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FORECAST OF 1966 PINK AND CHUM SALMON RUNS IN PRINCE WILLIAM SOUND

By:

Robert S. Roys
Division of Commercial Fisheries
Research Section
Cordova, Alaska

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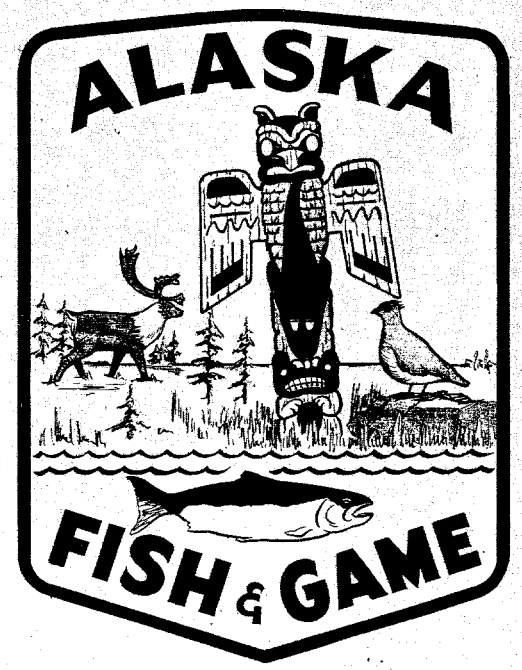

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by

Robert S. Roys, Fishery Biologist
Alaska Department of Fish and Game
Division of Commercial Fisheries
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INTRODUCTION

This is the fifth report on salmon forecast studies in Prince William Sound. Noerenberg (1961, 1963, 1964) forecast pink salmon runs in Prince William Sound by analysis of data collected annually from three successive life history stages: (1) relationship of indexed spawners to return, (2) relationship of indexed alevin abundance to return, and (3) relationship of indexed early-stage fry abundance in the estuarine environment to return. In this period it was suggested alevin abundance, of the three programs carried out, was the most reliable basis for forecasting pink salmon runs returning to Prince William Sound. As a result, Roys and Noerenberg (1965) forecast the 1965 pink salmon run based almost entirely on the linear relationship that exists between the pink salmon alevin index (average number of live pink alevins hydraulically excavated per square meter) and the resultant, returning run approximately 15 months later. In the 1965 forecast, however, alevin densities were weighted by associated escapement indices, in an attempt to categorize the total run forecast into forecasts by districts and timing (early-middle-late).

In this report the following information will be presented: (1) Relative success of the pink salmon forecasts to date using the alevin indices as a basis for forecasts of total run, by districts and by timing; (2) effect of the "Good Friday Earthquake" on 1964 spawning distributions of pink salmon and probable implications on 1966 production; (3) changes in techniques of the estuarine monitoring program; (4) "best" estimate of the 1966 Prince William Sound pink and chum runs.

Relative Success of Forecasts for Prince William Sound Total Pink Salmon Run Using Weighted Alevin Index

The history and relative accuracy of the total run pink salmon forecasts based upon the alevin index is illustrated in Figure 1 and the contributing data listed in Table 1.

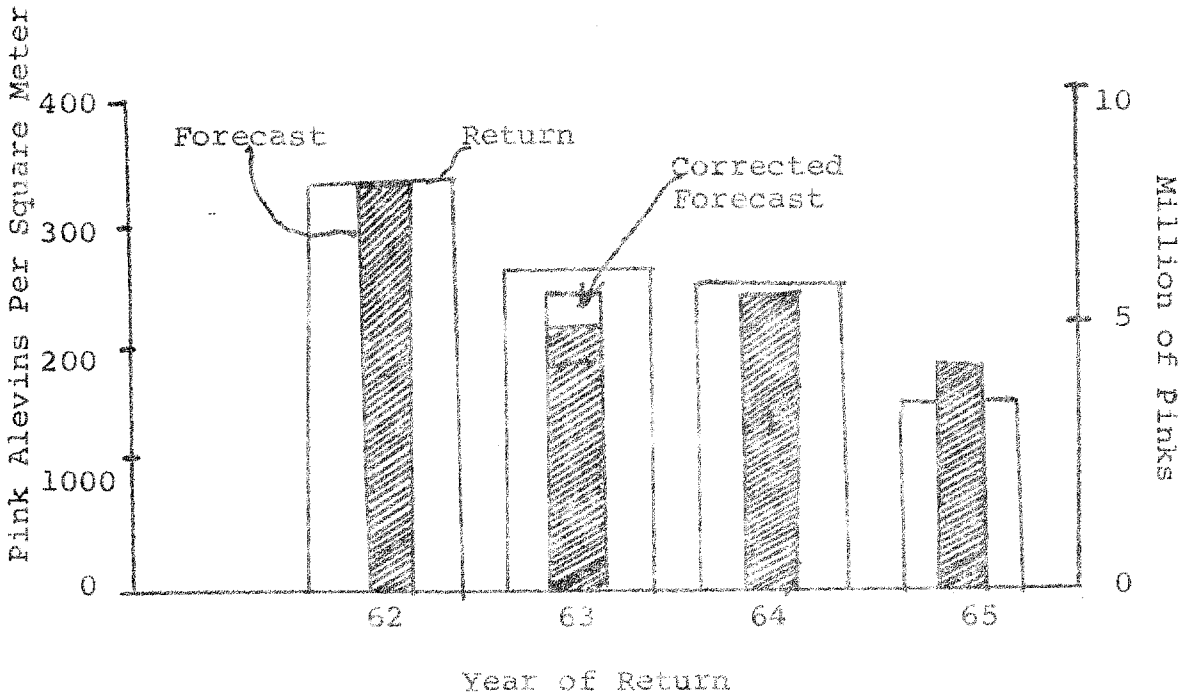


Figure 1. Comparison of pink salmon forecast and return using the weighted pink salmon alevin density index.

Table 1. Percent deviation of the alevin forecast index for forecasting Prince William Sound pink salmon runs, 1962-1965.

Year of return	1962	1963	1964	1965
Forecast, in millions	8.9	5.8[1/]	6.1	4.2
Return, in millions	8.7	6.6	6.0	3.4
% Error	1.1	13.2	1.1	19.4

The forecast for 1965 indicated the total run should have approximated 4.2 million (± 1.5 million 95% confidence interval). The actual return about 3.4 million (2.4 million catch + calculated escapement of 1 million). This was about 800 thousand below the mean estimate, but about 700 thousand above the lower range of the forecast.

Although odd-year forecasts continue to be less precise than even-year forecasts, they are still accurate enough to be usable by management and the industry (Table 1). One of the probable reasons why the odd- and even-year forecasts differ in accuracy has been discussed in previous reports and is generally attributed to difficulties arising in obtaining a representative alevin index from the upstream spawning areas that are more heavily utilized by odd-year spawners than even-year spawners. This problem is partially compensated for by weighting upstream and intertidal alevin densities by the percent of spawners that utilize those areas in any given year (see Table 5).

Relative Success of the 1965 Pink Salmon Forecast by Timing Using a Weighted Alevin Index

In the 1965 pink salmon forecast report, an attempt was made to breakdown the 4.2 million total run estimate into a "timing" forecast, i.e., the percent contribution of the early, middle, and late segments of the total run. The percent estimates for the 1965 run were then compared to the projected percentages for 1963 to determine whether the relative strength of the 1965 early, middle, and late segments differed from 1963 (Table 2).

1/ 1963 forecast from intertidal fry production was only 5.0 million. Weighted fry densities, to include upstream production indicated 5.8 million.

Table 2. Estimated timing of pink runs, Prince William Sound, 1963 and 1965.

	Early	Middle	Late
1963	24.7	25.6	49.7
1965	16.6	22.1	61.3

From the results in Table 2 it was concluded that the early and middle segments would contribute a smaller percentage to the total run in 1965 than in 1963. The run in 1965 followed this pattern, early and middle runs were less important in 1965 than in 1963, but even less important than anticipated. Changes in analysis of early, middle, late-run segments will be presented in the 1966 forecast section.

Relative Success of the 1965 District Forecasts Using a Weighted Alevin Index

Reliable district forecasts are important for a number of reasons. Two of these are:

1. Foresight as to which districts will furnish the greatest production over escapement goals allow a more orderly and efficient harvest.

2. Foresight as to which districts might not be producing a significant level over escapement goals would yield an insight as to what areas might need more restrictive regulations. Anticipation of probable restrictions would represent a savings to the industry and probably would lead to a more accurate and usable analysis of the developing run.

In the 1965 forecast besides attempting a breakdown of the 4.2 million estimate into timing segments, we also attempted to breakdown the total run estimate in the production levels of each district. The results of this attempt are summarized in Table 3.

Table 3. District pink salmon forecasts - 1963 and 1965.

	Forecasted Runs (Percent)		Actual Runs (Percent)		Percent Differences Estimate	Actual
District	1963	1965	1963	1965	63-65	63-65
Eastern	30.9	31.9	25.2	25.2	1.0	.0
Northern	.5	5.4	1.6	1.8	4.9	.2
N.W. & Cog-hill	18.1	29.8	17.5	22.3	11.7	4.8
S.W. & Eshamy 1/	7.9	7.3	15.0	29.0	.6	14.0
Montague	13.5	3.5	15.0	2.3	10.0	12.7
Southeastern	29.1	22.1	25.6	20.3	7.0	5.3

1/ Southwestern and Eshamy District reflect intensity of effort on traveling fish that are passing through and destined for other districts.

Of particular interest is the comparison of forecast "percentage of total run estimates" in the Eastern, Montague and Southeastern districts for 1963 and 1965. The Eastern district forecast percentage for 1963 (30.9) and for 1965 (31.9) were similar and the percentage of total run returning to this district in 1963 and 1965 was the same (25.2% or 0.0% difference). The percent of total run estimate for Montague District in 1963 was 13.5% whereas the estimate for 1965 was only 3.5%. The returns in 1963 and 1965 followed this pattern quite closely (1963- 15%, 1965-2.3%). The Southeastern district percent estimate of 1965 indicated percent reduction in importance from 29.1% in 1963 to 22.1% in 1965. The percent difference between actual and estimated was 5.3%.

Of interest also was the Southwestern-Eshamy district where considerable numbers of fish traveling to other districts (particularly Northwestern-Coghill district) are taken. In 1963 and 1965 the percent estimates were similar (7.9 and 7.3 respectively) but the percent of total runs were considerably different (15.0 and 29.0 respectively). An effort analysis has not yet been completed but there is a possibility that this increase in the Southwestern district in 1965 was a reflection of increased effort in this district operating more intensely on fish destined for other areas than had occurred in 1963. If this possibility is substantially correct then the differences in the Northwestern-Coghill percent estimates and actuals would be more precise.

In general it is reasonably safe to assume that if our total run forecasts continue to be fairly accurate then our district and timing forecasts will be also. It is to be remembered that if the total run returns in the lower range of the forecasts the percent contribution may be substantially correct but the number returning to each district would of course be lower or higher if the run returns in lower or upper range of the forecast. A slightly different analysis is used in the 1966 forecast as the odd- and even-year runs differ. For example the Northern district has been relatively important only on the even-year cycle.

