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FORECAST RESEARCH ON 1966 KODIAK AREA PINK SALMON FISHERIES

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INTRODUCTION

The need and value of forecasting pink salmon returns are fairly obvious. Essentially forecasts provide information relating to relative abundance of returning pink salmon and in many cases indicate both weak and strong areas of expected abundance. The implications to the fishery manager are many and provide him with a workable tool for formulating his management policy. Industry as a whole can utilize this information to gear operations more efficiently and thereby decrease costs and increase profits.

In Kodiak forecast research began as a pilot project in 1962 and has expanded each year as rapidly as information could be assimulated and funds made available. Much of the ground work of this program was conducted by Wallace H. Noerenberg, Robert S. Roys and William L. Sheridan. Periodic reporting of this work has been in the form of Alaska Department of Fish and Game Informational Leaflets. These publications include Informational Leaflets #36 and #65.

Basically, forecasts are made on the relative densities of pre-emergent fry and the parent-cycle adult escapements. However, as one might suspect there are associated observations on each cycle which might yield additional forecast information. Such things as the relative size and condition of the fry, period of outmigration, escapement distribution, and physical factors which may affect environmental conditions are all important.

Nearly all Alaska Department of Fish and Game work dwells on the freshwater stages of salmon life history, but we are well cognizant of the salt water life history. Various cooperating organizations are laying ground work in this direction. For example the Fisheries Research Institute, University of Washington is actively engaged in estuarine sampling of fry abundance in the Alitak, Uyak and Uganik Bay areas. In addition considerable work has been conducted by the Institute and U.S. and Canadian federal agencies on high seas sampling. In essence then, we are making advances in many directions which should ultimately

enable fishery biologists to provide more and more reliable forecast information.

METHOD OF STUDY

Pre-emergent pink salmon fry sampling during the spring of 1965 in the Kodiak-Afognak Islands area followed essentially the same pattern as was initiated in 1963. Areas sampled within the streams are marked so that each successive year essentially the same area is sampled though not always the same riffle areas, which is nearly impossible due to the differences in stream levels. The number of samples taken from each locale has been kept fairly constant, although a few more were taken in most streams during 1965 than in 1963.

Twenty streams were sampled in 1965 during the period from March 2 to April 23. This rather extensive field work required five temporary aides and one full-time biologist. Also five weeks of vessel time were utilized, supplied by the State motor vessel TEAL. In addition twin- and single-engine aircraft were used to reach the more inaccessible areas. Even so, certain areas are not reachable by these conventional means, and it is proposed helicopters be utilized in future years. A map of the Kodiak area is shown in Figure 1, page 10.

The data collected thus far are insufficient for regression analysis. Fry index-return run comparisons are available for only two runs (1963-64, 1964-65) and the fry data accumulated during 1964 were considered incomplete. Being so, the approach used has been to examine each stream individually and attempt to relate this to the 1966 return run as a whole. Our basis for forecast consists primarily of only two factors, i.e. magnitude of the escapement and pre-emergent fry densities. Other useful factors are usually not available at present such as changes due to land subsidence, which could affect the ecology of a stream as freezing and flooding or other natural phenomena. A brief look at yearly temperature and hydrological conditions is included, but confined mainly to Humpy Creek which may have had a heavy mortality rate due to scouring.

In addition, though not previously utilized in conjunction with pre-emergent fry studies, this report makes use of the percent of negative samples as a secondary indicator; whereas a negative sample is defined as one in which no live fry were excavated, though dead or decaying eggs may or may not have been present. The hypothesis is that the percent of negative samples of the total number taken within a given stream will provide an insight on spawning success and survival distribution for a given year which can then be compared to other years. Average pre-emergent fry densities for a certain stream are probably not readily comparable from year to year unless something is known of how the live fry are distributed within the gravel, which can and does differ significantly from year to year. For example, the Buskin River in 1963 had a pre-emergent fry index of $36.6/.1m^2$ and 24 percent of the samples taken gave negative results. In 1965 the pre-emergent fry index was $36.3/.1m^2$ yet only 12 percent of the samples were negative.

Another prime example is the Frazer River, which in 1963 had a pre-emergent fry index of 15.5/.1m^2 and 63 percent of the samples taken were negative. Comparing this with 1965, the pre-emergent fry index was 2.2/.1m^2 and 90 percent of all samples were negative. Checking field data revealed that in 1963 fry were found throughout the stream, but that only two of twelve riffles yielded live fry in 1965. These are but two examples, however a similar pattern is true for all 20 streams sampled. This of course, gives us only a generalized idea of how live fry were distributed within the stream, but to advance further is beyond the scope of this report.

SUMMARY OF STREAM OBSERVATIONS

The comparative fry densities from 1961-1964, fry density for 1965, and the catch-escapement for 1937-1964 are presented at the end of this section in Tables 1, 2 and 3, pages 11 to 13.

Chiniak Bay

The sampling program was initiated the first week of March 1965 in the Chiniak Bay area. Three streams of primary importance here, Buskin River, American River and Sid Old's Creek are accessible by road from the City of Kodiak. Escapements into these three streams were at a high level in 1962 and again in 1964. The Buskin River received over 200,000 spawners in 1962 and close to 100,000 in 1964. Pre-emergent fry sampling indicated nearly identical densities of 36.6/.1m^2 in the spring of 1963 and 36.3/.1m^2 in the spring of 1965. Relative survival and distribution were determined exceptionally good throughout the Buskin River in 1965; only 12 percent of the 115 samples taken resulted in no live fry excavated. Prospects appear bright for an excellent return in 1966 to the Buskin River.

Parent escapements in 1962 into the American River, Middle Bay, were approximately half of the 48,000 estimated in 1964, yet the fry index was slightly better, 12.2/.1m^2 and 17.5/.1m^2 respectively. Sampling in the spring of 1965 indicated that live fry distribution within the sampling area was relatively good. With the evidence on hand it is foreseen that the 1966 return will at least equal if not exceed the parent return.

