Informational Leaflet 105

BRISTOL BAY RED SALMON FORECAST OF RUN FOR 1967

Edited by:

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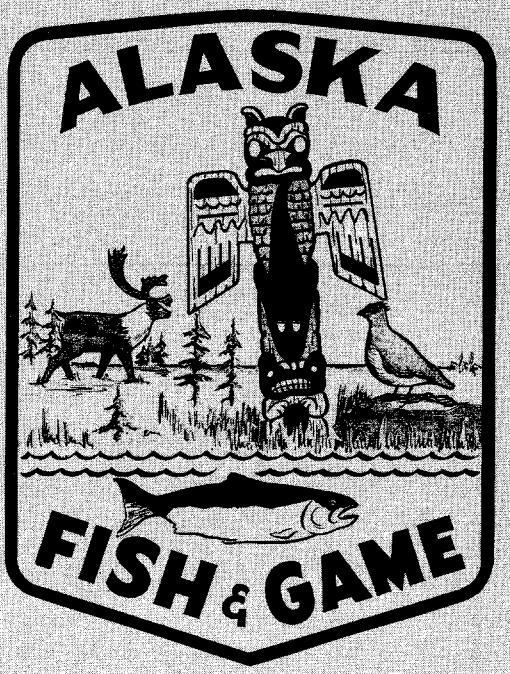

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Summary of the River System Forecast of the
Bristol Bay Red Salmon Run for 1967 (in millions of fish).

River System	.2-ocean	.3-ocean 1/	Total
Togiak	.096	.084	.180
Igushik	.035	.118	.153
Snake	.077	0	.077
Nuyakuk	.075	.053	.128
Wood	1.372	1.112	2.484
Nushagak-Mulchatna	.002	.044	.046
Nushagak Sub-total	1.561	1.327	2.888
Kvichak	1.888	2.105	3.993
Naknek	1.666	.898	2.564
Branch (Alagnak)	.697	.113	.810
Naknek-Kvichak Sub-total	4.251	3.116	7.367
Egegik	1.668	.713	2.381
Ugashik	.460	.473	.933
North Side Alaska Peninsula	.844	.396	1.240
Total	8.880	6.109	14.989

1/ The .3-ocean return has been adjusted by subtracting the Japanese high seas catch of immature red salmon in 1966.

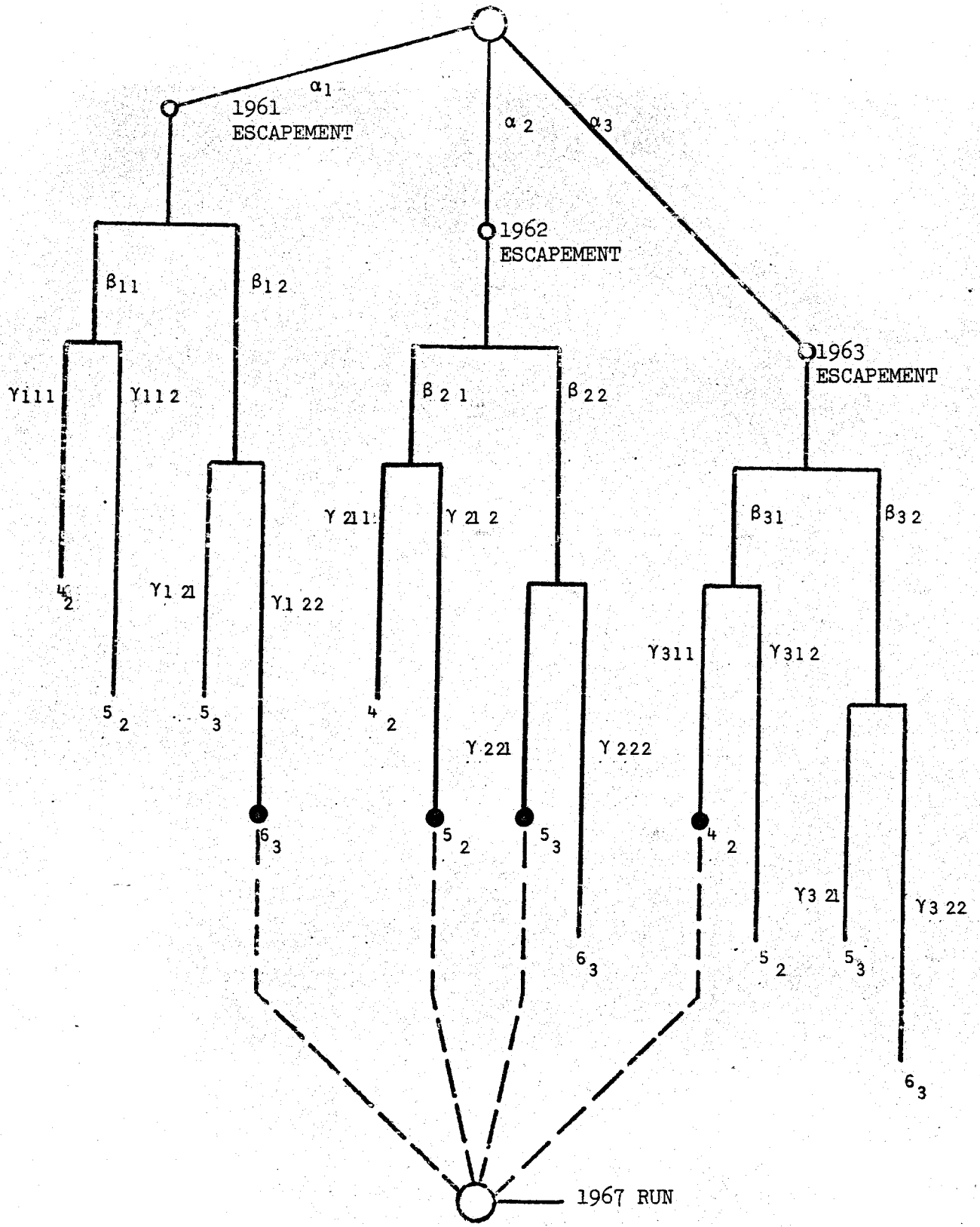

FIGURE 1. Probability Tree Diagram of Escapement-Return.

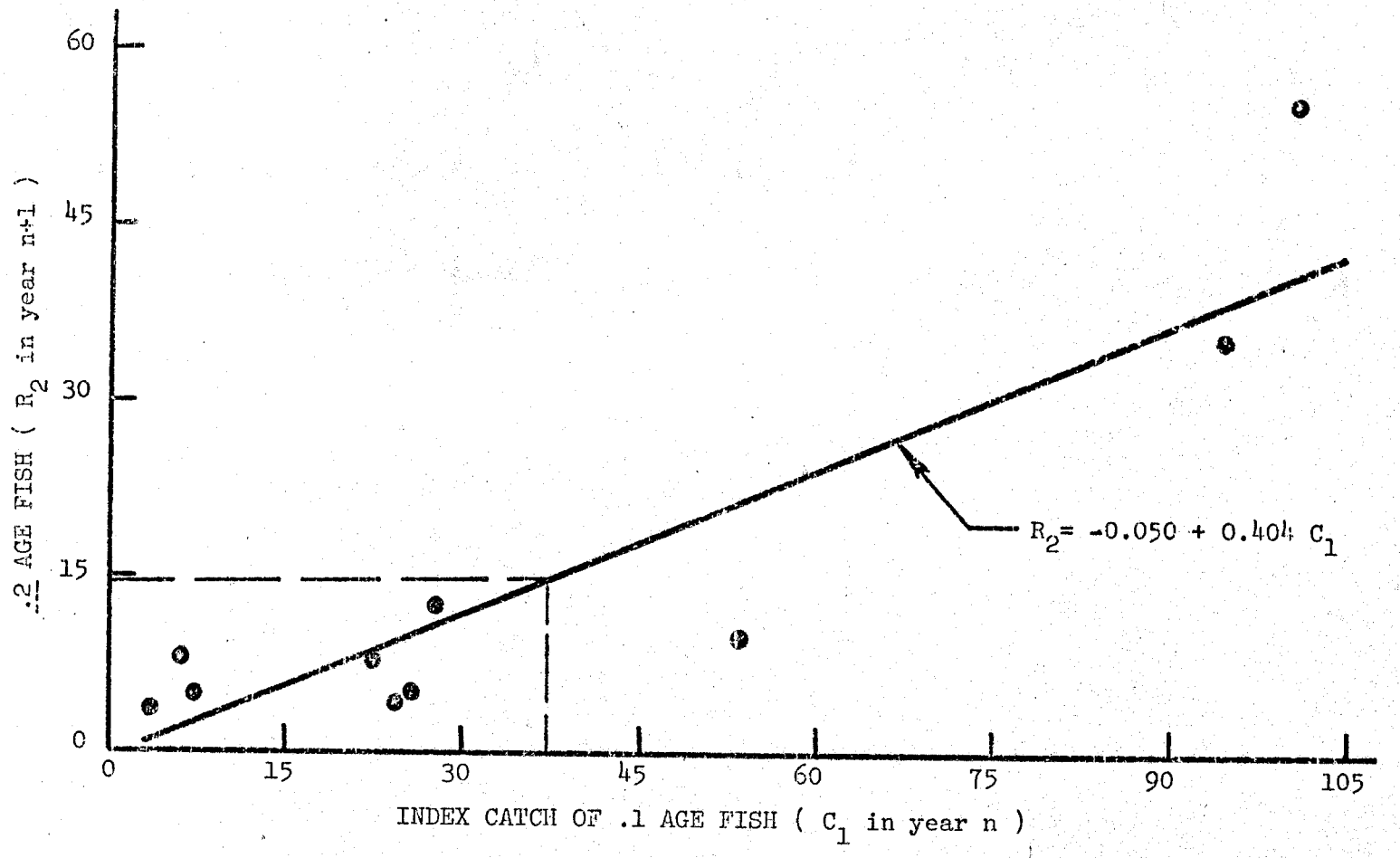

Figure 2. Relationship of .1 age seine index catch and .2 age Bristol Bay run (in millions of fish).

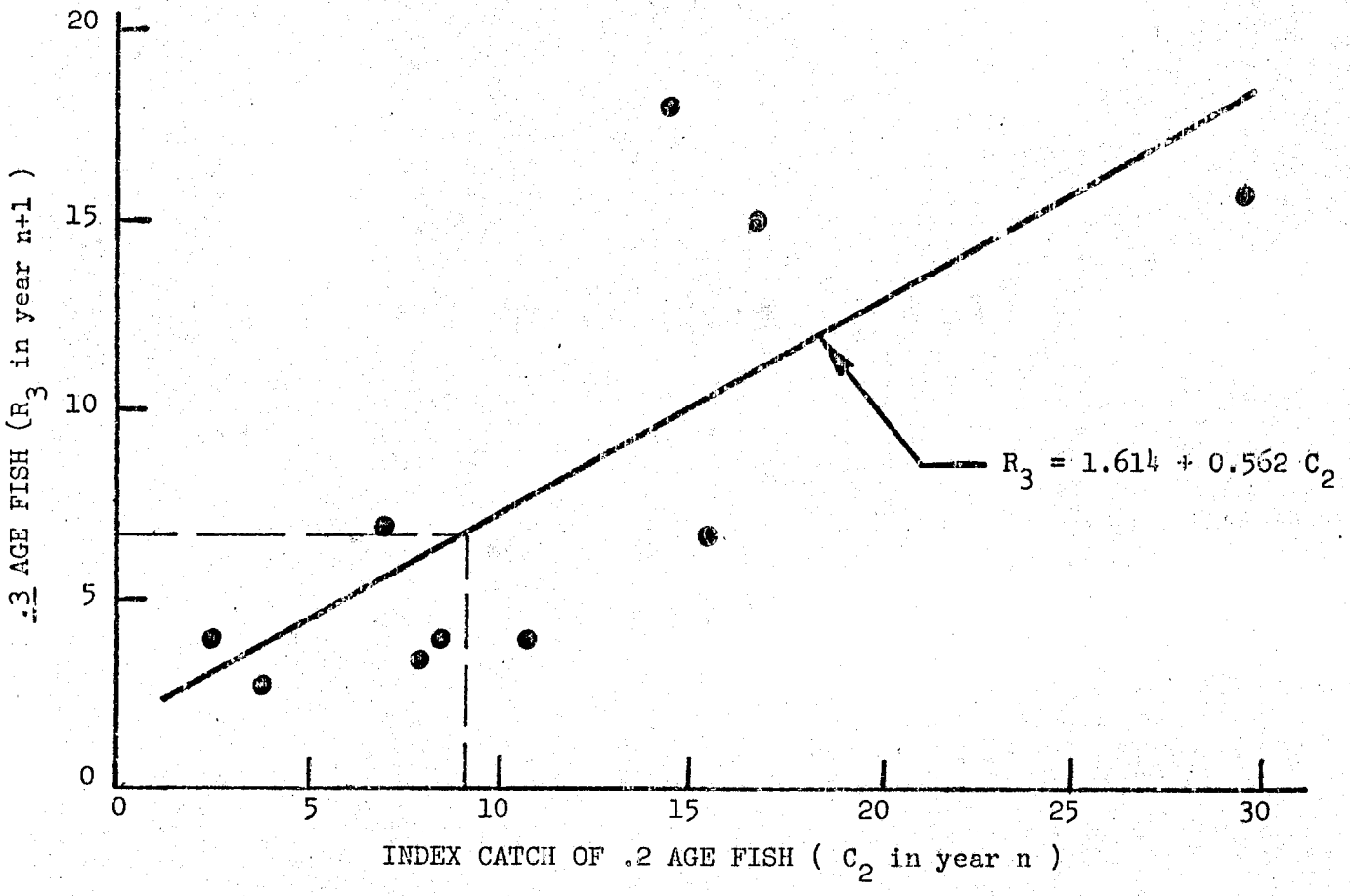

Figure 3. Relationship of .2 age seine index catch and .3 age Bristol Bay run (in millions of fish).

