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ALASKA SALMON RESEARCH

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to

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INTRODUCTION

The Fisheries Research Institute was established in 1946 with the financial support of the major Alaskan salmon processors to (1) investigate the causes of the declines in production that had occurred in most of the stocks since the 1930s, (2) work with the government management agency to increase our knowledge of the biology of salmon and the effects of the fisheries on the stocks, and (3) assist salmon processors by providing a second opinion on matters of salmon fisheries management. Although these objectives are still valid today, with the return to high levels of production by the 1980s, our primary objectives are now to determine how to maintain that production and how to harvest/ process salmon most efficiently, e.g., accurate forecasts and in-season fishing distributed throughout the run.

We presently have salmon research projects in Bristol Bay, Southeast Alaska, Chignik and a study of the high seas distribution of salmon stocks. In recent years we have also worked at Kodiak, the Alaska Peninsula, and on the Yukon River stocks. All of these projects have been carried out in cooperation with the Alaska Department of Fish and Game or the National Marine Fisheries Service (high seas) and we have also had cooperative research projects with salmon biologists from Japan and the U.S.S.R.

This report will focus on our Bristol Bay and Southeast projects with emphasis on salmon forecasting and research relevant to escapement policies to maximize production at present and in the future.

BRISTOL BAY

FORECASTING

Forecasts of the 1990 Bristol Bay sockeye runs were provided to Bristol Bay processors in October, 1989 and they are presented in Table 1 with the forecasts and actual runs for the past five years. The two river system forecasts (FRI and ADF&G) are based on the same data sources but different methods of analysis have often been used. The FRI forecast for 1989 was fairly close to the actual run (within 16%) but this was not the case for the 1987 and 1988 forecasts which were off by 40% and 24% respectively; however, in all three years the in-season forecast from the Port Moller test boat has been much closer to the actual run (within 4% or about 1-2 million fish). The accuracy of the Port Moller forecast is strongly dependent on a consistent relationship between the index catch of sockeye (number per 100 fathoms per hour) and the numbers of returning sockeye. This ratio (fish per index) has been fairly constant since 1985 when the gill nets were changed, however it was quite variable in past years (Table 2).

We now fish a 200 fathom gill net that is 60 meshes deep and has 5 inch stretched mesh. The web is multistrand monofilament (center core). Since 1987 we have used a 70 ft vessel (Nettie H) and fished each day (weather permitting) at four stations (Fig. 1). Usually one station is repeated each day for a total of five drifts. Scales are sent into King Salmon periodically to be read by ADF&G to determine the age composition. This is an important consideration especially if the ages are not what we expect from the pre-season forecasts.

The test fishery run timing curves (cumulative daily indices) provide a measure of the run size and timing. For the four years of comparable data (1985, 1987-89) the Port Moller catches have reflected the Bristol Bay runs in relative timing and magnitude (Figs. 2 and 3). For the 1989 forecast we applied the average of the ratios of run to index in 1985, 1987-88 to the 1989 index and this provided forecasts of 50 million on June 25 and 37 million on June 30. A final forecast of 42 million was issued on July 3 (Tables 3 and 4). The last forecast also considered the early escapements and catches in the fishing districts.

The early catches at Port Moller strongly favored 3-ocean sockeye and this was unexpected since a large run should have contained mostly 2-ocean sockeye; however, after the 25th the age composition shifted to a predominance of 2-ocean sockeye. This same shift in age composition was observed in the runs to the fishing districts in 1989—high percentages of 3-ocean fish followed by mostly 2-ocean fish in the middle and late parts of the run. The Port Moller index catches peaked on June 28 and then again on July 4 and 6 with relatively low catches in between. The runs to the Naknek/Kvichak, Egegik and Nushagak districts also showed a low abundance in the fisheries during July 7-9 and then an increase during July 10-12 corresponding to the catches of July 4-6 at Port Moller (Figs. 4-6).

The Port Moller program in 1989 was especially successful in the management of the Kvichak run. The relatively high index catches through June 25 provided evidence that the Kvichak run was going to come in higher than the ADF&G forecast and fishing got under way on June 19. Through June 23 the catch totalled nearly one million fish and an opening on June 26 produced a catch of 642,000 which was followed by a catch of 1.5 million on June 29. With excellent management of the fishery, the Kvichak escapement goal was met and the surplus was caught (Fig. 4). Unfortunately this was not the case in the Nushagak, Egegik and Ugashik districts where the runs were also larger than forecasted but not enough early season fishing time was given to completely harvest the surplus above escapement goals. In the Nushagak this was mostly caused by management concern for an apparently weak chinook run and very few boats in the district which was caused by no fishing time until June 26 (Fig. 6). In Egegik and Ugashik there was less early season fishing time than there might have been because of concern over the interception of sockeye bound for the Naknek/Kvichak district.(Figs 5 and 7).

LAKE RESEARCH

During the summer of 1989, we continued our long-term studies of spawning distribution, growth and abundance of fry, and the physical and biological environment for the sockeye salmon of the Wood River (Nushagak) and Kvichak lake systems. Most of our annual observations in the Wood River Lakes extend over more than 30 years and constitute the longest continuous biological and environmental record on any salmon stock in Alaska. In 1989, we also initiated a field study of bear predation on spawning sockeye salmon in the Wood River Lakes and a study of the annual

freshwater and marine growth of Nushagak sockeye salmon through scale measurements on samples dating back to the early 1900s (funded by NOAA). Finally, in 1989 we counted the sockeye escapement into the Newhalen River/ Lake Clark system of the Kvichak. Lake Clark makes up about 9% of the surface area of the Kvichak lake system; however, from 1980 through 1986 it received an average of 20% of the sockeye salmon escapement and in 1988 an estimated 52% of the Kvichak escapement of 4.1 million spawned in the tributaries to Lake Clark.

Newhalen River Escapement

The annual escapements of sockeye salmon to the Kvichak lake system are estimated from expanded 10-min counts on each bank of the river at the outlet of Lake Iliamna (Igiugig) by ADF&G. The relationship between the escapement and the returns (catch plus escapement) 4-6 years later has formed the basis for the escapement goals and thus has largely determined the catches from the annual Kvichak runs. This approach to management assumes that the annual escapements are uniformly or randomly distributed among the many spawning grounds. In the mid-1970s, our spawning ground surveys indicated that a greater proportion of the Kvichak escapement was going to the Newhalen River/Lake Clark system than was the case in prior years. For Lake Clark alone, we believe that the limited spawning area could support no more than about two million spawners before overcrowding and loss of eggs would occur and Lake Clark does not appear to have the rearing capacity for fry that Lake Iliamna has. We assume that the fry from the spawning in the Newhalen River and it's tributaries drop down into Lake Iliamna to rear.

We began estimating the annual escapements up the Newhalen River in 1979 by counting from the river banks near the mouth of the river. Then from 1980 to 1985 we also counted at a point 22 miles up-river that produced more accurate counts, but at more cost and less value for possible in-season management. The escapement is now estimated near the mouth of the river (about two days travel time from Igiugig), and is made by expanding 20-min counts on one bank, for each of ten daylight hours, to a daily count for both banks. We count when and where the visibility is best and assume that the fish utilize both banks equally and that their migratory rate does not change at night. We then compare the daily counts at Newhalen with the Igiugig counts to estimate travel time between the two places, and by lagging the Newhalen counts back to Igiugig the appropriate number of days, we can calculate the daily proportions of the cumulative Kvichak run that went up the Newhalen River.

The cumulative daily escapements for the two rivers timed to the Kvichak are given in Table 5 for 1983-1989 (no Newhalen counts for 1987). In mid-July milling fish often, swim up river along the bank of the Newhalen and are counted, and then drift down river in the middle where they can't be seen only to swim up river again. This inflates the counts for the escapement; therefore, we have used the average proportion of Newhalen count to Kvichak count for day 5 to 16 (day one equals the first day of 100,000 in the Kvichak) and the seasons total Kvichak escapement to estimate the Newhalen/Lake Clark escapement.