Results in Sid Old's Creek, Kalsin Bay, as determined by pre-emergent sampling were quite good: 20.7/.1m^2 in the spring of 1965. This is much better than the previous cycle indicated, (8.0/.1m^2) yet escapements were at radically different levels, being near 168,000 in 1962 compared to only 30,000 in 1964. This is a prime example where a much lesser escapement gave a considerably higher pre-emergent index. Of the samples taken 41 percent gave negative results which is slightly below the 45.5 percent average as computed for all the streams sampled during the spring of 1965. These data give inclination that the 1966 return will exceed the parent run by some margin.

Land subsidence exceeding 5 feet has been recorded as a result of the earthquake in the Chiniak Bay region, which has caused some loss of spawning gravel. The net effect is unknown but believed to be negligible. Past records

show that intertidal spawning is unimportant in the Chiniak Bay region, however previous spawning area now covered by salt water has become moribund regarding pink salmon production.

Saltery Creek - Ugak Bay

The Ugak-Saltery Cove area appeared weak. Pre-emergent fry densities following even-year spawning in 1962 and 1964 were 5.3/.1m^2 and 2.2/.1m^2 respectively, neither of which are considered good. Escapements into this stream were at a sufficient level both years. Sampling gave strong indication that although live fry were found in most sections of the stream they were not well distributed. As many as 68 percent of the samples taken exhibited negative results. Saltery Creek has a strong tendency to produce heaviest on the odd-year cycle, which may partially explain the poor results for reasons not yet discovered. Due to the timing of the sampling work in 1965 (April 23) the possibility exists that outmigration was well underway, giving a false appearance. Considerable land subsidence occurred in this area also, due to the earthquake, and perhaps as much as 1/3 mile of the lower spawning gravel was lost to productivity. In any event, the 1966 return outlook for this stream can only be seen as poor.

Kaiugnak Creek

Sampling of Kaiugnak Creek in 1965 yielded excellent live fry densities. An escapement of about 34,000 in 1962 gave a pre-emergent fry index of 43.1/.1m^2 yet the much lower 1964 estimated escapement of 10,000 gave a pre-emergent fry index of 39.2/.1m^2. Freshwater survival was evidently excellent. Distribution of fry within the sampling area was quite good, only 37 percent of the samples taken gave negative results. All considered, an excellent return to this stream in 1966 is expected.

Seven River's, Geese Channel

Seven Rivers in contrast to Humpy Creek on the opposite side of the Aliulik Peninsula did not exhibit drastic mortalities, but pre-emergent fry densities were only fair. Resultant pre-emergent fry density from the 1962 spawning was 13.8/.1m^2 and 8.6/.1m^2 from the 1964 spawning. Part of this reduction may be explained by the fact that escapements were twice as great in 1962 than the estimated 58,000 in 1964. Also, aerial surveys showed that the main body of spawners entered the lower forks of the stream which are not included in the sampling area. There is some feeling that these lower forks are not as productive as the main channel, but this is without proof. In the future, sampling may be rearranged to include the spawning area in the lower end, especially on years when large bodies of fish spawn there. In view of the low pre-emergent fry index and the fact that 55 percent of the samples gave negative results it is likely that

Seven River's will have only fair production in 1966 and may well fall short early in the season.

Humpy Creek, Alitak Bay

Sampling of Humpy Creek revealed some very interesting results. Of 105 samples taken in the spring of 1965 completely negative results were obtained. Only in one short section were 3-4,000 dead eggs found, the only indication spawning had occurred at all, yet aerial surveys estimated 80,000 spawners in 1964. Exactly what happened here is open to question, but something assuredly did. Checking past records it was found that the escapement in 1962 was near 300,000 in Humpy Creek, yet the returning run needed protection in 1964. No pre-emergent fry index was obtained in the spring of 1963 due to high water conditions, but it is quite probable that flooding and scouring were a major cause of mortalities in both years (see remarks under Climatology).

There are a couple of other possibilities which could explain the completely negative results found in Humpy Creek. First, the sampling area could have missed the spawning area, which extended 2-1/2 to 3 miles, but aerial surveys refute this. Second, some other natural phenomona could have occurred but no evidence of such was found. It is almost a certainty that Humpy Creek will have a weak run in 1966 and there is justification to assure maximum protection to whatever remnant may return.

Frazer River, Olga Bay

Aerial surveys on the Frazer River branch of Dog Salmon River indicated there were 290,000 spawners in 1962 and 53,000 in 1964. On even years pinks tend to spawn heaviest in the Frazer River branch which empties out of Frazer Lake. On the odd years pinks tend to spawn almost entirely in the upper regions of the Dog Salmon River. The pre-emergent sampling scheme is geared in like manner. Resultant pre-emergent fry density for the 1962 run was 15.5/.1m^2 and only 2.6/.1m^2 for 1964. Since both the spawning escapement and pre-emergent fry index were considerably lower for 1964 than for 1962 there is good indication that the returning run in 1966 will be poor. To give further evidence, of the 125 samples taken a high 90 percent of them gave negative results; only two short sections contained live fry.

Sturgeon and Karluk Rivers

The Sturgeon and Karluk Rivers were not sampled due to the inaccessibility of these two systems via conventional means. Both are huge systems situated so that the only practical method to get in is by helicopter. This is an unfortunate circumstance since on the even-year cycle they are primary producers on Kodiak

Island. In 1964 the escapement into the Karluk River was near 1/2 million and Sturgeon received an estimated 350,000. Even mediocre freshwater survival should assure these two systems of being primary producers again in 1966.

Red River

Red River escapements in 1964 were estimated at nearly 1/2 million and exceeded 1 million in 1962. This stream was sampled in the spring following both these years and pre-emergent fry densities recorded at 10.3/.1m^2 in 1965 and 27.3/.1m^2 in 1963. Due to the fact that sampling was not accomplished until April 15 in the spring of 1965 (the lake remained frozen until April 10) there is good reason to believe outmigration was well underway. Close to 95 percent of all fry excavated were buttoned up and ready to migrate. Live fry were found throughout the sampling area, only 38 percent of all samples were negative. In such a huge system as Red River with it's extensive spawning area a pre-emergent fry density of 10.3/.1m^2 should be considered good. Assuming outmigration had in fact begun, the pre-emergent index must have necessarily been minimal. With this in view it becomes evident that the 1966 return should be good though somewhat below the parent return.

