



Volume 10

1968-1969

6 SH,
11
.A73
A4
v.10

STATE OF ALASKA
Keith H. Miller, Governor



ANNUAL REPORT OF PROGRESS, 1968 - 1969
FEDERAL AID IN FISH RESTORATION PROJECT F-9-1
SPORT FISH INVESTIGATIONS OF ALASKA

ALASKA DEPARTMENT OF FISH AND GAME
Wallace H. Noerenberg, Acting Commissioner

Alaska Rupert E. Andrews, Director
Division of Sport Fish

Louis S. Bandirola, Coordinator

ARLIS
Alaska Resources
Library & Information Services
Anchorage, Alaska

ALASKA RESOURCES LIBRARY
U.S. DEPT. OF THE INTERIOR
ANCHORAGE, ALASKA
EST. 1957

44
11
A 93
A 4
U. 10
Volume 10

THE STATE OF ALASKA
MILLER, GOV.

INTRODUCTION

This report of progress involves the findings and work accomplished under the State of Alaska, Federal Aid in Fish Restoration, Project F-9-1, "Sport Fish Investigations of Alaska".

The work conducted during this reporting period constitutes effort on nine separate studies which are crucial in evaluating the sport fishing resources of the State. Recreational demands have necessitated broadening our knowledge of the fishery. All 20 jobs were of continuing nature enabling the Department to keep abreast of present and future impacts on certain fish species. Specifically, the work included work on inventory and cataloging of the sport fish and sport fish waters of the State, sport fishery creel census and access. Special emphasis was given to Dolly Varden, silver salmon, anadromous fish, grayling, salmon, sheefish, pike, and char. The information gathered has provided supporting documentation for better fish management and a basis for necessary future investigations.

The subject matter contained in these reports may be inconclusive. The findings and interpretation are subject to re-evaluation as the work progresses.

CAMP
MILLER, GOV.

ALASKA
Alaska Resources

RESEARCH PROJECT SEGMENT

STATE: ALASKA Name: Sport Fish Investigations of Alaska.
 Project No.: F-9-1 Title: Investigation of Anadromous Dolly Varden Populations in Hood Bay Drainages, South-eastern Alaska.
 Job No.: 2-B

Period Covered: July 1, 1968 to June 30, 1969.

ABSTRACT

This report presents the results of the fourth year of study at Hood Bay and the seventh year of investigation on the life history of the Dolly Varden, Salvelinus malma (Walbaum). In addition to the operation of the weir on the South Arm Stream, two weirs were built and operated on two of the streams entering the North Arm of Hood Bay. Emphasis of study included determining the amount of interstream movement of Dolly Varden between the Hood Bay streams and their migration patterns as related to maturity. Homing tendencies, maturity composition of immigrants, spawning frequencies, mortality rates and age studies were investigated at these streams. In addition, information was gathered on rearing Dolly Varden and smolts with special emphasis on the relationship of these fish with regard to competition for food and space with other species.

A total of 9,162 Dolly Varden smolts left the South Arm Stream in 1968. Of these, 6,729 left during a spring outmigration from mid-May to mid-June and 2,433 during a fall outmigration from late August to early November. Also, 4,000 coho salmon smolts were estimated to have left the South Arm Stream with the same timing as the spring outmigrant char. Both species left the system after the majority of pink and chum fry had outmigrated. Dolly Varden smolts were mostly ages III and IV and coho smolts were mostly ages I and II. Both species fed mostly on pink and chum salmon young and insects. The average condition factor of the coho smolts (1.10) was higher than that of Dolly Varden smolts (0.89).

Considerable numbers of Dolly Varden smolts entered the North Arm streams after leaving the South Arm Stream. It was concluded that a distinct migration of the smolts originating from the South Arm Stream to other stream systems was occurring.

Food studies of the rearing fish in Hood Bay Creek indicated that competition for food was occurring between Dolly Varden, coho and cottids. Competition for space between Dolly Varden and coho was also indicated. It was estimated that rearing Dolly Varden, coho and cottids consumed between 11 and 20 percent of the pink and chum salmon fry outmigrating the South Arm Stream in 1968.

Estimates of the numbers of Dolly Varden entering the Hood Bay streams in 1968 were: South Stream = 5,007; North Stream #1 = 8,285; North Stream #2 = 4,653. The number of spawners entering these streams were 1,488, 1,045, and 738, respectively. The other immigrants were nonspawners and appeared to consist mainly of char from other stream systems.

Age groups II through XI were found among the immigrant char with the majority of these fish occurring in age groups III through VI. By maturity most nonspawners were in age groups III, IV and V and potential spawners in age groups IV, V and VI.

Of the char spawning in the South Arm Stream in 1968, 18, 29 and 54 percent were estimated to have spawned three, two and one year respectively. Females spawning more than one year were much more abundant than males. The mortality of Dolly Varden spawners between entering the South Arm Stream and leaving was estimated to be 8.8 percent for females and 49.2 percent for the males.

Dolly Varden were displaced from each of the three Hood Bay streams to a point in saltwater off the junction of the North and South Arms of the Bay. Mature char homed to the system displaced from while immature char did not. Further evidence of homing was obtained from the char originating from the South Arm Stream in 1967 (as smolts) which returned to their home stream to spawn in 1968. Most of the char entering their home stream were mature, and most entering the North Arm streams were immature. They were recorded as spawning only in their home stream.

RECOMMENDATIONS

Research

The major emphasis of research should continue to be directed toward the study of the migration habits of Dolly Varden with special emphasis on their homing capabilities as related to their maturity. This study should follow three lines of investigation which are as follows:

1. Determining the homing capabilities, at maturity, of Dolly Varden originating from the South Arm Stream. If Dolly Varden return to their home stream to spawn, then the majority of the char spawning in the South Arm Stream this year (1969) should be the char marked during their migration as smolts in 1967 and 1968. Special emphasis should be made this year (1969) to capture the spawned-out char leaving the South Arm Stream to determine the number of these char that have returned to their home stream for spawning.
2. Determining the stimuli used by Dolly Varden in locating their home stream and lakes in which to winter. The use of sonic transmitters attached to displaced char and plotting their direction of travel with a sonic receiver would be one approach to this study. Mature, immature and spawned-out char should be used in the displacement experiments so the results can be related to their degree of maturity. Consideration should be given to conducting these experiments with blinded and olfactory-occluded char to determine the role these senses play in determining their migration routes.

3. Determining if Dolly Varden smolts and pre-smolts transplanted from one system to another will return to the receiving system at maturity. These fish could be captured in the North Arm streams and transplanted to the South Arm Stream. The transplanted char should be fin-clipped for identification of these fish that return to the receiving system to spawn.

Emphasis should also be placed on conducting research to determine rearing capacities of streams for Dolly Varden young and the factors controlling the numbers of rearing char a stream can support. This research should include:

1. Determining if Dolly Varden and coho young compete for space and if so, how this competition affects the rearing capacity of an area for each species.
2. Determining environmental factors of a stream which affect the numbers of Dolly Varden and coho rearing in a given area. Some factors to consider are shade, cover, streambed gravel size, number of pool and riffle areas, and water conditions.
3. Determining the amount of intrastream movement of the rearing fish and reasons for movement (if occurring).

Management

The ultimate objective of the Dolly Varden project is to provide information for management of the species. Since any management recommendation should be based on a thorough understanding of biology, ecology, and life history of the species, most of our research to date has been directed toward obtaining information on these aspects. This was especially important since little was known about Dolly Varden at the onset of the project. Another important approach has been to determine what information others have gathered on the life history and management of this char.

A thorough search of the literature for information on Dolly Varden has been completed and published (Armstrong and Morton, 1969). Also, a substantial amount of information has been gathered on the biology, ecology, and life history of the species, most of which has been published (Armstrong, 1963; 1965a; 1965b; 1965c; 1967; Armstrong and Blackett, 1966a; 1966b; Armstrong and Winslow, 1968; Blackett, 1968; Blackett and Armstrong, 1965a; 1965b; and Heiser, 1966).

For maximum value to management this information should be brought together and interpreted as to how it can be used in future management of our Dolly Varden stocks. It is therefore recommended that a publication on the life history of the Dolly Varden with recommendations for management be written.

The information gathered this field season supports the management recommendations presented by Armstrong and Winslow, 1968. An additional and very important potential future management problem brought out this year concerns the number of Dolly Varden spawners entering our streams. From the information gathered on the maturity of immigrant Dolly Varden it was concluded that 1,500 to 2,000 Dolly Varden spawners may be a high annual average number entering streams on the islands of Southeastern

Alaska. The amount of fishing pressure these spawning populations can tolerate should be taken into consideration. When conducting a creel census program on char, the maturity composition of the catch should be obtained.

OBJECTIVES

1. Determine the number and timing of Dolly Varden smolts leaving the South Arm Stream.
2. Determine the size, age, sex, and food of Dolly Varden smolts leaving the South Arm Stream.
3. Determine the number and percent of the South Arm Stream Dolly Varden smolts entering the streams of the North Arm of Hood Bay in the same year as their outmigration from the South Arm Stream and in subsequent years.
4. Determine the number and percent of the South Arm Stream Dolly Varden smolts returning (homing) to the stream in the same year as outmigration and in subsequent years.
5. Determine the size, age, sex, and maturity of the South Arm Stream Dolly Varden smolts entering the North Arm streams and of those returning to the South Arm Stream.
6. Determine the amount of interstream migration of immigrant Dolly Varden entering Hood Bay streams.
7. Determine the number and timing of Dolly Varden entering the streams of Hood Bay.
8. Determine the size, age, sex, and maturity of Dolly Varden entering the streams of Hood Bay.
9. Determine the number and timing of Dolly Varden leaving the South Arm Stream.
10. Determine the frequency of spawning, by sex, of Dolly Varden spawning in the South Arm Stream.
11. Determine the percent mortality of Dolly Varden after spawning, by sex.
12. Determine the homing tendencies, by maturity, of Dolly Varden displaced from the Hood Bay streams.
13. To compare the types of food ingested by Dolly Varden young during their period of rearing in the South Arm Stream to the types of food ingested by coho salmon young during their period of rearing in the South Arm Stream.
14. To design and instigate experiments which will determine if competition for rearing space between Dolly Varden and coho salmon young in the South Arm Stream exists and if so, to obtain an indication of the effects this competition may have on the rearing capacity of the South Arm Stream for each of the species.

15. Determine the numbers and timing of salmon entering Hood Bay streams.
16. Determine the timing of pink, chum and coho salmon young leaving the South Arm Stream.

TECHNIQUES USED

Studies were conducted on three streams in Hood Bay on Admiralty Island, Southeastern Alaska. For ease of discussion, each stream has been given a name. They are: South Arm Stream, North Arm Stream #1, and North Arm Stream #2 (Figure 1).

In the South Arm Stream, an 85-foot wood weir with removable 1/2- or 5/8-inch mesh screens was used to capture smolt, immigrant and outmigrant Dolly Varden (Figure 2). The weir contained three traps of which two were operated in the direction of major migration.

Temporary weirs were built on two streams in the North Arm of Hood Bay during June, 1968 (Figures 3 and 4). These weirs consisted of one 9- by 9-foot permanent trap, identical in basic construction to the ones on Hood Bay Creek, with wire mesh leads. The traps were modified to capture both immigrant and outmigrant char simultaneously.

All Dolly Varden smolts captured at the South Arm Stream weir were measured (fork length in mm) and fin clipped (right ventral) or sampled. Each char smolt sampled was measured, weighed and dissected to determine sex and stomach content. Otoliths were obtained from the sampled char and stored (dry) for later age analysis.

Immigrant Dolly Varden captured at the three weirs were measured and examined for fin clip or tag. All char were given a partial anal fin clip (South Arm Stream) or a hole was punched in the upper or lower portion of the caudal fin (North Arm streams). Samples of the immigrant Dolly Varden were taken to determine age, sex and maturity. Outmigrant char captured in the traps of the three weirs were measured and examined for fin clip or tag. Nonspawners were marked identically to the immigrants. Spawned-out char were sexed by external characteristics, fin clipped adipose, and tagged with numbered dart or internal anchor tags.

A marked-to-unmarked ratio of the outmigrants (Peterson Estimate) was used to estimate the total number of char that had entered the three streams because removal of the weir screens and leads during high water periods caused some char to be missed. The estimated immigration for the South Arm Stream was computed as follows:

$$\frac{639 \text{ unmarked outmigrants}}{664 \text{ marked outmigrants}} \times \frac{\text{estimated number missed}}{2,275 \text{ number available for recapture (marked)}} = 2,189 \text{ Total Fish Missed}$$

$$\begin{array}{r} 2,189 \text{ estimated number missed} \\ + 2,275 \text{ number available for recapture} \\ + 279 \text{ fish sampled} \\ + 162 \text{ fish dead} \\ + 102 \text{ fish displaced} \\ \hline \end{array}$$

5,007 estimated immigration

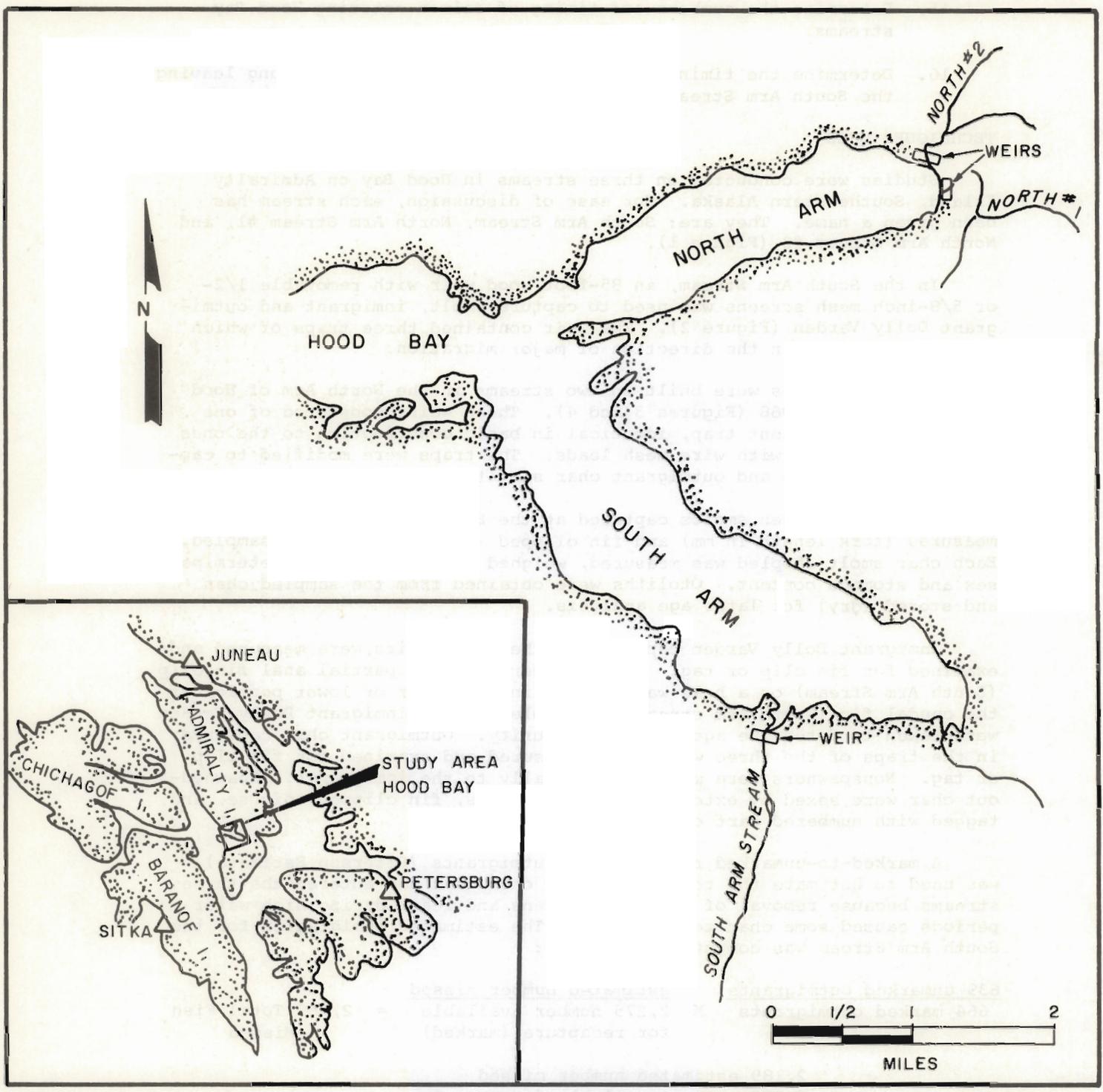


FIGURE 1. SKETCH MAP OF HOOD BAY SHOWING THE LOCATIONS OF THE STUDY SITES.

