Informational Leaflet 39

BRISTOL BAY RED SALMON
FORECAST OF RUN FOR 1964

Compiled jointly by the:

ALASKA DEPARTMENT OF FISH AND GAME

U. S. BUREAU OF COMMERCIAL FISHERIES

FISHERIES RESEARCH INSTITUTE

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INTRODUCTION

This forecast for the 1964 Bristol Bay red salmon run was prepared jointly by the Alaska Department of Fish and Game, the U.S. Bureau of Commercial Fisheries, and the Fisheries Research Institute of the University of Washington.

The following scientists participated in the analysis of the data: Mr. Frank J. Ossiander, Mr. Melvin Seibel, and Dr. Howard D. Tait of the Alaska Department of Fish and Game; Dr. C.J. DiCostanzo, Dr. George Y. Harry and Mr. H. Jaenicke of the Auke Bay Laboratory of the Bureau of Commercial Fisheries; Mr. Robert French and Mr. R.A. Fredin of the Seattle Biological Laboratory of the Bureau of Commercial Fisheries; Dr. Robert L. Burgner, Mr. Allan C. Hartt, Dr. Ted S.Y. Koo, Mr. Steve Mathews, Dr. Ole Mathisen, and Dr. William F. Royce of the Fisheries Research Institute. Many others have participated in the collection of data and preliminary analysis.

Mr. Frank J. Ossiander served as editor and assembled this material in its present form.

METHODS OF FORECAST

The forecast represents an application of the use of mathematics to study biological phenomena. Every attempt to use mathematics to study some real phenomena must begin with building a mathematical model of these phenomena. Of necessity, the model simplifies matters to a greater or lesser extent and a number of details are ignored. The success depends on whether or not the details ignored are really unimportant in the development of the phenomena studied. The solution of the mathematical problem may be correct and yet it may be in violent conflict with biological reality simply because the original assumptions of the mathematical model diverge essentially from the conditions of the biological system considered. Beforehand, it is impossible to predict with certainty whether or not a given mathematical model is aequate. To find this out, it is necessary to calculate a number of consequences of the model and to compare them with actual observations.

The models used here take into account explicity a number of details of the life histories of red salmon and the process of fishing but ignore a great many others. It is hoped that these models provide the greatest information from the data now available. However, it is not claimed that this method of attack is the only one possible, modifications which eventually will provide an adequate model of the biological phenomena under consideration may be desirable.

These forecasts give the expected return to the major rivers in each fishing district of Bristol Bay. A variety of data is available on the returns to these rivers which provides bases for several separate estimates of the size of returning runs (Table 1.

Table 1. Data and method of analysis.

River System	Type of Data	Extent of Data	Method of Analysis
Nushagak			
Igushik	Escapement-return	1950 to present	Geometric mean
Wood	Smolt outmigration	1951 to present	Linear regression
Tikchik	Escapement-return	1950 to present	Linear regression
Naknek-Kvichak			
Kvichak	Smolt outmigration	1955 to present	Geometric mean
Branch	Escapement-return	1955 to present	Geometric mean
Naknek	Smolt outmigration	1956 to present	Geometric mean
Egegik	Escapement-return	1945 to present	Linear regression
Ugashik	Smolt outmigration	1958 to present	Geometric mean

Independent of the river system forecasts data from samples of salmon in the high seas and the relationship of the returns of certain year groups are utilized. The assumptions inherent in the use of these methods and the reliability expected may be stated as follows.

1. Analysis based on escapement-return relationship. It is assumed that the highly variable mortalities do not mask the computed relationships. The variable age of return also reduces the reliability of the method.

2. Smolt outmigration and return relationship. In some of the major rivers of Bristol Bay, indices of the number of smolts migrating to the sea have been obtained for several years. These data are subject to sampling errors, the representativeness of the sampling plan, and the variations in salt water mortality.

3. The relationship of the return of certain year groups. Bristol Bay salmon commonly spend two or three years in the ocean and the relation of the return after three years to the return after two years may be used for a forecast. The variable age of return reduces the reliability of this method.

4. Abundance of immature salmon at sea. Abundance indices of the immature red salmon in the vicinity of the eastern and central Aleutian Islands have been obtained for several years. These data have been obtained independently from two sources: (i) the catches of purse seine vessels operating south of the Aleutian Islands where the immature red salmon pass in very large numbers during the mid-summer, and (ii) by gill net vessels operated over a somewhat larger area of the North Pacific Ocean in the central Aleutian Islands. These indices assume a representative sampling plan in relation to salmon of Bristol Bay origin.

FORECASTS BY RIVERS BASED ON PARENT CYCLE ESCAPEMENTS AND SMOLT ABUNDANCE

Our first step in the forecast is to bring together the data from cycle analysis or outmigration of smolts for each of the major rivers.

Nushagak System

The Nushagak escapement enters three major spawning areas: Wood River, Igushik River, and the Tikchik Lakes. Data on escapement to each of these areas are available since 1946, but the commercial catch from Nushagak Bay cannot be separated directly into parts bound for the separate rivers. Therefore, the annual percentage of each system's escapement has been applied to the catch and the total run to each spawning system estimated for the last twelve years.

Wood River

Indices of the outmigrations of smolts have been obtained in the Wood River system since 1951. These have had a rather variable relation with the return

because of varying marine mortality, but enough data are available to permit a regression analysis. Original data are transformed to logarithm scales to simplify presentation and to help satisfy certain requirements for statistical analysis (Figures 1 and 2). The expected return in 1964 from 1962 seaward migration is 700,000 adult reds; from the 1961 seaward migration, 700,000. Thus, a total return to the Wood River system of 1,400,000 fish is expected on the basis of the smolt index-adult return relationship.

Tikchik Lakes

The forecast for the Tikchik system is based on escapement-return relationships (Table 2).

Simple linear regression was used to formulate an estimate of the return for 1964 based on the relationship of escapement to 4-year and 5-year return (Figures 3 and 4). The expected return in 1964 is 46,000 red salmon from the 1960 escapement and 70,000 red salmon from the 1959 escapement for a total return in 1964 of 116,000 red salmon.

Igushik Lakes

The Igushik system forecast is also based on escapement-return relationships (Table 3). Linear regression was used to obtain estimates of 281,000 red salmon from the 1960 escapement and 654,000 red salmon from the 1959 escapement for a total return in 1964 of 935,000 red salmon (Figures 5 and 6).

Naknek-Kvichak System

The largest red salmon run in Alaska enters the Kvichak River system which together with the smaller Naknek and Branch (Alagnak) system receives the runs going through this fishing area.

The best information available on which to base a forecast are the indices of the outmigration of smolts which have been obtained since 1955. The 1964 Kvichak run will originate from the smolt migrations of 1961 and 1962. The indices and the return of adults after two and three years in the ocean are shown in Table 4.

The geometric mean of the return per index point multiplied by the year group index provides an estimate for the coming year. Thus, the expected return of fish after two years in the ocean from the index of 1962 is approximately 8,210,000; after, three years in the ocean from the index of 1961 it is approximately 60,000, for a total return in 1964 to the Kvichak system of 8,270,000 fish.

Branch River

There is little information available upon which to base a forecast of the 1963 Branch (Alagnak) River red salmon run. Total runs and escapement data exist for the years 1955-1963 (Table 5). The sparse age composition data available indicate a dominance of age group 4_2 red salmon in the returns (approximately 80 percent).

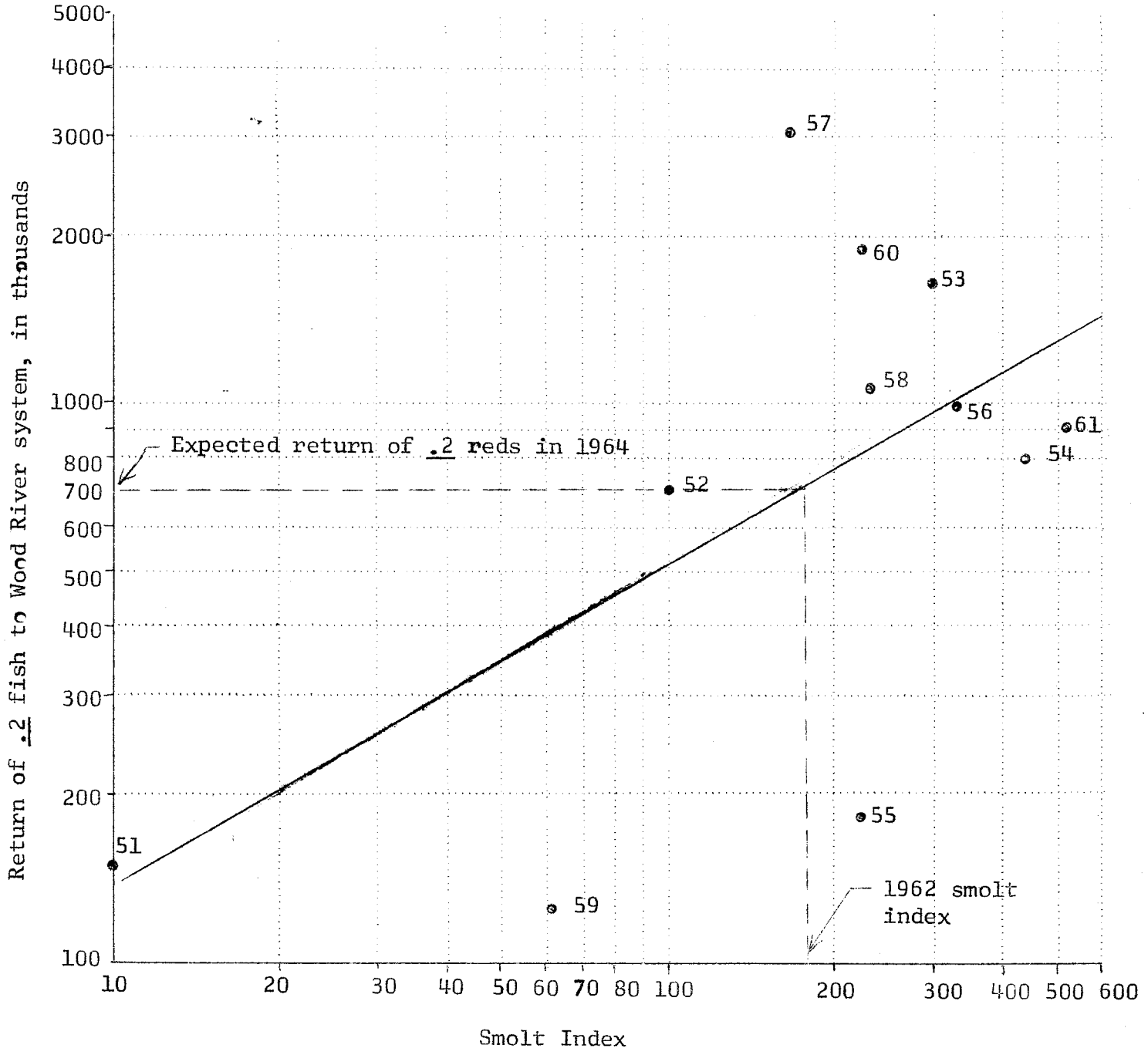

Figure 1. Relationship between Wood River smolt index and return of .2 reds to Wood River. Years indicate years of seaward migration (on log-log scale).