DISCUSSION 1966 FORECAST

Unusual Factors Affecting the 1966 Pink Salmon Run Spawning Distribution in 1964

Investigations over the past twelve years indicated that approximately 75% of the even-year pink salmon escapement normally utilizes intertidal spawning areas. Roys (1965) reported on the effects of land form changes (originating from the Good Friday Earthquake) on the spawning distribution of the 1964 pink salmon escapement whose progeny will be returning as adults in 1966. These studies indicated that pink salmon spawners returning in 1964 reacted to land form changes in three ways (Figure 2).

1. Pink spawners returning to the uplifted zone not only spawned in pre-earthquake intertidal riffles that are now in some cases fresh water but

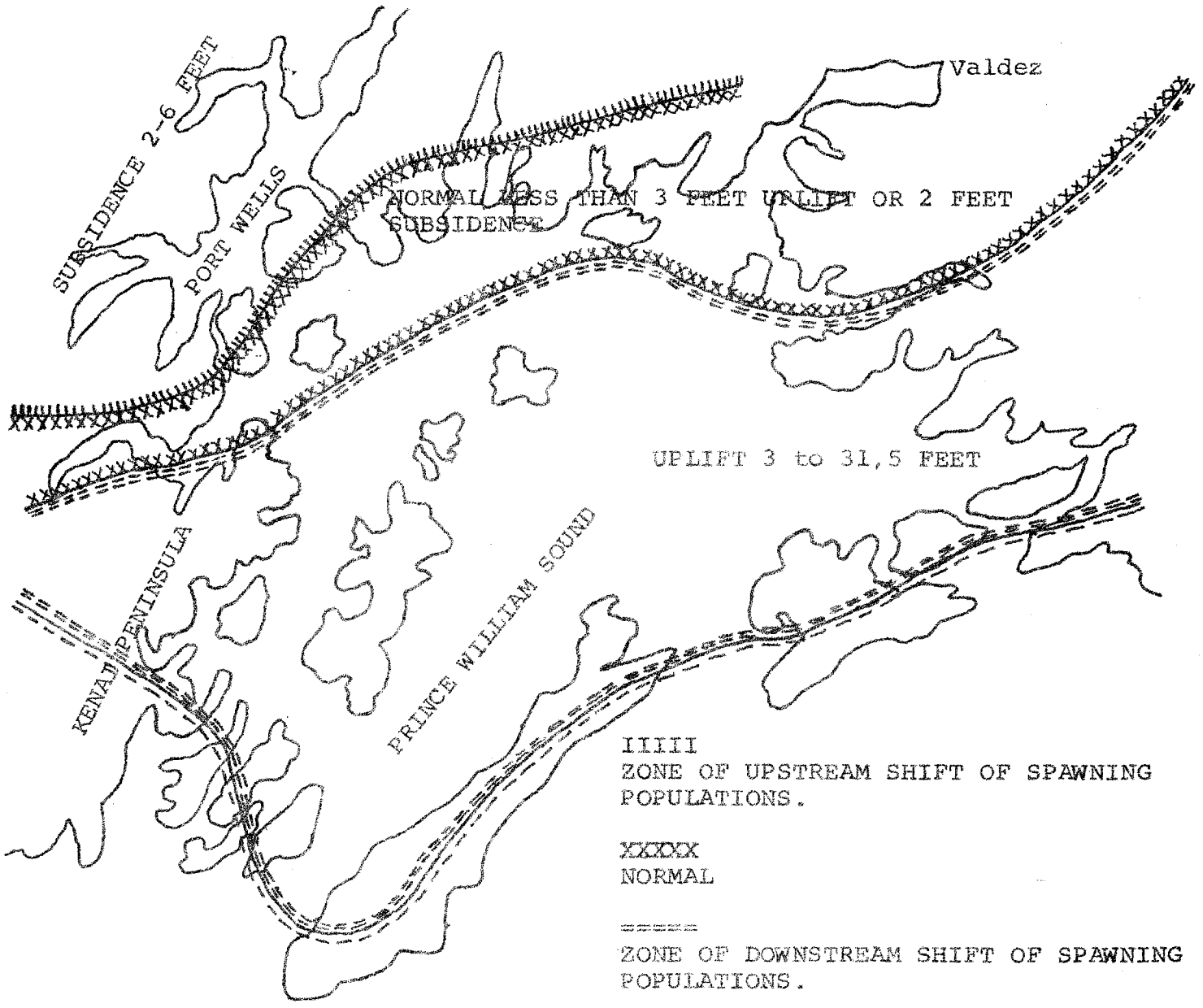


Figure 2. Effect of the Earthquake on Pink Salmon Spawning Distributions-1964.

also selected the new intertidal zones that had never been utilized for spawning prior to the earthquake.

2. Pink spawners returning to the subsided areas of the Sound had a tendency to move upstream into pre-earthquake fresh water zones (now in part intertidal).

3. Pink spawners returning to those areas in the Sound that were not subjected to a great deal of land form change distributed themselves in the intertidal and fresh water zones as in the past.

Total escapement in 1964 was calculated to be in the neighborhood of 1.8 million pinks[1/]. Of this number approximately 1.3 million returned to spawn in pre-earthquake spawning habitat and approximately one-half million spawned in areas of the uplift zone that were downstream from the pre-earthquake lower limit of productive spawning. The important question is how will this spawning distribution change affect the subsequent production of pinks in 1966.

The alevin sampling program conducted during the spring of 1965 was designed to obtain samples from pre-earthquake spawning areas (to be comparable with past sampling programs) and also the new spawning areas inthe uplifted zone. The results of this sampling by spawning area are summarized in Table 4 and shown by stream in Figures 3 and 5.

Table 4. Comparison of mean pink alevin densities per square meter in the three zones of Prince William Sound, March and April 1965.

Spawning Area	Pre-earthquake Intertidal Areas	Pre-earthquake Freshwater Areas	Post Earthquake New Areas
Zone			
Uplift	276	310	54
Normal	270	234	--
Subsidence	151	228	--

Alevin densities obtained in the subsided and new zones were considerably lower than densities from pre-earthquake intertidal and freshwater spawning areas in the uplift and the normal zones. The affect of these densities on possible

1/ Breakdown of 1964 pink salmon escapements are given in Appendix Tables A,1 through A,8 and Appendix B.

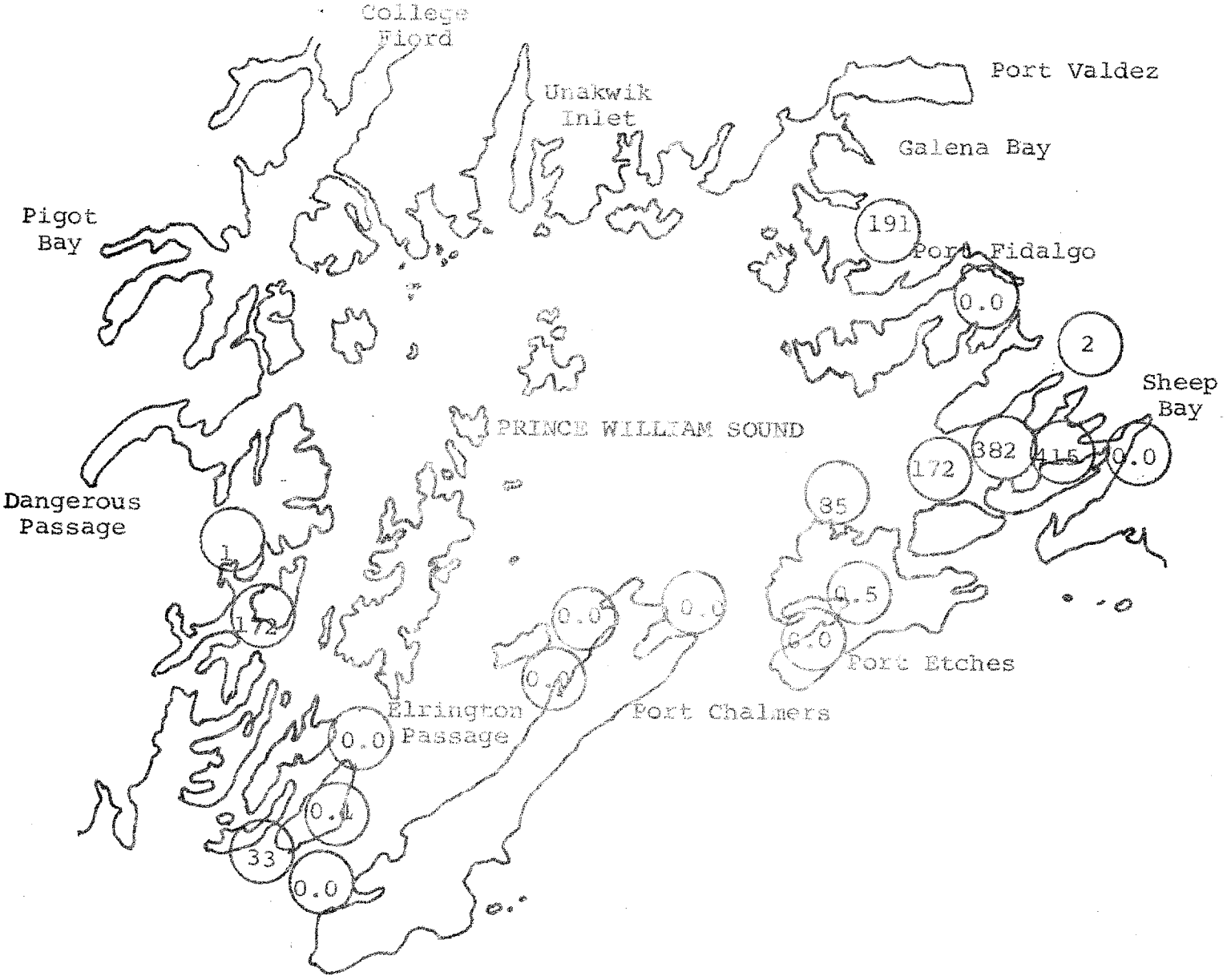


Fig. 3. Pink Alevins per square meter in new spawning areas of the Uplifted zone in Prince William Sound-Excavated March-April 1965.

production in 1966 will be discussed in a later section on the 1966 district forecast.

Possible Effects of the Cold Winter of 1964-1965 on 1964 Brood Year

Sheridan (1962) suggested that in Southeastern Alaska pink salmon spawn earlier in the season in colder streams and later in the season in warmer streams. Furthermore, he concluded that deviations from the normal timing of spawning or in temperature during development may influence survival rates. If this postulation is substantially correct then a considerable disruption of the normal timing and temperature relationships probably occurred on 1964's pink spawn in some areas of Prince William Sound that may cause lowered sea survival rates. For example, late-run spawners that returned to the uplifted zone in some instances selected freshwater spawning areas instead of intertidal locations. This would mean a late deposition of eggs in a colder habitat which in effect would undoubtedly contribute to a later outmigration in the spring of 1965. During alevin excavations in the spring of 1965 considerable numbers of partially absorbed yolk-sac alevins were recovered particularly in the late-run areas in the pre-earthquake intertidal spawning areas that are now freshwater. Conversely, in the old intertidal spawning areas of the subsided zone alevins were well advanced and probably migrated to sea earlier than normal. Excavations in the normal zone indicated a slight retardation in development and was undoubtedly related to the exceptionally cold winter that had occurred. (Coldest since 1955-1956 according to the U.S. Weather Bureau Records at Cordova Airport).

