MONTANA FISH AND GAME DEPARTMENT
FISHERIES DIVISION

JOB PROGRESS REPORT

State Montana

Project No. F-33-R-5 Name Flathead Lake Fisheries Study

Job No. I-b Title Age and Growth Analysis of the Fishes of Flathead Lake - Pygmy Whitefish

Period Covered July 1, 1970 through June 31, 1971

ABSTRACT

A total of 493 scale samples collected from pygmy whitefish from April 1967 through May 1971 provided the data for the age analysis of this species. The species was first reported from Flathead Lake in 1967. They were found to be distributed over most of the lake and to prefer to occupy the benthic areas in water depths ranging from 60 to 270 feet. Specimens ranged in size from 79 mm (3.1 inches) to 178 mm (7.0 inches) with the largest fish weighing 45 g. (0.10 pounds). The most common fish species found associated with the pygmy whitefish in its benthic habitat were the lake whitefish and Dolly Varden.

The Flathead Lake pygmy whitefish population was primarily that of fish in their third year of life and younger. The oldest fish was a five-year old female. Male pygmy whitefish were generally more numerous, smaller in size and younger than the females. The variation in the body-scale measurements suggests a strong linear relationship. Growth rates were back calculated from the regression equation determined from 493 body-scale measurements.

Most male pygmy whitefish were sexually mature by age 2 (I+ annulus) while the majority of the females matured at age 3 (II+ annulus). Indications for consecutive year spawning were documented.

BACKGROUND

Flathead Lake in northwest Montana is the state's largest and one of the most important fishing lakes. The fishery almost entirely depends on natural reproduction and recruitment from the lake and tributary system. This drainage system lies at the headwater area of the Columbia River, in an area that is rapidly changing due to the development of its natural resources: water, timber and recreation.

This large lake contains populations of 20 fish species. The knowledge of their habitats and the relationship that exists between them is essential to maintain the fisheries resource. Determination of the ages of fishes is important because it is basic to assessing intra- and inter-specific relationships. Age determination, in conjunction with length and weight, can relate changes such as year-class strength, life span, mortality, growth and productivity.

Age and growth studies have been limited on this lake because of its large size and great depth and the difficulty to procure adequate scale samples. The recent fish sampling program, 1967-1970, systematically and seasonally sampled fish in the entire lake and provided the necessary scale collections to determine basic age and growth of the major game fish species.

OBJECTIVES

The objective of this job is to read, interpret and analyze and report on the five year accumulation of scale samples that were collected during the systematic and seasonal sampling of fish on Flathead Lake. The initial work will include the analysis of the age and growth factor that involves the major game fish species; they are the lake whitefish, kokanee salmon, cutthroat trout, Dolly Varden, lake trout and pygmy whitefish.

PROCEDURES

Specimens of pygmy whitefish were collected by gill nets and by electrofishing for age analysis. Specimens in the lake were taken in gill nets with 98 percent being collected in the two smallest meshes of the net; the 5/8 and 1 1/4 inch, stretched measure sections.

Fish were measured to the nearest millimeter in total length and weighed to the nearest gram. A scale sample was extracted from each fish in an area above the lateral line and just posterior to the dorsal fin. The extraction spot was generally located in the fourth row of scales above the lateral line. Scales were stored in individual envelopes. Plastic impressions were made from the scales in a hydraulic press with head plates regulated at 200° F.. Scale measurements were made with the aid of a Bausch and Lomb microbeam projector. Scale diameters were enlarged 67 times. Measurements of the anterior radii were used to develop the body-scale relationship.

FINDINGS

A total of 493 scale samples were collected from pygmy whitefish in Flathead Lake during the fish survey program, April, 1967 through May, 1971. The number of scale samples collected each year were 39-1967, 114-1968, 200-1969, 133-1970 and 7-1971. Sex was determined on 272 fish or approximately one-half of the total fish aged. Most of the fish, where sex was determined, 70.8 percent, were collected from spawning concentrations.

