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THE SPAWNING MIGRATION AND AGE AND GROWTH STUDIES OF STEELHEAD IN THE HURON RIVER, BARAGA COUNTY, MICHIGAN 1966 - 1970

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SUMMARY

From 1966 to 1970 the spawning runs of steelhead trout were monitored in the Huron River, Baraga County to gain information on this phase of the fish's life history. Age and growth of the steelhead was also studied.

This report presents the data obtained on the timing and size of the steelhead migration, factors influencing the time of migration, the age composition, sex ratio, and size of the fish involved. It also details the rate of the growth of steelhead in both length and weight.

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INTRODUCTION

The steelhead (rainbow) trout, Salmo gairdnerii, is an important sport fish, but little is known about its life history in the Lake Superior drainage.

From 1966 to 1970, spawning runs and growth rates of steelhead in the Huron River, Baraga County were studied to document these phases of the fish's history. Records of the U.S. Fish and Wildlife Service dating back to 1957 are included to add continuity to the report.

METHODS OF MONITORING SPAWNING MIGRATIONS

The principal device used to monitor the upstream migrations of steelhead in the Huron River was the U.S. Fish and Wildlife Service electrical sea lamprey weir located 2.5 miles upstream from Lake Superior.[1] The weir was operated in the spring and fall of 1967 and the spring of 1968, 1969 and 1970. Basically, the weir consists of two electrode arrays (2-inch galvanized pipe suspended from cables) which produce electrical fields across the stream to block upstream migrations of sea lamprey and fish. The downstream array produces a D.C. field and extends in an upstream angle from one stream bank to the lead wing of a pair of trap boxes on the opposite bank. The upstream array extends across the stream perpendicular to stream flow above the traps and produces an A.C. field. The D.C. field serves to repel lamprey and fish and is so positioned as to assist in leading them to the trap boxes. The A.C. field is maintained as a complete block to upstream migration in the event anything is able to break through the D.C. field. Essentially, everything attempting to migrate upstream is captured in the trap boxes (Figure 1). Lamprey weirs have been suspected of partially blocking steelhead runs in several streams but this particular one is thought to be quite efficient in trapping fish, and no concentrations of steelhead were ever observed downstream from the electrical field.

METHODS OF DETERMINING AGES AND GROWTH RATES

Length and weight data and scale samples were collected randomly from steelhead regardless of size, sex, or state of maturity. Total lengths were recorded to the nearest tenth of an inch. Weight was measured to the nearest ounce. Scale samples were collected from the fish behind the dorsal fin and above the lateral line on either side.

Ages and growth rates were obtained from scale impressions made in cellulose acetate and magnified by a microprojector. Ages were designated by the number of years of stream life and the number of years of lake life. For example, a fish of age 2/3 is 5 years old and has spent 2 years in a stream and 3 years in Lake Superior.

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[1]Trap, fyke, pound, and gill nets were used on occasion to monitor the fall runs because the sea lamprey weir was not always in operation during this period.

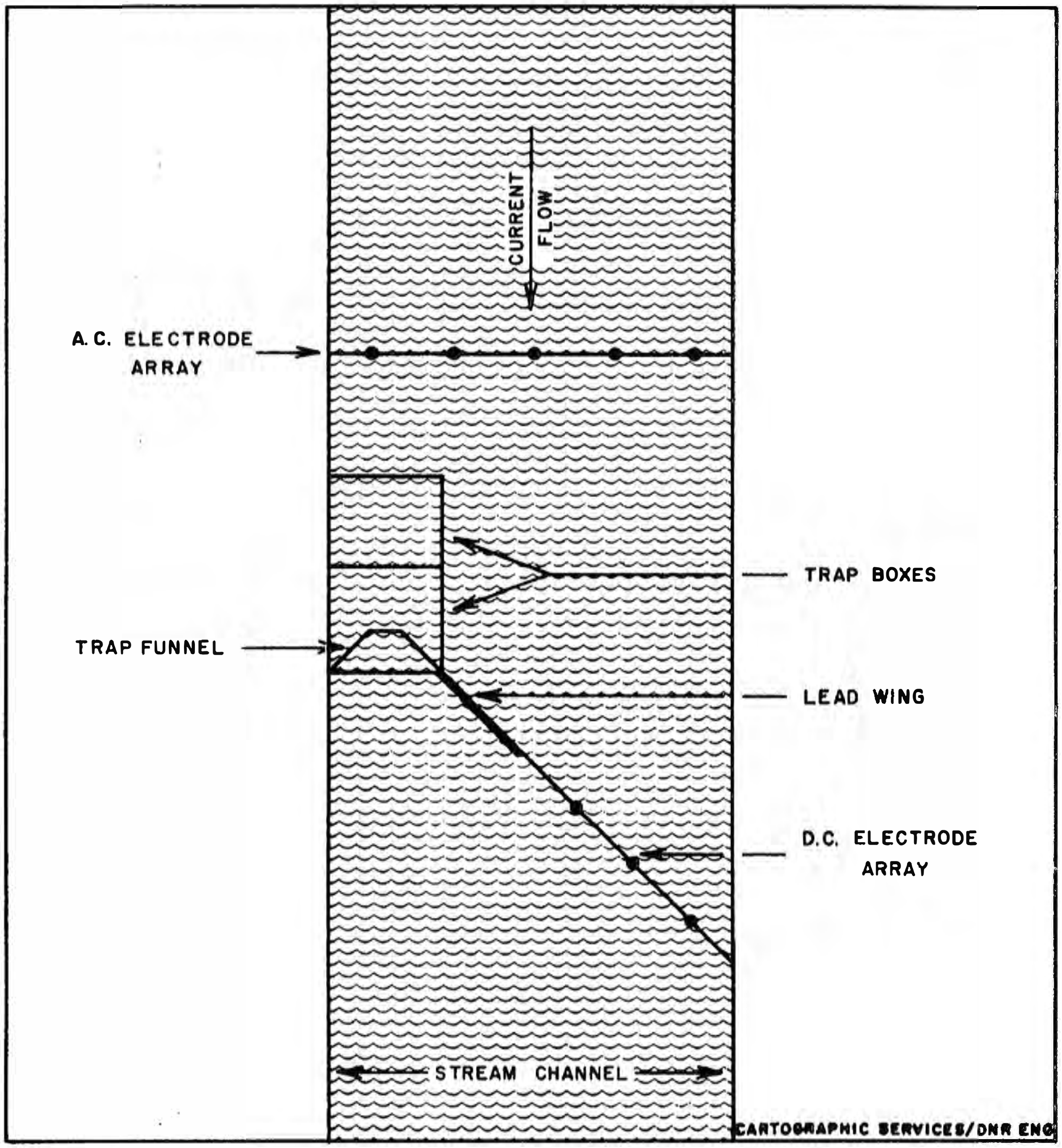

Figure 1 Diagramatic sketch of U.S. Fish and Wildlife Service electrical sea lamprey weir on the Huron River

Growth rates were determined with the aid of a nomograph. No body length-scale length correction factor was used because calculated lengths and empirical lengths were closely comparable (Figure 2).

