Informational Leaflet 146

FINAL FORECAST OF 1970 BRISTOL BAY SOCKEYE RUN

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July 9, 1970

STATE OF ALASKA
KEITH H. MILLER - GOVERNOR

DEPARTMENT OF FISH AND GAME

SUBPORT BUILDING, JUNEAU 99801

ALASKA
FISH & GAME

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Forecast by System

Table 1. Bristol Bay sockeye salmon 1970 forecast of inshore run, escapement goals and allowable harvest in millions of fish.

System	Inshore Forecast	Sockeye Salmon Escapement Goal	Sockeye Salmon Escapement Management Range	Inshore Harvest Percent	Inshore Harvest No. of Fish
NAKNEK-KVICHAK					
Kvichak	43.732	19.000	15.000 - 23.000	56.6	24.732
Branch 1/	.513	.223	.190 - .250	56.6	.290
Naknek	2.904	1.000	.800 - 1.200	65.6	1.904
Subtotal	47.149	20.223	15.990 - 24.450	57.1	26.926
EGEGIK	4.050	1.000	.800 - 1.200	75.3	3.050
UGASHIK	1.252	.700	.500 - .900	44.1	.552
NUSHAGAK-IGUSHIK					
Wood	1.865	1.000	.800 - 1.200	46.4	.865
Igushik	.680	.200	.100 - .300	70.6	.480
Nuyakuk 1/	.400	.214	.180 - .240	46.4	.186
Snake 1/	.017	.009	.007 - .011	46.4	.008
Nushagak-Mulchatna 1/	.127	.068	.060 - .080	46.4	.059
Subtotal	3.089	1.491	1.147 - 1.831	51.7	1.598
TOGIAK	.272	.100	.080 - .120	63.2	.172
TOTAL BAY	55.812	23.514	18.517 - 28.501	57.9	32.298
			Range of Harvest	27.311 - 37.295	

1/ These systems cannot be managed separately from the major system in their district. Consequently, the harvest rates presented above for these systems are merely the harvest rates anticipated for the major system in the district. The corresponding escapement goals do not necessarily coincide with the escapement levels which would be achieved if the systems could be managed independently.

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INTRODUCTION

Contributors

The 1969 and 1970 forecasts of the Bristol Bay sockeye run were prepared by the Commercial Fisheries Division, Alaska Department of Fish and Game. Mr. Frank Ossiander of the USFWS Bureau of Commercial Fisheries provided the high seas catch apportionment by river system by age class.

The yearly field data collection for the Bristol Bay sockeye run is carried out under the direction of Mr. Larry Van Ray, Mr. Donald Siedelman, Mr. Thomas Schroeder, Mr. Darwin Biwer, Mr. Robert Paulus and Mr. Michael McCurdy of the Alaska Department of Fish and Game, Commercial Fisheries management and research staffs. Data compilation and scale aging are primarily the responsibility of the management staff.

Mr. Steven Pennoyer, Mr. Melvin Seibel, Mr. Robert Paulus and Mr. Michael McCurdy of the Alaska Department of Fish and Game participated in the analysis of the data. Mr. Seibel, senior Department biometrician, prepared the spawner-recruit curves and N-ocean to (N+1) ocean analysis, suggested the standard error of forecast analysis and reviewed the final draft of this publication. Messrs. Pennoyer, Paulus and McCurdy assembled the forecast data and performed most of the computations. Mr. Pennoyer served as editor and prepared the report in its present form.

General Remarks

Forecasts of adult returns can be based on information obtained at different stages in the life history of the Bristol Bay sockeye. Returns can be forecasted from individual river system data on escapement, return and/or smolt production. The fishery is managed by system or groups of systems (districts) and consequently the river system forecast is one of the basic tools for management of the run. Other forecast methods based on sampling of the Bristol Bay sockeye population as a whole on the high seas yield a total Bay forecast. These provide valuable checks on the forecast magnitude and age composition but by themselves do not provide the data needed to manage individual district fisheries. The river system forecast is presented in this report. Table 1 summarizes the 1970 inshore forecast, escapement goals and estimated harvest by river system. Figure 1 depicts the major river systems and fishing districts in Bristol Bay.

1969 Forecast

An Informational Leaflet was not published for the 1969 Bristol Bay sockeye forecast. Forecast methods and data were undergoing considerable modification and time did not permit formal publication. As usual, a preliminary forecast was presented in the fall of 1968 for the use of industry and management in long range pre-season planning. Documentation of final forecast levels by age by system, escapement goals, anticipated level of harvest and a general review of methods was available in draft form prior to the 1969 season (Appendix A). This final forecast came too late for industry to extensively modify plans made on the basis of the preliminary forecast the previous fall, but it gave the Department information to work from during the season for district by district management.

Data on the 1969 Bristol Bay sockeye run is not finalized, but the 1969 inshore forecast compares to our preliminary data as shown in Table 2.

Table 2. Bristol Bay sockeye 1969 inshore run forecast accuracy by system in millions of fish.

System-district	Forecast	1969 run	% error from run
NAKNEK-KVICHAK			
Kvichak	12.780	11.667	9.5
Branch	.416	.427	- 2.6
Naknek	2.741	2.473	10.8
Subtotal	15.937	14.566	9.4

(Continued)

FIGURE 1. Bristol Bay river systems and fishing districts.

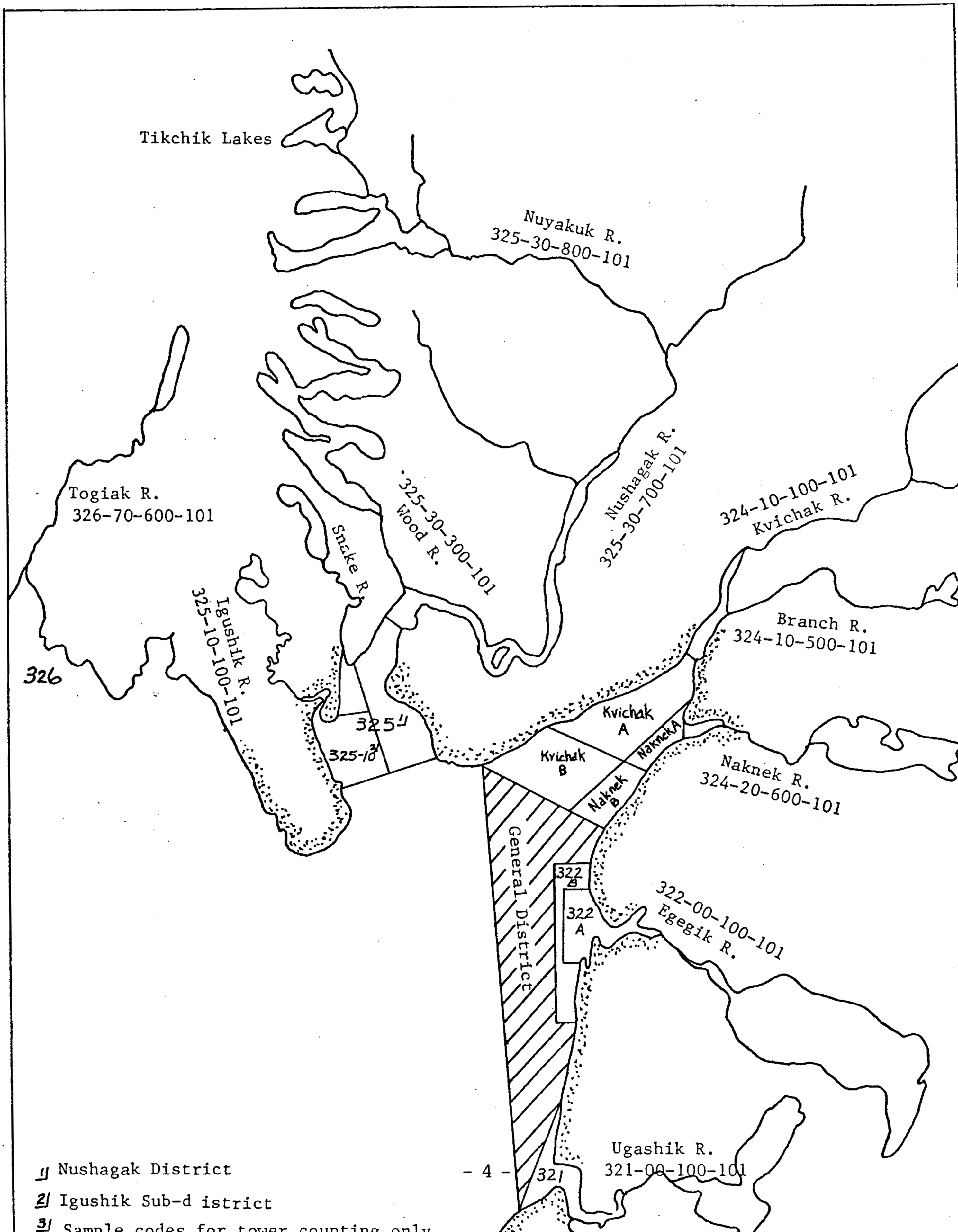


Table 2. Bristol Bay sockeye 1969 inshore run forecast accuracy by system in millions of fish (continued).

System-district	Forecast	1969 run	% error from run
EGEGIK	1.972	1.898	3.9
UGASHIK	.712	.325	119.1
NUSHAGAK-IGUSHIK			
Wood	1.618	1.036	56.2
Igushik	.424	.630	- 32.7
Nuyakuk	.334	.261	28.0
Snake	.022	.010	120.0
Nushagak-Mulchatna	.075	.055	36.4
Subtotal	2.473	1.992	24.1
TOGIAK	.180	.263	- 31.6
BAY TOTAL	21.274	19.045	11.7

The total Bay forecast accuracy is certainly good compared to past years (range -12 to +97%, absolute average 39.3%, 1960-1968), and the accuracy by system for most of the Bay is encouraging. This has not been a notable feature of past forecasts and yet the runs in the Bay are managed on a district basis.

The most notable discrepancy between forecast and run was in the Ugashik district. The bulk of the Ugashik forecast was based on a predicted .549 million 5_3 return from brood year 1964 which failed to materialize. The other error of major importance was in Wood River where .928 million 4_2 were forecasted and only .481 million returned. The Nushagak and Togiak districts as a whole had a poorer forecast accuracy than the Egegik and Naknek-Kvichak districts although by comparison with past average accuracy (30% Togiak and 34% Nushagak) the 1969 forecast for these districts was not bad.

1970 Forecast

The 1970 run is expected to be a peak year in the Bristol Bay fishery. Interest by processors, fishermen, international negotiating groups and regulatory bodies required early estimates of run size. Accordingly, following the field season in September of 1969, a preliminary inshore run forecast of 64.000 million was made. This forecast was revised to 56.018 million in November of 1969 on the basis of more final data for the 1969 run and further analysis. Removal of escapement requirements from this forecast left an estimated inshore harvest of 32.000 million. These figures served as a basis for processors' preparation to handle this harvest which would be the largest in Bristol Bay history (Figure 2). They also were the basis for the Alaska Board of Fish and Game decision to relax district boundary and gear limitations to facilitate this harvest. Undoubtedly many fishermen made their plans based on this forecast. Preliminary forecasts for the whole state were published in Informational Leaflet No. 136 (Noerenberg and Seibel /Ed./, 1970).

The final forecast presented here will have no effect on the preparations described above as significant differences were not found. It is intended as a guide for in-season management by system and a documentation of methods and data used.

The new forecast methods initiated in 1969 are approaching finalization and hopefully can be computerized in time for the 1971 forecast. If this is the case, the same delays should not be experienced and a final forecast should be ready by early spring.

METHODS AND PROCEDURES

Terminology and Notation

The Gilbert-Rich system of age class designation for salmon is used in this report. In this system, an "i_j" fish refers to a fish of total age i with j years of freshwater residence. The difference (i-j) represents the number of years of marine residence. Thus, a "5_2" fish would be a fish of total age 5 years, freshwater residence of 2 years and marine residence of (5-2) = 3 years.

In addition to the standard Gilbert-Rich age class notation, the following notation is used to designate special age groups:

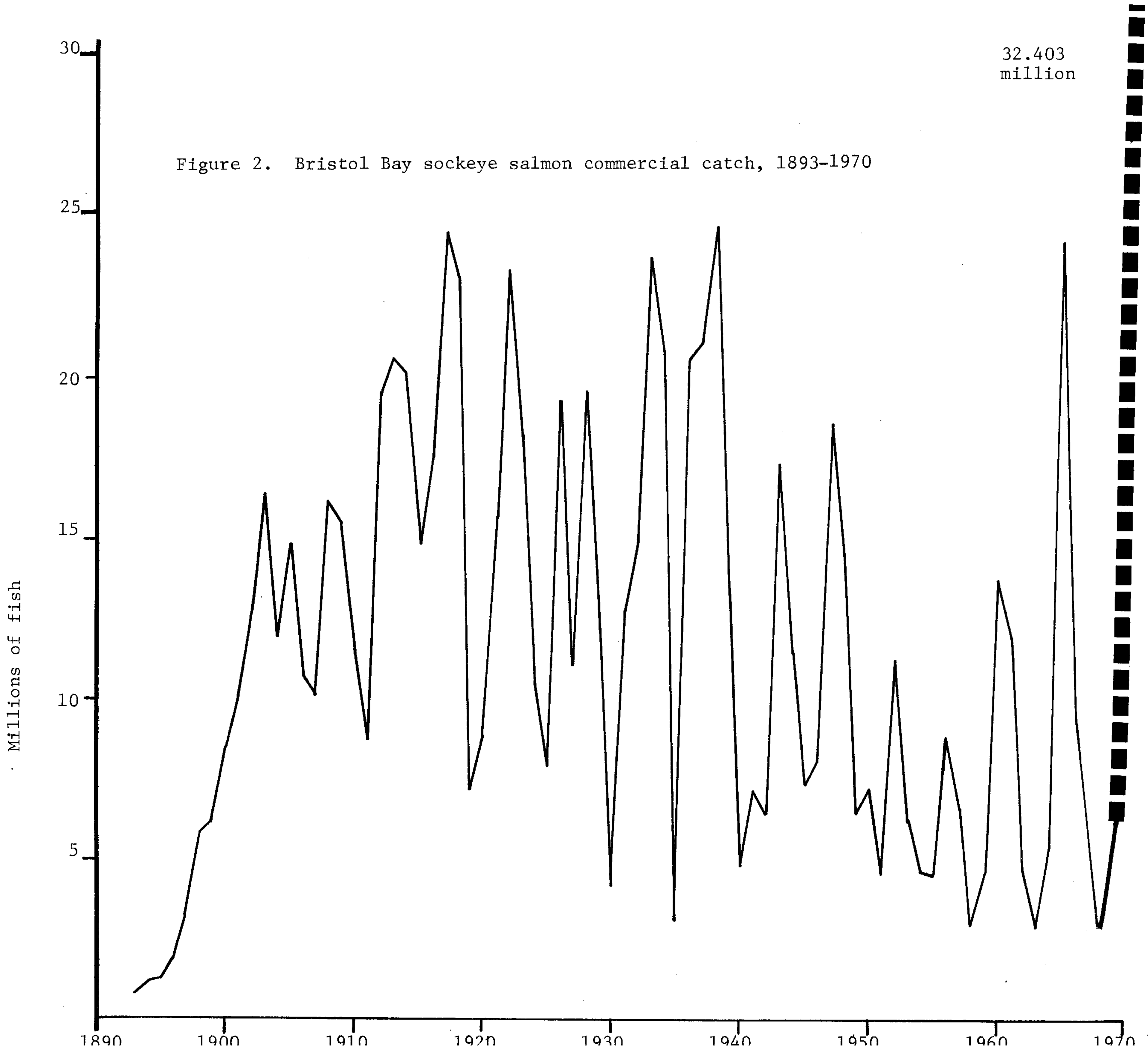


Figure 2. Bristol Bay sockeye salmon commercial catch, 1893-1970

Age I smolt - Smolt with a single winter of lake residence (excluding the first winter after spawning occurred),

Age II smolt - Smolt with 2 winters of lake residence,

1 FW Adult - Adult fish from the Age I smolt group,

2 FW Adult - Adult fish from the Age II smolt group,

2-ocean Adult - Adult fish with 2 winters of ocean residence,

3-ocean Adult - Adult fish with 3 winters of ocean residence.

Figure 3 illustrates the use of some of the above age class notation as it applies to the age classes contributing to the 1970 forecast.

Additional notation used is as follows:

Y - X linear regression - regression of the variable Y on the variable X, e.g. 5_2-4_2 linear regression,

Y/X - The ratio of the variable Y to the variable X, e.g. 4_2/1 FW,

ER - Escapement-return (i.e. spawner-recruit) relationship,

SEF - Standard error of forecast.

East Side Systems - Egegik, Ugashik, Naknek, Kvichak and Branch.

West Side Systems - Wood, Igushik, Nuyakuk, Snake, Nushagak-Mulchatna and Togiak.

Forecast Data

The amount of data available for use in forecasting varies from system to system and is summarized in Table 3. As the number of years of reliable data increases, earlier years of questionable data are dropped. In this way we are gradually eliminating escapements estimated by aerial survey, return age compositions based on small samples, catches from enlarged fishing districts, etc.

In most systems the data considered for the 1970 forecast has been extended back to brood year 1952 even if it involved use of aerial survey

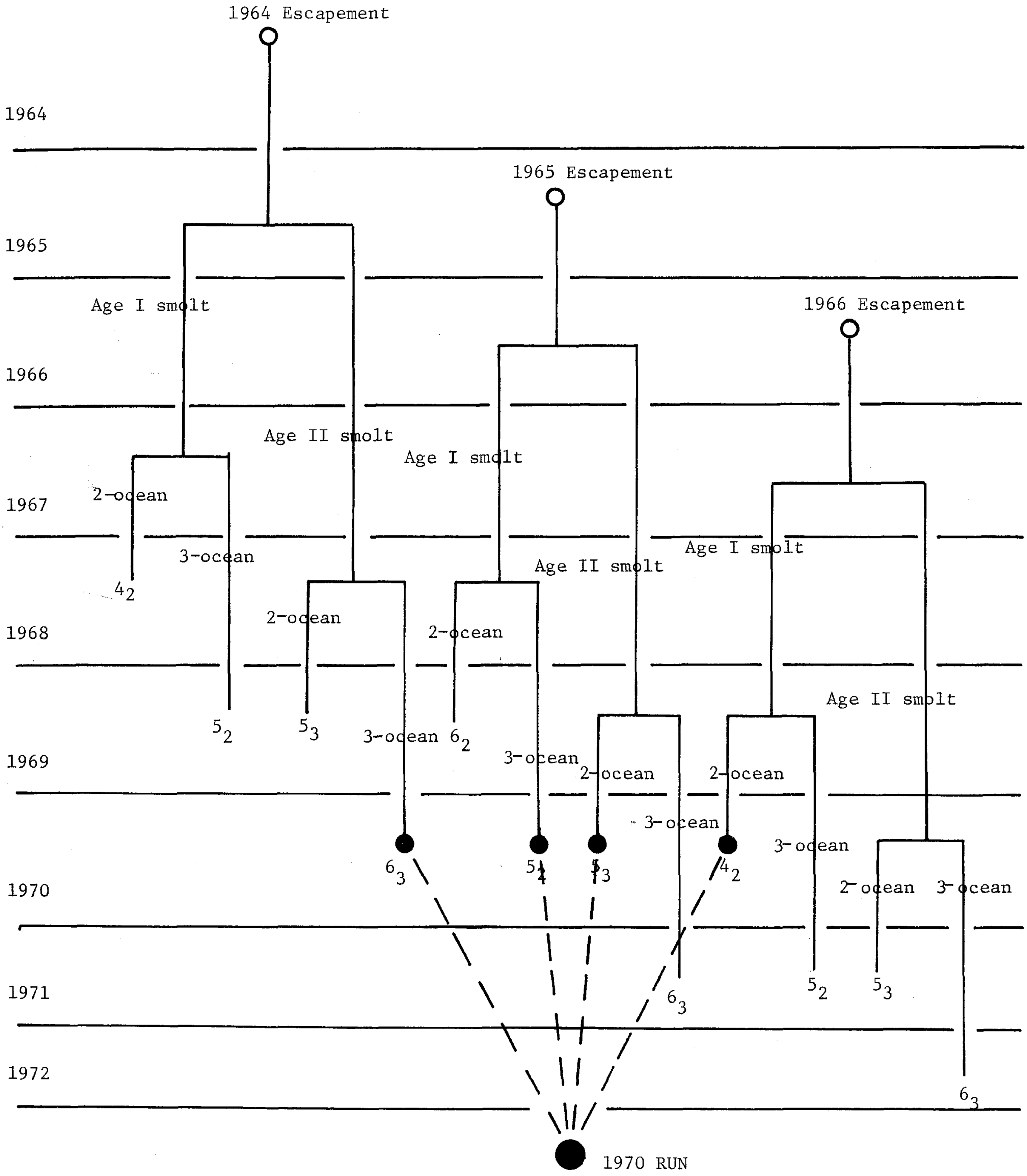


Figure 3. 1970 Bristol Bay sockeye forecast schematic.

Table 3. Data available for forecast of returning sockeye salmon runs by system, Bristol Bay [1/].

System	Escapement [2/]	Return by age class [3/]	Smolt Index	Smolt Outmigration	3_2 jacks	4_3 jacks
Kvichak	12	12	14		3	7
Branch	10	12				
Naknek	15	12		12		10
Egegik	15	12				6
Ugashik	15	12		8		7
Wood	14	12	4/			
Igushik	9	12				
Nuyakuk	8	12				
Snake [5/]						
Nushagak/Mulch [6/]	1	0				
Togiak	7	12				

1/ Number of years of data available since 1952 given under each category.
2/ Counting tower of weir counts 1952 through 1966. Earlier aerial survey data was used in forecast if necessary to extend series back to 1952.
3/ Years of complete returns from brood year escapements.
4/ Index data available consistently through 1967, but does not contribute to 1970 forecast.
5/ Tower used 1960-1964 since then escapement by aerial survey. Wood River age composition applied to returns.
6/ First tower counts in 1966. Prior to that aerial surveys. No complete brood year returns from tower counts as yet.

estimates of escapement. This was done to standardize the number of observations used by system and additionally the 1952 brood year is considered to have the earliest valid escapement-return and age composition data for the widest number of systems. Prior to 1954 in the Naknek-Kvichak, Ugashik and Nushagak and 1955 in the Egegik district boundaries in the Bay were greatly expanded and catches of mixed stocks within a district may have been more common than at present. General methods of catch and escapement data sampling are illustrated in Informational Leaflet No. 121 (McCurdy and Pennoyer /Ed./, 1968). Smolt sampling techniques are given in Informational Leaflet No. 138 (McCurdy, Michael L. /Ed./, 1969).

The data upon which the forecast is based is given by system in Appendix Tables B1 through B15. All data on the 1968 and 1969 inshore runs should be considered preliminary, since work on the apportionment of catch by river system is still being carried on. This affects the following age classes:

Brood year	Age classes with preliminary data
1961	7_4
1962	7_4, 6_3, 6_4
1963	6_3, 6_4, 5_2, 5_3
1964	5_2, 5_3, 4_1, 4_2, 4_3
1965	4_1, 4_2, 4_3

High seas catch apportionment by river system by age class was based in part on information in Informational Leaflet Nos. 105 and 123 (Ossiander, Frank J. /Ed./, 1967 and 1968) and on recent personal communication with Mr. Ossiander.

Forecast Methods

Description of Different Forecast Methods

As a result of the availability of extensive data on the sockeye stocks of Bristol Bay, more than one method is generally available for predicting the magnitude of returns of a specific age class of salmon. Thus, the 5_2 fish return to the Naknek River in 1970 may be predicted by: i) applying an average maturity schedule to the total return-estimated on the basis of a fitted spawner-recruit curve - from the 1965 brood year escapement , ii) utilizing the relationship between the number of 5_2 fish returning in one year and the 4_2 fish returning the previous year - the estimate of 5_2 fish returning in 1970 being based on the 4_2 fish return in 1969, iii) applying an average marine maturity schedule to the estimated number of smolt migrating in 1967, or several other variations of these techniques.

Because of the desirability of presenting a single point forecast, the existence of several different forecasts requires some means of combining these forecasts. Several approaches are available. All prediction methods available could be used to construct estimates, these estimates then being combined by some averaging techniques to arrive at a single predicted return. Another approach would be to compare the reliability of the different prediction methods in terms of their ability to hindcast past returns and use only that method with the greatest reliability. Because of the relatively small number of observations in some cases and because of the large variation occurring in much of the data, the latter approach would not necessarily result in the same choice of forecast techniques each year. Another disadvantage of the latter approach is that it does not appear to make use of all the information available.

