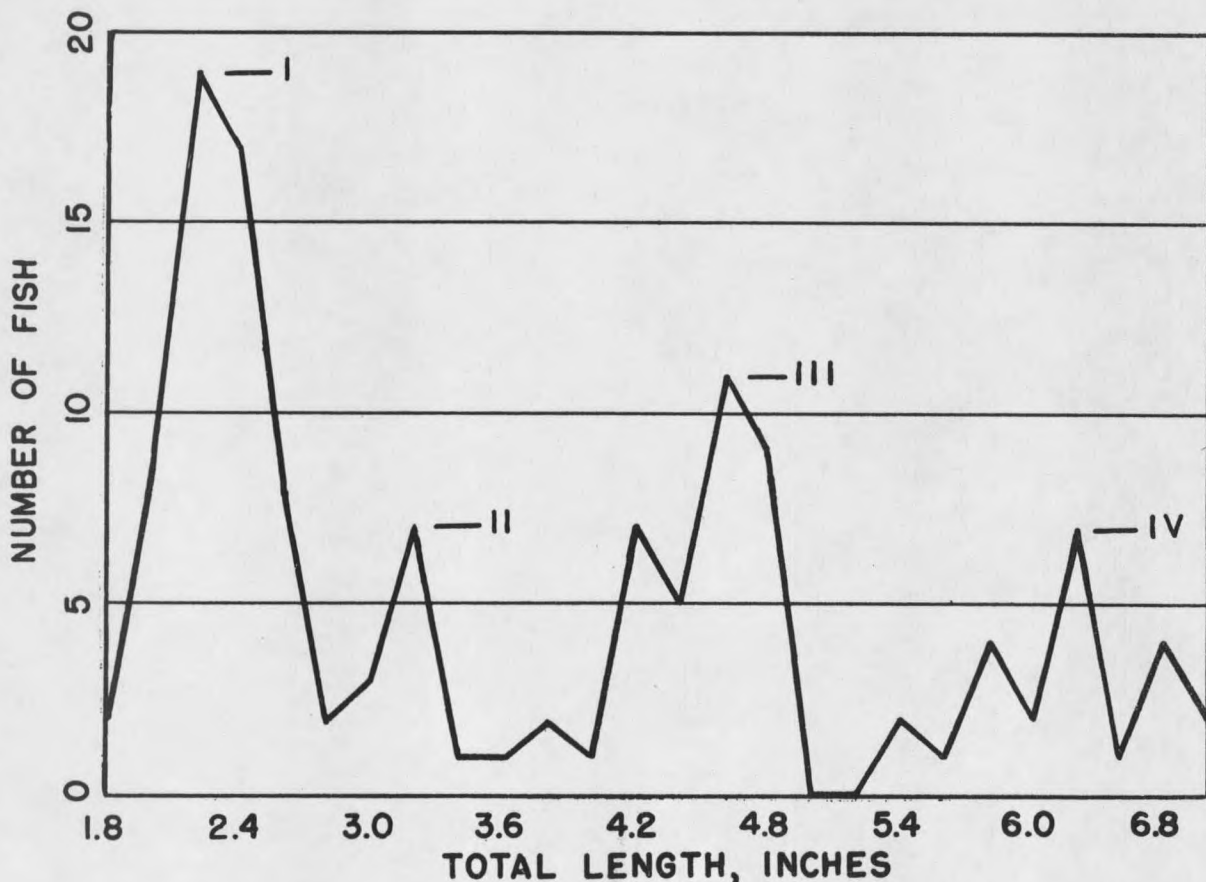


Figure 2. Length-frequency distribution of 127 Columbia squawfish collected in the Clearwater River, July 17 and 27 and August 3, 1956.

4.2-11.3 inches in length were collected by angling on July 27 and August 3, 1956. The length-frequency distribution of these combined samples ex-

hibited modes at 2.4, 3.3, 4.6 and 6.1 inches. Modes at greater lengths were not evident. An examination of the scales of these fish indicated that the above modes represented age classes I through IV. The comparative weakness of the mode at 3.3 inches was due to the low vulnerability of this size group to both collection methods used.