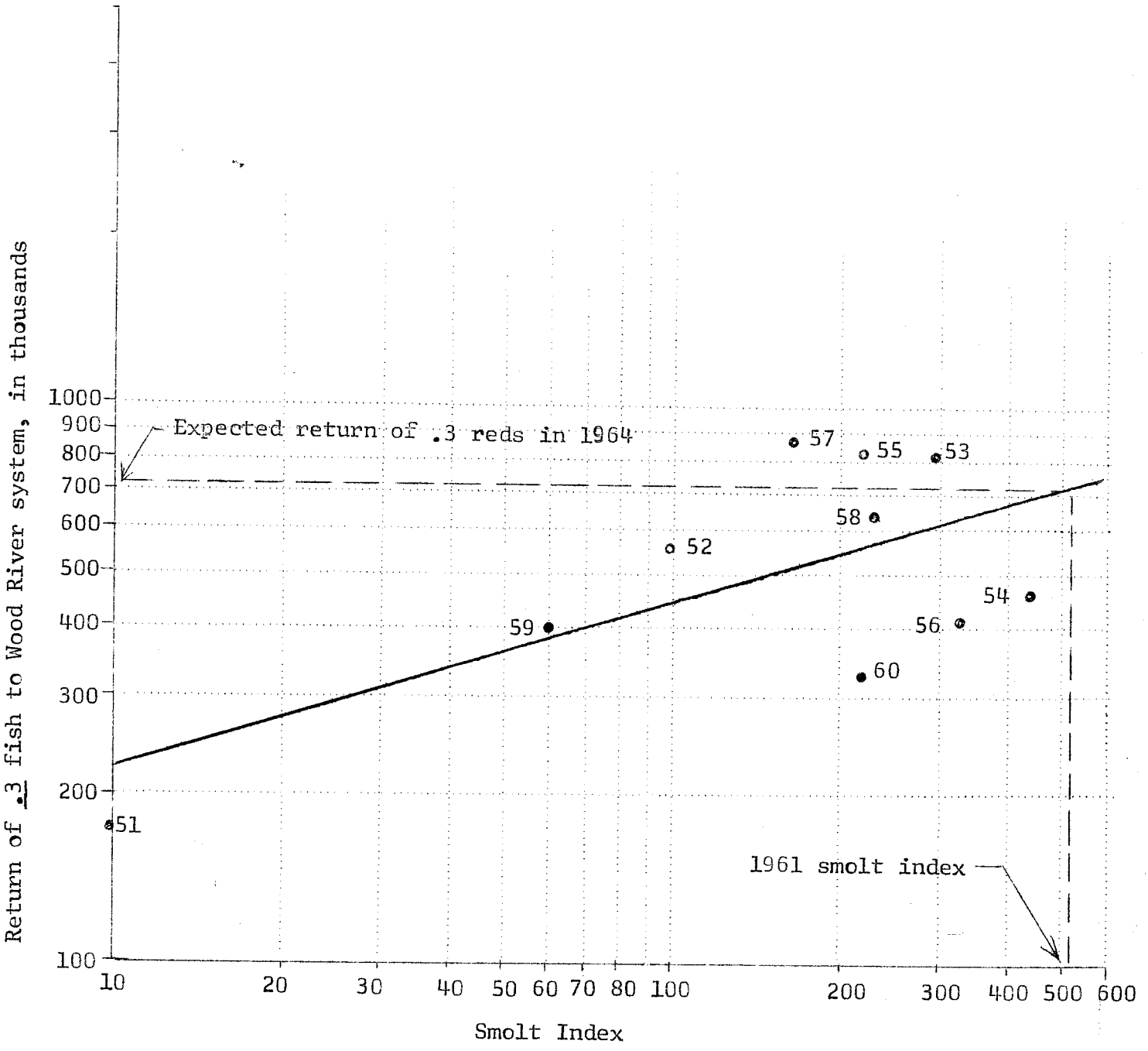

Figure 2. Relationship between Wood River smolt index and return of .3 red to Wood River. Years indicate years of seaward migration (on log-log scale).

Table 2. Tikchik Lakes - escapement and returns.

Year	Escapement	4-yr. return	5-yr. return
1950	42,000	7,000	10,000
1951	39,000	13,000	53,000
1952	38,000	7,000	97,000
1953	189,000	39,000	312,000
1954	29,000	45,000	47,000
1955	16,000	5,000	63,000
1956	30,000[1]	206,000[1]	122,000[1]
1957	67,000	5,000	19,000
1958	196,000	75,000	332,000
1959	49,000	66,000	(70,000)
1960	146,000	(46,000)	

1964 forecast is shown in parenthesis.

[1] The 1956 figures were considered outliers and omitted from the calculations.

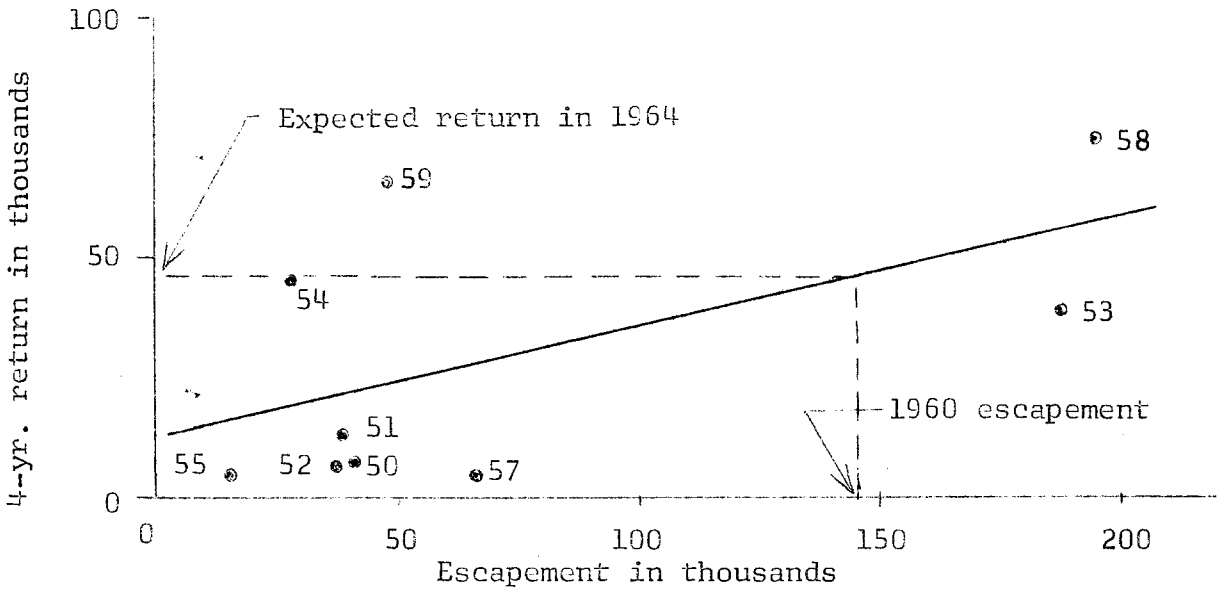

Figure 3. Relation of 4-yr. return to escapement Tikchik Lakes. Numbers indicate brood year.

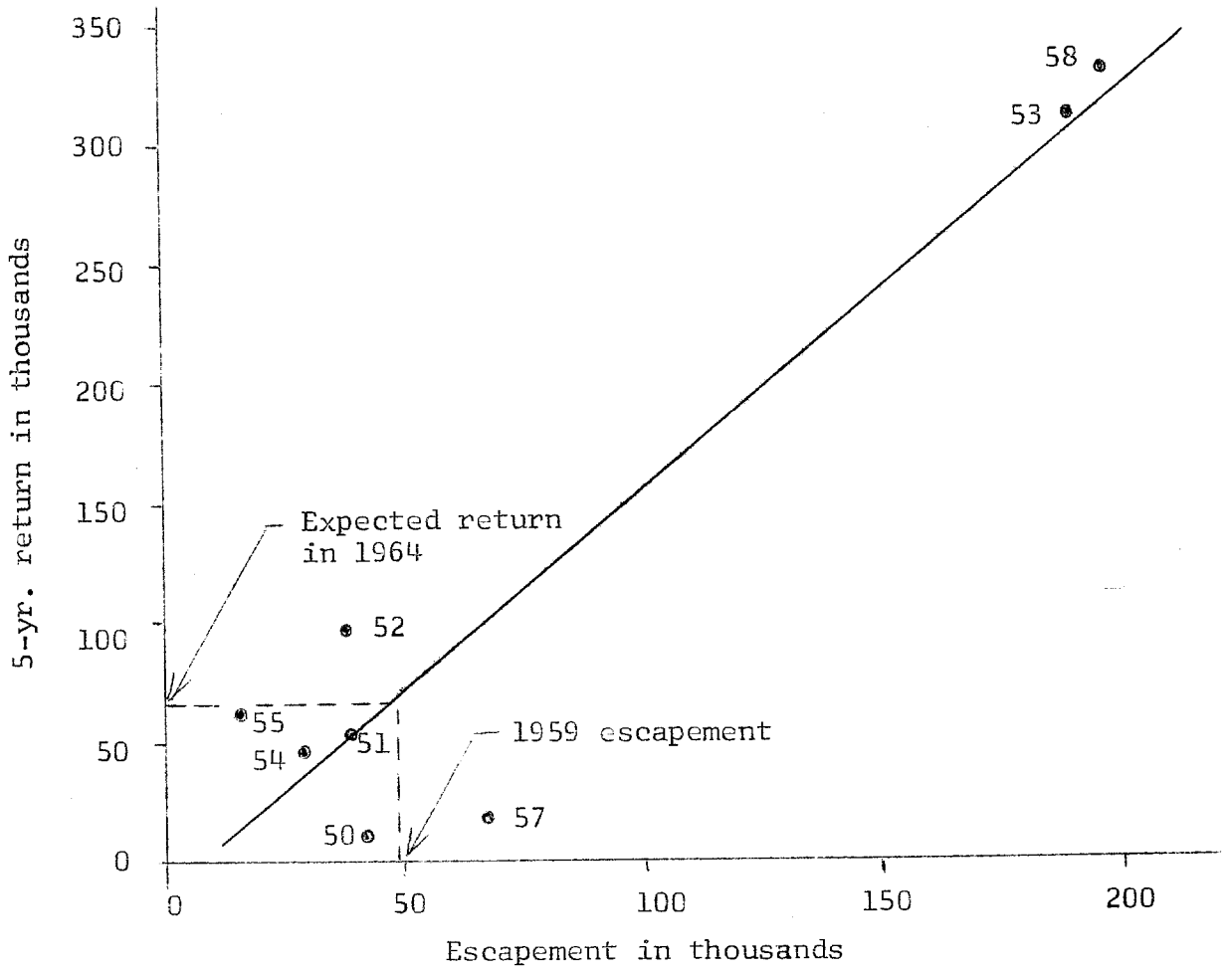

Figure 4. Relation of 5-yr. return to escapement Tikchik Lakes. Numbers indicate brood year.

Table 3. Igushik Lakes - escapement and returns.

Year	Escapement	4-yr. return	5-yr. return
1950	75,000	80,000	250,000
1951	40,000[1]	525,000[1]	620,000[1]
1952	150,000	170,000	190,000
1953	100,000	55,000	125,000
1954	80,000	40,000	375,000
1955	500,000	610,000	570,000
1956	400,000	290,000	427,000
1957	130,000	15,000	32,000
1958	107,000	22,000	70,000
1959	644,000	85,000	(654,000)
1960	495,000	(281,000)	

1964 forecast is shown in parenthesis.

[1] The 1951 figures were considered outliers and omitted from the calculations.