THE SPAWNING MIGRATION

Time and Size of the Migration

Many Lake Superior streams which receive major steelhead spawning runs have two peak periods when adult fish move upstream--fall and spring. The fall run begins in the Huron River in September and continues until ice cover forms. The peak of the migration occurs in October. These fish are sexually "green" and remain in the slow, deep water areas until the following spring when they ripen and migrate further upstream to spawn. The fall run in the Huron River is small with only 50 to 100 fish moving upstream over 2 miles. Fall runs were monitored in 1966, 1967 and 1970 (Table 1).

The spring run is larger than the fall run. Fish which winter in the river begin their upstream migration during the spring break-up and are followed by steelhead entering the river from Lake Superior. From 1957 through 1970 an average of 328 steelhead 12 inches and over were captured per year at the lamprey weir between April and July (Figure 3.) The largest run ever recorded at the weir was 623 steelhead in 1959, and the smallest run occurred in 1964 when 180 fish were captured.

Two peak migration periods are associated with the spring run in the Huron River. Runs from 1962-1965 exhibited a primary migration peak during the week of May 6 and a secondary peak during the week of May 20. In recent years (1967-1970), peak migration periods have been earlier in the season. The primary peak now occurs during the week of April 22, and the secondary peak occurs the week of May 13 (Figure 4).

Factors Influencing the Time of Migration

In addition to approaching sexual maturity, water levels (volume) and temperatures influence the timing and intensity of the run. These factors were measured with the U.S. Fish and Wildlife Service staff gauge and thermograph at the lamprey weir in the spring and fall of 1967 and spring of 1968 to study their effect on the numbers of steelhead captured each week during those migration seasons. Water level measurements represent only changes in volume. Water temperatures were taken each morning when the steelhead were removed from the traps.

In the fall of 1967, a sharp rise in catch coincided with a drop in water temperature from 50°F. to 40°F. and a 6-inch increase in the water level (Figure 5). The catch continued to increase as water temperatures declined to 40°F. and while the water level increased. The catch declined sharply after the water temperature dropped below 40°F. even though the water level continued to rise.

In the spring of 1967 and 1968, rises in water temperature appeared to be the key factor initiating steelhead movement. In both years, trap catches rose abruptly as water temperatures climbed rapidly from 35°F.to over 40°F. (Figure 6). Water level changes differed in those years. In 1967, the water

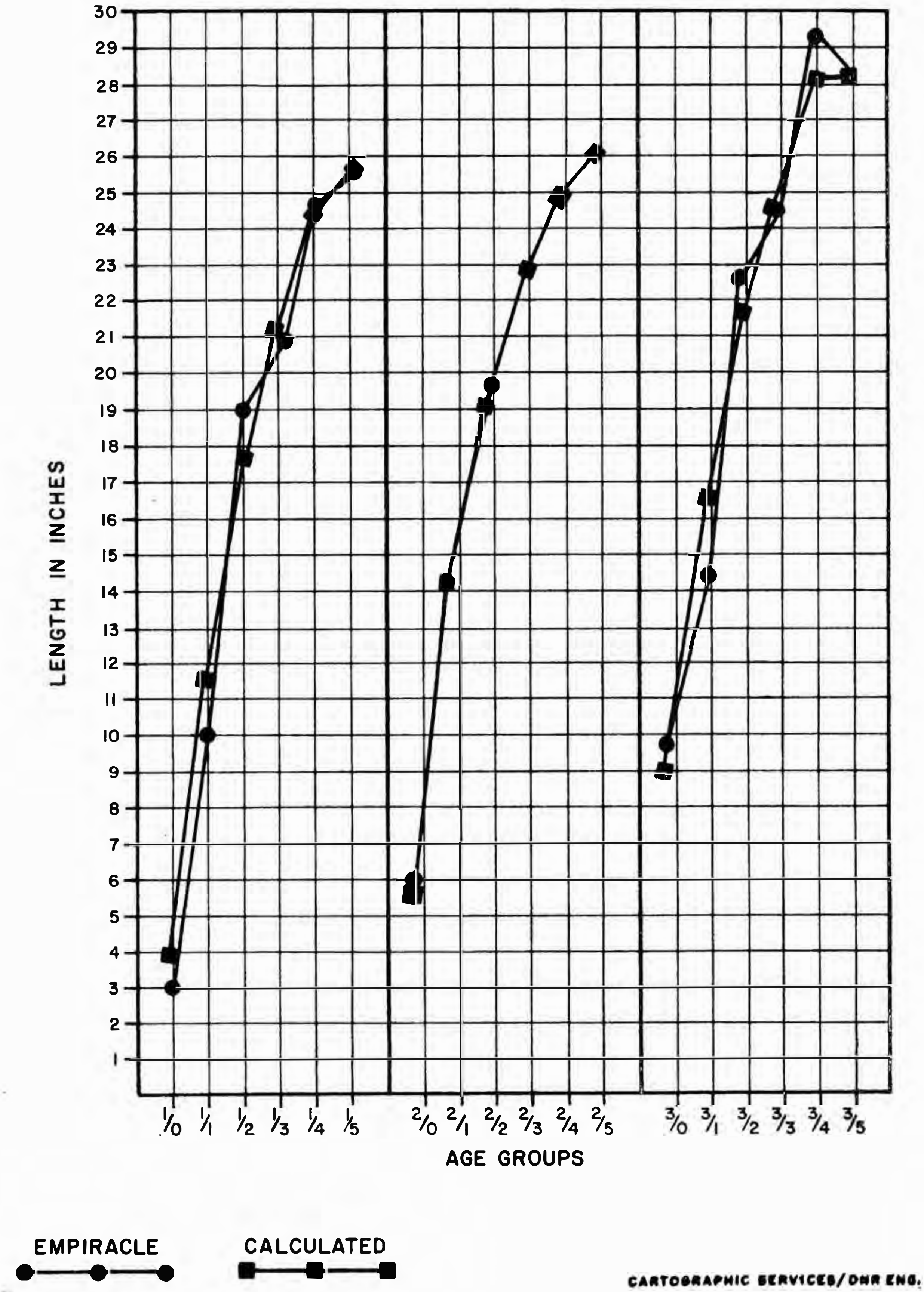

Figure 2 Empiricle vs. calculated lengths of steelhead

TABLE 1 Fall Steelhead (12" +) Migrations For Weekly Periods In The Huron River (1966, 1967, 1970)

Date	Year 1966 (1)	1967 (2)	1970 (3)
9/11 - 17	--	0	1 (4)
9/18 - 24	3	1	2
9/25 - 10/1	--	0	0
10/2 - 8	4	1	10
10/9 - 15	2	10	4
10/16 - 22	12	12	0
10/23 - 29	32	17	19
10/30 - 11/5	2	5	6
11/6 - 12	3	2	2 (4)
11/13 - 19	0	2 (4)	
11/20 - 26	2		
11/27 - 12/3	1 (4)		
Totals	61	50	44

(1) Records for the period 9/18 - 24 were obtained from a 125 ft. gillnet set on 9/23 at the river mouth. Records from the period beginning 10/2 through the period beginning 11/27 were obtained from fyke net, pound net, and U. S. Fish and Wildlife Service weir catches from the river mouth to 2.5 miles upstream.