Uyak Bay

Three streams are sampled in the Uyak Bay area: Uyak River, Brown's Lagoon and Zachar River. Uyak River has a tendency to peak on the odd-year cycle, but is also a fair producer on even years. Pre-emergent fry sampling in the spring of 1965 indicated a density of 25.0/.1m^2; no sample was taken in 1963. Escapements in 1964 were near 100,000, which is above average. From the limited information on hand it is concluded that the return to Uyak River will most probably be good in 1966.

High water conditions in 1965 prevented extensive pre-emergent fry sampling in Zachar River. From 50 samples taken in 1965 the live fry density was calculated at 4.4/.1m^2 as a result of some 24,000 spawners in 1964. Though not conclusive, there is reason to believe that this stream could handle considerably higher escapement levels. The 1962 estimated escapement of 36,000 indicated a pre-emergent fry density of 12.9/.1m^2. Considering that fry index densities found in 1965 (4.4/.1m^2) were minimal, the run in 1966 can at best be fair and could easily be poor.

Sampling in Brown's Lagoon showed that fairly low pre-emergent fry densities were present in late March of 1965, being only 7.0/.1m^2. This in comparison to 15.1/.1m^2 found in the spring of 1963. Parent escapement levels were at a similar magnitude, in the 40-50,000 category. This tends to indicate that freshwater survival was not good over winter 1964-65. The 1966 return will

most probably not reach that of the parent run and can therefore be only considered as fair.

Uganik River, Mush Bay (East Arm)

The Uganik River in Mush Bay received a 1964 escapement of near 98,000 pinks and subsequent sampling determined the pre-emergent fry index was 28.8/.1m^2. Overwinter survival may therefore have been excellent. It became evident while sampling that live fry were well distributed throughout the sampling area, in fact only a low 17 percent of all samples taken in 1965 in the Uganik River gave negative results. Since it is known that the 15.1/.1m^2 pre-emergent fry index found for the 1962 run resulted in near record returns in 1964 there is good reason to believe that the much higher index of 28.8/.1m^2 for 1964 will give equally as good and perhaps better return in 1966.

Terror Bay

Terror River had nearly identical escapements in 1962 and in 1964. Overwinter survival, however was nearly twice as great for 1964. The pre-emergent indices were 4.7/.1m^2 for 1962 and 8.8/.1m^2 for 1964. Since the lower index resulted in a fair return it becomes possible to forecast with some degree of certainty that the higher index of 8.8/.1m^2 will produce even better results. How much better is open to question, but no doubt the 1966 return will at least be fair.

Overwinter survival in Bauman's Creek was exceptional. An estimated spawning escapement of 8,000 in 1964 indicated a subsequent pre-emergent fry density of 49.0/.1m^2. This can be compared to 30,000 escapement in 1962 with a resultant pre-emergent density of only 7.6/.1m^2. If one could rely completely on pre-emergent indices, a fantastic return would have to be forecast for 1966. It is likely that an escapement in the 8-15,000 range would adequately seed this stream, anything more may be redundant. The excellent return expected in 1966 should become apparent early in the season.

Elbow Creek, Sharatin Bay

The last stream sampled on Kodiak Island proper in the spring of 1965 was Elbow Creek in Sharatin Bay. Escapements were of similar magnitude in 1962 and 1964 (15-20,000 range). Pre-emergent fry densities were found at 11.3/.1m^2 and 18.0/.1m^2 for the 1962 and 1964 runs respectively. This is further evidence that good freshwater survival occurred in the Uganik, Terror and Sharatin Bay areas over the winter of 1964-65. Distribution and subsequent survival of fry was comparatively uniform within the sampling area in Elbow Creek, only 24 percent of the samples taken gave negative results. It should

be safe to say that a comparatively good return can be expected in 1966 to Elbow Creek.

AFOGNAK ISLAND STREAMS

In the following discussion four streams of primary importance on Afognak Island will be considered: Afognak, Danger, Portage and Paramanof Rivers.

Afognak River

Previous to the earthquake and associated tsunami the main spawning channel of Afognak River was at least 1/2 mile in length and free of salt water influence. This area has now been reduced to not over 1/4 of a mile and the lower portions are subject to the tides. The spawning area free of tidal action has become filled with small debris of all descriptions. Spawning escapements in 1962 were near 75,000 pinks as opposed to 45,000 in 1964. Results of pre-emergent fry sampling gave associated fry densities of 23.5 and 1.1 per $.1m^2$ respectively. Spring sampling in 1965 determined that heavy mortalities occurred, many thousands of dead eggs and early stage fry were found. It becomes apparent then that this stream has been seriously damaged and may be a long time recovering.

Portage River, Perenosa Bay

Portage River also suffered as a consequence of the earthquake, mainly in the lower sections which have been primary contributors to the runs. A parent escapement of about 27,000 pinks in 1962 produced a pre-emergent fry index of $50.7/.1m^2$. In comparison, the 37,000 or so spawners in 1964 yielded fry samples averaging only $11.2/.1m^2$. The latter year sampling gave evidence that heavy spawning had occurred, but that associated mortalities were also heavy. As was noticed in Afognak River, conspicuous amounts of debris were present in the lower stream sections. The adult return may still be fair to good in 1966, but will probably fall well short of the parent run.

Danger River, Kazakof Bay

The changes due to the earthquake in Danger River appeared slight. Land subsidence occurred, but the primary spawning area was untouched. The estimated 1964 escapement of 25,000 spawners gave a pre-emergent fry index of $26.7/.1m^2$. This in comparison to the estimated 40,000 escapement in 1962, which exhibited a pre-emergent fry index of $16.9/.1m^2$. In other words, a much

smaller 1964 escapement gave a much higher pre-emergent index than did the previous cycle, i.e. good evidence that freshwater survival conditions were quite favorable. Moreover, distribution of live fry within the area sampled was judged good; only 16 percent of the samples gave negative results. It is not improbable to expect the 1966 return to this stream to be excellent.