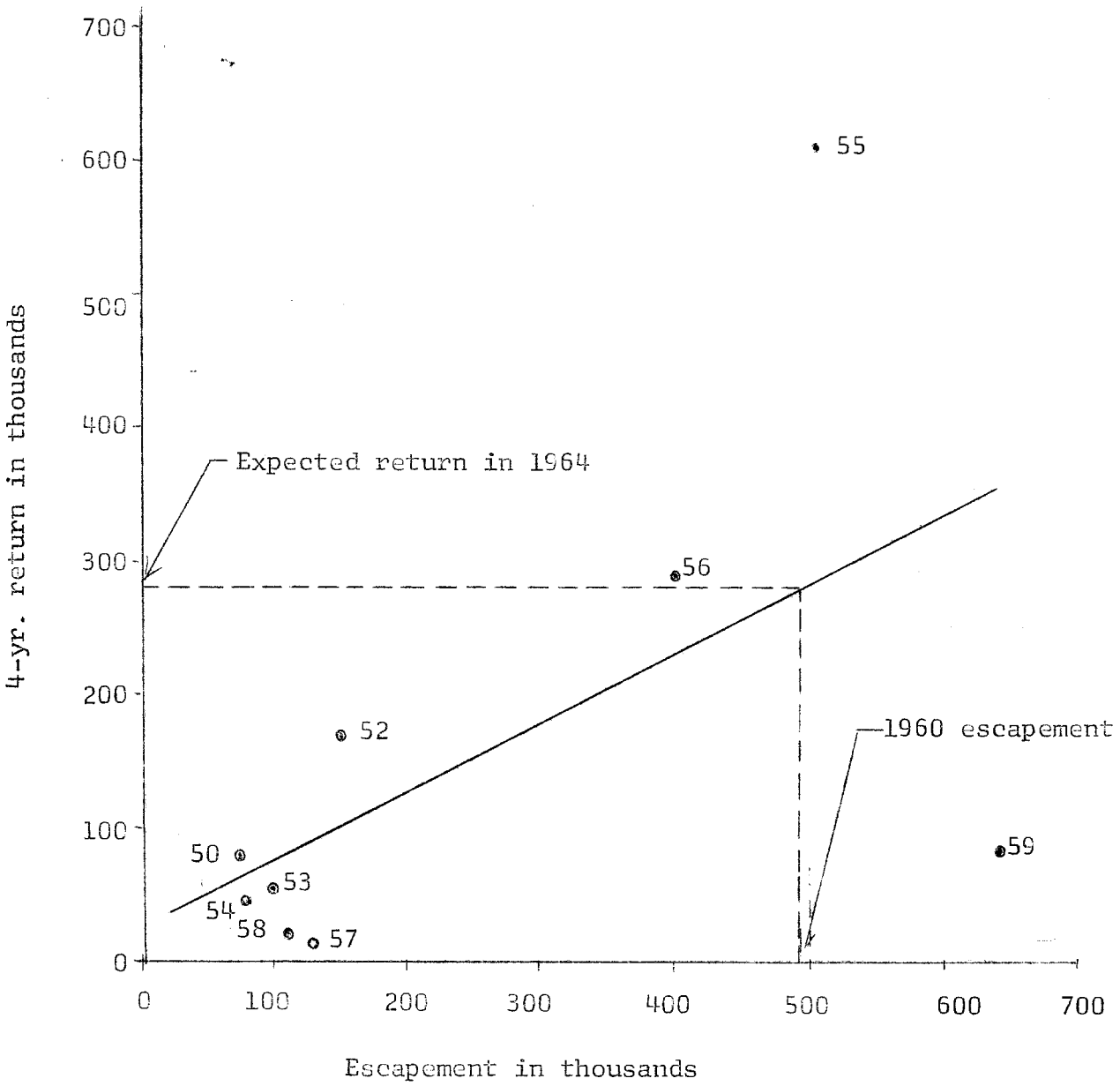

Figure 5. Relation of 4-yr. return to escapement Igushik Lakes. Numbers indicate brood year.

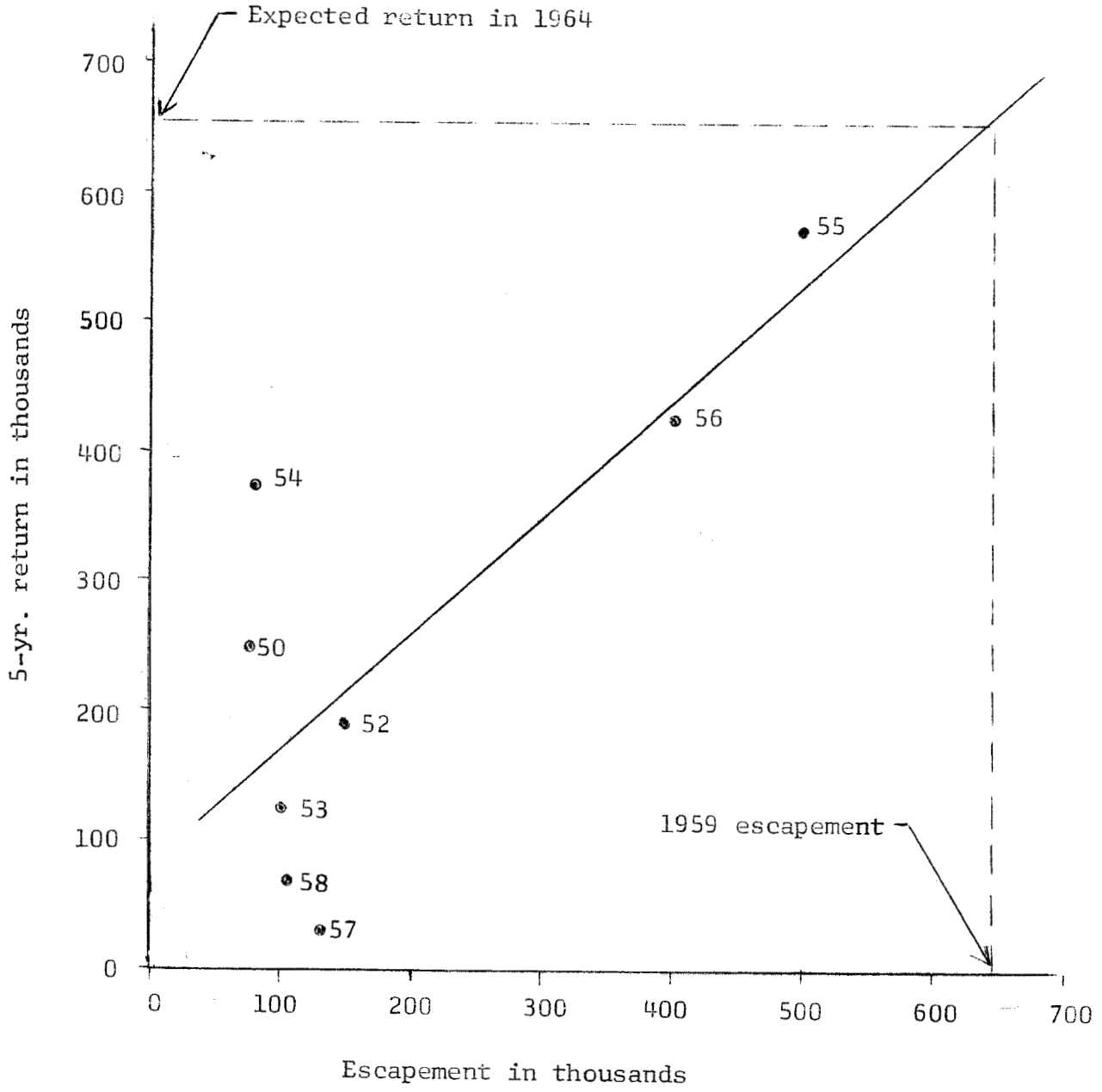

Figure 6. Relation of 5-yr. return to escapement Igushik Lakes. Numbers indicate brood year.

Table 4. Kvichak River - smolt index and return of adults in thousands of fish.

Year	Smolt index.	Return after two years		Return after three years	
		Return of - .2's	Return per index point	Return of - .3's	Return per index point
1955	7.8	2,171	278.33	632	81.03
1956	2.3	438	190.43	88	38.26
1957	0.9	853	947.78	630	700.00
1958	100.0	22,083	220.83	5,520	55.20
1959	85.9	5,308	61.79	1,331	15.49
1960	18.4	3,067	166.67	264	14.35
1961	1.1	303	275.45	(60)	54.65*
1962	36.1	(8,210)	227.43*		

* Geometric mean

Estimated return in 1964 is shown in parenthesis.

Table 5. Branch River - escapement and return in thousands of fish.

Brood Year	Escapement	Return after four years		Return after five years	
		Return	Return per spawner	Return	Return per spawner
1955	166	933	5.620	418	2.518
1956	785	1,672	2.130	56	0.071
1957	125	223	1.784	31	0.248
1958	91	124	1.363	89	0.978
1959	820	356	0.434	(373)	0.454*
1960	1,241	(2,061)	1.661*		

* Geometric mean of return per spawner.

Estimated return in 1964 is shown in parenthesis.

The 1964 run is expected to derive from the escapements of 1959 and 1960, if it is assumed that 20 percent of the run will originate from the 1959 escapement and 80 percent from the 1960 escapement, the expected run in 1964 should be approximately 2,400,000 red salmon.

Naknek River

Indices of smolt abundance have been obtained annually for the Naknek River since 1956. These have been compared with actual returns after two and three years in the ocean (Table 6).

No statistically significant relationships were indicated, therefore; simple application of the geometric mean rates of return to the indices of 1962 and 1961 results in a forecast of 1,179,000 2-ocean red salmon and 590,000 3-ocean red salmon for a total return of 1,769,000 for the 1964 season.

Egegik River

The 1964 forecast for the Egegik River is again based on escapement-return relationships (Figure 7).

The 1964 run will consist of 4-year fish arising from the 1960 escapement, 5-year fish from the 1959 escapement, 6-year fish from the 1958 escapement, and 7-year fish from the 1957 escapement; the estimated return by age groups is given in Table 7. The return is expected to consist of 960,000 2-ocean red salmon, 680,000 3-ocean red salmon; for a total return of 1,640,000 red salmon.

Ugashik River

Comparable indices of smolt abundance are available for the Ugashik River for the years 1958 through 1962, and these are used as a basis for estimating the 1964 returns (Table 8). The returns per index point indicates that approximately 740,000 red salmon might he expected from the 1962 smolt migration and 200,000 from the 1961 smolt migration.

ABUNDANCE OF YOUNG SALMON AT SEA

Purse Seine Catch Data

The abundance and age composition of immature red salmon at sea as indicated by the purse seine catches south of Adak Island has been used as an index to the abundance and age composition of the following year's run to Bristol Bay. Seining has been conducted in June, July, and August each year since 1956 and this data is used to express the relation of the average seine catches to the runs in Bristol Bay.

A basic assumption underlying the use of this index is that we are obtaining a representative sample from the flow of immature reds through the index area. The evidence from the direction of catch of the purse seines and from the width of the column of fish passing Adak Island suggests that a large proportion of

Table 6. Naknek River smolt indices and adult return.

Year	Smolt index	Return after 2 years		Return after 3 years	
		Thousands of fish	Thousands per index point	Thousands of fish	Thousands per index point
1956	60	277	4.62	415	6.92
1957	30	2,821	94.03	1,357	45.23
1958	100	590	5.90	1,045	10.45
1959	116	35	0.30	715	3.58
1960	66	747	11.32	751	11.38
1961	56	770	13.75	(590)	10.54*
1962	168	(1,179)	7.02*		

* Geometric mean of return per index point.