(2) All fish taken at U.S. Fish and Wildlife Service weir.

(3) All fish taken in trap net located 1.2 miles downstream from U.S. Fish and Wildlife Service weir.

(4) Gear not fished for complete period.

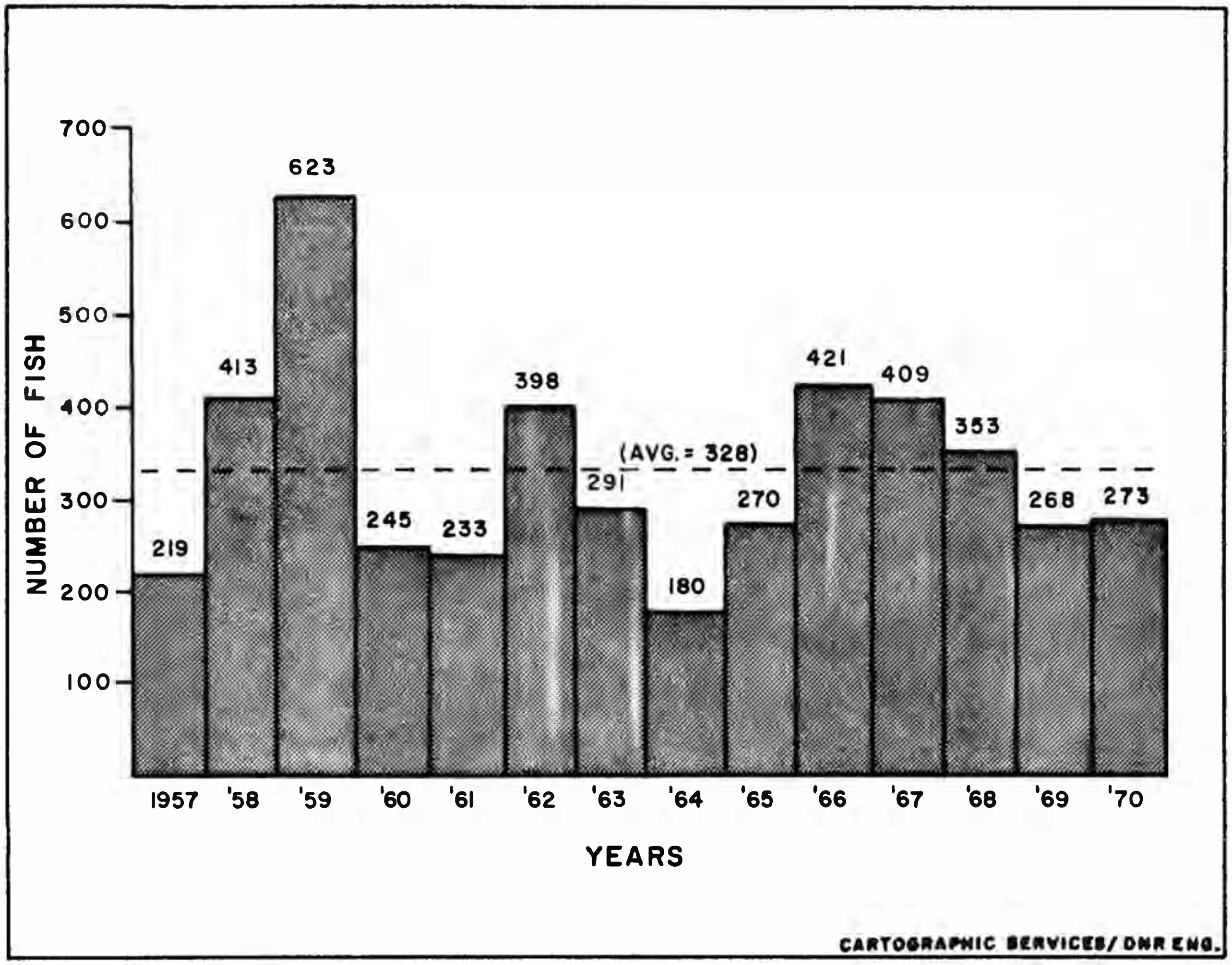

Figure 3 Huron River Steelhead (12" +) runs 1957-1970 from U.S. Fish & Wildlife Service Weir Records