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I. Contributors

The forecast for the 1967 Bristol Bay red salmon run was jointly prepared by the Alaska Department of Fish and Game, the Fisheries Research Institute of the University of Washington, and the U.S. Bureau of Commercial Fisheries.

The yearly field collection of the Bristol Bay red salmon run data is carried out under the direction of Alaska Department of Fish and Game, Area Management Biologists Kenneth Middleton, Michael J. Nelson and Angus Robertson.

The following scientists participated in the analysis of the data: Mr. Frank J. Ossiander and Mr. Melvin Seibel of the Alaska Department of Fish and Game; Dr. William F. Royce, Dr. Robert L. Burgner, Dr. Ole Mathisen, and Mr. Allen C. Hartt of the Fisheries Research Institute; Mr. Reynold A. Fredin, Mr. Donald L. Worlund of the U.S. Bureau of Commercial Fisheries.

A draft of the 1967 forecast was compiled in October, 1966, using preliminary data on the 1966 run. This forecast uses final 1966 run data from all river systems in Bristol Bay.

The forecast methodology used and the accuracy of the computations are the responsibility of the editor.

II. Introduction

Forecasts are made of the expected return to the major river systems in each fishing district of Bristol Bay and of the expected return to Bristol Bay as a whole. Data used in these forecasts are: the inshore abundance and age composition of the catch and escapement, smolt outmigration age composition, the Japanese high seas catch and age composition of western Alaska red salmon, and purse seine catches of immature red salmon south of Adak Island.

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Forecasts are based on the relationship of return to abundance at some preceding stage of the red salmon life cycle. For the separate river system forecasts the relationship of escapement to subsequent return is used. The maturity schedule is estimated using smolt age and ocean age composition. A forecast of the total red salmon run to western Alaska is based on the previous year's purse seine index catch of immature red salmon south of Adak Island.

In the following sections data and relationships for each forecast method are given. These computations depend upon the adequacy of the basic data which is influenced by sampling errors and the representativeness of the sampling plans. Additional inaccuracies arise from not having sufficient data on the Japanese high seas catch of red salmon to adequately prorate their catch to the inshore river systems. Other assumptions and rationale are given in the particular forecast section.

III. Estimation of Total Runs to Each River System

The total runs to Bristol Bay are composed of the inshore catch and escapement and the fish which would be expected to return if they were not intercepted by a high seas fishery. As a first step in forecast analysis it is necessary to assign this total run to its target river system. The inshore catch and escapement data is obtained within districts for which target river systems can be directly assigned for the Togiak, Egegik and Ugashik river systems. In the Nushagak and Naknek-Kvichak fishing districts the red salmon return to several separate systems. Since the commercial catch is taken in the respective bays it cannot be separated directly into parts bound for the separate spawning systems. Therefore, the catch has been prorated to the separate spawning systems on the basis of the escapement by age groups to each river system. On the other hand, the high seas fishery takes fish of many different origins; however, from tagging and experimental fishery studies of the migration and distribution of red salmon in the ocean it has been established that at certain times and in certain areas the Japanese high seas fishery catches red salmon bound for Bristol Bay. For mature red salmon these times and areas include the May and June 1-10 catches east of 170° E, the June 11-20 catches east of 175° E, and the June 21-30 catches east of 180°. For immature red salmon it includes the July and August catches east of 170° E, and the June 21-30 catches between 170° E and 180°.

Total catch data for the Japanese high seas fishery is available for all years. The age structure is available for the years 1956 through 1965 but it must be estimated for 1966. The 1966 Japanese high seas catch of mature fish was assigned an age structure on the basis of the inshore catch. In years in which there is a high proportion of .3-ocean fish in the run (as was the case in 1966) the age structure of the high seas catch and inshore catch is similar. The total yearly run (inshore run plus high seas catch) to each river system is estimated by assigning the Japanese high seas catch by age structure to each river's inshore run on the basis of that river's inshore contribution to the particular age of the yearly Bristol Bay run. The inshore and

prorate total run figures are given in Appendix Tables 1 through 22.

For each river this procedure assumes that the Japanese catch the same proportion of fish from each age class as appear in the inshore run. This may not be the case since the high seas fishery is selective toward older ocean age fish and certain rivers may contribute a higher proportion of these fish to the total Bristol Bay runs. No allowance is made for ocean mortality which would be expected to apply between the time fish are taken on the high seas and when they would have returned to Bristol Bay. Likewise, no drop-out (a drop-out is a fish which falls from the gear as a dead fish or subsequently dies because of its encounter with the gear and is lost from the fishery) factor is applied to the Japanese high seas fishery. Additional errors probably arise because of changes from year to year in the migratory pattern of red salmon in the ocean; consequently, affecting the estimates of high seas catches of Bristol Bay red salmon.

IV. River System Forecasts

The forecast for each river is based upon an escapement-return relationship. This gives the total return expected from each escapement which will be contributing to the 1967 run. Subsequently the age structure of each total return must be estimated to obtain its contribution to the 1967 run.

The escapement-return relationship used is expressed by the equation:

$$R = a E^{b} e^{-cE} .$$

This is a general depensatory-compensatory type of two-stage reproduction curve. It has been comprehensively treated in other studies; notably, Ricker (1958 a, b), Larkin et. al. (1964), Ward and Larkin (1964), Paulik and Greenough in Watt (1967), and Johnson (1966). Its selection and use here is based on prior knowledge gained from these studies. The data available on Bristol Bay red salmon is used to derive values from the equation parameters.

The parameters, a, b and c, in this equation are found using a digital computer program devised by Gales (1964). This program uses a combination of steepest descent and iteration by linearization numerical techniques. The iteration process continues to solve for sets of parameter values until a specified residual error level between the data and the fitted curve is satisfied. The particular set of parameters obtained depends upon the level of residual error selected. The practical limitations of computer time and inherent information content of the data determines the residual error level to select for a particular solution. A differently selected level of residual error may yield a different solution.

One should keep in mind that the a posteriori information yield of the data in this analysis is the forecast, not subsequent comparisons of the parameters or attempts to further relate the fitted curves to environmental or biological phenomena.

Appendix Tables 23 through 34 give the forecasts and the solution to the escapement-return relationship for each river. Appendix Figures 1 through 9 show graphs of the data and the fitted curves.

For an estimate of the size of the run it remains to determine the age at maturity for each return forecasted by the above equation. Usually one or two age classes make up the great bulk of the adult runs, and one would suppose that the average age composition could be used. However, there is considerable year to year variation in the proportions of the age-classes that appear in the annual runs. This irregularity ruins the average age composition as an effective estimator of age at maturity. The factors that are the direct contributors to the maturing ages must be used in the forecast.

It is recognized that hereditary factors and environmental conditions are responsible for influencing the rate of maturing of red salmon, and, therefore, the age at which they return. The study by Godfrey (1958) on sockeye salmon at Rivers Inlet and Skeena River, B.C., has shown that the more important influences upon age at maturity appear to be heritable ones. Godfrey points out that if environmental conditions were primarily responsible for determining age at maturity, then it would be expected that apparently random and (at present) unpredictable fluctuations would characterize the changes in abundance of the different age-classes among the returning adults. However, if hereditary factors are of major importance in governing the age of return, then the fluctuations in abundance of different age-classes would tend to follow predictable patterns, and levels of abundance of particular age-groups would tend to be stable (apart from fluctuations caused by variations in survival rates). Historically Bristol Bay red salmon runs show a cyclic tendency which indicates the importance of hereditary influences. It is also recognized that the trends of the runs contain random fluctuations and hence are also influenced by a combination of conditions.

It remains to employ methods which will account for these effects and yield estimates of the age at maturity. The age composition of the parent escapements can be used to estimate the influence of hereditary factors, and the relationships of the age composition of the yearly runs can be used to estimate the influence of environmental conditions.

From a given escapement the proportions of each age class that compose a return will sum to one and this property can be utilized to express age compositions as probabilities. In this manner, the age composition for each forecasted return (using the escapement-return relationship $R = aE^b e^{-cE}$) can be calculated as a probability set. Usually in Bristol Bay the four age classes, 4_2, 5_2, 5_3 and 6_3, make up the great majority of each return and the probability set will have four elements. These age classes arise from the prior fourth, fifth and sixth year's escapements; therefore, a particular year's run will have contributions from three separate year's escapements. The total number of age class elements involved will be twelve, only four of which contribute to a

particular run. If the above convention were followed the sum of these probability elements would be three, but it would be more convenient to combine the three contributing returns so that the sum of the twelve age class elements would be one. This technique is followed and the probability tree diagram is shown in Figure 1. The methods of calculating the probabilities for each age class are given below.

In Figure 1 the α branchings represent the estimated returns from the three escapements which will be contributing to the 1967 run. Each α branch subbranches into the β branches which correspond to the freshwater outmigration age composition. The β branches subbranch into the $\checkmark$ branches which correspond to the ocean age composition.

The following notation will be used in the subsequent computations:

i : year of escapement

$i = 1, 2, 3$

$i = 1$: 1961 escapement

$i = 2$: 1962 escapement

$i = 3$: 1963 escapement.

j : freshwater age

$j = 1, 2$

$j = 1$: one winter freshwater

$j = 2$: two winters freshwater.

k : ocean age

$k = 1, 2$

$k = 1$: two winters in ocean

$k = 2$: three winters in ocean.

R_i : estimated return from escapement in year i,

$R_i = a E_i^b e^{-c E_i}$.

R_T : total estimated returns from all escapements which contribute to a particular yearly run,

$R_T = \sum_i R_i$, for $i = 1, 2, 3$.

R_{ijk} : estimated return (or run) from escapement in year i of freshwater age j and ocean age k.

$$\sum_i \sum_j \sum_k R_{ijk} = R_T \ .$$

α_i : proportion of total estimated return contributed by escapement in year i.

$$\sum_i \alpha_i = 1 \ .$$

β_{ij} : proportion of freshwater outmigration from escapement i of age j.

$$\sum_j \beta_{ij} = 1, \text{ for fixed } i \ .$$

γ_{ijk} : proportion of mature returns from escapement i of freshwater age j and ocean age k.

$$\sum_k \gamma_{ijk} = 1, \text{ for fixed } i \text{ and } j \ .$$

p_{ijk} : probability of the return from escapement i of freshwater age j and ocean age k.

$$\sum_i \sum_j \sum_k p_{ijk} = 1 \ .$$

The probability of the α_i branchings are calculated as:

$$\alpha_i = \frac{R_i}{R_T} \quad \text{for } i = 1, 2, 3 \ .$$

The β_{ij} branchings are obtained from the smolt outmigration data for those rivers for which smolt samples are taken. β_{i1} represents the proportion of one winter freshwater smolt outmigration from escapement of year i, and β_{i2} represents the proportion of two winters freshwater smolt outmigration from escapement of year i. Appendix Table 37 gives the smolt outmigration proportions.

For those rivers for which no smolt samples are taken, the β_{ij} branchings are calculated from the proportions of the one and two winter freshwater ages of the resulting returns. This is done by taking the geometric mean of the ratios of the 4_2 plus 5_2 returns and the 5_3 plus 6_3 returns. In this manner

the influence of the magnitude of the returns is removed. This is identical to finding the average slope of a ray of lines joining the origin with the observed points where the distance from the origin has no influence, Deming (1948, pp. 30 to 34).

The γ_{ijk} branchings are calculated from the proportions of two and three winter ocean ages in the resulting returns. The computations are performed in the same manner as the β_{ij} computations.

Subsequently the β_{ij}'s and γ_{ijk}'s are weighted by the age composition of each parent escapement. The weighted β_{ij}'s and γ_{ijk}'s are combined with the original figures using an adjustment procedure given by Deming (1948, Chapter VII).