Estimated return in 1964 is shown in parenthesis.

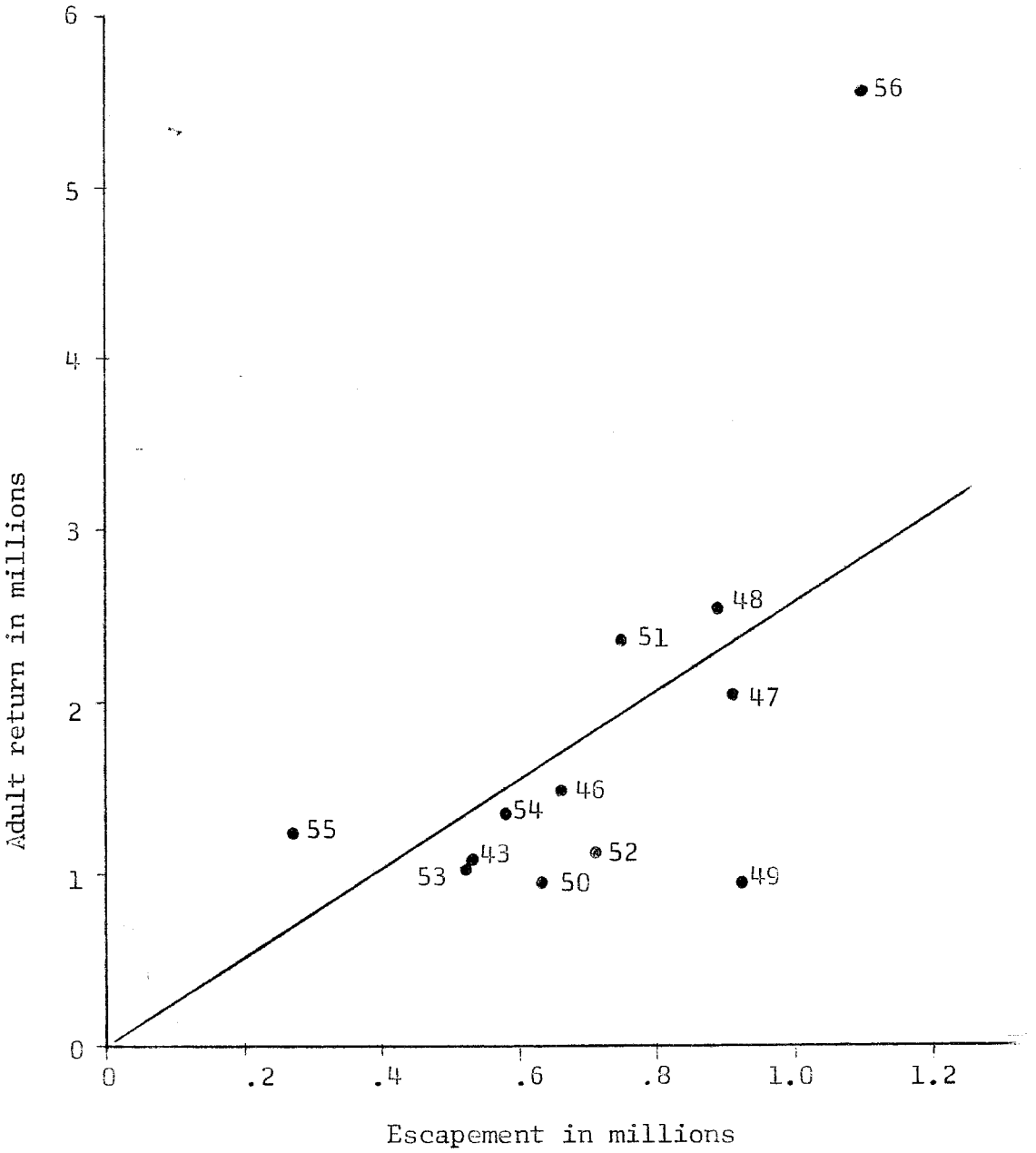

Figure 7. Relation of return to escapement Egegik River. Numbers indicate brood year.

Table 7. Estimated returns from brood years 1957-1960, Egegik system.

Brood Year	Escapement in thousands	Estimated return in thousands[1]	Estimated return by age groups-1964 returns[2]					
			4_2	5_2	5_3	6_3	6_4	7_4
1957	390	990						70
1958	250	630				290	20	
1959	1,070	2,720		320	760			
1960	1,800	4,570	180					

[1] Determined from data in Figure 6.

[2] Based on average age composition as follows: 4_2, 4 percent; 5_2, 12 percent; 5_3, 28 percent; 6_3, 46 percent; 6_4, 3 percent; 7_4, 7 percent.

Table 8. Ugashik smolt indices and adult returns.

Year	Smolt Index	Return after 2 years		Return after 3 years	
		Thousands of fish	Thousands per index point	Thousands of fish	Thousands per index point
1958	100.00	2,855.7	28.6	613.3	6.1
1959	41.98	131.8	3.1	122.1	2.9
1960	76.49	379.8	5.0	175.2	2.3
1961	59.60	401.7	6.7	(205.0)	3.4*
1962	100.88	(742.5)	7.4*		

* Geometric mean of return per index point.

Estimated return in 1964 is shown in parenthesis.

the immature Bristol Bay red salmon present in the sea travel past Adak during the summer months. Therefore, if an index of the number of salmon in this movement is obtained, it should be representative of the numbers in the Bristol Bay stock.

Sampling off Adak has usually been in an area about 12 miles offshore, and it appears that this place is in the main path of immature red salmon in most years. But in 1957 the main body of the run was apparently further offshore, (according to the distribution found by research vessels using gill nets) and thus an abnormally low index value was obtained that year.

Since the purse seine indices represent samples from the high seas population of red salmon it is necessary to adjust the return to Western Alaska for the catches of Japanese high seas red salmon which would ordinarily be expected in the return (Table 9). Using these figures the Adak purse seine sampling in 1963 indicates that the expected return of 2-ocean red salmon in 1964 is 14.5 million and the expected return of 3-ocean red salmon is 4.8 million for a total return of 19.3 million red salmon (Table 10, Figures 8 and 9).

Gillnet Catch Data

Another method of forecasting the red salmon run to Western Alaska is based on the abundance of 1 winter-at-sea fish and 2 winter fish in the high seas gillnet catches related to the abundance of returning 2 and 3 winter-at-sea red salmon the following year. The high seas index area used in the gillnet forecast is bounded roughly be the Aleutian chain and latitude 50° N. and between the longitudes 170° W. and 173° E., an area of approximately 90,000 square miles. Generally the forecasts based on gillnet catches have not been accurate because, among other things, there is lack of specific knowledge of the distribution by time and area of immature red salmon and of the racial origin of the stocks. In addition, fishing cruises and station patterns have not been programmed with forecasting as the specific objective.

In 1963 the distribution of red salmon south of Adak Island by fishing repetitive nets between Adak and latitude 50° N. was analyzed. In all, 43 gillnet sets were made between July 3 and September 11. The average catch per shackle of gillnet by time period and distance offshore is given in Table 11. During the 1963 season the greatest abundance of 1 winter-at-sea red salmon was found within 20 miles of shore at this longitude. Two winter red salmon were most abundant within 20 miles of shore during the latter half of July, but appeared most abundant further offshore in early August.

The highest catches of 1 winter red salmon (three instances where the catch per shackle was in excess of 40 fish) occurred at 11, 15, and 19 miles offshore. Similarly, two relatively high catches of 2 winter red salmon (over 6 fish per shackle) occurred at 15 and 22 miles offshore.

Results of tabulating catches by distance offshore for other years and longitudes are shown in Tables 12, 13, and 14. A lack of sampling within 20 miles of shore prevented the determination of the red salmon distribution for these times and areas. These data do reveal, however, that in many instances relatively high catches were made many miles offshore at different longitudes along the central Aleutian chain area.

Table 9. Total red salmon runs to western Alaska, 1956-1963 (in thousands of fish).

YEAR	CATCH			ESCAPEMENT			EST. TOTAL RUN TO W. ALASKA		
	W.Alaska Catch 1/	Japanese High Seas Catch Matures 3/	Japanese High Seas Catch Immatures Previous Year 4/	Bristol Bay	Estimated Other Western Alaska Areas 5/	Percent of .2 Age Matures in Bristol Bay	Age .2	Age .3 (incl. immatures)	Total
1956	10,252	3,115	60	12,483	216	84	21,895	4,230	26,125
1957	6,631	6,951	1,114	4,693	355	24	4,471	15,273	19,744
1958	3,460	584	144	2,423	474	52	3,609	3,476	7,085
1959	5,249	678	151	8,132	641	81	11,907	2,944	14,851
1960	14,411	4,008	1,185	22,386	707	87	36,115	6,582	42,697
1961	12,307	6,420	936	6,200	393	32	8,102	18,154	26,256
1962	4,990	1,313	653	5,718	272	69	8,482	4,464	12,946
1963	3,204 2/	1,014	399	3,954	437	57	4,907	4,101	9,008

Sources: Catches 1956-1962 - INPFC stat. yearbooks; 1963 ADF&G and FWS unpublished data.

Escapements 1956-1961 - ADF&G, FWS, and FRI tables of unpublished data. 1962 - ADF&G mimeo. tables. 1963 - ADF&G and FWS unpublished data.

Age composition of run - 1956-1959 - Compiled by Fredin from ADF&G, FWS & FRI data; 1960-1962 - From ages in catch and escapement as compiled in ADF&G, FWS, and FRI tables, unpublished. 1963 - ADF&G and FWS unpublished data.

1/ Western Alaska districts including Bristol Bay, Yukon, Kuskokwim, Aleutians and north side Alaska Peninsula.

2/ Includes estimate of 437,000 for Yukon, Kuskokwin, north side Alaska Penn., and Aleutians obtained by averaging the catches of the preceding 7 years.

3/ Includes for 1956-1959 the high seas catches east of 170° E during May and those east of 175° during June. Includes for 1960-1963 the May and June 1-10 catches east of 170° E, the June 11-20 catches east of 175° E, and the June 21-30 catches east of 180°.

4/ Includes red salmon taken on high seas at times and in areas where immature Bristol Bay reds are in large majority. These are mostly .2 age fish that otherwise would be expected to mature and return to Bristol Bay as .3's. Includes July and August catches east of 170° E, and June 21-30 catches between 175° E and 180° for those years with catch data by 10-day periods (1960-1963).

5/ Escapement arbitrarily estimated as same as catch (from INPFC stat. yearbooks).

Table 10. Average catch per seine set of immature red salmon south of Adak Island compared with following year's return to Bristol Bay and the 1964 forecast values based on regression equations.