This diminutive form of the whitefish was first reported in the state by Schultz (1941) from the tributaries of Lake McDonald, Glacier National Park. Other state records include that of Weisel and Dillon (1954) when they observed the pygmy whitefish in Bull Lake, Kootenai drainage and more recently when Hanzel (1970) first reported them in Flathead Lake. Hanzel found them distributed over most of the lake area and it appeared that they preferred to live most of their lives in the benthic areas in water depths ranging from 60 to 270 feet. It was only during the spawning season, late November, December, that large numbers of pygmy whitefish move into the shallow waters along shore. Specimens collected in this lake have ranged in size from 79 mm (3.1 inches) to 178 mm (7.0 inches) with the largest fish weighing 45 g. (0.10 pounds). A length frequency distribution of all the fish aged is presented in Figure 1. The most common fish species found associated with the pygmy whitefish in their benthic habitat were the lake whitefish and Dolly Varden.

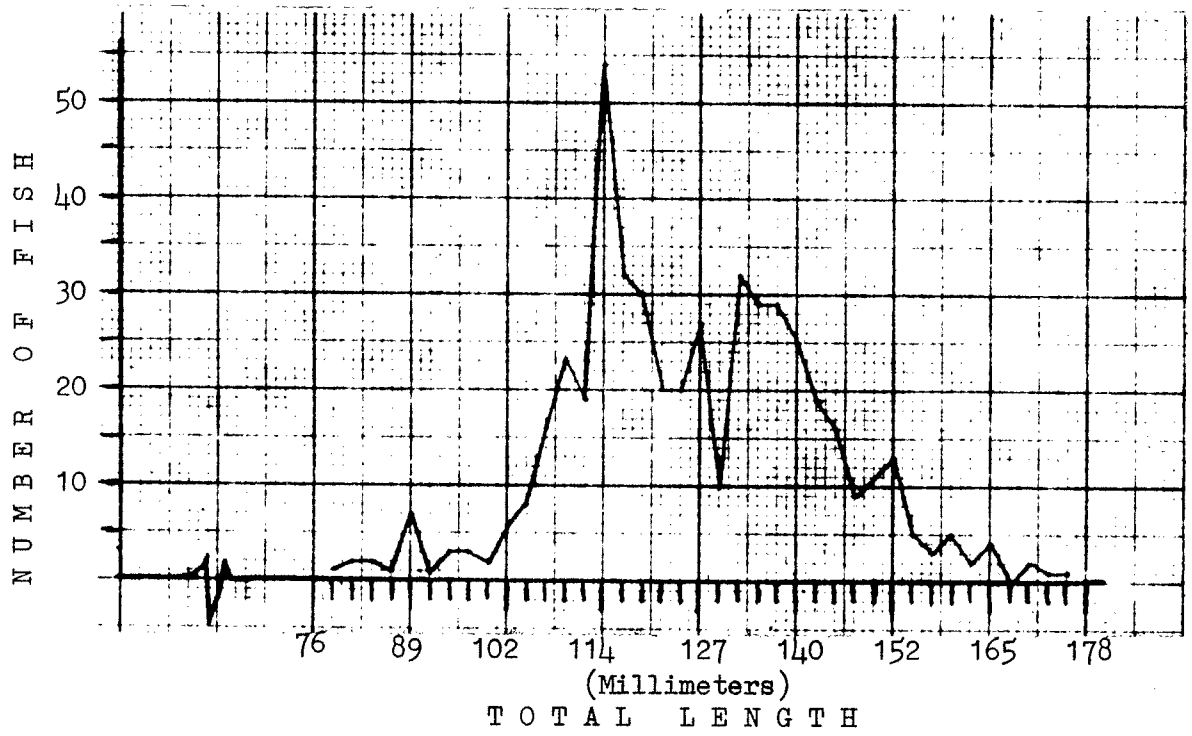

Figure 1. Length frequency distribution of 493 pygmy whitefish from Flathead Lake, April, 1967 through May, 1971.