Until the run returns in 1966 we will not know whether this spawning distribution change will contribute to an estuarine mortality that is greater than those estuarine and ocean mortalities encompassed by the 95% confidence band in Figure 4.

The 1966 Pink Salmon Forecast Based on Weighted Alevin Densities

Total Run. The linear relationship between pink salmon alevins per square meter and returning run one year later is illustrated in Figure 4 and the contributing data is listed in Table 5. The assumption must be made if this linear relationship is used that sampling error, estuarine, and ocean mortality will not be greater or lesser than those expressed by the 95% confidence interval about the fitted line in Figure 4.

Calculations from this relationship indicate: (1) the relationship between alevins per square meter and returning run is linear at greater than the 99% level of significance, (2) the correlation coefficient "r" is .971, (3) using 95% confidence interval the returning run in 1966 should be between 3.9 and 8.7 million with the expected return from that level of alevin (236) abundance at 6.3 million. Figure 5 shows the densities obtained from pre-earthquake spawning areas during

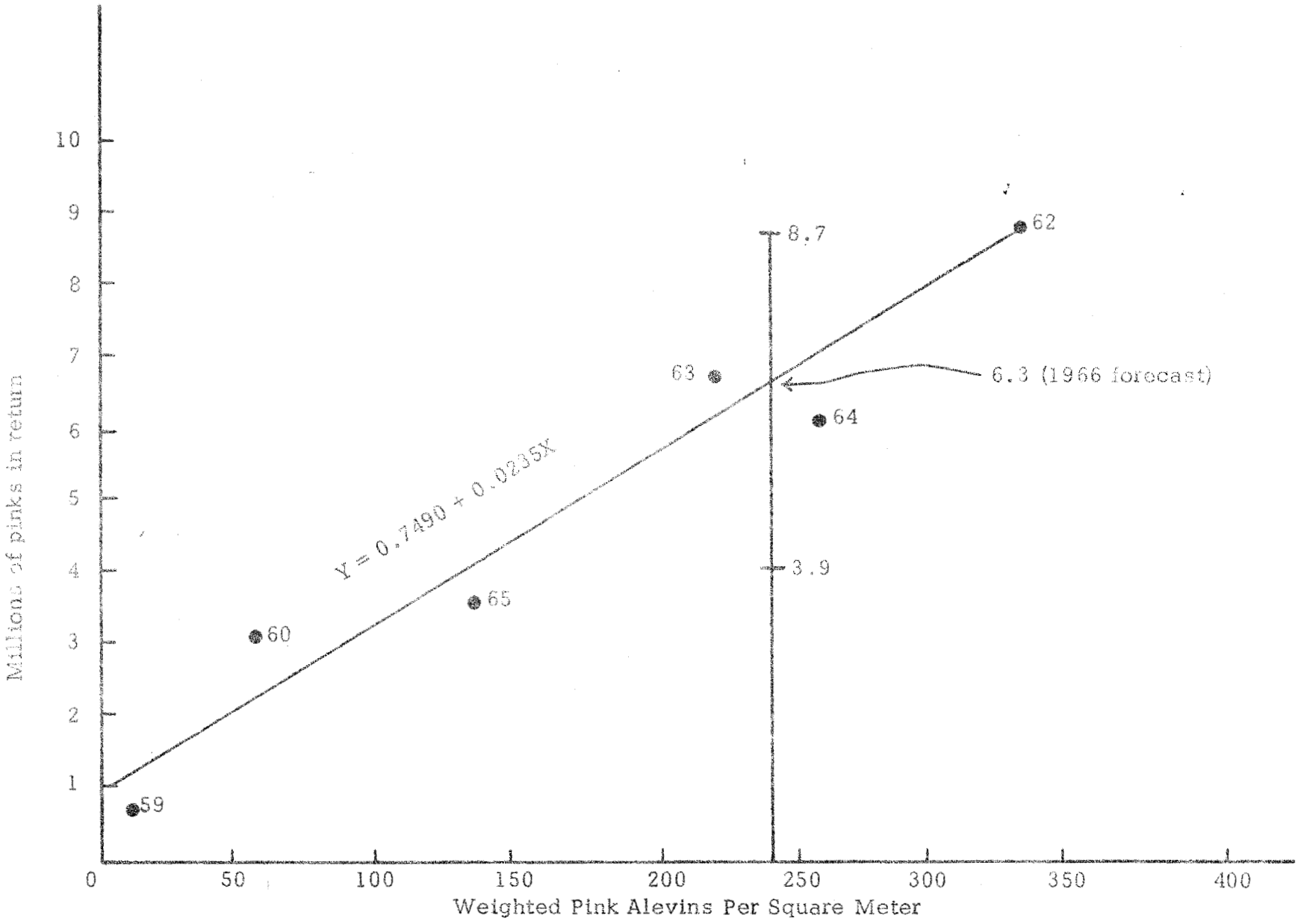


Figure 4. Relationship between pink alevin densities and return. Numbers beside points indicate year of return.

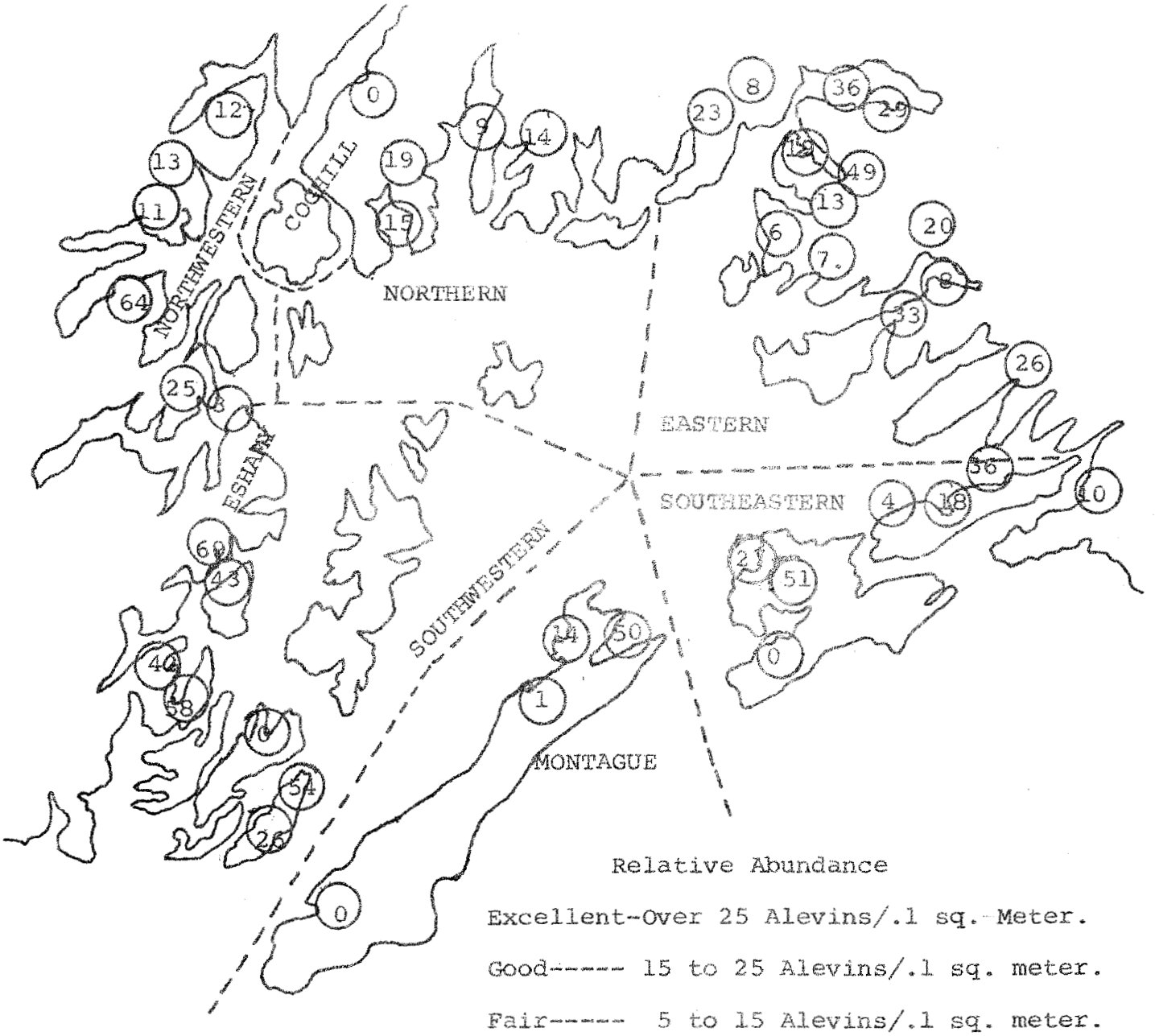


Figure 5. Mean pink alevin abundance per tenth square meter in pre-earthquake spawning area of 42 streams sampled March and April 1965.

Table 5. Weighted results of pre-emergent pink salmon alevin sampling 1958-1964.

Year of spawning	Number and Percent of Intertidal Spawners		Number and Percent of Upstream Spawners		Resultant Alevins Densities per Sq. Meter[1]			Return Run (Catch & Escapement) in Millions
					6-12" Int. Zone[2]	Freshwater Zone[3]	Weighted	
1957	55,900	43%	74,100	57%	11.8	(14.1)	13.1	0.6
1958	652,000	76%	204,900	24%	64.9	(77.4)	67.9	3.2
1960	1,038,000	77%	310,000	23%	331.4	339.8	333.4	8.7
1961	771,400	35%	1,432,600	65%	158.0	247.9	216.4	6.6
1962	1,413,300	70%	605,700	30%	246.4	269.0	253.2	6.0
1963	618,700	46%	726,300	54%	114.5	157.7	137.8	3.4
1964[4]	867,000	65%	459,000	35%	248.8	216.9	236.0	

Year of Sampling	X	Y	N=6	
1958	13.1	.6	$\Sigma X = 1021.8$	$\bar{X} = 170.3$
1959	67.9	3.2	$\Sigma Y = 28.5$	
1961	333.4	8.7	$\Sigma XY = 6541.68$	$\bar{Y} = 4.75$
1962	216.4	6.6	$\Sigma X^2 = 245.865.62$	
1963	253.2	6.0	$\Sigma Y^2 = 117.41$	
1964	137.8	3.4		

1/ Square-yard samples in 1958, 1959, and 1961; 3-square foot samples in 1962, 1963 and 1964, 2 square-foot samples in 1965.

2/ Samples from 4'-6' tide stratum eliminated for years of 1961 and 1962; adjustment estimated for years 1958 and 1959.