Year of catch at sea	Average catch/set (index points) -.1	-.2	All Ages	Year of B.B. Catch	"Bristol Bay" run (millions) -.2	-.3	All Ages
1956	16.4	29.2	45.6	1957	4.5	15.3	19.7 1/
1957	4.1	2.9	7.0	1958	3.6	3.5	7.1
1958	39.0	3.2	42.2	1959	11.9	2.9	14.8
1959	126.1	14.5	140.6	1960	36.1	6.6	42.7
1960	12.9	28.6	41.5	1961	8.1	18.2	26.2 1/
1961	19.8	1.9	21.7	1962	8.5	4.5	12.9 1/
1962	20.5	10.2	30.7	1963	4.9	4.1	9.0
1963	46.6	6.9	53.5	1964	(14.5) 2/	(4.8) 2/	(19.3)

1/ Discrepancy between total and sum of .2 and .3 ages due to rounding errors

2/ Regression equations

$$Y_2 = 1.95619 + .26840X_1$$

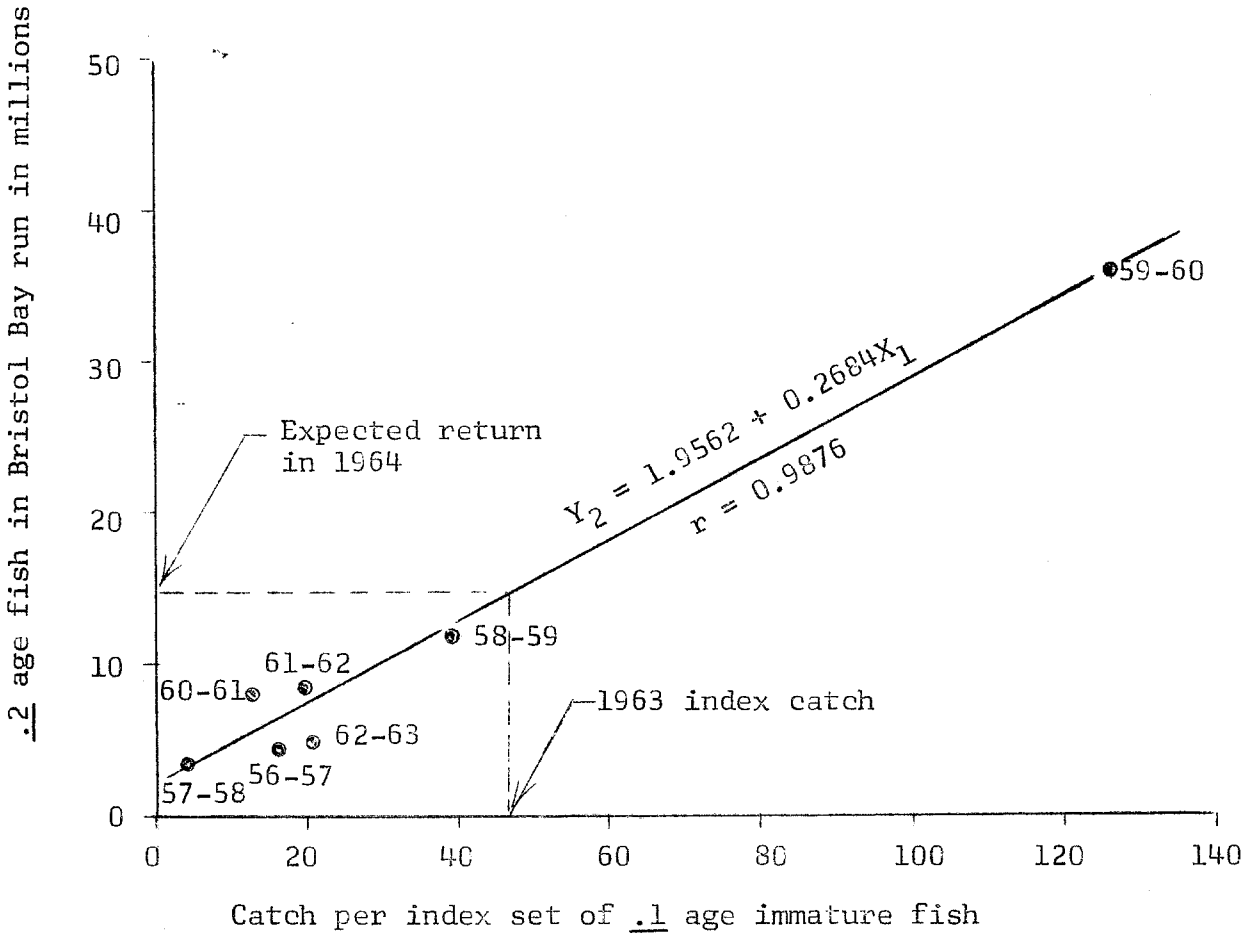

Figure 8. Regression of numbers of .2 age red salmon in Bristol Bay on catch per index set of .1 age immature red salmon the previous year.

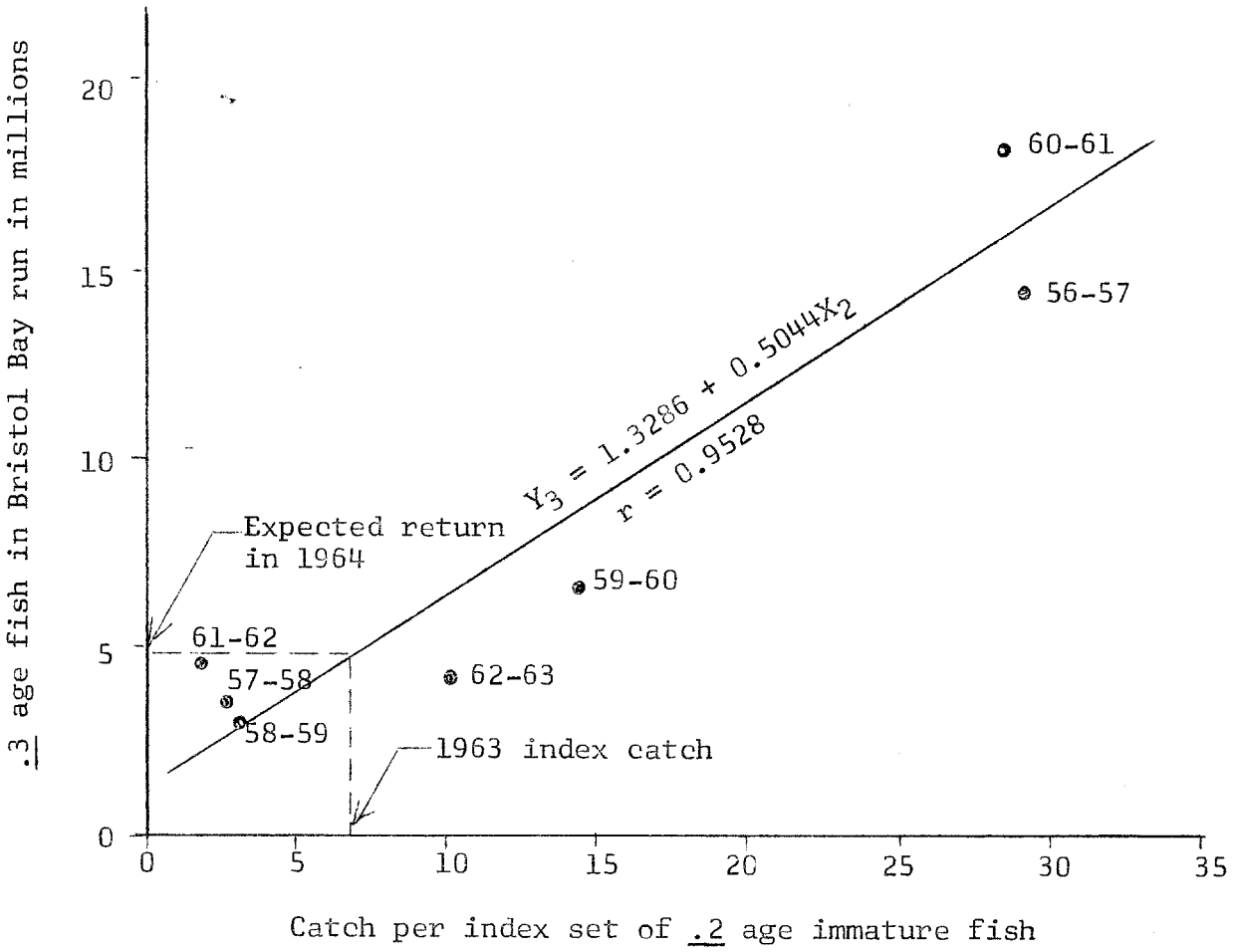

Figure 9. Regression of numbers of .3 age red salmon in Bristol Bay on catch per index set of .2 age immature red salmon the previous year.

Table 11. Average catch per shackle of sockeye salmon by distance from land along 176° 20' W. longitude, 1963 summer season.

176 20' W. Date	0-20	21-40	41-60	61-80	81-100	101-120
			1 Winter Sockeye			
July 1-15	.300	.325	.200	-	-	-
July 16-31	27.775	5.150	5.950	2.100	-	-
August 1-15	46.067	6.250	.700	5.500	-	.350
August 16-31	11.511	2.920	-	-	-	-
Sept. 1-15	-	6.876	.600	1.788	1.900	-
			2 Winter Sockeye			
July 1-15	.185	.952	.556	-	-	-
July 16-31	6.806	4.722	4.083	.222	-	-
August 1-15	1.375	3.222	.467	3.861	-	.806
August 16-31	.449	.461	-	-	-	-
Sept. 1-15	-	1.938	.444	2.653	.833	-

Table 12. Average catch per shackle sockeye salmon by distance from land and according to longitude, 1960 summer season.

Longitude & time period	0-20	21-40	41-60	61-80	81-100	101-120	121-140
			1 Winter Sockeye				
			Distance from land (miles)				
170° W. 7/17-23	-	3.750	14.500	2.500	3.125	4.875	1.500
173° W. 7/11-15	-	.375	.875	.375	.250	-	-
176° 30' W. 8/14-20	7.375	3.000	2.500	.875	-	-	-
178° E. 7/27-8/1	-	.125	3.875	.625	3.625	-	-
173° E. 7/16-19	-	1.563	2.125	0	-	-	-
			2 Winter Sockeye				
170° W. 7/17-23	-	1.964	6.214	3.750	3.250	5.714	1.786
173° W. 7/11-15	-	5.536	3.214	2.000	.786	-	-
176° 30' W. 8/14-20	12.250	8.286	7.964	7.464	-	-	-
178° E. 7/27-8/1	-	5.357	10.321	8.214	6.679	-	-
173° E. 7/16-19	-	5.250	4.143	2.429	-	-	-

Table 13. Average catch per shackle of sockeye salmon by distance from land and according to longitude, 1961 summer season.

Longitude & time period	Distance from land (miles) 0-20	21-40	41-60	61-80	81-100	101-120	121-140
1 Winter Sockeye							
169° W. 8/16-17	-	-	.625	-	2.500	-	-
171° W. to 172° W. 8/10-13	-	-	1.000	-	2.875	1.000	.125
175° W. 8/4-8	-	-	1.250	-	1.375	1.125	.750
176° W. to 178° 30' W. 7/10-14	0	-	.125	0	0	-	0
177° E. 30' to 179° E. 7/15-26	4.875	5.500	.250	-	0	-	-
174° E. to 175° E. 7/27-30	-	-	3.250	5.375	-	-	-
2 Winter Sockeye							
169° W. 8/16-17	-	-	.143	-	.500	-	-
171° to 172° W. 8/10-13	-	-	.357	-	1.857	1.929	.857
175° W. 8/4-8	-	-	1.500	-	1.107	2.357	1.538
176° 30' W. to 178° 30' W. 7/10-14	.036	-	.571	.750	.107	-	.321
177° 30' E. to 179° E. 7/15-26	2.607	4.357	1.786	-	.250	-	-
174° E. to 175° E. 7/27-30	-	-	1.857	6.821	-	-	-

Table 14. Catch per shackle of sockeye salmon by distance from land and according to longitude, 1962 summer season.