Age and Growth

The pygmy whitefish population sampled in Flathead Lake was primarily young fish, 93.5 percent of the fish aged were classified as three years or younger. The oldest fish was a five-year old female. Only one age 0+ fish was collected during the sampling program. The small representation of 0+ age is believed to be a result of sampling techniques and equipment rather than its availability or abundance in the lake. The percent of the total fish by age class was: 0+, 0.01 percent; I+, 47.3 percent; II+, 46.2 percent; III+, 5.9 percent; and IV+, 0.1 percent. Males collected in the benthic areas of the lake out numbered the females at a ratio of 1,9♂:1♀. Male sex ratios increased to 6.7♂:1♀ when the pygmy whitefish concentrated in the shallow areas during their spawning season.

Considerable overlap was found to exist in the length-frequency distribution between adjacent age groups and between the sexes of four year olds and younger Flathead Lake pygmy whitefish (Table 1). The degree of overlap decreased with age. The oldest females age group was the only group distinguishable by size alone.

Male pygmy whitefish were generally smaller in size and younger than the females. Average total length for the males and females was 122 mm (4.8 inches) and 138 mm (5.4 inches), respectively. The largest age group of males was fish in their second year of life. This group represented 66.3 percent of their total numbers.

The largest female group was in its third year of life, one year older than the males. It represented 63.7 percent of the female numbers as shown in Table 2.

Table 2. Age composition in percent for male and female whitefish, Flathead Lake, 1967-1971

	Annuli				
	0+	I+	II+	III+	IV+
Male	-	66.3	33.1	0.6	-
Females	-	19.8	63.7	13.2	3.3

Growth rate of the pygmy whitefish in Flathead was determined by first establishing the relationship between the body length and the anterior scale radius (mm multiplied by 67x). The value of 0.9854, the coefficient of variation "r", developed on 493 measurements suggests a strong degree of linearity between the body-scale measurements. This strong linearity differs considerably from the highly sigmoid relationship found for pygmy whitefish from Alaskan waters by Heard and Hartman, (1965).

Table 1. Length frequency of age groups of pygmy whitefish, Flathead Lake, 1967-1971

Total inches	Length millimeters	I		II		III		IV		Total		Total Both Sexes
		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	
3.0	76											
.1	79											
.2	81											
.3	84		1								1	1
.4	86											
3.5	89	1								1		1
.6	91											
.7	94	1								1		1
.8	97											
.9	99	1								1		1
4.0	102	1								1		1
.1	104	2		1						3		3
.2	107	4	1							4	1	5
.3	109	8	3	1	1					9	4	13
.4	112	8	2							8	2	10
4.5	114	31	2		3					31	5	36
.6	117	21	3	1						22	3	25
.7	119	18	2	5						23	2	25
.8	122	10		2	1					12	1	13
.9	124	6	1	5	1					12	2	14
5.0	127	5		7	1					12	1	13
.1	130			5						5		5
.2	132	2		12	8		1			14	9	23
.3	135	1		4	3					5	3	8
.4	137		3	7	6					7	9	16
5.5	140			1	5	1				2	5	7
.6	142			2	5		1			2	6	8
.7	145			3	7					3	7	10
.8	147			3	4					3	4	7
.9	150			1	4		1			1	5	6
6.0	152				4		2				6	6
.1	155				3		2				5	5
.2	157				1		1				2	2
.3	160				1		4				5	5
.4	163								2		2	2
6.5	165											
.6	168											
.7	170								1		1	1
.8	173											
.9	175											
7.0	178											
	TOTAL	120	18	60	58	1	12	-	3	181	91	272

A regression equation was calculated from the individual pairs of body-scale measurements:

Body Length (T.L.) = 0.9132 Anterior Scale Radius + 61.6306

Mean body lengths from each scale radius were plotted against the calculated regression line as shown in Figure 2. Growth rates were back calculated from the empirical formula with total lengths at annulus formation (Table 3).