3/ No upstream samples taken 1958 and 1959 fry population; estimated from observed ratios of 1961-64 samples.

4/ Calculated escapement and alevin densities utilized from pre-earthquake spawning areas only.

Source: 1957-1958, Kirkwood (1962); 1962-1965 ADF&G Forecast Reports.

the sampling in March and April of 1965.

Timing Forecast. It seems reasonable to assume that since there is a relationship between the mean alevin density from all timing segments and all districts and the total returning run then there should be relationships in various segments of the run, i.e., early and returning early run, middle and returning middle run, and late run densities and returning late run. The accuracy of a breakdown of this type would of course depend on (1) the accuracy of a breakdown of total run into the various contributing segments, (2) whether estuarine and ocean mortalities were similar in the three segments and (3) whether the arrival of the three timing segments (early, middle and late) were similar each year.

If we had predicted early, middle and late pink salmon runs of 1964 on the basis of observed ratios of alevin densities from 1960 and 1962 brood years our percent error in 1964 between actual and calculated returning run for the early-run was 58.5, middle run 10.2 and the late run 9.1 (Table 6). The run returning to each of the three timing categories was computed as follows; catches to July 15 and the peak escapements to July 29 were classed as early, catches from July 16 to July 29 and escapement peaks from the 29th of July to August 16th were classed as middle, and catches after July 30 and peak escapements after August 16 and to the 1st of September were classed as late.

Thus in 1966 we would expect the timing to be similar to 1964, with the early run reduced to about 265,000, middle run 2,375,000 and the late run 3,660,000.

District Forecasts. The 1965 (see reliability of forecast) district predictions were estimated by determining the expected percent of the total run occurring in each district by weighting the escapement by subsequent alevin indices, then the total run prediction (from the linear regression) was multiplied by these percentages to arrive at approximate number of fish to be expected in each district. The data from past even-year cycles and for 1966's run was treated in the same manner. However, inconsistencies occurred for the even-year cycle and since there was a possibility the fishery may have been responsible for this certain districts data were combined. Where district alevin densities were combined they were weighted by the percent of the total Prince William Sound escapement that was received in the respective districts.

In Table 7 these calculations are listed. If the 1964 run had been forecast in this manner the district and district groups would have been exceptionally precise with the exception of the Montague District.

In forecasting the 1966 district runs the assumption again must be stated that estuarine and ocean mortality per se are not higher or lower than those affecting the returning runs included in the linear regression (Figure 4). If this assumption is valid then we would expect in 1966 the estimates listed in Table 7.

Table 6. Timing forecasts for Prince William Sound [1/]

Year of Return	Alevin Density .1 Sq. Meter	Calculated Total Return Run	Percent of Total Return Run	Estimated Return Run	Percent Error	Corrected to Regression
Early						
1962	24.6	444,000	5.0			
1964	27.0	202,000	3.3	487,000	58.5	
Average	25.5	323,000	4.1			
1966	20.3		4.2	257,000		265,000
Middle						
1962	28.8	2,298,000	26.1			
1964	34.4	2,464,000	39.7	2,745,000	10.2	
Average	31.4	2,386,000	32.9			
1966	30.4		37.7	2,310,000		2,375,000
Late						
1962	38.3	6,058,000	68.8			
1964	20.5	3,535,000	57.0	3,240,000	9.1	
Average	31.3	4,797,000	62.9			
1966	23.2		58.1	3,556,000		3,660,000
					TOTAL	6,300,000

1/ Since there are but two years data to average we cannot put a confidence interval on the timing forecasts but we would expect the various estimates by timing to be lower or higher depending on whether the run in 1966 ranges greater or lesser than the forecast estimate.

Table 7. 1964-1966 district pink salmon forecasts - Prince William Sound.

Year	Weighted Alevin Density per .1 Sq. Meter	Escapement	Actual Calculated Return	% of Total Return	Estimated Return	% Estimated Return	1966 Corrected to Regression
Eastern-Southeastern Districts							
1962	30.2	643,000	2,791,000	32.1			
1964	22.0	922,000	2,030,000	33.6	2,033,000	31.3	
Average	26.1		2,411,000	32.8			
1966	26.2	844,000			2,420,000	39.4	2,482,000
Northern District							
1962	30.4	134,000	1,511,000	17.4			
1964	30.0	236,000	1,305,000	21.6	1,491,000	23.0	
Average	30.2		1,408,000	19.1			
1966	14.7	349,000			685,000	11.2	706,000
Northwestern-Coghill Southwestern-Eshamy							
1962	37.3	359,000	3,425,000	39.4			
1964	25.8	525,000	2,410,000	39.9	2,369,000	36.5	
Average	31.7		2,918,000	39.6			
1966	29.5	529,000			2,715,000	44.2	2,785,000
Montague							
1962	30.4	215,000	958,000	11.0			
1964	19.0	318,000	289,000	4.8	599,000	9.2	
Average	24.7		624,000	8.5			
1966	12.6	122,000			318,000	5.2	328,000
Totals							
1962		1,351,000	8,685,000	100.00			
1964		2,001,000	6,034,000	100.00	6,492,000		
Average		1,676,000	7,361,000	100.00			
1966		1,844,000			6,138,000		6,300,000
Linear Regression					6,300,000		

1.	Eastern-Southeastern Districts	2,482,000
2.	Northern District	706,000
3.	Northwestern-Coghill Southwestern-Eshamy	2,785,000
4.	Montague	328,000

The most serious reductions since 1962 will probably occur in the Northern and Montague districts and in part are related to the earthquake. If the Northwestern, Coghill, Eshamy and Southwestern districts are examined in detail it appears runs destined for the Southwestern district will be greater than in 1964, whereas the Northwestern-Coghill runs will probably be lesser than in 1962 or 1964.

NOTE: Northern, Northwestern and Coghill districts subsided 2-6 feet; Montague raised 8 to 31.5 feet.

FORECAST OF THE 1966 CHUM SALMON RUN

Relative Accuracy of the 1965 Chum Forecasts. In forecasting the 1965 chum salmon run in Prince William Sound we analyzed four types of data: (1) historic population trends, (2) recent escapement trends, (3) age composition of the runs and (4) chum alevin densities.

We assumed that the percent age composition of the run in 1965 would be similar to 1963 and 1964, and using historic population trends and the chum alevin index the 1965 forecast indicated a run below 1964 (924,000) and in the neighborhood of 700,000 (based on alevin index). Actual return in 1965 was approximately 400,000 or 43 percent lower than forecast. This relatively high percent error in part may have been caused by the lack of 3-year old chums in the 1965 run (Table 8 and 9).

Table 8. Chum salmon age analysis by comparable time periods in the fishery 1964-1965.

Date		No. of chums sampled by age group				Percent each age group			
		3	4	5	Total	3	4	5	Total
7/22-7/28	1964	188	372	25	585	32.14	63.59	4.27	100
	1965	19	427	14	460	4.13	92.83	3.04	100
7/28-8/2	1964	345	476	9	830	41.57	57.35	1.08	100
	1965	4	84	5	93	4.30	90.32	5.38	100

Table 9. Chum age analysis in streams, 1964-1965.

		No. of chums sampled age				Percent each age			
		3	4	5	Total	3	4	5	Total
Years	1964	103	436	87	627	16.45	69.65	13.90	100
	1965	31	355	34	420	7.38	84.52	8.10	100

Recent Population Trends

Noerenberg (1964) pointed out that historically, (in 1930's and 1940's) abundance peaks in pink salmon were usually accompanied by similar abundance peaks in chum salmon about two years later. Furthermore, from these same data

it appears that when pink runs increased substantially over a given parent year, chum runs increased also, only one and two years later. For example in Table 10 the pink run in 1959 was estimated at 601,000; there was an increase to 4.5 million in 1961. One year later (1962) the chum run (3's from 1959's escapement) was 1.4 million. The pink run in 1960 (3.2 million) increased to 8.7 million in 1962; thus 4's from the high pink survival year of 1959, and 3's from the high pink survival year of 1960 made up the 1963 chum run of 1.3 million. The pink run in 1961, (4.5 million) increased to 6.6 million in 1963, indicating moderate pink survival. The chum run on the other hand, declined one year later (1964), when 3's from the moderate pink survival year of 1961, and 4's from the good pink survival year of 1960 made up most of the run. The chum run in 1965 was composed of 4's from the moderate pink survival year of 1961, and 3's from the reduced pink survival year of 1962 that yielded approximately 400,000 total run. The run in 1966 will be composed of 4's from the reduced pink survival year of 1962 and 3's from the earthquake affected spawn of 1963 which yielded only 3.4 million pinks in 1965. Based on this analysis the run in 1966 will probably we similar to 1965's run or at best slightly larger.

Table 10. Pink and chum salmon runs in Prince William Sound - 1956-1965 total run.

Year	Pinks	Chums
1956	5,800,000	735,000
1957	700,000	794,000
1958	7,100,000	773,000
1959	600,000	158,000
1960	3,200,000	584,000
1961	4,500,000	560,000
1962	8,700,000	1,359,000
1963	6,600,000	1,304,000
1964	6,000,000	924,000
1965	3,400,000	395,000

Source: F.R.I., University of Washington, 1956-1958; U.S.F.W.S. 1956-1959; ADF&G, 1960-1965.

Recent Escapement Trends in Chum Salmon

The estimated chum salmon escapements by district for Prince William Sound from 1956-1963 are listed in Table 11 1/. No relationship was evident between escapements and returning runs. Returning run to any particular escapement level was determined by percent age composition of runs 3, 4 and 5 years later. The escapement in 1962 (486,900) that will be contributing 4-year-olds to

1/ Breakdown of 1961, 1962, 1963 and 1964 chum escapements are given in Appendix C,1 through C,6 and Appendix D,E,F and G.

Table 11. Chum salmon escapements, by management district, 1956-1963.

Management District	1956	1957	1958	1959	1960	1961	1962	1963
Eastern	100,200	161,500	42,400	35,100	92,100	118,000	238,700	148,100
Northern	46,000	33,200	12,300	4,000	24,700	50,400	67,700	68,400
Northwestern	64,500	46,200	10,500	107,100	40,500	70,900	96,000	114,200
Southwestern	4,900	5,300	4,400	1,300	4,800	4,800	10,600	5,300
Montague	4,900	8,700	7,000	3,500	16,800	34,400	34,200	15,100
Southeastern	17,100	13,500	9,200	6,700	23,000	59,900	39,700	20,000
Prince William Sound Total	237,600	269,400	85,800	157,700	201,900	338,400	486,900	371,100

Source: F.R.I., University of Washington, 1957-1958; U.S.F.W.S. 1956-1959; A.D.F.&G., 1960-1963.

the run in 1966 was larger than any escapement since 1952. This would lead to an optimistic outlook for 1966 since 4-year-olds on the average make up 75 percent of chum salmon runs (Thorsteinson, Noerenberg and Smith, 1963). However, without a correlation between escapements and return little faith can be placed upon this.