Paramanof River

Changes as a result of the earthquake in Paramanof Bay are nearly undetectable, at least to the unexperienced eye. From about 18,000 spawning pinks in Paramanof River in 1964 a resultant pre-emergent fry index of 40.8/.1m^2 was obtained, which is exceptional. The previous (1962) cycle received a similar number of spawners yet resulted in a pre-emergent index of only 5.8/.1m^2. Quite apparently then, the overwinter survival during 1964-65 was good. With this in view a forecast for an excellent return in 1966 is anticipated.

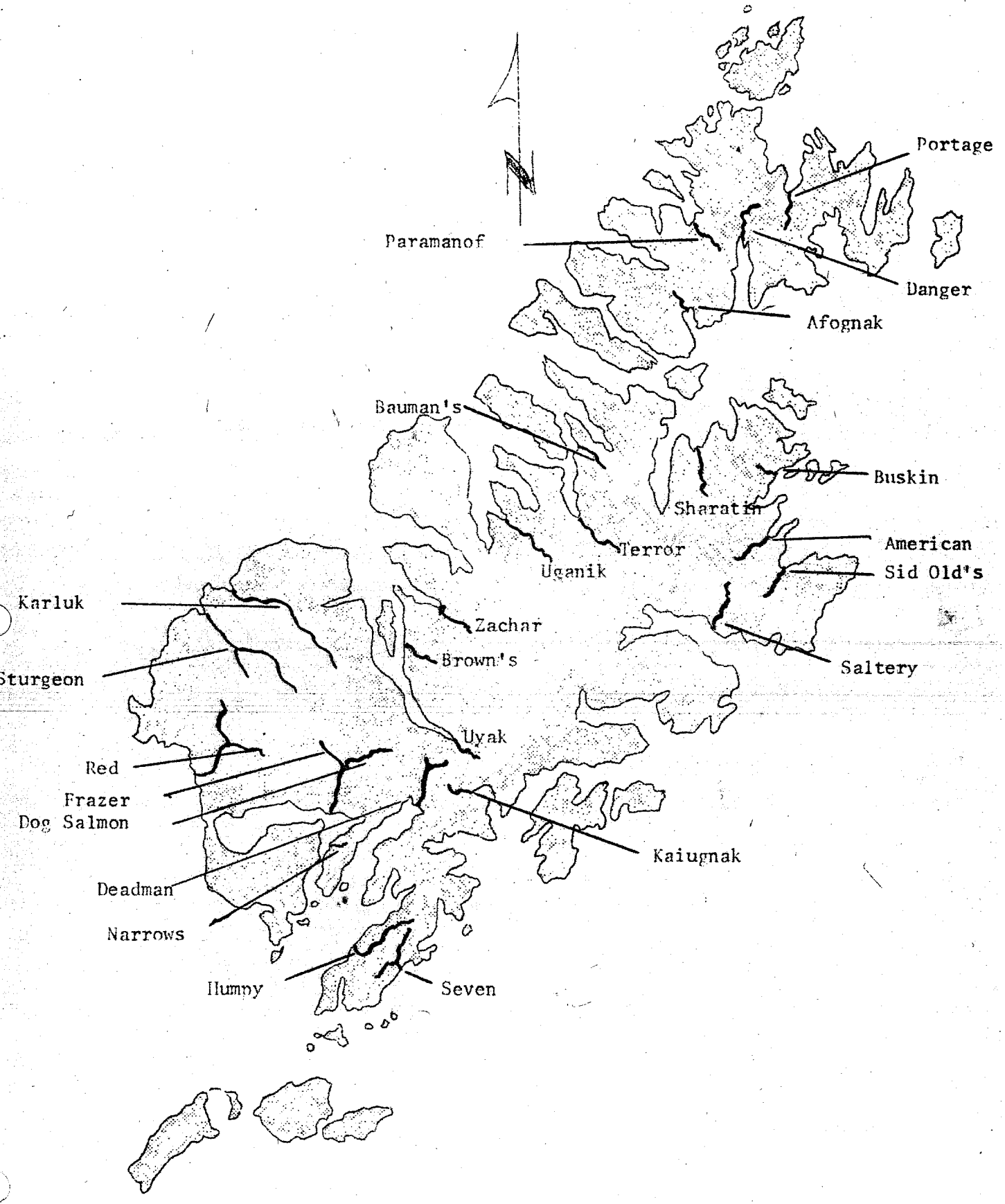

Figure 1. A map of the Kodiak area showing the important pink salmon sampling sites.

Table 1. Results of pre-emergent pink salmon fry sampling in the Kodiak area

Streams and comparative densities from March-April 1961-1964

Name of stream	1965 sampling: Date sampled	No. of samples	Fry recovered	Year and density of fry/.1m^2: 1962	1963	1964	1965
American R.	March 2-3	115	3,750	----	12.2	6.8**	17.5
Sid Old's C.	March 3-4	115	4,423	----	8.0	0.9**	20.7
Buskin R.	March 5-6	114	7,681	2.5	36.6	6.8	36.3
Kaiugnak C.	March 16	51	3,712	60.4	43.1	----	39.2
Humpy R.	March 22	105	0	----	----	----	0
Seven R.	March 22-23	75	1,196	13.6	13.8	----	8.6
Narrows C.	------	---	-----	----	37.2	----	----
Brown's L.	March 25	85	1,104	----	15.1	----	7.0
Uyak R.	March 26	80	2,237	----	----	38.8	15.0
Zackar R.	March 27	50	411	----	12.9	----	4.4
Uganik R.	March 28	70	3,743	----	15.1	6.5**	28.8
Bauman's C.	March 28	35	3,184	----	7.6	15.3**	49.0
Terror R.	March 29	70	1,139	----	4.7	7.2**	8.8
Sharatin C.	March 30	45	1,501	----	11.3	10.4	18.0
Afognak R.	April 3	45	80	----	23.5	----	1.1
Danger R.	April 4	80	3,971	----	16.9	----	26.7
Portage R.	April 6	50	1,041	----	50.7	----	11.2
Paramanof R.	April 7	71	5,389	----	5.8	----	40.8
Frazer R.	April 12	125	606	----	15.5	----	2.6
Red R.	April 15	180	3,449	----	27.3	18.3**	10.3*
Saltery R.	April 23	80	312	5.4	5.3	----	2.2*
Big Kitoi C.	------	---	-----	66.2	18.0	----	----
	TOTAL	1,641	48,929	MEAN	19.03	12.3	17.41

* From outward appearances outmigration was underway when sample was taken and as a result these figures are minimal.