The approach which has been used to forecast the 1970 Bristol Bay sockeye returns consists of a combination of the two approaches described above. Forecast techniques which rather consistently perform poorly in terms of hindcast ability are rejected entirely while those techniques which generally exhibit the better levels of hindcast ability are used to construct estimates which are then combined to yield a point estimate. Techniques which lead to independent forecasts of sockeye returns are generally retained and included in the forecast procedure.

For the purpose of comparing the reliability of different forecast techniques, a measure of residual variance, the "standard error of forecast" (SEF) is defined by

$$SEF^2 = 1/d \sum_{i=1}^{n} (R_i - \hat{R}_i)^2$$

where

R_i = actual return observed in year i.

$\hat{R}_i$ = predicted return in year i.

n = number of years for which returns can be hindcasted.

d = an integral divisor.

When the prediction technique is classical linear regression, d is set equal to (n - 2) and the SEF is equivalent to the usual standard error of estimate, provided that the dependent variable is in fact R and not some transformed function of R. More generally, when curvilinear regression is used, d is set equal to (n - p) where p is the number of curve parameters being estimated. However, in some cases, it is not clear what value of d should be used, i.e. how many degrees of freedom should be associated with the sum of squared residuals. This problem arises, for example, when $\hat{R}_i$ is actually obtained by combining the results of several estimation problems, e.g. the return of 5_2 salmon to the Naknek River in 1970 can be predicted by estimating the total adult return from the 1965 brood year, applying the freshwater maturity schedule estimated from smolt outmigration data and finally applying an estimated marine maturity schedule. In such instances, an attempt is made to choose values of d which will approximately reflect the degrees of freedom associated with the sum of squared residuals.

The solution of the problem of combining multiple predictions is being sought in the following direction.

1) Eliminate those forecast techniques which consistently perform poorly in terms of their SEF's.

2) Determine the SEF's for those prediction techniques which are to be included in the forecast process, and

3) Combine the different predictions by weighting each prediction with the reciprocal of its SEF.

The above approach has been partially incorporated in the 1970 forecast.

Figure 3 illustrates the life history stages at which various methods of forecast are made. It also follows the contributing brood year escapements through their maturity stages to the age classes comprising the 1970 run.

Brood Year		Age Class Returning in 1970
1964	-	6_3
1965	-	5_2 and 5_3
1966	-	4_2

Only these four major age classes are forecasted since they account for over 95% of the run. Exceptions to this are the Nushagak-Mulchatna system which has a significant number of 4_1 (fish spending no winters in freshwater) and the Egegik which at times has significant numbers of 6_4 and 7_4.

After examination of various combinations of the forecast methods mentioned above it was decided to basically compare four specific methods for each age class where the data was available. These are:

1. Average percentage contribution of an age class to the total return from brood years applied to the spawner-recruit estimate of total return from the contributing brood year.

2. Percent Age I or Age II smolt produced from the contributing brood year applied to the spawner-recruit relationship estimate of total return to obtain an estimate of total 1 FW or 2 FW adults to which an average 2 or 3-ocean proportion is applied.

3. Age I or Age II smolt average marine survival applied to the number of smolt from the contributing brood year to obtain an estimate of total 1 or 2 FW adults to which an average 2 or 3-ocean proportion is applied.

4. The regression of (N + 1) ocean fish to N-ocean fish from the previous year, both of the same freshwater age group.

Systems not having smolt data, of course, were limited to methods 1 and 4.

The two smolt methods appear similar, but actually one utilizes data on actual production and survival while the other is used to assign maturity to the ER total return estimate. Both were examined since it was felt that in cases where the numerical smolt estimate was not consistently reliable the proportion of Age I/Age II might still be valuable in breaking down the total return estimate from ER.

Return to date from a given brood year was used in some cases as a restriction on the methods chosen for forecast. For example, in a system with a 4 and 5 year return to date from the contributing year of 2.000 million and an ER estimate of total return of only 1.000 million, the ER estimate would not be used in forecast of the 1970 6_3 age class.

Further explanation of spawner-recruit curves and (N + 1) to N-ocean fish regression is given below:

Spawner-Recruit Curves

For the purpose of describing the spawner-recruit relationships, the following generalized Ricker-type curve was used:

$$R = A\,E^{B}\,e^{-CE} \qquad (1)$$

where

E	=	number of parent spawners.
R	=	number of returning adult salmon.
e	=	base for natural logarithms.
A, B, C	=	curve parameters to be estimated on the basis of observed data.

Since Equation (1) is non-linear in the parameters, a non-linear regression technique (Snedecor and Cochran, 1967) was used to estimate parameters. The technique is iterative and requires initial estimates of the parameters. Initial estimates of the parameters were obtained by applying a logarithmic transformation to Equation (1), thereby reducing it to linear form and allowing the use of stand linear regression techniques. Beginning with the initial parameter estimates thus obtained, improved parameter estimates were obtained iteratively with the iterative procedure being terminated when the proportionate reduction of the residual mean square, s^2, between consecutive iternations fell below a preassigned level of .01. Computations were performed with the aid of an IBM 360/40 computer.

Under the assumption that the residuals ϵ_i in the statistical model

$$R_i = AE_i^B \, e^{-CE_i} + \epsilon_i$$

are distributed with zero means and constant variances, the parameter estimates obtained by the above procedure approximate least squares estimates.

In the past, the omission of outliers (extreme or abnormal observations) has been considered with some reservation due to the limited amount of data actually available. At present escapement-return data is available for approximately twelve years for the major sockeye stocks of Bristol Bay. Although it is realized that this is not a large number of observations, it does provide some margin for the omission of one or two extreme observations if justified.

The omission of an observation at this point does not imply that the data on which the observation is based is in error or that the observation did not, in fact, occur as recorded. Rather, the observation is omitted since it appears to have represented an extreme occurrence and the reason for this large variation is not presently known or understood and, therefore, cannot be explained or accounted for by the present prediction model. Since the inclusion of an "extreme" observation can often result in a prediction model which neither describes the "normal" observations nor the "extreme" observations, there is often justification for the omission of such an outlier.

For the 1970 forecast, the escapement-return data was critically reviewed in an attempt to isolate those observations which appeared to be "extreme" and which, if included in the analysis, would result in a prediction model which would poorly describe a large portion of the "normal" observations. The criteria for omitting an observation was a) appearance of the graphical representation of the data, b) comparison with analagous information from other sources and c) reduction in the residual mean square as a result of omitting that observation.

For the purpose of forecasting adult returns from brood year escapements, the spawner-recruit curves obtained are interpreted only as empirical curves and no interpretations are made regarding the biological implication of the specific values of the parameters.

Spawner-recruit curves for Bristol Bay river systems are presented in Appendix Figures C1-C12.

Analyses of the (N + 1)-Ocean Fish Return in One Year Versus the N-Ocean Fish Return in the Preceding Year

To facilitate this discussion, the following notation is introduced:

"R fish (S)" refers to "the return of age class R fish in year S".

As an example, "5_2 fish (K + 1) refers to "the 5_2 fish return in year (K + 1)", while "4_2 fish (K)" refers to "the 4_2 fish return in year K". Note that (N + 1)-ocean fish (K + 1) and N-ocean fish (K) both eminate from the same brood year, provided they are both of the same freshwater age class. In the following discussion, when (N + 1)-ocean fish (K + 1) are compared to N-ocean fish (K) it will be assumed that both are of the same freshwater age class unless specified otherwise.

Past evidence suggests that in some cases the variable (N + 1)-ocean fish (K + 1) is related to the variable N-ocean fish (K). For prediction purposes, this relationship is used, for example, to predict the return of 5_2 fish in one year on the basis of the return of 4_2 fish the previous year. The use of such a relationship for forecasting purposes is intuitively appealing from the standpoint that the N-ocean fish (K) may provide information regarding survival conditions encountered not only by the N-ocean fish (K) but also by the (N + 1)-ocean fish (K + 1) from the same brood year. Whereas the use of a spawner-recruit curve per se for forecasting necessarily assumes, in addition to other things, constant freshwater and marine survival, available evidence strongly indicates that freshwater survival especially may vary greatly between years. For those sockeye streams for which no information is available on freshwater survival, the first indication of total survival enjoyed by the progeny of a specific brood year may be obtained from the return of adults of the younger age classes.

Several different empirical functions were investigated for the purpose of describing the relationship between the (N + 1)-ocean fish (K + 1) and the N-ocean fish (K). Using the N-ocean fish (K) as the independent variable, three candidates were investigated for use as the dependent variable, viz. the (N + 1)-ocean fish (K + 1), the ratio of (N + 1)-ocean fish (K + 1) to N-ocean fish (K) and the natural logarithm of the ratio. The latter two candidates were suggested by techniques used to forecast the Chignik system sockeye returns (Dahlberg and Lechner, 1968). The primary age classes for which these relationships were investigated were 5_3 fish (K + 1) versus 4_3 fish (K), 5_2 fish (K + 1) versus 4_2 fish (K) and 6_3 fish (K + 1) versus 5_3 fish (K).

In terms of the standard error of forecast, the regression of (N + 1)-ocean fish (K + 1) on N-ocean fish (K) more consistently provided a better basis for forecasting than did the other two regressions. Consequently, this method was used as one means of estimating the returns of certain age class fish in 1970. The estimates thus obtained were incorporated in the forecasting procedure.

RESULTS

Comparison of Methods

The three systems for which smolt data was available varied considerably in comparative SEF by method by age class. The 4_2 age class, for which little if any (N + 1) to N-ocean data exists, had a lower SEF for forecasts based on smolt in two cases and average age composition in one case.

The 5_2 age class was best forecasted by (N + 1) to N-ocean in one case and no apparent difference existed between that and one or both of the smolt methods in the other two. The 5_3 age class had a lower SEF for the N-ocean method (4_3 "jacks") in one case and smolt data methods were best in the other two. The 6_3 age class had the lowest SEF for the N-ocean age class in two cases and there was no apparent difference between smolt and average age composition in the other system.

Neither of the two methods using smolt data consistently outperformed the other. In each system the SEF was of the same general order of magnitude for both methods.

In several cases a method with a comparatively low SEF was unusable for the 1970 forecast for other reasons. For example, a low SEF for average percent 4_2 of ER in a system with historically few 4_2's, but an exceptionally large Age I outmigration in 1968.

Generally, then, where smolt data was available it performed best in the majority of cases in forecasting 4_2 and 5_3 (the primary adult returns from Age I and Age II smolt). Where an adult (non-"jack") return of the freshwater age class had occurred (5_2 and 6_3), the N-ocean method was generally better and sometimes considerably so.

The non-smolt systems (Egegik and all the West Side systems) had only average age composition and N-ocean methods available for forecast. In nearly every case that N-ocean data was available (5_2 and 6_3 forecasts) this method outperformed the average age composition method. Unfortunately, with the exception of 4_3 "jacks" in Egegik, only the average age composition method was usable for 4_2 and 5_3 forecasts in these systems.

Of special interest is the use for forecast of "jack" salmon - sexually mature fish, predominately males, returning after only one winter in the ocean. There are two age classes of "jacks", 3_2 and 4_3, but 3_2 are present in such small numbers and so few years in most systems that they are useless for forecast purposes. They occur in the sampling taken from only three brood years in the Kvichak and the SEF for the regression with the subsequent year's 4_2's is 15.314 million (compared to 5.816 for the average percent 4_2 from brood year method). The 4_3's, however, occur in more substantial numbers as illustrated in Table 4.

The use of 4_3's to forecast the following year's 5_3's had the lowest SEF of any method in Naknek and Egegik, higher than other methods (.385 million compared to next poorest of .311 and best of .274) in Ugashik and higher in the Kvichak (11.514 million compared to 9.229 and 4.645). There is a relationship in each system, but it is of variable accuracy.

TABLE 4. 4_3 ("jack") sockeye salmon by system and brood year, Bristol Bay, in thousands of fish.

Brood year	Kvichak	Branch	Naknek	Egegik	Ugashik	Total
1951					3	3
1952						
1953						
1954	16		18	4	3	41
1955	14		1		1	16
1956						
1957			2			2
1958			4	2		6
1959	1		7	2		10
1960	131		9	21	10	171
1961		1	3		2	6
1962	2		4		2	8
1963	3	1	8	2		14
1964	95		25	6	9	135
1965	482	2	41	31	6	561

The "jacks" are such a small percentage of the returning runs in most years that sampling errors must greatly affect estimation of their numbers. Prior to 1964 sampling levels in some systems were at such low levels it may have been impossible to estimate numbers of jacks accurately. It is also still unclear what the relative influence of growth and genetics is on age at maturity. There is a great deal of evidence that good growth may stimulate early return particularly in the case of "jacks" (Foerester, R.E., 1968). This may partially explain the exceptionally large return of 4_3's in 1969 which, if used by itself in forecast, yields unbelievably large returns for 1970. These "jacks" averaged some 13 mm larger than those of 1965 in the Kvichak. As more data is accumulated it may be possible to weight "jack" numbers by ocean growth and improve the accuracy of this method of forecast.

At this time it would not seem advisable to rule out use of any one of these four methods, since each was the best or only available in some cases. The smolt data does significantly contribute to forecast in the systems for which it is available. Some methods may have a high SEF for an age class in a system due to one brood year but may perform very well for all other brood years. This may compare favorably with a method that performs poorly for all years. Further treatment of the SEF may be desirable.

This presentation should not be taken to mean that these methods are the final answer. Undoubtedly new methods or modifications of those used in this forecast will be incorporated as we gain further measurements and understanding of environmental and biological factors affecting survival, improve the accuracy of data collection, become better able to apportion high seas and inshore catch to system of origin and accumulate a longer series of observations on escapement - smolt production and return.

East Side Peak Year

There is evidence to suggest that some or all of the East Side systems (Kvichak, Branch, Naknek, Egegik and Ugashik) may produce large runs coincidentally with the Kvichak cycle. Examination of the spawner-recruit curves and the brood year return tables in the appendix will reveal that:

1. In the Kvichak, Egegik and Ugashik two separate levels of production have existed since the 1952 brood year. The higher level includes two brood years, 1956 and 1960. These of course are the last two so-called

"peak" brood years of the Kvichak cycle.

In the Egegik the lower level of production shows a leveling off at escapements in the .350 - .400 level, but the "peak year" level shows increasing returns with escapements of up to 1.799 million. In Ugashik, unlike Egegik, the brood year 1960 return while large was not exceptionally large for the size of the escapement (2.304 vs. 2.992). It is possible that the 1960 escapement was so large that it suppressed any "peak year" benefit. Although numbers of both Age I and Age II smolt produced (Appendix Table B10) was quite high both of these age classes and particularly the Age II were greatly reduced in average size. Unless there is a weather cycle coincidental with these peak years it would seem that any logical benefit or interaction might be occurring when these stocks pass through common areas - in the estuarine or ocean environment. Perhaps the small size of the Ugashik Age II smolt from 1960 had an adverse affect on their marine survival.

Figures 4, 5 and 6 compare escapement - smolt production and Age I and II to adult return relationships for Ugashik. As can be seen in neither 1956 or 1960 were an exceptionally large number of smolts/spawner produced. The 1960 escapement produced a large number of smolt that had an average marine survival resulting in a large run, but not out of proportion to the number of spawners. The 1956 escapement did not produce an abnormal number of smolt, but the Age I (entered the estuary the same year as the 1956 Kvichak progeny) smolt had a very high marine survival rate resulting in a large 1960 run. These facts tend to support the marine environment as the main factor in any "peak year" cycle for the East Side systems. Also of interest is the fact that although the 1956 escapement in the Kvichak produced a nearly equal smolt index for Age I and Age II, only the Age I produced a large adult return. The Age I's outmigrated in the same year as the smolt producing the large 1960 returns in Egegik and Ugashik.

2. Age composition (1 FW and 2 FW) in brood year returns fluctuate coincidentally between Kvichak, Egegik and Ugashik during "peak" years. This trend extends back to 1952. Brood year 1952 and 1956 returns were predominately 1 FW in all three systems although 1 FW fish are not normally present in numbers in either Egegik or Ugashik. All three systems shifted to primarily 2 FW progeny from brood year 1960.

3. The Naknek follows the trend in age composition in the returns from 1952 and 1956 and to a lesser degree from 1960. Production in the Naknek from brood year 1952 was large in terms of return/spawner while that from 1956 was large, but relatively poor in terms of return/spawner. The escapement in 1956 was quite large, 1.773 million and may have somewhat depressed production. Age I and Age II smolt size was well below the average (Appendix Table B6) and this may have resulted in reduced marine

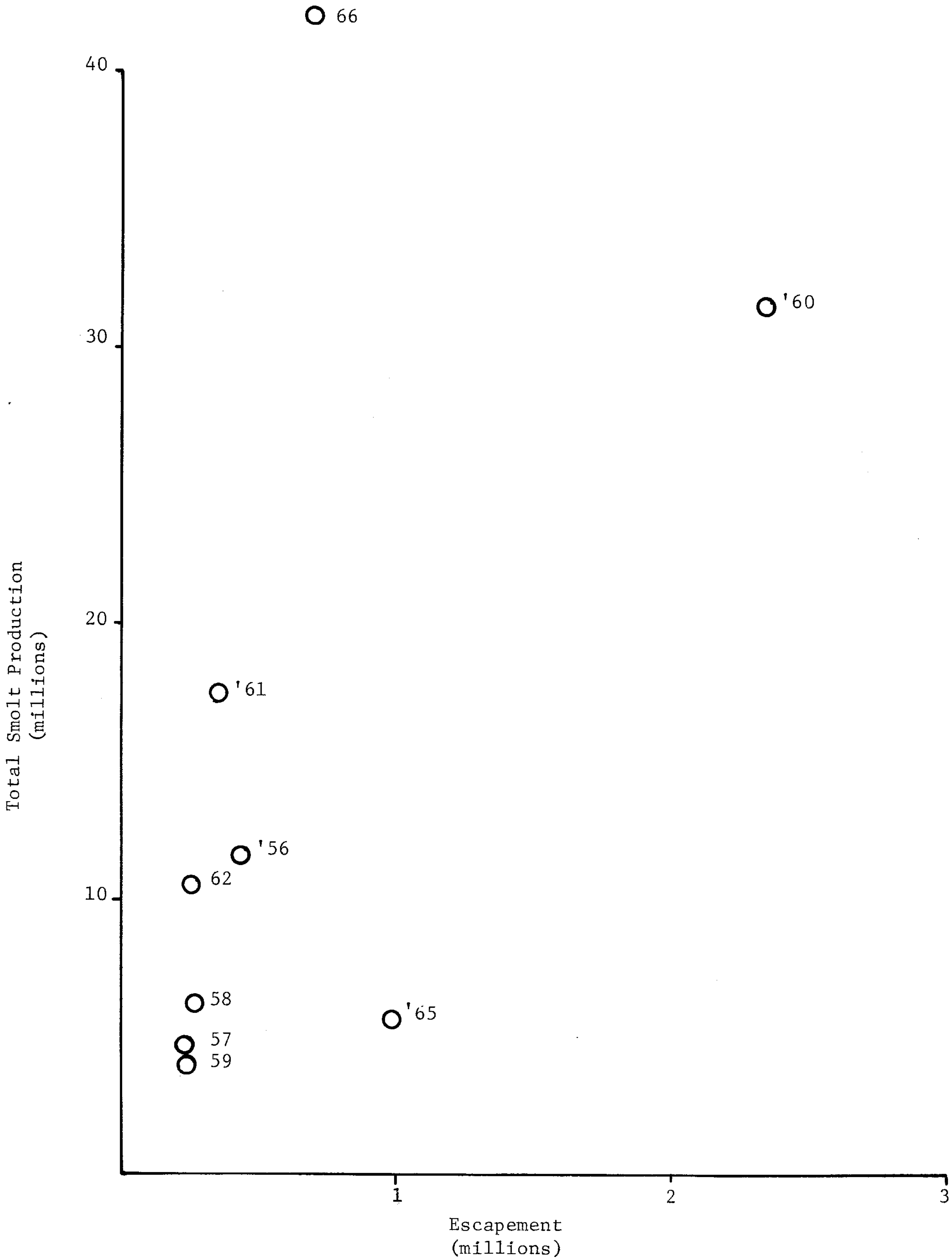


Figure 4. Ugashik River sockeye smolt production from brood year escapements.

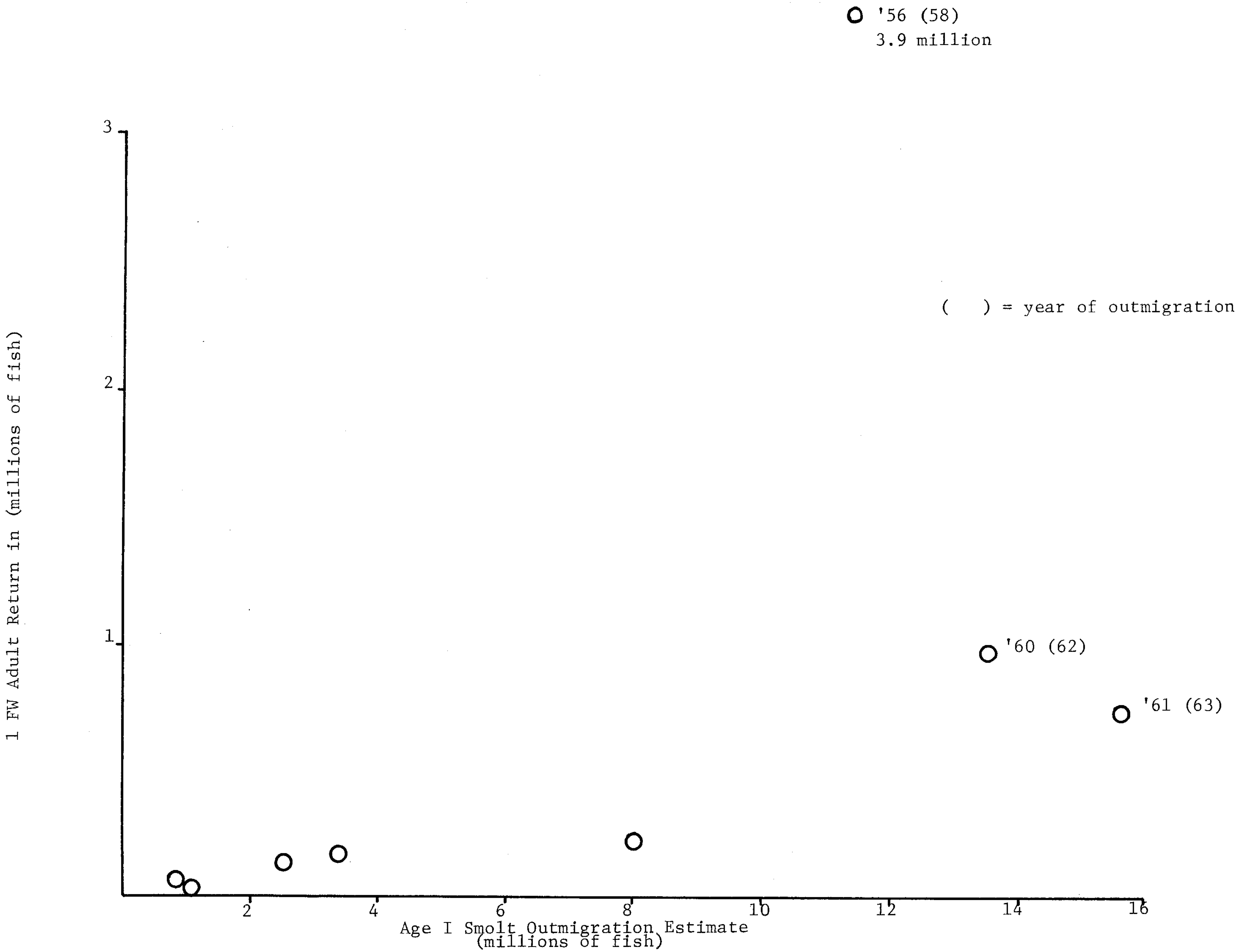


Figure 5. Ugashik River sockeye salmon Age I smolt to adult 1 FW return from brood year.