Results of Chum Salmon Alevin Sampling

Major chum salmon streams have been sampled comprehensively in the Sound only since 1961. The results are summarized in Table 12 in chum alevins per square meter for early-middle- and late-run stream categories. Chums from the 1962 samples will be returning in 1966 as 5 year olds; 1963's samples as 4's and 1964 samples as 3's. In the 1965 chum forecast using the alevin index, alevin densities from those sampling years that would contribute 3 and 4's in the 1965 run were averaged and compared to 1964's run. This indicated the run in 1965 should have been around 700,000 (300 high). This was assuming that the 3 age classes would be contributing in similar percentages as occurred in 1963 and 1964. This did not occur in 1965 as three-year-olds contributed around 6 percent (see Table 8 and 9). Though it is still premature to use the chum alevin index as a method of forecasting chum runs there is a possibility that a more useful approach than used in 1965 is to forecast in terms of the relative numbers of 4-year olds in the returning run. If this approach had been used for the 1965 forecast the estimated number of 4's returning in 1965 would have been 290,000 or about half of what returned in 1964 (Table 13). The actual return of 4's was about 336,000 or an error of 15 percent. Using this same analysis for 1966 it appears that the 4-year old chum should contribute about 441,000 to the 1966 run. Then using an average of 75 percent fours in the run a total run forecast of 580,000 for 1966 is suggested. This is considerably lower than the large runs of 1962 and 1963, and only slightly larger than 1965's run. Since the earthquake and tsunamies affected the three-year old chum that were in the gravel in the spring of 1964, there is a distinct possibility that 4-year old chums may make up an exceptionally high percentage of the run in 1966. If this in fact does occur then our total run estimate for 1966 is probably high.

The data in Table 12 suggests that the late run should be the strongest segment.

Table 12. Results of pre-emergent chum fry sampling in Prince William Sound, 1961-1964.

Sampling Year	Number of Streams Sampled	Number of Samples Taken	Mean Fry Density Per Square Meter
A. Early-Run Streams			
1961	6	93	86.32
1962	6	220	27.63
1963	7	202	48.48
1964	6	239	24.83
B. Middle-Run Streams			
1961	7	89	103.20
1962	6	153	78.91
1963	7	219	47.09
1964	7	384	36.55
C. Late-Run Streams			
1961	4	46	25.05
1962	5	136	12.04
1963	4	136	81.81
1964	4	147	56.33
D. All Major Chum Streams			
1961	17	228	80.52
1962	17	509	38.92
1963	18	557	56.01
1964	17	770	36.77

Table 13. Comparison of chum alevin densities and returns.

Year of Spawning	Alevin Density	Percent 4 Year Olds in Return	Estimated Return	4 Year Actual Return	Percent Error
1960	80.52	65%		601,000	
1961	38.92	85%	290,000	336,000	15
1962	56.01	75%	441,000 1/		
1963	36.77	---			

1/ Computed from average of 1961 and 1962's contributing densities and returns.

SUMMARY AND CONCLUSIONS OF PINK AND CHUM FORECASTS

PINK SALMON

1. The alevin index continues to be exceptionally precise for forecasting Prince William Sound pink salmon runs. A weighted pink alevin index (to compensate for upstream spawning) of the pre-earthquake spawning areas indicated the 1966 total pink salmon should be between 3.9 and 8.7 million (95% confidence interval) with the average return calculated at 6.3 million.

2. The possibility exists because of earthquake caused spawning distribution change and the exceptionally cold winter of 1964-1965 that estuarine mortality may be different than those experienced by the brood years from 1960 to 1963.

3. The probable timing of the 1965 pink salmon run was determined by breaking down the total run forecast into three segments: (a) to July 15, approximately 265,000 pinks, (b) July 16 to July 29 approximately 2,375,000 pinks, (c) after July 30 3,660,000.

4. The ratio of a weighted alevin index in districts, and district groups to returning runs within the district or district groups indicated that the: (a) Eastern-Southeastern district runs should approximate 2,482,000, (b) Northern district 706,000, (c) Northwestern-Coghill-Southwestern-Eshamy 2,785,000, (d) Montague 328,000.

5. If our expectations of the 1966 pink run are being realized and depending on the level of gear operating, particularly restrictive field regulations may be necessary during the middle run in the Northwestern-Coghill districts, and during the late run in the Northern and Montague districts.

SUMMARY AND CONCLUSIONS OF PINK AND CHUM FORECASTS

CHUM SALMON

1. Based upon the historic population trends, and associated pink survival years, the chum run in 1966 will probably be similar to 1965 with a possibility of being slightly larger.

2. The chum alevin index (only two years of data) indicated that the 4-year old run should be in the neighborhood of 441,000 or when expanded to all age groups should be around 580,000.

3. Evidence suggests that the late chum run should be the strongest feature.

ESTUARINE INVESTIGATIONS

Theoretically a representative index of pink and chum fingerlings in the estuaries of Prince William Sound should provide a more accurate basis for forecasts than the alevin index. Analysis of data obtained from timed surveys on 80 miles of beaches in Prince William Sound since 1961 did not demonstrate a usable relationship between mean estimate of fingerlings per mile of beach and the returning runs. However, much valuable information was obtained concerning timing of outmigration from streams, probable timing of migrants in the estuarine environment, condition of migrants, feeding behavior, and schooling characteristics.

Since no relationship was apparent between relative abundance of pink and chum fingerlings in the estuaries and the returning runs, the program in the spring of 1965 was altered considerably. Our approach was somewhat more basic with the following long-term objectives:

1. Categorization of estuaries in Prince William Sound by using temperature and salinity profiles.

2. Determination of the distribution and abundance of pink and chum fingerlings in various estuaries immediately following outmigration (using a tow net and visual observations) by time period.

3. Determination of robustness (condition factor) of downstream migrants and fingerlings within various estuaries by time period.

Results in 1965

Categorization of estuaries: Visually, it was obvious in Prince William Sound that there were probably differences in salinity and temperatures between various estuaries at any particular time period. Those estuaries exposed to the more direct influence of Gulf of Alaska waters in the spring probably would be warmer and more saline (example - Port Etches) than those estuaries of a more sheltered nature and influenced by glaciers (example - Unakwik Inlet).

During May and June of 1965 transects were established in 5 estuaries of Prince William Sound. Temperature-salinity profiles for these five estuaries during the latter part of May and early June are shown in Figure 6. Of particular interest is Galena Bay where we would have expected the waters to be relatively cold (adjacent to Valdez Arm) compared to Port Etches. This was not the case as Galena proved to be warmer earlier than any of the other estuaries sampled. At present the affect of these varied conditions in the estuaries on survival is unknown

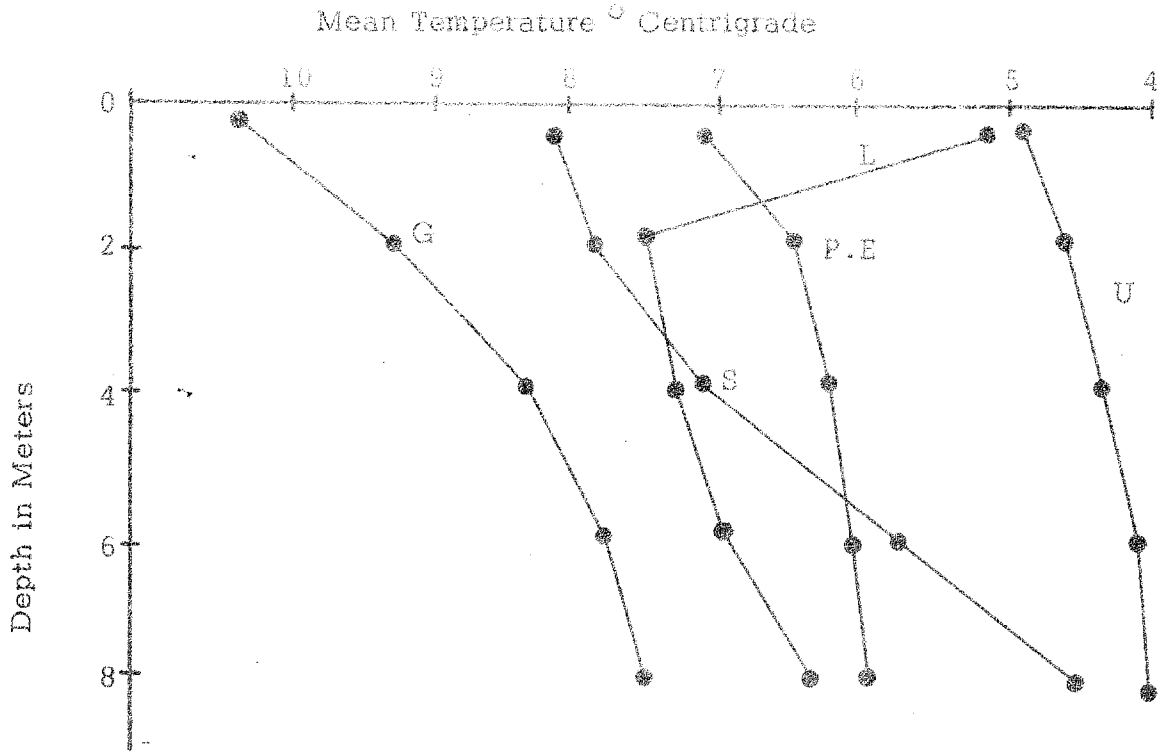
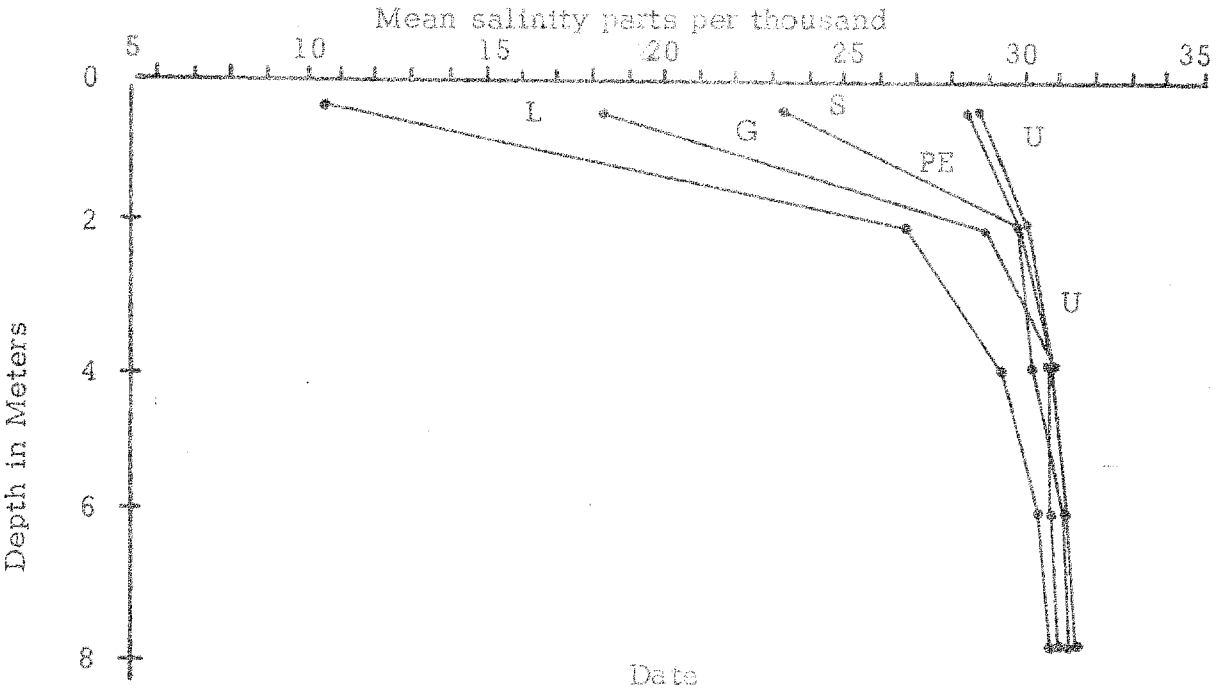


Figure 6. Salinity temperature profiles from 5 estuaries in Prince William Sound



Estuary	Date Transected	Number of Stations
G-Galena Bay	5-28-65	17
L-Long Bay (Culross Pass)	5-31-65	5
S- Sheep Bay	5-26-65	23
P-Port Etches	6-02-65	21
U-Unakwik Inlet	5-31-65	21

and to what degree the conditions in the estuaries vary from year to year can only be determined by intensive annual monitoring.