Information on growth of Columbia squawfish in Alva Lake was obtained from scales of 267 specimens collected during the summers of 1956 and 1957 (Table III). Age classes IV through XV were represented in this sample. Since no smaller fish from Alva Lake were available, younger fish from the Clearwater River and from Placid Lake were used to aid in evaluating growth in the first few years of life. Young-of-the-year Columbia squawfish collected in Placid Lake in September (2.0 inches in length) had 9-12 circuli.

Females grew slightly faster and attained a greater age than males. The difference in growth, noted in all age classes in the Alva Lake sample, was 0.7 inches at formation of the ninth annulus. The oldest males in the sample (13.0 and 13.2 inches long) were aged at 11 years. One female 18.3 inches long was aged at 15 years. Several other females up to 22.3 inches in length were collected, but they could not be aged with any degree of confidence and are not included in the growth data.

The growth of Columbia squawfish in Seeley Lake, based on an examination of the scales of 72 fish, was slightly greater than in Alva Lake. Age classes VI through XV were represented in this sample. Average calculated lengths at annulus (A) formation (sexes and age classes combined) were: A1 - 2.2; A2 - 3.5; A3 - 5.0; A4 - 6.5; A5 - 7.9; A6 - 9.2; A7 -

Table III. Calculated growth of Columbia squawfish in Alva Lake.

Age Class	Sample size				Average length at annulus formation											
	I*	M	F	T	1	2	3	4	5	6	7	8	9	10	11	12
IV	4			4	2.0	3.6	5.1	6.5								
V	30			30	1.9	3.0	4.4	5.7	7.1							
VI	52	1		53	2.0	3.2	4.5	5.8	7.2	8.3						
VII	54	8	5	67	2.1	3.3	4.6	6.0	7.2	8.4	9.5					
VIII	26	9	5	40	2.2	3.5	4.7	6.0	7.2	8.3	9.5	10.5				
IX	3	21	11	35	2.2	3.4	4.7	6.1	7.5	8.7	9.8	10.9	11.8			
X		14	8	22	2.1	3.3	4.7	6.0	7.1	8.2	9.2	10.2	11.2	12.1		
XI		2	5	7	2.4	3.4	4.7	5.8	7.2	8.3	9.4	10.4	11.5	12.5	13.4	
XII**			9	9	2.1	3.3	4.5	5.7	7.0	8.3	9.4	10.5	11.5	12.5	13.5	14.4
Average	169	55	43	267	2.1	3.3	4.6	5.9	7.2	8.4	9.5	10.5	11.5	12.3	13.4	14.4

\* I: immature; M: male; F: female; T: total.

\*\* includes fish 12 years and older.



10.3; A8 - 11.4; A9 - 12.6; A10 - 13.9; A11 - 14.8; A12 - 15.9. One female, 17.4 inches in length, was aged at 15 years. Others up to 19.5 inches in length could not be aged with any degree of certainty.

#### Reproduction

Fecundity. Fish of both species were collected on March 25-27, 1957 in Seeley Lake for the purpose of estimating egg numbers. About two months in advance of the spawning seasons, this was a favorable time for collecting ovaries since eggs were large enough for accurate enumeration, yet there was no danger of loss during capture. Ovaries were removed from the fish and preserved in formalin. After removal of adhering fatty tissue, total volume of the ovaries was determined by displacement in water. The ovaries were then broken up and two or three samples, representing 5-10 percent of the total volume, were selected at random. The eggs contained in these samples were counted. Volumes of the samples were determined by displacement and an estimate of the total number of eggs was calculated.