In 1989, we estimated that 2.6 million of the Kvichak escapement of 8.3 million (about 31%) ended up in the Newhalen River/Lake Clark system (Table 6). We had expected a strong return to Lake Clark in 1989 because in the parent brood year for most of the run (1984) there was a large escapement to Lake Clark. We have not received the results of ADF&G's aerial surveys to provide an estimate of the number of

Newhalen River spawners, but it would appear that the distribution of the 1989 escapement was fairly typical of recent years and that the Lake Clark spawning grounds were seeded just about to their capacity.

Sockeye Fry in Iliamna Lake

We have sampled the sockeye salmon fry in the Kvichak lake system each year since 1962 (1961 brood year) by townetting at night in late-August to early September. Only the upper end of Lake Iliamna, where most of the spawning and fry are concentrated, is routinely sampled. We have not usually sampled the fry in Six-mile Lake (upper end of the Newhalen River) of the Lake Clark system, where fry from the Tazimina River are likely to concentrate. The geometric means of the catches provide a measure of relative density (number per 5 min tow) and the mean lengths of the fry are adjusted each year, based on their daily growth rate, to September 1 (Table 7).

The sockeye fry are usually smaller in Lake Clark than in Lake Iliamna (as was the case in 1989) because temperatures are usually colder and there is a shorter ice-free period. In both lakes, the annual growth of the fry is correlated with water temperatures which are greatly influenced by spring weather. Cold temperatures usually result in small fry (40-50 mm) which then spend two years in the lake before seaward migration and tend to return as adults five years after their parents. Warm temperatures usually result in large fry (over 60 mm) which tend to migrate to sea after one year and return four years after their parents.

The tow net sampling has been very useful in predicting, three years in advance, the main age at return from the larger escapements in the Kvichak. The fry from the 1984 brood year averaged only 46 mm in 1985. Based on the relationship between length and the percentage of adults returning with a freshwater age of 1, only about 15% of the production of 2-ocean fish should have returned in 1988. That return was 2.8 million, so we predicted that the remaining 85% (19 million) would return in 1989. The preliminary return of those sockeye in 1989 is 18 million. The majority of the production from the 1985 escapement (7.2 million) should return in 1990 (5 years later) whereas the majority of the production from the 1987 escapement (6.1 million) should return in 1991 (4 years later). Therefore we should have three successive years with relatively large runs even though one year (1986) had a very small escapement. Unfortunately, neither the tow net catches of fry nor the estimates of smolts point to very large runs in 1990 and 1991.

Wood River Lakes Research

The Bristol Bay research program of FRI began with spawning ground surveys in the Wood River Lakes in 1946 to determine where, when and how many sockeye salmon spawned there. During the early 1950s, methods were established to enumerate and sample the commercial catches, escapements (towers) and the smolts produced. By the late 1950s and early 1960s we had established several important measurements which we have maintained to the present in order to characterize each year's environment for spawning adults and rearing juveniles.

The spring of 1989 was about average; however, heavy winter snowfall covering lake ice delayed ice breakup in the Nushagak to about 8 days later than average (Table 8). The following summer was cloudier than normal with higher than average rainfall and the result was less sunlight, colder water temperatures, and higher water

levels than normal. Phytoplankton and zooplankton standing crops were above average but growth of the sockeye fry was a little below average because temperatures were cool. Lake level was especially high during September when most river and beach spawners were spawning. This may result in substantial mortalities, particularly in the rivers where there were very high spawner densities, because many fish probably spawned in marginal areas where the eggs would be susceptible to winter freezing. Fortunately, water levels were about normal in August when fish were spawning in the small creeks.

We have sampled the Arctic char in Little Togiak River each spring since 1972 to follow the rate of predation on sockeye smolts. This short river flows from Little Togiak Lake into Lake Nerka and the smolts are very vulnerable to the char for the few minutes it takes them to move from one lake to the next. Large char usually eat more smolts than small char, but we were surprised in 1989 when the char we caught were the smallest ever but still averaged one smolt per stomach (Table 9). There are about 5,000 char in and around the river mouth, so that at just one sockeye smolt per char per night for a migration of 20 to 30 days, a significant number of smolts are lost form the production of this small lake in the system.

The spawner distribution of the 1989 escapement to the Wood River Lakes was just as expected from the distribution of the parent spawners in 1984 for the 3-ocean fish which are mostly river spawners, and in 1985 for the 2-ocean fish which are mostly beach spawners (Table 9, and Figs. 8 and 9). The spawning grounds that contain a high percentage of 2-ocean fish (most beaches and many small creeks) exhibit a significant 4-year cycle of low abundance. This can be seen in Figure 8 by marking every fourth year beginning with 1953 and the 1989 run was in a low-cycle year. The upper lakes of the Wood River system, which contain about 90% beach spawners, show this cycle quite clearly (Fig. 9). These lakes (Beverley and Kulik) make up about one-third of the surface area of the lake system, but in 1989 only 6% of the 1.2 million escapement spawned in the upper lakes (Table 10). An uneven distribution of spawners in the lake system has generally resulted in poor production for the lake system in contrast to the same number of spawners evenly distributed.

Nushagak Chinook Salmon

The Nushagak king salmon are a valuable resource when they are harvested in June prior to the sockeye run; however, when they are caught in late-June or July along with the more abundant sockeye they have much less value to processors and can even be a nuisance. In recent years there has been a disturbing trend in that direction while at the same time subsistence and sport catches have increased (Table 11). No fishing time was permitted during the king salmon season (about June 1 to 25) in either 1988 or 1989 and only 2 days in early June of 1987. This lack of fishing was caused by 1) a perceived poor run or escapement based largely on the Nushagak sonar counter and 2) that king salmon migrate into Nushagak Bay and stay there for a long period before moving on up river. Therefore a one-day opening could harvest a high (25% ?) percent of the run. There is a need for research on both of these issues e.g. it is known that sonar counters underestimate king salmon when the daily numbers are relatively small (a few thousand or less) and it is suspicious that the sport catch per unit effort has gone up while the sonar estimates have dropped. There is a need for some behavioral studies of king salmon in Nushagak Bay by sonic and/or radio tags to determine their rate of movement through the fishing district.

Table 1. Pre-season Bristol Bay sockeye salmon forecasts and the actual runs (millions).

YEAR	Forecast/Run	Kvichak	Naknek	Egegik	Ugashik	Nushagak	Total Run	Catch
1985	FRI	12.2	5.3	5.8	4.4	4.3	33.0	18.2
	ADFG	12.2	4.9	6.6	5.6	4.3	35.0	20.3
	Japan CPUE						38.0	
	Actual Run	13.4	3.7	8.6	7.4	3.0	36.6	23.5
1986	FRI	9.2	4.5	5.9	6.7	4.8	32.1	19.4
	ADFG	4.5	3.2	5.4	4.9	3.8	22.5	13.3
	Japan CPUE						31.7	
	Actual Run	2.0	3.9	6.2	5.9	4.9	23.7	15.8
1987	FRI	2.8	2.0	5.8	3.1	5.1	19.5	12.4
	ADFG	2.7	2.1	4.9	3.1	3.3	16.8	9.3
	Japan CPUE						17.0	
	Actual Run	9.6	2.4	6.7	2.8	5.1	27.3	16.0
1988	FRI	12.3	3.1	6.2	3.1	5.0	30.6	20.8
	ADFG	9.3	2.5	5.6	3.2	5.6	26.5	16.8
	Japan CPUE						18.5	
	Actual Run	6.8	1.8	8.0	2.2	3.2	23.4	14.0
1989	FRI	20.4	3.6	6.7	3.0	3.4	38.0	25.4
	ADFG	12.5	3.1	5.6	3.6	3.1	28.9	16.2
	Japan CPUE						26.9	
	Actual Run	19.8	3.2	10.3	4.9	5.0	43.9	28.7
1990	FRI	10.1	4.8	6.6	3.0	4.6	29.8	19.0
	ADFG	8.9	3.6	5.6	3.1	3.5	25.4	14.7
	Japan CPUE							
	Actual Run							

Table 2. Bristol Bay runs and sockeye per Port Moller index catch (sum of stations 2, 4, 6 and 8, through 7/5).