Annual growth of the female pygmy whitefish in Flathead Lake was greater (Figure 3) then the growth reported for Brooks Lake, Alaska (Heard and Hartman, 1965), Lake Superior, Michigan and Lake McDonald, Montana (Eschmeyer and Bailey, 1955) and nearly the same as Bull Lake, Montana (Eschmeyer and Bailey, 1955). The initial growth of Flathead Lake pygmy whitefish was only exceeded in Wood Lake, Alaska (Rogers, 1963), and after the third year of life in MacLure Lake, British Columbia (McCart, 1963) the fastest growth reported for this species.

Age and Size of Maturity

Spawning concentrations of pygmy whitefish were observed and sampled during the 1969 and 1970 seasons near the mouths of the Swan and Flathead Rivers. As stated previously, the sex ratio of males to females increased considerably from 1.9 to 6.7 males to 1 female, during the spawning season. A major portion of the age 2 (I+ annulus) male pygmy whitefish, 74.5 percent, and all older were found to be sexually mature. Ten percent of the spawning males measured more than 135 mm (5.4 inches) in total length with the largest male 150 mm (5.9 inches). The rate of maturation of the females was slower than the males. Females showed 27.8 percent maturity at age 2 (I+ annulus), 90.2 percent at age 3 (II+ annulus) and 100 percent for all older females. The spawning females ranged in size from 109 mm (4.4 inches) to 178 mm (7.0 inches) with 90 percent of the females larger than 127 mm (5.0 inches). Indications are that pygmy whitefish spawn in consecutive years as documented when two egg sizes were found in the body cavity of some spawning females. The mature ripe eggs, 3 mm in diameter, were loose in the cavity while the smaller sized egg, 1 mm in diameter, were developing in the ovaries. The incidence of eggs of two sizes was noted in the females in their third and fourth years and was observed during the months of November and December.

RECOMMENDATIONS

It is recommended the analysis of the age and growth of the major game species, an incidental part of the study, be continued with emphasis being directed toward the interpretation of the scale collections from kokanee salmon, Dolly Varden and cutthroat trout. This information is basic to the assessment of mortality rates, abundance, distribution and habitat requirements.