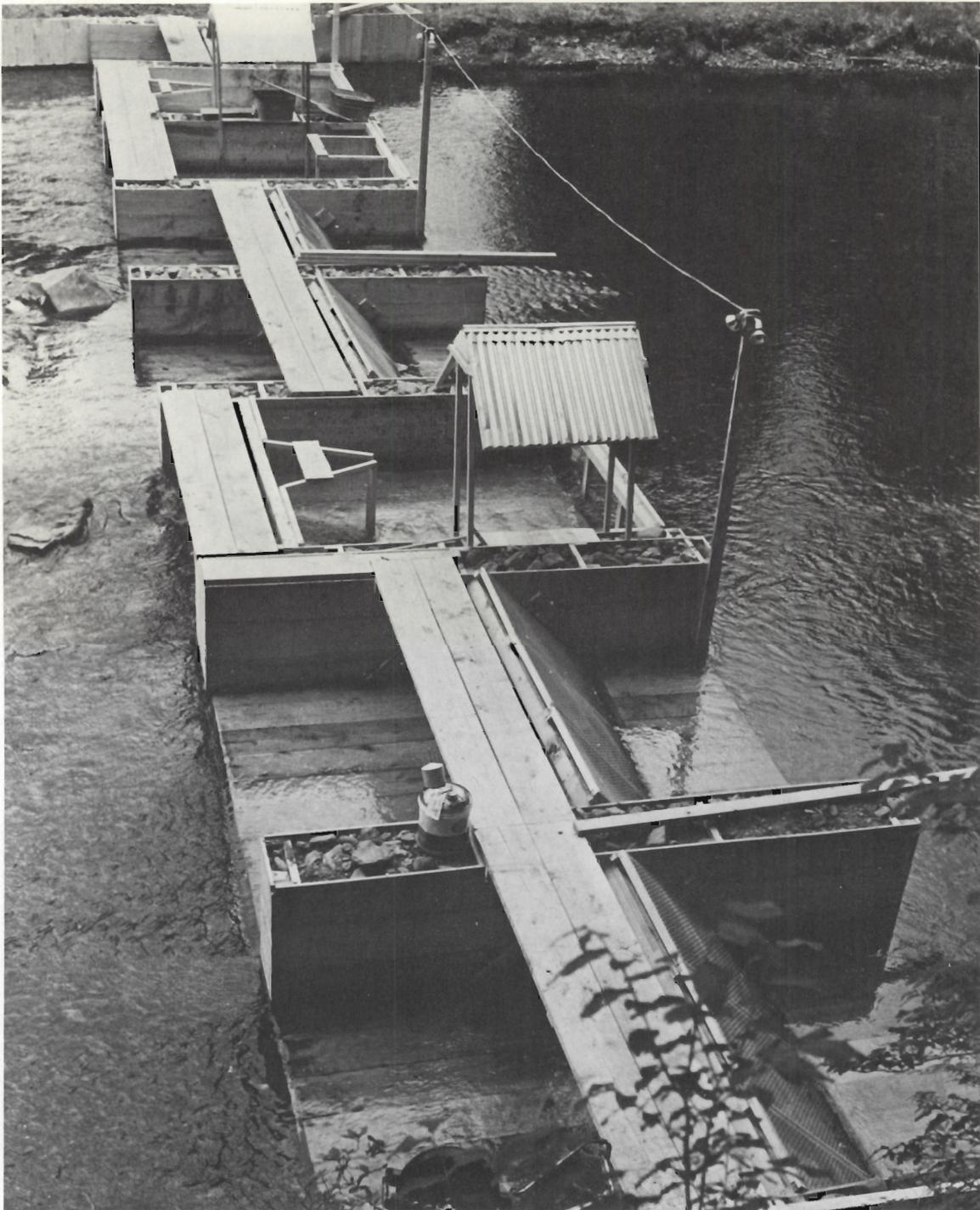


FIGURE 2. The Weir on the South Arm Stream.

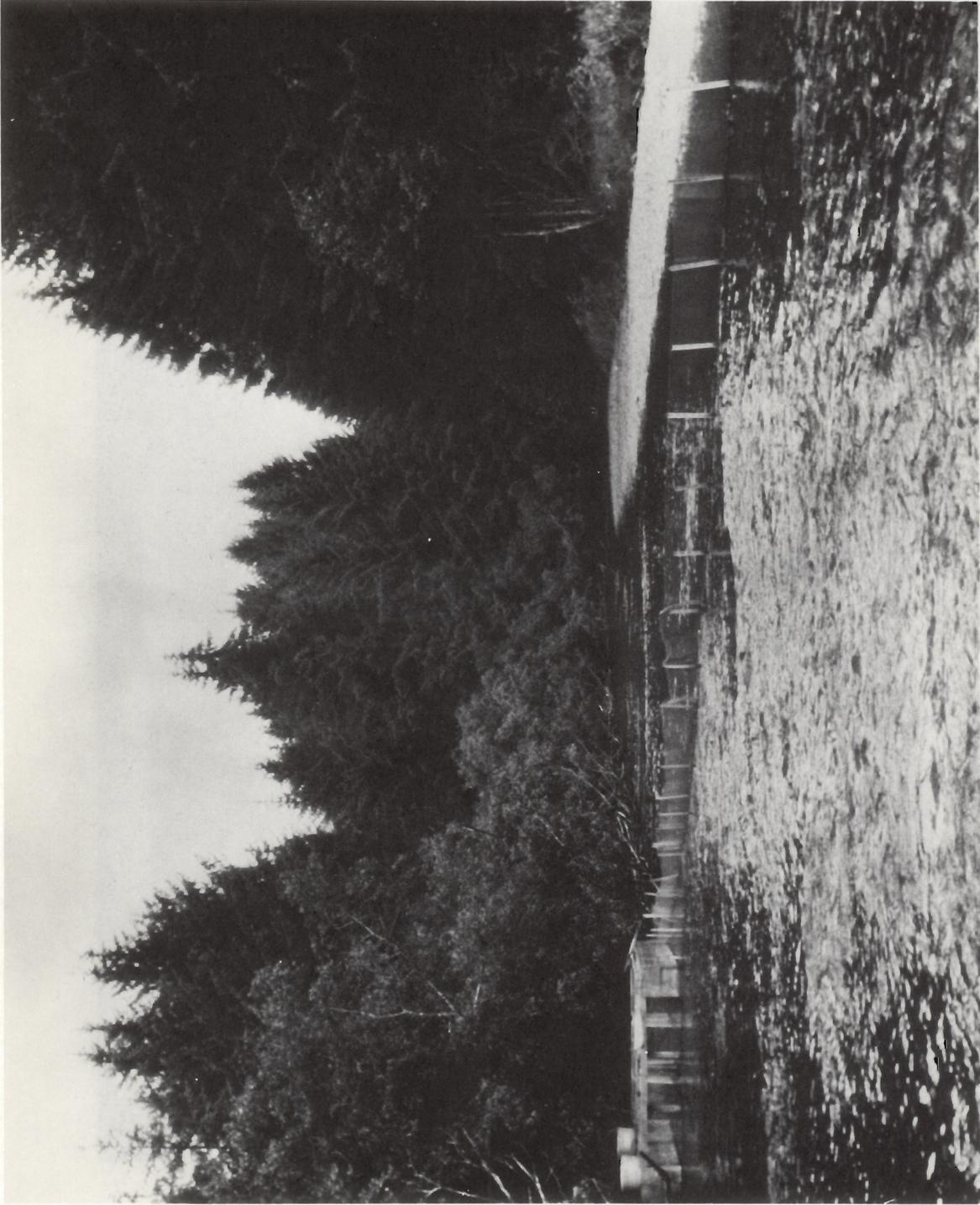


FIGURE 3. The Weir on the North Arm Stream #1.

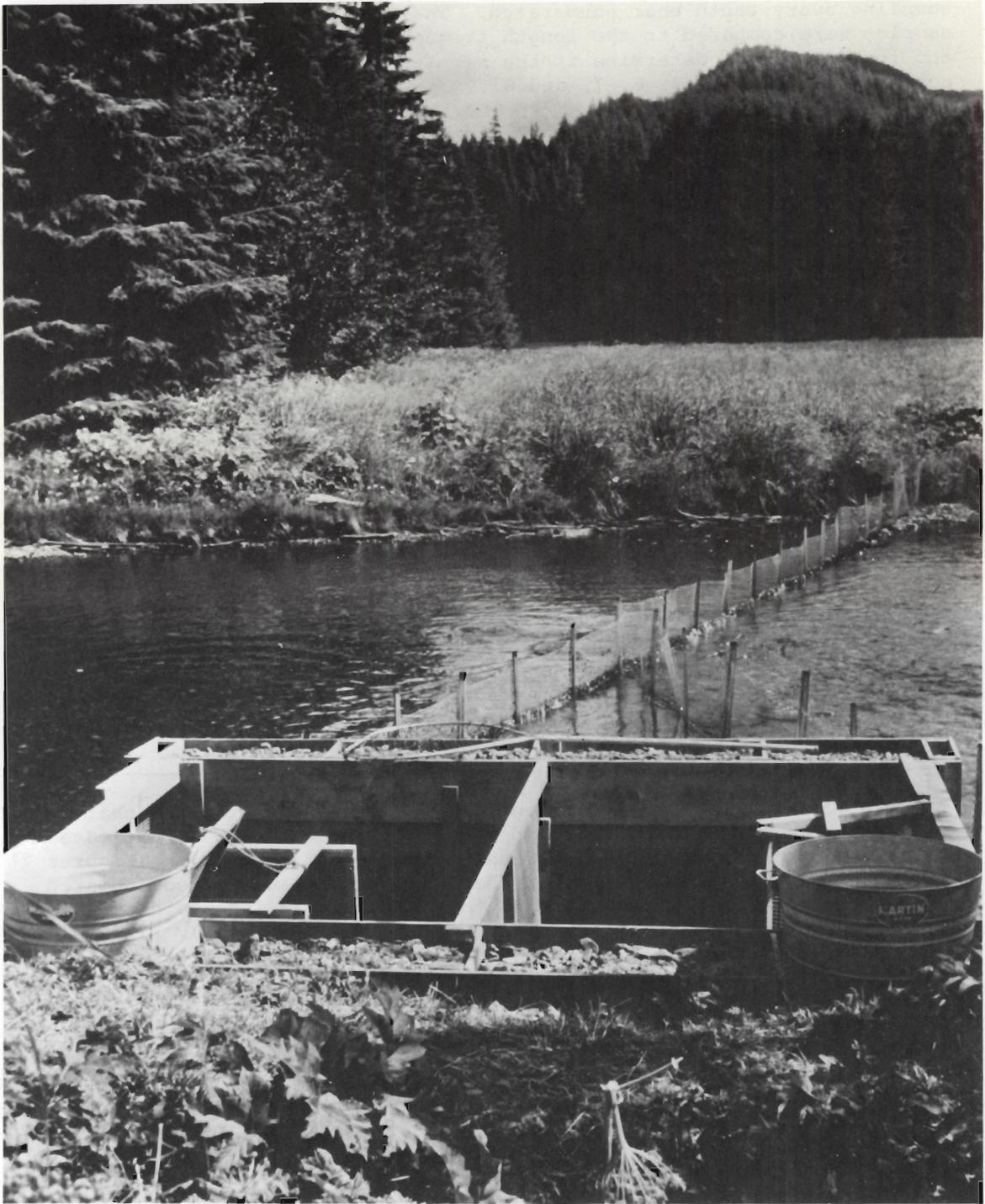


FIGURE 4. The Weir on the North Arm Stream #2.

Validity of Sample

The sample of smolts and immigrant Dolly Varden was obtained by sampling every tenth char enumerated. The length frequencies of these samples were compared to the length frequencies of the enumerated smolts and immigrants to determine if the samples were representative of the populations (Figures 5, 6, 7, and 8).

Comparison of Dolly Varden smolts sampled to those enumerated (Figure 5) for the spring smolt outmigration at the South Arm Stream showed close correlation and a chi-square test confirmed that the sample was representative of the population (Table 1). The sample size of the fall smolts was so small (n=32) that we felt valid conclusions could not be made.

TABLE 1 - Computed Chi-Square Values for the Dolly Varden Sampled Compared to Those Enumerated at the Hood Bay Weirs.

<u>Stream</u>	<u>Computed x²</u>	<u>DF*</u>	<u>Theor. x² α = .05</u>	<u>Significant</u>
South Arm Stream:				
Immigrant spawners	1.8	2	5.9	No
Immigrant nonspawners	25.1	10	18.3	Yes
Spring smolt	6.1	9	16.9	No
North Arm Stream #1 (immigrants)	11.0	19	30.1	No
North Arm Stream #2 (immigrants)	11.7	15	25.0	No

*DF = Degrees of freedom.

Graphing of the length frequencies of those enumerated vs. char sampled in North Arm Streams #1 and #2 were similar enough to indicate that the immigrant sample was representative of the population (Figures 6 and 7). In the South Arm Stream the Dolly Varden enumerated compared to those sampled showed variation in the smaller size intervals (Figure 6), so a chi-square significance test was computed (Table 1). It was found that there was a significant difference at the 95 percent level caused mainly by undersampling of fish in the 100 to 170 mm size ranges. Dividing the population into spawners and nonspawners, fish over 300 mm are usually classified as potential spawners, for which another chi-square test was computed (Table 1). It was found that with the potential spawners there was no significant difference at the 95 percent level, while with fish under 300 mm there was. The sampling variation occurred within the nonspawner size group as the 100 to 170 mm size range was undersampled and the 230 to 280 mm size range was oversampled; however, the percentage of char less than 300 mm in the sample (78 percent) was close to the same group among enumerated char (77 percent). Therefore, the estimated maturity composition of the population should be reliable and the conclusions drawn from the sample, with the possible exception of the age composition of nonspawners, should be reliable.

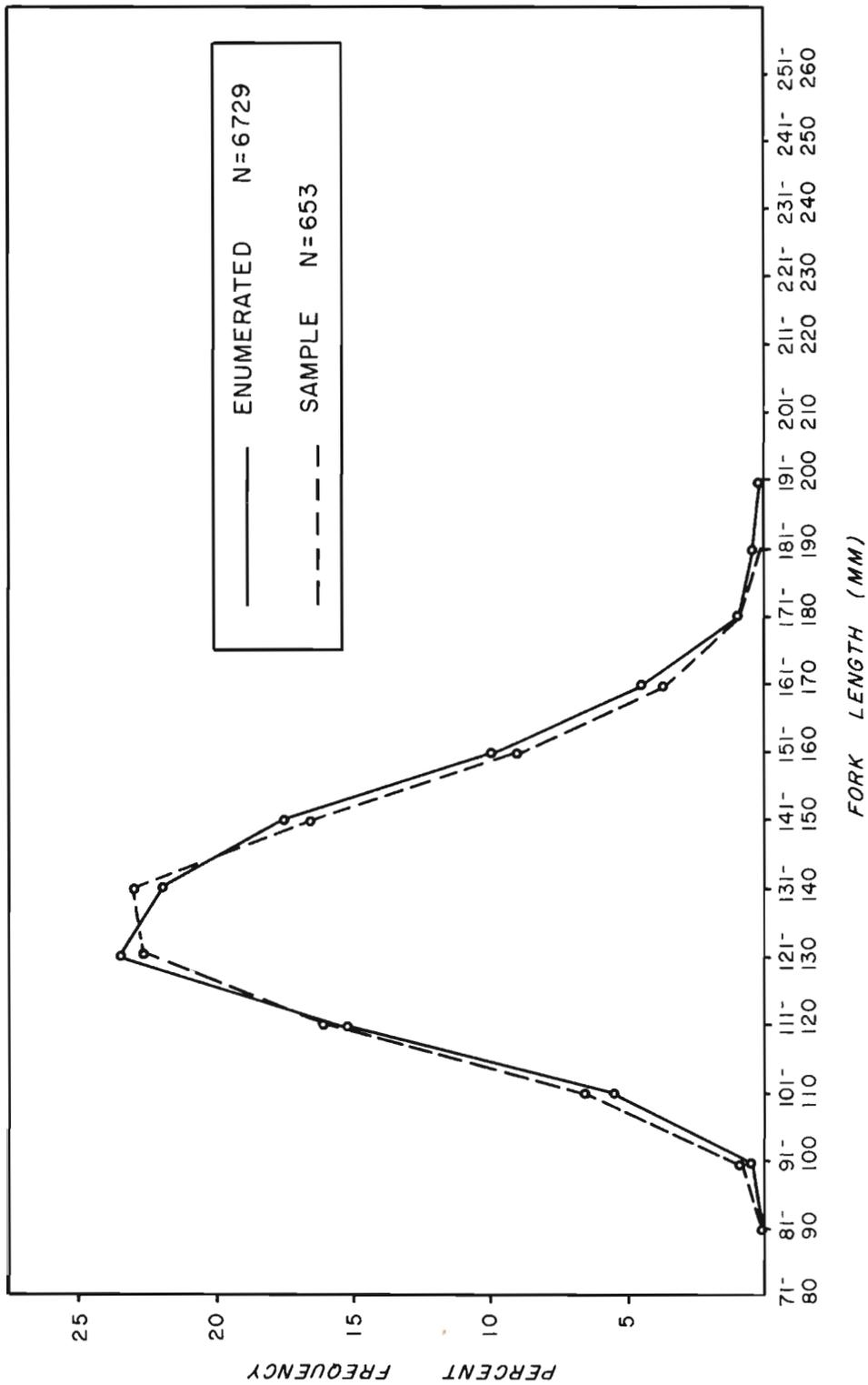


FIGURE 5. LENGTH FREQUENCY OF DOLLY VARDEN SMOLTS SAMPLED COMPARED TO THOSE ENUMERATED AT THE SOUTH ARM STREAM WEIR DURING THE SPRING OUTMIGRATION, 1968.