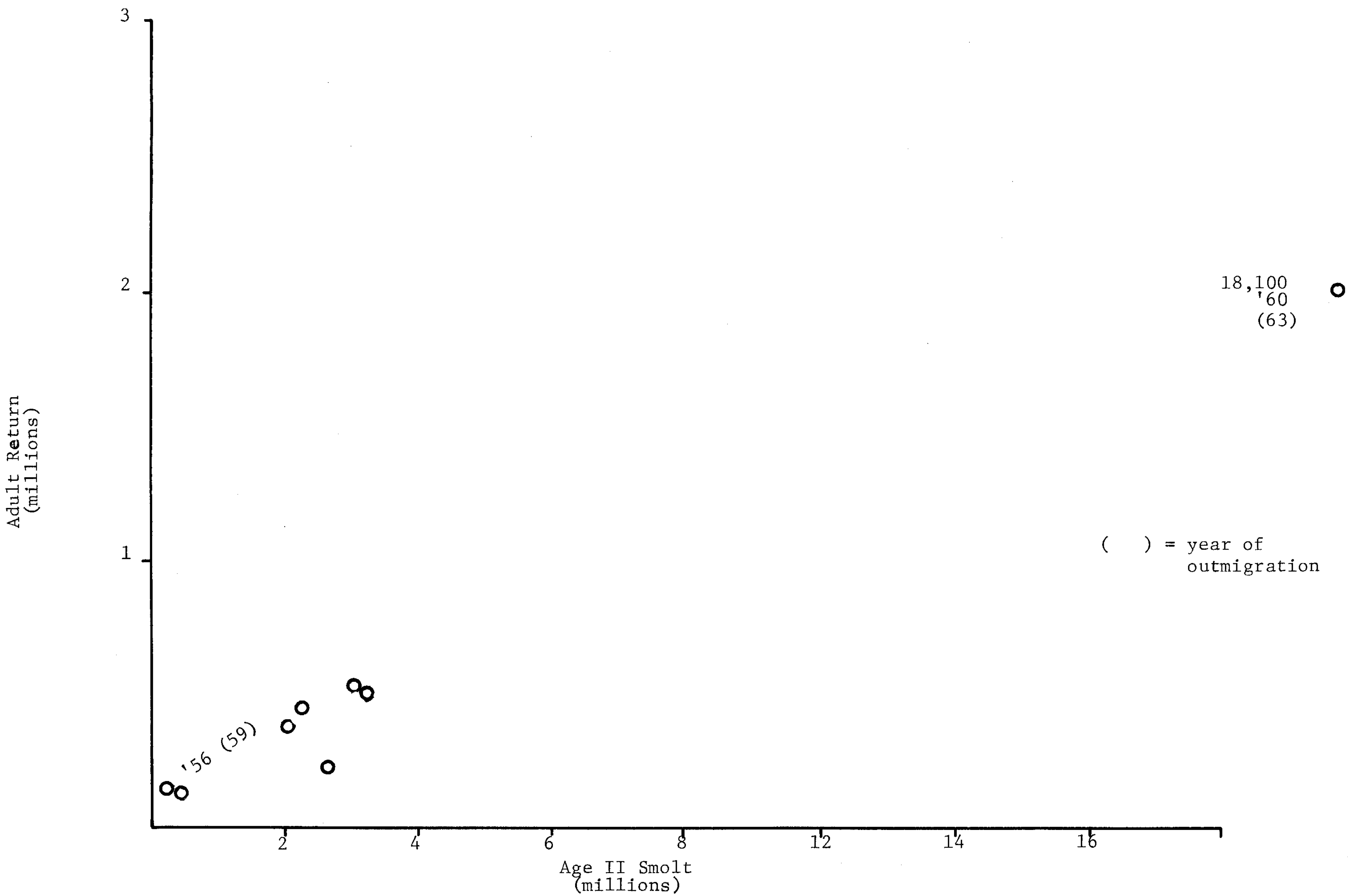


Figure 6. Ugashik River sockeye salmon Age II smolt to adult 2 FW return from brood year.

survival. Returns from 1960 were large both in absolute magnitude and relative production.

4. Branch River returns from 1956 conform to the pattern, but returns from 1960 were not large and age composition was not consistent with the other four systems. The extremely large escapement of 1.241 million in 1960 may have affected this.

Comparative data between these systems is summarized in Table 5.

The above evidence points to similar factors affecting survival, probably in the marine environment, in East Side systems during peak years in the Kvichak cycle. These factors may have a beneficial effect on survival of smolt of the same freshwater age class and same year of outmigration as peak year Kvichak fish. That this may occur in 1970 is supported by the high numbers of "jack" 4_3's in East Side systems in 1969 (Table 4). 1970 should be a peak year 5_3 run to the Kvichak. The above phenomena is considered separately for each system in the forecast by age class by system analysis in Appendix D.

Total Forecast

The 1970 forecast of total run by age class by system to Western Alaska is summarized in Table 6.

The methods used to forecast the total run of each individual age class by system are detailed in Appendix D. Also included in this section for each system are returns to date from contributing brood years, estimates of total return from contributing brood years and the rationale for the choice of forecast methods.

Inshore Forecast Derivation

The forecast based on production data is the total return by age class from brood years. However, prior to the time the adult fish return to Bristol Bay a portion of them will migrate west of 175° W. long. and become exposed to gill nets of the Japanese High Seas Mothership fleet. The fishery since 1952 has annually harvested between .367 and 9.736 million mature and immature sockeye of Bristol Bay origin.

The inshore run forecast is derived by removing an estimated Japanese

TABLE 5. Comparative data on sockeye salmon returns from brood years for East Side systems in Bristol Bay.

Brood year	System	Escapement1/	Total1/ return	Avg. total 1/ return 1952-1963	Return per spawner	Age classes in return percentage 1 FW	2 FW
1952	Kvichak	5.970	21.307	10.963	3.57	81	
	Branch	-----	------	.650	-----	—	
	Naknek	.103	1.553	2.063	14.88	79	
	Egegik	.757	1.722	2.703	2.27	61	
	Ugashik	.651	1.180	1.131	1.82	74	
1956	Kvichak	9.443	37.784	10.963	4.00	80	
	Branch	.784	2.385	.650	3.04	98	
	Naknek	1.773	2.420	2.063	1.36	87	
	Egegik	1.104	6.745	2.703	6.12	75	
	Ugashik	.425	3.976	1.131	9.39	97	
1960	Kvichak	14.630	54.019	10.963	3.70		96
	Branch	1.241	.460	.650	.37		36
	Naknek	.828	4.005	2.063	4.84		49
	Egegik	1.799	7.828	2.703	4.36		88
	Ugashik	2.304	2.981	1.131	1.30		67
1965	Kvichak	24.326					
	Branch	.175					
	Naknek	.718					
	Egegik	1.445					
	Ugashik	.997					

1/ Millions of fish.

TABLE 6. Western Alaska 1970 sockeye salmon total run forecast in millions of fish.

System	4_2	5_3	6_4	.2-ocean	4_1	5_2	6_3	7_4	.3-ocean	Total
Kvichak	.882	44.234	--	45.116	--	3.024	.562	--	3.586	48.702
Branch	.246	.071	--	.317	--	.137	.141	--	.278	.595
Naknek	.307	1.548	--	1.855	--	.697	.889	--	1.586	3.441
NAKNEK-KVICHAK	1.435	45.853	--	47.288	--	3.858	1.592	--	5.450	52.738
EGEGIK	.038	3.412	.043	3.493	--	.123	1.110	.055	1.288	4.781
UGASHIK	.687	.434	--	1.121	--	.158	.100	--	.258	1.379
Wood	1.256	.202	--	1.458	--	.500	.090	--	.590	2.048
Igushik	.078	.046	--	.124	--	.589	.101	--	.690	.814
Nuyakuk	.063	.013	--	.076	--	.381	.015	--	.396	.472
Snake	.012	.002	--	.014	--	.004	.001	--	.005	.019
Nushagak-Mulchatna	.021	.002	--	.023	.033	.089	.001	--	.123	.146
NUSHAGAK-IGUSHIK	1.430	.265	--	1.695	.033	1.563	.208	--	1.804	3.499
TOGIAK	.083	.010	--	.093	--	.206	.019	--	.225	.318
TOTAL BAY	3.673	49.974	.043	53.690	.033	5.908	3.029	.055	9.025	62.715
NORTH PENINSULA	.350	.403	.007	.760	--	.218	.169	.006	.393	1.153
WESTERN ALASKA	4.023	50.377	.050	54.450	.033	6.126	3.198	.061	9.418	63.868
Percent of Total	6.3	78.9	0.1	85.3	0.1	9.6	5.0	0.1	14.7	

high seas catch from the total forecast. The average percentage the Japanese have taken by age class in past years is applied to the forecast by age class by system to derive a forecast of Japanese catch by age class. This catch is then subtracted from each system's total forecast by age class (Table 6) to arrive at an inshore forecast of run. The average Japanese catch was based on percent high seas catch of the Western Alaska run by age class for the years 1956-1968.

The unusually high percentage catches in 1957 and 1961 were omitted as outliers in the computation of the averages.

The average percentages used were:

4_2 - 4.30%; 5_3 - 9.64%; 6_4 - 42.15%; 5_2 - 16.76%; 6_3 - 29.00%; 7_4 - 71.64% and 4_1 - 9.02%.

Removal of these estimated Japanese high seas harvests by age class from the Western Alaska total forecast resulted in the inshore forecast given in Table 7.

The Bristol Bay inshore forecast of 55.812 million presumes a Japanese catch of 6.903 million Bristol Bay sockeye and .147 million Alaska Peninsula sockeye for a total of 7.050 million. This compares to the peak year catches from the 1965 run (matures and immatures) of 8.001 million. The 1965 run was of the same general magnitude as the 1970 forecast thus supporting this estimate of high seas catch.

Two other estimates of the 1970 Bristol Bay inshore run have been made. The Fisheries Research Institute, University of Washington, earlier published a forecast (Rogers, 1970) based on the relationship of their purse seine sampling of immatures south of Adak and inshore adult returns the following year. Their forecast was for a run of 57.2 million (range 44.8 to 65.6).

The Bureau of Commercial Fisheries, USFWS, conducted a winter test fishing cruise in the early spring of 1970. Following this winter cruise of the G.B. KELEZ the Bureau compared their catches to catches made in 1962, 1967 and 1969. This resulted in a forecast for 1970 of 52.1 - 56.9 million 2-ocean and 3.3 - 7.5 million 3-ocean (French, Robert R. and Richard G. Bakkala, 1970).

Table 8 compares these forecasts by age class with the ADF&G river system forecast. As can be seen the total run figures are nearly identical. The primary difference is the higher number and percentage of 2-ocean fish in the BCF and FRI forecasts.

TABLE 7. Bristol Bay sockeye salmon 1970 inshore forecast of run by river system in millions of fish.

System		4_2	5_3	6_4	2-ocean	4_1	5_2	6_3	7_4	3-ocean	Total
Kvichak	No.	.845	39.970	-	40.815	-	2.518	.399	-	2.917	43.732
	%	1.9	91.4	-	93.3	-	5.8	0.9	-	6.7	
Branch	No.	.235	.064	-	.299	-	.114	.100	-	.214	.513
	%	45.8	12.5	-	58.3	-	22.2	19.5	-	41.7	
Naknek	No.	.294	1.399	-	1.693	-	.580	.631	-	1.211	2.904
	%	10.1	48.2	-	58.3	-	20.0	21.7	-	41.7	
Naknek-Kvichak	No.	1.374	41.433	-	42.807	-	3.212	1.130	-	4.342	47.149
	%	2.9	87.9	-	90.8	-	6.8	2.4	-	9.2	
Egegik	No.	.036	3.083	.025	3.144	-	.102	.788	.016	.906	4.050
	%	0.9	76.1	0.6	77.6	-	2.5	19.5	0.4	22.4	
Ugashik	No.	.657	.392	-	1.049	-	.132	.071	-	.203	1.252
	%	52.5	31.3	-	83.8	-	10.5	5.7	-	16.2	
Wood	No.	1.203	.182	-	1.385	-	.416	.064	-	.480	1.865
	%	64.5	9.8	-	74.3	-	22.3	3.4	-	25.7	
Igushik	No.	.075	.042	-	.117	-	.491	.072	-	.563	.680
	%	11.0	6.2	-	17.2	-	72.2	10.6	-	82.8	
Nuyakuk	No.	.060	.012	-	.072	-	.317	.011	-	.328	.400
	%	15.0	3.0	-	18.0	-	79.2	2.8	-	82.0	
Snake	No.	.011	.002	-	.013	-	.003	.001	-	.004	.017
	%	64.7	11.8	-	76.5	-	17.6	5.9	-	23.5	

TABLE 7. (continued) Bristol Bay sockeye salmon 1970 inshore forecast of run by river system in millions of fish.

System		4_2	5_3	6_4	2-ocean	4_1	5_2	6_3	7_4	3-ocean	Total
Nushagak-	No.	.020	.002	-	.022	.030	.074	.001	-	.105	.127
Mulchatna	%	15.7	1.6	-	17.3	23.6	58.3	0.8	-	82.7	
Nushagak-	No.	1.369	.240	-	1.609	.030	1.301	.149	-	1.480	3.089
Igushik	%	44.3	7.8	-	52.1	1.0	42.1	4.8	-	47.9	
Togiak	No.	.079	.009	-	.088	-	.171	.013	-	.184	.272
	%	29.0	3.3	-	32.3	-	62.9	4.8	-	67.7	
TOTAL BAY	No.	3.515	45.157	.025	48.697	.030	4.918	2.151	.016	7.115	55.812
	%	6.4	80.9	-	87.3	0.1	8.8	3.8	-	12.7	

TABLE 8. Bristol Bay sockeye salmon 1970 forecasts of inshore run by age class and agency.

Age Class	Forecasts[1/] ADFG River System		BCF[2/] Winter Cruise [3/]		FRI Adak Sampling[4/]	
	No.	(%)	No.	(%)	No.	(%)
4_2	3.52	(6.3)	4.6	(7.7)	7.71	(13.5)
5_3	45.16	(80.9)	49.4	(82.8)	44.33	(77.5)
6_4	.02	-	0.3	(0.5)	0.06	(0.1)
2-ocean	48.70	(87.3)	54.3	(91.0)	52.10	(91.1)
4_1	.03	(0.1)	0.1	(0.2)	-	-
5_2	4.92	(8.8)	3.5	(5.8)	3.98	(7.0)
6_3	2.15	(3.9)	1.8	(3.0)	1.10	(1.9)
7_4	.02	-	-	-	0.02	(0.0)
3-ocean	7.12	(12.8)	5.4	(9.0)	5.10	(8.9)
TOTAL	55.81		59.7		57.20	

1/ In millions of fish.

2/ Midpoint of ranges used.

3/ French, Robert R. and Richard Bakkala, 1970.

4/ Rogers, Donald E., 1970

The inshore forecast of 55.812 million compares favorably to the preliminary forecast of 56.018. There was some variation by system, but the only significant change was an increase in the Egegik district of .738 million primarily based on an increase in the forecast of the 5_3 age class.

Analysis of methods used has not proceeded to the point that confidence intervals were computed for the forecast estimates. However, some idea of the possible variation in the run can be gained by comparing forecasts obtained by summing the methods (only those considered as usable in each case - methods giving extreme values have been eliminated) giving the maximum forecast and those giving the minimum forecast for each age class and system. This procedure results in a maximum point estimate forecast of total run to the Bay (excluding the Alaska Peninsula) of 83.700 million and a minimum of 46.700 million. Removal of an average Japanese high seas catch yields a range of 41.500 - 74.600 million for the inshore run. This is not to mean that it is considered equally likely that the run could fall anywhere in this range. This is simply the range in estimates of methods considered and reflects possible variation in returning run size that could occur due to extremes in survival. The data supports the point estimate forecast of 55.812 million as being most likely. It is interesting, though that the general "rule of thumb" of ± 25% allowable forecast error to be of use in managing the run roughly corresponds to this range.

The Bay inshore run is forecasted to be 87.3 percent 2-ocean fish. The only systems with a preponderance of the larger 3-ocean fish in their forecasted runs are Igushik, Nuyakuk, Nushagak-Mulchatna and Togiak, all with relatively minor numbers of sockeye. The high percentage of 2-ocean fish and the large number of fish in the run would lead us to expect that the overall average size of fish in the Bay in 1970 will be small, probably on the order of 14-16 fish/case. Table 9 summarizes the background data on run size, percent 2-ocean and average fish per case. Large runs with high percentages of 2-ocean fish have the highest fish/case averages.

The desired escapements for a peak year run of this magnitude are summarized in Table 1. These goals are based, for the most part, on the escapement return curves used for forecast (Appendix Figures C1 - C12). In the case of Egegik and Ugashik the escapement goals are set higher than the indicated optimum for all brood years to take advantage of possible "peak year" survival benefits. In other systems the goal is normally set slightly higher than the indicated optimum to minimize the occurrence of low escapements. The management range reflects variation inherent in management techniques and includes the range of escapement acceptable over a rather wide variation in actual return.

Predicted harvest and percent harvest rate by system are also given

TABLE 9. Average fish per case, inshore run size and age composition, Bristol Bay sockeye, 1956-1969.

Year	Inshore[1] run size	Percent 2-ocean in run	Average fish/case
1956	23.848		12.91
1957	11.009	27	11.79
1958	5.769	51	12.30
1959	12.889	85	12.80
1960	36.372	88	14.58
1961	18.098	34	11.93
1962	10.405	70	12.45
1963	6.896	57	12.15
1964	10.928	79	13.57
1965	53.127	92	15.75
1966	17.543	25	12.62
1967	10.348	67	12.96
1968	8.010	65	12.76
1969	19.040	84	15.04
1970[2]	55.812	86	-

1/ Millions of fish.

2/ Forecast

in Table 1. A total harvest range for Bristol Bay of 27.311 to 37.295 million is forecasted. Harvest rates vary considerably from system to system with a high of 75.3% forecasted for Egegik and a low of 44.1% for Ugashik. In no system, however, is the forecasted run too poor to allow a substantial harvest. The Naknek-Kvichak district at a forecasted harvest rate of 57.1% of the returning run should sustain a harvest of 26.926 million or 83.4% of the forecasted Bay total.

Table 10 gives some comparisons of the 1970 inshore forecast with past years. The 1970 forecasted run is substantially larger than past average runs since 1950 in all districts but Togiak.

CONCLUSIONS

A forecasted inshore run of 55.812 million sockeye salmon would result in an allowable harvest of 32.403 million. This would exceed the largest previous catch in history of 24.700 million in 1938 by 7.703 million.

The Naknek-Kvichak district with a forecasted catch of 26.926 million sockeye will be the major harvest area in the Bay. The Egegik district has the highest percentage harvest forecasted at 75.3% of the inshore run and Ugashik the lowest at 44.1%.

The run should be comprised primarily (80.9%) of 5_3 fish and the majority (88.5%) of these should be destined for the Kvichak River as part of the peak year return from brood year 1965.

The Bay inshore run is predicted to be 87.3% 2-ocean and 12.7% 3-ocean fish. The high percentage of 2-ocean fish and large numbers in the forecast indicate that overall fish size should be small, probably somewhat on the order of 1965 or about 14-16 fish/case average.

Table 10. Comparison of 1970 Bristol Bay forecast of inshore sockeye run with past years[1/].

Period	Naknek/ Kvichak	Egegik	Ugashik	Nushagak/ Igushik	Togiak	Total
1952-59 Average	7.572	1.527	.901	2.092	.154	12.241
1960-1969 Average	13.240	2.511	.999	2.121	.250	19.399
1970 Forecast	47.149	4.050	1.252	3.089	.272	55.812
Percent Different from 1960-69	+256%	+62%	+25%	+46%	9%	+188%

1/ Fish in millions.

LITERATURE CITED

Dahlberg, M. L. and J. Lechner, 1968. Forecast of the sockeye salmon run to Chignik in 1968. Alaska Department of Fish and Game, Informational Leaflet No. 115.

Foerester, R. E., 1968. The sockeye salmon, Oncorhynchus nerka. Fisheries Research Board of Canada Bulletin 162. 422 p.

French, Robert R. and Richard G. Bakkala, 1970. Revised forecast Bristol Bay inshore run. U.S. Fish and Wildlife Service unpublished memorandum.

McCurdy, M. L. and S. Pennoyer, 1968. Bristol Bay red salmon (Oncorhynchus nerka), 1967, a compilation of the catch and escapement data. Alaska Department of Fish and Game, Informational Leaflet No. 121. 107 p.

McCurdy, M. L., 1969. 1968 Bristol Bay sockeye salmon smolt studies. Alaska Department of Fish and Game, Informational Leaflet No. 138, 95 p.

Noerenberg, Wallace H. and Melvin C. Seibel, Eds. 1969. A summary of preliminary 1970 salmon forecasts for Alaskan fisheries. Alaska Department of Fish and Game, Informational Leaflet No. 136. 52 p.

Ossiander, Frank J., 1967. Bristol Bay red salmon forecast of run for 1967. Alaska Department of Fish and Game, Informational Leaflet No. 105. 51 p.

Ossiander, Frank J., 1968. Bristol Bay red salmon forecast of run for 1968. Alaska Department of Fish and Game, Informational Leaflet No. 123. 11 p.

Rogers, Donald E., 1970. Forecast of the sockeye salmon run to Bristol Bay in 1970 based on purse seine catches of immature sockeye salmon south of Adak. Fisheries Research Institute, University of Washington, Circular No. 70-3, 21 p.

Snedecor, G. W. and W. G. Cochran, 1967. Statistical methods (Sixth Edition). The Iowa State University Press, Ames, Iowa.

APPENDIX A

BRISTOL BAY SOCKEYE FORECAST OF RUN FOR 1969

Attached are tables giving the final forecast of the sockeye run to Bristol Bay in 1969. Table 1 gives the inshore run forecast by system by age class. Table 2 compares the forecast by river system with the desired escapement goals and anticipated harvest.

The inshore run of 21,274,000 was derived by subtracting a predicted Japanese high seas harvest (mature fish in 1969 + immatures in 1968) of 2,399,000 sockeye from the total forecasted run of 23,673,000. This estimated high seas harvest was prorated to the various river systems proportional to their percentage of the total forecast. No allowance was made for Bristol Bay fish taken elsewhere (e.g. South Peninsula fishery).

Several relationships were examined that had not been previously used for the forecast. Some of these show promise and will be utilized in future forecasts.

This brief review will comprise the total 1969 forecast for public distribution - there will be no Informational Leaflet this year. The forecast of the 1970 run will include a section critiqueing the 1969 forecast. Problems with apportionment of the 1968 run by river system, an unfortunate delay in the data processing of the 1968 catch data and consequent delay in the high seas catch apportionment precluded formal publication of the 1969 forecast.

Table A1. 1969 Bristol Bay Sockeye Forecast of Inshore Runs (Millions of Fish).

System		4_2	5_3	6_4	2-ocean Subtotal	4_1	5_2	6_3	7_4	3-ocean Subtotal	Total
Kvichak	#	8.927	3.113	--	12.040	--	.690	.050	--	.740	12.780
	%	69.9	24.3	--	94.2	--	5.4	0.4	--	5.8	
Branch	#	.120	.089	--	.209	--	.152	.055	--	.207	.416
	%	28.7	21.4	--	50.1	--	36.5	13.2	--	49.7	
Naknek	#	.105	1.396	--	1.501	--	.375	.865	--	1.240	2.741
	%	3.8	50.9	--	54.7	--	13.7	31.6	--	45.3	
Naknek-Kvichak	#	9.152	4.598	--	13.750	--	1.217	.970	--	2.187	15.937
	%	57.4	28.9	--	86.3	--	7.6	6.1	--	13.7	
Egegik	#	.034	1.186	0.25	1.245	--	.196	.523	.008	.727	1.972
	%	1.7	60.2	1.3	63.2	--	9.9	26.5	0.4	36.8	
Ugashik	#	.091	.549	--	.640	--	.047	.025	--	.072	.712
	%	12.8	77.1	--	89.9	--	6.6	3.5	--	10.1	
Wood River	#	.928	.096	--	1.024	--	.568	.026	--	.594	1.618
	%	57.4	5.9	--	63.3	--	35.1	1.6	--	36.7	
Igushik	#	.065	.036	--	.101	--	.278	.045	--	.323	.424
	%	15.3	8.5	--	23.8	--	65.6	10.6	--	76.2	
Nuyakuk	#	.066	.039	--	.105	--	.220	.009	--	.229	.334
	%	19.8	11.7	--	31.5	--	65.8	2.7	--	68.5	
Snake	#	.011	.003	--	.014	--	.006	.002	--	.008	.022
	%	50.0	13.6	--	63.6	--	27.3	9.1	--	36.4	

(Continued)

Table A1. 1969 Bristol Bay Sockeye Forecast of Inshore Runs (Millions of Fish)(Continued).