Year	Inshore Run (millions)	Cumulative P. M. Index	Fish per Index (thousands)
1968	8.0	301	27
1969	19.0	603	32
1970	39.4	823	48
1971	15.8	680	23
1972	5.4	98	55
1973	2.4	340	7
1974	11.0		
1975	24.2	1289	19
1976	11.5	689	17
1977	9.7	782	12
1978	19.9	447	45
1979	39.9	1034	39
1980	62.5	527	118
1981	34.5	1052	33
1982	22.2	759	29
1983	45.9	645	71
1984	41.1	633	65
1985	36.6	1804	20
1986	23.7		
1987	27.3	1215	22
1988	23.4	803	29
1989	43.9	1898	23

Table 3. Ratios of final Bristol Bay run to Port Moller index catches through three dates.

Year	Run (millions)	Through 25-Jun		Through 30-Jun		Through 5-Jul	
		P.M. Index	Run per Index	P.M. Index	Run per Index	P.M. Index	Run per Index
1985	36.5	714	0.051	1446	0.025	1804	0.020
1987	27.2	540	0.050	1065	0.026	1215	0.022
1988	23.0	296	0.078	593	0.039	803	0.029
1989	43.8	849	0.052	1262	0.035	1898	0.023

Table 4. The 1989 Bristol Bay catches (millions) and the projected final catches estimated from average percentages made through selected dates in the past 10 years.

District	Through 25-June		Through 30-June		Through 5-July		Final Catch	Final Run	3-Jul Port Moller Run Forecast
	Actual Catch	Projected Final	Actual Catch	Projected Final	Actual Catch	Projected Final			
Naknek/Kvichak	1.0	34.3	3.1	15.6	7.9	17.7	13.9	23.5	26.5
Egegik	0.7	9.5	2.4	8.5	4.4	8.7	8.7	10.3	8.0
Nushagak	0.0	0.0	0.5	2.2	1.7	3.4	2.9	5.0	5.0
Ugashik	0.1	4.7	0.1	1.1	0.3	1.1	3.2	4.9	2.5
Togiak	0.0	- -	0.0	- -	0.0	- -	0.1	0.2	- -
TOTAL	1.8	48.5	6.1	27.4	14.3	30.9	28.8	43.9	42.0

Table 5. Cumulative daily escapements in the Kvichak and Newhalen Rivers, 1983-1989 (in 1,000s). Newhalen escapements estimated from expanded counts lagged back 3 days for 1986 and 2 days for other years.

	1983		1984		1985		1986		1988		1989	
Date	Kvichak	Newhalen	Kvichak	Newhalen	Kvichak	Newhalen	Kvichak	Newhalen	Kvichak	Newhalen.	Kvichak	Newhalen
25-Jun			17	10					1	0		
26			86	34					4	5		
27	3	2	121	42	1	0			75	85	58	17
28	142	142	133	75	113	14			264	128	299	97
29	521	220	804	258	362	38			313	140	532	162
30	943	280	1821	389	631	67			328	187	660	200
1-Jul	1366	358	2600	635	979	110			364	244	899	454
2	1683	458	3116	913	1216	192	1	0	778	456	1515	641
3	1779	523	3630	1185	1337	278	8	3	1193	632	2058	712
4	1865	577	4320	1385	1601	350	75	7	1598	676	2572	785
5	1965	614	5113	1652	1907	451	212	8	1901	784	3293	892
6	2012	635	5968	1899	2330	480	268	16	2079	1076	4383	1185
7	2054	651	6787	2232	2738	538	278	24	2189	1313	5423	1287
8	2210	685	7581	2474	3137	754	280	30	2232	1505	5952	1358
9	2559	713	8437	2669	3833	874	310	51	2272	1629	6616	1567
10	2654	749	8992	2887	4625	1138	442	72	2389	1721	7187	1962
11	2686	834	9222	3060	5327	1311	539	98	2775	1868	7523	2317
12	2735	891	9358		5800	1373	680	189	3473	2106	7674	2478
13	2790	933	9748		6067	1445	854	250	3753	2372	7713	2614
14	2853	948	10032		6366		987	320	3840	2657	7748	2728
15	3195	1121	10111		6586		1080	359	3948	2848	7799	2829
16	3417	1219	10172		6674		1012	382	3990	2976	7869	2944
17	3447	1261	10270		6706		1110	391	4020	3094	7969	
18	3487	1301	10360		6856		1115	397	4046	3203	8115	
19	3539	1345	10430		6976		1119	406	4057	3313	8215	
20	3558	1386	10455		7051		1122	410	4062	3435	8265	
21	3564	1418	10467		7116		1130	420	4065		8306	
22	3568	1472	10476		7171		1154	428	4065		8312	
23	3569	1490	10485		7201		1169	441			8318	
24		1500	10490		7211		1174	450				
25		1540	10491				1177	454				

Table 6. The Kvichak lake system escapements and the percentages going to the Newhalen River and Lake Clark. Newhalen River spawners estimated by two times the aerial survey estimate.

Year	Kvichak System Escapement (millions)	Newhalen/Lake Clark Escapement (millions)	Percent of Kvichak (%)	Newhalen River Spawners (millions)
1979	11.22	9.00	80	0.56
1980	22.51	7.50	33	2.64
1981	1.75	0.26	15	0.03
1982	1.14	0.34	30	0.13
1983	3.57	1.08	30	0.41
1984	10.49	3.20	31	0.67
1985	7.21	1.62	22	0.15
1986	1.18	0.29	25	0.01
1987	6.07	- - -	- -	1.46
1988	4.06	2.41	59	0.29
1989	8.32	2.59	31	
1990				

Table 7. Mean tow net catches and lengths (mm) of sockeye fry in Lakes Iliamna and Clark.

Brood Year	Kvichak Escapement (millions)	Lake Iliamna Mean Catch	Lake Iliamna Mean Length	Lake Clark Mean Catch	Lake Clark Mean Length
61	3.7	90	53	13	50
62	2.6	12	45	54	50
63	0.3	5	54	3	50
64	1.0	7	62	2	50
65	24.3	170	53	23	52
66	3.8	67	57	15	47
67	3.2	78	62	47	59
68	2.6	43	62	9	50
69	8.4	386	61	11	55
70	13.9	127	44	20	38
71	2.4	4	50	15	41
72	1.0	3	58	17	48
73	0.2	2	71	12	57
74	4.4	491	54	80	55
75	13.1	252	49	105	49
76	2.0	16	53	- -	- -
77	1.3	11	61	- -	- -
78	4.1	339	62	65	56
79	11.2	282	53	60	48
80	22.5	134	61	26	59
81	1.8	37	52	58	46
82	1.1	9	68	18	57
83	3.6	242	64	40	56
84	10.5	147	46	84	51
85	7.2	63	54	16	49
86	1.2	10	60	- -	- -
87	6.1	79	63	11	56
88	4.1	22	58	21	48
89	8.3				
90					

Table 8. Summary of 1989 measurements in Lake Aleknagik (Wood River Lakes).

Measurement and years measured	Dates	1989	Past years Average	Range
1. Date of ice breakup 1949-		9-Jun	1-Jun	14 May, 16-Jun
2. Water temperature, 0-20m (C) 1958-	25-Jun	5.2	5.7	3.7, 9.2
	15-Jul	7.4	8.4	5.7, 12.0
	5-Aug	9.0	10.7	7.7, 14.0
	1-Sep	10.6	11.1	9.3, 13.0
3. Water transparency Secchi depth (m) 1962-	25-Jun	8.0	8.4	5.5, 10.5
	15-Jul	7.9	8.4	5.0, 10.9
	5-Aug	10.7	9.5	6.3, 11.9
	1-Sep	8.6	9.5	5.8, 12.1
4. Average daily solar radiation (gm/cal/cm) 1964-	June 16-30	414	427	283, 572
	July 1-15	346	405	284, 543
	July 16-31	285	358	192, 485
	Aug. 1-15	271	311	203, 386
	Aug. 16-31	197	260	165, 420
	Sept. 1-15	129	216	114, 300
5. Lake level (cm) 1952-	June 1-15	179	138	84, 222
	June 16-30	187	149	102, 218
	July 1-15	148	130	75, 191
	July 16-31	119	105	54, 172
	Aug. 1-15	103	84	34, 173
	Aug. 16-31	112	80	30, 184
	Sept. 1-15	158	80	29, 131
6. Chlorophyll "a", 0-20m (mg/m2) 1963-	25-Jun	32	27	10, 45
	15-Jul	38	27	10, 43
	5-Aug	21	21	6, 36
	1-Sep	22	22	12, 37
7. Zooplankton volume (ml/m2) 1967-	25-Jun	53	52	20, 168
	15-Jul	67	82	45, 161
	5-Aug	164	117	67, 226
	1-Sep	91	63	26, 107
8. Mean length of sockeye fry (mm) 1958-	1-Sep	55.4	56.9	43.4,66.7

Table 9. Little Togiak River sockeye smolts in Arctic char stomachs during 30 days after ice out.