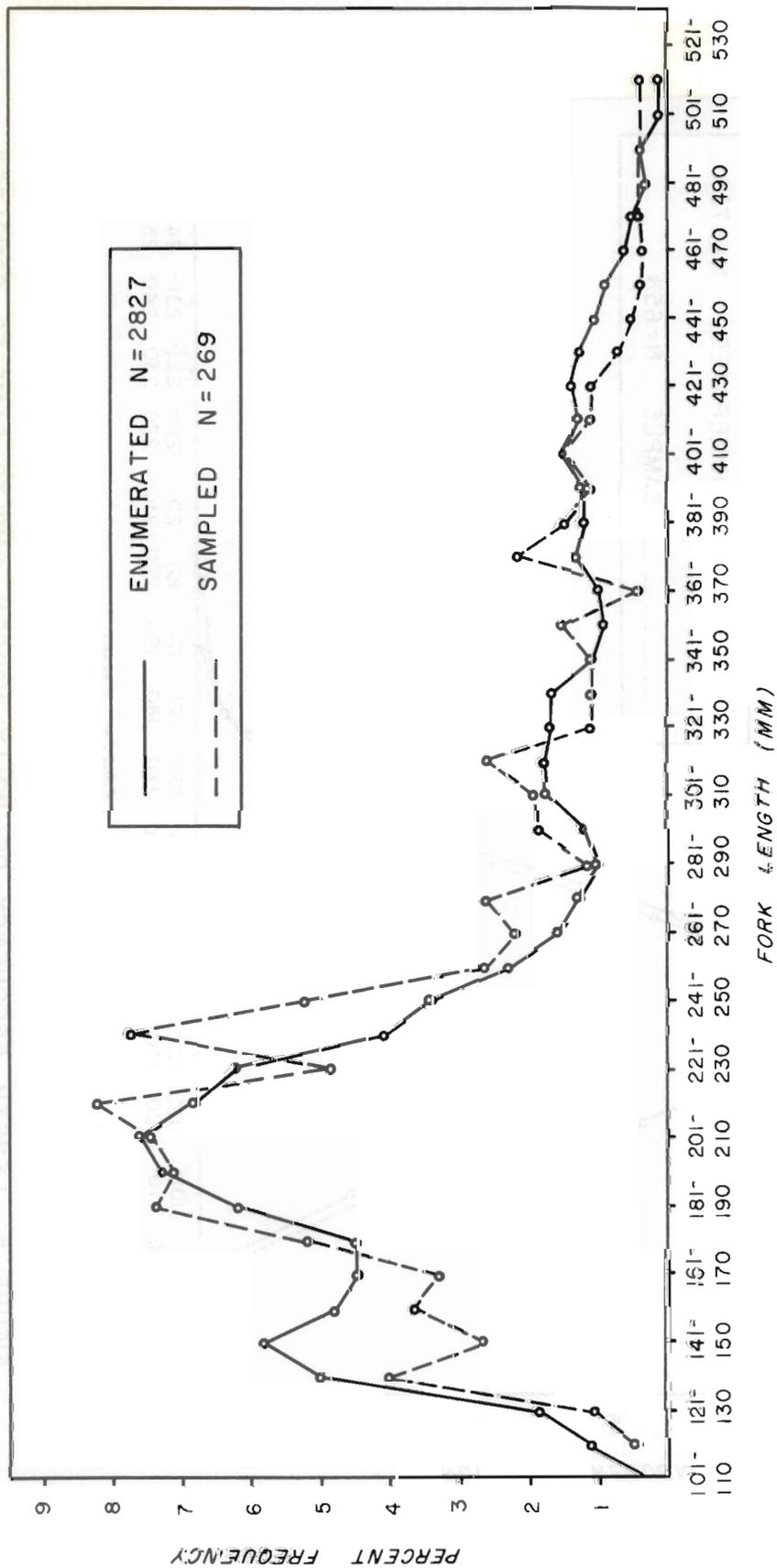


FIGURE 6. LENGTH FREQUENCY OF IMMIGRANT DOLLY VARDEN ENUMERATED AND SAMPLED AT THE SOUTH ARM STREAM WEIR, 1968.

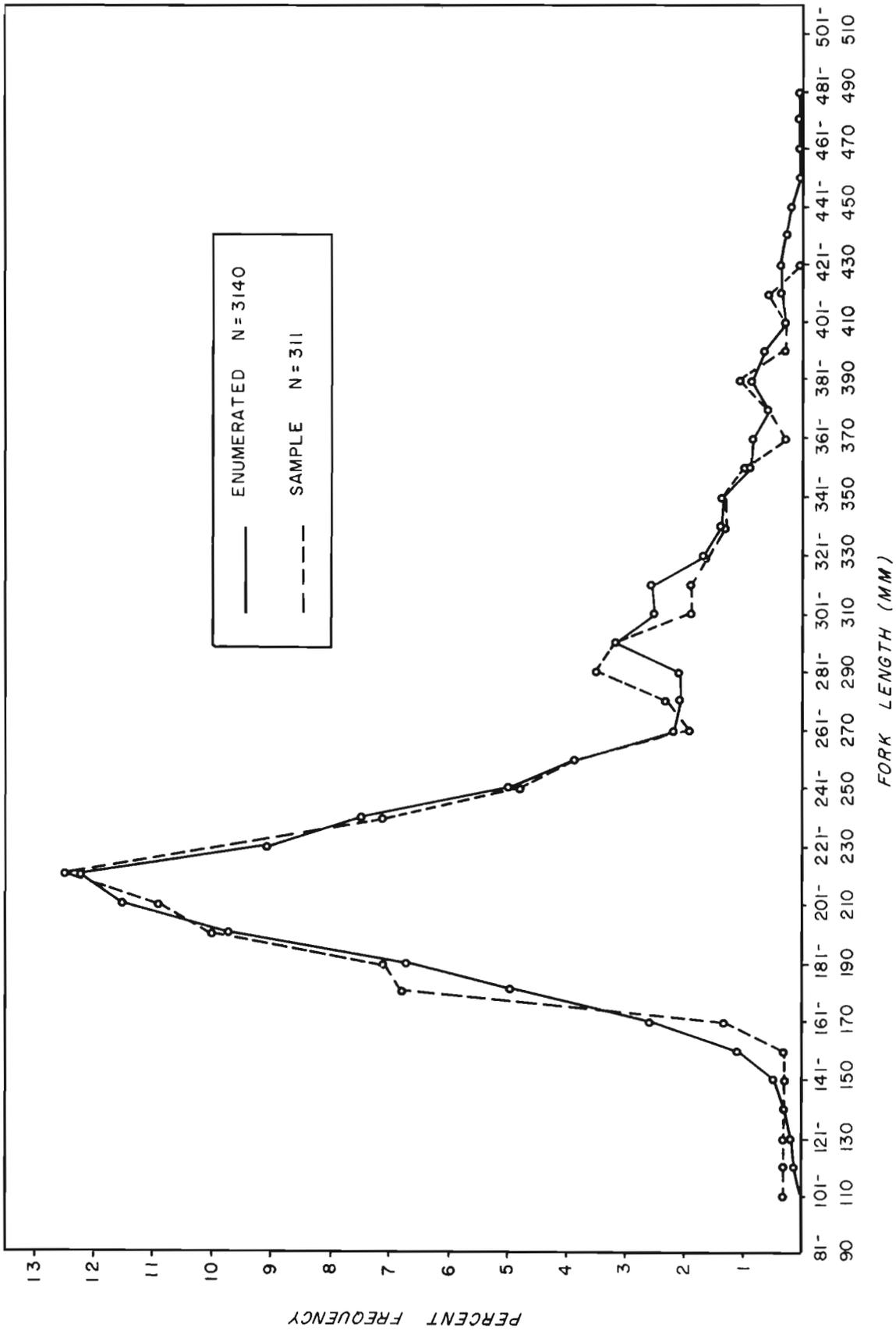


FIGURE 7. LENGTH FREQUENCY OF IMMIGRANT DOLLY VARDEN ENUMERATED AND SAMPLED AT THE NORTH ARM STREAM No. 1 WEIR, 1968.

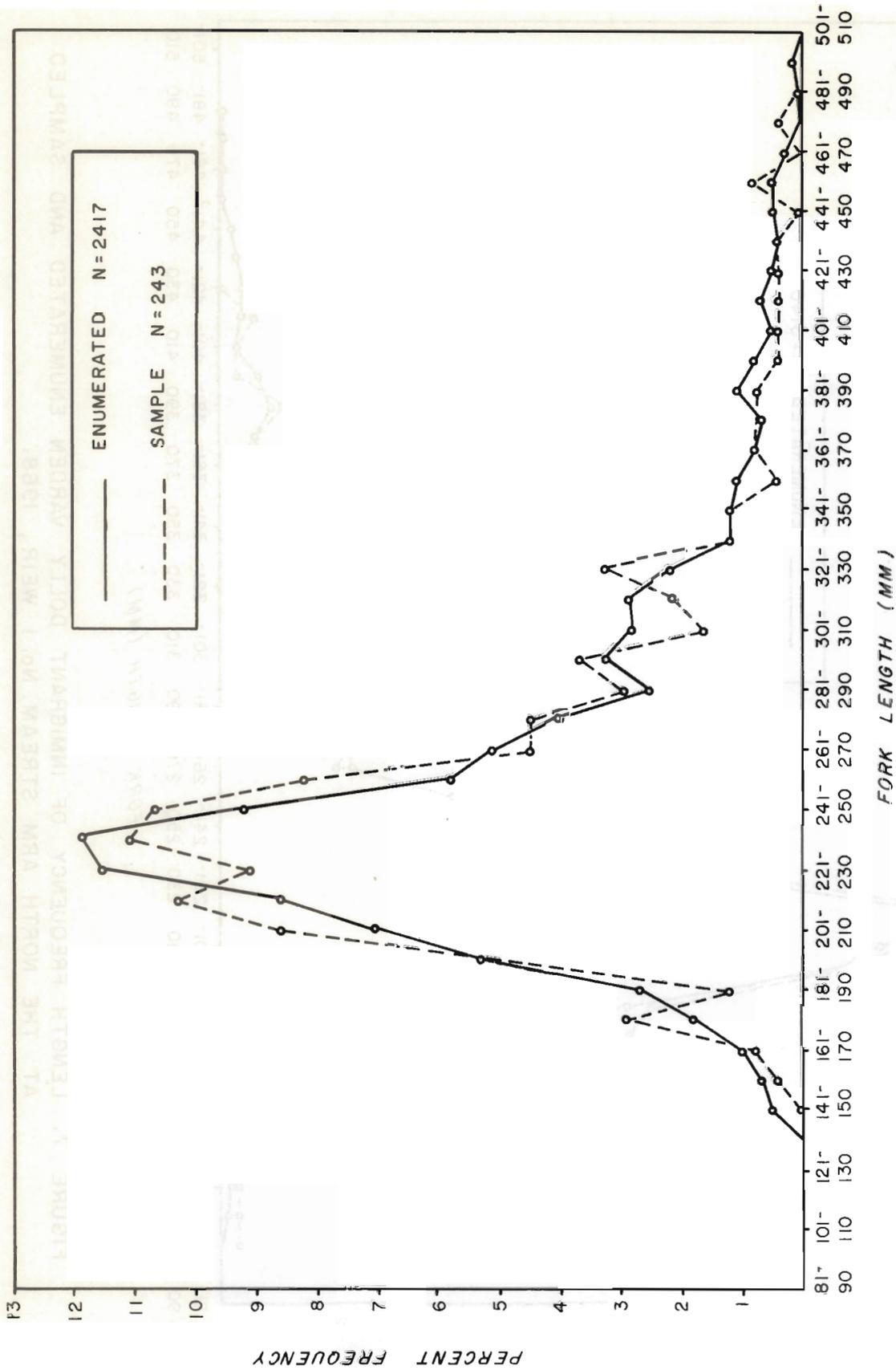


FIGURE 8. LENGTH FREQUENCY OF IMMIGRANT DOLLY VARDEN ENUMERATED AND SAMPLED AT THE NORTH ARM STREAM No. 2 WEIR, 1968.

FINDINGS

Numbers and Timing of Dolly Varden Smolts

A total of 9,162 Dolly Varden smolts left the South Arm Stream in 1968. Of these, 6,729 left during a spring outmigration and an estimated 2,433 during a fall outmigration. This migration is compared with the 1967 smolt migration and the estimated smolt migration at Lake Eva in 1962 and 63 in Table 2. The most notable difference between the non-lake and lake system is the lack of the fall migration of smolts from the lake system.

TABLE 2 - Numbers of Dolly Varden Smolts Outmigrating from the South Arm Stream and Lake Eva During the Years of Study.

	<u>SOUTH ARM STREAM</u>		<u>LAKE EVA</u>	
	<u>1967</u>	<u>1968</u>	<u>1962</u>	<u>1963</u>
Spring	6,735	6,729	6,000*	5,000*
Fall	<u>2,542</u>	<u>2,433*</u>	<u>-0-</u>	<u>-0-</u>
Total	9,277	9,162	6,000	5,000

*Estimated

Length frequency and age composition of the fall migrating smolts at the South Arm Stream indicate that these fish were not of sufficient size to migrate in the spring but had attained sufficient size by the fall. This probably also occurs in the lake system but instead of migrating to the sea, they may move from their rearing areas in the tributary streams, then to the lake environment in the fall.

Most of the 1968 spring outmigration at the South Arm Stream occurred from mid-May to mid-June and peaked in late May (Figure 9). This timing is almost identical to that observed at the system in 1967 (Armstrong and Winslow, 1968) and at Lake Eva in 1962 and 63.

The 1968 fall outmigration at the South Arm Stream began in late-August, peaked periodically (during high water periods) and ended in early November (Figure 9). The 1968 migration began one month earlier than the 1967 migration of smolts reported by Armstrong and Winslow (1968). Periods of flooding appeared to be a contributing factor to variances in timing from one year to the next.

The 1968 spring smolt migration at Hood Bay Creek began at a water temperature of 38°F, peaked at 41°, and was mostly over at 44°. These temperatures were identical to those observed during the smolt migration at the South Arm Stream in 1967. The smolt migration at Lake Eva also began at a water temperature of 38°F in 1962 and 63 and peaked and ended at temperatures similar to the South Arm Stream in 1968. The 1963 water temperatures at Lake Eva were higher during the peak and end of the smolt migration and averaged 48° and 51°, respectively.

The fall smolt migration at the South Arm Stream began at a water temperature of 47°F and ended at 42° in both study years.

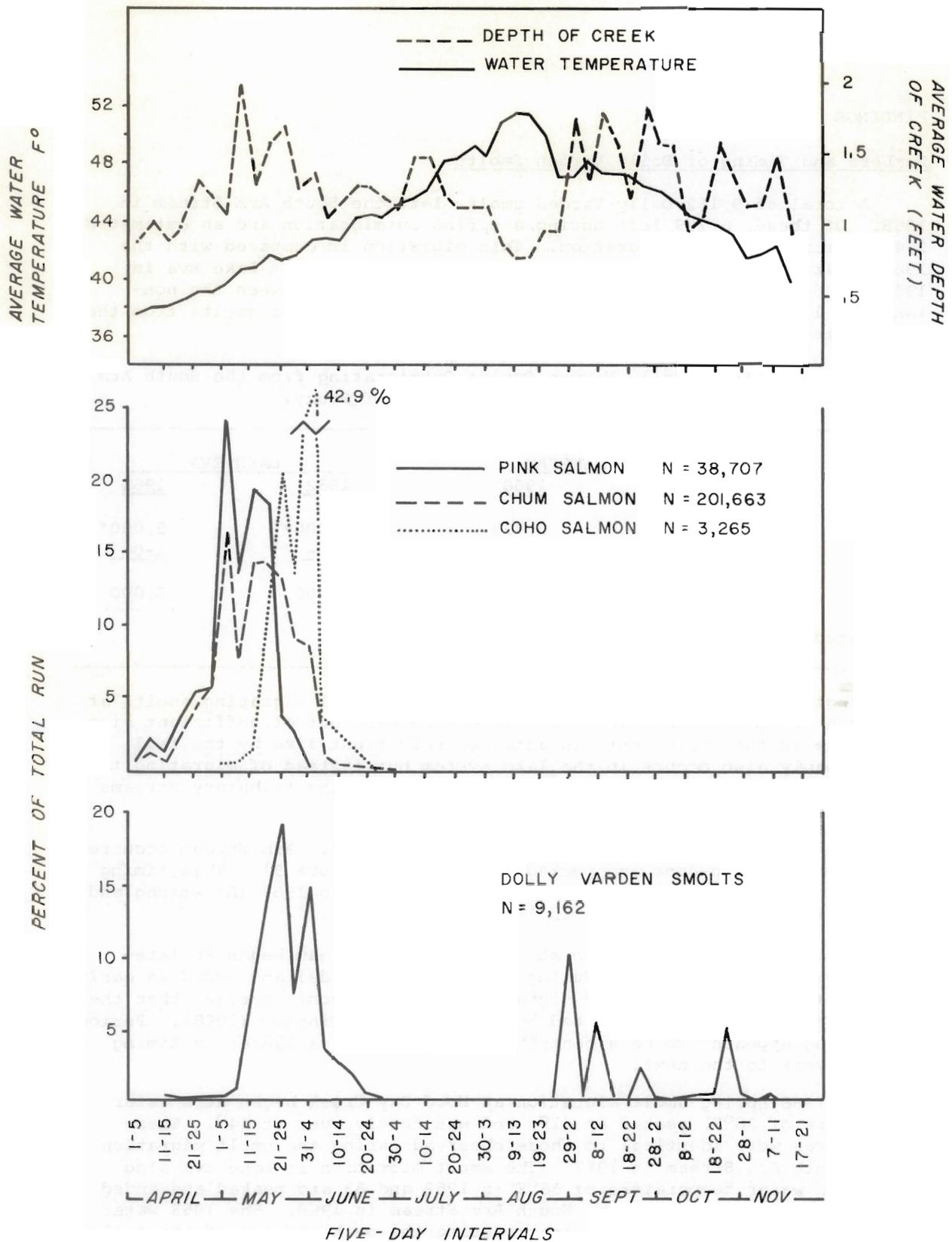


FIGURE 9. TIMING OF OUTMIGRANT DOLLY VARDEN SMOLTS, PINK AND CHUM FRY, AND COHO SMOLTS BY FIVE-DAY INTERVALS WITH THE AVERAGE WATER DEPTH AND TEMPERATURE AT THE SOUTH ARM STREAM, 1968.