Longitude & time period	0-20	21-40	41-60	61-80	81-100	101-120	121-140
			1 Winter Sockeye				
			Distance from land (miles)				
167° W. 7/12-15	-	21.000	-	3.833	10.500	-	-
171° W. 7/17-19	-	7.500	4.167	-	.667	-	-
174° W. 7/21-25	-	6.955	9.083	1.500	3.083	-	-
176° 30' W. 7/31	-	5.364	-	-	-	-	-
179° W. 8/4-8	-	6.167	4.583	-	-	-	-
176° E. 8/9-10	-	-	2.333	-	.818	-	-
173° E. 8/11-14	-	6.545	-	8.364	6.091	-	-
			2 Winter Sockeye				
167° W. 7/12-15	-	12.579	-	1.250	7.105	-	-
171° W. 7/17-19	-	5.000	3.464	-	2.450	-	-
174° W. 7/21-25	-	3.158	8.050	.950	2.900	-	-
176° 20' W. 7/31	-	2.053	-	-	-	-	-
179° W. 8/4-8	-	6.650	5.450	-	-	-	-
176° E. 8/9-10	-	-	8.400	-	3.842	-	-
173° E. 8/11-14	-	8.053	-	9.316	3.421	-	-

These findings have a direct bearing on the accuracy of forecasts derived from gillnet catches. Since fishing cruises from 1955 to 1962 were not designed primarily to intercept immature salmon, the abundance obtained may or may not adequately represent the relative abundance of salmon in a given year. In the light of recent forecasts, it appears that sampling has not been adequate, assuming, of course, that gillnets are an adequate sampling tool.

For the 1964 forecast, the problem exists of relating gillnet abundance indices to returns to western Alaska knowing that sampling leaves much to be desired and knowing little of racial origin of the samples. In addition, since the 1963 forecast from gillnet data differed greatly from actual returns, the problem also exists of whether to include the 1962 abundance index in the calculations. As a preliminary step several combinations of sampling areas and abundance indices were treated by regression analyses. In all instances the 1963 abundance index was derived from all 43 sets made between Adak Island and latitude 50°N.

A summary of these different forecasts is given in Table 15. Considering all areas, the combination of catches of 1 winter-at-sea red salmon in the 2-1/2 inch and 3-1/4 inch mesh nets produced the best fit (items 1 and 2, Table 15). Similarly, for a 2 winter fish the best fit resulted from using catches in 3-1/4, 4-1/2, and 5-1/4 inch mesh nets (see items 1-3, Table 15). In neither case, however, are the relationships close (see appended Figures 10 and 11). Abundance indices from these mesh combinations were used in treating other combinations of areas and time periods. These other treatments, items 4 to 8, gave varying results. Usually in choosing specific sampling areas and time periods, a high coefficient of correlation value and a lower standard error of regression was obtained for the 1 winter fish but not necessarily for the 2 winter fish. In all but one instance a better fit was obtained and a higher forecast resulted when the 1962 abundance index was omitted from calculations. The range of forecast for the different treatments (using mesh combinations of 2-1/2 and 3-1/4 inch for 1 winter fish and 3-1/4, 4-1/2, and 5-1/4 inch for 2 winter fish) was from 17.1 to 24.7 million fish, a spread of 7.6 million.

Some hesitation in the use of abundance indices obtained from specific areas and time periods or obtained by deleting the 1962 data as the basis for the forecast is expressed here since this would indicate the consideration that these indices were the most representative. Although it may happen that certain sets of indices may provide the best fit to our limited data, this occurrence may not endure over longer periods. Until we possess fuller knowledge of immature red salmon movements, distributions, and racial origins, the catch data from all sets within the index area for all years will be used to derive the forecast.

The forecast for 1964, from high seas gillnet data, Table 16, calls for a return to western Alaska, including the Japanese high seas mothership catch, of 16.9 million 2 winter red salmon and 5.5 million 3 winter red salmon for a total run of 22.4 million fish.

Table 15. Summary of forecasts of sockeye to western Alaska for 1964 using gillnet abundance indices based on catches in different mesh size combinations, areas, and time periods.

Item	Sampling area and mesh combination	1 Winter			2 Winter			Total Forecast (millions)
		r value	Standard error	Forecast (millions)	r value	Standard error	Forecast (millions)	
1	All areas - $2\frac{1}{2}$" + $3\frac{1}{4}$" and $4\frac{1}{2}$" + $5\frac{1}{4}$"	.933	4.502	16.9	.512	5.671	5.1	22.2
		*.962	3.707	17.9	*.805	4.354	5.1	*23.0
2	All areas - $3\frac{1}{4}$" and $4\frac{1}{2}$" mesh only	.903	5.377	18.6	.549	5.689	5.4	24.0
3	All areas - 2 winter fish in $3\frac{1}{4}$", $4\frac{1}{2}$" and $5\frac{1}{4}$"	-	-	-	.647	5.193	5.5	
					*.865	3.675	6.0	
4	All areas - Highest 50% of catches - $2\frac{1}{2}$" + $3\frac{1}{4}$", $3\frac{1}{4}$" + $4\frac{1}{2}$" + $5\frac{1}{4}$"	.952	3.812	17.7	.649	5.177	5.7	23.4
		*.965	3.540	18.3	*.808	4.317	6.4	*24.7
5	Eastern Area - 170° W. - 179° W. July 16-Aug 15. $2\frac{1}{2}$" + $3\frac{1}{4}$", $3\frac{1}{4}$" + $4\frac{1}{2}$" + $5\frac{1}{4}$"	.964	3.305	12.2	.718	4.736	4.9	17.1
		*.975	2.962	12.9	.790	4.490	5.5	*18.4
6	Western Area 180° - 170° E. July 16-Aug. 15. $3\frac{1}{4}$" + $4\frac{1}{2}$" + $5\frac{1}{4}$" no data for 1956	Neg. corr. this combination last year			.495	5.620	5.9	
					*.906	3.091	7.4	
7	Eastern Area - July 16-Aug. 15 $3\frac{1}{4}$" and $4\frac{1}{2}$" only	.968	3.160	19.4	.489	5.778	9.5	28.9
		*.985	2.326	20.2	*.645	5.601	10.9	*31.1
8	Western Area $4\frac{1}{2}$" mesh only	-	-	-	.467	5.720	4.8	

* These are computations in which the 1962 high seas catch index and returns to western Alaska in 1963 have been deleted.

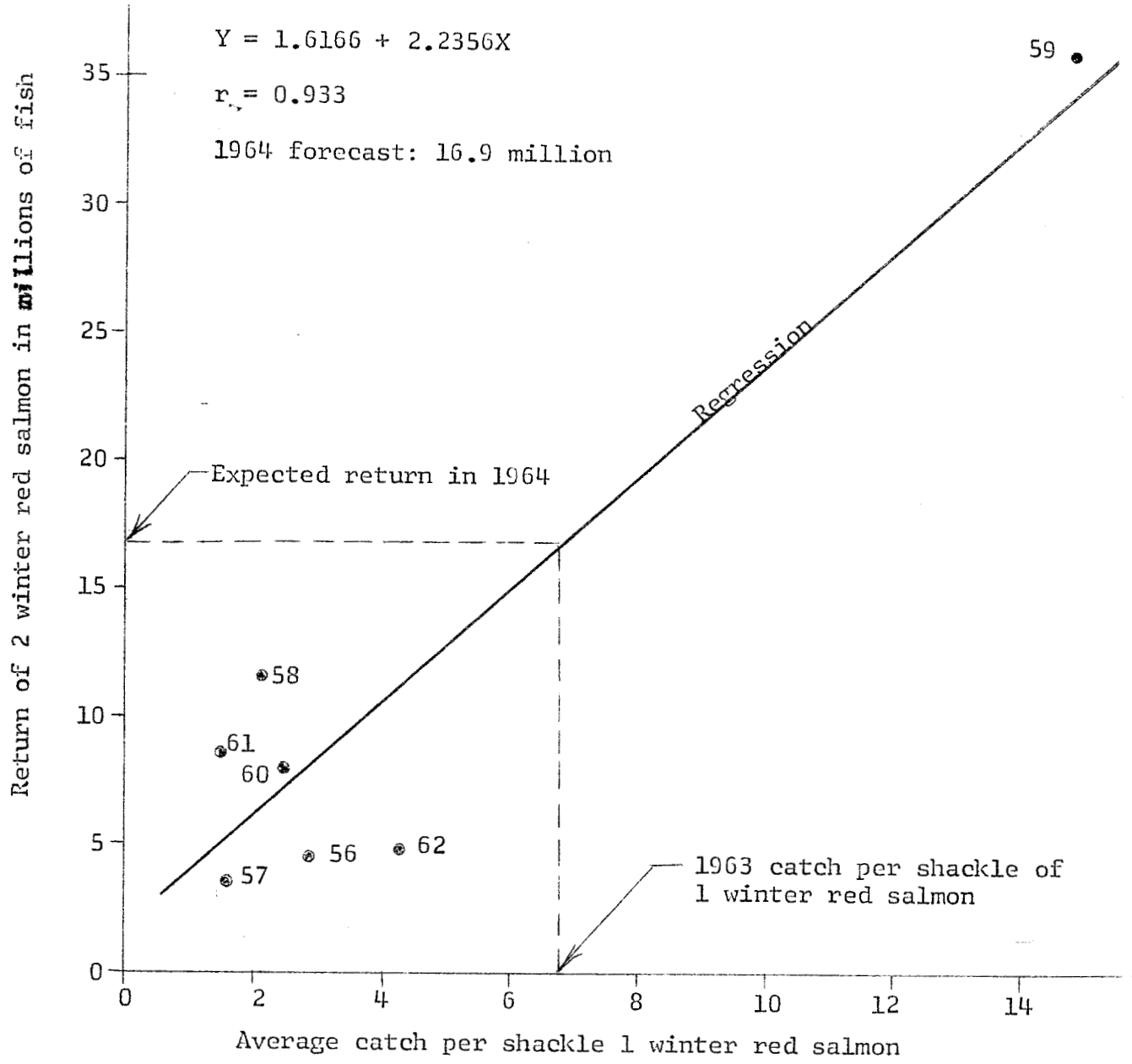

Figure 10. Regression of returns of 2 winter-at-sea red salmon on catch per shackle of 1 winter red salmon the previous year.