Year	Number of char examined	Mean Length (mm)	Percent of char with smolts	Mean number of smolts per char	Sockeye escapement in year-2 (1,000s)
72	82	446	60	4.5	55
73	121	446	44	2.9	24
74	64	429	39	1.6	14
75	71	415	36	1.8	14
76	96	418	56	2.2	48
77	325	403	17	0.4	30
78	316	437	42	1.5	18
79	178	438	25	1.2	26
80	278	459	81	9.4	45
81	124	415	31	1.4	44
82	105	450	61	6.4	81
83	78	424	14	0.3	60
84	56	408	18	0.4	36
85	60	437	30	1.2	31
86	61	437	56	2.7	17
87	51	451	78	4.9	21
88	43	431	26	0.8	21
89	105	388	38	1.3	15

Table 10. Wood River sockeye escapements (1000s), distributions (%), and ocean age compositions, 1983-89.

Lake/Type	Percent of Lake system surface area	1983			1984			1985			1986		
		Escape.	Percent	% age .3	Escape.	Percent	% age .3	Escape.	Percent	% age .3	Escape.	Percent	% age .3
Aleknagik	20	247	18	20	311	31	99	184	20	35	330	40	82
So. Cent. Nerka&LT	28	177	13	34	164	16	60	187	20	51	122	15	56
North Nerka	20	247	18	58	377	38	94	494	52	89	257	31	84
Beverley & Mikchalk	21	444	33	7	89	9	63	40	4	54	63	8	22
Kulik	11	246	18	11	62	6	60	35	4	67	47	6	38
Rivers		274	20	47	590	59	97	531	56	88	480	59	86
Creeks		241	18	20	129	13	66	198	21	35	135	16	64
Beaches		846	62	15	284	28	68	211	22	52	204	25	40
Lake system	425 km2	1361		15	1003		71	940		51	819		64

		1987			1988			1989			1990		
		Escape.	Percent	% age .3	Escape.	Percent	% age .3	Escape.	Percent	% age .3	Escape.	Percent	% age .3
Aleknagik	20	335	25	41	276	32	78	478	40	58			
So. Cent. Nerka &LT	28	320	24	7	247	28	61	265	22	33			
North Nerka	20	307	23	28	196	23	68	375	32	87			
Beverley & Mikchalk	21	247	18	5	83	10	54	26	2	2			
Kulik	11	128	10	7	65	7	40	42	4	13			
Rivers		189	14	62	190	22	69	588	50	84			
Creeks		401	30	22	283	33	69	279	24	35			
Beaches		748	56	8	394	45	62	319	26	32			
Lake system	425 km2	1337		18	867		63	1186		51			

Table 11. Nushagak chinook salmon runs (in thousands), 1966-1989.

	Commercial fishery					Subsis-			Escapement		
	Chinook season		Sockeye season		Total	tance	Sport fishery		Aerial		Sonar
Year	Catch	Days	Catch	Days	catch	catch	Catch	CPUE	Count	Expanded	count
66	27	10	31	14	58	4			- -	<40>	
67	35	12	61	6	96	4			- -	<65>	
68	47	12	31	8	78	7			11	70	
69	55	13	26	8	81	7			6	35	
70	50	13	38	11	88	6			8	50	
71	21	17	62	8	83	4			- -	<40>	
72	30	14	26	4	46	4			5	25	
73	25	13	5	3	30	7			11	35	
74	26	12	6	9	32	8			15	70	
75	13	13	8	5	21	7			16	70	
76	30	12	31	8	61	7	- -		21	100	
77	79	14	6	4	85	5	1	0.34	14	65	
78	79	12	40	16	119	7	<1	0.16	29	130	
79	84	11	73	20	157	9	1	0.17	20	95	<33>
80	58	10	7	13	65	12	1	0.26	36	141	56
81	83	10	110	23	193	12	1	0.31	34	150	115
82	65	12	130	21	195	12	2	0.35	30	147	125
83	67	12	70	14	137	12	2	0.27	34	162	104
84	29	7	32	11	61	10	2	0.43	14	81	- -
85	21	7	47	8	68	8	2	0.26	23	116	99
86	36	7	28	5	64	13	5	0.71	- -	- -	43
87	5	2	43	11	48	12	3	0.44	- -	- -	84
88	0	0	16	6	16	10	3	0.29	10	- -	57
89	0	0	18	15	18	- -	- -	- -	- -	- -	78
90											

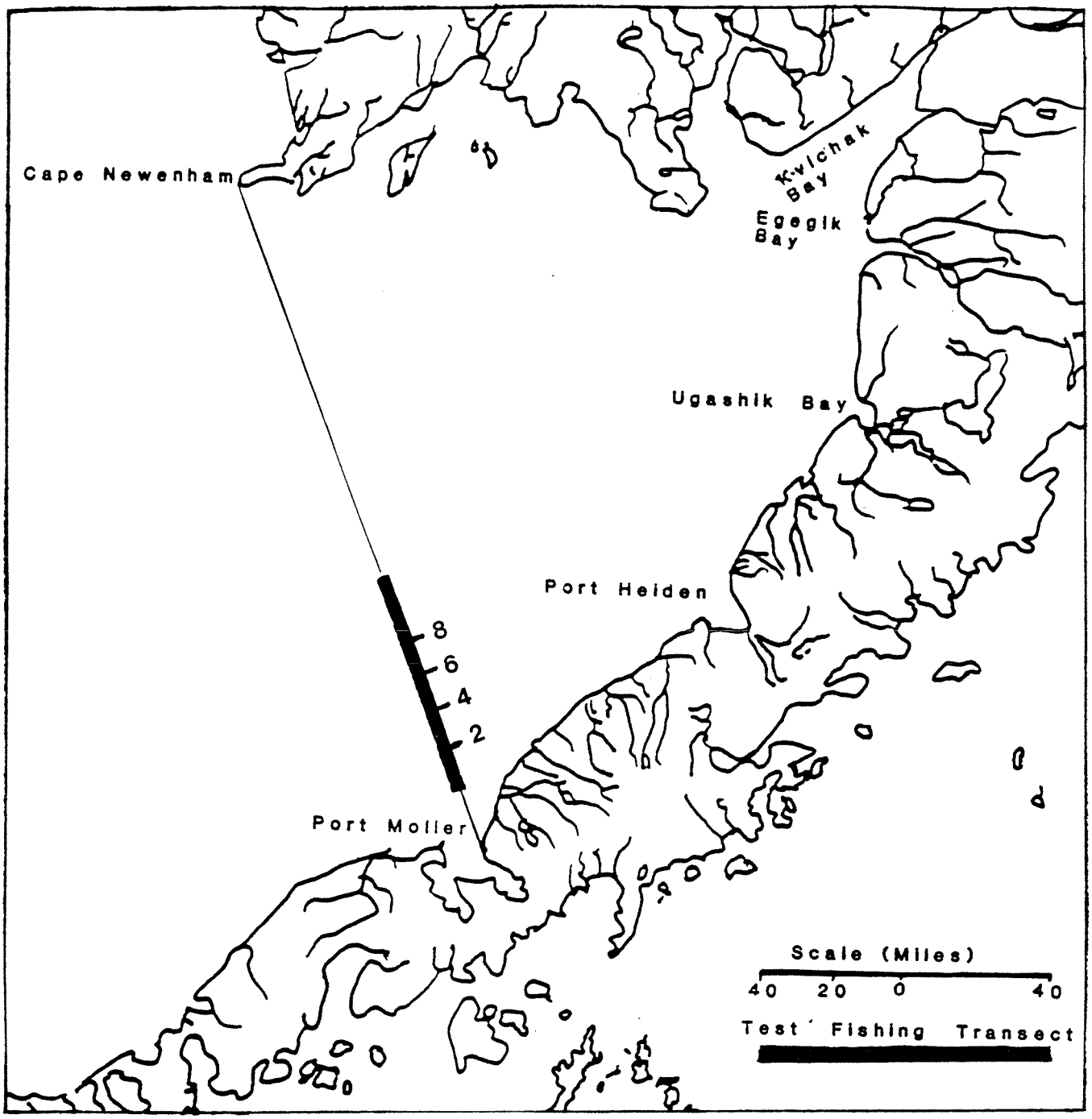

Figure 1. Location of the Port Moller test fishery.