The spring smolt migration of Dolly Varden was similar to the timing of the coho smolt migration. Both species primarily migrated from the South Arm Stream after approximately 90 percent of the pink and 70 percent of the chum salmon fry migration was over (Figure 9). Since both Dolly Varden and coho smolts feed heavily on pink and chum fry, a decrease in the numbers of these fry may have some influence on the time of out-migration of Dolly Varden and coho smolts from this stream.

Age Composition of Dolly Varden Smolts

Age groups II through VI were found among the Dolly Varden smolts at the South Arm Stream with over 90 percent of them migrating at age III and IV (Table 3). Based on information gathered on Dolly Varden originating from other stream systems and entering Lake Eva for the winter and on the smolts leaving the Lake, it appears that most smolts in the area migrate at ages III and IV (Armstrong, 1965; Heiser, 1966).

The smolts migrating to sea in the fall from the South Arm Stream are generally younger than those in the spring. More of the fall smolts migrated at age II and less at age IV than the spring migrants (Table 3).

TABLE 3 - Age Composition of Dolly Varden Smolts Sampled at the South Arm Stream Weir, 1967 and 1968.

Age Group	Spring		Fall		Spring & Fall		Total*
	1967	1968	1967	1968	1967	1968	
II	0.4	1.6	27.9	8.6	7.9	3.5	5.7
III	53.6	55.8	67.9	71.4	57.5	59.9	58.7
IV	42.5	39.1	4.2	20.0	32.0	34.0	33.0
V	3.4	3.3	0.0	0.0	2.5	2.4	2.5
VI	0.2	0.2	0.0	0.0	0.1	0.1	0.1
Sample size:	532	629	57	35	589	644	1,253

*Weighted on the basis of total numbers in spring and fall migrations each year.

By sex, the age compositions were similar although the information indicated males have a tendency to migrate at an earlier age than females. For instance, 58 percent of the males and 52 percent of the females were in age group III (1967 and 1968 combined).

The male:female ratio of the sampled smolts was 48:52 in 1967 and 47:53 in 1968.

A sample of 321 coho smolts taken at the South Arm Stream weir in 1968 were primarily from age groups I (43 percent) and II (50 percent). The sex ratio of these sampled smolts was 45.6 percent females and 54.4 percent males. Although large numbers of age 0 coho young annually migrate to sea from these systems, based on Chapman's (1962) work, it is doubtful that they survive.

Length of Dolly Varden Smolts

Most of the Dolly Varden smolts were between 100 and 180 mm in fork length with a mean length of 135.7 mm (Figure 10). The spring outmigrants averaged slightly smaller (\bar{x} =134.2 mm) than the fall outmigrants (\bar{x} =141.0 mm) and the mode of the smolts migrating in the spring (121 to 130 mm) was less than the mode of those migrating in the fall (141 to 150 mm).

Among the spring Dolly Varden smolts sampled, the mean fork length of age group IV (\bar{x} =138.7 mm) was larger than that of age group III (\bar{x} =130.0 mm); however, the length frequencies of these age groups overlap considerably (Figure 11) indicating that the outmigration of these fish may be a factor of size and not age.

The length frequencies of coho smolts also showed considerable overlap between age groups I and II (Figure 12). The coho smolts migrated to sea at an earlier age and smaller size than the Dolly Varden.

Condition Factor of Dolly Varden and Coho Smolts

The coefficient of condition, K, was computed by age and 10 mm intervals for about 10 percent of the Dolly Varden and coho smolts migrating to sea in the spring of 1968. Lagler's (1956) equation $K_{(FL)} = W/L^3$ was slightly modified to make values near 1.00 for ease of comparison.

Table 4 shows that there was a very small weighted difference between age classes of Dolly Varden and coho, but as their lengths increased, the condition factor tended to decrease. Studies conducted by Cooper and Benson (1951) for both brook and brown trout populations in Michigan found a similar length-condition factor relationship.

Based on 629 fish, the weighted condition factor of Dolly Varden smolts was .89 and 1.10 for coho smolts based on 316 fish. The higher condition factor of coho may be due to more aggressive behavior during rearing. If coho are more aggressive, they may tend to consume a larger percentage of the available food. This was shown to be the case in a food study undertaken where 95 percent of the coho had food in their stomachs; only 70 percent of the Dolly Varden stomachs contained food.

Migration of 1968 Smolts

Of the 6,729 Dolly Varden smolts enumerated during the spring outmigration at the South Arm Stream weir, 5,819 were marked (right ventral) and released. Of the number marked and released, 554 (9.5 percent) returned to the South Arm Stream the same year. Most of these fish returned in July and early August after spending 30 to 60 days away from the system. Most of these returning smolts left the system again in September. Only 10 of the returning smolts were recorded as having spawned in the South Arm Stream in 1968.

Many of the smolts entered the other weir streams in Hood Bay after leaving the South Arm Stream (Table 5). The numbers are significant enough to indicate a definite movement of these smolts to systems other than the one from which they originated. Only a small number (six) were recorded as entering the North Arm streams and returning to the South Arm Stream.

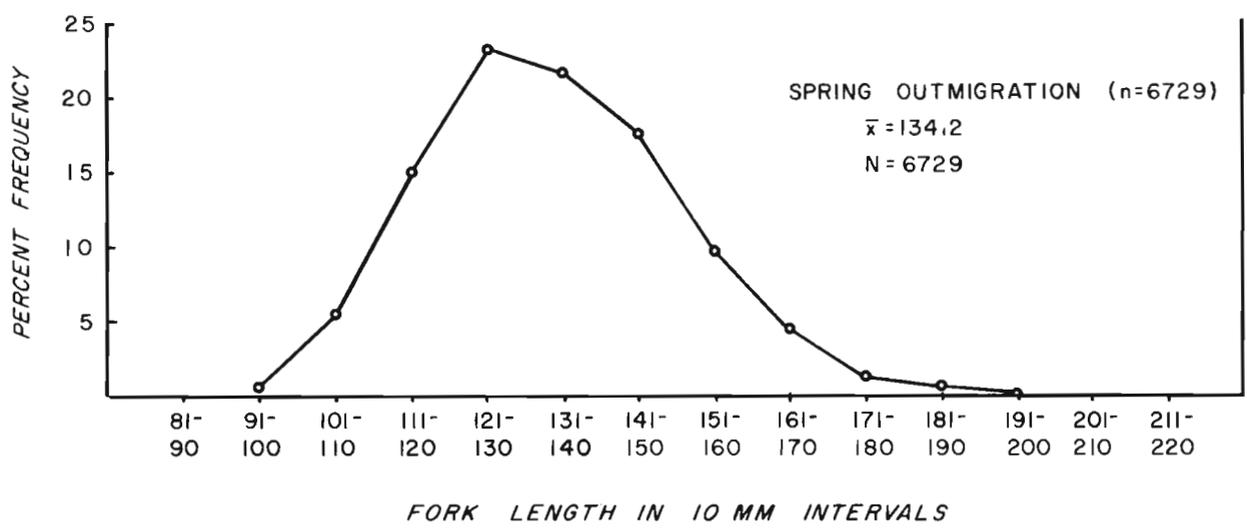
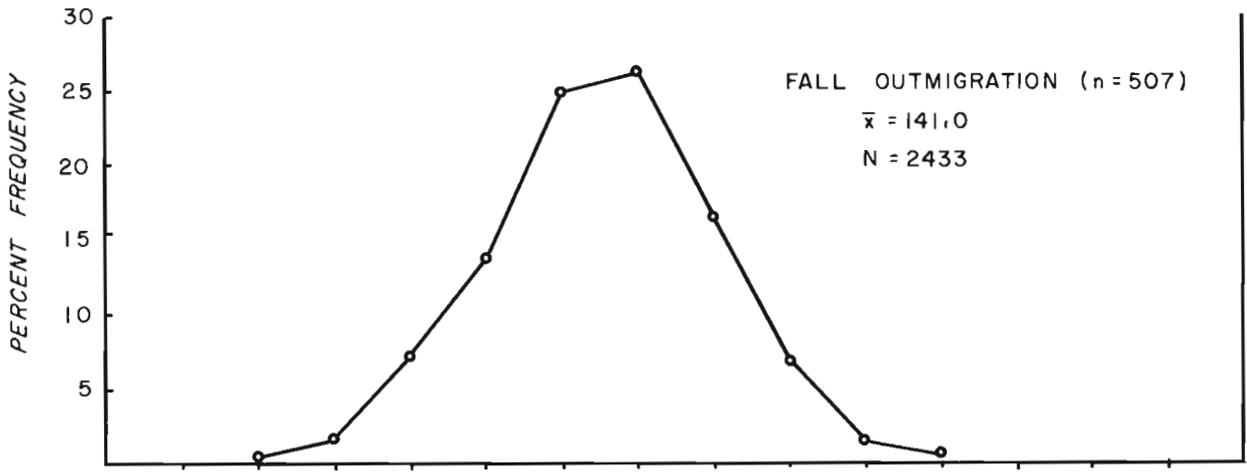
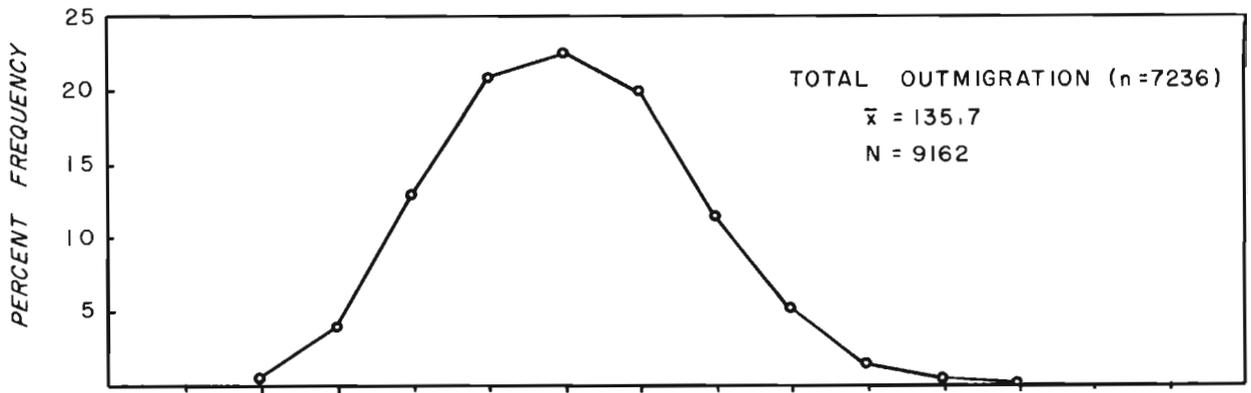


FIGURE 10. LENGTH FREQUENCIES OF DOLLY VARDEN SMOLTS MEASURED AT THE SOUTH ARM STREAM WEIR, 1968.

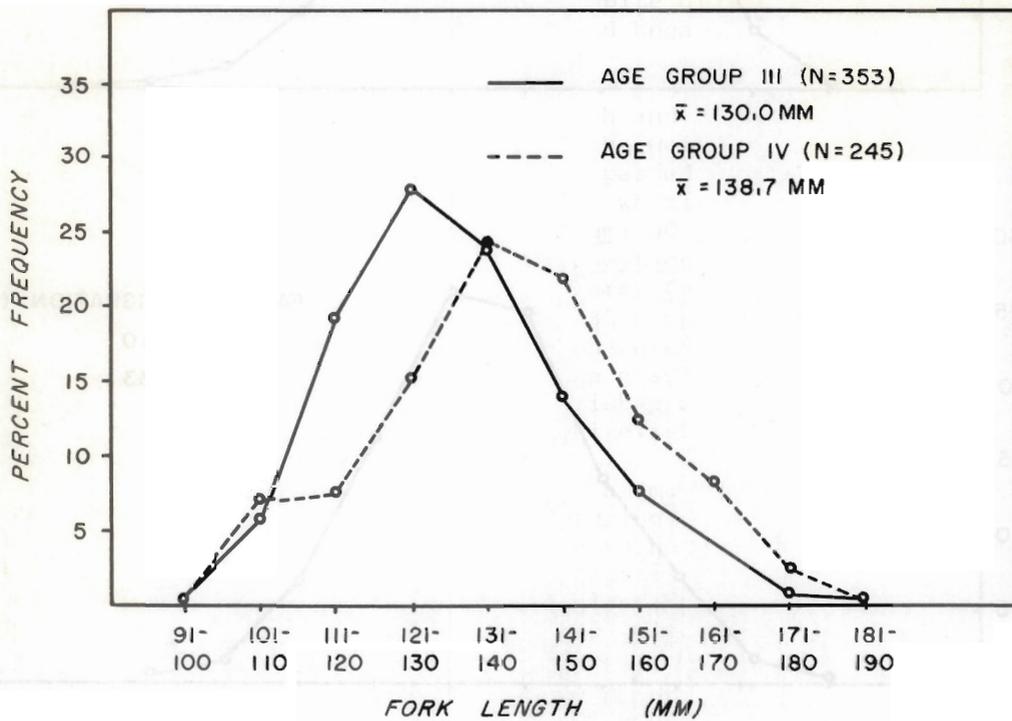


FIGURE II. LENGTH FREQUENCY OF AGE III AND IV DOLLY VARDEN SMOLTS SAMPLED DURING THE SPRING OUTMIGRATION AT THE SOUTH ARM STREAM WEIR, 1968.

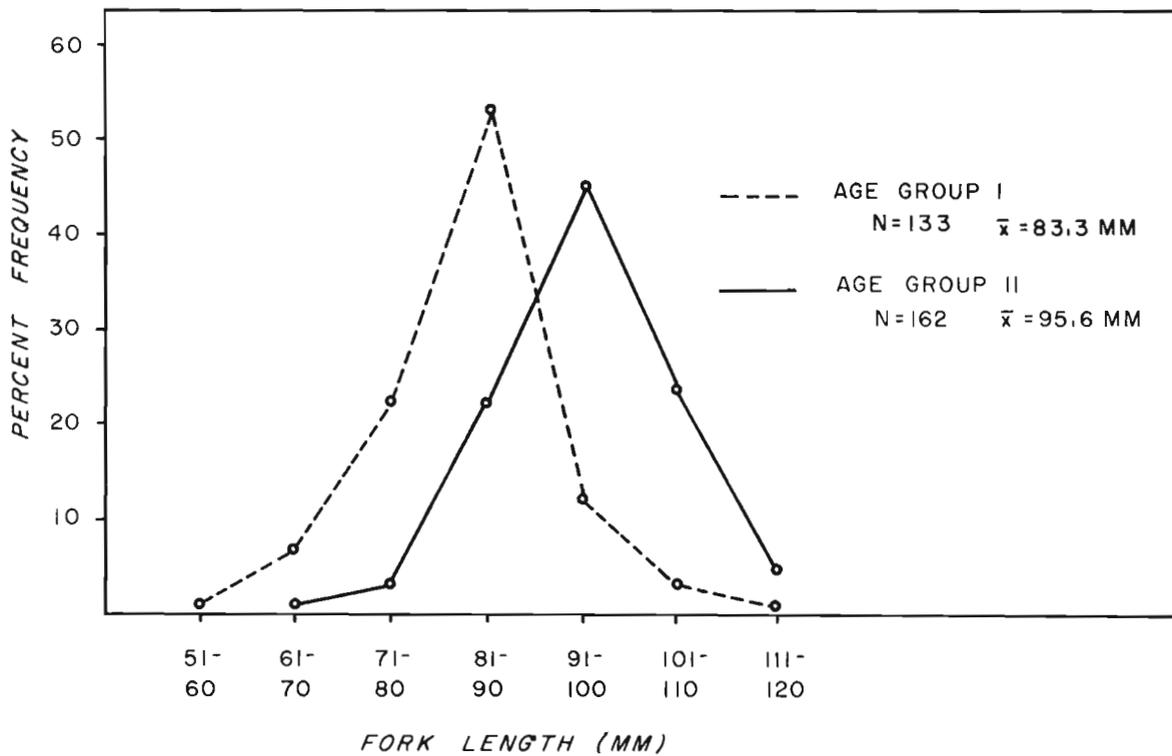


FIGURE 12. LENGTH FREQUENCY OF AGE I AND II COHO SMOLTS SAMPLED DURING THEIR OUTMIGRATION FROM THE SOUTH ARM STREAM, 1968.