Distribution and Abundance of Fry: Preliminary tow netting studies in five estuaries of Prince William Sound during May and June of 1965 revealed that the behavior and distribution of migrating fingerlings within the estuaries studied was exceedingly complicated and no overall pattern was evident (Table 14).

Table 14. Results of tow-netting in five estuaries of Prince William Sound late May and early June 1965.

Estuary	Mean number pinks per tow minute	Mean number chums per tow minute	Date
Sheep Bay	.30	.10	May 27, 1965
Galena Bay	44.40	7.33	May 29, 1965
Culross Passage (lower)	.06	.01	June 1, 1965
Port Etches	.60	.10	June 3, 1965
Siwash Bay (Unakwik)	.70	.03	June 13, 1965

For example, pink and chum fingerlings were found along the shores and throughout the middle of Galena Bay with no significant size difference between fish sampled in these areas. This distribution pattern was similar to Siwash Bay (Unakwik Inlet) except that fingerlings appeared to be distributed across the head of the bay near the stream mouths and along shores only near the Southern entrance of the bay. These differing distribution patterns in part may explain why beach counts were not providing a usable index. In Port Etches, Culross Passage, and Sheep Bay few fish were taken with the townet though fingerlings (pinks and chums) were observed along the shores. This was probably in part an indication of delayed outmigration. In the spring of 1966 intensive investigations will be carried out in these five estuaries to determine currents, migration patterns, behavior of fingerlings in relation to tide, etc. Once the distribution of pink and chum fingerlings within the various estuaries is known then a method to determine an index to relative abundance can probably be ascertained.

Condition of Downstream Migrants: Noerenberg and Sheridan (1961) postulated that the condition of downstream migrants may be related to subsequent survival

in the estuarine environment. The survival of downstream migrants that were in relatively poor condition (thin) might be less than downstream migrants that were more robust (fatter). Investigations in the spring of 1966 will be more intense and samples of downstream migrants will be taken from early, middle and late run streams, by zone when possible (intertidal and upstream) and the condition factor determined by length-weight relationships. Analysis of past condition factors and data from 1966 will be presented in next year's forecast report.

In summary, the estuarine work accomplished to date exposed many variables that have to be eliminated and sampling techniques are being refined or changed to eliminate them. In general, though the data obtained during the spring of 1965 was fragmentary, estuarine observations indicated outmigration was decidedly later than normal in the uplifted zone of the Sound and what effect this delayed outmigration will have on the magnitude of 1966's pink salmon run is unknown.

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Appendix A,1. Prince William Sound Pink Salmon, 1964
(Live counts in streams) 1/

Stream No. 5/	EASTERN DISTRICT Stream or Bay	WEEK ENDING 7/5	7/12	7/19	7/26	8/2	8/9	8/16	8/23	8/30	9/6	9/13	9/20	Calculated Season Total
1	Hartney Creek													3000
11	Humpy Creek				600	900	710	2500		1400				3560
21	Rogue Creek			0	0	300		150	415	2500				2650
35	Koppen Creek			1500	11000	12000		11000		19600		14190		45470
36	Sheep River			150	3800	1500		3300		5000	7000	8600		15180
46	Comfort Creek			0	0	0		100		4000				4240
48	Beartrap River			0	1200			5200	15000	18000				30960
49	Cataract Creek			0	0	300		1000						2500
50	Gravina River			0	0	0		3500				100		4640
51	Olsen Creek		50	200	1500	3600		10000		24000		4000		31220
52	Control Creek			100	100	3000		1500	7100	6000				9680
61	Port Gravina					0		2000	1500		500	200		2520
76	Irish Creek			1500	500	700		1000		7500		2200		9480
80	Whalen Creek			0	200	100		500		10000				12080
88	Short Creek			0	0	0		200		2200		250		2260
89	Fish Creek			200	1500	3000	3500	3500		7500				13680
92	Fish Bay			0	0		500	300		1500				2000
94	Fish Bay			0	0	0	100	300		2500		320		2670
99	Lagoon Creek			0	1500		8500	6000		37500		12250		49100
115	Millard Creek			0	3500	3250	4500	10000			9000	3810		15770
116	Duck River			0	0	500	2000	2000			15000	46300	25000	38520
117	Indian Creek			0	4000	13300	6500	4500			10000	11600		24960
120	Donaldson Creek			4000	0	200	400	1200			1200			5040
121	Levshakoff Creek			0	0	1770	200	2200			5000			6270
123	Gregorieff Creek			300	500		3500	1300			3000			4780
127	Naomoff Creek			0			3500	1500			11000			14600
129	Vlasoff Creek			0	2800	4300	3800				5000			10840
131	Port Valdez			0	0	4100	3100							4400

continued next page

Appendix A,1 (Continued)

Prince William Sound Pink Salmon, 1994
(Live counts in streams) 1/

Stream No. 5/	EASTERN DISTRICT Stream or Bay	WEEK ENDING 7/5	7/12	7/19	7/26	8/2	8/9	8/16	8/23	8/30	9/6	9/13	9/20	Calculated Season Total
133	Sawmill Creek			0	200	2500	4000							4860
133	Siwash Creek				0		1500							3020
152	Twin Falls Creek			0	100						4000	16550		18260
153	Stellar Creek		2000	6000	10000	44700	20000	2500			25000			61230
Other Streams (43) 2/ 3/					1100	2600	5150	8500	12825	14275	10280	7090	3190	25970
DISTRICT TOTAL 3/		1,550		14,150		116,370		100,250		225,075		190,710		485,460
(99 Streams)			4,150		44,600		106,460		152,840		208,830		72,390	

1/ Ground counts underlined; others are aerial estimates.

2/ From records maintained on small streams which had a total of less than 2,000.

3/ Contains interpreted data where surveys lacking on certain weeks.

4/ Stream life factor 4.0 week. All others calculated from stream life factor 2.5 weeks.

5/ Stream numbering system revised in 1962.

Appendix A,2. Prince William Sound Pink Salmon, 1964
(Live counts in streams) 1/

Stream No. 4/	COGHILL DISTRICT Stream or Bay	WEEK ENDING 7/12	7/19	7/26	8/2	8/9	8/16	8/23	8/30	9/6	9/13	9/20	Calculated Season Total
303	Triple Creek			800		200	1800						3460
322	Coghill River		1000	2000		2000	4000	7000					9720
Other	Streams (8) 2/ 3/		100	330	1250	2500	2300	3485	1735	600	220	80	5040
DISTRICT TOTAL (10 Streams) 3/		500	1,500	3,130	3,700	4,700	8,100	13,485	7,235	1,900	820	480	18,220

1/ Ground counts underlined; others are aerial estimates.

2/ From records maintained on small streams which had a total of less than 2,000.

3/ Contains interpreted data where surveys lacking on certain weeks.

4/ Stream numbering system revised in 1962.

Appendix A,3. Prince William Sound Pink Salmon, 1964
(Live counts in streams) 1/

Stream No. 5/	NORTHERN DISTRICT Stream or Bay	WEEK ENDING 7/19	7/26	8/2	8/9	8/16	8/23	8/29	9/6	9/13	9/20	Calculated Season Total
204	Columbia Bay								2500			3140
208	Long Bay								6500			7480
214	Long Creek				2000	1500			21000			22600
216	Vanishing Creek				3100	1000			27000			27840
224	Backyard Creek		0			300	500		3000			3220
229	Cedar Creek				1000	0			6000			6860
234	Wells River		0		4500	1200			20000			21280
241	Cannery Creek	0	3000		15000	30000			35000			42500 4/
242	Cowpen Creek					2500			2500			4360
257	Jonah Bay	0	0		500	800			3000			4000
258	Jonah Creek		0		85000	75000			50000			102500 4/
263	Waterfall Creek		0		4500	500			5000			8120
264	Siwash River	0	300		500	3700			20000			20160
265	Cutthroat Creek	0	0		0				5000			6000 4/
273	Schoppe Creek		0		100				4500			4840
276	Black Bear Creek		0		2600	200						2560
279	Canyon Creek		0		300	30000			10000			32380
281	Eaglek River		0		1200	0			4000			4480
283	Eaglek Bay					0			3600			4080
291	Derickson Bay		0			200			3500			3380
Other Streams (29) 2/ 3/				2260	4430	5120	4900	7330	11390	5380	2355	17210
DISTRICT TOTAL (53 Streams) 3/		1,000	5,800	84,160	126,600	154,670	141,200	205,230	243,990	95,230	32,105	348,990

1/ Ground counts underlined; others are aerial estimates.
2/ From records maintained on small streams which had a total of less than 2,000.
3/ Contains interpreted data where surveys lacking on certain weeks.
4/ Stream life factor 4.0 weeks. All others calculated from stream life factor 2.5 weeks.
5/ Stream numbering system revised in 1962.

Appendix A,4.

Prince William Sound Pink Salmon, 1964
(Live counts in streams) 1/

Stream No. 5/	NORTHWESTERN DISTRICT Stream or Bay	WEEK ENDING 6/28	7/5	7/12	7/19	7/26	8/2	8/9	8/16	8/23	8/30	9/6	9/13	9/20	Calculated Season Total
414	Harrison Creek					3500		7500	4000						11820
421	Mill Creek				0			10000	4000			6000			17000
425	Hummer Bay				2000	0		5000	1000			7000		1000	12480
428	Pirate Creek					0		100	500	2500	100				2130
430	Meacham Creek				1000	3000	7500	15000	10000	7000		13000	4000		29640
432	Swanson Creek				25000	18000		41700	25000			21000			86280
435	Logging Camp Creek				750			6700	4500			3000			11540
454	Halferty Creek				0	0		6500	1300			4500			8160
455	Paulson Creek				1000	1200		2750	4000			4500			10340
459	Rainy Creek											10000			15800
461	Cochrane Creek				0				1100			700			2840
473	Goose Bay				0	0			2000			1000			4480
476	Shrode Creek				0	0			15000			49700			40430
479	Culross Creek				0	200		400	3000		7000	5200			8840
480	Mink Creek				200	3000		2500	12000		19300	4000			24580
484	East Finger Creek					0		3000	12000			4000			13800
485	West Finger Creek					0		2500	5000			12000			16600
486	Turn Creek					0		500	2500						2160
498	McClure Creek								1500		2500				3880
Other Streams (46 streams) 3/					100	900	2520	4410	5840	7250	7930	6290	2830	1040	15650
DISTRICT TOTAL		400		15,400		35,600		119,660		127,900		154,540		23,560	
(46 streams) 3/			2,950		32,050		69,770		116,240		147,930		60,730		338,450

1/ Ground counts underlined; others are aerial estimates.
2/ From records maintained on small streams which had a total of less than 2,000.
3/ Contains interpreted data where surveys lacking on certain weeks.
4/ Stream life factor 4.0. All others calculated from stream life factor 2.5.
5/ Stream numbering system revised in 1962.