Prepared by Delano A. Hanzel

Date June 7, 1972

Water referred
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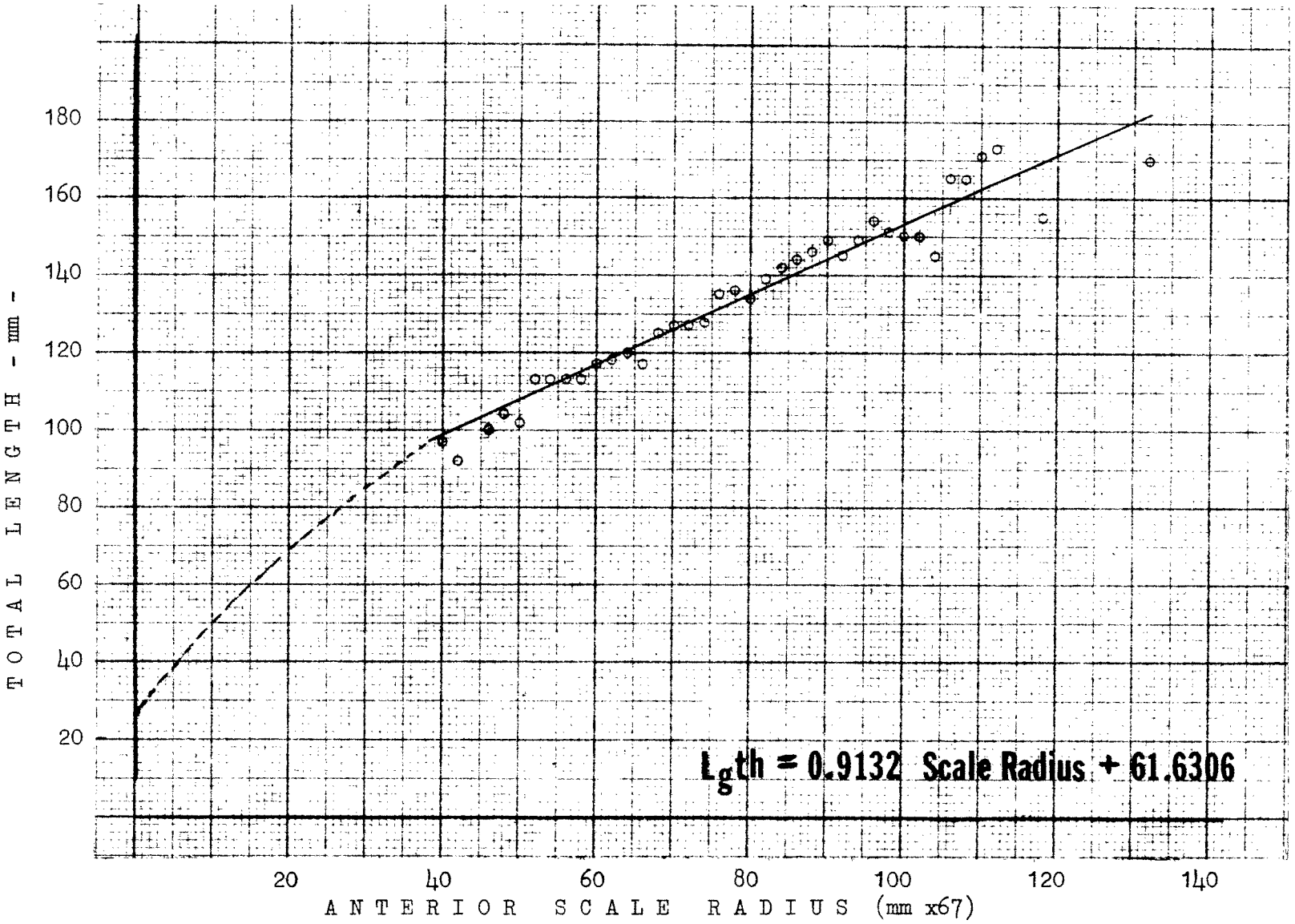

Figure 2. Body length - scale radius relation of pygmy whitefish in Flathead Lake. Solid line is calculated equation; circles represent mean body lengths for given scale radii; dashed line connects estimated intercept at 25 mm, length at scale formation.

Table 3. Average calculated total length (millimeters) and average length at capture of pygmy whitefish collected in Flathead Lake, 1967-1971

Group	Sex	Number of fish	Average length at capture -mm-	Average length at capture -inches-	Calculated length at annulus formation 1	2	3	4
0	Unknown	1	79	3.1	-	-	-	-
I	Male	120	117	4.6	100	-	-	-
	Female	18	116	4.6	99	-	-	-
	Unknown	95	110	4.3	95	-	-	-
II	Male	60	128	5.0	98	116	-	-
	Female	58	140	5.5	98	122	-	-
	Unknown	110	134	5.3	101	123	-	-
III	Male	1	140	5.5	100	124	142	-
	Female	12	154	6.1	100	124	141	-
	Unknown	16	150	5.9	101	122	137	-
IV	Male	-	-	-	-	-	-	-
	Female	3	168	6.6	99	130	145	155
	Unknown	-	-	-	-	-	-	-
Average Increment	Male	181	122	4.8	99	18	25	-
	Females	91	138	5.4	98	24	20	13
	Unknown	221	-	-	98	22	14	-
Average Length	Male				99	117	142	-
	Females				98	122	142	155
	Unknown				98	123	137	-
	Combined				99	121	139	155