** Actual field data was lost during the seismic wave, small variances may be involved.

Table 2. Kodiak streams in order of relative fry density per unit area in 1965*

Parent escapement	River	Live fry per .1m^2	Percent of negative samples of total	
80,000	Humpy Creek	0	100%	
45,000	Afognak River	1.1	47%	Poor
45,000**	Saltery Creek	2.2	68%	
53,000***	Frazer River (Dog Salmon)	2.6	90%	
52,000	Zachar River	4.4	62%	
65,000	Brown's Lagoon Creek	7.0	62%	Fair
58,000	Seven Rivers	8.6	55%	
40,000	Terror River	8.8	51%	
425,000**	Red River	10.3	38%	
37,000	Portage River	11.2	56%	
100,000	Uyak River	15.0	53%	Good
49,000	American River	17.5	46%	
17,500	Sharatin Creek	18.0	24%	
30,000	Sid Old's Creek	20.7	41%	
25,000	Danger River	26.7	16%	
201,000	Uganik River	28.8	17%	
93,000	Buskin River	36.3	12%	Excellent
10,000	Kaiugnak Creek	39.2	37%	
18,000	Paramanof River	40.8	21%	
13,600	Bauman's Creek	49.0	14%	
	Mean	17.4	Mean 45.5%	

* A measure of fry per unit area and not of actual total fry production, due to vast differences in the size of the spawning grounds.

** Due to the late date that samples were taken it is strongly suspected that outmigration was well underway

*** Only the Frazer Lake Branch of the Dog Salmon River was sampled. Spawning distribution was not noted, hence, the index may be misleading.

Table 3. Kodiak Island area pink salmon catch-escapement 1937-1964.

Year	Escapements FRI*	Escapements ADF&G	Commercial catch	Case-pack 1# Talls	Average Fish/case
1937			15,101,471	933,391	20.59
1938			8,455,479	450,098	18.79
1939			10,360,881	603,492	17.17
1940			?	443,154	?
1941			8,583,731	508,306	16.89
1942			6,601,279	313,711	21.04
1943			12,711,298	555,209	22.89
1944			5,382,870	335,683	16.03
1945			11,462,026	491,346	23.33
1946			11,927,423	541,334	22.03
1947			8,856,666	494,211	17.92
1948			5,958,577	303,564	19.63
1949			4,928,210	208,537	23.63
1950			5,304,701	266,694	19.89
1951			2,005,947	126,238	15.89
1952	2,274,500		4,553,697	281,405	16.18
1953	1,125,500		4,947,491	273,344	18.10
1954	1,917,400		8,325,034	382,779	21.75
1955	1,277,050		10,794,164	525,322	20.55
1956	1,777,030		3,349,203	156,127	21.45
1957	465,000		4,690,994	232,975	20.14
1958	924,850		4,038,938	254,320	15.88
1959	975,750		1,799,675	110,510	16.29
1960	1,404,800	1,833,330	6,684,798	281,122	23.78
1961	604,700	609,230	3,926,023	258,767	15.17
1962	3,340,800	4,597,100	14,188,745	565,770	25.08
1963	740,950	941,580	5,480,158	261,831	20.93
1964	2,037,900	2,762,630	11,861,785	500,780	23.69

Data from Kodiak Annual Reports and FRI Stream Surveys.

* Fisheries Research Institute, University of Washington. Independent surveys from ADF&G.

CLIMATOLOGY

In examining the weather conditions of Kodiak Island during the 1964-65 spawning and brood year three major factors are considered; temperatures, rainfall and snowfall. Precipitation figures include snowfall at a ratio of 1:10. All weather data was provided by the US Naval Station, Kodiak and was recorded at sea level on the station. It is of primary importance that note is made of the weather recording location since it may or may not be reflective of the actual conditions on other parts of Kodiak and Afognak Islands. It does, however, serve to give the general picture, which can be applied to other parts of the area from what is known of them.

Figure 2 and Table 4 gives the annual monthly precipitation from June 1964 through May of 1965, with a comparison to the 16 year means. From this graph it is easily seen that precipitation during July was below normal, but that during August and September precipitation was considerably above normal. Escapement begins in July and continues on into August with spawning occurring mainly during August and September. It is evident then that sufficient water levels were present during peak spawning activity.

Precipitation was noteably less than normal during November, December and again in February, during which period average temperatures are lowest. This may well have resulted in lower stream flows and perhaps some mortality due to freezing. In general it is felt mortality due to freezing was light, but what did occur is probably synergetic of high water during spawning and associated low water during the period a freeze was most likely.

The month of March is of special interest, as rainfall during this month was much greater than the 16-year mean, most of which fell during a 3-day period, the 16th through the 18th when 6.8 inches fell. The associated temperatures were also well above average for the same period.

Figure 3 and Table 5 shows the annual monthly snowfall from September, 1964 through May, 1965. Aerial observations during early March indicated that the South end of Kodiak Island received little snowfall which resulted in heavy formation of ice. The North and West sides of Kodiak received a much heavier snow deposition and Afognak Island had an even greater amount. Incidentally, Afognak Island temperatures range up to 10^{o} F colder than they do on Kodiak Island, hence it normally freezes up sooner and thaws later.