If independence is assumed among the α, β and γ branches the probability of a particular age composition will be the product of these values. For example,

$$p_{ijk} = \alpha_i \beta_{ij} \gamma_{ijk} = \frac{R_{ijk}}{R_T}$$

Hence,

$$R_{ijk} = R_T p_{ijk} .$$

From each yearly escapement, i, this equation gives the expected return of each age class.

V. Forecast of Total Run Based on High-Seas Purse-Seine Sampling

Forecast of Run

The forecast of the total run to western Alaska in 1967 based on the 1966 purse-seine sampling of immature red salmon south of Adak is as follows:

.2 age	14.8 million
.3 age	6.7 million
Total run	21.5 million red salmon

The above figures are based on a regression analysis of the index catches and the resultant runs to Bristol Bay for the years 1956-1966, as shown in Table 1, Figures 2 and 3.

The average index catch was calculated from the catches of all effective seine sets made within 50 miles of shore, and during three time periods: June

Table 1. Average catch per index seine set of immature red salmon south of Adak Island compared with the following year's Bristol Bay run, 1956-1966.

Year of index catch	Average catch/set .1 age	Average catch/set .2 age	Year of Bristol Bay run	Total run to Bristol Bay 1/ (millions) .2 age	Total run to Bristol Bay 1/ (millions) .3 age
1956	7.5	16.7	1957	4.9	16.0
1957	3.5	8.3	1958	3.7	4.0
1958	27.4	3.7	1959	12.5	2.7
1959	94.6	15.3	1960	35.7	6.8
1960	6.7	14.4	1961	8.1	18.0
1961	22.5	2.4	1962	8.2	4.0
1962	24.2	10.9	1963	4.6	4.0
1963	53.2	8.0	1964	9.6	3.5
1964	100.7	7.0	1965	55.9	6.9
1965	25.3	29.6	1966	5.0	15.6
1966	36.7	9.1	1967	14.8 2/	6.7 2/

1/ Including high-seas catch of Bristol Bay fish.

2/ 1967 forecast values based on linear regression equations:

$$R_2 = -0.050 + 0.404 C_1$$

$$R_3 = 1.614 + 0.562 C_2$$

where R_2 is number of .2 age fish in the run

R_3 is number of .3 age fish in the run

C_1 is index catch of .1 age fish

C_2 is index catch of .2 age fish.

11-30, July 1-20, and July 21-August 10. The average index catches for these periods were then summed and divided by 3 to derive the season's index. This method largely eliminates the effect of the different dates of commencement and termination of indexing and also gives equal weight to three parts of the season during which index operations were conducted.

The basic assumptions underlying the high-seas index of abundance are the same as in previous years.

1. The seine catches are proportional to the abundance of immature red salmon passing through the index area each year.

2. The flow of red salmon passing through the index area contains a major and relatively constant proportion of the immature Bristol Bay red salmon at sea.

3. The flow of red salmon passing through the index area contains a high and relatively constant proportion of red salmon of Bristol Bay origin.

Extrapolation of the seine index catch data to determine total numbers of fish passing Adak Island, and tag returns and age composition analysis indicate that assumptions 2 and 3 were reasonably satisfied in most years. Assumption 1 is open to question. In 1966 a Fisheries Research Institute seiner and a Bureau of Commercial Fisheries gillnetter fished intensively in the Adak area to test the validity of the assumption. In addition, Bureau of Commercial Fisheries gillnetters sampled at two locations east of Adak to test assumptions 2 and 3.

Forecast of Fish Size in 1967

As shown below, both the .1 age and the .2 age immature red salmon of Adak in 1966 were approximately of average size. The data suggest that both groups in the Bristol Bay fishery will be of average size in 1967.

Average length of immature red salmon at Adak

	.1 age	.2 age
1956-1965 average	35.3 cm	46.8 cm
1966 $\bar{X}$	35.0 cm	47.4 cm

Ocean-Age Composition in 1967

The age composition of immatures in the Adak seine samples in 1966 was 80% .1 age, which should result in a run composed on approximately 68% .2 age in Bristol Bay in 1967. The relationship of age composition in the Adak samples and in the Bristol Bay run a year later has been relatively reliable, with a correlation coefficient of 0.91. The expected 68% of .2 age fish in 1967 compares to only 24% of this age group in 1966, so that fish-per-case will be proportionately greater. Fish-per-case should be similar to the 1962 and 1964 values when .2 age fish made up 66% and 73% of the run respectively. Fish-per-case in those years was 13.0 and 14.9 respectively, based on published catch and pack figures (I.N.P.F.C. Statistical Yearbooks for 1962 and 1964).

Critique of 1966 Forecast

We now have data on hand which may at least partially explain the large error in the 1966 forecast (the actual run was only 20.6 million, or 61% of the 33.8 million forecast on the basis of the seine index catches). As stated in our forecast for 1966, we expected .3 age fish to predominate in the run, and that the fish would be oriented well to the west where the Japanese fleet would be able to intercept a substantial part as in previous years (1957, 1961) when .3 age fish predominated as shown below. The forecast of age composition proved to be accurate, but the relatively small proportion taken by the high seas fleet (9.2% see below) suggested that the run must have been oriented much farther to the east, which is an abnormal situation in years when the older fish predominate.

Year	% .3 age fish in run	Catch of Bristol Bay red salmon by Japan (millions)	Total run to Bristol Bay (millions)	Percent taken by Japan
1957	75	7.7	21.7	35.3
1961	70	6.4	26.3	24.5
1966	76	2.0	21.9	9.2

The abnormal distribution of matures in 1966 suggests that there may have been an abnormal distribution of immatures with respect to the index area in 1965. The erroneously high index values in 1965 suggest that a larger-than-normal proportion of the run of immatures passed through the index area that year. The above data imply a changed seasonal migration pattern in 1965-66, and that assumption 2 was not met. The new Bureau of Commercial Fisheries program of gill-net sampling immatures at three different longitudes should help to detect gross changes in migration pattern in the future.

APPENDIX TABLE 1.

River	Age Composition of 1956 Inshore Run						
	4_2	5_3	6_4	5_2	6_3	7_4	Total
Togiak	150,390	52,309	0	96,772	27,462	0	326,933
Igushik	145,277	61,053	0	606,209	76,461	0	889,000
Snake	3,340	1,404	0	2,225	281	0	7,250
Wood	680,463	285,966	0	449,373	56,680	0	1,472,482
Nuyakuk	5,844	2,456	0	54,503	6,874	0	69,677
Nushagak-Mulchatna	0	0	0	0	0	0	21,405 1/
Kvichak	10,794,000	3,005,000	0	184,000	200,000	0	14,183,000
Branch	481,000	354,000	0	284,000	245,000	0	1,364,000
Naknek	114,000	812,000	0	1,435,000	1,172,000	0	3,533,000
Egegik	614,079	1,003,606	68,740	320,787	270,378	13,748	2,291,338 2/
Ugashik	501,011	171,487	0	46,017	44,414	1,603	764,532
North Side Alaska Peninsula							2,645,000*

* No age data available for North Side Alaska Peninsula runs.

1/ Age 4_1 fish.

2/ Age composition estimated.

APPENDIX TABLE 2.

River	Age Composition of 1957 Inshore Run						
	4_2	5_3	6_4	5_2	6_3	7_4	Total
Togiak	21,920	4,943	0	34,799	3,382	0	65,044 1/
Igushik	61,195	5,927	0	177,162	17,097	0	261,381
Snake	2,001	194	0	3,567	344	0	6,106
Wood	188,160	18,223	0	326,383	31,498	0	564,264
Nuyakuk	34,601	3,351	0	87,392	8,434	0	133,778
Nushagak-Mulchatna	0	0	0	0	0	0	21,853 2/
Kvichak	58,675	1,902,874	0	4,023,786	597,700	0	6,583,035
Branch	2,562	69,739	0	165,666	46,683	0	284,650 1/
Naknek	14,615	66,537	0	692,263	729,298	2,829	1,505,542
Egegik	16,263	150,848	1,194	260,483	760,584	13,450	1,202,822
Ugashik	134,710	130,459	531	228,270	68,990	1,800	564,760
North Side Alaska Peninsula							633,000*

* No age data available for North Side Alaska Peninsula runs.

1/ Age composition estimated.

2/ Age 4_1 fish.

APPENDIX TABLE 3.

River	Age Composition of 1958 Inshore Run						
	4_2	5_3	6_4	5_2	6_3	7_4	Total
Togiak	18,212	7,696	0	77,074	5,420	0	108,402
Igushik	44,718	5,040	0	183,085	18,658	575	252,076
Snake	11,180	1,260	0	2,641	269	8	15,358
Wood	1,137,832	128,255	0	303,675	30,947	955	1,601,664
Nuyakuk	48,445	5,461	0	390,816	39,827	1,229	485,778
Nushagak-Mulchatna	0	0	0	0	0	0	7,804 1/
Kvichak	74,185	335,287	1,341	56,394	598,961	230	1,066,398
Branch	14,857	50,863	470	25,830	97,166	82	189,268
Naknek	77,775	163,220	697	123,768	160,950	119	526,529
Egegik	10,226	399,732	17,750	35,507	270,673	5,522	739,410
Ugashik	22,484	386,049	2,255	227,650	71,304	0	709,742
North Side Alaska Peninsula							914,000*

* No age data available for North Side Alaska Peninsula runs.

1/ Age 4_1 fish.

APPENDIX TABLE 4.

River	Age Composition of 1959 Inshore Run						
	4_2	5_3	6_4	5_2	6_3	7_4	Total
Togiak	142,696	12,591	0	150,767	16,788	0	322,842
Igushik	432,175	194,711	0	251,856	60,826	0	939,568
Snake	146,005	65,781	0	8,290	2,002	0	222,078
Wood	2,292,281	1,032,757	0	131,060	31,652	0	3,487,750
Nuyakuk	49,642	22,365	0	3,553	858	0	76,418
Nushagak-Mulchatna	0	0	0	0	0	0	30,657 1/
Kvichak	238,708	611,820	0	27,444	56,237	521	934,730
Branch	750,275	373,516	0	102,259	0	633	1,226,683
Naknek	685,862	2,026,789	40,053	283,100	192,577	1,711	3,230,092
Egegik	19,092	1,132,671	241,490	12,103	315,717	4,999	1,726,072
Ugashik	16,148	375,868	6,830	26,250	202,356	78	627,530
North Side Alaska Peninsula							1,225,000*

* No age data available for North Side Alaska Peninsula runs.

1/ Age 4_1 fish.

APPENDIX TABLE 5.

River	Age Composition of 1960 Inshore Run						
	4_2	5_3	6_4	5_2	6_3	7_4	Total
Togiak	113,095	8,955	1,990	185,065	16,583	0	325,688
Igushik	152,013	101,926	0	691,388	100,116	1,552	1,046,995
Snake	11,408	5,889	0	12,050	963	0	30,310
Wood	698,494	360,455	0	739,600	58,893	0	1,855,442
Nuyakuk	196,062	9,267	0	8,576	0	0	213,905
Nushagak-Mulchatna	0	0	0	0	0	0	38,636 1/
Kvichak	21,977,161	532,729	0	89,295	0	0	22,599,185
Branch	1,706,543	22,578	0	210,490	125,631	0	2,066,242
Naknek	428,598	193,560	0	729,332	521,801	726	1,874,017
Egegik	1,833,246	608,569	78,427	144,601	569,697	10,760	3,245,300
Ugashik	2,856,538	106,691	0	29,142	54,026	0	3,046,397
North Side Alaska Peninsula							1,096,000*

* No age data available for North Side Alaska Peninsula runs.

1/ Age 4_1 fish.

APPENDIX TABLE 6.

River	Age Composition of 1961 Inshore Run						
	4_2	5_3	6_4	5_2	6_3	7_4	Total
Togiak	33,212	7,381	0	270,742	7,357	0	318,692
Igushik	1,706	9,037	0	382,782	68,826	0	462,351
Snake	1,074	185	0	4,840	1,102	0	7,201
Wood	101,822	17,620	0	459,215	104,625	0	683,282
Nuyakuk	2,828	0	0	118,627	0	0	121,455
Nushagak-Mulchatna	0	0	0	0	0	0	54,431 1/
Kvichak	181,518	4,839,724	14,706	5,110,994	389,536	21,507	10,557,985
Branch	3,915	0	356	336,401	32,128	521	373,321
Naknek	39,303	2,250	1,366	1,241,506	64,405	1,998	1,350,828
Egegik	27,882	691,709	4,202	2,339,752	290,706	33,393	3,387,644
Ugashik	26,126	59,739	0	614,031	4,902	0	704,798
North Side Alaska Peninsula							846,000*

* No age data available for North Side Alaska Peninsula runs.

1/ Age 4_1 fish.

APPENDIX TABLE 7.