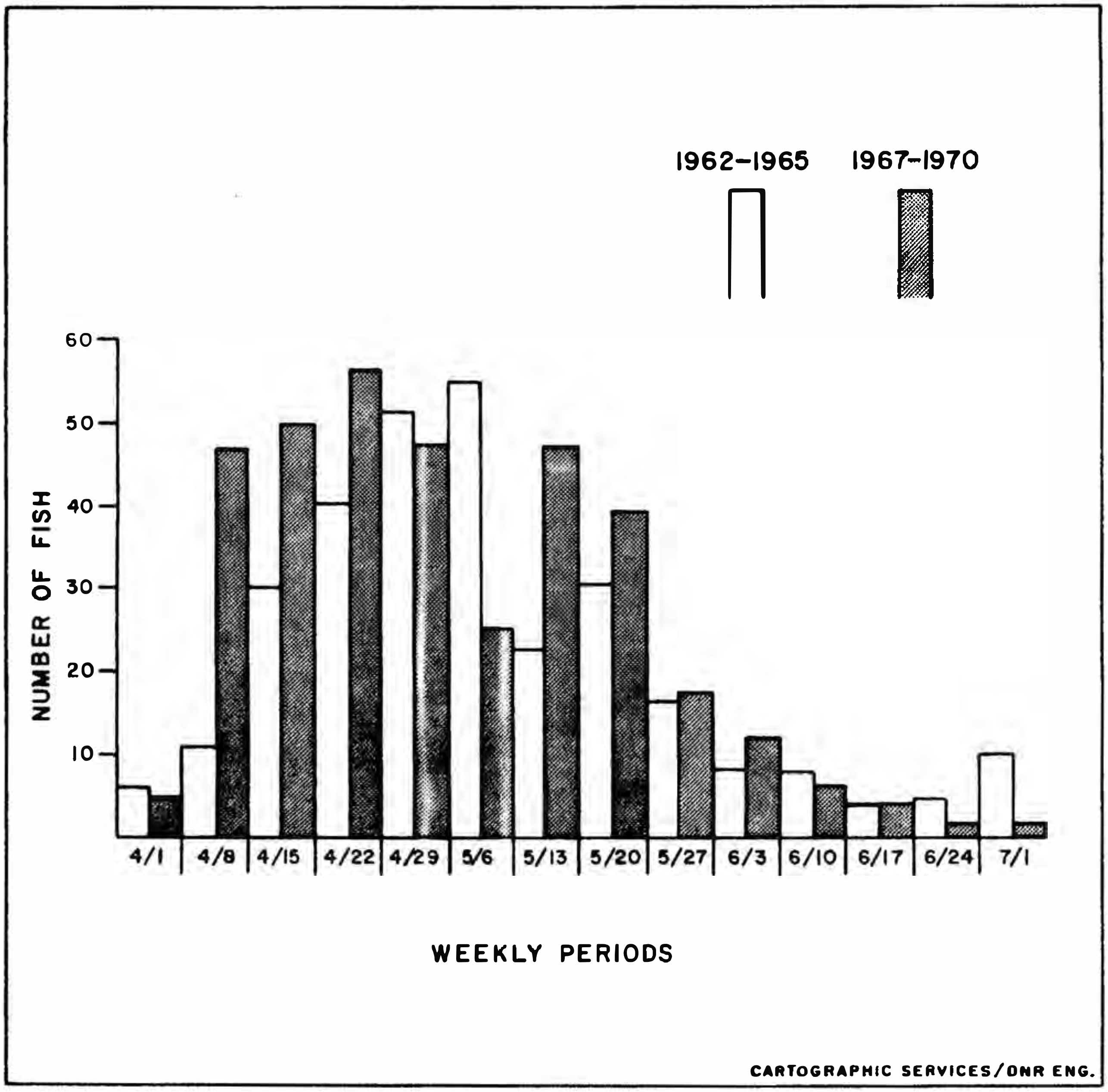

Figure 4 U.S. Fish & Wildlife Service weir catches of steelhead (12 inches and over) for weekly periods in the years 1962-1965, and 1967-1970

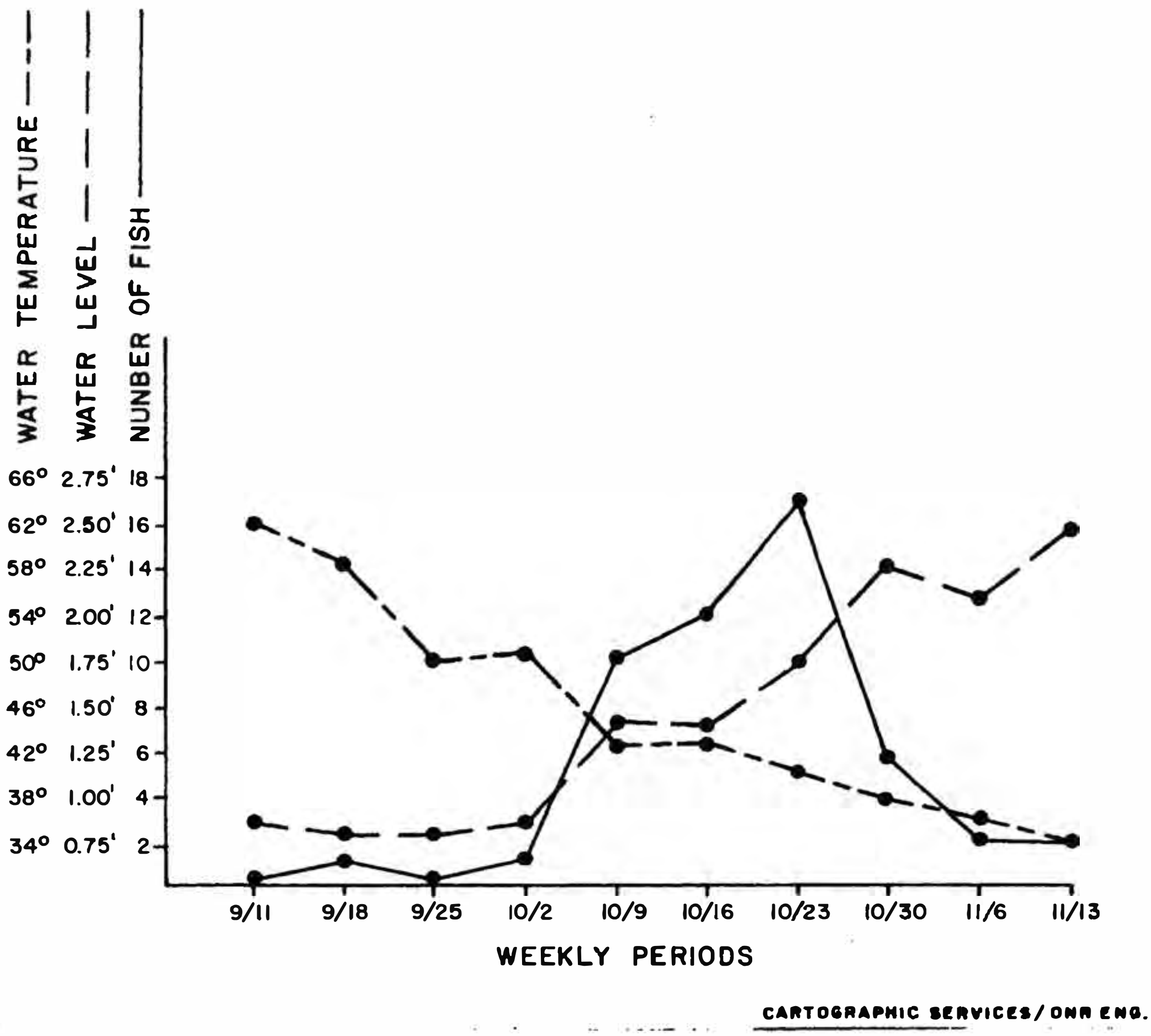

Figure 5 Effect of water temperature and level on the fall steelhead (12" +) run in the Huron River, 1967 (weekly averages)