Sampling Humpy Creek on the South end of Kodiak indicated complete mortality, at least in the 2-1/2 to 3 miles sampled, which encompasses the main spawning grounds. Our hypothesis here is that the interaction of cold weather and light snowfall caused Humpy Creek to freeze over in the upper reaches. Ice was measured at a foot to a foot and a half thick. Warm, torrential March rains caused rapid thaw of this entire area. Humpy Creek is a rather

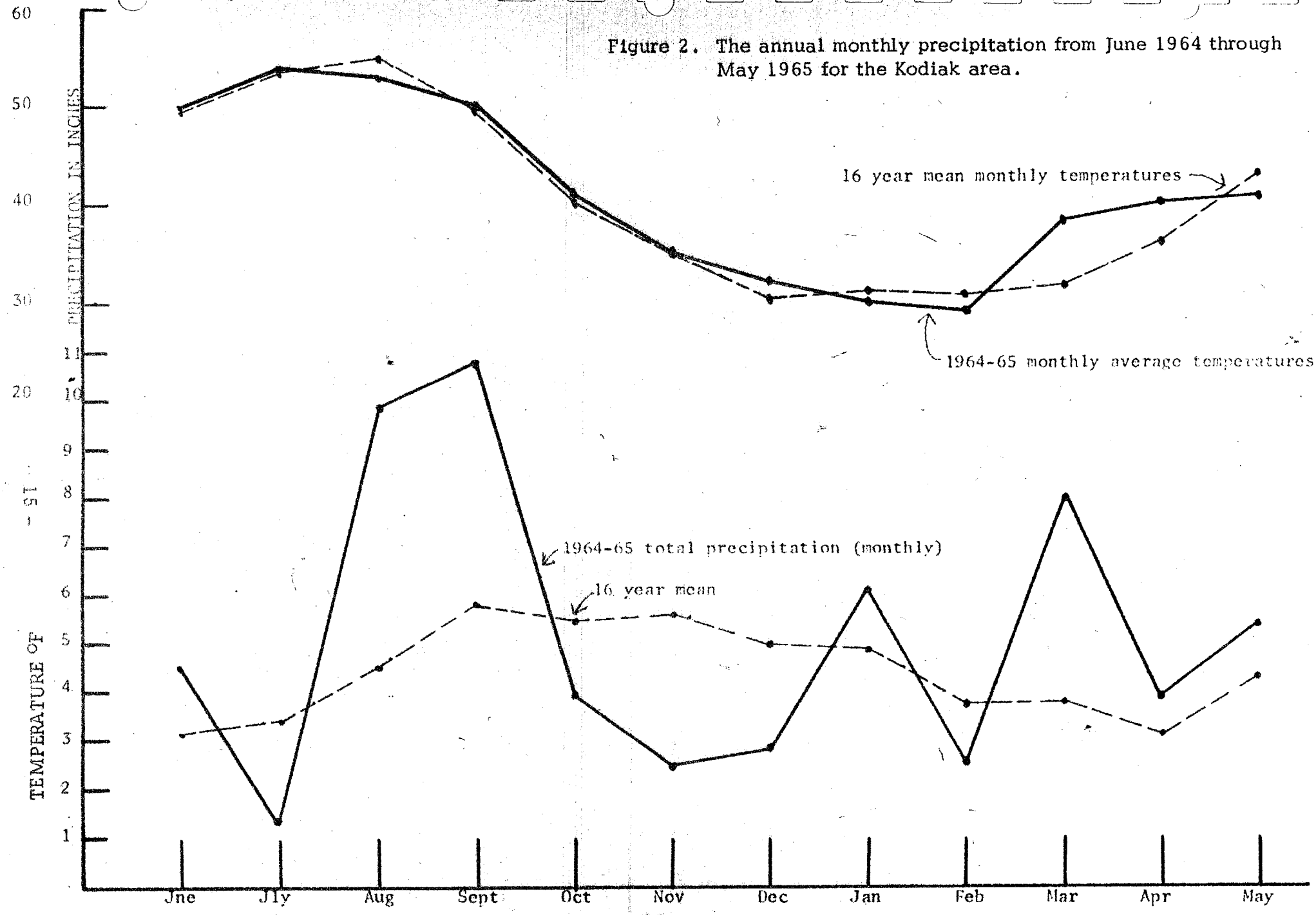

Figure 2. The annual monthly precipitation from June 1964 through May 1965 for the Kodiak area.

Table 4. Daily temperatures and precipitations, March 1965

Month	Day	Temp.	Precipitation
March 1965	1	36.0° F	.43
	2	36.5	.13
	3	36.5	.14
	4	36.5	T
	5	36.0	.22
	6	36.5	.70
	7	35.0	.56
	8	41.0	.98
	9	43.0	.09
	10	36.5	.56
	11	41.5	T
	12	37.5	.00
	13	35.5	.00
	14	34.0	.00
	15	34.5	.00
	16	35.0	.20
	17	35.5	1.10
	18	36.0	5.50
	19	38.0	T
	20	38.5	.00
	21	38.0	.00
	22	46.0	.00
	23	41.5	.00
	24	40.5	.00
	25	43.5	.00
	26	42.0	.00
	27	40.5	.00
	28	40.0	.00
	29	40.0	.00
	30	40.5	T
	31	37.5	T

Figure 3. The annual monthly snowfall from September 1964 through May 1965 for the Kodiak area.