Estimated egg numbers for seven Columbia River chub (11.8-12.8 inches in length) ranged from 11,800 to 18,900 (Table IV). Estimated egg numbers for seven Columbia squawfish (11.3-13.8 inches in length) showed much greater variation between individuals than Columbia River chub. Two fish, 12.1 and 12.3 inches long, contained 27,500 and 6,700 eggs, respectively. No relationship between fish size and number of eggs was noted in either species within the size ranges of the samples.

Age at sexual maturity. The sample discussed previously (see

Table IV. Estimated numbers of eggs contained in the ovaries of fish collected in Seeley Lake, March 25, 26 and 27, 1957.

Species	Total length, inches	Weight pounds	Number of eggs
Columbia River chub	11.8		11,800
" " "	11.9	0.66	16,400
" " "	12.1	0.70	18,900
" " "	12.3	0.73	15,200
" " "	12.4	0.69	16,400
" " "	12.6	0.83	16,800
" " "	12.8	0.76	15,400
Columbia squawfish	11.3	0.46	18,200
" "	11.4	0.48	9,800
" "	11.5	0.48	19,200
" "	12.1	0.51	27,500
" "	12.2	--	20,700
" "	12.3	0.54	6,700
" "	13.8	0.78	20,000

"Growth", p. 10) indicates that Columbia River chub in Placid Lake matured at three to five years of age. Mature males made up about 20 percent (18 of 94) of age class III. Mature females were well represented in age class IV, the first age class in which they were found. Only one of fifty-one fish in age class V was immature. The average calculated length at annulus formation of the mature three year old males was 6.5 inches; that of the mature four year old females was 8.4 inches.

Columbia squawfish collected in Alva Lake matured later in life than Columbia River chub in Placid Lake. Attainment of maturity by these Columbia squawfish also extended over a longer period of years. The youngest mature male in the sample was six years of age and the youngest mature female was seven. Immature fish made up the majority (26 of 40) of age class VIII and were present in small numbers (3 of 35) in age class IX. Average calculated lengths at annulus formation of mature seven year old males was 9.9 inches, that of females was 10.0 inches.

Spawning season. Gonad condition was recorded for adult fish of both species collected in Placid Lake between May 28 and July 6, 1957 and in Seeley Lake between June 3 and July 4, 1957. Females were classed as: full (including 'ripe' and 'green' individuals) or spent. These two conditions were readily recognized; the former is characterized by large ovaries with distinct large eggs, and the latter by small, flaccid ovaries colored dark red by abundant vascular tissue and containing occasional large eggs. The distinction between green and ripe fish could not be readily established and these classes were combined. An additional ovary condition (discussed below), representing non-breeding fish, was common

among Columbia squawfish. Males were classed as: ripe - with large white testes from which sperm could be squeezed; or spent - with flaccid, red testes in which sperm was no longer apparent. All fish used in evaluating the spawning seasons were collected in gill nets, except the June 9 and 16 collections from Placid Lake, which were obtained with a box trap set at the outlet.

Maximum-minimum water temperatures were taken to the nearest degree F. at the outlets of the above lakes at intervals of 1-4 days from May 9 to July 1, 1957. The thermometers were suspended 1-2 feet below the surface of the water and were protected from direct sunlight. These temperatures were believed to be about the same as those in the shoal areas which the fish inhabited, although no comparisons were made. Water temperatures expressed in Figures 3 and 4 were determined by averaging the maximum and minimum readings for each three day period.

Spawning activity of Columbia River chub in Placid Lake was in progress when collections began on May 28, 1957. Thirty-nine percent (12 of 31) of the females captured on that day were spent. Of the females collected in nets set near the inlet, few (2 of 18) had spawned while most (10 of 13) females collected near the outlet had spawned. The inlet side of the lake is characterized by extensive shoal areas with sand and silt bottoms and abundant vascular vegetation while most of the shoal area within one mile of the outlet has a bare bottom of gravel or rubble. The latter is similar to that used in spawning by Columbia River chub in Washington Lake (Schultz, 1935). It is probable that those individuals which became ripe early had concentrated in the areas favorable for spawn-