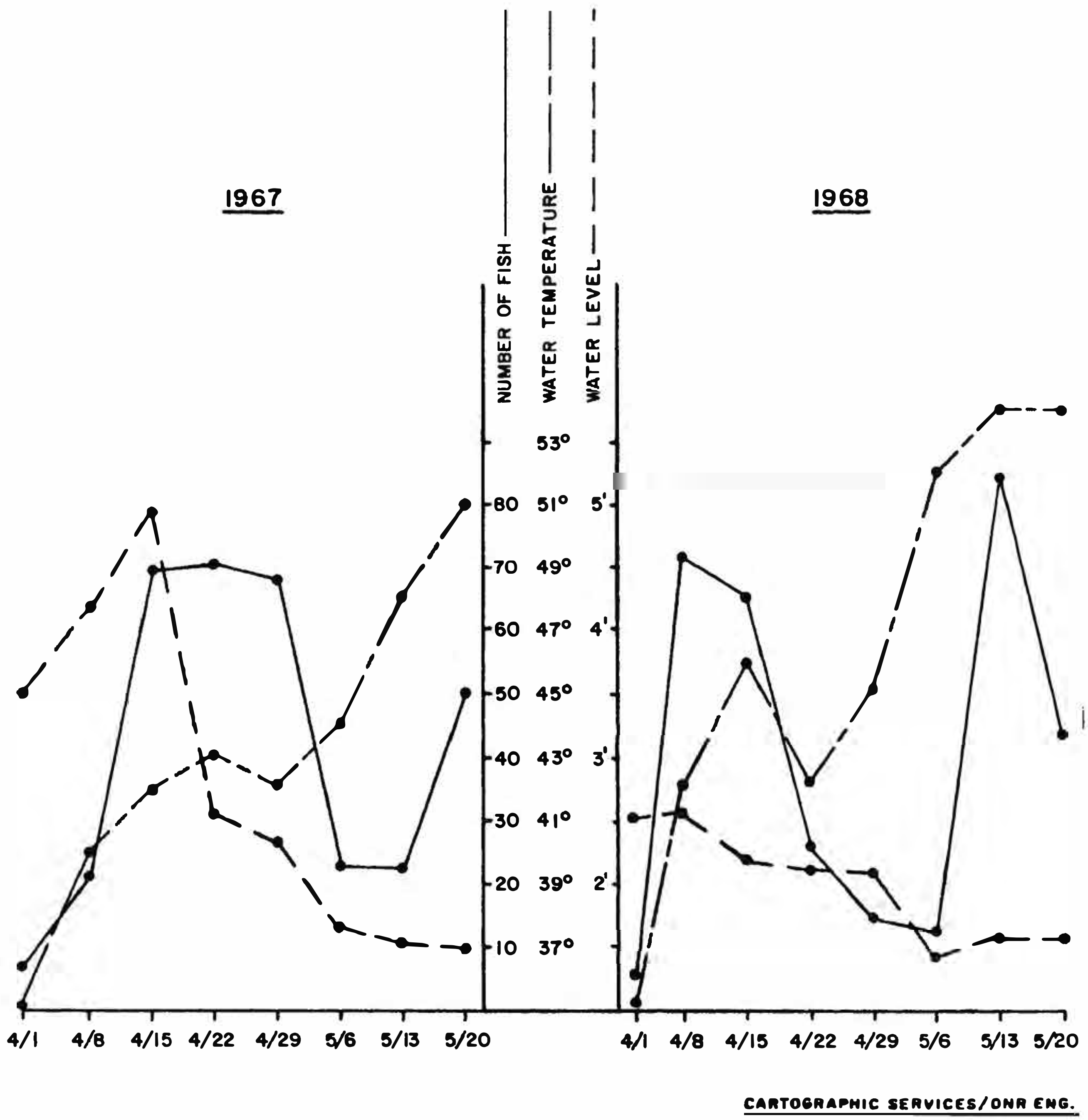

Figure 6 Effect of water temperature and level on the spring steelhead (12"+) runs in the Huron River, 1967-1968 (weekly averages)

level increased steadily for two weeks until peak flow occurred the week of April 15. Then, it steadily dropped toward the normal summer level. In 1968, the water level increased very slightly for one week, then dropped slowly to its summer level.

A second increase in trap catches in 1967 was observed after water temperatures rose steadily for two weeks (40°F. - 48°F.). This also occurred in 1968 when temperatures increased from 42°F. to 52°F. over a two-week period. It is felt that the delayed response of the second large influx of steelhead might be due to the migration distances involved. The initial steelhead movement consists of fish already in or near the river mouth and the second migration peak may result from steelhead moving toward the river from some distance away in Lake Superior.

Age and Size of Fish

Many age groups of steelhead were found in the Huron River. Fish from age 1/1 to age 3/5 were examined. No fish spent more than five years in Lake Superior and prior to migration into the lake all had spent 1 to 3 years in the parent stream. Random samples in 1967 (41 fish) and 1968 (247 fish) indicate that the bulk of the run (57.5%) is made up of steelhead aged 2/2 and 2/3. A summary of the contributions of each age group to the spring, 1967 and 1968 steelhead runs is presented in Table 2.

A length-frequency distribution (Figure 7) of 345 steelhead 12 inches and over trapped at the weir in 1968 shows most fish were from 17 to 25 inches long. Males averaged 20.0 inches and 2.9 pounds and females averaged 22.2 inches and 3.5 pounds. Combining sexes, the average was 21.4 inches and 3.5 pounds.

Sex Ratio

Examination of 98% of the steelhead (12 inches and over) captured at the lamprey weir in the spring of 1968 yielded a sex ratio of one male to 1.6 females (135:210). At no period during the run did the number of males exceed the number of females, but on several occasions the sex ratio was greater than 1:1.6. Similar ratios have been observed in other years but the causes of the unbalanced sex ratio are not definitely known. Since some males may migrate upstream before the weir begins operation in the spring, they may not be included in these data. The sex ratio of the fall runs is similar to the spring runs.

AGE AND GROWTH OF STEELHEAD

Length-Weight Relation

The length-weight relation of Huron River steelhead was based on approximately 400 fish captured in the river with various types of gear from 1967 through 1969. The fish ranged in size from less than 1 inch to over 30 inches and were of both sexes and all states of maturity.

TABLE 2 Contribution of Various Age Groups to The Huron River Steelhead Runs in 1967 and 1968

Age group	1967 Total number of fish aged and (% of total number)	1968 Total number of fish aged and (% of total number)
1/1	0 (0.0)	15 (6.1)
1/2	7 (17.1)	11 (4.5)
1/3	2 (4.9)	14 (5.7)
1/4	2 (4.9)	4 (1.6)
1/5	0 (0.0)	2 (0.8)
Sub-total	11 (26.9)	46 (18.7)
2/1	1 (2.4)	30 (12.1)
2/2	9 (21.9)	62 (25.1)
2/3	16 (39.1)	71 (28.8)
2/4	2 (4.9)	20 (8.1)
2/5	0 (0.0)	2 (0.8)
Sub-total	28 (63.3)	185 (74.9)
3/1	0 (0.0)	2 (0.8)
3/2	1 (2.4)	8 (3.2)
3/3	0 (0.0)	4 (1.6)
3/4	1 (2.4)	1 (0.4)
3/5	0 (0.0)	1 (0.4)
Sub-total	2 (4.8)	16 (6.4)
Grand totals	41 (100.0)	247 (100.0)