System		4_2	5_3	6_4	2-ocean Subtotal	4_1	5_2	6_3	7_4	3-ocean Subtotal	Total
Nushagak/	#	.004	--	--	.004	.014	.057	--	--	.071	.075
Mulchatna	%	5.3	--	--	5.3	18.7	76.0	--	--	84.7	
Nushagak/Igush.	#	1.074	.174	--	1.248	.014	1.129	.082	--	1.225	2.473
Subtotal	%	43.4	7.0	--	50.4	0.6	45.7	3.3	--	49.6	
Togiak	#	.082	.016	--	.098	--	.064	.018	--	.082	.180
	%	45.5	8.9	--	54.4	--	35.6	10.0	--	45.6	
TOTAL BAY	#	10.433	6.523	.025	16.981	0.14	2.653	1.618	.008	4.293	21.274
	%	49.0	30.7	0.1	79.8	0.1	12.5	7.6	--	20.2	
North	#	.335	.380	.004	.719	--	.383	.126	.002	.511	1.230
Peninsula	%	27.2	31.0	0.3	58.5	--	31.1	10.2	0.2	41.5	
Western	#	10.768	6.903	.029	17.700	0.14	3.036	1.744	.010	4.804	22.504
Alaska	%	47.9	30.7	0.1	78.7	0.1	13.5	7.7	--	21.3	

Table A2. 1969 Bristol Bay Sockeye Forecast and Escapement Goals.

System	Inshore Prediction	Sockeye Escapement Goal	Escapement Mgmt. Range	Inshore Harvest Point Estimate	Inshore Harvest Range
NAKNEK-KVICHAK					
Kvichak R.	12,780,000	6,000,000	5,000 - 7,000,000	6,780,000	7,780 - 5,780,000
Branch R.	416,000	160,000	120 - 200,000	246,000	296 - 216,000
Naknek R.	2,741,000	1,000,000	800 - 1,200,000	1,741,000	1,941 - 1,541,000
Subtotal	15,937,000	7,160,000	5,920 - 8,400,000	8,777,000	10,017 - 7,537,000
EGEGIK	1,972,000	700,000	500 - 900,000	1,272,000	1,472 - 1,072,000
UGASHIK	712,000	400,000	300 - 500,000	312,000	412 - 212,000
NUSHAGAK					
Wood R.	1,618,000	750,000	500 - 1,000,000	868,000	1,118 - 618,000
Igushik R.	424,000	200,000	150 - 250,000	224,000	274 - 224,000
Nuyakuk R.	334,000	150,000	100 - 200,000	184,000	224 - 134,000
Snake R.	22,000	10,000	5 - 15,000	12,000	17 - 7,000
Nush.-Mulch.	75,000	35,000	20 - 50,000	40,000	55 - 15,000
Subtotal	2,473,000	1,145,000	725 - 1,465,000	1,328,000	1,748 - 1,008,000
TOGIAK	180,000	100,000	70 - 130,000	80,000	110 - 50,000
TOTAL BRISTOL BAY	21,274,000	9,505,000	7,515 -11,395,000	11,769,000	13,759 - 9,879,000

APPENDIX B

TABLE B1. Kvichak River sockeye salmon adult returns by age class from brood year escapements, in thousands of fish.

Brood year	Escapement	Adult return 1/										
		4_2	%	5_2	%	$5_2/4_2$	5_3	%	6_3	%	$6_3/5_3$	Total 2/
1951							3,408		1,469		0.431	5,308
1952	5,970	11,162	52	6,259	29	0.561	3,083	14	803	4	0.260	21,307
1953	321	72	12	64	11	0.889	379	64	76	13	0.201	591
1954	241	76	10	32	4	0.421	647	86	0	0	0.000	755
1955	251	244	12	114	5	0.467	661	32	1,061	51	1.605	2,080
1956	9,443	23,509	62	6,716	18	0.286	6,164	16	1,395	4	0.226	37,784
1957	2,843	233	6	257	6	1.103	3,253	80	274	7	0.084	4,017
1958	535	70	24	50	17	0.714	131	45	38	13	0.290	289
1959	680	194	35	137	25	0.706	204	37	16	3	0.078	551
1960	14,630	1,271	2	597	1	0.470	45,606	84	6,545	12	0.144	54,019
1961	3,706	317	9	187	5	0.590	2,278	64	779	22	0.342	3,561
1962	2,581	104	2	150	3	1.442	4,602	85	527	10	0.114	5,383
1963	339	46	4	50	5	1.087	554	54	382	37	0.690	1,032
1964	957	1,896		467		0.246	1,839					
1965	24,326	8,729										

1/ Total return includes estimate of high seas catch.
2/ Total of major age classes (4_2, 5_2, 5_3 and 6_3) only.

TABLE B2. Kvichak River sockeye salmon smolt index catch by age class from brood year escapement with resultant adult return in thousands of fish.

Brood year	Escapement	Age I Index catch	Age I Adult return	Age I Adult/ smolt	Age II Index catch	Age II Adult return	Age II Adult/ smolt	Index catch	Percentage in Index Age I	Percentage in Index Age II
1952	5,970		17,421		242	3,886	16.06			
1953	321	18	136	7.55	47	455	9.68	65	27.7	72.3
1954	241	30	108	3.60	9	647	71.89	39	76.9	23.1
1955	250	22	358	16.27	67	1,722	25.70	89	24.7	75.3
1956	9,443	3,267	30,225	9.25	2,778	7,559	2.72	6,045	54.0	46.0
1957	2,964	86	490	5.70	553	3,527	6.38	639	13.5	86.5
1958	535	61	120	1.97	10	169	16.90	71	85.9	14.1
1959	680	26	331	12.73	72	220	3.06	98	26.5	73.5
1960	14,630	1,131	1,868	1.65	4,116	52,151	12.67	5,247	11.6	78.4
1961	3,706	113	504	4.46	1,603	3,057	1.91	1,716	6.6	93.4
1962	2,581	458	254	0.55	1,748	5,129	2.93	2,206	20.8	79.2
1963	339	64	96	1.50	25	936	37.44	89	71.9	28.1
1964	957	252	2,363	9.38	223			475	53.0	47.0
1965	24,326	2,866			5,475			8,341	34.4	65.6
1966	3,775	648			541			1,189	54.5	45.5
1967	3,216	594								

TABLE B3. Kvichak River sockeye smolt proportions by age class from brood year weighted by differential average survival[1/] to adult.

Brood year	Percentage produced by age class		Percentage weighted by average survival	
	Age I	Age II	Age I	Age II
1953	28	72	20	80
1954	78	22	68	32
1955	25	75	17	83
1956	54	46	43	57
1957	14	86	9	91
1958	86	14	79	21
1959	26	74	19	81
1960	22	78	15	85
1961	7	93	4	96
1962	21	79	14	86
1963	72	28	62	38
1964	54	46	42	58
1965	34	66	25	75
1966	60	40	43	57

1/ Average marine survival for Naknek River smolts (omitting 1956, 1957 and 1959 outmigration data) was used to weight Kvichak index catch age class proportions. These figures are 13.6% for Age I and 21.5% for Age II. This means that, on the average Age II have a 1.58/1 survival advantage over Age I. This ratio was used to weight the proportion of Age I/II applied to the ER return estimate to forecast proportion 1 FW/2 FW adults.

TABLE B4. Branch River sockeye salmon adult returns by age class from brood year escapements in thousands of fish.

Brood year	Escapement	Adult return1/ 4_2	%	5_2	%	$5_2/4_2$	5_3	%	6_3	%	$6_3/5_3$	Total2/
1951							401		115		0.287	
1952		497	50	258	26	0.519	113	11	130	13	1.150	998
1953		3	3	29	32	9.667	58	64	0	0	0.000	90
1954		15	2	120	16	8.000	395	52	235	31	0.595	765
1955	172	766	66	268	23	0.350	29	2	88	8	3.034	1,151
1956	784	1,825	79	442	19	0.242	0	0	41	2	-----	2,308
1957	127	5	6	24	28	4.800	42	49	14	16	0.333	85
1958	95	39	23	27	16	0.692	26	15	76	45	2.923	168
1959	825	277	34	312	38	1.126	121	15	113	14	0.934	823
1960	1,241	101	22	196	43	1.941	132	29	31	7	0.235	460
1961	90	84	31	182	67	2.167	7	3	0	0	0.000	273
1962	91	128	52	90	37	0.703	3	1	24	10	8.000	245
1963	203	188	52	130	36	0.691	30	8	13	4	0.433	361
1964	249	87		219		2.517	296					
1965	175	249										

1/ Total return includes estimate of high seas catch.
2/ Total of major age classes (4_2, 5_2, 5_3 and 6_3) only.

TABLE B5. Naknek River sockeye salmon adult returns by age class from brood year escapements, in thousands of fish.

Brood year	Escapement	Adult return1/										
		4_2	%	5_2	%	$5_2/4_2$	5_3	%	6_3	%	$6_3/5_3$	Total2/
1951	359			1,624			921		1,792		1.946	
1952	103	118	8	1,077	71	9.127	108	7	216	14	2.000	1,519
1953	282	18	3	140	23	7.778	185	31	259	43	1.400	602
1954	799	79	2	331	9	4.190	2,145	61	975	28	0.455	3,530
1955	278	701	34	927	45	1.322	240	12	175	9	0.729	2,043
1956	1,773	458	19	1,631	68	3.561	3	0	324	13	108.000	2,415
1957	635	50	3	346	22	6.920	493	31	712	44	1.444	1,601
1958	278	103	9	220	20	2.136	523	48	248	23	0.474	1,094
1959	2,232	320	13	414	16	1.294	736	29	1,048	42	1.424	2,518
1960	828	1,362	34	663	16	0.487	679	17	1,290	32	1.900	3,994
1961	351	227	11	733	36	3.229	313	16	733	36	2.345	2,006
1962	723	75	6	227	19	3.027	346	29	537	46	1.552	1,185
1963	905	129	6	410	20	3.178	798	39	728	35	.912	2,065
1964	1,350	445		296		.665	1,346					
1965	718	654										

1/ Total return includes estimate of high seas catch.
2/ Total of major age classes (4_2, 5_2 and 5_3) only.

TABLE B6. Naknek River sockeye salmon smolt production, adult return, and marine survival by brood year. Fish in thousands.

Brood year	Escapement	Age I Smolt Outmig. est.	Age I Smolt Average length (m.m.)	Age I Smolt Adult return	Age I Smolt Marine survival %	Age II Smolt Outmig. est.	Age II Smolt Average length (m.m.)	Age II Smolt Adult return	Age II Smolt Marine survival %	Total outmig. est.
1954	799					1,280	112	3,120	243.8	
1955	278	1,760	111	1,628	92.5	362	114	415	114.6	2,122
1956	1,773	9,698	91	2,089	21.5	2,431	106	327	13.4	12,129
1957	635	10,035	97	396	3.9	3,118	109	1,205	38.6	13,153
1958	278	3,553	99	323	9.1	1,246	113	771	61.9	4,799
1959	2,232	4,367	103	734	16.8	8,462	112	1,784	21.1	12,829
1960	828	8,001	105	2,025	25.3	8,717	114	1,969	22.6	16,718
1961	351	6,050	98	960	15.9	4,973	110	1,046	21.0	11,023
1962	723	2,248	97	302	13.4	9,879	114	883	8.9	12,127
1963	905	14,741	99	539	3.7	6,098	118	1,526	25.0	20,839
1964	1,350	3,115	106	741	23.8	5,285	119			8,400
1965	718	4,097	113			10,544	108			14,641
1966	1,016	7,662	99			4,490	112			12,152
1967	756	7,056	100							

TABLE B7. Naknek River sockeye smolt proportions by age class from brood year weighted by differential average survival[1/] to adult.

Brood year	Percentage produced by age class		Percentage weighted by average survival	
	Age I	Age II	Age I	Age II
1955	83	17	75	25
1956	80	20	72	28
1957	76	24	67	33
1958	74	26	64	36
1959	34	66	25	75
1960	48	52	37	63
1961	55	45	44	56
1962	19	81	13	87
1963	71	29	60	40
1964	37	63	27	73
1965	28	72	20	80
1966	63	37	52	48

1/ Average marine survival was computed omitting the 1957, 1958 and 1961 outmigration data (App. Table B6). The data obtained during these years resulted in unbelievably high survival to adult for Age I or Age II or both. Average marine survival for Age I is 13.6% and Age II 21.5%. This means that on the average the Age II have a 1.58/1 survival advantage over Age I. This ratio was used to weight the proportion of Age I/II applied to the ER return estimate to forecast proportion of 1 FW/2 FW adults.

TABLE B8. Egegik River sockeye salmon adult returns by age class from brood year escapements, in thousands of fish.

Brood year	Escapement	Adult return 1/																
		4_2	%	5_2	%	$5_2/4_2$	5_3	%	6_3	%	$6_3/5_3$	Total 2/	6_4 3/	%	7_4	%	$7_4/6_4$	Total return
1951							1,138		1,869		1.642		102		33		0.324	
1952	757	635	37	405	24	0.638	244	14	363	21	1.488	1,647	40	2	35	2	0.875	1,722
1953	519	20	1	40	3	2.000	452	32	425	30	0.940	937	323	23	160	11	0.495	1,420
1954	507	10	-	14	1	1.400	1,199	48	1,064	42	0.887	2,287	126	5	90	4	0.714	2,503
1955	271	20	1	184	10	9.200	755	42	792	44	1.049	1,751	9	1	29	2	3.222	1,789
1956	1,104	1,961	29	3,075	46	1.568	881	13	730	11	0.829	6,647	26	-	72	1	2.769	6,745
1957	391	36	2	46	2	1.278	1,070	46	980	42	0.916	2,131	80	3	109	5	1.363	2,321
1958	246	39	3	77	5	1.974	794	56	453	32	0.571	1,363	31	2	29	2	0.935	1,423
1959	1,072	67	3	193	9	2.881	1,029	49	695	33	0.675	1,984	89	4	47	2	0.528	2,120
1960	1,799	433	6	348	4	0.804	4,339	55	2,584	33	0.596	7,704	49	1	75	1	1.592	7,828
1961	702	78	5	226	13	2.897	443	26	906	52	2.077	1,653	44	3	14	1	0.230	1,711
1962	1,027	22	1	68	4	3.091	935	60	495	31	0.529	1,520	24	2	40	2	0.792	1,584
1963	998	15	1	114	9	7.600	494	41	594	49	1.202	1,218	61					
1964	850	110		61		0.555	1,419											
1965	1,445	85																

1/ Adult return includes estimate of high seas catch by Japanese.

2/ Total return of 4_2, 5_2, 5_3 and 6_3 only. Percentages for these age classes are computed using this return.

3/ Percentages of 64 and 74 computed using return of all age classes.

TABLE B9. Ugashik River sockeye salmon adult returns by age class from brood year escapements in thousands of fish.

Brood year	Escapement	Adult return[1/]										
		4_2	%	5_2	%	$5_2/4_2$	5_3	%	6_3	%	$6_3/5_3$	Total[2/]
1951	206			52			194		170		0.876	
1952	651	518	44	355	30	0.685	211	18	96	8	0.455	1,180
1953	1,056	166	15	258	23	1.554	437	38	273	24	0.625	1,134
1954	459	23	4	31	6	1.348	398	72	101	18	0.254	553
1955	77	16	8	37	19	2.312	132	67	13	6	0.098	198
1956	425	3,056	77	807	20	0.264	76	2	37	1	0.487	3,976
1957	215	34	6	110	18	3.235	345	58	106	18	0.307	595
1958	280	58	8	110	16	1.897	431	63	97	14	0.225	696
1959	219	16	3	44	8	2.750	307	54	196	35	0.638	563
1960	2,304	652	22	313	10	0.480	1,525	51	491	16	0.322	2,981
1961	349	228	21	492	45	2.158	245	22	137	12	0.559	1,102
1962	255	77	18	128	30	1.662	182	43	36	9	0.198	423
1963	388	13	9	21	15	1.615	84	59	25	17	0.298	143
1964	473	27		14		0.519	233					
1965	997	80										

1/ Adult return includes estimate of high seas catch by Japanese.
2/ Total of major age classes (4_2, 5_2, 5_3, 6_3) only.

TABLE B10. Ugashik River sockeye salmon smolt production, adult return and marine survival by brood year. Fish in thousands.

Brood year	Escapement	Age I Smolt				Age II Smolt				Total outmig. est.
		Outmig. est.	Average length (m.m.)	Adult return	Marine survival %	Outmig. est.	Average length (m.m.)	Adult return	Marine survival%	
1955	77			53		200	112.0	145	72.5	
1956	425	11,400	93.0	3,863	33.9	400	120.0	113	28.2	11,800
1957	215	2,500	90.0	144	5.8	2,200	108.0	451	20.5	4,700
1958	280	3,300	90.0	168	5.1	3,000	112.0	528	17.6	6,300
1959	219	800	90.0	60	7.5	3,200	112.0	503	15.7	4,000
1960	2,304	13,500	88.0	965	7.1	18,100	104.3	2,016	11.1	31,600
1961	349	15,600	89.8	720	4.6	2,000	118.3	382	19.2	17,600
1962	255	8,000	92.2	205	2.6	2,600	114.1	218	8.4	10,600
1963	388	1,000	93.7	33	3.4			109		
1964	473			41		2,400	113.1			
1965	997	2,700	87.5			2,900	112.6			5,600
1966	704	39,300	92.8				121.2			
1967		3,800	97.4			2,700				

TABLE B11. Ugashik River sockeye smolt proportions by age class from brood year weighted by differential average survival[1/] to adult.

Brood year	Percentage produced by age class		Percentage weighted by average survival	
	Age I	Age II	Age I	Age II
1956	97	3	90	10
1957	53	47	26	74
1958	52	48	25	75
1959	20	80	7	93
1960	43	57	18	82
1961	89	11	70	30
1962	75	25	48	52
1963	Smolt program not conducted in 1966, thereby losing two years proportion data.			
1964				
1965	48	52	22	78
1966	94	6	82	18

1/ Average marine survival (omitting 1958 outmigration data) of Age I in Ugashik is 5.2% and of Age II, 17.2%. This means on the average Age II have a 3.3/1 survival advantage over Age I. This ratio was used to weight the proportion of Age I/II applied to the ER return estimate to forecast proportion of 1 FW/2 FW adults.

TABLE B12. Wood River sockeye salmon adult returns by age class from brood year escapements in thousands of fish.

Brood year	Escapement	Adult return1/ 4_2	%	5_2	%	$5_2/4_2$	5_3	%	6_3	%	$6_3/5_3$	Total2/
1951	458			509			324		77		0.238	
1952	227	704	55	508	40	0.722	30	2	41	3	1.367	1,283
1953	516	232	30	344	45	1.483	145	19	43	6	0.297	764
1954	571	1,163	46	153	6	0.132	1,093	43	110	4	0.101	2,519
1955	1,383	2,341	58	938	23	0.401	447	11	285	7	0.638	4,011
1956	773	747	54	603	44	0.807	22	2	0	0	0.000	1,372
1957	289	131	30	270	62	2.061	34	8	0	0	0.000	435
1958	960	1,967	79	405	16	0.206	73	3	48	2	0.658	2,493
1959	2,209	897	50	468	26	0.522	358	20	82	4	0.229	1,805
1960	1,016	1,422	52	1,089	40	0.766	105	4	99	4	0.943	2,715
1961	461	242	17	1,111	79	4.591	22	2	33	2	1.500	1,408
1962	874	973	63	401	26	0.412	118	8	45	3	0.381	1,537
1963	721	573	48	527	44	0.920	57	5	46	4	0.807	1,203
1964	1,076	341		330		0.968	321					
1965	675	500										

1/ Includes Japanese high seas catch estimate.

2/ Total of major age classes (4_2, 5_2, 5_3 and 6_3) only.

TABLE B13 Igushik River sockeye salmon adult returns by age class from brood year escapements in thousands of fish.

Brood year	Escapement	Adult return[1]										
		4_2	%	5_2	%	$5_2/4_2$	5_3	%	6_3	%	$6_3/5_3$	Total[2]
1951	40						69		42		0.609	
1952	150	150	32	276	60	1.840	10	2	25	5	2.500	461
1953	100	76	20	207	56	2.724	6	2	82	22	13.667	371
1954	80	46	6	295	40	6.413	206	28	187	25	0.908	734
1955	500	441	27	879	54	1.993	126	8	187	11	1.484	1,633
1956	400	163	23	503	70	3.086	12	2	36	5	3.000	714
1957	130	2	3	29	42	14.500	17	25	21	30	1.235	69
1958	107	7	5	74	53	10.571	19	14	40	28	2.105	140
1959	644	93	23	183	46	1.968	91	23	33	8	0.363	400
1960	495	59	12	325	66	5.508	41	8	63	13	1.537	488
1961	294	31	7	385	86	12.419	21	4	8	2	0.381	445
1962	16	28	14	144	74	5.143	5	3	18	9	3.600	195
1963	92	167	39	208	48	1.246	40	9	19	4	0.475	434
1964	129	167		414		2.479	102					
1965	181	287										
1966	206											

1/ Total return includes estimate of high seas catch.
2/ Total of major age classes (4_2, 5_2, 5_3 and 6_3) only.

TABLE B14. Nuyakuk River sockeye salmon adult returns by age class from brood year escapements in thousands of fish.

Brood year	Escapement	Adult return[1/]										
		4_2	%	5_2	%	$5_2/4_2$	5_3	%	6_3	%	$6_3/5_3$	Total[2/]
1951	39			62			3		21		7.000	
1952	38	6	3	136	68	22.677	5	2	53	26	10.600	200
1953	189	43	9	442	90	10.279	6	1	1	0	0.167	492
1954	29	50	64	4	5	0.080	24	31	0	0	0.000	78
1955	16	51	70	11	15	0.216	11	15	0	0	0.000	73
1956	30	210	57	156	43	0.743	0	0	0	0	0.000	366
1957	67	4	22	12	66	3.000	1	6	1	6	1.000	18
1958	196	85	19	321	71	3.776	30	7	17	4	0.567	453
1959	49	10	11	68	72	6.800	3	3	13	14	4.333	94
1960	146	145	25	396	69	2.731	21	4	11	2	0.524	573
1961	80	35	10	296	89	8.457	3	1	1	0	0.167	335
1962	38	18	26	44	63	2.444	0	0	8	11	-	70
1963	167	4	1	386	95	96.500	8	2	10	2	1.250	408
1964	103	35		72		2.057	20					
1965	203	103										

1/ Includes estimates of high seas catch.
2/ Total of major age classes (4_2, 5_2, 5_3 and 6_3) only.

TABLE B15. Togiak River sockeye salmon adult returns by age class from brood year escapements in thousands of fish.

Brood year	Escapement[2/]	Adult return[1/]										
		4_2	%	5_2	%	$5_2/4_2$	5_3	%	6_3	%	$6_3/5_3$	Total
1951	51			110			59		8		0.136	
1952	102	156	69	54	24	0.346	8	4	7	3	0.875	225
1953	102	27	18	87	60	3.222	9	6	23	16	2.556	146
1954	57	19	8	176	74	9.263	13	5	31	13	2.385	239
1955	104	146	35	236	57	1.610	11	3	20	5	1.818	413
1956	225	121	25	356	73	2.942	9	2	1	0	0.111	487
1957	25	43	26	86	51	2.000	1	1	37	22	37.000	167
1958	72	92	31	115	38	1.250	55	18	37	12	0.673	299
1959	179	123	41	109	36	0.886	55	18	11	4	0.200	298
1960	163	182	32	309	54	1.698	23	4	56	10	2.435	570
1961	95	88	24	234	64	2.659	16	4	29	8	1.333	367
1962	47	52	26	128	65	2.462	6	3	12	6	2.000	198
1963	102	48	28	75	45	1.562	19	11	27	16	1.421	169
1964	96	42		63		1.500	41				0.427	
1965	88	143										

1/ Includes Japanese High seas catch estimate.

2/ Kulukak and tributaries not included.