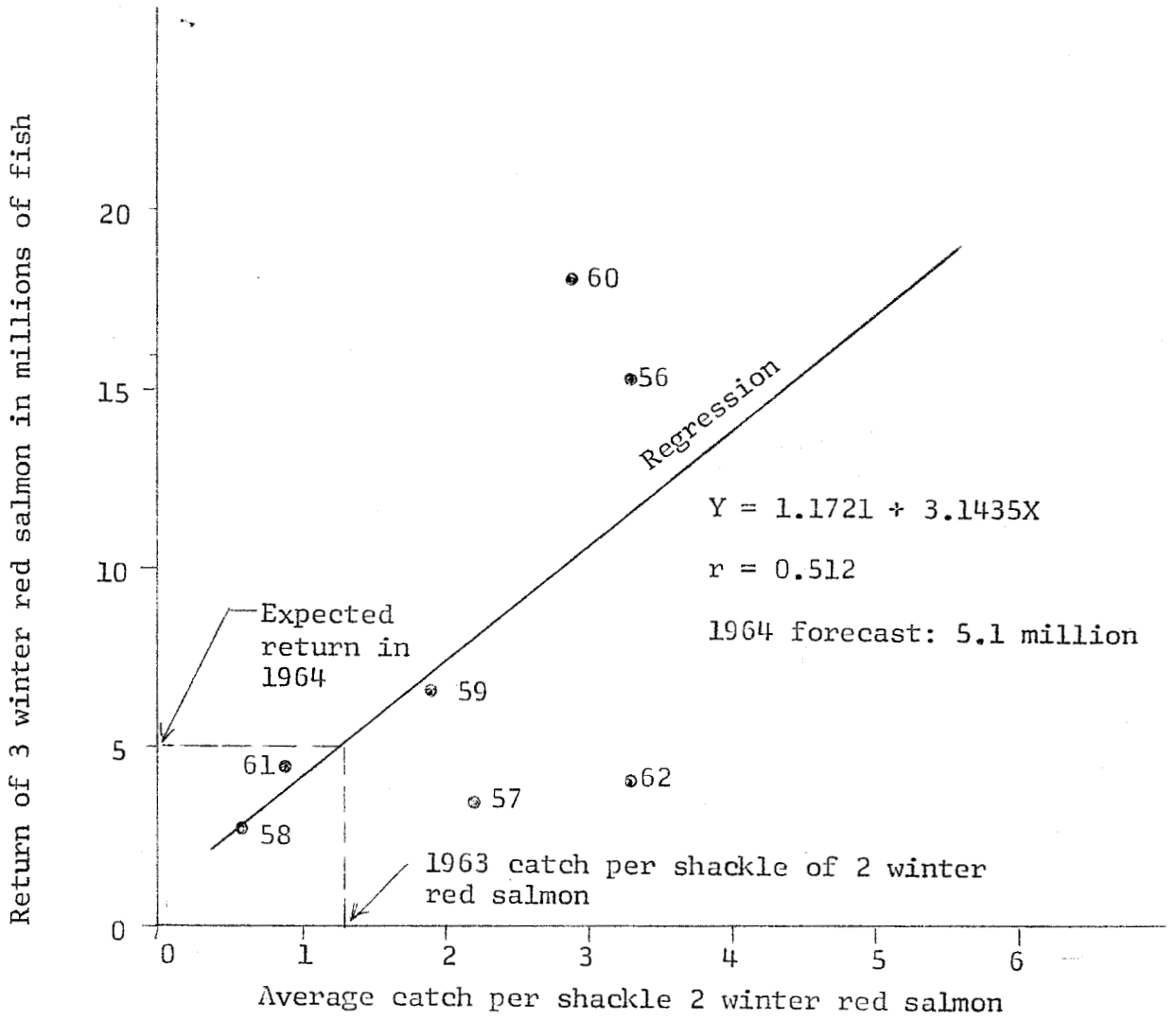

Figure 11. Regression of returns of 3 winter-at-sea red salmon on catch per shackle of 2 winter red salmon the previous year.

Table 16. Average catch per shackle of immature sockeye salmon in index area compared with following years return to western Alaska. (Index area bounded by Aleutian Chain and latitude 50°N. and between longitude 170° W. and 173° E.)

Year of catch	Number of sets	Average catch per shackle[1]		Year of return	Estimated return to Western Alaska (in thousands)[2]		
		1 winter fish in $2\frac{1}{2}$" and $3\frac{1}{4}$" mesh	2 winter fish in $3\frac{1}{4}$", $4\frac{1}{2}$", $5\frac{1}{4}$" mesh		2 winter	3 winter	Total
1956	9	2.917	2.591	1957	4,471	15,273	19,744
1957	21	1.557	1.737	1958	3,609	3,476	7,085
1958	16	2.155	.423	1959	11,907	2,944	14,851
1959	10	14.811	1.718	1960	36,115	6,582	42,697
1960	24	2.462	2.696	1961	8,102	18,154	26,256
1961	22	1.454	.737	1962	8,482	4,464	12,946
1962	16	4.293	2.683	1963	4,907	4,101	9,008
1963	43	6.824	1.247	1964[3]	(16,900)	(5,500)	(22,400)

[1] These catch per shackle figures differ from those given past years. Formerly weighted averages were used, in this table equal weight is given to each mesh size and each set.

[2] Data on returns to Western Alaska obtained from F. R. I.

[3] 1964 forecasts shown in parenthesis.

MULTIPLE REGRESSION PREDICTION

In past years the Bristol Bay forecast has been made on the basis of independent predictions from several sources. Although recognized as somewhat inadequate, an arithmetic mean of the separate predictions was used as the forecast figure.

Data from sufficient years from both high seas and freshwater research are accumulating to the point where a multiple regression analysis now appears reasonable for separately predicting returning numbers of red salmon after 2-ocean and 3-ocean years. For our multiple regression prediction of 2-ocean fish the dependent variable is the total yearly run of 2-ocean fish to western Alaska. The three independent variables in the analysis are (1 and 2) the average catch per-index set with purse seines and the average catch-per-shackle with experimental gill nets of 1-ocean immature red salmon in the year preceding the return, and (3) a single freshwater index value for the year group combined from smolt indices and escapement-return relationships of individual Bristol Bay rivers (Table 17). The prediction of 3-ocean fish is similarly made, (Table 17) but a fourth independent variable is included, the size of the preceding year's western Alaska run of 2-ocean red salmon.

In the analysis the total returns are derived from the known or estimated catches and escapement for each Bristol Bay stream (Table 18) plus estimates of the Japanese high seas catch of Bristol Bay red salmon (Table 19) apportioned into each stream on the basis of the percent of total yearly catch and escapement contributed by each stream (Table 20).

The high seas indices and the incorporation of the 2-ocean return into the regression model for predicting 3-ocean returns need no further comment. The derivation of the freshwater index value, however, is somewhat involved and requires some explanation.

The need is to combine by year information from all Bristol Bay streams into two indices, one for 2-ocean returns and the other for 3-ocean returns. Indices of smolt outmigration are obtained from four of the major systems, the Wood, Kvichak, Naknek, and Ugashik Rivers (Table 21). Indices based on escapement-return relationships, which by themselves, of course yield only rough predictions, are given for the Igushik, Tikchik, Branch, and Egegik systems in Table 22. For the Igushik, Tikchik, and Branch the majority of 2-ocean fish are assumed on the average to be four years total age while the 3-ocean fish are assumed to be of five years. Thus, the index for 2-ocean return is the escapement four years previously and that for 3-ocean return is the escapement five years previously. In the Egegik River the majority of 2-ocean fish are five years of age while the 3-ocean fish are mainly six years old. The respective index values for this river are, therefore, the escapements five and six years preceding the run.

The freshwater indices given in Tables 21 and 22 are only relative abundance figures within individual river systems and are not necessarily comparable from one system to the next. Therefore, as they stand they cannot be added together to give single yearly indices for Bristol Bay. In order to standardize them, so as to make additive, 1957-1963 average returns per-index-point

Table 17. Values used in multiple regression analysis for prediction of Bristol Bay red salmon run, 1964.

2-ocean fish

Year of B.B. run	Y	X_1	X_2	X_3
1957	5.1	16.4	2.9	7.0
1958	3.6	4.1	1.6	4.7
1959	12.1	39.0	2.2	3.0
1960	35.0	126.1	14.8	23.5
1961	8.8	12.9	2.5	20.4
1962	8.5	19.8	1.4	7.2
1963	5.0	20.5	4.3	6.2
1964		46.6	6.8	13.9

Y = millions of fish in run.
X_1 = purse seine index 1-ocean check immatures the year preceding the run.
X_2 = gill net index 1-ocean check immatures the year preceding the run.
X_3 = total adjusted freshwater index.

3-ocean fish

Year of B.B. run	Y	X_1	X_2	X_3	X_4
1957	14.8	29.2	2.6	11.4	21.9
1958	3.7	2.9	1.7	5.6	5.1
1959	2.9	3.2	0.4	3.8	3.6
1960	6.2	14.5	1.7	3.1	12.1
1961	17.4	28.6	2.7	10.7	35.0
1962	4.5	1.9	0.7	10.4	8.8
1963	4.0	10.2	2.7	4.8	8.5
1964		6.9	1.2	5.2	5.0

Y = millions of fish in run.
X_1 = purse seine index 2-ocean check immatures the year preceding the run.
X_2 = gill net index 2-ocean check immatures the year preceding the run.
X_3 = total adjusted freshwater index.
X_4 = previous years' Bristol Bay run of 2-ocean checks.

Table 18. Combined catches and escapements of red salmon for western Alaska rivers, 1957-1963, in million of fish[5/].

2-ocean fish

Year of run	Igushik[1/]	Tikchik[1/]	Wood River[1/]	Kvichak[2/]	Naknek[2/]	Branch[2/]	Egegik[2/]	Ugashik[2/]	Others Inc. Togiak[3/]	Total
1957	.055	.039	.174	1.962	.081	.217[4/]	.168	.266	.514	3.476
1958	.040	.045	.964	.409	.242	.066	.428	.411	.663	3.268
1959	.610	.005	3.056	.842	2.737	1.502	1.393	.400	.980	11.525
1960	.290	.206	1.049	22.510	.622	1.730	2.520	1.475	1.101	31.503
1961	.015	.005	.125	5.021	.043	.004	.724	.086	.760	6.783
1962	.022	.075	1.810	3.119	.562	.080	1.017	.409	.475	7.569
1963	.105	.041	.883	.300	.770	.284	.836	.401	.755	4.375

3-ocean fish

1957	.190	.097	.433	4.621	1.424	.067[4/]	1.035	.299	.276	8.442
1958	.125	.312	.823	.655	.295	.123	.312	.299	.357	3.301
1959	.375	.047	.414	.074	.437	.220	.333	.229	.528	2.657
1960	.570	.063	.860	.089	1.252	.336	.725	.049	.593	4.537
1961	.427	.122	.634	5.522	1.308	.369	2.664	.620	.410	12.076
1962	.032	.019	.399	1.358	.554	.054	.646	.121	.256	3.439
1963	.076	.323	.306	.260	.748	.033	.856	.175	.406	3.183

1/ 1957-1962 from Forecast of Bristol Bay Red Salmon Run in 1963, A.D.F. & G. Informational Leaflet #23.

2/ 1957-1962 from tables provided by Dr. Charles DiCostanzo, U.S. Bureau of Commercial Fisheries, Auke Bay, Juneau, Alaska.

3/ Escapements estimated as equal to catch, as listed in INPFC statistical yearbooks. Numbers of .2 checks to .3 checks assumed 65:35 based on overall ratio for all other Bristol Bay river systems, 1957-63.

4/ Age composition data not available for 1957. Total run apportioned by averaging age composition for following 6 years.

5/ All 1963 data from Bristol Bay Red Salmon Run in 1963, A.D.F. & G. Informational Leaflet #35.

Table 19. Estimates of Japanese high seas catch of Bristol Bay red salmon, 1956-1963, in million of fish[1/].

Year	Number of immatures[2/] previous year	Number of matures
1956	.060	3.115
1957	1.114	6.951
1958	.144	.584
1959	.151	.678
1960	1.185	4.008
1961	.936	6.420
1962	.653	1.313
1963	.399	1.014

1/ 1956-1962 from I.N.P.F.C. Statistical yearbooks; 1963 from preliminary unofficial estimates.

2/ Includes red salmon taken on high seas at times and in areas where immature Bristol Bay reds are in large majority. These are mostly 2-ocean fish that otherwise would be expected to mature and return to Bristol Bay as 3's. Includes July and August catches of 170° E., and June 21-30 catches between 175° E. and 180° for those years with catch data by 10-day periods.

3/ Includes for 1956-1959 the high seas catches east of 170° E. during May and those east of 175° E. during June. Includes for 1960-1963 the May and June 1-10 catches east of 170° E., and the June 11-20 catches east of 175° E., and the June 21-30 catches east of 180°.