Appendix A,5.

Prince William Sound Pink Salmon, 1964
(Live counts in streams) 1/

Stream No. 4/	ESHAMY DISTRICT Stream or Bay	WEEK ENDING 7/12	7/19	7/26	8/2	8/9	8/16	8/23	8/30	9/6	9/13	9/20	Calculated Season Total
510	Ellishansky Creek			3500					2500	1775			13750
Other Streams (3) 2/ 3/			50	100	800	1500	2450	1900	2100	1200	530	240	4350
DISTRICT TOTAL (5 streams) 3/		900	1,850	3,600	5,800	9,500	8,454	5,900	4,600	2,975	1,130	540	18,100

1/ Ground counts underlined; others are aerial estimates.

2/ From records maintained on small streams which had a total of less than 2,000.

3/ Contains interpreted data where surveys lacking on certain weeks.

4/ Stream numbering system revised in 1962.

Appendix A,6. Prince William Sound Pink Salmon, 1964
(Live counts in streams) 1/

Stream No. 5/	SOUTHWESTERN DISTRICT Stream or Bay	WEEK ENDING 7/12	7/19	7/26	8/2	8/9	8/16	8/23	8/30	9/6	9/13	9/20	Calculated Season Total
603	Ewan Creek						3000			9400			15200
604	Erb Creek						1500			3000			6980
608	Jackpot River			2000			7000			40000			32750
610	Jackpot Bay			1500			1000			1000			3140
612	Jackpot Bay			2500			100			100			3180
613	Jackson Creek						3500	3000		2300			6700
621	Totemoff Creek						1500			3500			5240
628	Chenega Creek									2500			2600
630	Bainbridge Creek			1000			1200			3800			6420
632	Claw Creek			2200			600			1300			4560
633	Pablo Creek			2500			500						3410
653	Hogg Creek						3500			3500			7580
666	O'Brien Creek			0			1800			5300			8200
670	Montgomery Creek						2200			2600			5220
673	Falls Creek						0			5450			6880
674	Latouche Island						7500			2500			10320
677	Hayden Creek						800			4000			4760
Other Streams (37) 2/ 3/		300	760	1730	2420	3840	6570	8020	9970	11125	6195	2920	21560
DISTRICT TOTALS (55 streams) 3/		3,400	6,560	14,730	20,220	27,740	42,570	59,020	84,270	101,425	53,315	22,570	154,700

1/ Ground counts underlined; others are aerial estimates.
2/ From records maintained on small streams which had a total of less than 2,000.
3/ Contains interpreted data where surveys lacking on certain weeks.
4/ Stream life factor 4.0. All others calculated from stream life factor 2.5.
5/ Stream numbering system revised in 1962.

Appendix A,7. Prince William Sound Pink Salmon, 1964
(Live counts in streams) 1/

Stream No. 4/	MONTAGUE DISTRICT Stream or Bay	WEEK ENDING 7/19	7/26	8/2	8/9	8/16	8/23	8/30	9/6	9/13	9/20	Calculated Season Total
707	MacLeod Creek				1200	300			7930			9330
715	Quadra Creek				3500	3000						23080
720			1000			500			900			3000
723	Montague Island	0			4500	6500						10400
726	Montague Creek	100	3500		0	450			2500	4500		7180
729	Montague Island					3200						3640
739	Swamp Creek	0				500			1600			2600
740	Kelez Creek	0			0	1100			1100			2260
741	Chalmers River	0				3000			8000	5290		12600
744	Whilby Creek	0			350	3200			600	340		2930
745	Wild Creek	0			350	2200			1500	2390		3830
746	Schuman Creek	0	0		1000	2200			2000			5080
747	Cabin Creek	0	0		3000	600			1700			3880
749	Shad Creek	0			100					2050		2490
755	Pautzke Creek	0	0		250	2200			5000	4310		8780
Other Streams (29) 2/ 3/			580	1640	3045	8940	8650	10050	10650	5720	2820	20840
DISTRICT TOTALS (58 streams) 3/		600	7,680	13,620	21,695	38,090	40,350	53,650	62,480	48,200	18,395	121,920

1/ Ground counts underlined; others are aerial estimates.
2/ From records maintained on small streams which had a total of less than 2,000.
3/ Contains interpreted data where surveys lacking on certain weeks.
4/ Stream numbering system revised in 1962.

Appendix A,8. Prince William Sound Pink Salmon, 1964
(Live counts in streams) 1/

Stream No. 5/	SOUTHEASTERN DISTRICT Stream or Bay	WEEK ENDING 7/19	7/26	8/2	8/9	8/16	8/23	8/30	9/6	9/13	9/20	Calculated Season Total
806	Dog Salmon Creek			0	8600					12430		26210
812	Nuchek Creek	0	2000	1000	5500	24000	22000	19000				34320
815	Constantine Creek	0	1000	1000		21000		22000		71970		93590
817	Deer Creek	0		0	1000	3000		3000				6120
818	Juania Creek	0		0	3300	1500		1500				4320
820	Shelter Bay	0		0				1000				2160
821	Brown Bear's Creek	0		450	3500	4500		11000				15940
827	Captain Creek			200	500	4500		4000		2960		7900
828	Cook Creek			100	2500	5000		13000		6130		18310
829	King Creek			0	0	1500		7000				7600
831	Double Creek			0	2200	7500		13000		2480		16870
834	Hardy Creek			0				14000				17600
835	Scott Creek							5000				5360
837	Dan's Bay			0	0	4500		5000				7800
838	Dan's Bay					2500						6060
839	Dan's Bay			0	100	1000						2560
844	Makarka Creek			0	200	4000		12000				14880
846	Hawkins Island				7500	3500						11120
847	Hawkins Creek		2000	0	800			17000		3500		16040
849	Rollins Creek			0	500	400		2600				2800
851	Zillesenoff Creek			0	200			2000				2060
856	Cedar Bay			0	1500	200		3000				3440
861	Cedar Bay							4000				14000
861	Bernard Creek			50	500	300		6000				7140
862	Clamdiggers Creek			0	300	2500						2680
Other Streams (24) 2/3/6/				150	3750	4480	6075	6450	5150	3770	1870	11970
DISTRICT TOTALS		2,000		7,450		123,180		191,950		132,440		358,850
(52 streams) 3/			7,550		72,850		150,175		161,650		53,670	

1/ Ground counts underlined; others are aerial estimates.

2/ From records maintained on small streams which had a total of less than 2,000.

3/ Contains interpreted data where surveys lacking on certain weeks.

4/ Stream life factor 4.0. All others, except one stream with less than 2,000 calculated from stream life factor of 2.5.

5/ Stream numbering system revised in 1962. 6/ One stream calculated using factor 4.0.

Appendix B. Recapitulation of Weekly Pink Salmon Counts in 1964, By District
(Live counts in streams) 1/

No. of Streams	District	6/28	7/5	7/12	7/19	7/26	8/2	8/9	8/16	8/23	8/30	9/6	9/13	9/20	Calculated Season Total
99	Eastern	0	1550	4150	14150	44600	116370	106460	100250	152840	225075	208730	190710	72390	485460
53	Northern	0	0	0	1000	5800	84160	126600	154670	141200	205230	243990	95230	32105	348990
10	Coghill	0	0	500	1500	3130	3700	4700	8100	13485	7235	1900	820	480	18220
46	N.Western	400	2950	15400	32050	35600	69770	119660	116240	127900	147930	154540	60730	23560	338450
5	Eshamy	0	0	900	1850	3600	5800	9500	8454	5900	4600	2975	1130	540	18100
55	S.Western	0	0	3400	6560	14730	20220	27740	42570	59020	84270	101425	53315	22570	154700
58	Montague	0	0	0	600	7680	13620	21695	38090	40350	53650	62480	48200	18395	121920
52	S.Eastern	0	0	0	2000	7550	7450	72850	123180	150175	191950	161650	132440	53670	358850
383	P.W.S. TOTAL	400	4500	24350	59710	122690	321090	489205	591550	689470	918940	935915	500275	222510	1844690

1/ The counts were derived from 1250 aerial surveys and 76 ground surveys.

Appendix C,1. Prince William Sound Chum Salmon, 1964
(Live counts in streams) 1/

Stream No. 5/	EASTERN DISTRICT Stream or Bay	WEEK ENDING 6/21	6/28	7/5	7/12	7/19	7/26	8/2	8/9	8/16	8/23	8/30	9/6	9/13	9/20	Calculated Season Total 4/
35	Koppen Creek				1200	18000	9500	4000		230						14790
36	Sheep River				0	400	1300	1000		7350				450		11080
48	Beartrap River				1000	6800	6500				1000	600				10340
50	Gravina River				0	0	350	500		3000	2100					4580
51	Olsen Creek				2700	4800	8000	7700			1200					14100
52	Control Creek				200	900	5200	500			200					3210
80	Whalen Creek					600	1100	1100								2360
87	Sunny Bay				0	0	0	50				8200		1700		9740
89	Fish Creek				200	1100	4000	700								3330
116	Duck River				0	400	4600		9500	15000		5000		200		21500
117	Indian Creek				5000	8800	9000		2500	2000				150		16180
123	Gregorieff Creek				300	300	1700									3790
127	Naomoff River				0	0			9600	10000			11000			29720
129	Vlasoff Creek				0	1700	200	100	2500	4500			2000	1000		7620
131	Waterfall Creek					0	2200		400							2060
133	Sawmill Creek					2000	600		500							2030
152	Twin Falls Creek					0	500			100				2730		3170
153	Stellar Creek				1000	2000	3000	2000	2000							5440
Other Streams (23) 2/ 3/			50	200	590	2460	2995	3420	4070	3450	3825	3605	2460	1600	500	11700
DISTRICT TOTALS (50 streams) 3/		500	2900	6200	13490	50260	63395	49120	52320	57110	48050	40525	30040	19200	8930	176840

1/ Ground counts underlined; others are aerial estimates.
2/ From records maintained on small streams which had a total of less than 2,000.
3/ Contains interpreted data where surveys lacking on certain weeks.
4/ Estimates calculated from stream life factor 2.5.
5/ Stream numbering system revised in 1962.