APPENDIX C

Spawner-Recruit Curves

THE FOLLOWING GRAPH IS A PLOT OF RETURN VERSUS ESCAPEMENT FOR 1970 KVICHAK RIVER RED SALMON FORECAST PEAK YEARS ONLY

SYMBOL A REPRESENTS THE ACTUAL OBSERVATIONS
O REPRESENTS AN OBSERVATION OMITTED AS AN OUTLIER
* REPRESENTS THE FITTED CURVE
(INTEGER) REPRESENTS A MULTIPLE POINT PLOT
$ INDICATES ESCAPEMENTS FOR WHICH CONSEQUENT RETURNS WILL BE CONTRIBUTING TO THE FORECAST
NOTE-BROOD YEAR INDICATED NEXT TO PLOTTED POINT

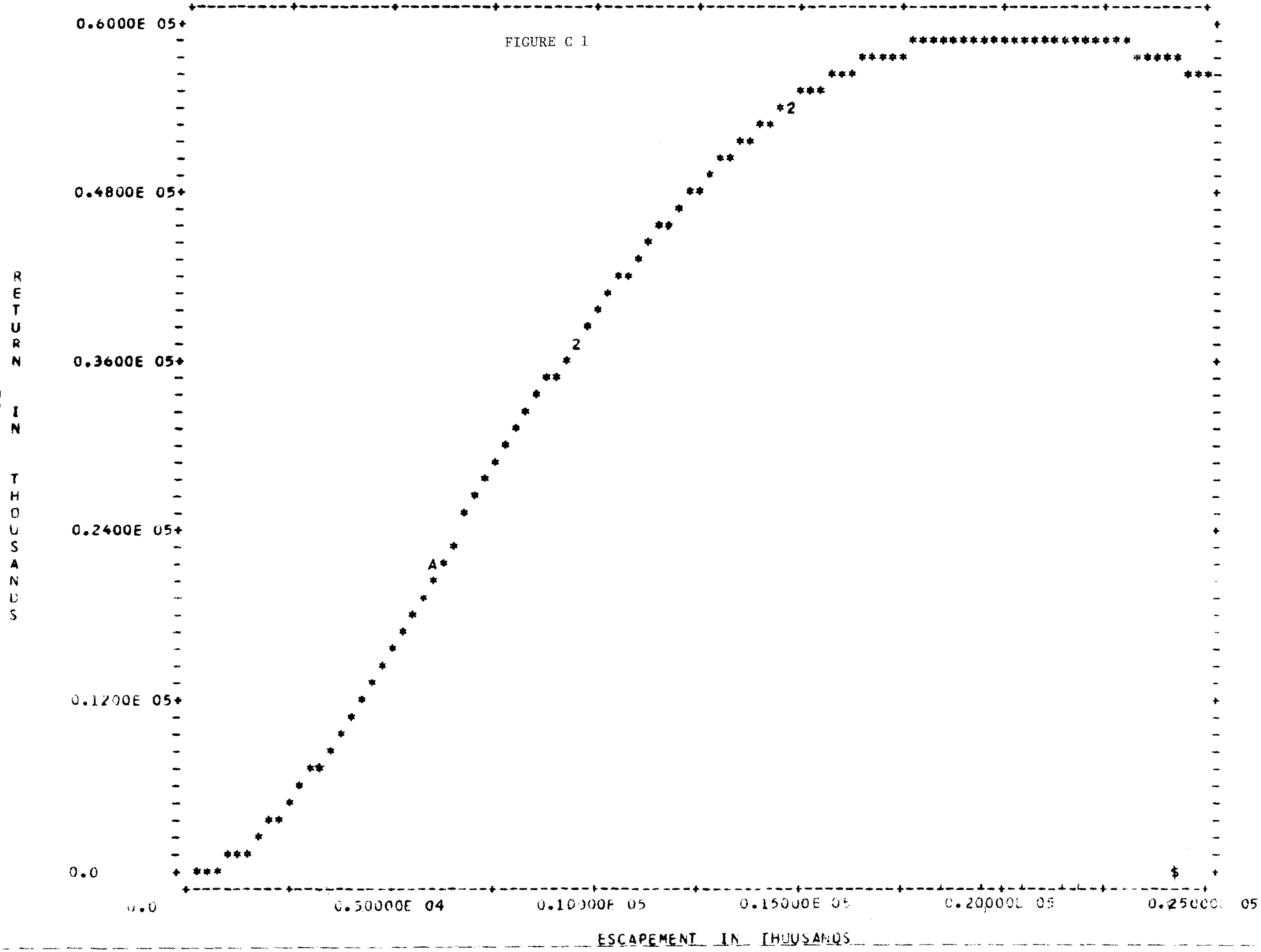
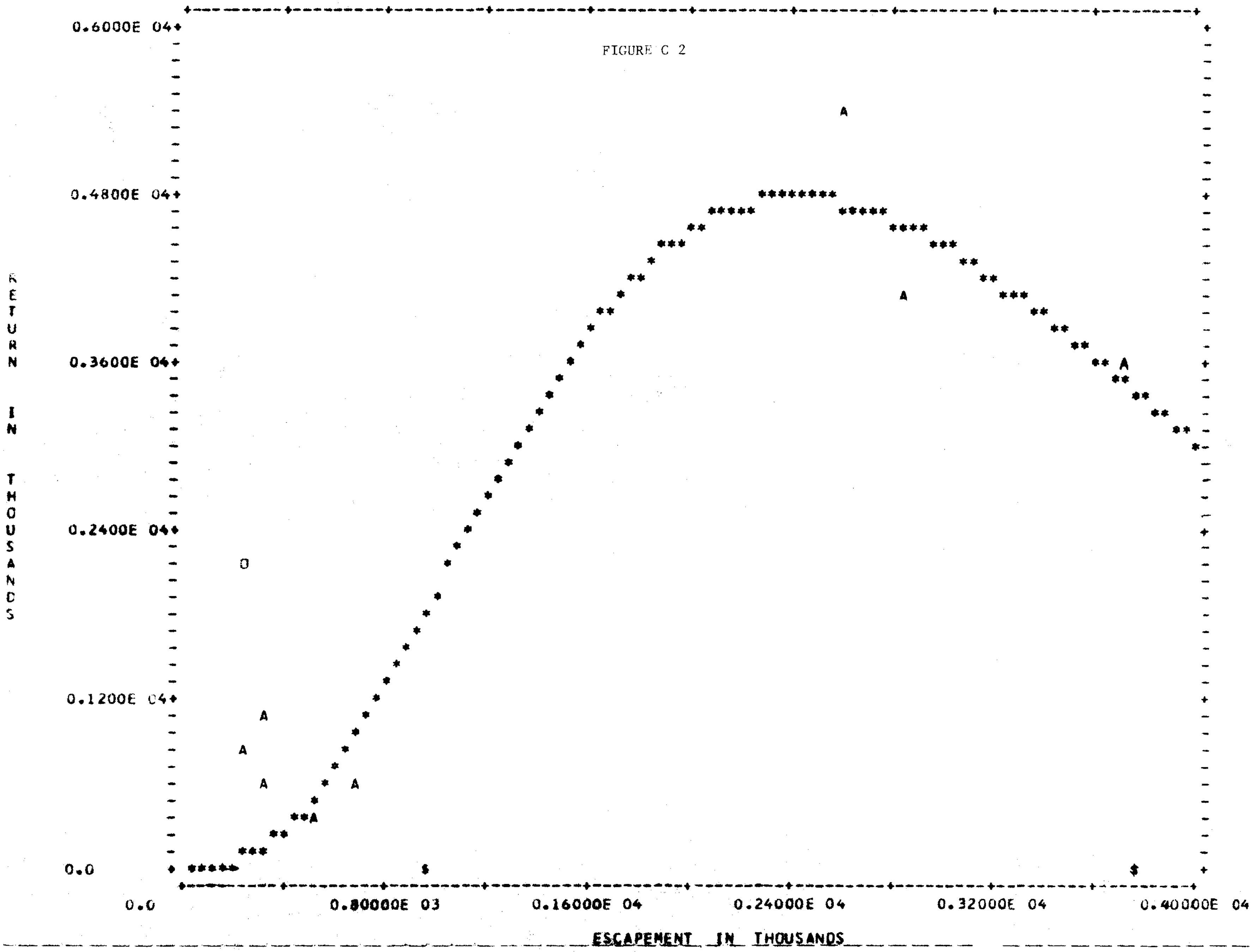


FIGURE C 1

THE FOLLOWING GRAPH IS A PLOT OF RETURN VERSUS ESCAPEMENT FOR 1970 KVICHAK RIVER RED SALMON FORECAST NON-PEAK YEARS ONLY

SYMBOL A REPRESENTS THE ACTUAL OBSERVATIONS
O REPRESENTS AN OBSERVATION OMITTED AS AN OUTLIER
* REPRESENTS THE FITTED CURVE
(INTEGER) REPRESENTS A MULTIPLE POINT PLOT
$ INDICATES ESCAPEMENTS FOR WHICH CONSEQUENT RETURNS WILL BE CONTRIBUTING TO THE FORECAST
NOTE-BROOD YEAR INDICATED NEXT TO PLOTTED POINT



THE FOLLOWING GRAPH IS A PLOT OF RETURN VERSUS ESCAPEMENT FOR 1970 BRANCH RIVER RED SALMON FORECAST
SYMBOL A REPRESENTS THE ACTUAL OBSERVATIONS
O REPRESENTS AN OBSERVATION OMITTED AS AN OUTLIER
* REPRESENTS THE FITTED CURVE
(INTEGER) REPRESENTS A MULTIPLE POINT PLOT
$ INDICATES ESCAPEMENTS FOR WHICH CONSEQUENT RETURNS WILL BE CONTRIBUTING TO THE FORECAST
NOTE-BROOD YEAR INDICATED NEXT TO PLOTTED POINT

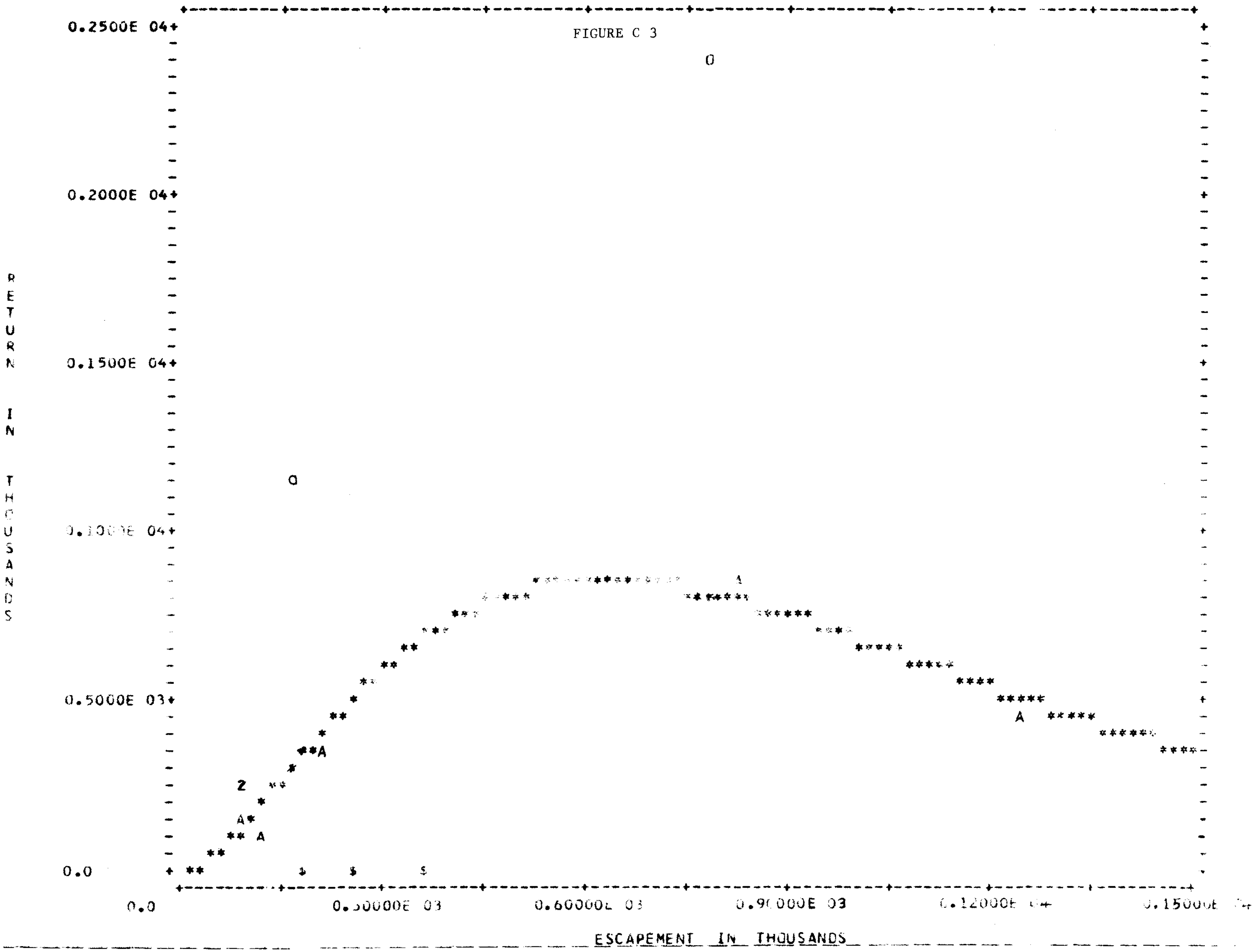
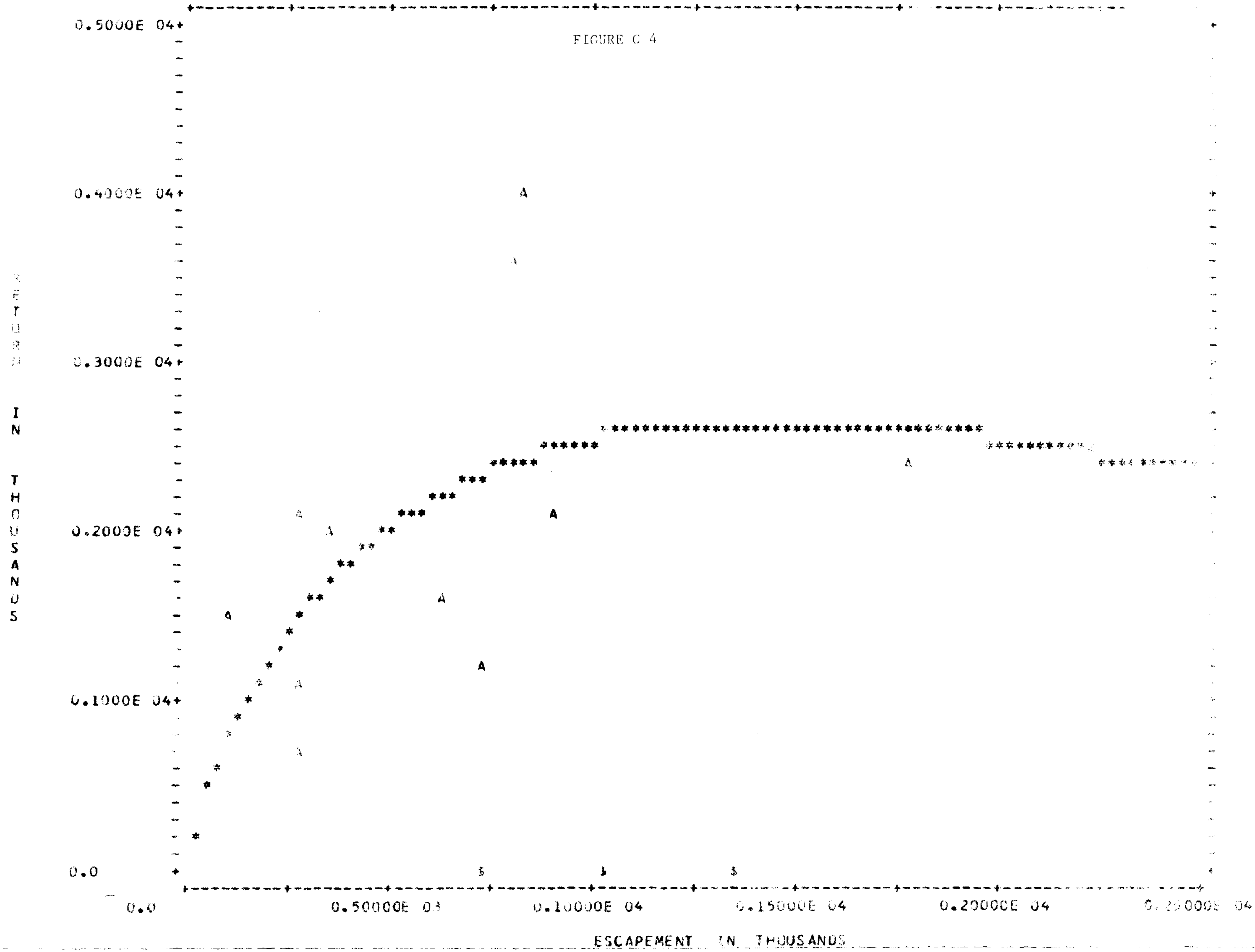


FIGURE C 3

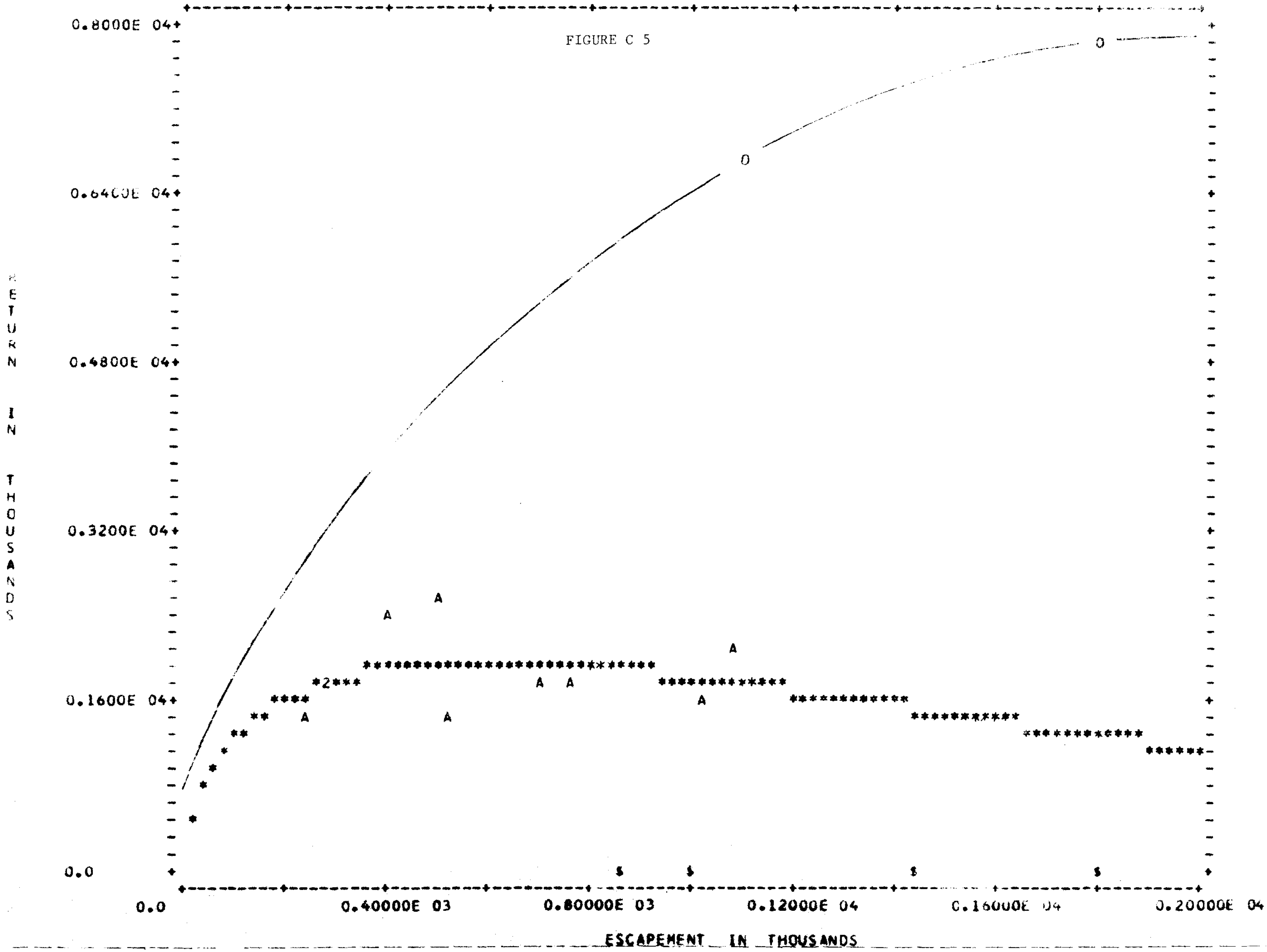
THE FOLLOWING GRAPH IS A PLOT OF RETURN VERSUS ESCAPEMENT FOR 1970 NAKNEK RIVER RED SALMON FORECAST
SYMBOL A REPRESENTS THE ACTUAL OBSERVATIONS
O REPRESENTS AN OBSERVATION OMITTED AS AN OUTLIER
* REPRESENTS THE FITTED CURVE
(INTEGER) REPRESENTS A MULTIPLE POINT PLOT
$ INDICATES ESCAPEMENTS FOR WHICH CONSEQUENT RETURNS WILL BE CONTRIBUTING TO THE FORECAST
NOTE-BROOD YEAR INDICATED NEXT TO PLOTTED POINT

FIGURE C 4



THE FOLLOWING GRAPH IS A PLOT OF RETURN VERSUS ESCAPEMENT FOR 1970 EGEGIK RIVER RED SALMON FORECAST
SYMBOL A REPRESENTS THE ACTUAL OBSERVATIONS
O REPRESENTS AN OBSERVATION OMITTED AS AN OUTLIER
* REPRESENTS THE FITTED CURVE
(INTEGER) REPRESENTS A MULTIPLE POINT PLOT
$ INDICATES ESCAPEMENTS FOR WHICH CONSEQUENT RETURNS WILL BE CONTRIBUTING TO THE FORECAST
NOTE-BROOD YEAR INDICATED NEXT TO PLOTTED POINT

FIGURE C 5



THE FOLLOWING GRAPH IS A PLOT OF RETURN VERSUS ESCAPEMENT FOR 1970 UGASHIK RIVER RED SALMON FORECAST
SYMBOL A REPRESENTS THE ACTUAL OBSERVATIONS
O REPRESENTS AN OBSERVATION OMITTED AS AN OUTLIER
* REPRESENTS THE FITTED CURVE
(INTEGER) REPRESENTS A MULTIPLE POINT PLOT
$ INDICATES ESCAPEMENTS FOR WHICH CONSEQUENT RETURNS WILL BE CONTRIBUTING TO THE FORECAST
NOTE-BROOD YEAR INDICATED NEXT TO PLOTTED POINT