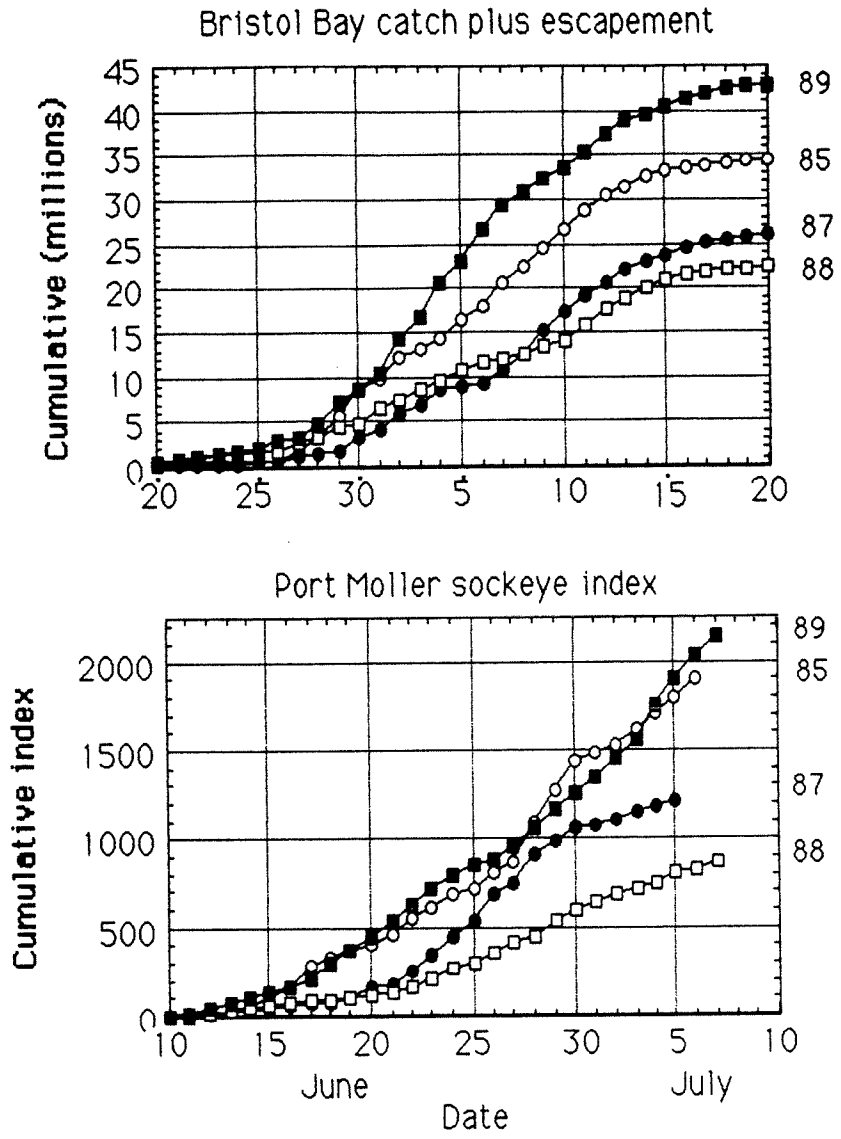

Fig. 2. Cumulative daily sockeye indices (sum of index catches for stations 2,4,6, and 8) at Port Moller for 1985, 1987-89 (bottom) and the cumulative catch plus escapement (at towers) in Bristol Bay.

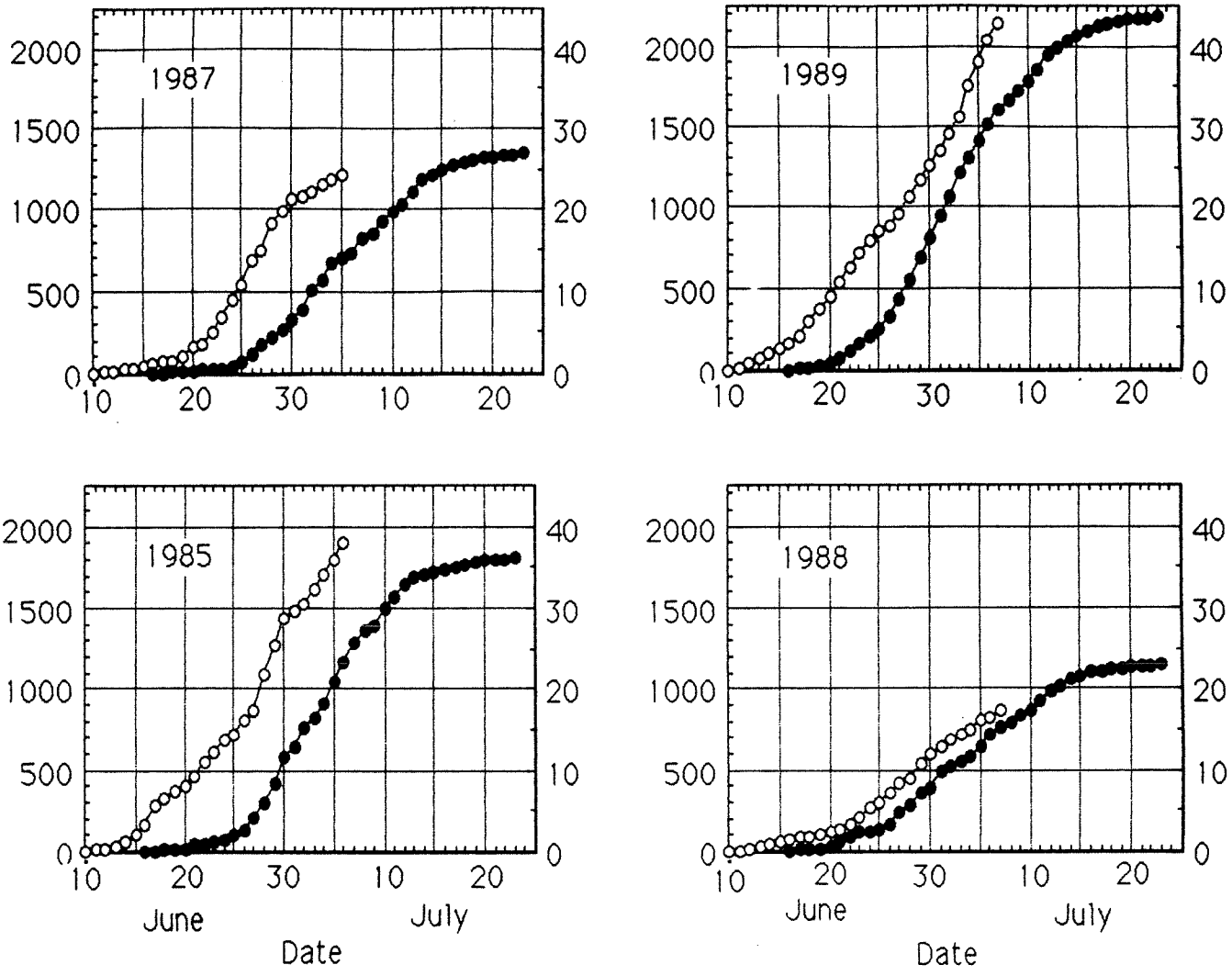

Fig. 3. Cumulative daily sockeye index catches at Port Moller (left) and the cumulative daily Bristol Bay runs in the fishing (right, in millions). Calculated post-season by date for 1985, 1987-89.