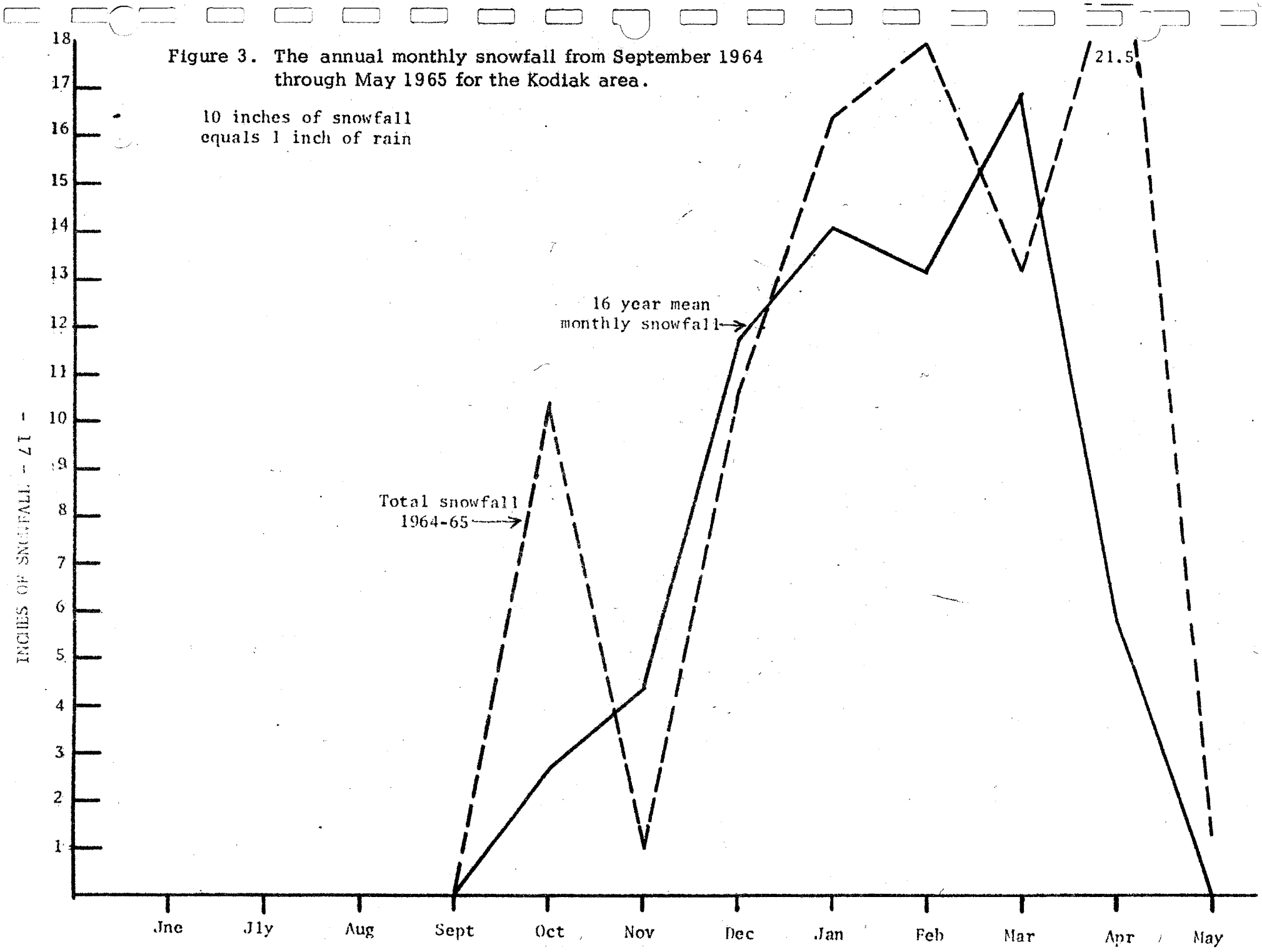

Table 5. Temperatures - precipitation - snowfall, 1964-65

Month	Temps.	Precipitation	Snow
June 1964	50.1° F	4.50 inches	0.0 inches
July	54.0	1.27	0.0
August	53.2	9.90	0.0
September	50.3	10.78	0.0
October	41.6	3.88	10.4
November	35.3	2.52	1.0
December	27.4	2.75	10.5
January 1965	29.9	6.10	16.4
February	27.8	2.51	18.5
March	38.4	8.02	13.1
April	40.4	3.90	21.9
May 1965	40.5	5.42	1.3
	40.7	61.55	93.10

16-Year Averages

June	49.7° F	3.31 inches	T inches
July	53.9	3.37	0.0
August	54.8	4.49	0.0
September	49.8	5.84	T
October	40.8	5.47	2.7
November	35.3	5.62	4.4
December	30.5	5.04	11.7
January	31.1	4.89	14.1
February	31.0	3.76	13.2
March	31.5	3.77	16.9
April	36.3	3.07	5.9
May	42.9	4.34	0.2
	40.6	52.97	69.10

slowly meandering stream, but has at least two sections where 180° bends exist in steep-walled canyon areas. It is believed that rapid thaw and high water conditions caused breakup to occur at once, resulting in an ice jam in the canyon areas flooding the entire stream in the section where the majority of spawning takes place. In 1963 the sampling crew was unable to work Humpy Creek because of the very phenomenon. The resulting run was quite light in 1964 and needed protection. From evidence gathered this very thing happened again in 1965, though pre-emergent sampling was possible since it did not take place until after the stream had returned to normal level. Only rough measurements were taken, but suffice to reconstruct the incident. On examination of the canyon walls of the sharp bends it became apparent where ice had ground away rock, shrubs, grass and etc. up to 8 feet above normal stream level. This was also clearly seen all along the river banks above the jam. Huge ice blocks were found strewn along the banks up to 200 feet from the streambed proper. Apparently, when the block in the stream let go terrific scouring occurred withdisasterous results to the young salmon.

Clearly a lot of this evidence is circumstantial. What cannot be ignored, is the probability of Humpy Creek producing a pink salmon run of any magnitude in 1966 is extremely unlikely.

Due to the warm spring rains in March of 1965 nearly all of Kodiak Island thawed with the exception of a few high lakes and shaded areas. Ice formation in Red and Saltery Lakes did delay sampling until late April, by which time out-migration was probably underway. The pre-emergent fry densities for these streams were therefore considered as minimal.