River	Age Composition of 1962 Inshore Run						
	4_2	5_3	6_4	5_2	6_3	7_4	Total
Togiak	89,984	958	0	70,877	1,007	0	162,826
Igushik	7,316	15,920	0	23,619	29,275	0	76,130*
Snake	3,864	55	0	448	0	0	4,367
Wood	1,927,247	31,165	0	222,533	0	0	2,180,945
Nuyakuk	83,543	1,355	0	9,643	0	0	94,541
Nushagak-Mulchatna	0	0	0	0	0	0	23,075 1/
Kvichak	68,564	2,997,922	0	212,091	1,135,068	0	4,413,645
Branch	38,318	38,932	2,447	20,014	33,183	0	132,894
Naknek	100,507	454,174	30	285,207	263,942	1,356	1,105,216
Egegik	38,204	985,975	885	37,558	594,193	5,116	1,661,931
Ugashik	56,990	318,374	0	90,841	30,368	0	496,573
North Side Alaska Peninsula							530,000**

* Catch only (FRI Circular 234, table 11)

** No age data available for North Side Alaska Peninsula runs.

1/ 728 .2-ocean fish and 22,347 .3-ocean fish.

APPENDIX TABLE 8.

River	Age Composition of 1963 Inshore Run						
	4_2	5_3	6_4	5_2	6_3	7_4	Total
Togiak	116,044	48,702	1,093	92,918	29,316	268	288,341
Igushik	87,356	17,313	3	59,884	16,549	0	181,105
Snake	58,970	1,221	1	983	0	0	61,175
Wood	844,809	64,664	20	328,317	0	0	1,237,810
Nuyakuk	9,599	26,720	4	260,020	1,041	0	297,384
Nushagak-Mulchatna	0	0	0	0	0	0	66,441 1/
Kvichak	182,971	116,544	0	40,586	219,129	105	559,335
Branch	260,470	23,213	0	22,015	10,941	63	316,702
Naknek	301,191	464,794	4,076	178,243	569,312	282	1,517,898
Egegik	63,294	705,571	60,353	62,070	783,548	9,963	1,684,799
Ugashik	15,168	383,491	3,047	88,986	84,648	0	575,340
North Side Alaska Peninsula							541,000*

* No age data available for North Side Alaska Peninsula runs.

1/ 4,646 age 3_1 fish and 61,795 age 4_1 fish.

APPENDIX TABLE 9.

River	Age Composition of 1964 Inshore Run						
	4_2	5_3	6_4	5_2	6_3	7_4	Total
Togiak	180,302	53,457	0	86,248	23,190	0	343,197
Igushik	58,206	87,479	0	144,877	25,439	0	316,001
Snake	13,723	6,298	0	6,803	223	0	27,047
Wood	1,405,281	344,956	0	370,440	30,262	0	2,150,939
Nuyakuk	143,216	2,652	0	53,598	10,683	0	210,149
Nushagak-Mulchatna	0	0	0	0	0	0	33,665 1/
Kvichak	1,255,719	196,948	0	108,697	24,292	1,606	1,587,262
Branch	100,011	116,844	0	247,282	45,151	491	512,779
Naknek	1,346,086	709,271	3,172	327,600	156,988	2,598	2,545,715
Egegik	427,704	991,340	15,085	152,550	287,072	58,135	1,931,886
Ugashik	644,082	296,037	0	35,142	61,346	1,656	1,038,263
North Side Alaska Peninsula							1,235,000*

* No age data available for North Side Alaska Peninsula runs.

1/ 2,300 age 3_1 fish and 31,355 age 4_1 fish.

APPENDIX TABLE 10.

River	Age Composition of 1965 Inshore Run						
	4_2	5_3	6_4	5_2	6_3	7_4	Total
Togiak	81,678	20,984	0	219,082	5,681	0	327,425
Igushik	29,073	37,248	0	230,091	16,768	0	313,180
Snake	4,427	1,296	0	13,495	928	0	20,146
Wood	225,574	95,174	0	771,675	41,432	0	1,133,855
Nuyakuk	32,579	19,468	0	280,597	6,511	0	339,155
Nushagak-Mulchatna	4,505	2,710	0	38,764	901	0	50,384 1/
Kvichak	295,484	41,382,920	0	422,767	7,959	2,454	42,111,590
Branch	78,429	119,885	462	138,693	57,021	0	394,490
Naknek	211,650	616,486	0	469,720	529,597	1,636	1,829,089
Egegik	72,515	3,936,922	12,536	246,251	351,120	2,392	4,621,736
Ugashik	212,579	1,383,848	0	222,018	98,940	0	1,917,385
North Side Alaska Peninsula							1,957,000*

* No age data available for North Side Alaska Peninsula runs.

1/ The total includes 3,504 age 4_1 fish.

APPENDIX TABLE 11.

River	Age Composition of 1966 Inshore Run						
	4_2	5_3	6_4	5_2	6_3	7_4	Total
Togiak	46,381	14,695	0	206,276	48,543	82	315,977
Igushik	25,344	19,085	74	339,354	54,195	0	438,052
Snake	3,253	75	2	3,653	319	0	7,302
Wood	873,845	19,785	499	979,583	85,382	1,340	1,960,434
Nuyakuk	16,344	2,437	68	261,310	9,580	0	289,739
Nushagak-Mulchatna	5,100	752	21	81,407	2,988	0	90,268
Kvichak	92,991	2,045,624	8,612	164,919	5,629,796	0	7,941,942
Branch	115,127	5,942	0	160,691	26,975	1,902	310,637
Naknek	67,674	281,026	932	645,867	1,109,630	0	2,105,129
Egegik	19,747	397,510	44,062	199,165	2,222,418	21,262	2,904,164
Ugashik	69,052	220,029	347	433,925	422,657	487	1,146,497
North Side Alaska Peninsula							512,000*

* No age data available for North Side Alaska Peninsula.

APPENDIX TABLE 12.

River	Age Composition of 1956 Combined Run						
	4_2	5_3	6_4	5_2	6_3	7_4	Total
Togiak	155,516	59,324	0	109,524	35,993	0	360,357
Igushik	150,229	69,241	0	686,094	100,214	0	1,005,778
Snake	3,454	1,593	0	2,519	369	0	7,935
Wood	703,658	324,317	0	508,590	74,288	0	1,610,853
Nuyakuk	6,043	2,785	0	61,686	9,009	0	79,523
Nushagak-Mulchatna	0	0	0	0	0	0	21,405 1/
Kvichak	11,161,930	3,408,007	0	208,247	262,131	0	15,040,315
Branch	497,396	401,476	0	321,425	321,111	0	1,541,408
Naknek	117,886	920,899	0	1,624,101	1,536,089	0	4,198,975
Egegik	635,011	1,138,202	106,017	363,060	354,373	70,225	2,666,888
Ugashik	518,088	194,485	0	52,081	58,211	8,188	831,053
North Side Alaska Peninsula	1,479,356	691,501	11,243	417,565	291,835	8,316	2,899,816 2/

1/ Age 4_1 fish.

2/ Age composition estimated.

APPENDIX TABLE 13.

River	Age Composition of 1957 Combined Run						
	4_2	5_3	6_4	5_2	6_3	7_4	Total
Togiak	27,069	8,008	0	54,130	8,312	0	97,519
Igushik	75,569	9,603	0	275,575	42,021	0	402,768
Snake	2,471	315	0	5,549	846	0	9,181
Wood	232,355	29,523	0	507,689	77,416	0	846,983
Nuyakuk	42,728	5,429	0	135,938	20,729	0	204,824
Nushagak-Mulchatna	0	0	0	0	0	0	21,853 1/
Kvichak	72,457	3,082,858	0	6,258,999	1,469,017	0	10,883,331
Branch	3,164	112,985	0	257,693	114,737	0	488,579
Naknek	18,048	107,797	0	1,076,815	1,792,457	37,782	3,032,899
Egegik	20,083	244,390	101,563	405,182	1,869,350	179,625	2,820,193
Ugashik	166,351	211,357	45,168	355,074	169,562	24,039	971,551
North Side Alaska Peninsula	37,314	215,437	8,292	527,401	314,455	13,644	1,116,543 2/

1/ Age 4_1 fish.

2/ Estimated age composition.

APPENDIX TABLE 14.

River	Age Composition of 1958 Combined Run						
	4_2	5_3	6_4	5_2	6_3	7_4	Total
Togiak	18,616	8,711	0	87,209	7,267	0	121,803
Igushik	45,709	5,705	0	207,162	25,014	3,469	287,059
Snake	11,427	1,426	0	2,988	361	48	16,250
Wood	1,163,048	145,160	0	343,609	41,489	5,761	1,699,067
Nuyakuk	49,519	6,181	0	442,209	53,394	7,414	558,717
Nushagak-Mulchatna	0	0	0	0	0	0	7,804 1/
Kvichak	75,829	379,480	3,047	63,810	803,000	1,387	1,326,553
Branch	15,186	57,567	1,068	29,227	130,266	495	233,809
Naknek	79,499	184,734	1,584	140,044	215,779	718	622,358
Egegik	10,453	452,420	40,332	40,176	362,879	33,311	939,571
Ugashik	22,982	436,933	5,124	257,587	95,594	0	818,220
North Side Alaska Peninsula	236,422	265,898	8,105	255,712	274,886	8,334	1,049,357 2/

1/ Age 4_1 fish.

2/ Estimated age composition.

APPENDIX TABLE 15.

River	Age Composition of 1959 Combined Run						
	4_2	5_3	6_4	5_2	6_3	7_4	Total
Togiak	145,758	13,323	0	176,495	22,617	0	358,193
Igushik	441,449	206,032	0	294,835	81,947	0	1,024,263
Snake	149,138	69,606	0	9,705	2,697	0	231,146
Wood	2,341,470	1,092,806	0	153,426	42,643	0	3,630,345
Nuyakuk	50,707	23,665	0	4,159	1,156	0	79,687
Nushagak-Mulchatna	0	0	0	0	0	0	63,415 1/
Kvichak	243,830	647,394	0	32,127	75,764	3,629	1,002,794
Branch	766,374	395,234	0	119,709	0	4,409	1,285,726
Naknek	700,579	2,144,635	53,517	331,411	259,446	11,918	3,501,506
Egegik	19,501	1,198,529	322,667	14,169	425,343	34,820	2,015,029
Ugashik	16,494	397,722	9,126	30,730	272,620	543	727,235
North Side Alaska Peninsula	463,375	588,232	36,622	110,896	112,556	5,258	1,316,939 2/

1/ Age 4_1 fish.

2/ Estimated age composition.

APPENDIX TABLE 16.

River	Age Composition of 1960 Combined Run						
	4_2	5_3	6_4	5_2	6_3	7_4	Total
Togiak	120,976	11,111	3,196	235,268	30,979	0	401,530
Igushik	162,606	126,462	0	878,943	187,027	23,013	1,378,051
Snake	12,203	7,307	0	15,319	1,799	0	36,628
Wood	747,168	447,226	0	937,691	110,018	0	2,242,103
Nuyakuk	209,724	11,498	0	10,902	0	0	232,124
Nushagak-Mulchatna	0	0	0	0	0	0	60,976 1/
Kvichak	23,508,609	660,971	0	113,519	0	0	24,283,099
Branch	1,825,461	29,254	0	267,590	234,692	0	2,356,997
Naknek	458,464	240,155	0	927,180	974,778	10,765	2,611,342
Egegik	1,960,993	755,068	125,938	183,828	1,064,253	159,546	4,249,626
Ugashik	3,055,592	132,374	0	37,047	100,926	0	3,325,939
North Side Alaska Peninsula	966,390	72,985	3,892	108,729	81,517	5,827	1,239,340 2/

1/ Age 4_1 fish.

2/ Estimated age composition.

APPENDIX TABLE 17.

River	Age Composition of 1961 Combined Run						
	4_2	5_3	6_4	5_2	6_3	7_4	Total
Togiak	42,592	9,400	0	355,766	20,043	0	427,801
Igushik	2,188	11,509	0	502,991	187,499	0	704,187
Snake	1,377	236	0	6,360	3,002	0	10,975
Wood	130,579	22,439	0	603,427	285,024	0	1,041,469
Nuyakuk	3,627	0	0	155,881	0	0	159,508
Nushagak-Mulchatna	0	0	0	0	0	0	83,762 1/
Kvichak	232,783	6,163,519	33,178	6,716,060	1,061,192	58,147	14,264,879
Branch	5,020	0	803	442,045	87,525	1,409	536,802
Naknek	50,403	2,865	3,082	1,631,391	175,455	5,402	1,868,598
Egegik	35,757	880,910	9,480	3,074,532	791,954	90,282	4,882,915
Ugashik	33,505	76,079	0	806,862	13,354	0	929,800
North Side Alaska Peninsula	25,179	335,523	2,179	669,238	122,892	7,268	1,162,279 2/

1/ Age 4_1 fish.

2/ Estimated age composition.

APPENDIX TABLE 18.