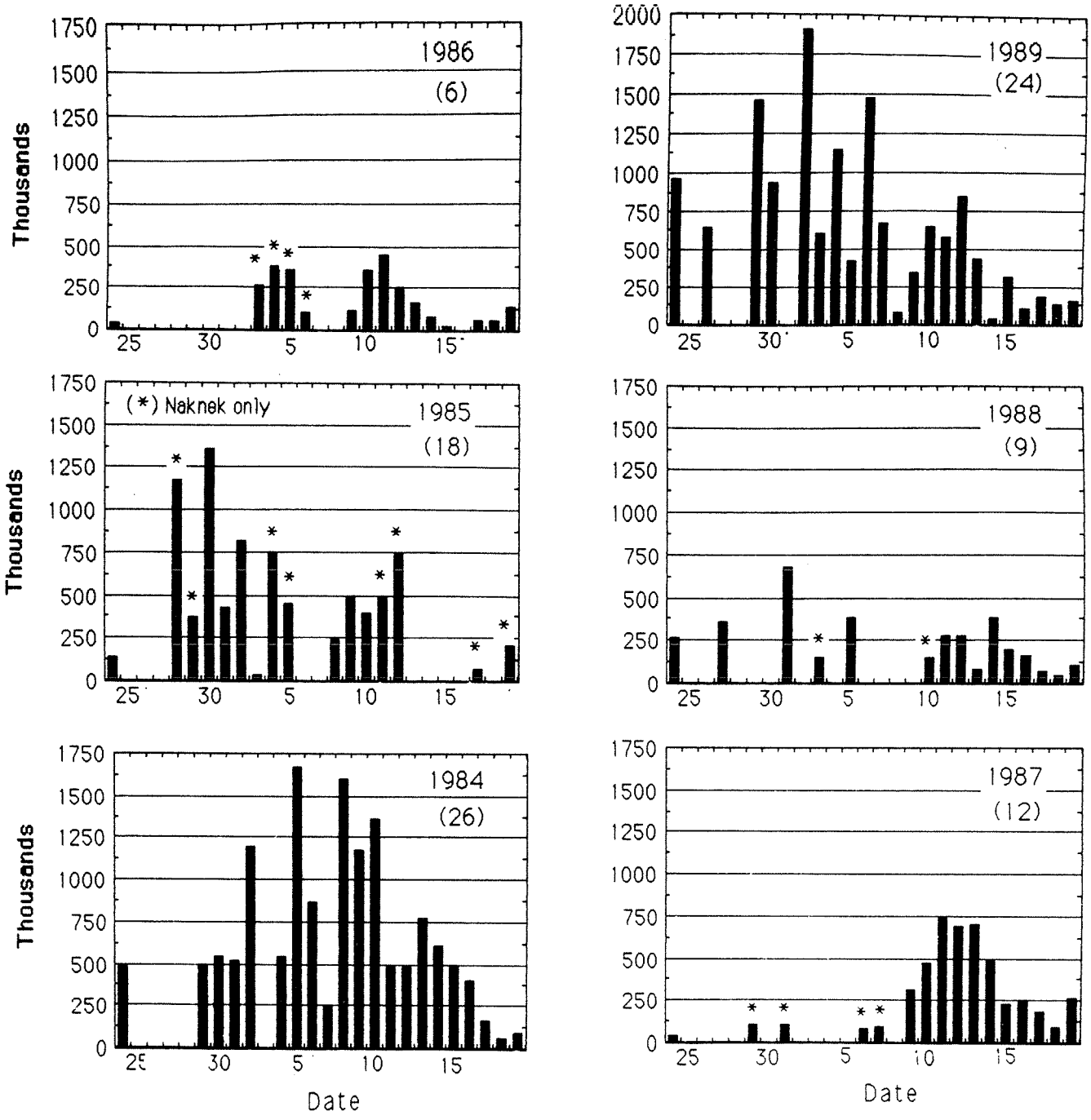

Fig. 4. Daily catches of sockeye salmon in the Naknek/Kvichak district. First bar for catches through June 24 and last bar for July 19 and later, 1984-1989. The run (catch + escapement, millions) is in parenthesis.

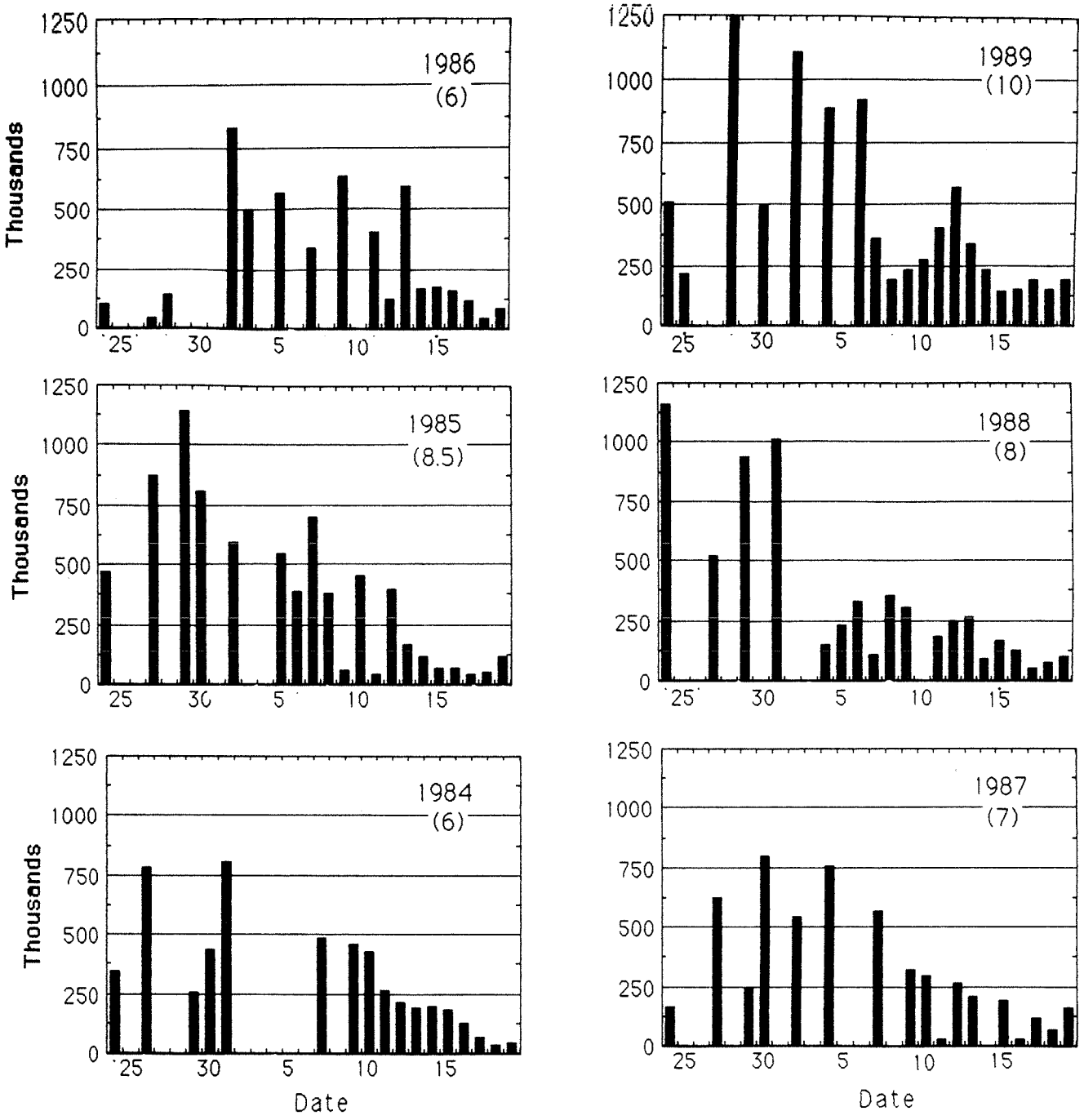

Fig. 5. Daily catches of sockeye salmon in the Egegik district. First bar for catches through June 24 and last bar for July 19 and later, 1984-89.