TABLE 4 - Condition Factors by Age and 10 mm Intervals of Coho and Dolly Varden Smolt Sampled at the South Arm Stream Weir, 1968.

	Dolly Varden						Coho				
	Age 2	Age 3	Age 4	Age 5	Average (Weighted)	Sample Size	Age 1	Age 2	Age 3	Average (Weighted)	Sample Size
51 - 60	--	--	--	--	--	--	1.75	--	--	1.75	1
61 - 70	--	--	--	--	--	--	1.21	1.11	--	1.21	11
71 - 80	--	--	--	--	--	--	1.23	1.32	--	1.25	36
81 - 90	--	--	--	--	--	--	1.08	1.15	1.12	1.10	110
91 - 100	--	1.09	.88	1.14	1.07	5	1.06	1.07	1.10	1.07	100
101 - 110	.98	.96	.99	1.11	.98	42	.94	1.02	1.06	1.02	49
111 - 120	1.00	.92	.94	.95	.93	99	1.04	1.03	.94	1.02	9
121 - 130	.94	.89	.91	.89	.90	142	--	--	--	--	--
131 - 140	--	.88	.88	--	.88	145	--	--	--	--	--
141 - 150	--	.83	.87	.85	.85	106	--	--	--	--	--
151 - 160	--	.89	.88	.79	.88	57	--	--	--	--	--
161 - 170	--	.85	.84	.84	.84	24	--	--	--	--	--
171 - 180	--	.68	.83	--	.81	7	--	--	--	--	--
181 - 190	--	--	.85	.80	.83	2	--	--	--	--	--
Weighted condition factor	.98	.89	.89	.95	.89		1.12	1.08	1.08	1.10	
Sample size	10	353	245	21	629		133	162	21	316	

TABLE 5 - Number of Marked Smolts Recovered by Recovery Area of the 5,819 Marked and Released at the South Arm Stream Weir, 1968.

	Estimated Number Entering Stream	Percent of Number Released	Percent of Estimated Immigrant Population
Hood Bay South	554	9.5	11.1
Hood Bay North #1	502	8.6	6.1
Hood Bay North #2	166	2.8	3.6
Total	1,222	1.0	6.7

Of the 2,433 estimated fall smolt outmigrants, 168 (6.9 percent) were estimated to have returned to the system. Most of these fish returned shortly after their release, and were again recorded as leaving the system soon after their date of entry. The in-and-out type of migration observed for the fall smolts may be due to some confusion among these fish by high water conditions encountered during their migration period.

Similar patterns of timing and return of smolts were observed at the South Arm Stream in 1967 (Armstrong and Winslow, 1968).

Food of Dolly Varden and Coho Smolts

Salmon young was the principal food item occurring in the stomachs of Dolly Varden and coho smolts (Table 6). Pink and chum salmon young were the only identifiable fish found in the stomachs of the smolts. An average of 1.7 salmon young per stomach for the Dolly Varden and 1.2 salmon young per stomach for the coho was found for those smolts feeding on salmon young. Insects, primarily of the orders Diptera, Ephemeroptera, and Plecoptera, were important items in both Dolly Varden and coho smolts (Table 6).

TABLE 6 - Stomach Content of Dolly Varden and Coho Smolts Sampled at the South Arm Stream Weir, May - June, 1968.

Stomach Content	Dolly Varden		Coho	
	Incidence of Feeding	Percent Occurrence in Feeding Fish	Incidence of Feeding	Percent Occurrence in Feeding Fish
Insects:				
Coleoptera	1	--	4	1%
Diptera	86	19%	121	38%
Ephemeroptera	130	29%	118	38%
Plecoptera	161	35%	134	43%
Trichoptera	16	4%	30	10%
Unidentifiable	79	17%	64	20%
Salmon young	220	48%	182	58%

TABLE 6 (Cont.) - Stomach Content of Dolly Varden and Coho Smolts Sampled at the South Arm Stream Weir, May - June, 1968.

Stomach Content	Dolly Varden		Coho	
	Incidence of Feeding	Percent Occurrence in Feeding Fish	Incidence of Feeding	Percent Occurrence in Feeding Fish
Dolly Varden young	3	1%	1	--
Miscellaneous:				
Amphipods	0	--	1	--
Annelids	9	2%	4	1%
Arachnids	1	--	2	1%
Cottid eggs	2	--	0	--
Ostracods	1	--	1	--
Unidentifiable	3	1%	2	1%
Debris (wood, rocks)	13	3%	3	1%
Number empty	193	(30%)	15	(5%)
Number feeding	454	(70%)	314	(95%)
Total examined	647		329	

Coho smolts fed more frequently on most items than did Dolly Varden smolts. Of the total examined, 95 percent of the coho contained food and 70 percent of the Dolly Varden had food in their stomachs.

Food of Rearing and Resident Fish in the South Arm Stream

Insects of the orders Diptera, Ephemeroptera, and Plecoptera were the most frequently found food items in the coho, Dolly Varden and cottid, Cottus aleuticus, stomachs examined (Table 7). During the period of pink and chum fry emergence (April, May and June) the larger coho, Dolly Varden and cottids fed on these salmon fry. Salmon eggs were also a frequent food item in the stomachs of the larger rearing and resident fish during the salmon spawning period in July, August and September.

Young-of-the-year coho and Dolly Varden fed almost exclusively on insects, with the order Diptera being most frequently found in their stomachs.

The similarity in type and percentage of food items ingested by coho, Dolly Varden and cottids is indicative of competition for food by these species in the South Arm Stream (Table 7). Before the seriousness or degree of competition for food between these fish can be assessed, more information would have to be obtained. This would include determining the availability of the food items and the aggressiveness and competition for space between the rearing and resident species.

TABLE 7 - Stomach Content of Rearing and Resident Fish Sampled in the South Arm Stream, 1968.

Stomach Contents	REARING DOLLY VARDEN AND COHO (EXCLUDING YOUNG-OF-THE-YEAR)			YOUNG-OF-THE-YEAR DOLLY VARDEN AND COHO			COTTIDS			
	Incidence of Feeding D.V. Coho	Percent Occurrence in Feeding Fish D.V. Coho	Percent Occurrence in Feeding Fish D.V. Coho	Incidence of Feeding D.V. Coho	Percent Occurrence in Feeding Fish D.V. Coho	Percent Occurrence in Feeding Fish D.V. Coho	Incidence of Feeding of Feeding Fish	Percent Occurrence in Feeding Fish	Incidence of Feeding of Feeding Fish	Percent Occurrence in Feeding Fish
Insects:										
Coleoptera	1	7	.4	3	0	1	0	4	0	0
Diptera	112	155	44	58	25	25	86	100	12	44
Ephemeroptera	82	95	32	36	2	3	7	12	15	56
Plecoptera	71	91	28	34	9	8	31	32	11	41
Trichoptera	29	46	11	17	2	3	7	12	2	7
Unidentifiable	50	86	20	32	7	0	24	0	8	30
Salmon eggs	51	45	20	17	0	0	0	0	6	22
Salmon fry	23	28	9	11	0	0	0	0	2	7
Miscellaneous:										
Annelids	4	2	2	.8	0	0	0	0	0	0
Arachnids	0	5	0	2	0	2	0	8	0	0
Cottid eggs	1	0	.4	0	0	0	0	0	0	0
Debris	44	12	17	5	1	0	3	12	2	7
Fish remains	1	3	.4	1	0	0	0	0	1	4
Yearling coho	4	0	2	0	0	0	0	0	0	0
Number empty	44	32	15	11	1	2	3	7	2	7
Number feeding	253	265	85	89	29	25	97	93	27	93
Total Examined	297	297		30	30	27			29	29

The higher percentage of debris found in Dolly Varden indicates these fish select food more frequently from the stream bottom than the coho young. Evidence of this is also presented in Blackett's (1968) discussion of the behavior of these rearing fish.

Effect of Predation on Pink and Chum Fry

An estimate of the total number of pink and chum salmon fry consumed in 1968 by Dolly Varden and coho smolt and rearing young in the South Arm Stream was computed (Table 8). The method of obtaining this estimate was computed as follows:

1. The number of fry found in the stomachs was assumed to represent the number ingested during a 24-hour period. This assumption was based on the study by Armstrong and Blackett (1966), which indicated the digestion of salmon fry by Dolly Varden is completed in 24 hours after ingestion. To obtain the total fry consumed we multiplied the average number consumed per fish sampled, by day, times the estimated number of predators present. This was done on a daily basis and the number of Dolly Varden and coho smolts leaving the system was subtracted from the population. The number of days that sufficient salmon fry were available to predators was determined from the daily number captured in out-migrant fry traps operated near the weir.
2. An estimate of the total pink and chum salmon fry available was made by multiplying the average fecundity of each species (Hunter's 1959 study at Hooknose Creek was used) times the number of females in the 1967 parent run at the South Arm Stream (from weir counts and assuming a 50:50 sex ratio) times the figures of percentage survival from deposition of pink and chum salmon eggs to emergence for Hooknose Creek (Hunter, 1959). The actual computation:

	<u>Chum</u>	<u>Pink</u>
Number females in parent run =	8,907	2,698
Average fecundity =	<u>x 2,488</u>	<u>x 1,592</u>
Potential egg deposition	22,160,616	4,295,216
 Total eggs deposited	 26,455,832	
Percentage survival to emergence (high) =	 <u>x 31.08</u>	
or (medium) =	<u>x 19.33</u>	
 Number fry available (High)	 <u>8,222,473</u>	
Number fry available (Medium)	<u>5,113,912</u>	

The percentage of the fry population consumed during a low survival year was not presented as we felt the low density of the available fry would affect the numbers consumed per predator. We feel the estimated total numbers of fry consumed by Dolly Varden and coho is a reliable estimate. The total effect this has on the population of pink and chum fry should be considered a hypothetical situation as figures on pink and chum salmon fecundity and survival were taken from studies on a system other than the study stream.

Rearing Dolly Varden were estimated to consume the greatest number of pink and chum salmon fry (Table 8) followed by rearing coho, Dolly Varden smolts and coho smolts. The average number of salmon fry consumed per fish per day was computed to be: coho smolt=.66; Dolly Varden smolt=.57; rearing Dolly Varden (ages II and III)=.44; and rearing coho (ages I and II)=.24.

TABLE 8 - Estimated Number and Percentage of Pink and Chum Salmon Fry Consumed by Dolly Varden and Coho Smolt and Rearing Fish in Hood Bay Creek, 1968.

	<u>Number of Predators Available</u>	<u>Number Pink and Chum Fry Eaten</u>	<u>Percentage of Total Fry Eaten**</u>	
Dolly Varden smolt	6,729	82,483	High survival	1.00
			Med. "	1.61
Rearing Dolly Varden	15,000*	513,900	High survival	6.25
			Med. "	10.05
Coho smolt	4,000	70,407	High survival	0.86
			Med. "	1.38
Coho rearing	10,000*	207,000	High survival	2.52
			Med. "	4.05
TOTAL	35,729	873,790	High survival	10.63
			Med. "	17.09

*Estimate

**Total estimated emergence of pink and chum fry for 1968=

high: 8,222,473

med.: 5,113,912

The coastrange sculpin was also found to feed on pink and chum salmon fry in Hood Bay Creek. Of the number examined (29) during the period of fry emergence, two (7 percent) were found to contain salmon young. The number of coastrange sculpin in Hood Bay Creek is unknown. McLarney (1967) has estimated the coastrange sculpin population of Sashin Creek on Baranof Island to range from 9,930 to 22,841 sculpins over 65 mm in length, for the area of Sashin Creek utilized by spawning salmon. If these figures were applied to Hood Bay Creek, and if we assumed one salmon fry ingested per sculpin feeding on them per day, we could make the following computation:

<u>No. of Sculpins</u>		<u>Percent Feeding on Salmon Fry</u>		<u>No. of Days Salmon Fry Available</u>		<u>Total Salmon Fry Consumed</u>
9,930	x	.07	x	74	=	51,437 .63
22,841	x	.07	x	74	=	118,316 1.01
						2.32

These figures could add 0.63 to 2.32 more to the percentage of total pink and chum fry eaten by fish predators in Hood Bay Creek.

Additional predation on pink and chum fry may occur from saltwater fish moving into the confines of the creek during high tidal periods. This occurred at Hood Bay Creek in 1967 when walleye pollock, Theragra chalcogrammus, were found feeding on salmon young within the confines of the stream banks (Armstrong and Winslow, 1968). This type of predation is difficult to assess; however, it could be quite serious when the fry are concentrated and vulnerable to these larger predators.

The total percentage of pink and chum fry consumed by fish predators in Hood Bay Creek in 1968 is probably between 11 and 20 percent.

Competition for Space Between Dolly Varden and Coho Young

To determine if rearing coho and Dolly Varden compete for space, experiments similar to Chapman's (1962) studies were conducted at Hood Bay Creek in the spring and summer of 1968.

Two troughs approximately 40 cms wide and 2.4 meters long were constructed with a trap on one end designed to capture any fish desiring to leave the trough. Gravel, after being sifted through 1/4-inch mesh screening, was arranged to create two pools and three riffle areas per trough. Water flow was regulated by gate valves at the head of each channel.

The experimental design required establishment of carrying capacities for both species of fish. When this was determined two or three of the opposite species were released into one trough and the fish displaced recorded. To assure that the experimental fish were competing only for space, frozen brine shrimp, Artemia sp., were introduced daily. We found that from three to six coho (50 to 75 mm) would reside in each trough. Dolly Varden of comparable size added to one trough containing coho were usually displaced within eight hours. After two repetitions of this experiment in which most Dolly Varden were displaced, the opposite procedure was tried, adding coho to a trough with an established number of Dolly Varden. Although establishment of Dolly Varden carrying capacities were difficult and few repetitions of this experiment undertaken, it was once again found that the char were displaced.

A constant source of water was the main problem encountered throughout the experiment. In the early spring there was a near constant water supply but as the year progressed either high or low water conditions of the Creek caused the experiments to be terminated in mid-August.

Preliminary results indicate that coho and Dolly Varden compete for space and that coho are dominant over the Dolly Varden.

Numbers and Timing of Immigrant Dolly Varden

Estimates of the numbers of Dolly Varden entering the Hood Bay streams in 1968 are: South Arm Stream=5,007; North Arm Stream #1=8,285; and North Arm Stream #2=4,653. Substantial numbers of char began entering these streams in July, peaked in late August and September and ended in early November (Figure 13). Approximately 50 percent of the total immigration had entered the Hood Bay streams by early September (Figure 14).