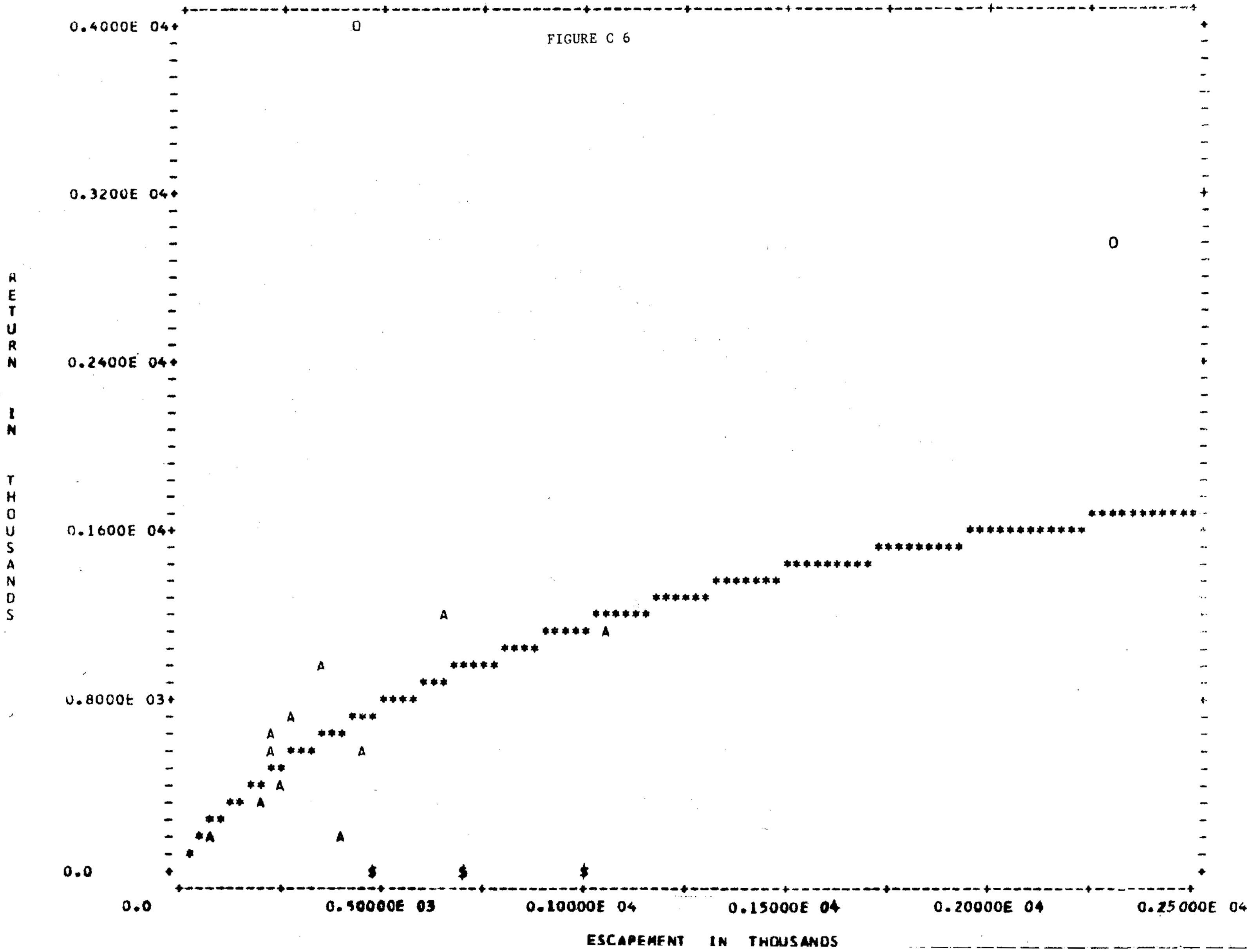
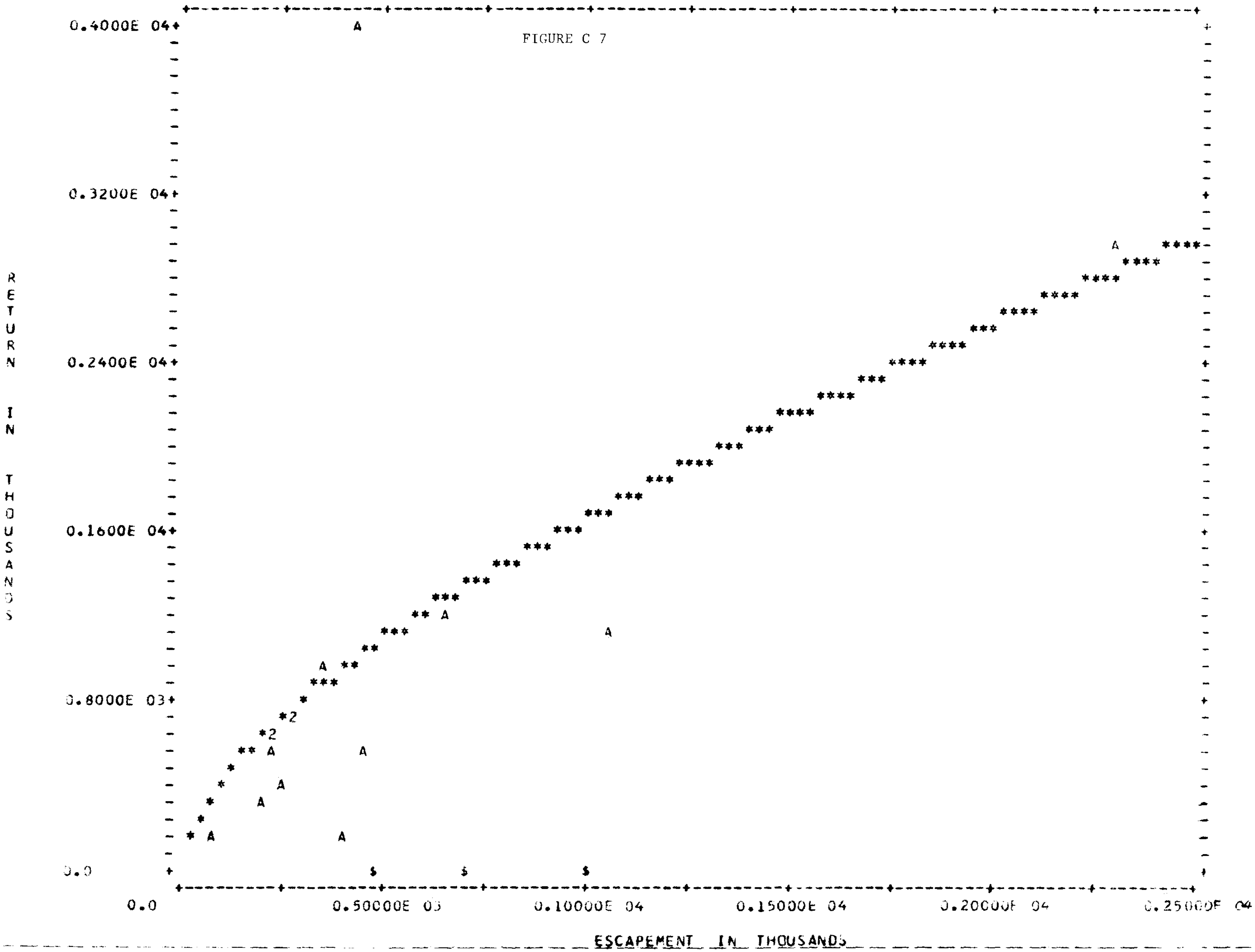


FIGURE C 6

THE FOLLOWING GRAPH IS A PLOT OF RETURN VERSUS ESCAPEMENT FOR 1970 UGASHIK RIVER RED SALMON FORECAST
SYMBOL A REPRESENTS THE ACTUAL OBSERVATIONS
O REPRESENTS AN OBSERVATION OMITTED AS AN OUTLIER
* REPRESENTS THE FITTED CURVE
(INTEGER) REPRESENTS A MULTIPLE POINT PLOT
$ INDICATES ESCAPEMENTS FOR WHICH CONSEQUENT RETURNS WILL BE CONTRIBUTING TO THE FORECAST
NOTE-BROOD YEAR INDICATED NEXT TO PLOTTED POINT

FIGURE C 7



THE FOLLOWING GRAPH IS A PLOT OF RETURN VERSUS ESCAPEMENT FOR 1970 WOOD RIVER RED SALMON FORECAST
SYMBOL A REPRESENTS THE ACTUAL OBSERVATIONS
O REPRESENTS AN OBSERVATION OMITTED AS AN OUTLIER
* REPRESENTS THE FITTED CURVE
(INTEGER) REPRESENTS A MULTIPLE POINT PLOT
$ INDICATES ESCAPEMENTS FOR WHICH CONSEQUENT RETURNS WILL BE CONTRIBUTING TO THE FORECAST
NOTE-BROOD YEAR INDICATED NEXT TO PLOTTED POINT

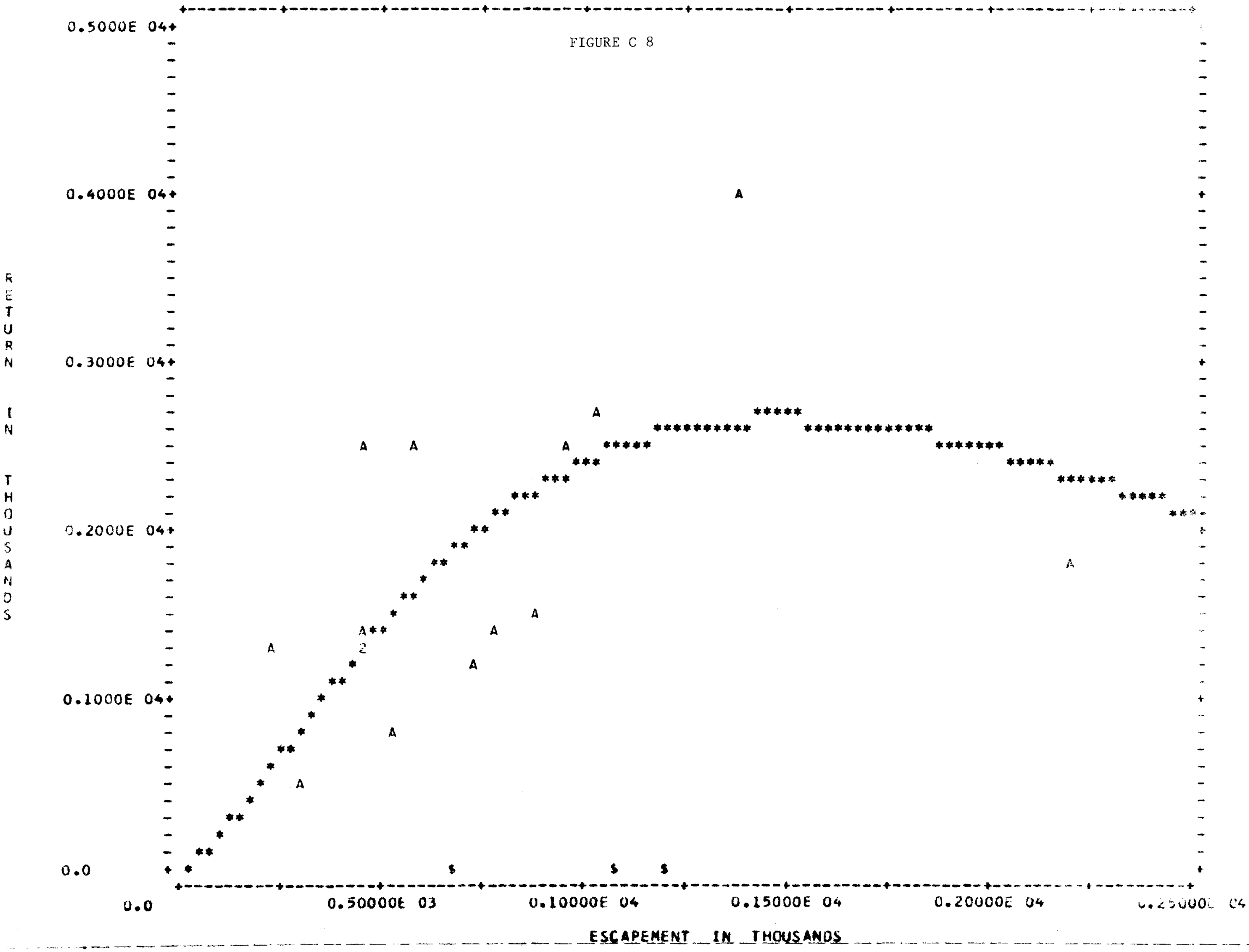


FIGURE C 8

THE FOLLOWING GRAPH IS A PLOT OF RETURN VERSUS ESCAPEMENT FOR 1970 IGUSHIK RIVER RED SALMON FORECAST
SYMBOL A REPRESENTS THE ACTUAL OBSERVATIONS
O REPRESENTS AN OBSERVATION OMITTED AS AN OUTLIER
* REPRESENTS THE FITTED CURVE
(INTEGER) REPRESENTS A MULTIPLE POINT PLOT
$ INDICATES ESCAPEMENTS FOR WHICH CONSEQUENT RETURNS WILL BE CONTRIBUTING TO THE FORECAST
NOTE-BROOD YEAR INDICATED NEXT TO PLOTTED POINT

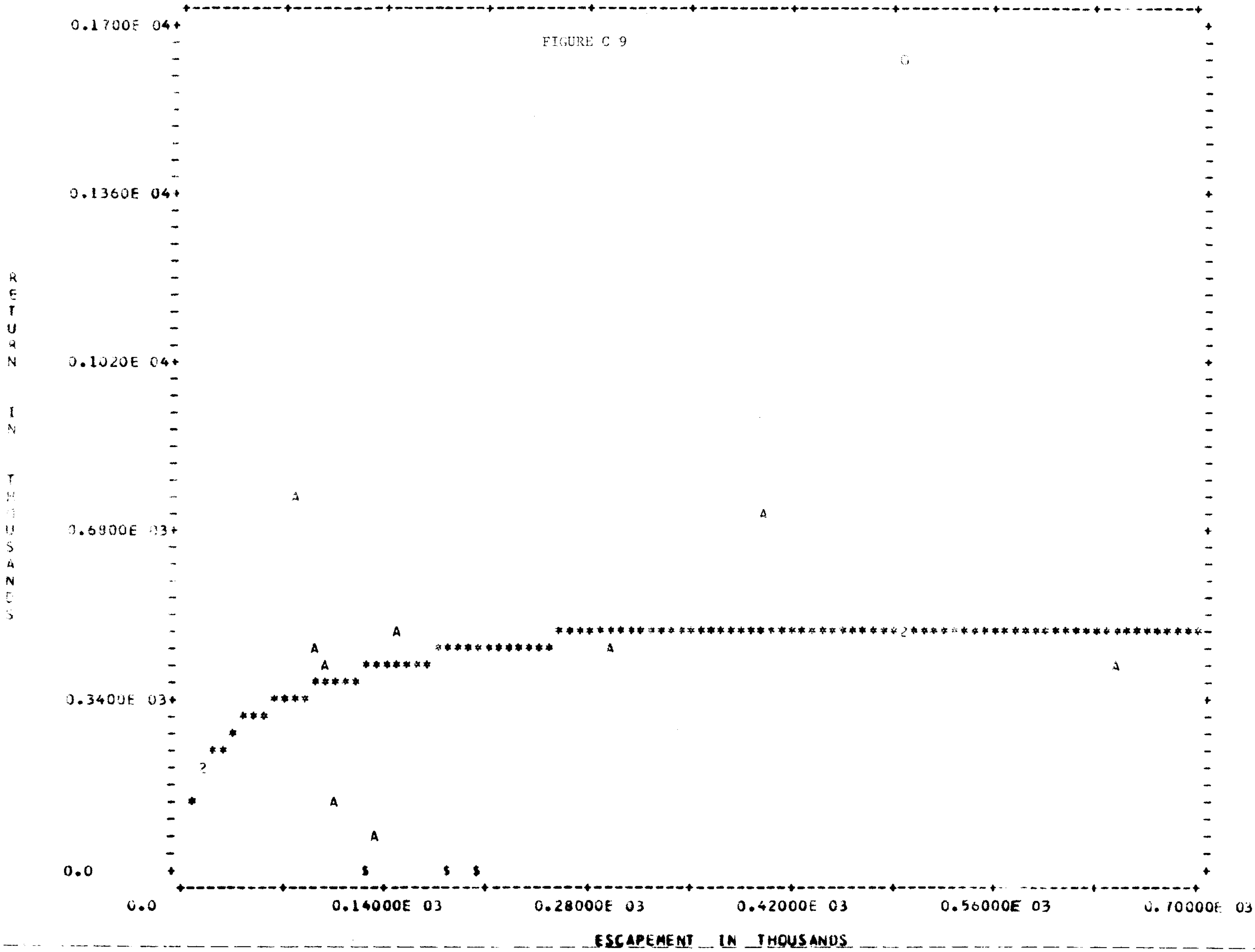
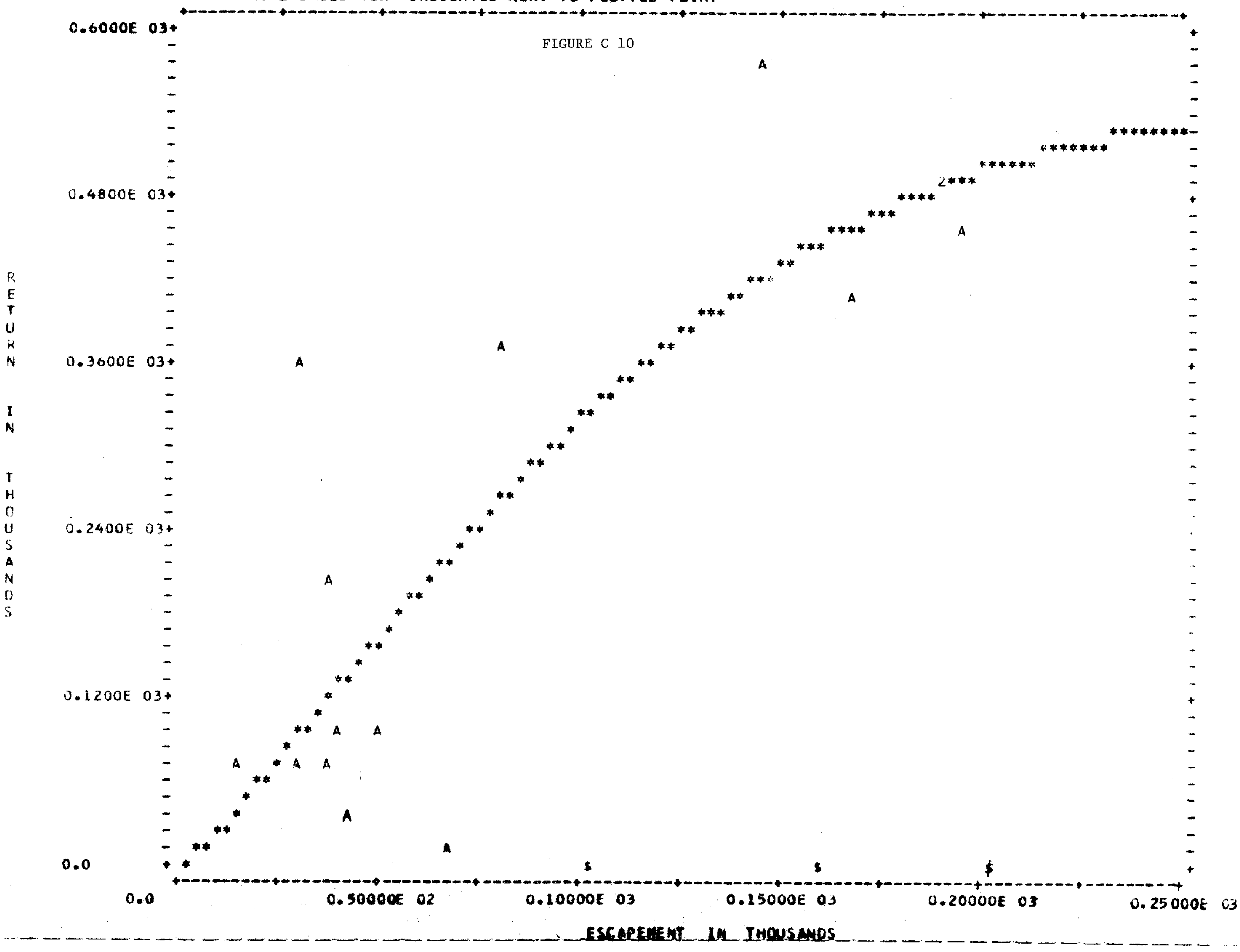


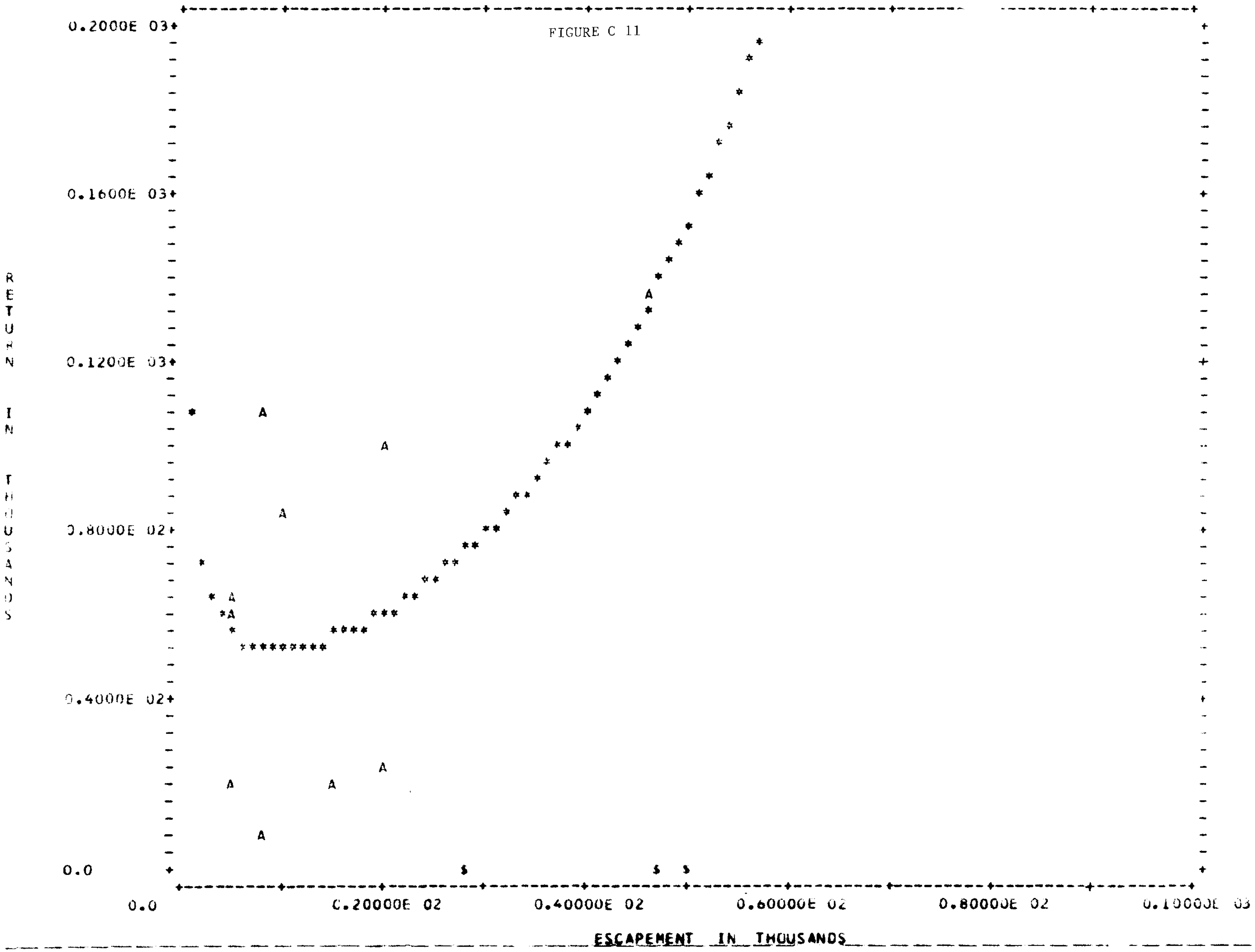
FIGURE C 9

THE FOLLOWING GRAPH IS A PLOT OF RETURN VERSUS ESCAPEMENT FOR 1970 NUYAKUK RIVER RED SALMON FORECAST
SYMBOL A REPRESENTS THE ACTUAL OBSERVATIONS
O REPRESENTS AN OBSERVATION OMITTED AS AN OUTLIER
* REPRESENTS THE FITTED CURVE
(INTEGER) REPRESENTS A MULTIPLE POINT PLOT
$ INDICATES ESCAPEMENTS FOR WHICH CONSEQUENT RETURNS WILL BE CONTRIBUTING TO THE FORECAST
NOTE-BROOD YEAR INDICATED NEXT TO PLOTTED POINT

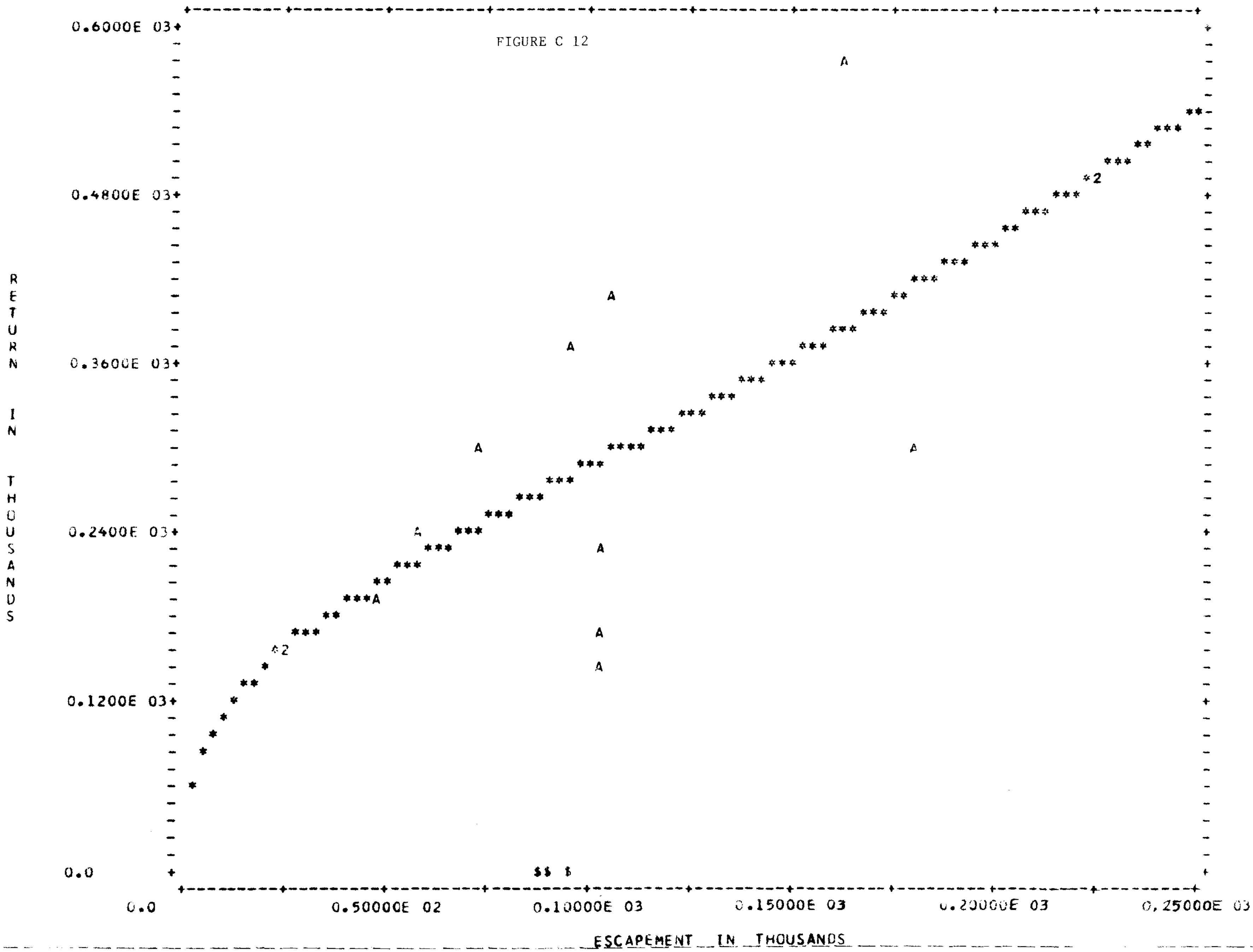


THE FOLLOWING GRAPH IS A PLOT OF RETURN VERSUS ESCAPEMENT FOR 1970 NUSH-MULCH SYSTEM RED SALMON FORECAST
SYMBOL A REPRESENTS THE ACTUAL OBSERVATIONS
O REPRESENTS AN OBSERVATION OMITTED AS AN OUTLIER
* REPRESENTS THE FITTED CURVE
(INTEGER) REPRESENTS A MULTIPLE POINT PLOT
$ INDICATES ESCAPEMENTS FOR WHICH CONSEQUENT RETURNS WILL BE CONTRIBUTING TO THE FORECAST
NOTE-BROOD YEAR INDICATED NEXT TO PLOTTED POINT

FIGURE C 11



THE FOLLOWING GRAPH IS A PLOT OF RETURN VERSUS ESCAPEMENT FOR 1970 TOGIAK RIVER RED SALMON FORECAST
SYMBOL A REPRESENTS THE ACTUAL OBSERVATIONS
O REPRESENTS AN OBSERVATION OMITTED AS AN OUTLIER
* REPRESENTS THE FITTED CURVE
(INTEGER) REPRESENTS A MULTIPLE POINT PLOT
$ INDICATES ESCAPEMENTS FOR WHICH CONSEQUENT RETURNS WILL BE CONTRIBUTING TO THE FORECAST
NOTE-BROOD YEAR INDICATED NEXT TO PLOTTED POINT



APPENDIX D

Forecast by System[1/]

Kvichak River

The ER relationships described earlier yield a return for contributing brood years of:

Fish in millions

Brood year	Escapement	Estimated return	Return to date
1964	.957	1.881	4.202
1965	24.326	56.946	8.729
1966	3.775	3.339	0

Due to the great difference in magnitude between peak and "off" (non-peak) year escapements and production and the probability that different factors affect survival in various years in the cycle, data for peak and off years was analyzed separately (Appendix Figures C1 and C2). Appendix Table B1 gives brood year escapement and return by age class.