Table 20. Total red salmon returns to western Alaska, 1957-1963, including Japanese high seas catch apportioned to separate rivers, in millions of fish 1/.

2-ocean fish

Year of run	Igushik	Tikchik	Wood	Kvichak	Naknek	Branch	Egegik	Ugashik	Others Including Togiak	Total
1957	.081	.058	.257	2.904	.120	.321	.249	.394	.760	5.144
1958	.044	.049	1.054	.447	.264	.072	.468	.449	.725	3.572
1959	.639	.005	3.202	.882	2.867	1.574	1.459	.419	1.027	12.074
1960	.322	.229	1.165	25.001	.691	1.921	2.799	1.638	1.223	34.989
1961	.019	.006	.163	6.541	.056	.005	.943	.112	.990	8.835
1962	.025	.084	2.027	3.492	.629	.090	1.139	.458	.532	8.476
1963	.118	.046	1.000	.340	.872	.322	.946	.454	.855	4.953

3-ocean fish

1957	.334	.171	.761	8.123	2.503	.118	1.819	.425	.485	14.839
1958	.141	.352	.929	.739	.333	.138	.352	.337	.403	3.724
1959	.414	.052	.458	.082	.483	.243	.368	.253	.584	2.937
1960	.784	.086	1.184	.122	1.723	.462	.997	.068	.816	6.242
1961	.614	.175	.913	7.947	1.882	.530	3.833	.892	.590	17.376
1962	.042	.025	.522	1.777	.725	.070	.845	.158	.334	4.498
1963	.096	.407	.386	.329	.944	.041	1.079	.221	.513	4.016

1/ These figures are combined catches and escapements, from Table 18, plus the Japanese catch, Table 19, apportioned to each river on the basis of percentage of catch and escapement that each river contributes to the yearly total.

Table 21. Smolt indices and returns[5] of Bristol Bay red salmon, returns in millions of fish.

Year of Index	WOOD RIVER Smolt Index[1]	Return .2	Return .3	KVICHAK Smolt Index[1]	Return .2	Return .3	NAKNEK Smolt Index[2]	Return .2	Return .3	UGASHIK Smolt Index[3]	Return .2	Return .3
1954	439		.761	109.0[4]		8.123	3.1[4]		2.503	470[4]		.425
1955	222	.257	.929	7.8	2.904	.739	7.8[4]	.120	.333	460[4]	.394	.337
1956	327	1.054	.458	2.3	.447	.082	6.0	.264	.483	32	.449	.253
1957	165	3.202	1.184	.9	.882	.122	3.0	2.867	1.723	19	.419	.068
1958	231	1.165	.913	100.0	25.001	7.947	10.0	.691	1.882	456	1.638	.892
1959	61	.163	.522	85.9	6.541	1.777	12.2	.056	.725	187	.112	.158
1960	223	2.027	.386	18.4	3.492	.329	6.6	.629	.944	352	.458	.221
1961	519	1.000		1.1	.340		5.6	.872		271	.454	
1962	17			36.1			16.4			460		

1/ From F. R. I. unpublished tabular data.

2/ From Summary Report of Studies on the Optimum Escapement of Sockeye Salmon in Southwestern Alaska, 1961-1962, F. R. I. and U. S. Bureau of Commercial Fisheries joint MS.

3/ From Ugashik River Smolt Studies, 1963 U. S. Bureau of Commercial Fisheries MS, by Herbert W. Jaenicke.

4/ Indices not available during early years. These figures derived from known escapements, average freshwater age compositions of the outmigrations, and relationships between smolt production and escapement as given in Figures 11, 17, and 18 of Summary Report of Studies on the Optimum Escapement of Sockeye Salmon in Southwestern Alaska, 1961-1963, F. R. I. and U. S. Bureau of Commercial Fisheries joint MS.

5/ All return figures from Table 20.

Table 22. Returns[1] and indices based on escapements, Bristol Bay red salmon, in millions of fish.

Year of escapement	IGUSHIK			TIKCHIK			BRANCH			EGEGIK		
	Index[2]	Return .2	Return .3	Index	Return[2] .2	Return .3	Index	Return[2] .2	Return .3	Index[2]	Return .2	Return .3
1951										.900		1.819
1952	.150		.334	.038		.171	.538[3]		.118	.760	.249	.352
1953	.100	.081	.141	.189	.058	.352	.538[3]	.321	.138	.520	.468	.368
1954	.080	.044	.414	.029	.049	.052	.538[3]	.072	.243	.510	1.459	.997
1955	.500	.639	.784	.016	.005	.086	.166	1.574	.462	.270	2.799	3.833
1956	.400	.322	.614	.030	.229	.175	.785	1.921	.530	1.100	.943	.845
1957	.130	.019	.042	.067	.006	.025	.125	.005	.070	.390	1.139	1.079
1958	.107	.025	.096	.196	.084	.407	.091	.090	.041	.250	.946	
1959	.644	.118		.049	.046		.820	.322		1.070		
1960	.495			.146			1.241					

1/ All return figures from Table 20.

2/ Igushik and Tikchik 1952-1959, Branch 1955-1960, and Egegik 1951-1960, from Forecast of Bristol Bay Red Salmon Run in 1963, Alaska Department of Fish and Game Informational Leaflet #23. Igushik and Tikchik 1960, from F. R. I. unpublished data.

3/ Average of years 1955-1960, since escapement unknown.

where calculated for each river for each ocean age group (Table 23). The yearly index values of Tables 21 and 22 were then multiplied by the average returns per-index-point to give the adjusted indices presented in Table 24. To give an example consider the adjusted Wood River index for the 1957 prediction of 2-ocean fish. The value for this in Table 24 is 1.126, which is obtained by multiplying the 1955 Wood River smolt index of 222 (Table 21) by the average 2-ocean return per-index point of .005073 (Table 23).

The total adjusted freshwater indices listed in Table 24 and used in the regression models are then obtained by summing the individual indices by year and ocean age.

The rationale for following this method of standardizing the freshwater indices as we have done and summing them to achieve a set of overall index values is given by the following example:

Assume we wish to predict the combined return to rivers A and B. River A on the average has a return per-index-point 10 times that of River B. In a particular year smolt indices of 10 and 20 are determined for A and B from which the combined return to A and B of 2-ocean fish 2 years later is to be predicted. A reasonable combination of these 2 values should place greater weight on A's index. The simplest method of doing this is merely to multiply A's index by 10 and add it to B's, giving a combined index, of 120 for this sample.

The regression equations using the Table 17 values are:

$$\text{2-ocean} \quad Y = 1.097 + .318K_1 - .902X_2 + .295X_3$$

$$\text{3-ocean} \quad Y = .115 + .267X_1 - .567X_2 + .276X_3 + .230X_4$$

From these the predicted returns for 1964 are 13.9 million 2-ocean and 3.9 million 3-ocean, or a total run of 17.8 million. Since this includes the Japanese high seas catch, the net return to western Alaska is, therefore, expected to be something less than the 17.8 million figure, depending on the magnitude of this variable.

A number of discrepancies will exist between certain data presented in this analysis and data presented in previous Bristol Bay forecasts. These arise from several sources: (1) The geographical areas and time period used for estimating the Japanese high seas catch (footnotes 1 and 2, Table 19) were altered somewhat from previous years on the basis of accumulated knowledge from high seas tag recoveries, (2) now included in each year's run of 3-ocean fish is an estimate of the preceding year's Japanese catch of immature 2-ocean fish of Bristol Bay origin, (3) in building up figures for the run as has been done, stream by stream, only fish of ocean ages 2 and 3 were included. Small numbers of 1-ocean and 4-ocean fish were included in the totals of 2- and 3-ocean fish in previous forecasts, (4) both the purse seine and the gill net indices were revised this year.

Table 23. Average red salmon return per-index-point for Bristol Bay rivers, 1957-1963, in millions of fish[1/].

	2-ocean	3-ocean
Igushik	.636410	1.653033
Tikchik	.828125	2.244248
Wood River	.005073	.003089
Kvichak	.183027	.058955
Naknek	.107402	.176448
Branch	1.40548	.576052
Egegik	2.106053	2.088315
Ugashik	.002208	.001191

1/ Total returns of Table 20, by 2-ocean and 3-ocean categories, divided by totals of index points of Tables 21 and 22 for the corresponding years of return.

Table 24. Adjusted freshwater indices, Bristol Bay rivers, 1957-1963 [1/].

2-ocean

Year of run	Igushik	Tikchik	Wood River	Kvichak	Naknek	Branch	Egegik	Ugashik	Total Index
1957	.064	.156	1.126	1.428	.838	.756	1.601	1.016	6.985
1958	.051	.024	1.659	.421	.644	.756	1.095	.071	4.721
1959	.318	.013	.873	.165	.322	.233	1.074	.042	3.040
1960	.254	.025	1.172	18.303	1.074	1.103	.569	1.007	23.507
1961	.083	.055	.309	15.722	1.310	.176	2.317	.412	20.384
1962	.068	.162	1.131	3.368	.709	.128	.821	.777	7.164
1963	.410	.040	2.633	.201	.601	1.152	.526	.598	6.161
1964	.315	.121	.086	6.607	1.761	1.744	2.253	1.016	13.903
				3-ocean					
1957	.248	.085	1.356	6.426	.547	.310	1.879	.560	11.411
1958	.165	.424	.686	.460	1.376	.310	1.587	.548	5.556
1959	.132	.065	1.010	.135	1.059	.310	1.086	.038	3.835
1960	.826	.036	.510	.053	.529	.096	1.065	.023	3.138
1961	.661	.067	.714	5.896	1.764	.452	.565	.543	10.662
1962	.214	.150	.188	5.064	2.153	.072	2.297	.223	10.361
1963	.177	.440	.689	1.085	1.164	.055	.814	.419	4.843
1964	1.064	.110	1.603	.065	.988	.472	.522	.323	5.147

1/ Unadjusted indices of Tables 21 and 22 multiplied by adjustment factors of Table 23.

SUMMARY OF BRISTOL BAY FORECAST FOR 1964

The results of the forecasts by river system, from high seas sampling, and multiple regression are brought together in Table 25. The estimates obtained from the river systems and by multiple regression procedures are in close agreement, the estimates from high seas data are higher. The method of forecast based on river systems represents an estimate of the return to Bristol Bay rivers. It does not include any high seas catch and does not include fish returning to streams in western Alaska other than Bristol Bay. The high seas sampling provides an estimate of the total population of western Alaska red salmon present in Aleutian waters at the time of sampling, and these estimates have been related to the total western Alaska catch including estimates of the high seas catch in each year. The multiple regression procedure incorporates data from the river systems and high seas sampling adjusted for the high seas catch.

Table 25. Summary of forecast of Bristol Bay red salmon run in 1963 (in millions of fish).

	Ocean age .2	Ocean age .3	Total
FORECAST BY RIVERS			
Wood River	.7	.7	1.4
Tikchik	.05	.07	.1
Igushik	.28	.65	.9
Total Nushagak	1.03	1.42	2.4
Kvichak	8.2	.06	8.3
Branch (Alagnak)	1.92	.48	2.4
Naknek	1.18	.59	1.8
Total Naknek-Kvichak	11.30	1.13	12.5*
Egegik	.96	.68	1.6*
Ugashik	.74	.20	.9*
TOTAL BRISTOL BAY	14.0	3.4	17.4
FORECAST FROM HIGH SEAS DATA			
Seining	14.5	4.8	19.3
Gillnetting	16.9	5.5	22.4
COMBINED FORECAST USING MULTIPLE REGRESSION			
All methods	13.9	3.9	17.8

* differences are due to rounding errors