FORECAST BY DISTRICT

In Table 6, an attempt has been made to give an insight as to the relative shift in emphasis in the magnitude of the run by major district from that which occurred in 1964 to that which is most probable in 1966. The catch and escapement by the major areas are given in Table 7. The term relative is used for a variety of reasons. First, since no pre-emergent fry data have been obtained from Karluk, Sturgeon or Deadman Rivers one is forced to assume that the index obtained for the Alitak District will apply to the Deadman's Bay area and that survival in the Sturgeon River was comparable to that of Red River. These are quite obviously weak assumptions. Second, since no data exists for the Karluk River the assumption is made that freshwater survival was constant for both years considered, which at best is wishful thinking. A third, and perhaps most important assumption made is that the pre-emergent fry indices obtained for each district are applicable to the district as a whole, and ultimately the entire area as a whole. The pre-emergent fry program is geared to monitor streams which normally contain nearly 80 percent of the salmon escapement of Kodiak and Afognak Islands, however, it must be strongly emphasized that the short history of data collection give us no insight into

Table 6. Estimates of 1966 pink salmon return by district.

District	Major system	Stat. Area	Estimated total run 1964	Percent of total	Pre-emergent fry density 1963	Pre-emergent fry density 1965	Percent difference 1965/1963	Expected 1966 return expressed as a percent of the total run	Estimated tot. return 1966
North Afognak Island	Malina, Paramanof, Portage	251	647,500	4.6	28.3	26.0	91.9	4.2	592,000
South Afognak Island	Kazakof, Marka Litnik (Afognak)	252	967,400	6.8	20.2	13.9	68.8	4.7	663,000
Uganik-Terror	Sharatin, Uganik, Terror, Bauman's	253	2,176,000	15.4	19.4	26.2	135.1	20.8	2,932,000
Uyak	Uyak, Browns, Zackar	254	975,700	6.9	14.0	13.2	94.3	6.5	916,000
Karluk	Karluk	255	1,818,100	12.9	?	?	?	12.9	1,818,000
Red-Sturgeon	Red, Sturgeon	256	3,264,900	23.2	27.3	10.3	37.7	8.8	1,241,000
Alitak	Frazer, Narrows, Deadman's, Humpy	257	1,601,400	11.4	15.5	1.3	8.4	1.1	155,000
Geese Channel-Sitkalidak	Seven, Kaiugnak	258	1,661,500	11.8	28.5	23.9	83.9	9.9	1,396,000
Ugak-Chiniak	Saltery, Sid Old's, American, Buskin	259	983,800	7.0	15.5	19.2	123.9	8.7	1,226,000
			14,096,300	100.0				77.6	10,939,000

Table 7. Catch and escapement by major statistical area *

Bay or Stream	Statistical Area	Escapement	Catch	Total
Malina Bay	251	35,000		
Paramanof Bay		26,300		
Perenosa Bay		37,000	549,166	647,500
Kazakof Bay	252	46,000		
Marka River		23,900		
Afognak River		45,000	852,450	967,400
Kizhuyak River	253	5,000		
Sharatin Bay		17,500		
Anton Larsen B.		13,500		
S. Arm Uganik		75,000		
Uganik River		201,800		
Terror River		27,900		
Bauman's Creek		13,900	1,821,353	2,176,000
Little River	254	50,000		
Uyak River		100,000		
Brown's Lagoon		65,000		
Zachar River		51,900		
Spiridon River		4,000	704,761	975,700
Karluk River	255	525,000	1,293,076	1,818,100
Red River	256	488,000		
Sturgeon River		337,000	2,399,854	3,264,900
Dog Salmon River	257	52,600		
Narrows Creek		7,800		
Deadman's River		29,000		
Humpy Creek		80,000		
Horse Marine Creek		4,500		
Sulua Creek		8,000	1,419,475	1,601,400
Kiliuda River	258	70,000		
Barling River		60,000		
Kaiugnak Creek		10,000		
Seven Rivers		58,000	1,463,524	1,661,500
American River	259	49,000		
Sid Old's Creek		30,000		
Buskin River		45,600		
Eagle Harbor		13,000		
Saltery Creek		93,000	733,238	983,800

* Escapement figures are for 36-40 selected streams, and were extracted from peak aerial counts made by FRI and ADF&G - no mainland data included.

variable marine mortality for certain fry levels. Also, the reliability of forecasting pink salmon runs from pre-emergent fry indices has not yet been proven.

Another important fact which must be considered is the change of observers which took place over the three years the program has been in effect in the Kodiak area. This could have introduced considerable bias because of techniques used, timing of the sampling, differences in the area sampled and a host of others.

Table 8 gives a breakdown of the estimated total return by district for 1966, with a comparison to that which occurrred in 1964.

Table 8. Estimated pink salmon returns in 1966 by district as compared with 1964.

District	Tabulated Return 1964	Estimated Return 1966
North Afognak Island	647,500	592,000
South Afognak Island	967,400	663,000
Uganik-Terror	2,176,000	2,932,000
Uyak	975,700	916,000
Karluk	1,818,100	1,818,000
Red-Sturgeon	3,264,900	1,241,000
Alitak	1,661,400	155,000
Geese Channel-Sitkalidak	1,661,500	1,396,000
Ugak-Chiniak	983,800	1,226,000
TOTAL	14,096,300	10,939,000

In general, it is thought there will be a considerable shift in emphasis in 1966 over that which occurred in 1964. If this proves correct, then the Uganik-Terror District should be by far the largest producer, considerably up from 1964; the Red-Sturgeon District should exhibit a very sizeable decrease in 1966 over the 1964 run; the Alitak District should prove quite weak, especially in the Humpy Creek and Olga Bay sections. The Chiniak portion of the Chiniak-Ugak District

should be very strong, however the return to Saltery Creek in Ugak Bay may well be weak. The remaining districts are expected to be slightly down from the 1964 return. In total, exclusive of the Mainland District, the run is expected to be some 22 percent lighter in 1966 over that of 1964. This then would amount to some 10.9 million pinks returning in 1966.

No pre-emergent fry sampling has been conducted in the Mainland District, hence it is not included in the forecast tables. About all that can be said of the Mainland is that quite strong runs were noted in 1962 and again in 1964, and that resultant escapements were at a high level. Going on this strength it is quite likely that this area will contribute substantial numbers of pinks to the overall return to the Kodiak registration area in 1966.

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