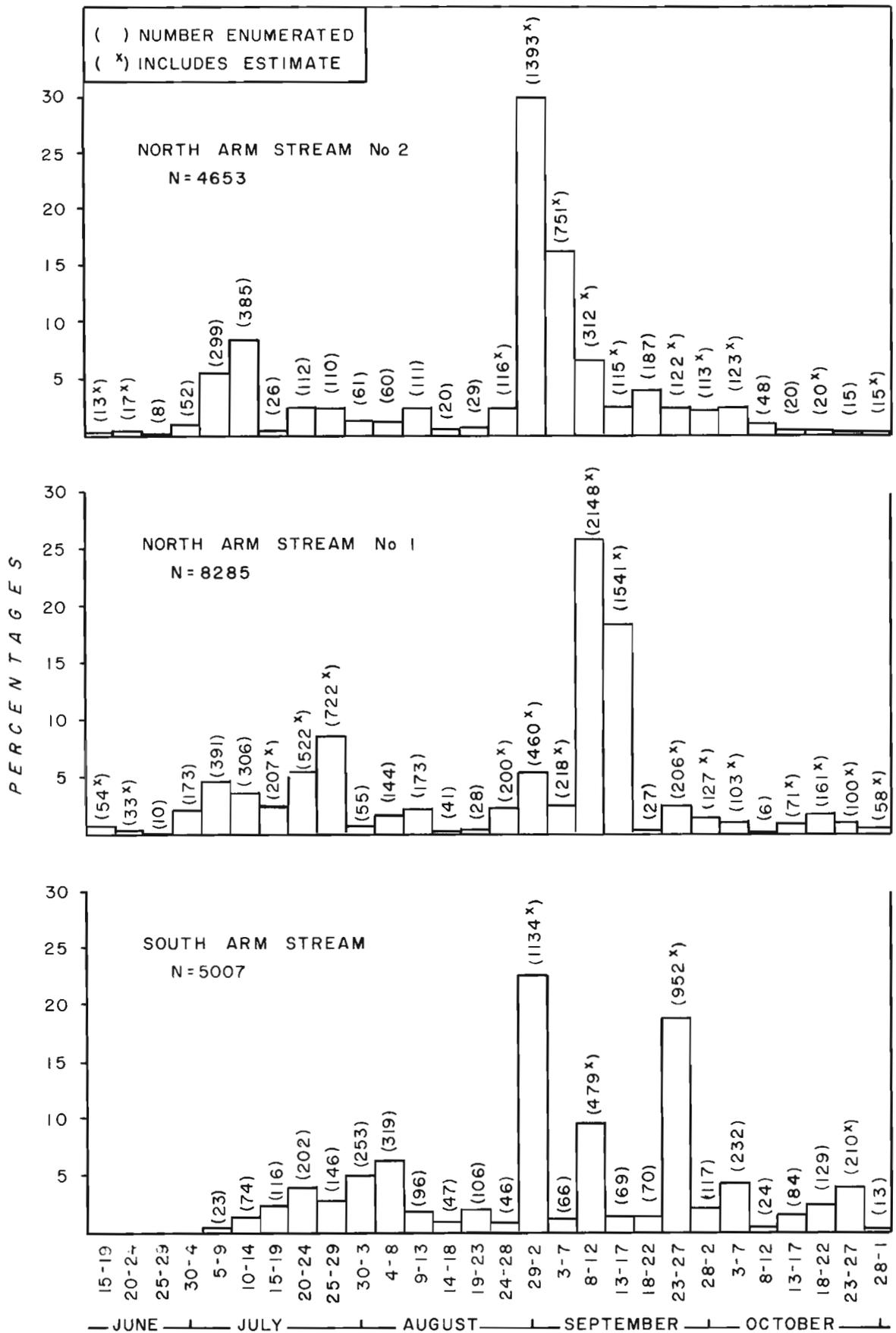


FIGURE 13. PERCENT AND NUMBER OF DOLLY VARDEN ENTERING THREE HOOD BAY CREEKS IN 1968 BY FIVE-DAY INTERVALS.

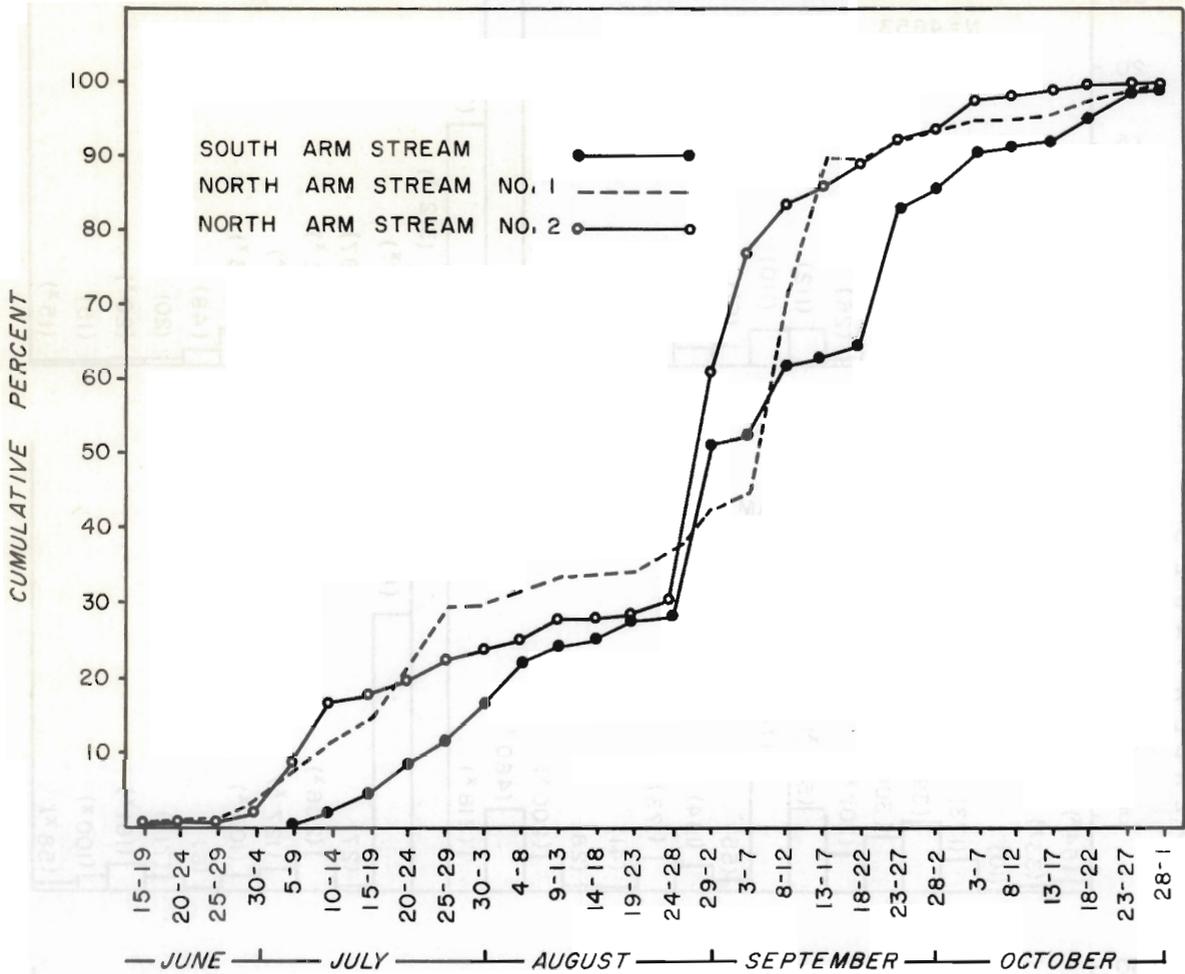


FIGURE 14. CUMULATIVE PERCENT OF DOLLY VARDEN ENTERING THREE HOOD BAY STREAMS BY FIVE-DAY INTERVALS, 1968.

TABLE 9 - Month of Immigration for Potential Spawner and Nonspawner Dolly Varden at Three Streams in Hood Bay, 1968.

HOOD BAY SOUTH						
	Sample Size	Potential Spawners in Sample		Estimated Immigration	Estimated Number of Potential Spawners	Estimated Number of Nonspawners
		n	%			
June	0	0	0.0	0	0	0
July	67	12	17.9	666	119	547
August	84	28	33.3	1,730	576	1,154
September	68	19	27.9	1,894	528	1,366
October	51	16	31.4	717	225	492
November	<u>0</u>	<u>0</u>	<u>0.0</u>	<u>0</u>	<u>0</u>	<u>0</u>
TOTALS	270	75	28.9*	5,007	1,448	3,559
HOOD BAY NORTH #1						
June	2	0	0.0	97	0	97
July	219	50	22.8	2,343	534	1,809
August	47	13	27.7	895	247	648
September	38	1	2.6	4,400	114	4,286
October	4	1	25.0	534	134	400
November	<u>1</u>	<u>1</u>	<u>100.0</u>	<u>16</u>	<u>16</u>	<u>0</u>
TOTALS	311	66	12.6*	8,285	1,045	7,240
HOOD BAY NORTH #2						
June	1	0	0.0	51	0	51
July	105	22	21.0	1,001	210	791
August	28	7	25.0	841	210	631
September	97	8	8.2	2,474	203	2,271
October	12	5	41.7	276	115	161
November	<u>0</u>	<u>0</u>	<u>0.0</u>	<u>10</u>	<u>0</u>	<u>10</u>
TOTALS	243	42	15.9*	4,653	738	3,915

*Weighted

The peaks of Dolly Varden immigration usually occurred during high water periods in all three streams. In the South Arm Stream, the migration began at a water temperature of 46° F. Most of the char entered at temperatures of 43° to 52°, and the migration ended at 42°. The North Arm Stream #1 migration of char began at 42°, with most entering at temperatures between 40° and 52° and ended at 38°. The North Arm Stream #2 was 51° F at the beginning of the Dolly Varden immigration, 44° to 54° throughout the main migration period, and 39° at the end of the migration. Most Dolly Varden entered the Hood Bay streams during the hours of darkness.

By maturity, there was no obvious period of immigration common to the three Hood Bay streams (Table 9). During July, August, September, and October, substantial numbers of non-spawner and potential spawner Dolly Varden were entering the Hood Bay streams.

Pink salmon began entering the South Arm Stream in substantial numbers in late July, peaked in late August and early September, and ended in late September. The chum salmon migration began entering the South Arm Stream earlier than pink in mid-July and was mostly over by late September. The late fall migration of chums that occurred in 1967 did not materialize this year and only a few entered the system in October. The migration of coho began in mid-September, peaked in mid-October and ended by November 1. A total of 32,347 pink, 4,071 chum, and 152 coho salmon was enumerated at the South Arm Stream weir in 1968 (Table 10).

TABLE 10 - Numbers of Dolly Varden, Pink, Chum, and Coho Entering the South Arm Stream by Five-Day Intervals, 1968.

		<u>Dolly Varden</u>	<u>Pink</u>	<u>Chum</u>	<u>Coho</u>
July	5 - 9	23	0	0	--
	10 - 14	74	0	17	--
	15 - 19	116	1	208	--
	20 - 24	202	47	308	--
	25 - 29	146	1,203	1,243	--
August	30 - 3	253	1,360	334	--
	4 - 8	319	1,778	144	--
	9 - 13	96	1,907	121	--
	14 - 18	47	1,905	118	--
	19 - 23	106	4,207	168	--
	24 - 28	46	3,772	47	--
September	29 - 2	1,134*	4,467*	425*	--
	3 - 7	66	5,775	362	--
	8 - 12	479*	3,828	400	1
	13 - 17	69	316	4	3
	18 - 22	70	1,476	106	0
	23 - 27	952*	300*	21*	5
October	28 - 2	117	5	11	1
	3 - 7	232	0	15	8
	8 - 12	24	0	3	0
	13 - 17	84	0	11	17
	18 - 22	129	0	5	117
	23 - 27	210*	0	0	0
November	28 - 1	<u>13</u>	<u>0</u>	<u>0</u>	<u>0</u>
Total		5,007	32,347	4,071	152

*Includes estimated number of fish missed during high water periods when the weir screens were removed.

The timing of the pink and chum salmon migration in the North Arm streams was earlier than the South Arm Stream. Peaks of migration occurred in these systems in mid-August and was mostly over by early September.

Maturity of Inmigrant Dolly Varden

The number of potential spawners entering the Hood Bay streams varied from 738 in the North Arm Stream #2 to 1,448 in the South Arm Stream (Table 11). These numbers ranged from 12.6 percent to 28.9 percent of the total number of Dolly Varden entering these streams. The other inmigrants are nonspawners and appeared to consist mainly of char from other stream systems, moving from one system to another.

TABLE 11 - Number and Sex of Dolly Varden Potential Spawners Entering the Hood Bay Streams, 1968.

	<u>South Arm Stream</u>	<u>North Arm Stream #1</u>	<u>North Arm Stream #2</u>
Females	1,119	538	439
Males	<u>329</u>	<u>507</u>	<u>299</u>
Totals	1,448	1,045	738

Despite the greater length and flow of the North Arm streams, the South Arm Stream had more potential spawners entering it. One possible reason may be that the South Arm Stream is less subjected to the adverse effects of flooding because of its steep and smaller watershed area. After fishing more than 50 nonlake streams on Baranof, Chichagof and Admiralty Islands during our early tag recovery work, we were impressed with the fishing success in this South Arm Stream on the larger or potential spawner Dolly Varden. It may be that 1,500 to 2,000 Dolly Varden spawners is a high annual average for nonlake streams on these Islands.

Sex ratios of the potential spawners entering these streams varied from a near equal ratio in the North Arm Stream #1 to a 77 percent female to 23 percent male in the South Arm Stream. In the South Arm Stream, the sex ratios have been considerably different between the years 1966, 67, and 68 (Table 12). In this system the number of males has decreased considerably from 1,170 in 1966 to 329 in 1968, while the number of females has remained relatively constant.

TABLE 12 - Number and Sex of Dolly Varden Potential Spawners Entering the South Arm Stream in 1966, 1967 and 1968.

	<u>1966</u>	<u>1967</u>	<u>1968</u>
Females	988	1,115	1,119
Males	<u>1,170</u>	<u>684</u>	<u>329</u>
Totals	2,158	1,799	1,448

Size and Age of Immigrant Dolly Varden

The length frequencies of the immigrant Dolly Varden measured at the weirs on the Hood Bay streams in 1968 are presented in Figures 15, 16 and 17. The immigrant char ranged from 81 to 520 mm in fork length and averaged between 234 and 251 mm. Most of the char between 81 and 300 mm were nonspawners and most over 300 mm were potential spawners, although significant numbers of potential spawners occurred in length groups from 190 mm on. The general length distributions of the char entering the three streams were similar, with the exception of a group of fish between 101 and 170 mm that entered the South Arm Stream. This group was not observed entering the North Arm streams. These fish were probably mostly fall smolts entering the South Arm Stream shortly after their outmigration from the same stream.

Age groups II through XI were found among the immigrant char with the majority of these fish occurring in age groups III through VI (Table 13). By maturity most nonspawners were in age groups III, IV and V and potential spawners in age groups IV, V, and VI.

The age, average length and length range of immigrant Dolly Varden by maturity is presented for the char sampled at the three weirs in Tables 14, 15 and 16. Potential spawners were larger in length than the nonspawners in most age groups. Nonspawners averaged 204 to 238 mm in fork length and potential spawners averaged 292 to 336 mm. Weights were taken only on the char sampled from the South Arm Stream (Table 17). The nonspawners averaged 0.23 lb and the potential spawners 1.12 lb.

Dolly Varden Outmigration - South Arm Stream

Dolly Varden immigrants leave the South Arm Stream the same year as entry. The outmigrants consist of both spawned-out and nonspawning char. In 1967, nonspawners averaged 14 days in the South Arm Stream and spawners 72 days in the system (Armstrong and Winslow, 1968).

Coverage of the outmigration was minimal in 1968 due to the die-off of pink salmon in August and September and high water conditions. The dead salmon accumulated in the outmigrant traps faster than they could be removed and greatly reduced the attraction current. High water caused frequent removal of weir panels. Nonspawning Dolly Varden began leaving the South Arm Stream in mid-July, peaked during late August and mid-October and was mostly over by early November. The majority of the spawned-out char left the system during the first two weeks of November. Fifty percent of the enumerated spawned-out fish left during a 36-hour period in early November. As observed in 1966 (Armstrong, 1967) and 1967 (Armstrong and Winslow, 1968), the spawned-out males left the system later than most of the females. Most of the outmigration occurred during a decrease from 48° to 42°F in water temperature. It appears that water height affects the timing of outmigration.