River	Age Composition of 1962 Combined Run						
	4_2	5_3	6_4	5_2	6_3	7_4	Total
Togiak	91,842	1,039	0	85,896	1,238	0	180,015
Igushik	7,467	17,273	0	28,624	35,976	0	89,340
Snake	3,943	60	0	543	0	0	4,546
Wood	1,967,039	33,813	0	269,687	0	0	2,270,539
Nuyakuk	85,268	1,470	0	11,686	0	0	98,424
Nushagak-Mulchatna	0	0	0	0	0	0	23,075 1/
Kvichak	69,980	3,252,604	0	257,032	1,394,892	0	4,974,508
Branch	39,109	42,240	72,248	24,255	40,779	0	218,631
Naknek	102,582	492,758	886	345,641	324,360	7,643	1,273,870
Egegik	38,992	1,069,737	26,130	45,516	730,207	28,838	1,939,420
Ugashik	58,167	345,421	0	110,090	37,319	0	550,997
North Side Alaska Peninsula	125,720	268,155	5,064	60,145	130,842	1,861	591,787 2/

1/ 728 .2-ocean fish and 22,347 .3-ocean fish.

2/ Estimated age composition.

APPENDIX TABLE 19.

River	Age Composition of 1963 Combined Run						
	4_2	5_3	6_4	5_2	6_3	7_4	Total
Togiak	123,270	54,784	1,450	114,582	36,665	1,937	332,688
Igushik	92,795	19,475	4	73,847	20,697	0	206,818
Snake	62,642	1,373	1	1,212	0	0	65,228
Wood	897,412	72,739	27	404,866	0	0	1,375,044
Nuyakuk	10,197	30,057	5	320,645	1,302	0	362,206
Nushagak-Mulchatna	0	0	0	0	0	0	78,700 1/
Kvichak	194,364	131,097	0	50,049	274,057	759	650,326
Branch	276,688	26,112	0	27,148	13,684	455	344,087
Naknek	319,945	522,833	5,407	219,802	712,020	2,038	1,782,045
Egegik	67,235	793,677	80,059	76,542	979,958	71,996	2,069,467
Ugashik	16,112	431,378	4,042	109,734	105,866	0	667,132
North Side Alaska Peninsula	163,344	165,157	7,213	110,850	169,970	6,118	622,652 2/

1/ 4,646 age 3_1 fish and 74,054 age 4_1 fish.

2/ Estimated age composition.

APPENDIX TABLE 20.

River	Age Composition of 1964 Combined Run						
	4_2	5_3	6_4	5_2	6_3	7_4	Total
Togiak	182,454	55,466	0	108,901	36,583	0	383,404
Igushik	58,900	90,767	0	182,928	40,131	0	372,726
Snake	13,887	6,535	0	8,590	352	0	29,364
Wood	1,422,053	357,919	0	467,734	47,739	0	2,295,445
Nuyakuk	144,925	2,752	0	67,675	16,853	0	232,205
Nushagak-Mulchatna	0	0	0	0	0	0	34,594 1/
Kvichak	1,270,706	204,350	0	137,246	38,322	3,020	1,653,644
Branch	101,204	121,235	0	312,229	75,960	923	611,551
Naknek	1,362,151	735,926	6,525	413,643	247,654	4,885	2,770,784
Egegik	432,808	1,028,595	31,031	192,616	452,867	109,313	2,247,230
Ugashik	651,769	307,162	0	44,372	96,776	3,114	1,103,193
North Side Alaska Peninsula	639,725	330,101	4,259	219,553	119,447	13,752	1,326,837 2/

1/ 2,300 age 3_1 fish and 32,294 age 4_1 fish.

2/ Estimated age composition.

APPENDIX TABLE 21.

River	Age Composition of 1965 Combined Run						
	4_2	5_3	6_4	5_2	6_3	7_4	Total
Togiak	87,618	23,125	0	309,170	11,244	0	431,157
Igushik	31,187	41,049	0	324,706	33,188	0	430,130
Snake	4,749	1,428	0	19,045	1,837	0	27,059
Wood	241,979	104,888	0	1,088,992	82,004	0	1,517,863
Nuyakuk	34,949	21,455	0	395,980	12,887	0	465,271
Nushagak-Mulchatna	4,833	2,987	0	54,704	1,784	0	64,308
Kvichak	316,973	45,606,164	0	596,611	15,753	30,013	45,565,514
Branch	84,133	132,120	3,271	195,724	112,859	0	528,107
Naknek	227,042	679,400	0	662,871	1,048,208	20,009	2,637,530
Egegik	77,789	4,338,695	88,769	347,511	694,956	29,255	5,576,975
Ugashik	228,039	1,525,073	0	313,313	195,827	0	2,262,252
North Side Alaska Peninsula	49,335	1,933,025	3,390	158,713	81,428	2,920	2,228,811 1/

1/ Estimated age composition.

APPENDIX TABLE 22.

River	Age Composition of 1966 Combined Run						
	4_2	5_3	6_4	5_2	6_3	7_4	Total
Togiak	51,645	16,363	0	234,033	56,437	181	358,659
Igushik	28,220	21,251	82	385,020	63,008	0	497,581
Snake	3,622	84	2	4,145	371	0	8,224
Wood	973,021	22,030	556	1,111,402	99,266	2,960	2,209,235
Nuyakuk	18,199	2,714	76	296,473	11,138	0	328,600
Nushagak-Mulchatna	5,679	837	23	92,362	3,474	0	102,375
Kvichak	103,545	2,277,790	9,590	187,112	6,545,271	0	9,123,308
Branch	128,193	6,616	0	182,315	31,361	4,201	352,686
Naknek	75,355	312,921	1,038	732,779	1,290,070	0	2,412,163
Egegik	21,988	442,625	49,063	225,966	2,583,811	46,960	3,370,413
Ugashik	76,889	245,001	386	492,317	491,386	1,076	1,307,055
North Side Alaska Peninsula	43,380	97,722	1,775	115,108	326,172	1,616	585,773 1/

1/ Estimated age composition.

Appendix Table 23. Escapement-Return Data for Bristol Bay Rivers (in millions of fish).

BROOD YEAR	RIVER																			
	Togiak		Igushik		Snake		Wood		Nuyakuk		Kvichak		Naknek		Branch		Egegik		Ugashik	
	E	R	E	R	E	R	E	R	E	R	E	R	E	R	E	R	E	R	E	R
1944																	.310	.630		
1945																	.530	.561		
1946									.432	.085							.660	1.296		
1947									.325	.060							.910	2.075		
1948									.303	.324							.890	2.425		
1949									.014	.043							.920	.961		
1950					.004	.016	.452	1.282	.042	.032							.630	1.367		
1951					.003	.038	.458	2.460	.039	.095							.950	2.953		
1952	.102	.225	.150	.461	.004	.009	.227	1.283	.038	.200	5.970	21.314	.103	1.533			.757	1.722	.651	1.187
1953	.102	.146	.100	.394	.004	.009	.516	.764	.189	.492	.321	.591	.285	.667			.519	1.420	1.056	1.143
1954	.057	.242	.080	.734	.004	.093	.571	2.519	.029	.078	.241	.829	.799	3.553			.507	2.507	.459	.556
1955	.104	.412	.500	1.633	.030	.174	1.383	4.011	.016	.073	.250	2.127	.279	2.055	.166	1.152	.271	1.791	.077	.200
1956	.225	.495	.400	.714	.004	.018	.773	1.378	.030	.366	9.443	37.798	1.773	2.420	.785	2.385	1.104	6.752	.425	3.990
1957	.025	.151	.130	.069	.003	.002	.289	.458	.067	.018	2.964	4.027	.635	1.613	.125	.086	.391	2.321	.215	.604
1958	.072	.300	.107	.141	.009	.006	.960	2.495	.196	.453	.535	.319	.278	1.125	.091	.168	.246	1.425	.298	.696
1959	.179	.299	.644	.400	.140	.081	2.206	1.818	.049	.094	.680	.552	2.232	2.525	.825	.830	1.072	2.122	.219	.564
1960	.163	.572	.495	.491	.017	.034	1.016	2.722	.146	.573	14.630	54.160	.828	4.005	1.241	.460	1.799	7.850	2.341	2.992

Appendix Table 24. TOGIAK RIVER - Estimated Return from Given Brood Years, in Millions of Fish.

Brood Year	Escapement	Estimated Return 1/	Estimated Run in 1967 by Age Class						Total
			4_2	5_3	6_4	5_2	6_3	7_4	
1960									
1961	0.095	0.301					0.012		0.012
1962	0.047	0.138		0.006		0.082			0.088
1963	0.102	0.321	0.090						0.090
Total run in 1967									0.190

1/ Estimated returns obtained from equation:

$$R = 30.82259\ E^{1.646057}\ e^{-7.922827E}$$

Appendix Table 25. IGUSHIK RIVER - Estimated Return from Given Brood Years, in Millions of Fish.

Brood Year	Escapement	Estimated Return 1/	Estimated Run in 1967 by Age Class						Total
			4_2	5_3	6_4	5_2	6_3	7_4	
1960									
1961	0.294	0.866					0.127		0.127
1962	0.016	0.008		0.001		0.005			0.006
1963	0.092	0.226	0.034						0.034
Total run in 1967									0.167

1/ Estimated returns obtained from equation:

$$R = 62.40486\ E^{2.137470}\ e^{-5.648867E}$$

Appendix Table 26. SNAKE RIVER - Estimated Return from Given Brood Years, in Millions of Fish.

Brood Year	Escapement	Estimated Return[1/]	Estimated Run in 1967 by Age Class						Total
			4_2	5_3	6_4	5_2	6_3	7_4	
1960									
1961	0.005	0.014					0		0
1962	0.002	0.006		0.001		0			0.001
1963	0.038	0.106	0.076						0.076
Total run in 1967									0.077

1/ Estimated returns obtained from equation:

Geometric mean of return per spawner.

Appendix Table 27. WOOD RIVER - Estimated Return from Given Brood Years, in Millions of Fish.

Brood Year	Escapement	Estimated Return 1/	Estimated Run in 1967 by Age Class						Total
			4_2	5_3	6_4	5_2	6_3	7_4	
1960									
1961	0.461	1.479					0.085		0.085
1962	0.874	2.585		0.183		1.162			1.345
1963	0.721	2.267	1.189						1.189
Total run in 1967									2.619

1/ Estimated returns obtained from equation:

$$R = 9.95970\ E^{1.700497}\ e^{-1.281216E}$$

Appendix Table 28. NUYAKUK RIVER - Estimated Return from Given Brood Years, in Millions of Fish.

Brood Year	Escapement	Estimated Return 1/	Estimated Run in 1967 by Age Class						Total
			4_2	5_3	6_4	5_2	6_3	7_4	
1960									
1961	0.080	0.305					0.009		0.009
1962	0.038	0.115		0.002		0.050			0.052
1963	0.167	0.451	0.073						0.073
Total run in 1967									0.134

1/ Estimated returns obtained from equation:

$$R = 136.29547\ E^{2.016959}\ e^{-12.586323E}$$

Appendix Table 29. Nushagak-Mulchatna River - .2-ocean and .3-ocean Runs and Estimated Run in 1967.

Run Year	.2-ocean Run	.3-ocean Run
1956	0	21
1957	0	22
1958	0	8
1959	0	63
1960	0	61
1961	0	84
1962	1	22
1963	5	74
1964	2	32
1965	8	61
1966	6	92
1967	2 1/	49 1/

1/ Estimated run obtained from the arithmetic mean of the .2-ocean and .3-ocean runs.

Appendix Table 30. KVICHAK RIVER - Estimated Return from Given Brood Years, in Millions of Fish.

Brood Year	Escapement	Estimated Return 1/	Estimated Run in 1967 by Age Class						Total
			4_2	5_3	6_4	5_2	6_3	7_4	
1960									
1961	3.706	6.580					2.139		2.139
1962	2.581	2.658		1.746		0.220			1.966
1963	0.339	0.300 2/	0.142						0.142
Total run in 1967									4.247

1/ Estimated returns obtained from equation:

$$R = 0.229458\ E^{3.130354}\ e^{-0.200883E}$$

2/ Minimum return for any escapement used.

Appendix Table 31. NAKNEK RIVER - Estimated Return from Given Brood Years, in Millions of Fish.

Brood Year	Escapement	Estimated Return 1/	Estimated Run in 1967 by Age Class						Total
			4_2	5_3	6_4	5_2	6_3	7_4	
1960									
1961	0.351	1.795					0.532		0.532
1962	0.723	2.934		1.095		0.474			1.569
1963	0.905	3.184	0.571						0.571
Total run in 1967									2.672

1/ Estimated returns obtained from equation:

$$R = 9.47971\ E^{1.230808}\ e^{-1.069860E}$$

Appendix Table 32. BRANCH RIVER - Estimated Return from Given Brood Years, in Millions of Fish.