Appendix C,2. Prince William Sound Chum Salmon, 1964
(Live counts in streams) 1/

Stream No. 5/	NORTHERN DISTRICT Stream or Bay	WEEK ENDING 6/28	7/5	7/12	7/19	7/26	8/2	8/9	8/16	8/23	8/30	9/6	9/13	9/20	Calculated Season Total 4/
214	Log Creek						1000	3300	6700			5000	2000		12560
216	Vanishing Creek							1000	2100						2280
234	Wells River			6500	15000	24000	16000	9400	1500						31700
264	Siwash River					1200	2700	4000	2100						5940
276	Blck. Bear Creek					1500			800			3000			6640
279	Canyon Creek					200			1500						2210
Other Streams (10) 2/ 3/			20	110	305	625	990	1120	2450	1420	890	390	190	20	3420
DISTRICT TOTALS (23 streams) 3/		2200	3520	7570	17275	28275	23290	20820	17150	13620	11290	9390	5140	2320	64750

1/ Ground counts underlined; others are aerial estimates.
2/ From records maintained on small streams which had a total of less than 2,000.
3/ Contains interpreted data where surveys lacking on certain weeks.
4/ Estimates calculated from stream life factor 2.5.
5/ Stream numbering system revised in 1962.

Appendix C,3. Prince William Sound Chum Salmon, 1964
(Live counts in streams) 1/

Stream No. 5/	NORTHWESTERN AND COGHILL DISTRICTS Stream or Bay	WEEK ENDING 6/28	7/5	7/12	7/19	7/26	8/2	8/9	8/16	8/23	8/30	9/6	9/13	9/20	Calculated Season Total 4/
322	Coghill River				16000	19000		8600	13000						37640
419	Bettles Bay					6500									8120
421	Mills Creek				0			6000	4000						10400
424	Hummer Bay				0	0		2500	300			500			2480
425	Hummer Creek				0	2200		1500	2000			7000			11880
430	Meacham Creek				4000	12000		3500	500			1500			14680
432	Swanson Creek				2500	8000		5500	5000			1000			15240
450	Tebenkof Creek								1800						2160
454	Halferty Creek					1200		1500	1000			800			3600
458	Parks Creek								1600						2190
476	Shrode Creek					1000			0			2000			3500
479	Culross Creek					1500		150				1000			3100
484	E.Finger Creek					2000		1500							3860
495	Chimevisky Lagoon					3000					3000				9760
Other Streams (16) 2/ 3/			280	1500	3170	3250	3005	2300	2405	1715	1050	820	320	120	7980
DISTRICT TOTALS (29 streams) 3/		800	4580	16830	34020	64150	53605	43250	38105	28515	25650	19370	10220	2370	136590

1/ Ground counts underlined; others are aerial estimates.
2/ From records maintained on small streams which had a total of less than 2,000.
3/ Contains interpreted data where surveys lacking on certain weeks.
4/ Estimates calculated from stream life factor 2.5.
5/ Stream numbering system revised in 1962.

Appendix C,4.

Prince William Sound Chum Salmon, 1964
(Live counts in streams) 1/

Stream No. 5/	SOUTHWESTERN & ESHAMY DISTRICTS Stream or Bay	WEEK ENDING 7/12	7/19	7/26	8/2	8/9	8/16	8/23	8/30	9/6	9/13	9/20	Calculated Season Total 4/
	Other Streams (10) 2/ 3/	70	210	450	580	1,020	1,470	1,370	1,210	1,350	820	360	3,560
	DISTRICT TOTALS (10 streams) 3/	70	210	450	580	1,020	1,470	1,370	1,210	1,350	820	360	3,560

1/ Ground counts underlined; others are aerial estimates.

2/ From records maintained on small streams which had a total of less than 2,000.

3/ Contains interpreted data where surveys lacking on certain weeks.

4/ Estimates calculated from stream life factor 2.5.

5/ Stream numbering system revised in 1962.

Appendix C,5. Prince William Sound Chum Salmon, 1964
(Live counts in streams) 1/

Stream No. 5/	MONTAGUE DISTRICT Stream or Bay	WEEK ENDING 7/19	7/26	8/2	8/9	8/16	8/23	8/30	9/6	9/13	9/20	Calculated Season Total 4/
741	Chalmers River		100		4,700	12,000			11,000			22,940
775	Pautzke Creek				4,000				520			4,370
Other Streams (6) 2/ 3/		300	610	720	1,045	2,825	1,600	1,400	1,300	690	340	4,340
DISTRICT TOTALS (8 streams) 3/		450	910	5,220	9,745	16,825	12,600	12,700	12,820	5,390	2,440	31,650

1/ Ground counts underlined; others are aerial estimates.

2/ From records maintained on small streams which had a total of less than 2,000.

3/ Contains interpreted data where surveys lacking on certain weeks.

4/ Estimates calculated from stream life factor 2.5.

5/ Stream numbering system revised in 1962.

Appendix C,6. Prince William Sound Chum Salmon, 1964
(Live counts in streams) 1/

Stream No. 5/	SOUTHEASTERN DISTRICT Stream or Bay	WEEK ENDING 7/12	7/19	7/26	8/2	8/9	8/16	8/23	8/30	9/6	9/13	9/20	Calculated Season Total 4/
812	Nuchek Creek			0	800				1000				2,280
815	Constantine Creek		100	3000	4000				2000		5000		11,260
821	Brown Bear Creek				450				2000				3,520
828	Cook Creek				100		1000		2000				2,590
831	Double Creek					300			2000		100		2,130
839	Dan's Bay					350			2500				3,940
Other Streams (3) 2/ 3/		250	620	1550	900	850	800	880	1100	700	650	300	3,440
DISTRICT TOTALS (14 streams) 3/		350	880	4,880	6,410	6,700	7,600	8,880	12,600	10,800	8,550	5,250	29,160

1/ Ground counts underlined; others are aerial estimates.

2/ From records maintained on small streams which had a total of less than 2,000.

3/ Contains interpreted data where surveys lacking on certain weeks.

4/ Estimates calculated from stream life factor 2.5.

5/ Stream numbering system revised in 1962.

Appendix D. 1964 Recapitulation of Weekly Chum Salmon Counts by District
(Live counts in stream) 1/

No. of Streams District	Week Ending 6/21	6/28	7/5	7/12	7/19	7/26	8/2	8/9	8/16	8/23	8/30	9/6	9/13	9/20	Calculated Season Total
50 Eastern	500	2900	6200	13490	50260	63395	49120	52320	57110	48050	40525	30040	19200	8930	176840
23 Northern		2200	3520	7570	17275	28275	23290	20820	17150	13620	11290	9390	5140	2320	64750
29 N.Western Coghill		800	4580	16830	34020	64150	53605	43250	38105	28515	25650	19370	10220	2370	136590
10 S.Western-Eshamy				70	210	450	580	1020	1470	1370	1210	1350	820	360	3560
8 Montague					450	910	5220	9745	16825	12600	12700	12820	5390	2440	31650
14 S. Eastern				350	880	4880	6410	6700	7600	8880	12600	10800	8550	5250	29160
134 P.W.S. TOTAL	500	5900	14300	38310	103095	162060	138225	133855	138260	113035	103975	83770	49320	21670	442,550

1/ The counts were derived from 1,250 aerial surveys and 76 ground surveys.

Appendix E. 1963 Recapitulation of Weekly Chum Salmon Counts by District
(Live counts in streams) 1/

No. of Streams District	Week Ending 6/23	6/30	7/7	7/14	7/21	7/28	8/4	8/11	8/18	8/25	9/1	9/8	9/15	9/22	Calculated Season Total
56 Eastern	2300	7250	16120	30390	66720	42330	34920	26810	43670	42030	25715	15692	9590	6555	148060
31 Northern Coghill	200	4420	14450	15140	16240	20925	25870	31200	10220	13610	9305	5380	2790	1220	68390
51 N.Western Eshamy	590	1400	10590	9930	34100	50550	52420	55140	24090	16720	7636	4360	1430	440	114240
17 S.Western	---	0	500	1050	1600	3220	2240	650	1850	1350	690	96	60	20	5320
19 Montague	---	0	50	100	300	500	0	7760	7150	9950	6350	3100	1700	720	15070
20 S. Eastern	300	500	4000	4000	3000	3900	3840	4500	5350	9000	6500	3070	1460	620	20020
194 P.W.S. TOTAL	3390	13570	45710	60610	212960	121405	119290	126060	92330	92660	56196	31698	17030	9575	371100

1/ The counts were derived from 1,086 aerial surveys and 185 ground surveys. Total surveys 1,271.

Appendix F. 1962 Recapitulation of Weekly Chum Salmon Counts by District
(Live counts in streams) 1/

No. of Streams District	Week Ending 6/30	7/7	7/14	7/21	7/28	8/4	8/11	8/18	8/25	9/1	9/8	9/15	9/22	Calculated Season Total
44 Eastern	3500	21210	34850	44250	59160	54090	52080	48610	51690	60120	64220	64150	38720	238680
19 Northern	150	5050	10500	15150	21500	18900	18870	21220	21050	22900	12210	1670	0	67670
35 N.Western & Coghill	0	1400	6450	22800	42860	46720	43310	37760	21200	11250	4550	700	100	96018
12 S. Western & Eshamy	100	350	1550	2820	3100	4810	4220	3680	3090	1850	750	200	0	10610
7 Montague	0	0	0	500	2000	5690	8750	12800	16950	19600	19700	10450	4390	34190
15 S. Eastern	200	500	3000	4300	7600	14850	13050	12960	10100	10100	10200	10340	2040	39690
132 P.W.S. TOTAL	3950	28510	56350	89820	136220	145060	141280	137030	124080	125820	111630	87510	45250	486858

1/ The total counts were derived from 877 aerial surveys and 226 ground surveys. Total surveys, 1,103.

Appendix G. 1961 Recapitulation of Weekly Chum Salmon Counts by District [1/]

No. of Streams District	Week Ending 7/1	7/8	7/15	7/22	7/29	8/5	8/12	8/19	8/26	9/2	9/9	9/16	9/23	Calculated Season Total
53 Eastern	2240	31310	38180	35930	18830	17240	23470	37100	36390	30700	15860	5320	1500	117950
26 Northern	350	3800	6600	9300	12150	14120	14550	13140	18180	19510	9530	4300	500	50420
34 N.Western & Coghill	0	5000	15600	14170	25710	39710	35800	20840	11210	6750	2000	550	0	70940
11 S.Western & Eshamy	0	110	250	600	900	1180	1560	2510	1940	1480	900	330	70	4750
14 Montague	0	0	100	430	910	4060	14700	21710	22920	10660	5680	3230	1540	34380
18 S. Eastern	500	4200	5700	5470	9260	14330	18900	22300	20980	23883	16410	10630	4470	62820
158 P.W.S. TOTAL	3090	44420	66930	65800	67760	90690	108980	47600	111620	92983	50380	92983	8080	341260

1/ Total figures slightly revised from live counts in stream by district. Refer to Memorandum #5 by W. H. Noerenberg for 1961 run for revised estimates.