Frequency of Spawning

In 1966 and 1967 all char captured at the South Arm Stream weir were tagged with dart tags using methods similar to those described by Armstrong and Blackett, 1966. The tag number, sex and maturity were recorded for all spawned-out char captured at the weir during their outmigration after spawning in the system. Hence, it could be determined if a tagged

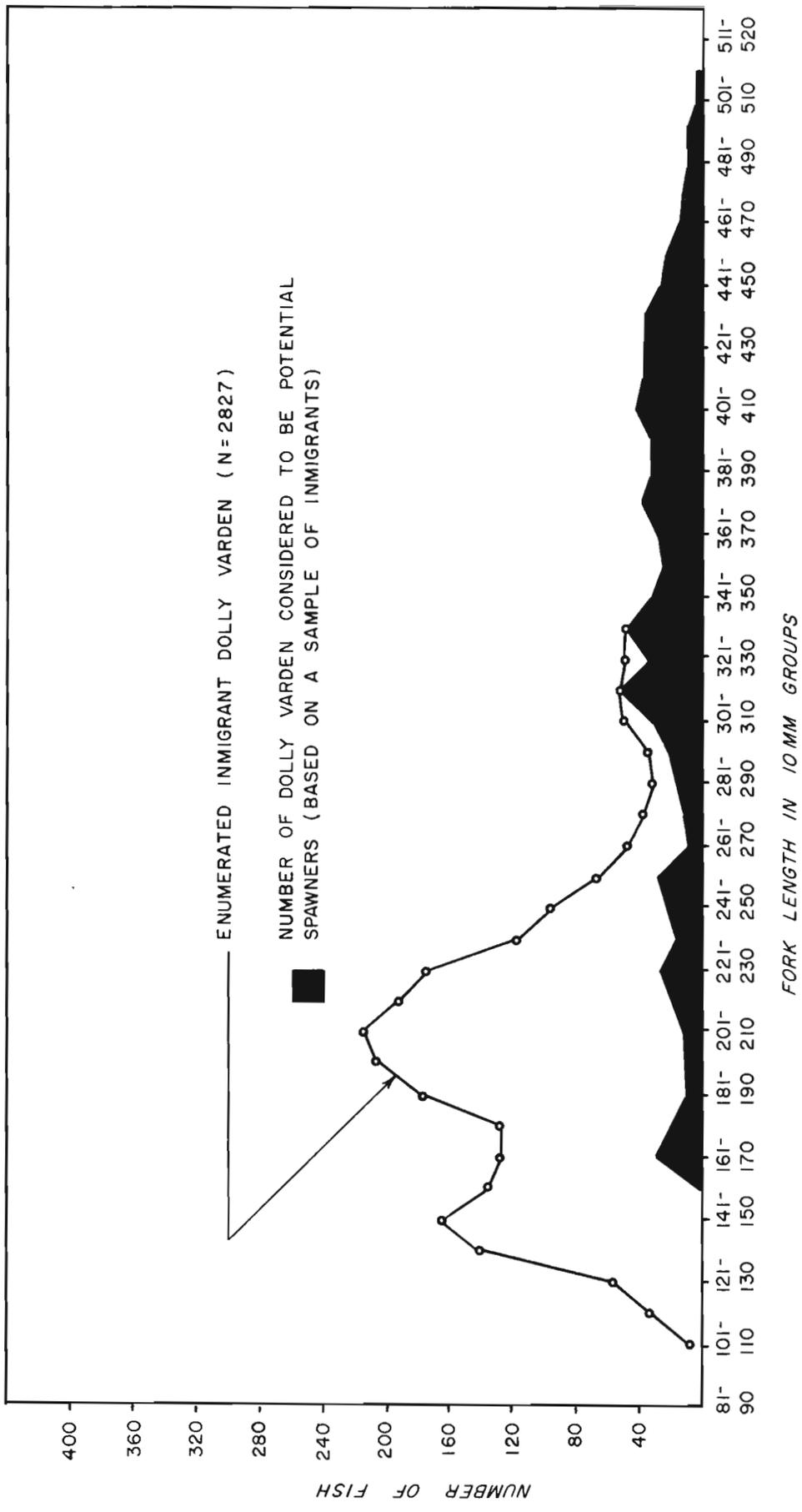


FIGURE 15. LENGTH FREQUENCY OF DOLLY VARDEN IMMIGRANTS ENUMERATED AT THE SOUTH ARM STREAM WEIR, 1968, SHOWING THE NUMBER OF THESE CHAR CONSIDERED TO BE POTENTIAL SPAWNERS FOR THE YEAR.

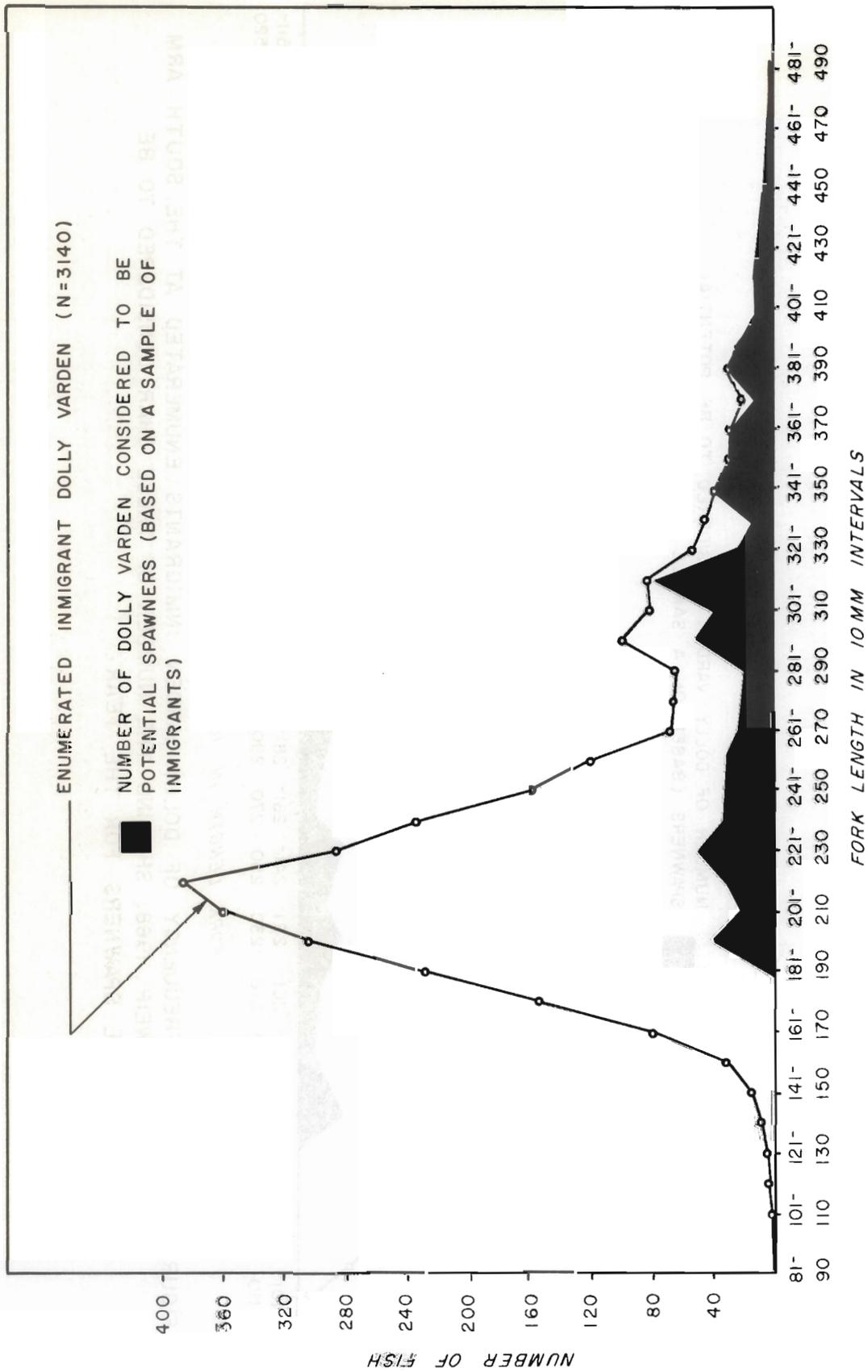


FIGURE 16. LENGTH FREQUENCY OF DOLLY VARDEN INMIGRANTS ENUMERATED AT NORTH ARM STREAM No 1, 1968, SHOWING THE NUMBER OF THESE CHAR CONSIDERED TO BE POTENTIAL SPAWNERS FOR THE YEAR.

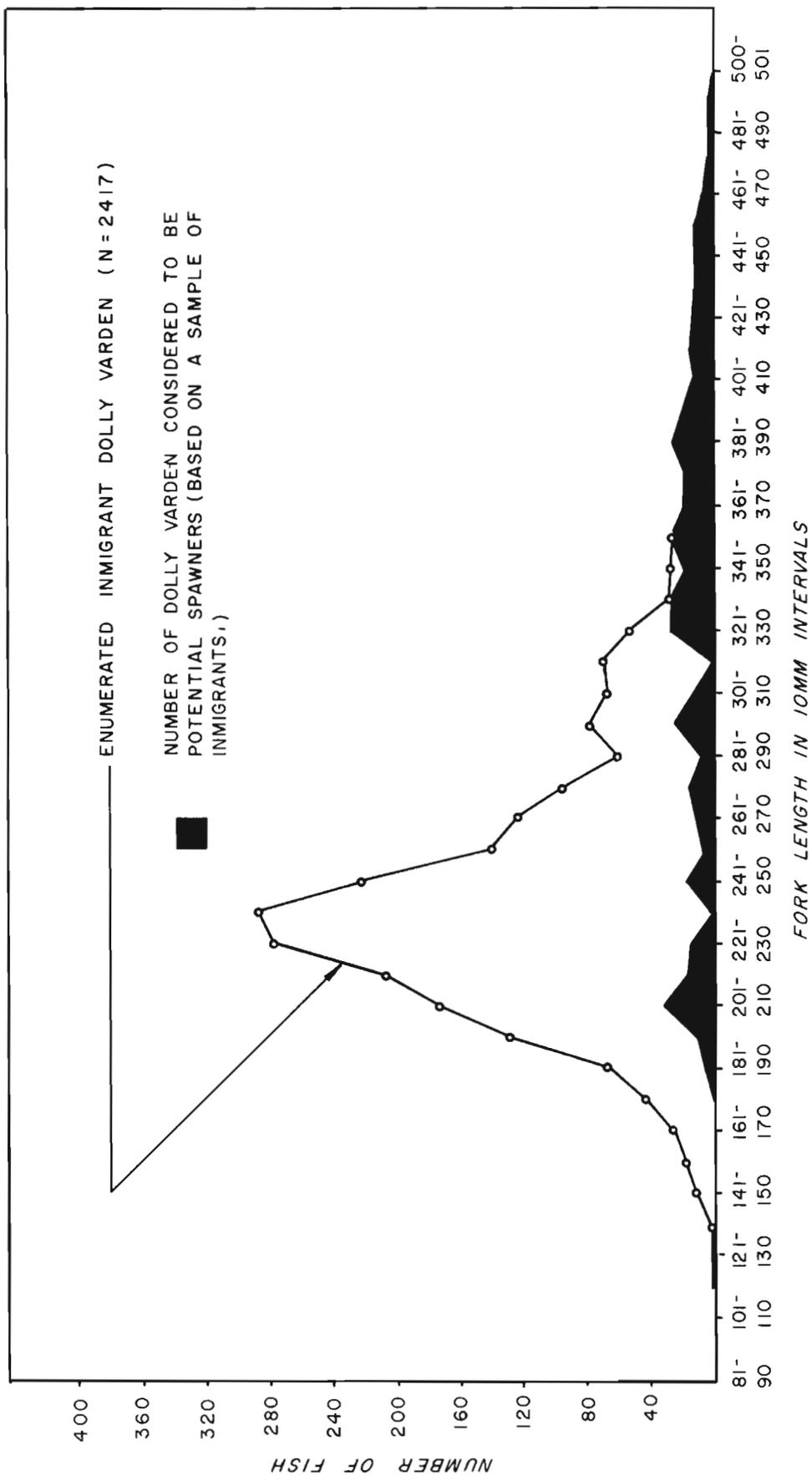


FIGURE 17 LENGTH FREQUENCY OF DOLLY VARDEN INMIGRANTS ENUMERATED AT NORTH ARM STREAM No 2, 1968, SHOWING THE NUMBER OF THESE CHAR CONSIDERED TO BE POTENTIAL SPAWNERS FOR THE YEAR.

TABLE 13 - Age Composition of Immigrant Dolly Varden Sampled at All Weirs in Hood Bay, 1968.

Age Group	NONSPAWNERS			POTENTIAL SPAWNERS			TOTAL		
	South Arm Stream #1	North Arm Stream #2	South Arm Stream	South Arm Stream	North Arm Stream #1	North Arm Stream #2	South Arm Stream	North Arm Stream #1	North Arm Stream #2
II	---	3.1%	---	---	---	---	---	---	2.6%
III	41.4%	18.9%	4.4%	---	---	2.5%	31.1%	14.8%	21.6%
IV	46.2%	59.7%	17.6%	28.1%	---	25.0%	39.0%	52.9%	43.8%
V	9.1%	18.0%	39.7%	40.6%	27.5%	27.5%	17.3%	22.9%	21.6%
VI	2.2%	3.4%	17.6%	23.4%	35.0%	35.0%	5.9%	7.7%	8.2%
VII	.5%	---	11.8%	7.8%	7.5%	7.5%	3.9%	1.7%	1.7%
VIII	.5%	---	7.4%	---	---	---	2.4%	---	---
IX	---	---	1.5%	---	---	---	.4%	---	---
XI	---	---	---	---	---	2.5%	---	---	.5%
Sample size	186	233	68	64	40	254	297	231	100.0%
	99.9%	100.0%	100.0%	99.9%	100.0%	100.0%	100.0%	100.0%	100.0%

TABLE 14 - Age, Average Length and Length Range of Immigrant Dolly Varden Nonspawners and Potential Spawners at the South Arm Stream, 1968.

Age Group	NONSPAWNERS			POTENTIAL SPAWNERS			TOTAL	
	No.	Average Length (mm)	Range (mm)	No.	Average Length (mm)	Range (mm)	No.	Average Length (mm)
III	76	183	120 - 261	3	217	163 - 252	79	184
IV	86	214	148 - 305	12	250	166 - 382	98	218
V	17	238	157 - 325	27	319	239 - 468	44	288
VI	4	255	214 - 304	11	380	308 - 458	15	347
VII	1	207	---	9	417	372 - 448	10	396
VIII	1	218	---	5	425	364 - 496	6	390
IX	0	0	0	1	518	---	1	518
TOTALS	185	204	120 - 325	68	336	163 - 496	253	240

TABLE 15 - Age, Average Length and Length Range of Immigrant Dolly Varden Nonspawners and Potential Spawners Sampled at North Arm Stream #1, 1968.

Age Group	NONSPAWNERS			POTENTIAL SPAWNERS			TOTAL	
	No.	Average Length (mm)	Range (mm)	No.	Average Length (mm)	Range (mm)	No.	Average Length (mm)
III	45	209	127 - 272	--	---	---	45	209
IV	140	209	106 - 310	18	241	192 - 317	158	213
V	42	250	171 - 339	26	283	197 - 388	68	263
VI	8	265	189 - 307	15	339	203 - 418	23	313
VII	--	---	---	5	376	324 - 420	5	376
TOTALS	235	218	106 - 339	64	292	192 - 420	299	234

TABLE 16 - Age, Average Length and Length Range of Immigrant Dolly Varden Nonspawners and Potential Spawners Sampled at the North Arm Stream #2, 1968.

Age Group	NONSPAWNERS			POTENTIAL SPAWNERS			TOTAL		
	No.	Average Length (mm)	Range (mm)	No.	Average Length (mm)	Range (mm)	No.	Average Length (mm)	
II	6	226	146 - 258	--	---	---	6	226	
III	48	223	158 - 269	1	201	---	49	223	
IV	91	229	118 - 312	10	236	164 - 341	101	230	
V	39	276	172 - 429	11	287	210 - 368	50	278	
VI	5	281	219 - 320	14	358	297 - 411	19	337	
VII	1	232	---	3	427	385 - 460	4	379	
TOTALS*	190	238	118 - 429	40	312	164 - 460	230	251	

*Totals include one age XI potential spawner 460 mm.

TABLE 17 - Age, Average Weight and Weight Range of Immigrant Dolly Varden Nonspawners and Potential Spawners Sampled at the South Arm Stream Weir, 1968.

Age Group	NONSPAWNERS			POTENTIAL SPAWNERS			TOTAL		
	No.	Average Weight (lb)	Range (lb)	No.	Average Weight (lb)	Range (lb)	No.	Average Weight (lb)	
III	76	.17	.03 - .46	3	.27	.11 - .40	79	.17	
IV	86	.25	.08 - .68	12	.51	.10 - 1.45	98	.28	
V	17	.36	.08 - .60	27	.88	.35 - 2.58	44	.68	
VI	4	.41	.20 - .63	11	1.45	.78 - 2.12	15	1.17	
VII	1	.81	.81	9	1.78	1.05 - 2.23	10	1.62	
VIII	1	.25	.25	5	1.98	1.18 - 3.08	6	1.69	
IX	--	---	---	1	3.40	---	1	3.40	
TOTALS	185	.23	.03 - .68	68	1.12	.10 - 3.40	253	.47	

spawned-out char leaving the system in 1968 had spawned in a previous year.

A total of 256 spawned-out Dolly Varden tagged in either 1967 or 1966 was captured at the weir in 1968. Of these, 228 (89 percent) were also recorded as having spawned in the system in 1967. Only 23 tagged char captured were recorded as having spawned in 1966. Of these, 22 spawned all three years and only one was recorded as spawning in 1966, not in 67, and again in 68. This information shows that the majority of the char enter the system more than one year for the purpose of spawning. Also, 448 char marked in a previous year were captured leaving the system in 1968; of these, 92.2 percent were spawned out. Only 5.3 percent left the system before spawning commenced and could be possible nonspawners. This clearly shows that most Dolly Varden return to the South Arm Stream for the purpose of spawning.

The information obtained from the marked char can be projected to estimate the percentage of the 1968 spawners which had spawned in previous years (Table 18). Of the char spawning in 1968 at the South Arm Stream, 53.6 percent were estimated to be first-time spawners, 28.5 percent second-time spawners, and 17.9 percent had spawned three years.

TABLE 18 - Estimated Frequency of Spawning for the Char Spawning in the South Arm Stream, 1968.

	<u>Male</u>	<u>Female</u>	<u>Total</u>
Three years (1966, 67 & 68)	8.6% (13)	20.3% (115)	17.9% (128)
Two years (1967 & 68)	13.9% (21)	32.4% (183)	28.5% (204)
One year (1968)	<u>77.5% (117)</u>	<u>47.3% (267)</u>	<u>53.6% (384)</u>
Totals	100.0% (151)	100.0% (565)	100.0% (716)

(n) = Number of marked fish captured in this category.