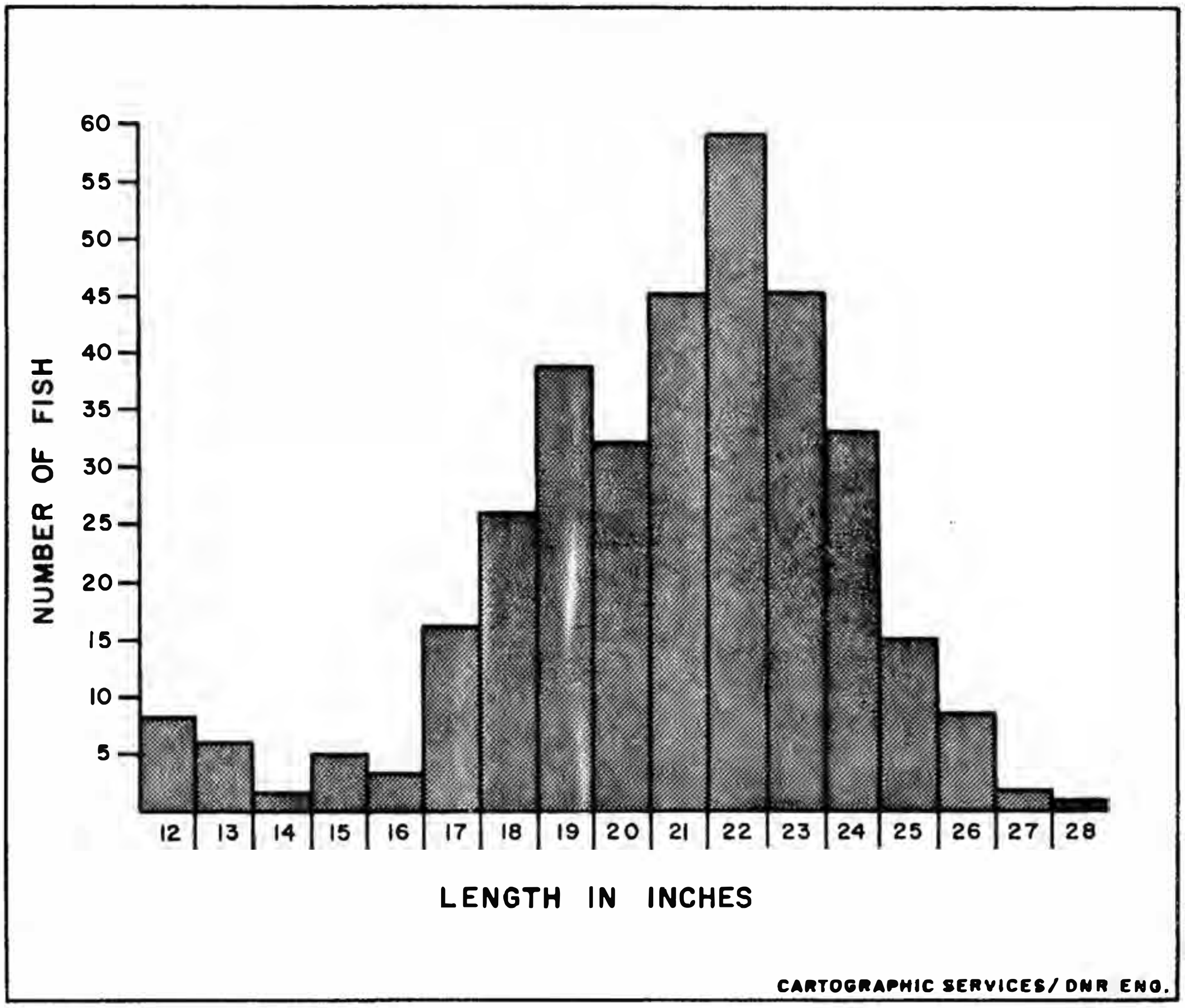

Figure 7 Length frequency distribution of the spring 1968 Huron River adult (12" +) steelhead run

The length-weight equation: $\text{Log } W = -3.35 + 2.91 \text{ Log } L$ or $W = 4.47 \times 10^{-4} L^{2.91}$ (W = weight in pounds, L = length in inches) was derived from fitting a straight line by eye to empirical lengths and weights of fish plotted on full logarithmic graph paper (Figure 8). The slope of the line thus formed was 2.91 and the logarithm of the intercept was calculated from: $\log W = \log c + n \log L$ (c = intercept, n = slope).

Agreement between empirical and calculated lenghts and weights was generally good (Figure 8). Accuracy was best with small fish and decreased with size. Largest deviations occur with large spawning fish where the weight of the gonads is more influential.

Growth in Length

Growth in length was calculated from scales taken from steelhead in 1968. Fish spending 1, 2, and 3 years in their parent stream before migrating to Lake Superior were isolated from each other to correctly calculate the growth pattern for each life history group. Because the fish were captured during and very near the time of annulus formation, empirical lengths and calculated lengths for the year of capture were considered equal.

Stream growth of young steelhead ranged from 2.6 to 3.9 inches annually. The slower growing young fish tended to remain in their parent stream longer than the faster growing fish.

Upon entering Lake Superior, the growth rate of the fish increased considerably. A growth increment of 7.5 to 8.4 inches was recorded in the first year. In successive years, however, the growth rate steadily declined. Table 3 presents the calculated growth in length for each life history category (1/, 2/, 3/). Since empirical lengths were considered equal to calculated lengths for the year of capture, they are included in the Table. It is interesting to note that the oldest fish in each category spent 5 years in the lake and consequently the largest fish captured were those which spent 3 years in their parent stream. Figure 9 illustrates the age-length relation. A separate growth curve is shown for each life history category.

Growth in Weight

Calculated growth in weight (Table 4) was obtained directly from the graph of the length-weight relation (Figure 8) and correspondes exactly with the calculated lengths in Table 3. The three life history growths were separated.

Young steelhead added weight very slowly in the stream but when they migrated to Lake Superior, yearly weight gains increased abruptly. A steady decline in the yearly increment of growth in weight was not evident until the last years of life in each life history group.

Figure 10 illustrates the age-weight relation. Separate growth curves are presented for each life history category. The weights correspond exactly with the lengths in the age-length relation (Figure 9), and is the summation of yearly growth increments.