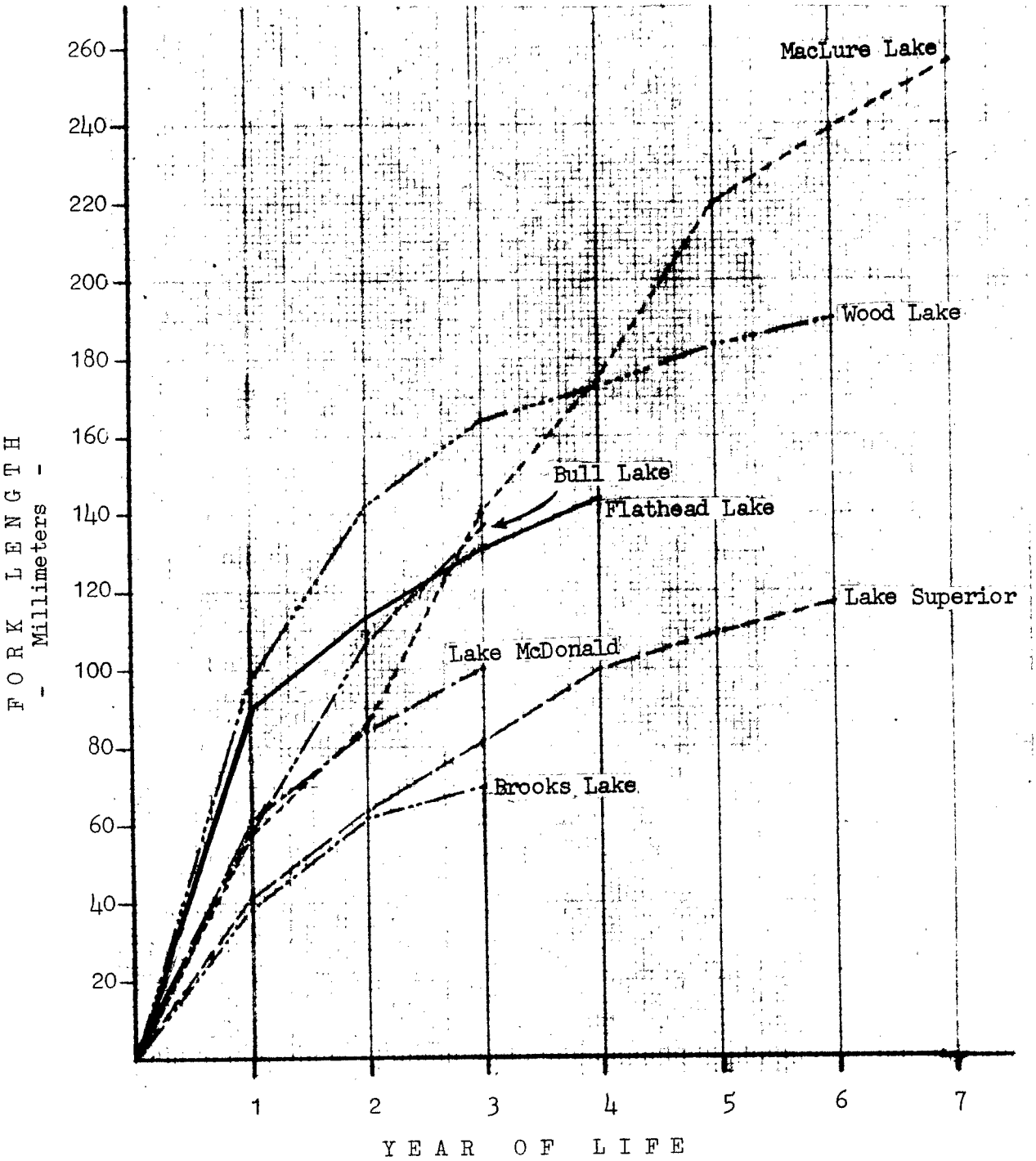

Figure 3. Calculated growth of female pygmy whitefish from Flathead Lake, compared with data from Bull and Lake McDonald, Montana and Lake Superior, Michigan, (Eschmeyer and Bailey, 1955), Wood Lake, Alaska, (Rogers, 1963), Brooks Lake, Alaska, (Heard and Hartman, 1965) and MacLure Lake, British Columbia, (McCart, 1963). Data from Flathead Lake and Lake Superior were converted from total length using the formula described by Heard and Hartman, 1965 where Fork Length = Total length / 1.0845.

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