Female Dolly Varden were estimated to spawn more frequently than males (Table 18). Males have been recorded as suffering a much higher mortality after spawning than females (Armstrong and Winslow, 1968), which would account for this difference in spawning frequency.

Mortality After Spawning

Since Dolly Varden spawners do not overwinter in the South Arm Stream, the difference between the number of potential spawners entering the stream and the number of spawned-out char leaving the system is considered to be the mortality of the fish while in the stream.

In 1968, an overall mortality (sexes combined) was computed to be 18.0 percent between their in- and outmigration (Table 19). Males suffered a much higher mortality (49.2 percent) than the female char (8.8 percent). Similar mortality rates were found for the char spawning in the South Arm Stream in 1967 (Armstrong and Winslow, 1968).

TABLE 19 - Mortality of Dolly Varden After Spawning and Before Outmigration in the South Arm Stream, 1968.

	Inmigrants Available* for Capture	Number of Outmigrants Enumerated**	Difference	Percent Mortality
Female	1,007	918	89	8.8
Male	297	151	146	49.2
Totals	1,304	1,069	235	18.0

*Based on a sample of the inmigrants.

**High water caused some fish to be missed during one night. The estimated number missed is included in these figures.

Male char spend more time on the spawning grounds and in the system (Armstrong, 1967) so they would be more susceptible to predation than female char. The river otter, Lutra canadensis, is frequently observed near the upstream spawning area and is suspected of preying on the spawning Dolly Varden. The higher mortality among the males is also thought to be due to their aggressiveness and fighting on the spawning site. Blackett (1968) has reported that only male Dolly Varden participated in aggression. The development of extreme sexual dimorphism among the males may also hinder their chances for survival.

Mortality, after the initial instream mortality, has been computed for the Dolly Varden spawning in the South Arm Stream in 1966 and 1967 (Figures 18 and 19). Male char obviously suffer their greatest mortality before leaving the system and probably after their first spawning. Female char appear to suffer their greatest mortality after leaving the system. Of the char spawning in 1966, approximately 20 percent of the females and one percent of the males were left at the time of the 1968 outmigration of spawners (Figure 18). It is doubtful that many of these fish will survive to spawn in 1969 as they were mostly age VIII fish. Very few of these char have been found older than this age group.

Of the char spawning in 1967, approximately 33 percent of the females and 6 percent of the males were left after spawning in 1968 (Figure 19).

Return of Dolly Varden Displaced from the Hood Bay Streams

In 1967 we displaced char from the South Arm Stream to three points in Hood Bay (Armstrong and Winslow, 1968). The results of this experiment indicated that the larger char (\bar{x} 301 mm) returned much more readily than the smaller char (\bar{x} 300 mm). Since most of the char from the larger size group were mature, it was concluded that most of the fish returning did so for the purpose of spawning.

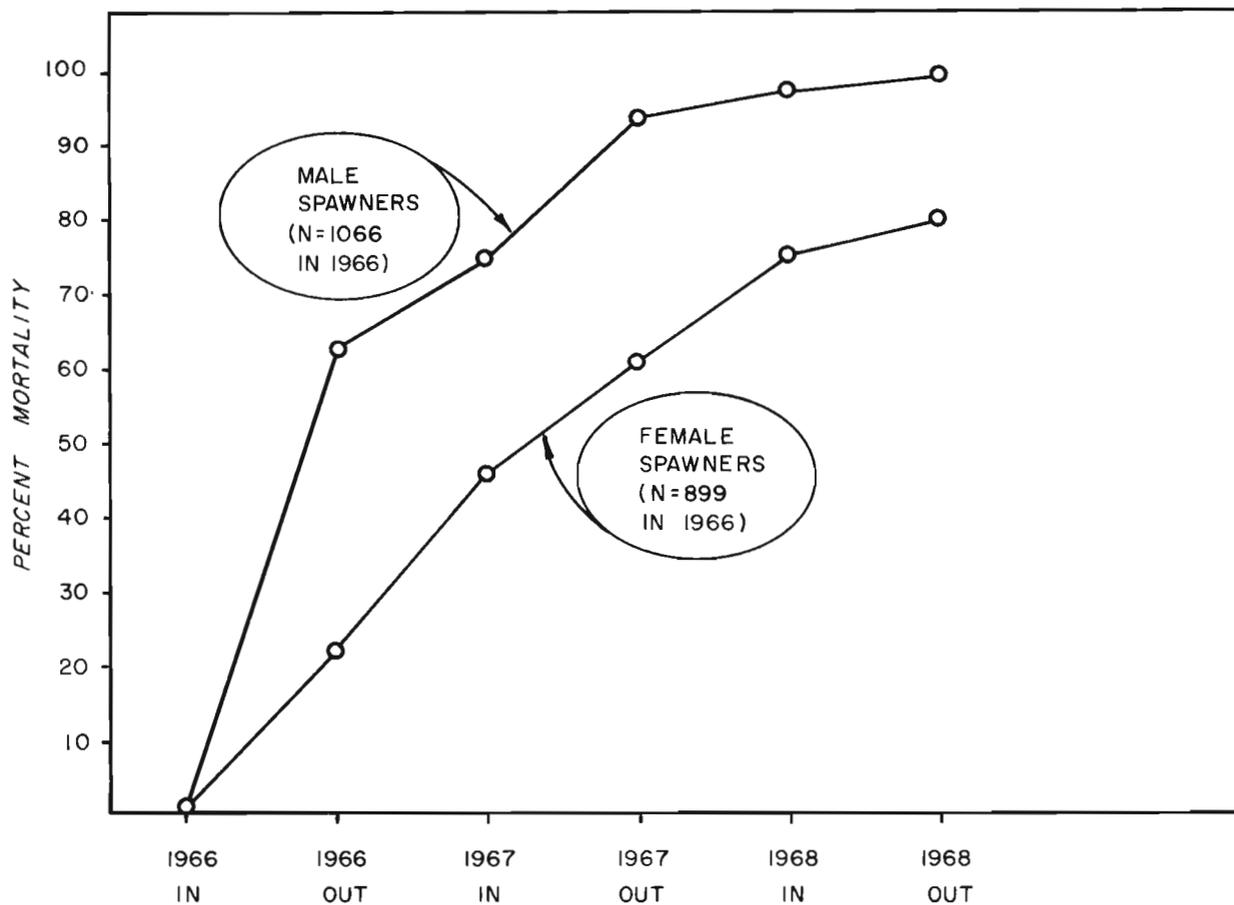


FIGURE 18. PERCENT MORTALITY OF THE MATURE (POTENTIAL SPAWNERS) DOLLY VARDEN ENTERING THE SOUTH ARM STREAM IN 1966 DURING SUBSEQUENT MIGRATIONS.

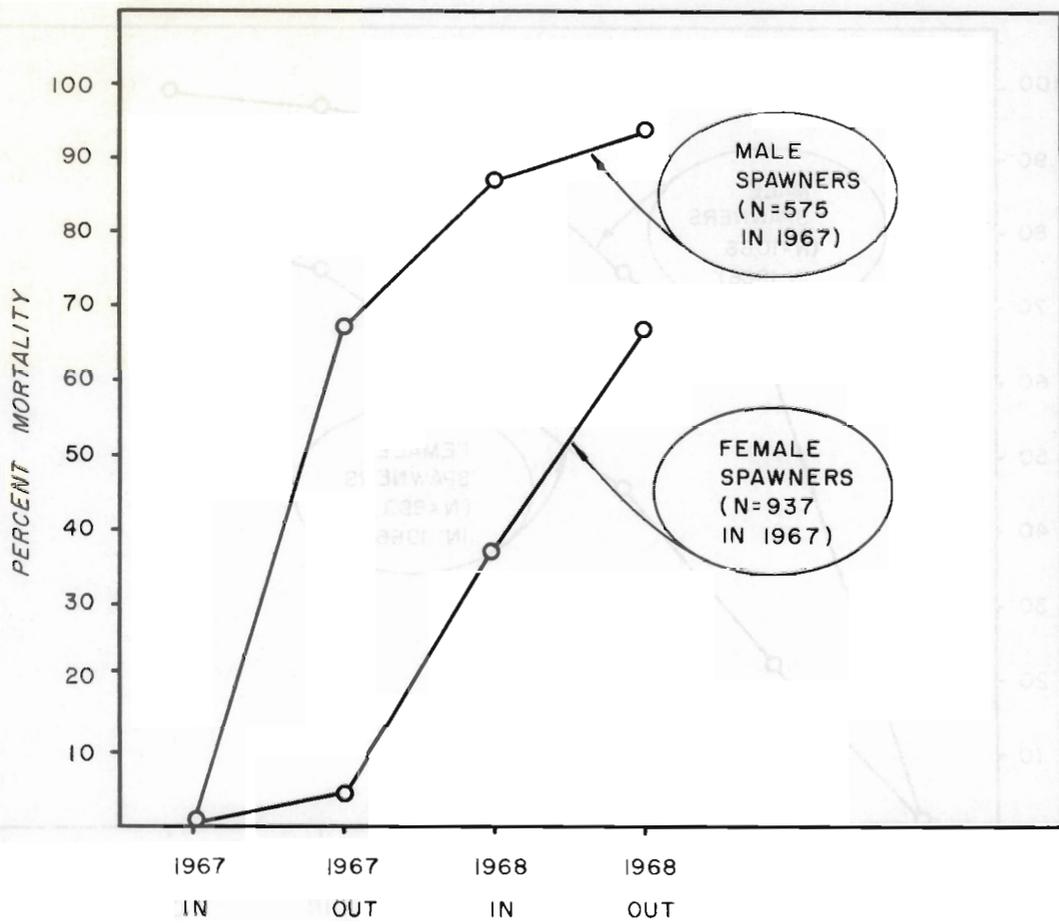


FIGURE 19. PERCENT MORTALITY OF THE MATURE (POTENTIAL SPAWNERS) DOLLY VARDEN ENTERING THE SOUTH ARM STREAM IN 1967 DURING SUBSEQUENT MIGRATIONS.

The displacement experiment in 1968 involved capturing inmigrant Dolly Varden in all three Hood Bay streams and displacing them to the junction of the North and South Arm of the Bay. The displaced char were marked by punching a hole in one of the fins. Two size groups, representing the immature fish (\bar{x} 275 mm) and the mature fish (\bar{x} 325 mm) were displaced from each system. Recovery of these displaced char was made at the weirs as they entered or left the systems. The coverage at the North Arm weirs was not sufficient to draw any conclusions; however, the South Arm Stream weir was in operation throughout most of the migration, and the results obtained from the displaced char entering and leaving this system should be valid.

Of the large-sized fish displaced (56) from the South Arm Stream, 68 percent (38) returned to the system. All of these char were either potential spawners (inmigrants) or spawned-out (outmigrants). The percentage return is probably higher as some of the fish returning would have died in the system after spawning and could not be recovered. Only one of these fish was recorded as entering the North Arm streams.

In contrast, none of the 46 small-sized char returned to the South Arm Stream after being displaced from that system. Two of these char were captured entering the North Arm streams.

To further test the homing tendencies of Dolly Varden, 177 were displaced from the North Arm streams and also released at the junction of the North and South Arms of Hood Bay. These fish were handled in an identical manner to those displaced from the South Arm Stream. If the char did not have a tendency to return to their home stream, then recoveries of the large-sized char displaced from the North Arm streams should have been made in the South Arm Stream; however, only 3 of 92 large-sized displaced char were recovered in the South Arm Stream.

Homing

The best method of determining homing in Dolly Varden is to mark the smolts during their outmigration and determine the return to their home stream in subsequent years. This was done for the 1967 and 1968 smolt migrations at the South Arm Stream. The 1969 return of these smolts will be most informative as most of the smolts marked in 1967 should have reached sexual maturity by this time.

The 1968 return of the smolts marked in 1967 gives some positive evidence of homing in Dolly Varden (Table 20). About 97 percent of the 1967 smolts which entered the South Arm Stream in 1968 were potential spawners, whereas 29 percent and 9 percent of these fish entering the two North Arm streams were estimated to be potential spawners.

Some of these mature char which had entered the North Arm streams later migrated to the South Arm Stream and spawned. This indicates that positive information on straying can only be obtained from char spawning in a system other than the one from which they originated. It is interesting to note that none of the char marked as smolts from the South Arm Stream were recorded as spawning in the North Arm streams in 1968 (Table 20).

TABLE 20 - Recovery of the Smolts Marked in 1967 at the South Arm Stream Weir, 1968.

<u>Stream</u>	<u>Estimated Number of Immigrants</u>	<u>Percent Potential Spawners*</u>	<u>Number Captured Leaving the System Spawned Out</u>
South	294	96.8	119
North #1	130	28.6	0
North #2	61	9.1	0

*Based on a sample of the immigrants.

ACKNOWLEDGEMENTS

The following men assisted in the 1968 collection of information at the Hood Bay field stations: Barry Bracken, Kenneth Cesar, Gerry Downey, Steven Elliott and Michael Potts. Mr. Bracken compiled most of the information collected at the North Arm streams.

LITERATURE CITED

- Armstrong, Robert H. 1963. Investigations of Anadromous Dolly Varden Populations in the Lake Eva-Hanus Bay Drainages, Southeastern Alaska. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1962-1963, Project F-5-R-4, 4:78-122.
- _____. 1965a. Annotated Bibliography on the Dolly Varden Char. Alaska Department of Fish and Game, Research Report Number 4. 26 pp.
- _____. 1965b. Some Feeding Habits of the Anadromous Dolly Varden, Salvelinus malma (Walbaum), in Southeastern Alaska. Alaska Department of Fish and Game, Informational Leaflet Number 51. 27 pp.
- _____. 1965c. Some Migratory Habits of the Anadromous Dolly Varden, Salvelinus malma (Walbaum), in Southeastern Alaska. Alaska Department of Fish and Game, Research Report Number 3. 36 pp.
- _____. 1967. Investigations of Anadromous Dolly Varden Populations in the Hood Bay Drainages, Southeastern Alaska. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1966-1967, Project F-5-R-8, 8:33-56.
- Armstrong, Robert H. and Roger F. Blackett. 1966a. Digestion Rate of the Dolly Varden. Transactions of the American Fisheries Society, 95(4):429-430.
- _____. 1966b. Use and Evaluation of the Dart Tags to Study the Migration Habits of Dolly Varden, Salvelinus malma (Walbaum). Transactions of the American Fisheries Society, 95(3):320-322.

- Armstrong, Robert H. and William A. Morton. 1969. Revised Annotated Bibliography on the Dolly Varden Char. Alaska Department of Fish and Game, Research Report Number 7. 108 pp.
- Armstrong, Robert H. and Peter C. Winslow. 1968a. An Incident of Walleye Pollock Feeding on Salmon Young. Transactions of the American Fisheries Society, 97(2):202-203.
-
- _____. 1968b. Investigations of Anadromous Dolly Varden Populations in Hood Bay Drainages, Southeastern Alaska. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1967-1968, Project F-5-R-9, 9:45-80.
- Blackett, Roger F. 1968. Spawning Behavior, Fecundity and Early Life History of Anadromous Dolly Varden, Salvelinus malma (Walbaum), in Southeastern Alaska. Alaska Department of Fish and Game, Research Report Number 6, 85 pp.
- Blackett, Roger F. and Robert H. Armstrong. 1965a. Collection of Two Abnormal Dolly Varden: One With Two Dorsal Fins, the other with Incomplete Pigmentation. Transactions of the American Fisheries Society, 94(4):409.
-
- _____. 1965b. Investigations of Anadromous Dolly Varden Populations in the Lake Eva-Hanus Bay Drainages, Southeastern Alaska. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1964-1965, Project F-5-R-6, 6:23-56.
- Chapman, D. W. 1962. Aggressive Behavior in Juvenile Coho Salmon as a Cause of Emigration. Journal Fisheries Research Board of Canada, 19:1047-1080.
- Cooper, Edwin L. and Norman G. Benson. 1951. The Coefficient of Condition of Brook, Brown, and Rainbow Trout in Pigeon Creek, Otsego County, Michigan. Progressive Fish-Culturist, 13(4):181-192.
- Heiser, David W. 1966. Age and Growth of Anadromous Dolly Varden Char, Salvelinus malma (Walbaum), in Eva Creek, Baranof Island, Southeastern Alaska. Alaska Department of Fish and Game, Research Report Number 5. 26 pp.
- Hunter, J. G. 1959. Survival and Production of Pink and Chum Salmon in a Coastal Stream. Journal Fisheries Research Board of Canada, 16(6):835-886.
- Lagler, Karl F. 1956. Freshwater Fishery Biology. Dubuque, Wm. C. Brown Co., 421 pp.
- McLarney, William O. 1964. The Coastrange Sculpin, Cottus aleuticus: Structure of a Population and Predation on Eggs of the Pink Salmon, Oncorhynchus gorbuscha. Master of Science thesis. University of Michigan. 83 pp.

Prepared by:

Robert H. Armstrong
Fishery Biologist

Paul D. Kissner, Jr.
Fishery Biologist

Date: November 1, 1969.

Approved by:

s/Louis S. Bandirola
D-J Coordinator

s/Rupert E. Andrews, Director
Division of Sport Fish