Brood Year	Escapement	Estimated Return 1/	Estimated Run in 1967 by Age Class						Total
			4_2	5_3	6_4	5_2	6_3	7_4	
1960									
1961	0.090	0.229					0.035		0.035
1962	0.091	0.235		0.046		0.092			0.138
1963	0.203	1.295	0.651						0.651
Total run in 1967									0.824

1/ Estimated returns obtained from equation:

$$R = 625.72658\ E^{3.041254}\ e^{-6.557379E}$$

Appendix Table 33. EGEGIK RIVER - Estimated Return from Given Brood Years, in Millions of Fish.

Brood Year	Escapement	Estimated Return 1/	Estimated Run in 1967 by Age Class						Total
			4_2	5_3	6_4	5_2	6_3	7_4	
1960	1.799	7.518						0.108	0.108
1961	0.702	1.841			0.044		0.540		0.584
1962	1.027	3.316		1.545		0.151			1.696
1963	0.998	3.175	0.079						0.079
Total run in 1967									2.467

1/ Estimated returns obtained from equation:

$$R = 3.75458\ E^{1.687039}\ e^{-0.164724E}$$

Appendix Table 34. UGASHIK RIVER - Estimated Return from Given Brood Years, in Millions of Fish.

Brood Year	Escapement	Estimated Return 1/	Estimated Run in 1967 by Age Class						Total
			4_2	5_3	6_4	5_2	6_3	7_4	
1960									
1961	0.366	1.259					0.135		0.135
1962	0.274	1.105		0.404		0.395			0.799
1963	0.397	1.305	0.056						0.056
Total run in 1967									0.990

1/ Estimated returns obtained from equation:

$$R = 2.26874\, E^{0.513272}\, e^{-0.198899E}$$

Appendix Table 35. North Side Alaska Peninsula - .2-ocean and .3-ocean Runs and Estimated Run in 1967.
(in millions of fish)

Year of Run	.2-ocean Run	.3-ocean Run
1956	2.182	.720
1957	.261	.857
1958	.510	.540
1959	1.088	.235
1960	1.044	.198
1961	.363	.805
1962	.399	.194
1963	.336	.293
1964	.975	.357
1965	1.986	.245
1966	.143	.444
1967	.844 1/	.444 1/

1/ Forecast based on arithmetic mean.

Appendix Table 36. Summary of the River System Forecast of the Bristol Bay Red Salmon Run for 1967 (in millions of fish).

River System	.2-ocean	.3-ocean	Total
Togiak	.096	.094	.190
Igushik	.035	.132	.167
Snake	.077	0	.077
Nuyakuk	.075	.059	.134
Wood	1.372	1.247	2.619
Nushagak-Mulchatna	.002	.049	.051
Nushagak Sub-total	1.561	1.487	3.048
Kvichak	1.888	2.359	4.247
Naknek	1.666	1.006	2.672
Branch (Alagnak)	.697	.127	.824
Naknek-Kvichak Sub-total	4.251	3.492	7.743
Egegik	1.668	.799	2.467
Ugashik	.460	.530	.990
North Side Alaska Peninsula	.844	.444	1.288
Total	8.880	6.846	15.726

Appendix Table 37. Proportion I-check and II-check smolt outmigrations 1/

Brood Year	RIVER							
	WOOD		KVICHAK		NAKNEK		UGASHIK	
	I-check	II-check	I-check	II-check	I-check	II-check	I-check	II-check
1961	.916	.084	.066	.934	.549	.451	.913	.087
1962	.970	.030	.200	.800	.186	.814	.571	.429
1963	.958	.042	.739	.261	.708	.292		2/

1/ I-check : one winter freshwater

II-check : two winters freshwater

2/ No smolt outmigration sample taken.

Note: In actual computations the proportions were rounded to the nearest tenth. Sampling error probably does not justify closer calculations.

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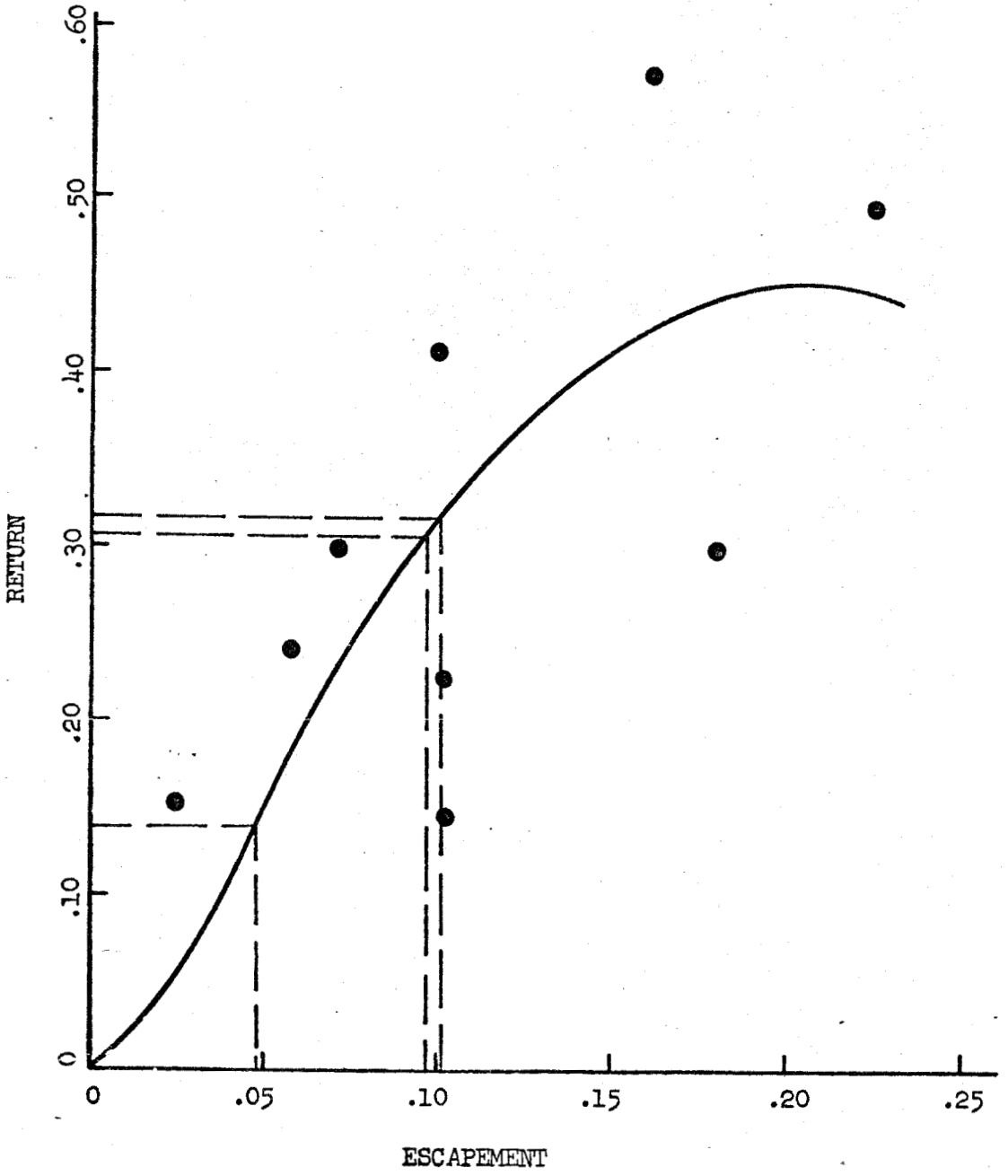
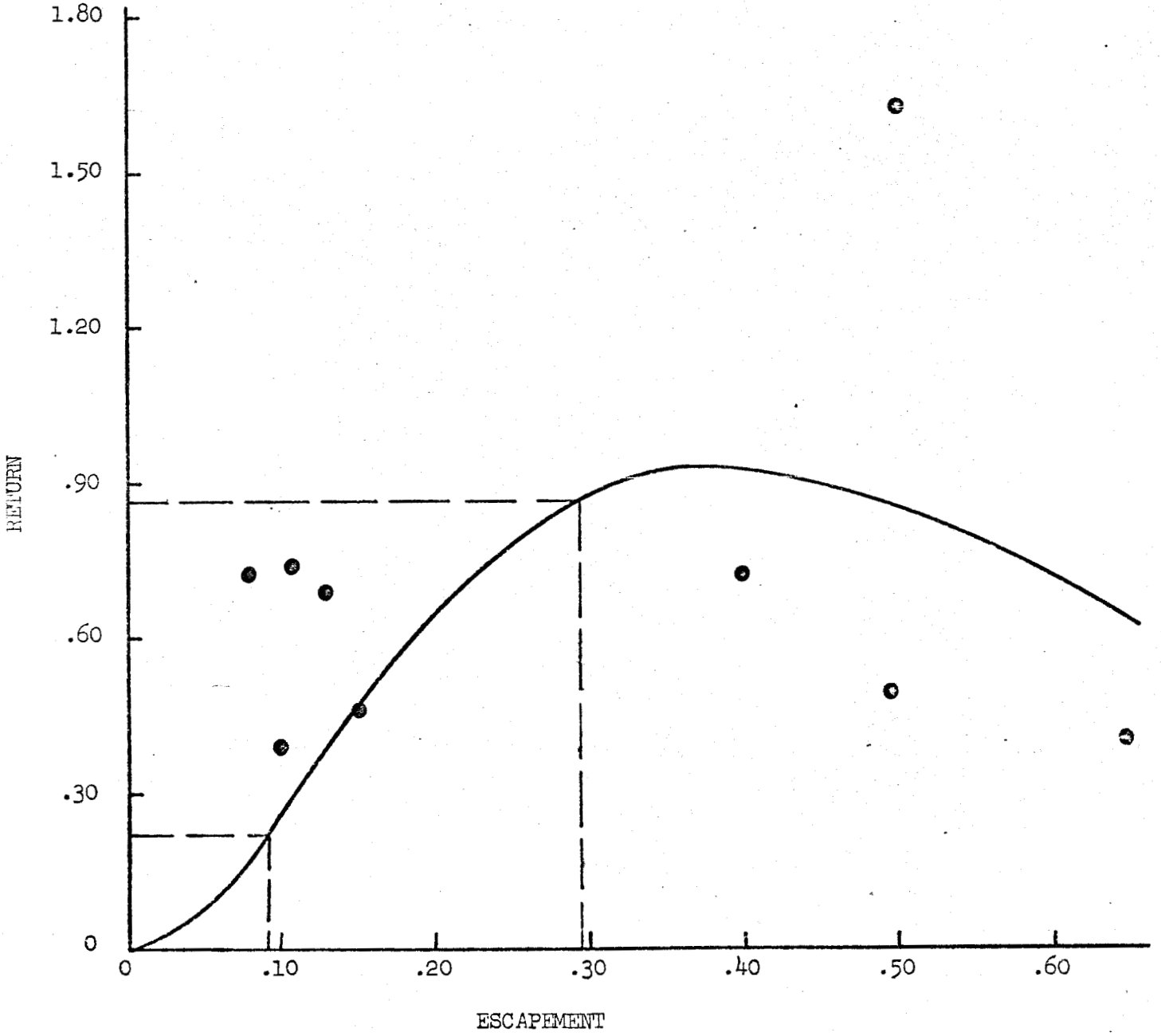
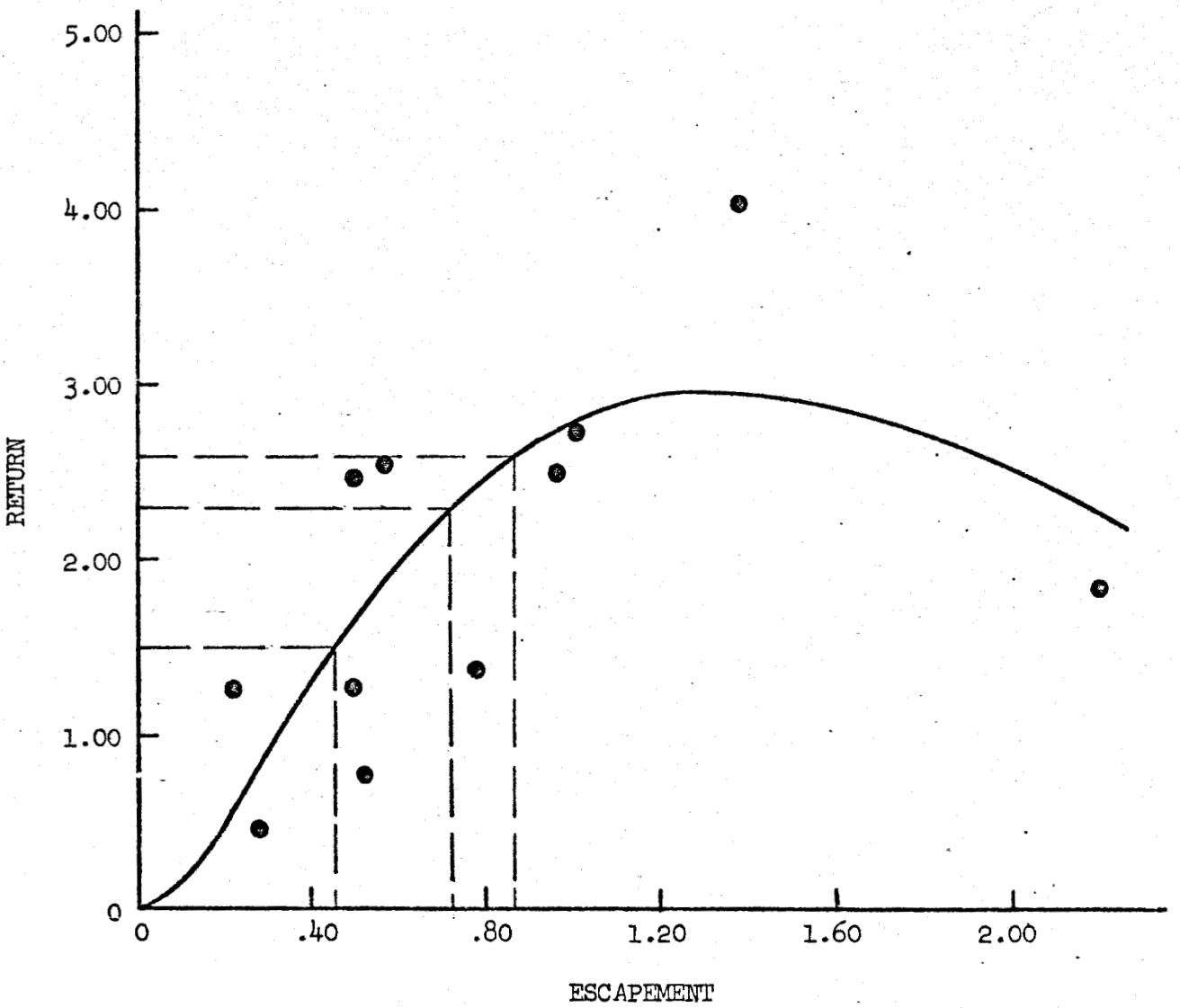