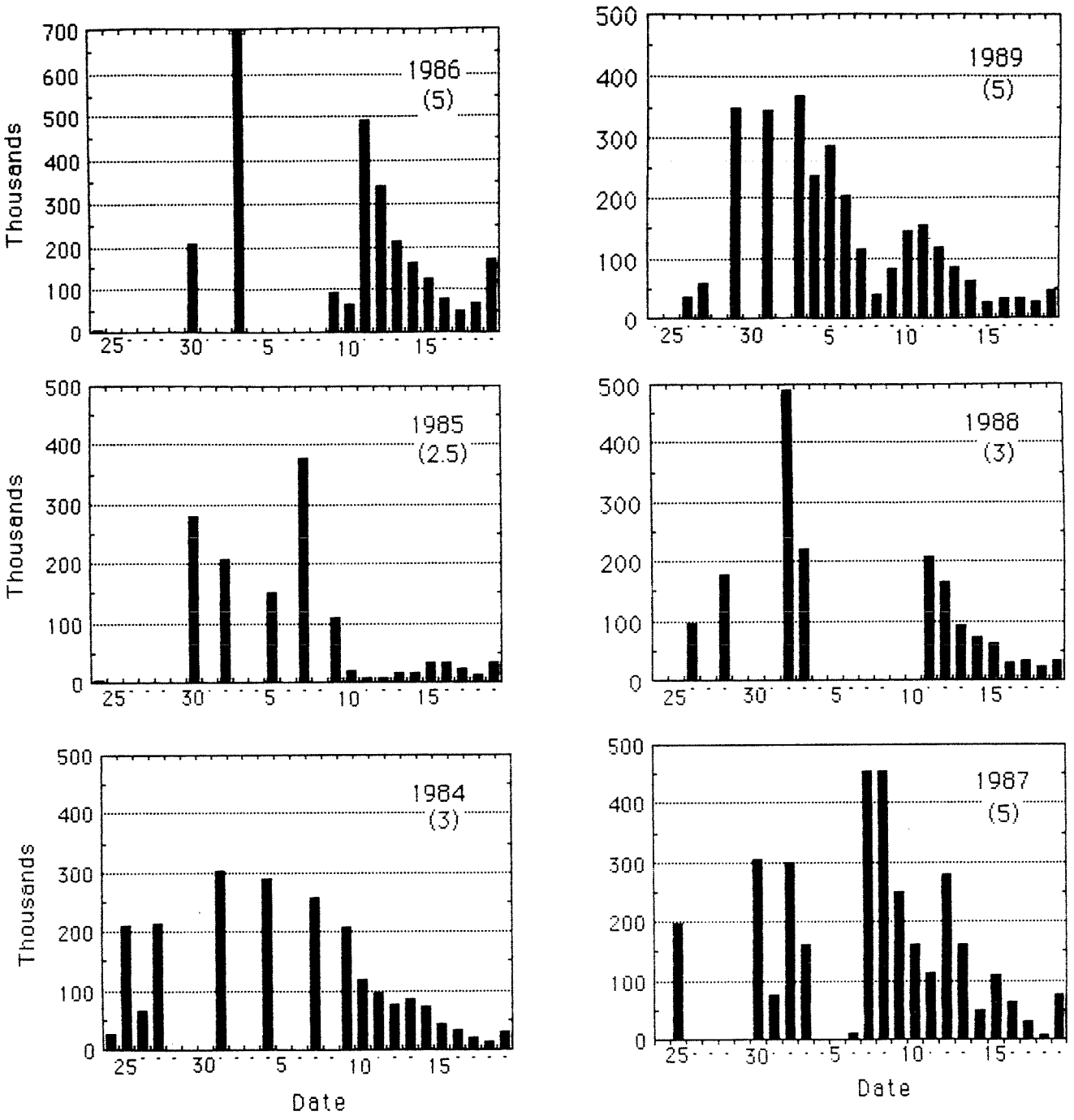

Fig. 6. Daily catches of sockeye salmon in the Nushagak district. First bar for catches through June 24 and last for July 19 and later, 1984-89.

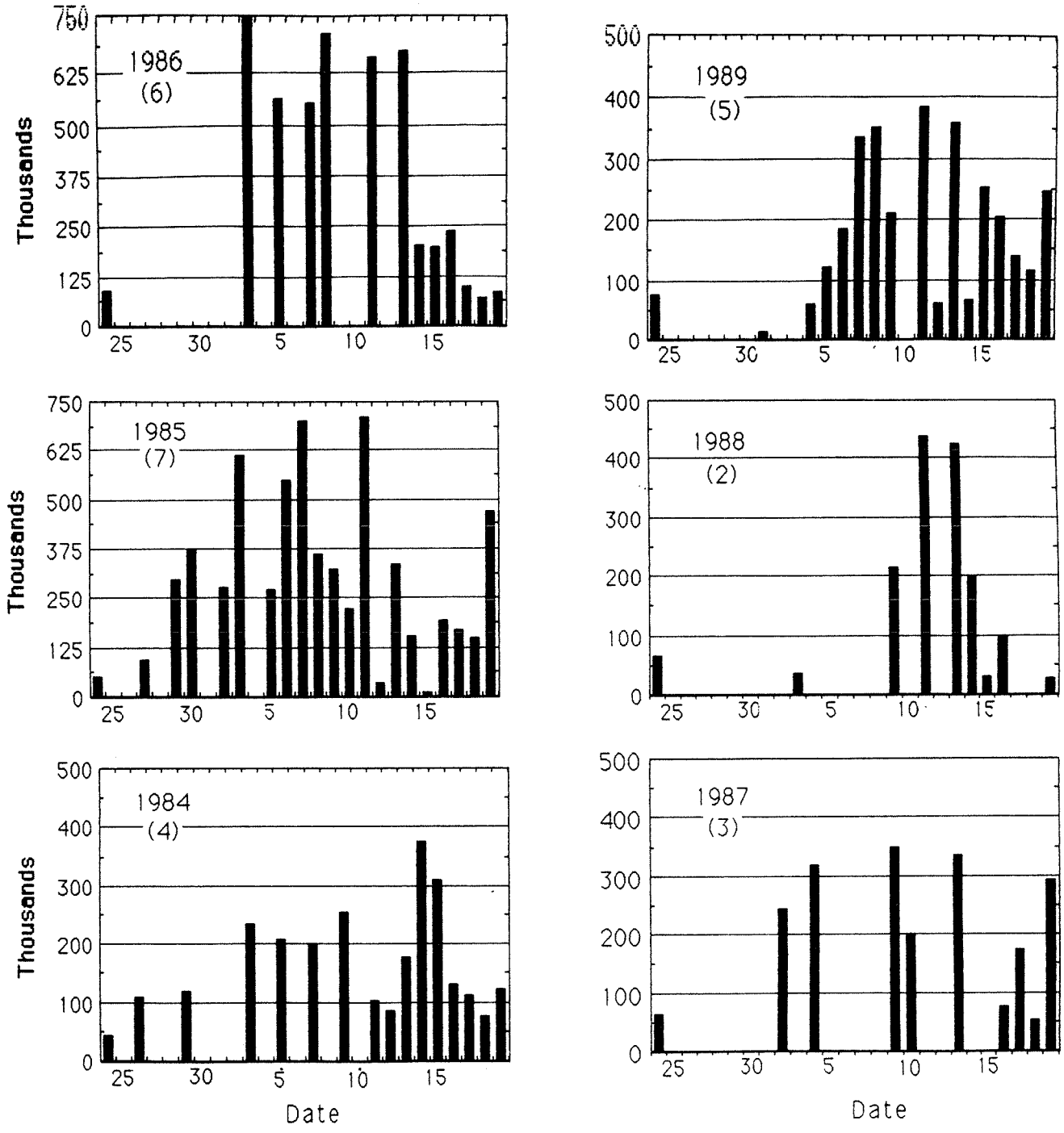

Fig. 7. Daily catches of sockeye salmon in the Ugashik district. First bar for catches through June 24 and last for July 19 and later, 1984-89.