Smolt production data is available for the Kvichak in the form of an annual index of abundance by age class (Appendix Table B2). As explained in the introduction this index may be used either to divide the escapement-return estimate of total return into one and two freshwater fish (see diagram, Figure 3) or to obtain an estimate of adult return by examination of ratios of past indices to adult return.

Since the Kvichak smolt data is in the form of an index, absolute estimates of marine survival are not available. In the past the actual proportion of Age I to Age II smolt index catch from a brood year has been used to divide the total return estimate into these two primary age groups. However, for both the Naknek and Ugashik systems the survival of Age II smolt has been shown to be significantly higher than that of the smaller Age I. A direct application of the Age I/Age II smolt proportion to the total return estimate could result in an underestimate of the adult proportion of 2 FW in the return.

1/ Unless otherwise noted all figures on numbers of fish in this section are in millions.

This assumption was tested by comparing percent of Age II smolt by brood year with corresponding percent 2 FW adults in the total return. Although variability would be bound to occur due to variable ocean mortality in different years of outmigration (Age I and Age II smolt from a given brood year enter the estuary in different years), the differences should not be directional if survival is not better for one age class than another. This relationship is depicted in Figure 7. Variations from a one to one relationship summed are + 151%. This plus visual examination of the graph indicate an overall underestimate of proportion of adult 2 FW fish in the return.

It was felt that a correction factor should be applied to the Age I/ Age II proportion. The geographically closest system to the Kvichak for which absolute smolt marine survival data is available is the Naknek. Both systems empty into the same estuary. Using a Naknek average Age II/Age I marine survival ratio of 1.58/1 (Appendix Table B7) a revised Age II/Age I smolt proportion was derived for the Kvichak, (Appendix Table B3). This adjustment reduced the directional variation from a one to one smolt to adult relationship to + 69%. Graphically the correction is depicted in Figure 7. Further adjustment favoring Age I survival may be warranted. It is possible that either Ugashik survival or the differential return per index smolt in the Kvichak itself may yield better results than use of Naknek smolt survival data (Ugashik smolt enter the estuary at generally the same time as Kvichak). These other methods will be examined in future forecasts.

By age class:

4_2 Forecast	Method	SEF	4_2 Forecast
1.	4_2-3_2 linear regression to 1969 3_2 return.	15.314	
2.	Average adult return per Age I smolt to 1966 Age I by 4_2/1 FW (.614)	3.214	
	(6.22)(.648)(.614) =		2.475
3.	Percent Age I (43) from 1966 brood year to ER estimate of return by average 4_2/1 FW (.614).	4.458	
	(.43)(3.339)(.614) =		.882
	Note: 4_2/1 FW varies .398 - .778, but 9 of 13 ratios in range of 0.5 - 0.8. Average if .614		
4.	Average percentage 4_2 (19.2) of total return		

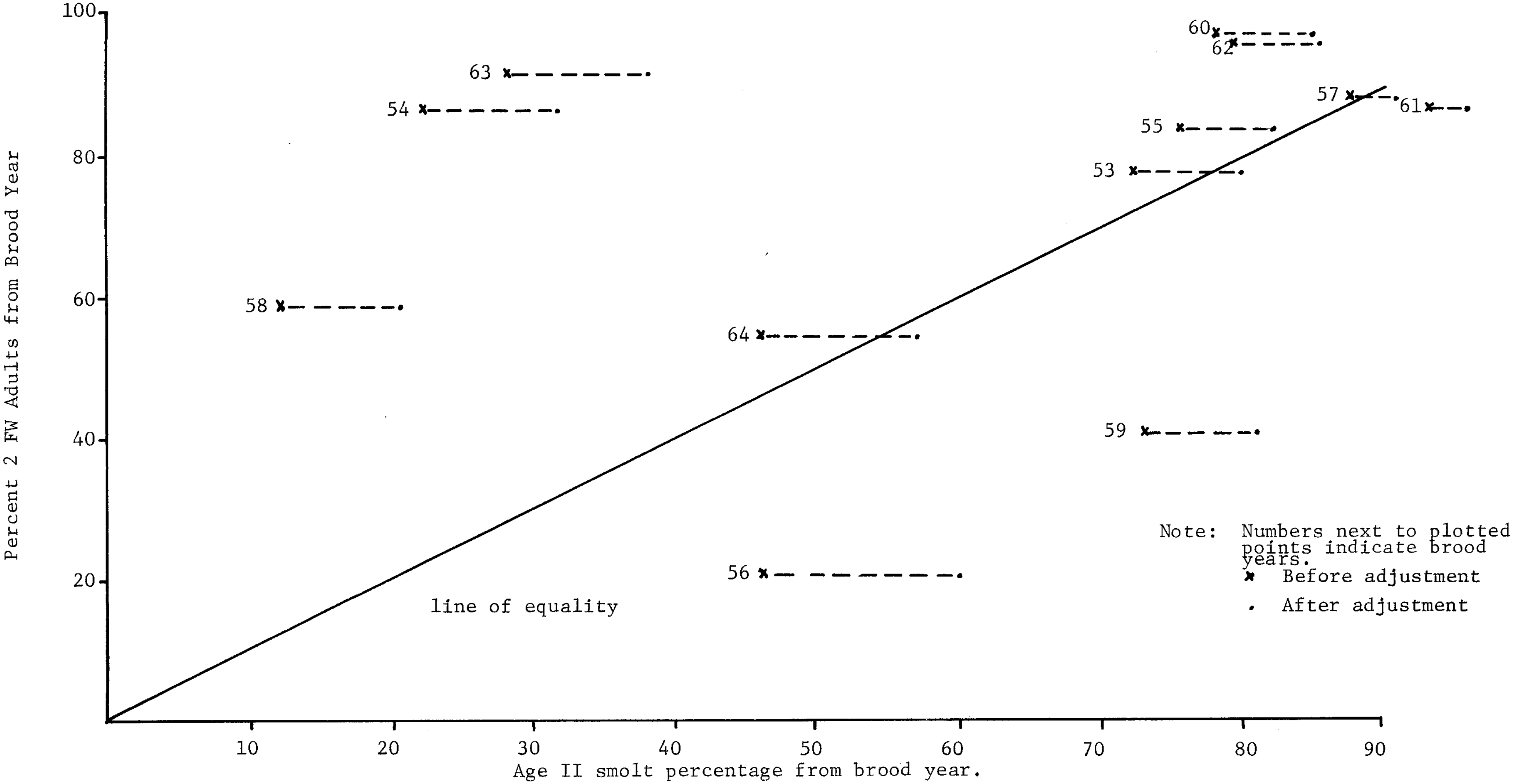


Figure 7. Kvichak River sockeye salmon percent Age II smolt and 2 FW adults from corresponding brood years before and after adjustment by average Naknek marine survival.

4_2 Forecast	Method	SEF	4_2 Forecast
	from brood year to 1966 ER return estimate.	5.816	
	(.192)(3.339) =		.641

Discussion: This age class is the progeny of the 1966 escapement. Within the limits of our data escapements in the year following the peak year have not produced well. Return per spawner from 1953 was 1.84, 1957 - 1.42 and 1961 - 0.97. As the size of the peak year escapement has increased the relative production of the escapement in the year following has decreased. This supports the ER relationship estimate of 3.339 total return from an escapement in 1966 of 3.775. The smolt index catch from 1966 of 1.189 as compared to an index catch of 1.716 from 1961 also supports this level of production. Age I smolt were in similar numbers for both years with the primary reduction in Age II smolt produced.

Average return per Age I smolt and 4_2-3_2 relationships were examined. 4_2-3_2 was quite variable (SEF of 15.314). Average return per Age I smolt (4.458) had a lower SEF of forecast (3.214) than Age I/II of ER, but the relationship is quite variable (0.6 - 16.1) and the resultant large forecast does not seem warranted in light of poor peak year plus one past production. Average age composition is again quite variable (SEF 5.822) and subject to changes in the cycle.

In view of the above the proportion Age I/Age II of ER (method 3) was chosen.

5_2 Forecast

This age class of course will be the progeny of the 1965 peak year escapement. One measure of the survival of the Age I smolt from that brood year already exists - the 4_2 return in 1969 of 8.729. Three methods were used to assess the 5_2 return in 1970:

	Method	SEF	5_2 Forecast
1.	5_2-4_2 linear regression to 1969 4_2 return (8.729).	.824	
	(.326134)(8.729) + .176732 =		3.024
2.	Percent Age I (25) from brood year 1965 to ER estimate by average $5_2/1$ FW (.386).	.821	
	(.25)(56.946)(.386) =		5.495
	Note: This yields a $5_2/4_2$ ratio of .630 or about average.		
3.	Average adult return per Age I smolt to 1965 Age I by $5_2/1$ FW (.386).	.820	
	(6.22)(2.866)(.386) =		6.881
4.	Average percentage 5_2 (10.8) of total return from brood years to 1965 ER estimate of return.	2.142	
	(1.08)(56.946) =		6.150

Discussion: The comparison of SEF between the four methods is not consistent since method 1 and 4 include brood year 1952, a major 1 FW year whereas methods 2 and 3 do not. Removing 1952 from the hindcast analysis in method 1 reduces the SEF to about .370.

SEF for the average percentage 5_2 still remains high, however. There is some evidence that as the number of 4_2 increases the proportion of 5_2 hold over decreases. The only other two years which had significantly high 4_2 returns (1952 and 1956) had an average $5_2/4_2$ of .424 which would yield a 5_2 forecast of 3.701. The questionableness of the ER return estimate and the improved SEF of the 5_2-4_2 regression led us to use method 1 for the forecast.

5_3 Forecast

Five year fish from the peak 1965 escapement of 24,326 should dominate the 1970 return. The majority of these should be 5_3 since the Age I/II proportion in the index catch was 25/75 (adjusted for Naknek survival). Since this will be the major age class in the return to the Bay as a whole, some time will be spent on the rationale for the 5_3 forecast.

The closest brood year in size to 1965 was 1960 (escapement 14.630). Some comparisons between these two years may be worthwhile.

	Escapement	Smolt Index Age I	Smolt Index Age II	Adult Return 4_2	Adult Return 5_3	Total	Number jacks(4_3)
1960	14.630	1.131	4.116	1.271	45.606	54.019	.131
1965	24.326	2.866	5.475	8.729	-	-	.463

Several approaches to forecasting this age class were examined. They and their standard errors of forecast are summarized below:

Method	SEF	5_3 Forecast
1. 5_3-4_3 linear regression to 1969 4_3 return (.463)	11.514	
(246.614)(.463) - 1.49999 =		114.032
2. Percent Age II (74.8) from brood year 1965 to ER estimate by average 5_3/2 FW.	4.559	
(.75)(56.946) = 42.710 2 FW		
Note: Average 5_3 of 2 FW 1951-1963 is 0.789		
(.789)(42.710) =		33.698
3. Average adult return per Age II smolt	8.460	
Note: 1954 omitted as an outlier.		
(12.2)(5.475) = 66.795 2 FW		
(66.795)(.789) =		52.701

Method	SEF	5_3 Forecast
However, for years with over 1.000 Age II smolt (only one peak year had mainly 2 FW production) ratio of Age II/adult is 5.02.		
(5.02)(5.475) = 27.484 2 FW		
(27.484)(.789) =		21.685
4. Average peak year relative production (52-56-60 brood years)		
(3.76)(24.326) - 1 FW 11.751 = 79.715		
(.789)(79.715) =		62.895
5. 1960 brood year adult production per Age II smolt.		
(12.7)(5.475) = 69.532 2 FW adult		
(69.532)(.789) =		54.861
6. Average percentage 5_3 (63.1) of total return from brood years to 1965 ER return estimate.	7.105	
(.631)(56.946) =		35.933

In choosing between these widely divergent estimates we have to consider:

a. A theoretical ER for brood year 1965 or 56.946 - again based on an estimate of what the relationship will be in an area of the curve for which we have no data.

b. A return to date from 1965 of 8.799 4_2 adults.

c. An Age II index catch from 65 larger than any measured before and larger than 1960 (5_3 production of 45.606). Smolt were also larger in size than those from 1960.

d. Large numbers of jacks in all East Side systems - in most cases the largest number since detailed age data has been recorded.

e. Good growth in the ocean at least through last summer as evidenced by size of 4_3 jacks.

In view of the above and lacking any reason to prefer one production level over the other it was decided to accept one estimate based on the ER theoretical relationship and one based on an actual measure or production to date. The 5_3-4_3 relationship was quite variable and yielded an unbelievably high 5_3 return. The exceptional Age II index smolt production from 1965 seemed to be one of the most important factors to consider and return from smolt was chosen for the non-ER forecast estimate. Average percentage 5_3 of ER was quite variable and percentage Age II was chosen to assign maturity to the ER estimate of total return.

Method 2 using proportion of smolt and average 5_3/2 FW to assign maturity to total return estimates from ER curve was averaged with method 5, the adult production per Age II smolt from brood year 1960 applied to the Age II smolt (5.475) from 1965. Average return per Age II smolt for all years (method 3) was quite variable and in any case only one brood year, 1960, produced anything like a similar number of Age II smolt. It also was the only peak year to produce a majority of 2 FW adults.

The average of these two methods:

$$\frac{54.861 + 33.608}{2} = \underline{44.234}$$

6_3 Forecast	Method	SEF	6_3 Forecast
1.	6_3-5_3 linear regression to 1969 5_3 return (1.839)	.409	
	(1.839)(.137290) + .309195 =		.562

Discussion: This age class will be the progeny of the 1964 brood year escapement of .957. The return to date from this brood year (4 and 5-year fish) is 4.202, already greatly exceeding the ER estimate of 1.881. Total reliance was therefore placed on the 6_3-5_3 linear regression.

1970 KVICHAK RIVER FORECAST

Brood year	Escapement	Age Class Return[1/] 4_2	5_2	5_3	6_3	1970 Forecast
1964	.957	1.896	.467	1.839	(.562)	.562
1965	24.326	8.729	(3.024)	(44.234)		47.258
1966	3.775	(.882)				.882
				Total 1970 Forecast		48.702

( ) = Forecasted age class

1/ Age class returns not shown in parenthesis are actual returns to date.

Branch River

The ER relationship (Appendix Figure C3) yields a return for contributing brood years of:

Brood year	Escapement	Estimated return	Return to date
1964	.203	.507	.602
1965	.249	.343	.249
1966	.179	.703	0

Escapement-return data by age class is given in Appendix Table B4.

By age class:

4_2 Forecast	Method	SEF	4_2 Forecast
	1. Average percentage 4_2 (35.0) of total return from brood years to 1966 ER return estimate.	.565	
	(.350) (.703) =		.246

Note: 1953, 1954 and 1957 percentages omitted as outliers in computation of average (Table 4).

Discussion: Only method available.

5_2 Forecast	Method	SEF	5_2 Forecast
1.	Average percentage 5_2 (31.8) of total return from brood years to 1965 ER return estimate.	.110	
	(.318)(.343) =		.109
2.	5_2-4_2 linear regression to 1969 4_2 return (.249)	.077	
	(.249)(.198194) + .115481 =		.165

Discussion: Average of methods 1 and 2 gave a 5_2 forecast of .137.

5_3 Forecast	Method	SEF	5_3 Forecast
1.	Average percentage 5_3 (20.8) of total return from brood years to 1965 ER return estimate.	.095	
	(.208)(.343) =		.071

Discussion: Only method available.

6_3 Forecast	Method	SEF	6_3 Forecast
1.	6_3-5_3 linear regression to 1969 5_3 return (.296)	.049	
	(.296)(.344727) +.0393613 =		.141

Discussion: Total return to date (4_2, 5_2 and 5_3) is more than ER estimate. Therefore average percentage 6_3 of ER was not used.

1970 BRANCH RIVER FORECAST

Brood year	Escapement	Return by age class 1/ 4_2	5_2	5_3	6_3	Forecast
1964	.203	.087	.219	.296	(.141)	.141
1965	.249	.249	(.137)	(.071)		.208
1966	.179	(.246)				.246
				Total 1970 Forecast		.595

( ) = Forecasted age class

1/ Age class returns not shown in parenthesis are actual returns to date.

Naknek River

The ER relationship (Appendix Figure C4) yields a return for contributing brood year of:

Brood year	Escapement	Estimated return	Return to date
1964	1.350	2.639	2.087
1965	.718	2.331	.654
1966	1.016	2.553	0

Escapement -return by age class and smolt production data is given in Appendix Tables B5-B7.

4_2 Forecast	Method	SEF	4_2 Forecast
	1. Average percentage 4_2 (8.0) of total return from brood years to 1966 ER return estimate.	.383	
	(.080) (2.553) =		.204

4_2 Forecast	Method	SEF	4_2 Forecast
	Note: 1955 and 1960 4_2 percentage omitted as outliers in computation of average (Appendix Table B5).		
2.	Percent Age I (52.0) from brood year 1966 to ER estimate of return by average $4_2/1$ FW (.303)	.467	
	(2.553)(.520)(.303) =		.402
	Note: Smolt proportions by brood year weighted by increased survival potential of Age II smolt factor Age II/I of <u>1.58</u> (Appendix Table B7).		
3.	Age I average marine survival to 1966 Age I by average $4_2/1$ FW (.303)	.493	
	(7.662)(.136)(.303) =		.316

Discussion: None of these methods perform very well. The SEF shown is for all years (1952-1965 method 1, 1955-1964 for methods 2 and 3). Omitting the obvious outlier years 1955 and 1960 method 1, 1960 method 2 and 1960 method 3, the SEF is .315, .311 and .374 respectively. This analysis tends to show that the average age composition method performs better than the methods using smolt data. However, in the absence of a method for weighting the methods by their relative accuracy, the three results were averaged to get a forecast of .307 4_2.

5_2 Forecast	Methods	SEF	5_2 Forecast
1.	5_2-4_2 linear regression to 1969 4_2 return (.654)	.426	
	(.654)(.390362) + .441797		.697
2.	Average percentage 5_2 (30.4) of total returns		

5_2 Forecast	Method	SEF	5_2 Forecast
	from brood years to 1965 ER return estimate.	.504	
	(.304)(2.331) =		.709
3.	Percent Age II (20.0) from brood year 1965 to ER estimate of return by average $5_2/1$ FW (.697).	.404	
	(.200)(2.331)(.697) =		.325
4.	Age I average marine survival to 1965 Age II by average $5_2/1$ FW (.697).	.556	
	(4.097)(.136)(.697) =		.388

Discussion: The 1969 4_2 return of .654 compares to forecasted returns of

Average % 4_2 to ER (.080)(2.331) = .186

Percent Age I from brood year to ER (.20) (2.331)(.303) = .248

Average Age I survival (.136)(4.097)(.303) = .168

Both smolt and ER seem to be underforecasting the 1 FW return. However, the average 5_2% of ER yields as high a forecast as the linear regression 5_2-4_2. Decreasing $5_2/4_2$ ratio with increasing number of 4_2 may account for this. Smolt methods yield total 1 FW less than the 1969 4_2 alone. It was decided to rely solely on 5_2-4_2 linear regression for a 5_2 forecast of <u>.697</u>.

5_3 Forecast	Method	SEF	5_3 Forecast
1.	5_3-4_3 linear regression to 1969 4_3 return (.041)	.334	
	(.041)(63.4905) + .247627		2.851

5_3 Forecast	Method	SEF	5_3 Forecast
	2. Age II average marine survival to 1965 Age II by average $5_3/2$ FW (.451).	.452	
	(.020)(10.544)(.451)		.951
	Note: 1956 brood year $5_3/2$ FW omitted as outlier in computation of average.		
	3. Percent Age II (77.6) from brood year 1965 to ER estimate of return by average $5_3/2$ FW (.451).	.553	
	(.80)(2.331)(.451)		.841

Discussion: Average percentage 5_3 of ER extremely variable and not considered. The largest previous 5_3 return was 2.145 (Appendix Table B5) and the next largest only 1.346. Although the 5_3-4_3 regression has the lowest SEF, we are forecasting from data far beyond the range of our observations (previous high 4_3 of .025). The high 4_3 return, large Age II outmigration and generally favorable outlook for E Side systems support a good 5_3 return, but the 5_3-4_3 result of 2.851 would exceed even maximum marine survivals and $5_3/2$ FW ratios previously experienced. Since all three methods utilize different data, it was decided to average them for a 5_3 forecast of <u>1.548</u>.

6_3 Forecast	Method	SEF	6_3 Forecast
	1. 6_3-5_3 linear regression to 1969 5_3 return (1.346).	.422	
	(1.346)(.500583) + .402164 =		1.076
	2. Average percentage 6_3 (30.2) of total returns from brood years to 1964 ER return estimate.	.304	
	(.302)(2.639) =		.797

6_3 Forecast	Method	SEF	6_3 Forecast
	3. Age II average marine survival to 1964 Age II by average $5_3/2$ FW (.549).	.321	
	(.215)(5.285)(.549) =		1.058
	4. Percent Age II (73) from brood year 1964 to ER estimate of return by average $6_3/2$ FW (.549).		1.058

Discussion: ER estimated return from brood year 1964 is 2.639. Return to date (4_2, 5_2 and 5_3) is 2.087. By subtraction 6_3 would be .552. However, 1969 5_3 return of 1.346 was much higher than would have been forecasted by methods 2-4. 6_3-5_3 SEF is poor. Averaged all methods to obtain a 6_3 forecast of .889.

1970 NAKNEK RIVER FORECAST

Brood year	Escapement	Return by age class 1/ 4_2	5_2	5_3	6_3	1970 Forecast
1964	1.350	.445	.296	1.346	(.889)	.889
1965	.718	.654	(.697)	(1.548)		2.245
1966	1.016	(.307)				.307
			Total 1970 Forecast			3.441

( ) = Forecasted age class

1/ Age class returns not shown in parenthesis are actual returns to date.