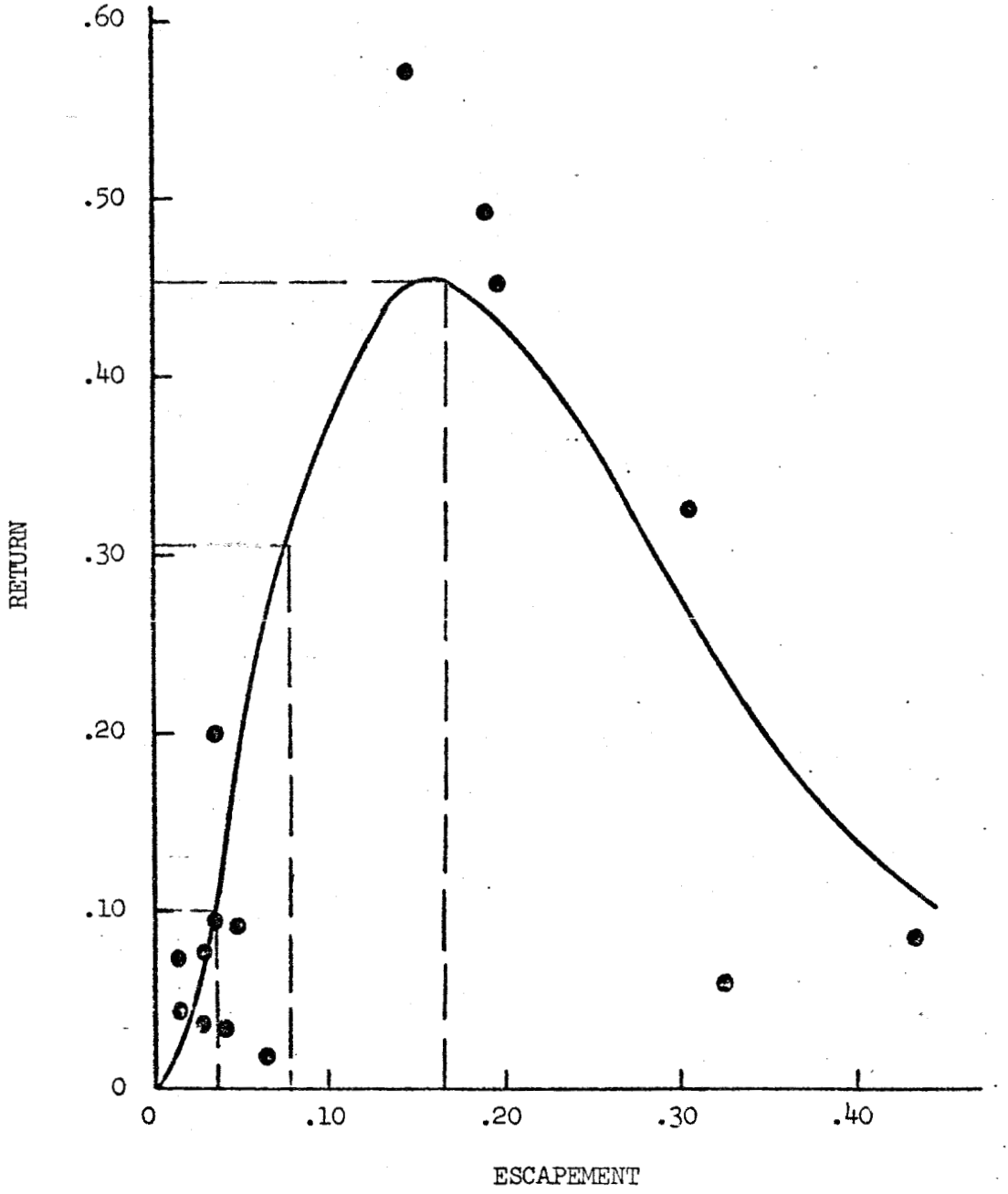
Appendix Figure 1.--Togiak River--Escapement--Return (in millions of fish).



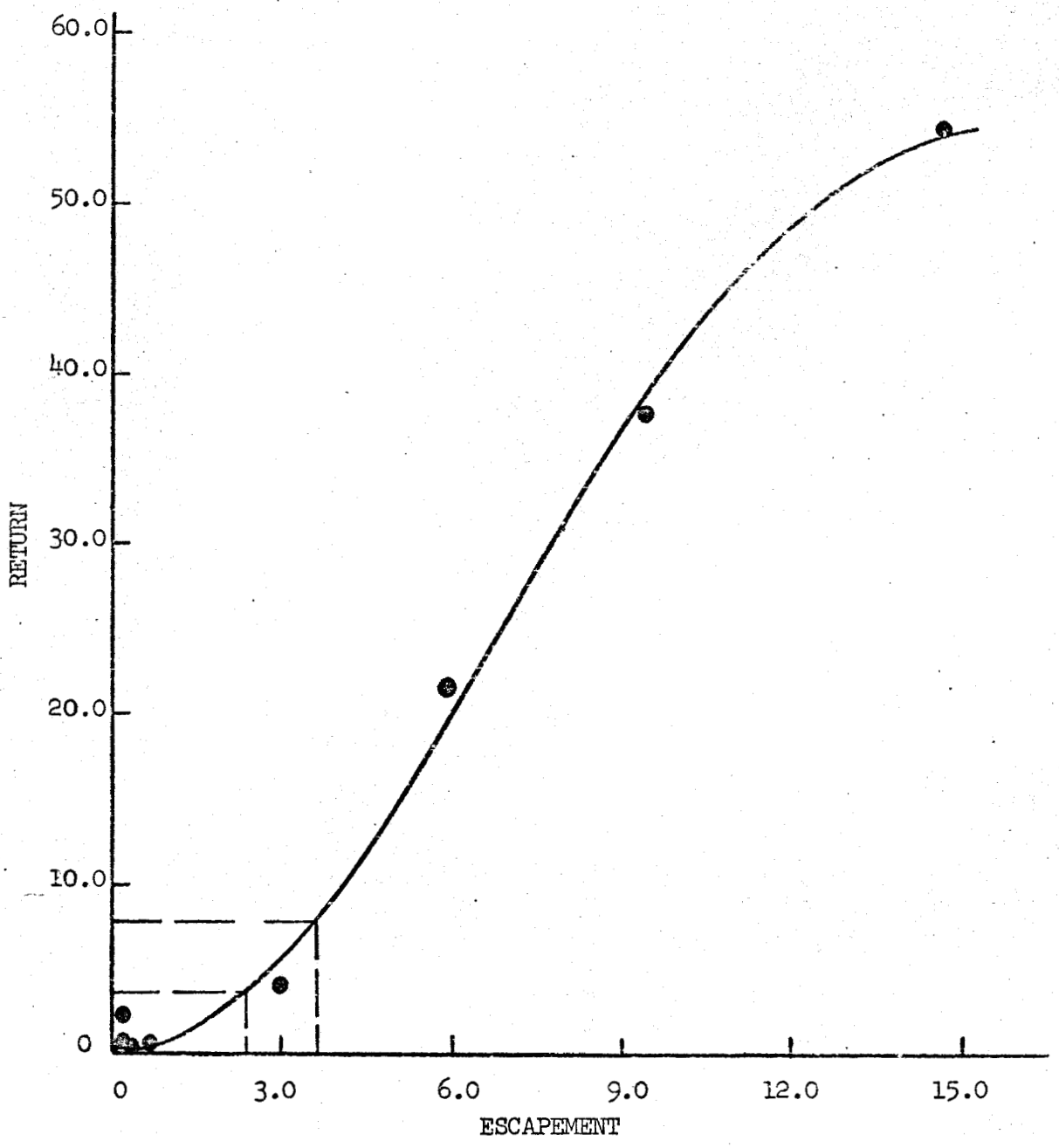
Appendix Figure 2.--Igushik River--Escapement-Return (in millions of fish).



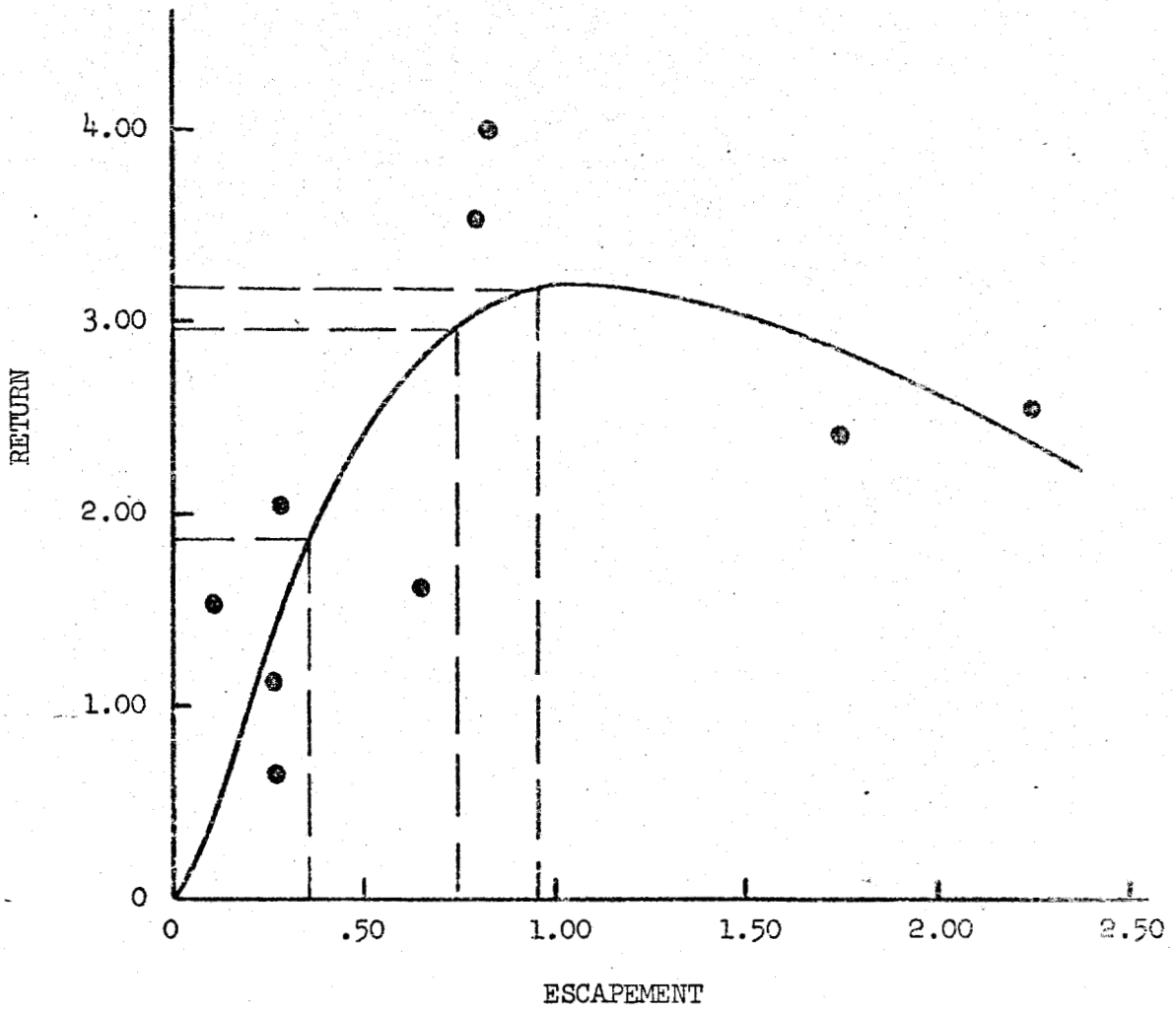
Appendix Figure 3.--Wood River--Escapement-Return (in millions of fish).