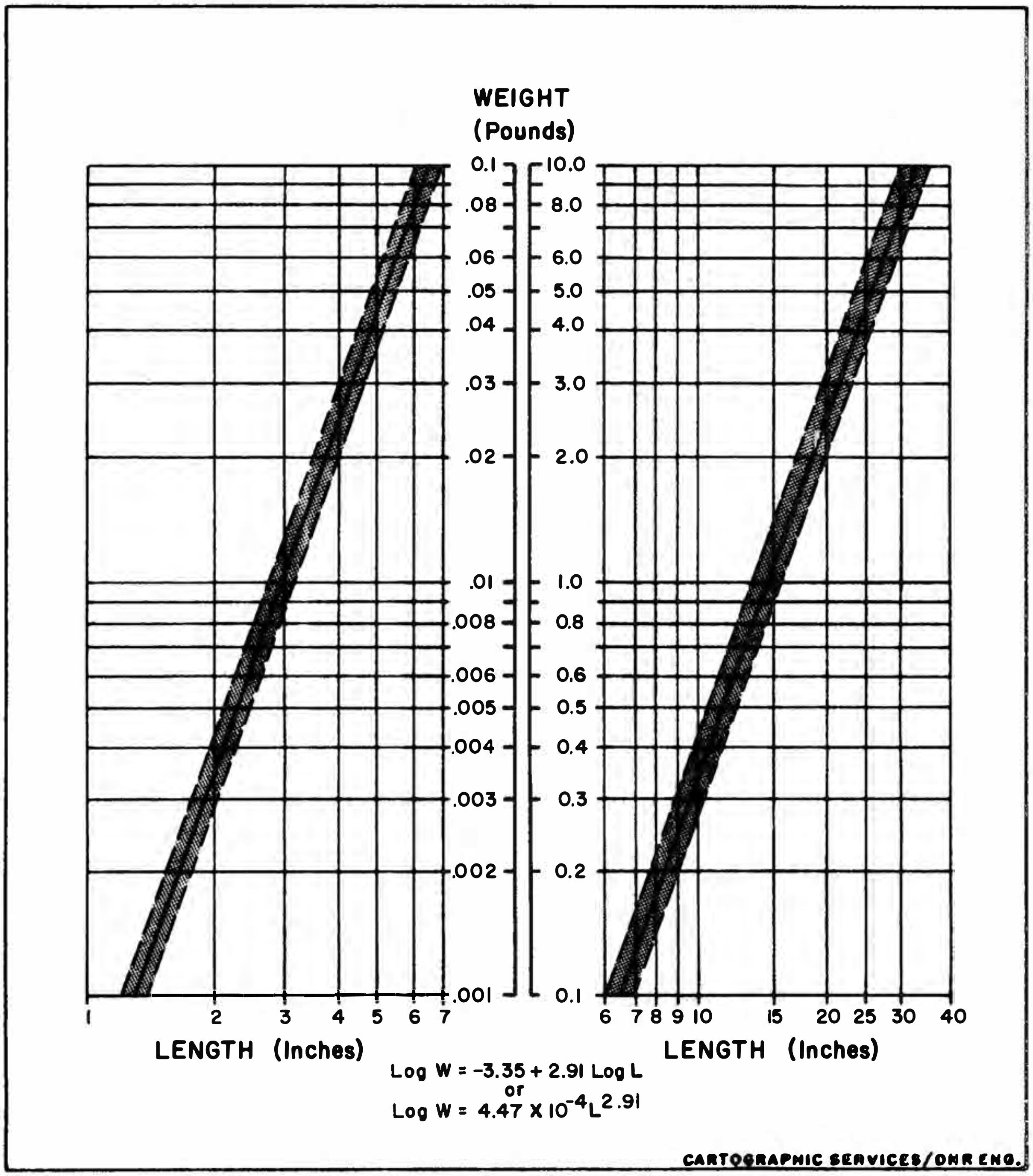

Figure 8 Length - weight relation of Huron River steelhead (dashed lines enclose 90% of empirical data)

TABLE 3 Age and Calculated Growth in Length of 375 Steelhead Captured in the Huron River in 1968

Age & number of fish	Calculated length at each annulus							
	I	II	III	IV	V	VI	VII	VIII
1/0 (103)								
1/1 (15)								
1/2 (11)								
1/3 (14)								
1/4 (4)								
1/5 (2)								
Averages	3.9	11.5	17.9	21.2	24.2	25.7		
Growth increments	7.6	6.4	3.3	3.0	1.5			
2/0 (21)								
2/1 (30)								
2/2 (62)								
2/3 (71)								
2/4 (20)								
2/5 (2)								
Averages	2.7	5.7	14.1	19.1	22.8	24.9	26.0	
Growth increments	3.0	8.4	5.0	3.7	2.1	1.1		
3/0 (4)								
3/1 (2)								
3/2 (8)								
3/3 (4)								
3/4 (1)								
3/5 (1)								
Averages	2.6	5.5	9.2	16.7	21.6	24.6	28.2	28.3
Growth increments	2.9	3.7	7.5	4.9	3.0	3.6	0.1	

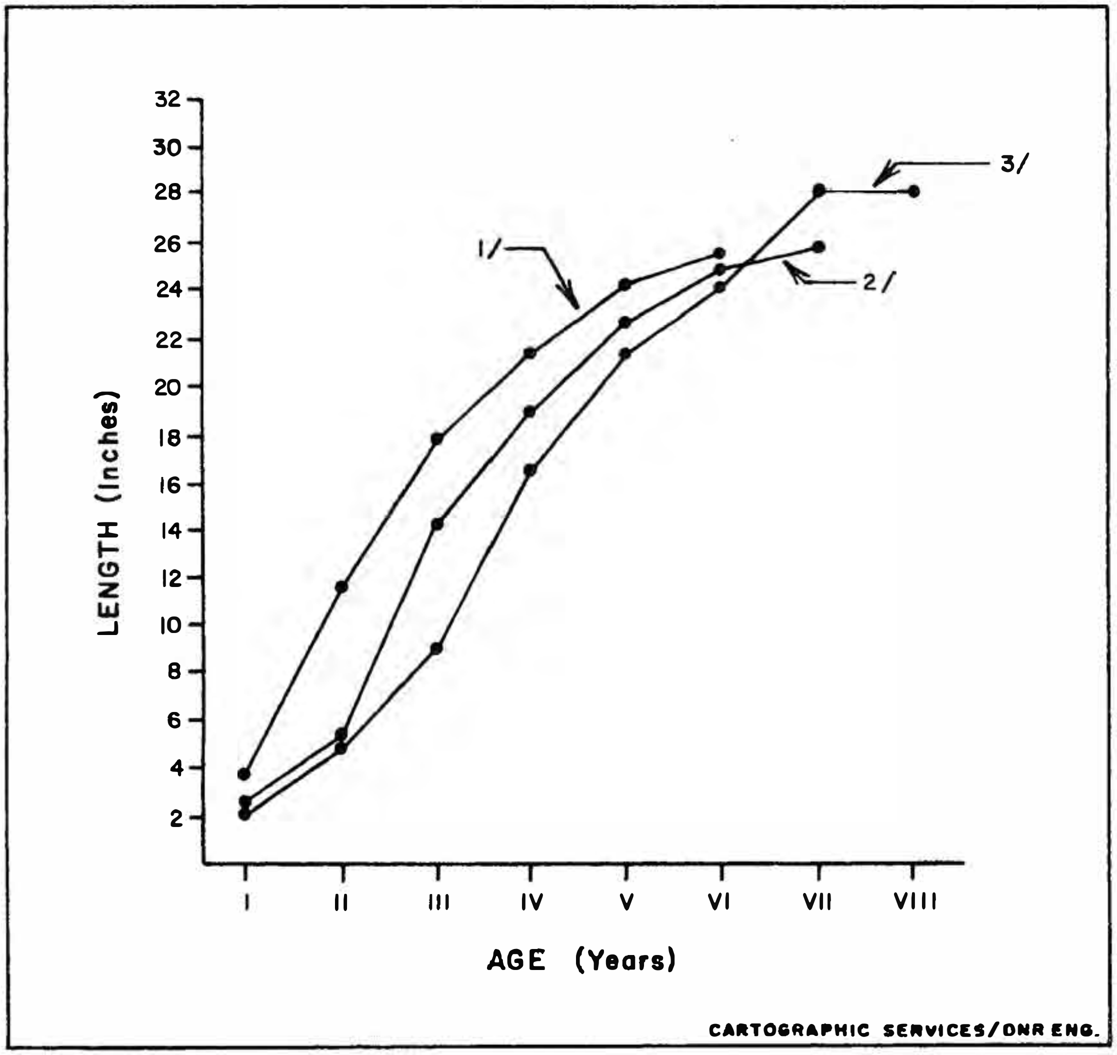

Figure 9 Age - length relation of steelhead living 1, 2, and 3 years in the parent stream before migrating to Lake Superior.