Egegik River

The ER relationship (Appendix Figure C5) yields a return for contributing brood years of:

Fish in Millions

Brood year	Escapement	Estimated return	Return to date
1963	.998	1.801	1.277
1964	.850	1.879	1.590
1965	1.445	1.502	.085
1966	.805	1.899	0

The only data available for forecast of Egegik runs are escapement and resultant returns by age class. Acting on the peak year premise a hand drawn ER curve was fitted to the 1956 and 1960 brood years for Egegik (Appendix Figure C5). The equation used for the ER relationship contains 3 parameters and with only two observations the curve fitting techniques could not be used. This "peak year" curve would yield a return from the 1965 brood year escapement of .445 spawners of about 7.500 or 5.2 fish/spawner.

Escapement return data by age class is summarized in (Appendix Table B8).

By age class:

4_2 Forecast	Method	SEF	4_2 Forecast
	1. Average percentage 4_2 (2.1) of total return from brood years to 1966 ER return estimate.	.594	
	(0.021)(1.899) =		.038

Note: Computation of average percentage 4_2 omits brood year 1952, 1956 and 1960, years of unusually high numbers of 4_2 fish, as outliers. Apparently these large numbers of 4_2 fish have tended to perpetuate themselves in a declining trend 52-56-60-64. There seems to be no reason to anticipate this occurrence in 1970.

Discussion: 3_2 jacks do not exist in any numbers in the Egegik system. The only method presently available to forecast 4_2 age class is the average percentage this age class has been of past returns.

Discussion: The 4_2 return from brood year 1965 of .085 in 1969 stands out as a fairly large 4_2 return. Average percent 5_2 of total return is small (vary 1-13% omit 52 - 56 - 60) but variable. The 5_2-4_2 relationship seems to be the obvious one to examine since the 4_2 return is the only concrete evidence of 1965 brood year production.

5_3 Forecast	Method	SEF	5_3 Forecast
1.	5_3-4_3 linear regression to 1969 4_3 return (.031).	.198	
	(187.381)(.031) + .390149 =		6.199
	Note: Highest previous number of 4_3 has been .021.		
2.	Average percentage 5_3 (45.5) of total return from brood years to ER return estimate.	1.188	
	(0.455)(1.502) =		.683
	Note: Average 5_3 percent omits brood year 1952 and 1956 (exceptionally high 4_2 percentage and low 5_3 percentage) as outliers.		
3.	Average percentage 5_3 (45.5) of total return from brood years to "peak year" ER return estimate.		
	(0.455)(7.500) =		3.412

Discussion: The five year, two freshwater fish (5_3) from brood year 1965 should comprise the bulk of the return if past coincidence of age class with Kvichak peak years holds up. This is supported by the large number of "jacks" (4_3) in the 1969 run. It is obviously tempting to use the method with the lowest SEF particularly since it is based on known return (4_3 in 1969). However, it should be pointed out that:

a. We are forecasting way beyond the range of our data (previous high 4_3 was .021).

b. A return of 6.199 5_3 would compare to a previous high of 4.339 and probably lead to a total brood year return of about 10.000 compared to a previous high of 7.782.

c. Considerable numerical error is possible due to sampling variation for an age class that forms such a minor part of the run - in 1969 4_3 were only .031 out of a run of 2.159.

Considering these factors it was decided to accept the 5_3-4_3 relationship as an indicator of a good return from the 1965 brood year, but not as a forecast of numbers of 5_3.

The above negates the use of the sub-peak year ER relationship (method 2) which forecasts a total return of only 1.502 from the 1965 escapement of 1.445. The concept of a good "peak year" return from a large escapement appears likely and therefore method 3 was chosen for 5_3 forecast.

6_3 Forecast	Method	SEF	6_3 Forecast
1.	6_3-5_3 linear regression to 1969 5_3 return (1.419).	.340	
	(.530938)(1.419) + .356722 =		1.110

Discussion: Return to date from 1965 brood year is 1.590. Total production from ER was only forecasted to be 1.879. Since 6_3 average nearly 40% of the total return from brood years (omitting 1952 and 1956 as outliers) it would seem that the ER estimated return is low. It would lead to a return of only .289 6_3 or only 15%.

6_4 Forecast	Method	SEF	6_4 Forecast

1. Average percentage 6_4 (2.3) of total returns from brood years to the 1964 ER return estimate.

   (.023)(1.879) = .043

   Note: 1953 6_4 percent omitted as outlier in computation of average.

   Discussion: Only method available.

7_4 Forecast	Method	SEF	7_4 Forecast

1. Average percentage 7_4 (2.2) of total return from brood years to the 1963 ER return estimate. — SEF .053

   (.022)(1.801) = .040

2. Average $7_4/6_4$ ratio (1.153) to 1969 6_4. — SEF .078

   (1.153)(.061) = .070

   Discussion: It seems probable that 7_4-6_4 linear regression will be an improvement over the average ratio, but it has not been computed. ER appears to be low for brood year 1964. Both methods were averaged for a .055 7_4 forecast.

1970 EGEGIK RIVER FORECAST

Brood year	Escapement	Return by age class 1/ 4_2	5_2	5_3	6_3	6_4	7_4	1970 Forecast
1963	.998	.015	.114	.494	.594	.061	(.055)	.055
1964	.850	.110	.061	1.419	(1.110)	(.043)		1.153
1965	1.445	.085	(.123)	(3.412)	-			3.535
1966	.805	(.038)						.038
						Total 1970 Forecast		4.781

( ) = Forecasted age class

1/ Age class returns not shown in parenthesis are actual returns to date.

Ugashik River

The ER relationship (Appendix Figure C6) yields a return for contributing brood years of:

Fish in Millions

Brood year	Escapement	Estimated return	Return to date
1964	.473	.754	.275
1965	.997	1.155	.080
1966	.704	.954	0

Escapement-return by age class and smolt outmigration data is given in Appendix Tables B9-B11.

The concept of a "peak year" East Side run might suggest a better return from the 1965 brood year escapement than indicated above. The relationship used in Appendix Figure C6 to derive the above returns omits 1956 and 1960 brood year returns as outliers. Including these two years of unusually high returns the relationship shown in Appendix Figure C7 is obtained.

The smolt production from the 1965 brood year escapement in Ugashik was disappointingly low (Appendix Table B10). However, it is possible that if the marine-estuarine environment plays a large part in any "peak year" production that exceptional survival may produce a large return. Using the ER relationship for all brood years a return from 1965 of 1.673 would be obtained.

By age class:

4_2 Forecast

The Age I smolt outmigration of 39.300 in 1968 from brood year 1966 is the outstanding feature of this system forecast. These fish entered the estuary the same year as the Age II smolt from the peak Kvichak 1965 escapement. They were of above average size. The return could be much higher than anticipated if "peak year" conditions do benefit survival for East Side systems' smolt entering the estuary in the same year and if this affects these

At any rate the 39.300 smolt fairly well invalidates the use of the ER return estimate of .954 for brood year 1966. Even at the minimum marine survival measured previously (2.6%) 1.000 1 FW adults alone (not counting production from Age II smolt) would be forecasted for brood year 1966.

4_2 Forecast	Method	SEF	4_2 Forecast
	1. Age I average marine survival to 1966 Age I by average $4_2/1$ FW (.336).	.183	
	(39.300)(.052)(.336) =		.687

Note: 1958 outmigration (Age I from 1956, Age II from 1965) marine survival omitted from computation of averages - percentages abnormally high plus first year of program.

1952, 1956, 1960 and 1964 $4_2/1$ FW ratio in adult return from brood year omitted. 4_2 proportion definitely on a higher level than other years and apparently cyclic. No reason to suspect 1966 should repeat.

Method	SEF	4_2 Forecast
2. Average marine survival Age I smolt brood year 1960 and 1961 (7.1 and 4.6% respectively) to 39.300 smolt by average $4_2/1$ FW.		
(0.58)(39.300)(.336) =		.766

Note: 1960 and 1961 brood year smolt production of Age I only ones approaching 1966 in numbers.

Discussion: No real difference is apparent between results of two methods. Decision was made to use method 1 which could be hindcasted.

5_2 Forecast

These fish although progeny of the 1965 escapement would have migrated to sea in a "non-peak" outmigration year.

Method	SEF	5_2 Forecast
1. 5_2-4_2 linear regression to 1969 4_2 return (.080).	.125	

5_2 Forecast	Method	SEF	5_2 Forecast
	(.24246)(.080) + .118140 =		.138
2.	Percent Age I (22.0) from brood year 1965 to non-peak ER estimate of return by average $5_2/1$ FW (.664).	.199	
	(1.155)(.22)(.664) =		.169
	Note: This method would result in a 4_2 forecast for 1969 of .085 compared to an actual return of .080. Smolt proportions by brood year weighted by increased survival potential of Age II smolt by factor Age II/I of 3.3 (Appendix Table B10).		
3.	Age I average marine survival to 1965 Age I by average $5_2/1$ FW (.664).	.191	
	(2.700)(.052)(.664) =		.094
4.	Average percentage 5_2 (20) of total return from brood years to 1965 non-peak ER return estimate.	.244	
	(1.155)(.20) =		.231
	Discussion: 5_2-4_2 regression has lowest SEF of four methods, but there is considerable variation at low levels of 4_2. Decided to average all four methods for a 5_2 forecast of .158.		

5_3 Forecast

"Peak year" age class progeny from 1965 brood year.

	Method	SEF	5_3 Forecast
1.	5_3-4_3 linear regression to 1969 4_3 return (.002).	.385	
	(96.2103)(.002) + .00324170 =		.196

5_3 Forecast	Methods	SEF	5_3 Forecast
2.	Percent Age II (78.0) from brood year 1965 to non-peak ER estimate of return by average $5_3/2$ FW (.724).	.253	
	(1.155)(.780)(.724) =		.652
	Note: $5_3/2$ FW vary .533-.910 but 11 of 13 only vary .610-.835.		
3.	Percent Age II (78.0) from brood year 1965 to peak year ER estimate of return by average $5_3/2$ FW (.724).		
	(1.673)(.78)(.724) =		.945
4.	Age II average marine survival to 1965 Age II by average $5_3/2$ FW (.724).	.311	
	(2.900)(.172)(.724) =		.361
5.	Average percentage 5_3 (45.6) of total return from brood years to 1965 non-peak ER return estimate.	.274	
	(.456)(1.155) =		.527

Discussion: The basic question is again whether to credit the Ugashik with some "peak year" survival benefit for the 1965 brood year 2 FW fish. On the plus side is the historical record and the incidence of 4_3 in most East Side systems in 1969. This incidence was not particularly high in Ugashik (as shown in Table 4), however. Another factor of concern is that the maximum Age II smolt marine survival measured (omitting 1955) has been 28.2 percent. Using this figure the 5_3 forecast would be only .588. Survival of Age II smolt may be above average due to the "peak year" cycle, but even so there are so few of them the run cannot be great.

It was decided to average methods 1, 2, 4 and 5 resulting in a 5_3 forecast of .434.

6_3 Forecast	Method	SEF	6_3 Forecast
	1. 6_3-5_3 linear regression to 1969 5_3 return (.233).	.060	
	(.311717)(.233) + .0272608 =		.100
	2. Age II average marine survival to 1964 Age II smolt by 6_3/2 FW (.276).	.158	
	(2.400)(.172)(.276) =		.114

Discussion: The ER estimated return from brood year 1964 was .754. Return to date (4_2, 5_2 and 5_3) is only .275. The 6_3 age class has never exceeded 35 percent of a total brood year return. It is obvious that the 1964 brood year is producing at a lower than average level invalidating use of the ER relationship for forecast.

The method with the lowest SEF was used to forecast the 6_3 return - 6_3-5_3.

1970 UGASHIK RIVER FORECAST

Brood year	Escapement	Return by age class 1/ 4_2	5_2	5_3	6_3	1970 Forecast
1964	.473	.027	.014	.233	(.100)	.100
1965	.997	.080	(.158)	(.434)		.592
1966	.704	(.687)				.687
			Total 1970 Forecast			1.379

( ) = Forecasted age class

1/ Age class returns not shown in parenthesis are actual returns to date.

Wood River

The ER relationship (Appendix Figure C8) yields a return for contributing brood years of:

Brood year	Escapement	Estimated return	Return to date
1964	1.076	2.497	.992
1965	.675	1.901	.500
1966	1.209	2.590	0

Escapement return by age class data is given in Appendix Table B12.

4_2 Forecast	Method	SEF	4_2 Forecast
1.	Average percentage 4_2 (48.5) of total return from brood years to 1966 ER return estimate.	.567	
	(.485)(2.590) =		1.256

Discussion: No other method exists for forecasting 4_2 fish although average percentage varies from 17-79%.

5_2 Forecast	Method	SEF	5_2 Forecast
1.	Average percentage 5_2 (37.6) of total return from brood years to 1965 ER return estimate.	.404	
	(.376)(1.901) =		.715
2.	5_2-4_2 linear regression to 1965 4_2 return (.500).	.309	
	(.500)(.124161) + .437619 =		.500

Discussion: 4_2 return (.500) in 1969 was only 26.3% of forecasted total return from 1965 brood year as opposed to all year average for 4_2 of 48.5%. For this reason and due to its lower SEF method 2 was chosen for a 5_2 forecast of <u>.500</u>. The 5_2-4_2 relationship is very poor, however.

5_3 Forecast	Method	SEF	5_3 Forecast
1.	Average 5_3 percentage (10.6) of total return from brood years to 1965 ER return estimate.	.308	
	(.106)(1.901) =		.202

Discussion: Although 1965 brood year production is in doubt due to low 4_2 return in 1969 this may apply only to 1 FW adults. At present no alternate to the average percentage method is available.

6_3 Forecast	Method	SEF	6_3 Forecast
1.	Average percentage 6_3 (3.2) of total return from brood years to 1964 ER return estimate.	.055	
	(.032)(2.497) =		.080
2.	6_3-5_3 linear regression to 1969 5_3 return (.321).	.067	
	(.104451)(.321) + .0563148 =		.090

Discussion: Return from the 1964 brood year to date (4_2, 5_2, 5_3) is only .992 as opposed to a total forecasted return of 2.497. It is obvious that total return will be lower than forecasted invalidating the use of the ER relationship for forecast.

1970 WOOD RIVER FORECAST

Brood year	Escapement	Return by age class 1/ 4_2	5_2	5_3	6_3	1970 Forecast
1964	1.076	.341	.330	.321	(.090)	.090
1965	.675	.500	(.500)	(.202)		.702
1966	1.209	(1.256)				1.256
( ) = Forecasted age class			Total 1970 Forecast			2.048

1/ Age class returns not shown in parenthesis are actual returns to date.

Igushik River

The ER relationship (Appendix Figure C9) yields a return for contributing brood years of:

Brood year	Escapement	Estimated return	Return to date
1964	.129	.401	.683
1965	.181	.432	.287
1966	.287	.443	0

Escapement-return by age class data is given in Appendix Table B13.

By age class:

4_2 Forecast	Method	SEF	4_2 Forecast
	1. Average percentage 4_2 (17.6) of total return from brood years to 1966 ER return estimate.	.134	
	(.176)(.443) =		.078

Discussion: No smolt data available. Average percentage by age class of ER only usable method.

5_2 Forecast	Method	SEF	5_2 Forecast
1.	Average percentage 5_2 (57.9) of total return from brood year 1965 ER return estimate.	.222	
	(.579)(.432) =		.250
2.	5_2-4_2 linear regression to 1969 4_2 return (.287).	.116	
	(1.62053)(.287) + .123434 =		.589

Discussion: Exceptional 4_2 return in 1969 (.287), second largest since 1952, casts doubt on the ER total return for 1965 of only .432. The 4_2 age class averages only 17.6% of total returns for all brood years and has never exceeded 39%. Even the lowest 4_2/total return ratio would give a total return of .735. Average 4_2 percentage (.176) would give a total return of 1.630. For these reasons plus the higher SEF of method 1 the ER relationship was ignored and method 2 used to give a 5_2 forecast of .589.

5_3 Forecast	Method	SEF	5_3 Forecast
1.	Average percentage 5_3 (10.7) of total returns from brood year to 1965 ER return estimate.	.064	
	(.107)(.432) =		.046

Discussion: 1965 total return estimate is already in doubt - however, the 4_2 return may only reflect good survival of Age I smolt. 5_3 average percentage by brood year is quite variable. Poor forecast estimate, but no better choice seems to be available.

6_3 Forecast	Method	SEF	6_3 Forecast
1.	Average percentage 6_3 (13.5) of total return from brood years to 1964 ER return estimate.	.066	
	(.135)(.401) =		.054
2.	6_3-5_3 linear regression to 1969 5_3 return (.102).	.036	
	(.135)(.401) =		.101

Discussion: Total return to date from brood year 1964 already exceeds ER estimate by .282. Method 2 was chosen for a 6_3 forecast of .101.

1970 IGUSHIK RIVER FORECAST

Brood year	Escapement	Return by age class 1/ 4_2	5_2	5_3	6_3	1970 Forecast
1964	.129	.167	.414	.102	(.101)	.101
1965	.181	.287	(.589)	(.046)		.635
1966	.287	(.078)				.078
				Total 1970 Forecast		.814

( ) = Forecasted age class

1/ Age class returns not shown in parenthesis are actual returns to date.

Nuyakuk River

The ER relationship (Appendix Figure C10) yields a return for contributing brood years of:

Brood year	Escapement	Estimated return	Return to date
1964	.103	.330	.127
1965	.203	.502	.103
1966	.161	.450	0

Escapement-return data by age class is given in Appendix Table B13.

By age class:

4_2 Forecast	Method	SEF	4_2 Forecast
	1. Average percentage 4_2 (14.0) of total return from brood years to 1966 ER return estimate.	.069	
	$(.140)(.450) =$		.063

Note: 1954-1956 brood year average percentages omitted from all 1 FW computations as outliers (Appendix Table B13).

Discussion: No other method of forecast is available at present.

5_2 Forecast	Method	SEF	5_2 Forecast
	1. Average percentage 5_2 (75.9) of total return from brood years to 1965 ER return estimate.	.095	
	$(.759)(.502) =$		.381
	2. 5_2-4_2 linear regression to 1969 4_2 return (.103).	.167	
	$(.633578)(.103) + .146387 =$		.212

Discussion: The 1969 4_2 return of .130 was considerably higher than the average 4_2 percent of ER would have forecasted (.059) indicating that the 1965 1 FW production may turn out to be higher than the ER curve predicts. However, the 5_2-4_2 relationship gives a lower forecast than the average % of ER. The 5_2-4_2 relationship is very poor and greatly underforecasts at the level of 4_2 in 1969. For want of another criteria method 1 was chosen giving a 5_2 forecast of .381. This is considered a conservative forecast.

5_3 Forecast	Method	SEF	5_3 Forecast
1.	Average percentage 5_3 (2.6) of total return from brood years to 1965 ER return estimate.	.010	
	(.026)(.502) =		.013

Note: 1954 and 1955 omitted from computation of average percentage as outliers.

Discussion: No other method is available.

6_3 Forecast	Method	SEF	6_3 Forecast
1.	Average percent 6_3 (5.4) of total return from brood years to 1964 ER return estimate.	.019	
	(.054)(.330) =		.018
2.	6_3-5_3 linear regression to 1969 5_3 return (.020).	.017	
	(.0769231)(.020) + .0135385 =		.015

Discussion: Both relationships are very poor. However, the return to date from 1964 (4_2, 5_2, 5_3) is only 28% of the total forecasted, placing the ER method in doubt. Method 2 was chosen for a forecast of .015 6_3.

1970 NUYAKUK RIVER FORECAST

Brood year	Escapement	Return by age class 1/ 4_2	5_2	5_3	6_3	1970 Forecast
1964	.103	.035	.072	.020	(.015)	.015
1965	.203	.103	(.381)	(.013)		.394
1966	.161	(.063)				.063
( ) = Forecasted age class				Total 1970 Forecast		.472

1/ Age class returns not shown in parenthesis are actual returns to date.

Snake River

In the absence of more refined data the total annual run to Snake River was averaged for 1956-1969 to obtain a total 1970 run forecast of 0.19. The 1959 return of .231 was omitted as an outlier.

This return was divided to age class by the forecasted Wood River 1970 percent age composition as follows:

1970 SNAKE RIVER FORECAST

	4_2	5_2	5_3	6_3	Total
Percent	61.3	24.4	9.9	4.4	100.0
Number	.012	.004	.002	.001	.019

Nushagak-Mulchatna

The ER relationship (Appendix Figure C11) yields a return from contributing brood years of:

Brood year	Escapement	Estimated return	Return to date
1964	.028	.076	.043
1965	.050	.157	.035
1966	.047	.141	0

Returns to the Nushagak-Mulchatna have been estimated in a variety of ways. Only in the past three years have actual escapement counts and age composition samples been taken.

Forecast is based on average age composition in the past three years' runs (brood year age composition is not even available) to the ER estimated return. The ER curve data is widely scattered, but the estimated returns appear realistic.

$4_1 = (.141)(23.4) = .033$

$4_2 = (.141)(14.6) = .021$

$5_2 = (.157)(57.0) = .089$

$5_3 = (.157)(1.3) = .002$

$6_3 = (.076)(1.6) = \underline{.001}$

1970 NUSHAGAK-MULCHATNA FORECAST

Brood year	Escapement	Return by age class 1/ 4_1	4_2	5_2	5_3	6_3	1970 Forecast
1964	.028	.014	.009	.017	.003	(.001)	.001
1965	.050	.011	.023	(.089)	(.002)		.091
1966	.047	(.033)	(.021)				.054
( ) = Forecasted age class				Total 1970 Forecast			.146

1/ Age class returns not shown in parenthesis are actual returns to date.

Togiak River

The ER relationship (Appendix Figure C12) yields a return for contributing brood years of:

Brood year	Escapement	Estimated return	Return to date
1964	.096	.282	.146
1965	.088	.270	.143
1966	.091	.274	0

Escapement-return data by age class is given in Appendix Table B14.

The Togiak district catch is composed of catches from several sub-districts and runs from several river systems. Until 1961 the catch was combined from all sub-districts, but the escapement data was for the main Togiak River in most years with only sporadic surveys on the other systems. Since that date tributary surveys have been fairly consistent. In this report total return includes all data, catch and escapement available, but the brood year escapement is for the main Togiak River only.

By age class:

4_2 Forecast	Method	SEF	4_2 Forecast
	1. Average percentage 4_2 (30.2) of total return from brood years to 1966 ER return estimate.	.047	
	(.302)(.274) =		.083

Discussion: Only method available.

5_2 Forecast	Method	SEF	5_2 Forecast
	1. Average percentage 5_2 (53.4) of total return from brood years to 1965 ER return estimate.	.084	
	(.534)(.270) =		.144

5_2 Forecast	Method	SEF	5_2 Forecast
2.	5_2-4_2 linear regression to 1969 4_2 return (.143).	.089	
	(.902424)(.143) + .0769338 =		.206

Discussion: Wide variability in both methods. 5_2 average percentage varies from 24% to 74% and 5_2-4_2 exhibits wide scatter about regression. However, 4_2 return of .143 in 1969 was 53% of total forecasted return from brood year 1965 from ER. 4_2 averages only 29% of brood year returns. This indicates the 1965 brood year return may be higher than indicated by the ER curve particularly with reference to 1 FW adults, and led us to use method 2 to forecast the 5_2 at .206.

5_3 Forecast	Method	SEF	5_3 Forecast
1.	Average percentage 5_3 (3.6) of total return from brood years to 1965 ER return estimate.	.021	
	(.036)(.270) =		.010

Note: 1958, 1959 and 1963 omitted as outliers in computation on average percentage.

Discussion: Only method presently available.

6_3 Forecast	Method	SEF	6_3 Forecast
1.	Average percentage 6_3 (9.6) of total return from brood years to 1964 ER return estimate.	.022	
	(.096)(.282) =		.027
2.	6_3-5_3 linear regression to 1969 5_3 return (.041).	.016	
	(.041)(-3.00456) + .0236564 =		.011

Discussion: Both methods very poor. 6_3 average percentage varies from 0 - 22% and 6_3-5_3 scatter is so great that no apparent relationship exists. Indications are that the 1964 brood year is not going to produce as forecasted (4_2, 5_2 and 5_3 total to date only .146 against forecasted total of .282). Average of method 1 and 2 used to forecast .019 6_3.

1970 TOGIAK RIVER FORECAST

Brood year	Escapement	Return by age class 1/ 4_2	5_2	5_3	6_3	1970 Forecast
1964	.096	.042	.063	.041	(.019)	.019
1965	.088	.143	(.206)	(.010)		.216
1966	.091	(.083)				.083
				Total 1970 Forecast		.318

( ) = Forecasted age class

1/ Age class returns not shown in parenthesis are actual returns to date.

Alaska Peninsula

The average run by age class, 1956-1969 was used as a forecast of the 1970 run:

4_2	5_3	6_4	5_2	6_3	7_4	Total
.350	.403	.007	.218	.169	.006	1.153