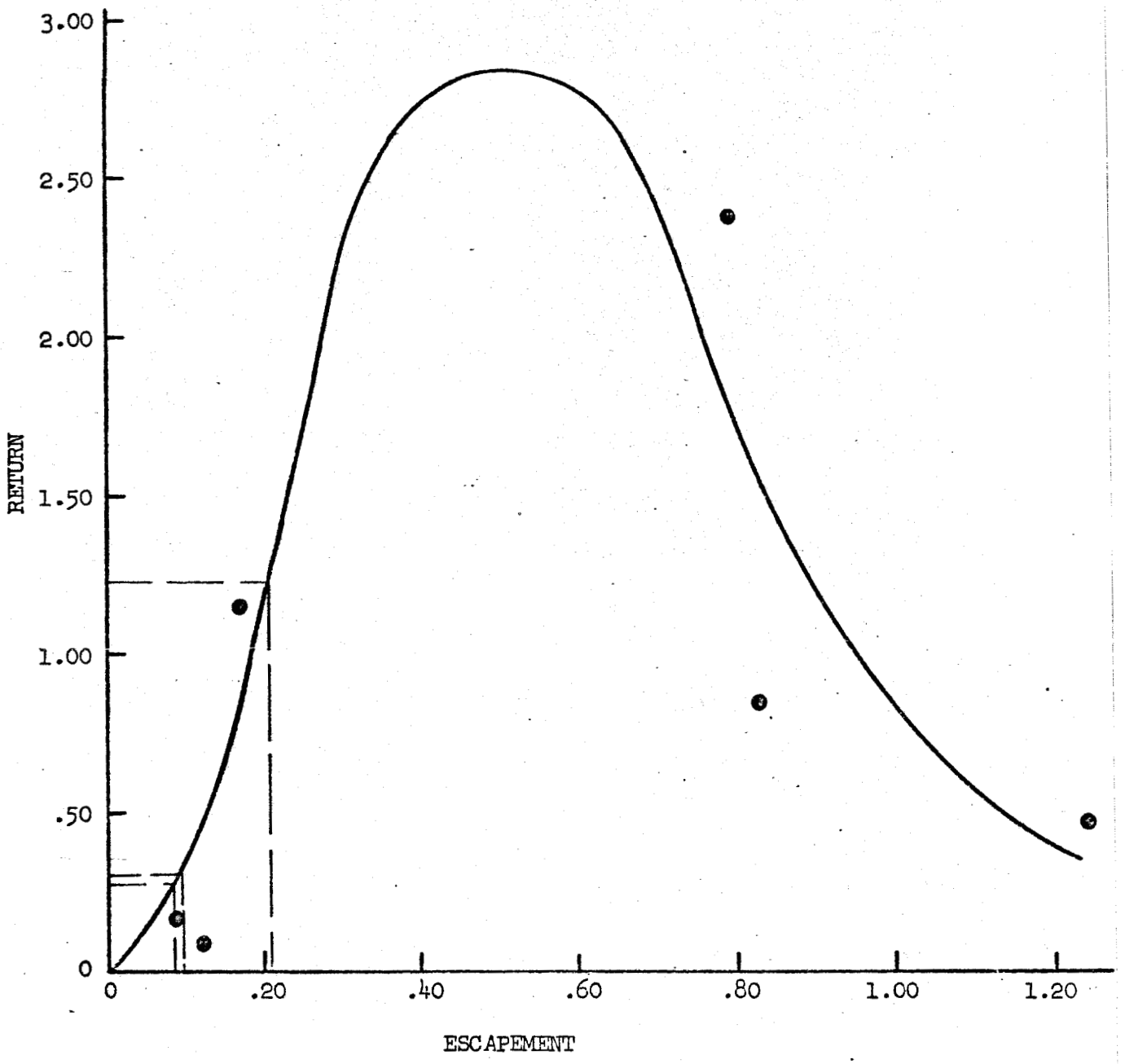
Appendix Figure 4.--Nuyakuk River--Escapement-Return (in millions of fish).



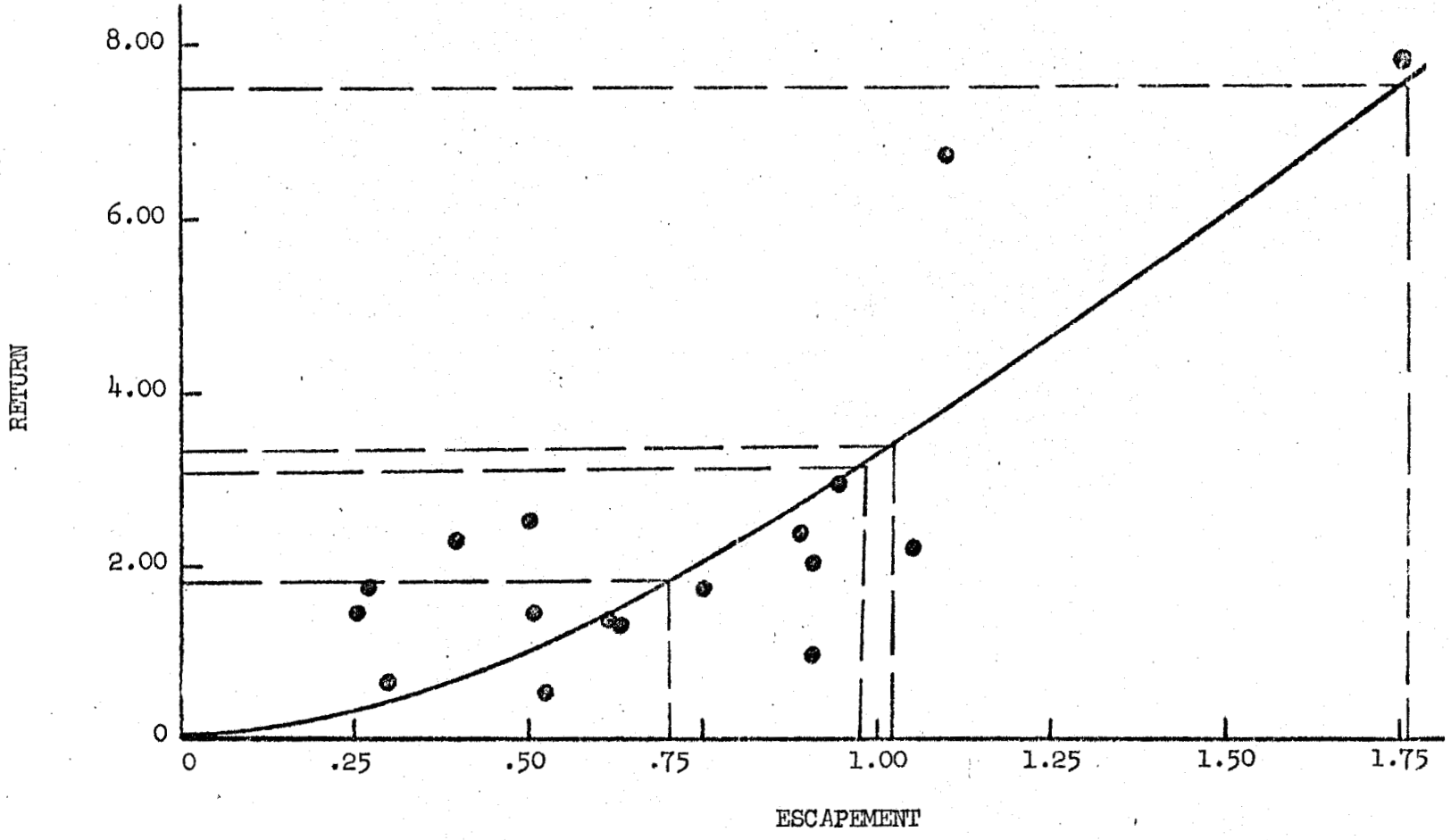
Appendix Figure 5.--Kvichak River--Escapement-Return (in millions of fish).



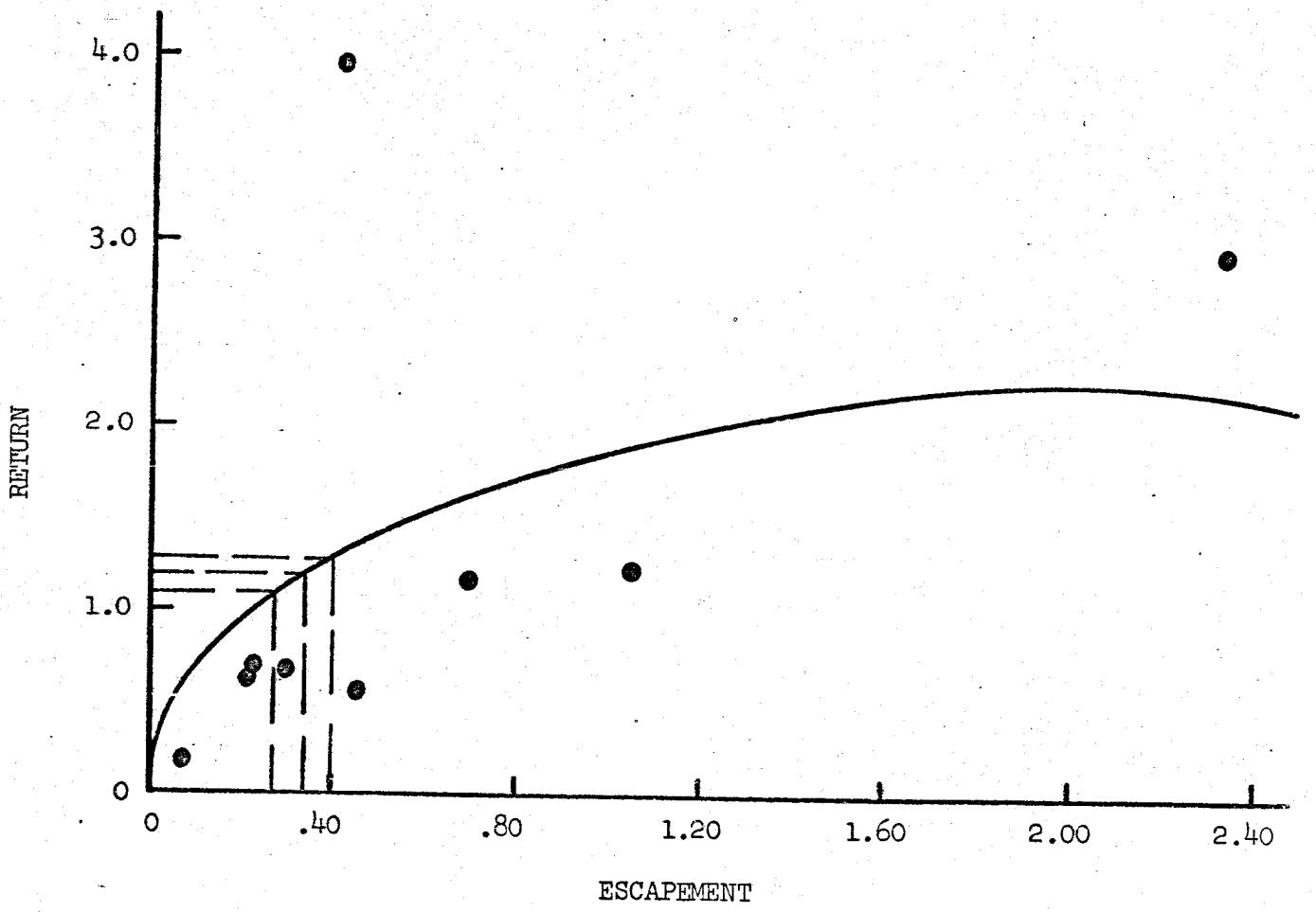
Appendix Figure 6.--Naknek River--Escapement-Return (in millions of fish).



Appendix Figure 7.--Branch River--Escapement-Return (in millions of fish).



Appendix Figure 8.--Egegik River--Escapement-Return (in millions of fish).



Appendix Figure 9.--Ugashik River--Escapement-Return (in millions of fish).