TABLE 4 Age and Calculated Growth in Weight of 375 Steelhead Captured in the Huron River in 1968

Age & Number of fish	Calculated weight (pounds) at each annulus							
	I	II	III	IV	V	VI	VII	VIII
1/0 (103)								
1/1 (15)								
1/2 (11)								
1/3 (14)								
1/4 (4)								
1/5 (2)								
Averages	0.02	0.52	1.90	3.05	4.55	5.45		
Growth increments		0.50	1.38	1.15	1.50	0.90		
2/0 (21)								
2/1 (30)								
2/2 (62)								
2/3 (71)								
2/4 (20)								
2/5 (2)								
Averages	0.008	0.07	0.95	2.30	3.80	4.85	5.55	
Growth increments		0.06	0.88	1.35	1.50	1.05	0.70	
3/0 (4)								
3/1 (2)								
3/2 (8)								
3/3 (4)								
3/4 (1)								
3/5 (1)								
Averages	0.007	0.06	0.27	1.52	3.30	4.75	7.10	7.15
Growth increments		0.05	0.21	1.25	1.78	1.45	2.35	0.05

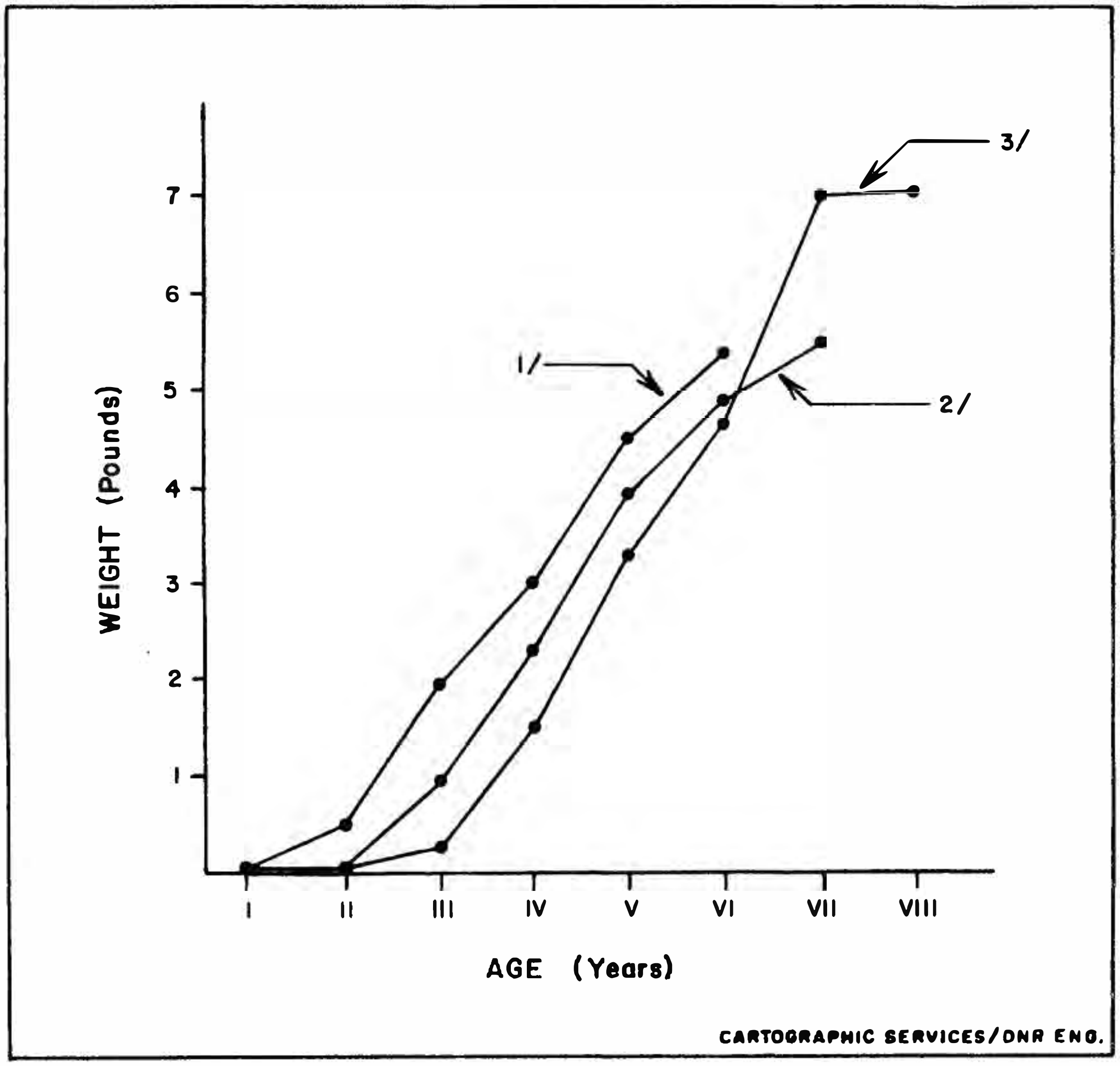

Figure 10 Age - weight relation of steelhead living 1, 2, and 3 years in the parent stream before migrating to Lake Superior

CONCLUSION

In summarizing the data obtained on the spawning migration and growth of steelhead in the Huron River, the following points are especially notable:

1. About 15% of the steelhead run entered the stream in the fall (primarily in October). Those fish over-wintered in the lower reaches of the river.

2. During the following spring, the remaining 85% of the run entered the river beginning in early April and extending into July.

3. Upstream movement of spring and fall migrants was triggered by water level and temperature fluctuations, as well as the fish's state of maturity.

4. The sex ratio of both the spring and fall runs was unbalanced toward females at the rate of about 1:1.6.

5. Of the 15 age groups of steelhead encountered (1/1 to 3/5), the predominate ones were age 2/2 and 2/3 (approximately 58% of the total run). Those fish averaged 19 to 23 inches in length and 2 to 4 pounds in weight.

6. The length-weight relation for Huron River steelhead was: $\text{Log } W = -3.35 + 2.91 \text{ Log } L$.

7. Stream growth of juvenile steelhead was slow (2.6 to 3.9 inches per year), but it increased rapidly when the fish migrated into Lake Superior (7.5 to 8.4 inches per year for the first year of lake life). Weight gains followed a similar pattern.