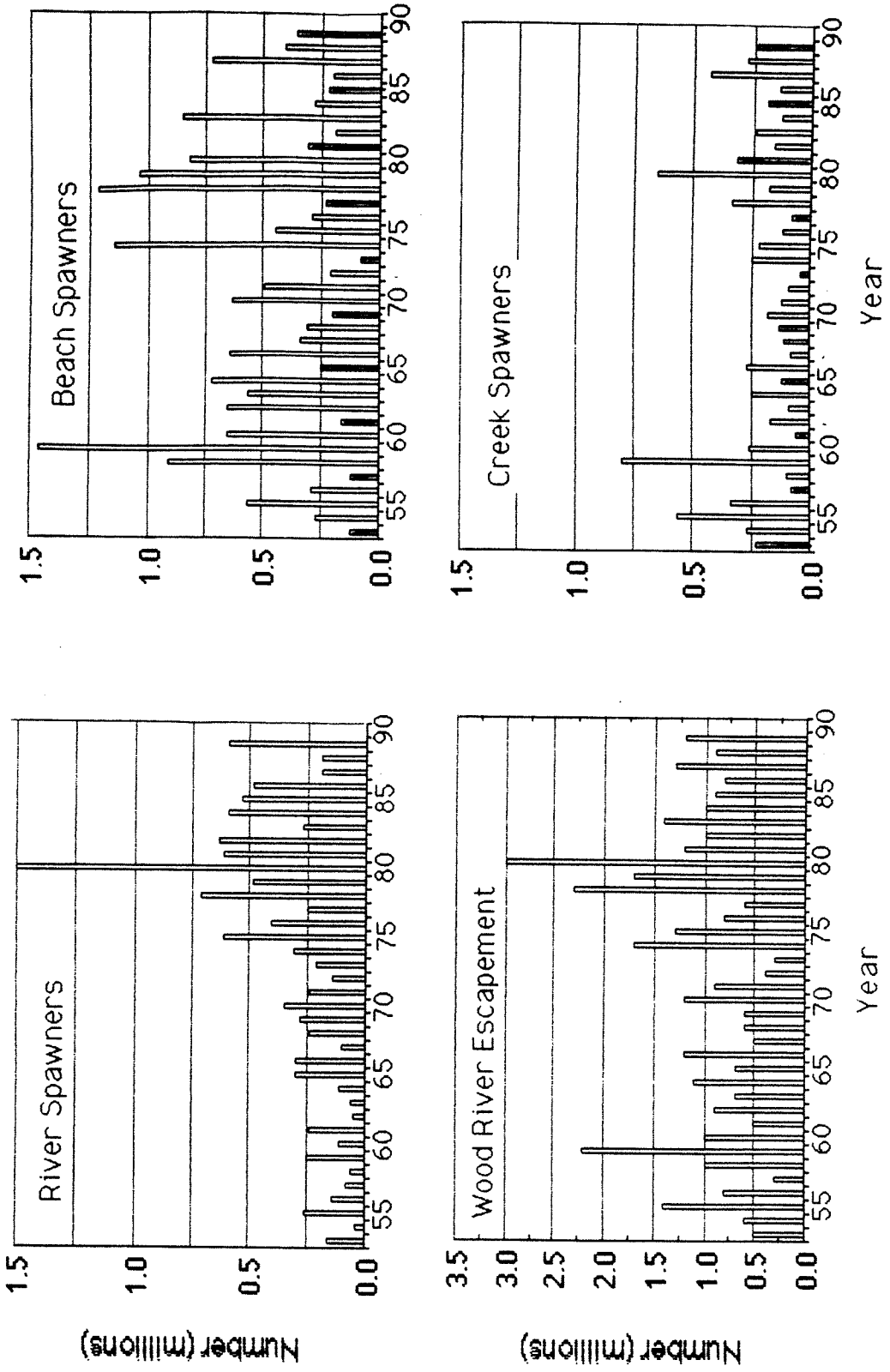

Fig. 8. Annual sockeye salmon escapements to the Wood River lake system, 1953-1989, and the numbers of spawners apportioned to the three types of spawning ground from aerial surveys.

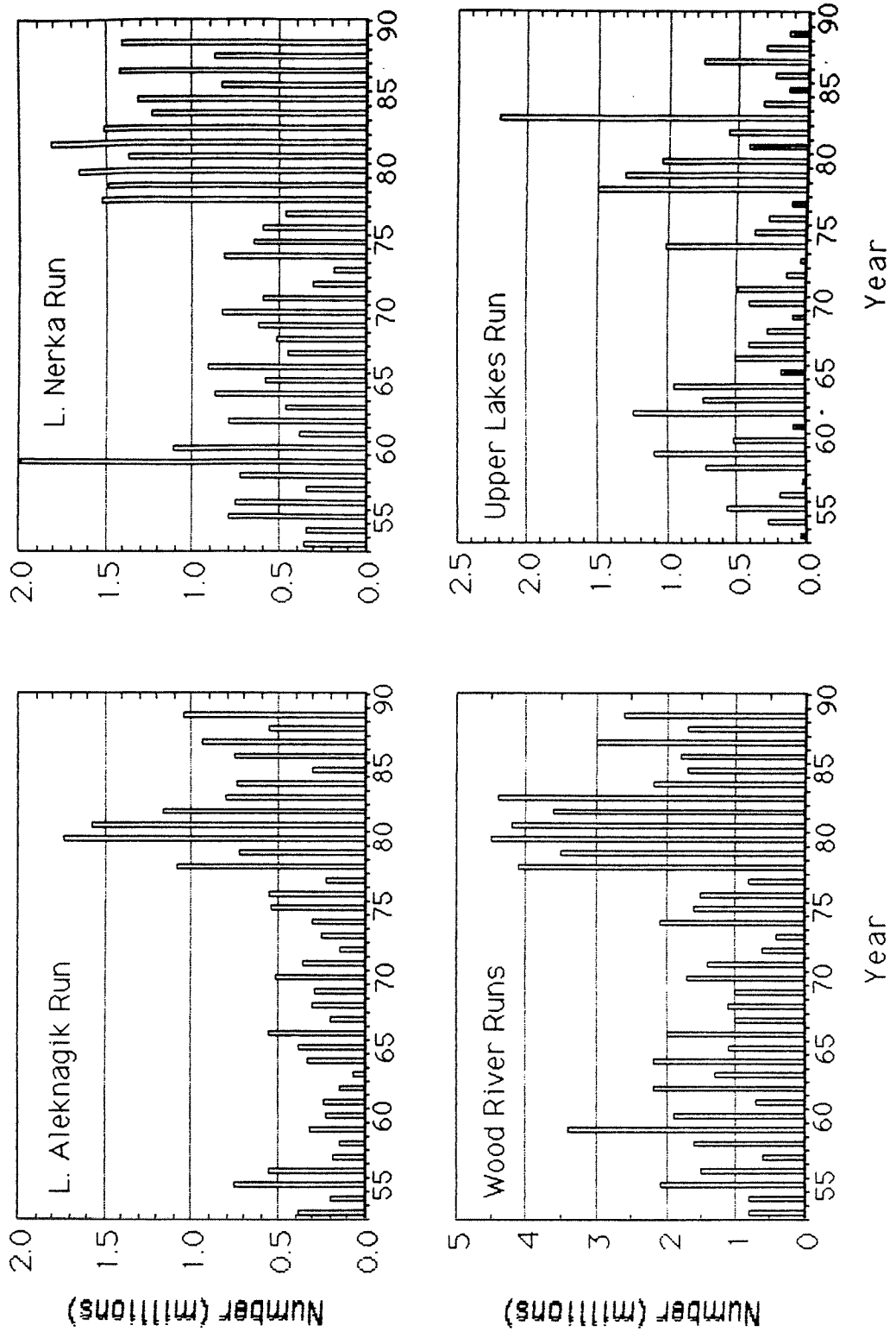

Fig. 9. Annual sockeye salmon runs to the Wood River lake system, 1953-1989, and the estimated runs to the three major parts of the system; Lake Aleknagik (20% of area), Lake Nerka (48% of area) and the upper lakes—Beverley and Kulik (32% of area).

SOUTHEASTERN

Our recent research program in southeastern Alaska has been mostly carried out by Dr. Ole Mathisen at the University of Alaska-Juneau. The emphasis has been on in-season forecasting of the pink salmon runs in the northern region (Icy Straits). Dr. Mathisen's report on that work in 1989 as well as a report on some related activities will follow a brief report of our efforts at forecasting pink salmon runs to the southern region (pre- and in- season).

The annual runs (catch plus escapement) have averaged larger and been more variable in the southern region than in the northern region since escapement estimates began in 1960 (Fig. 10). The even year runs have generally been stronger in the southern region while the odd year runs have been stronger in the northern region; however, the 1989 run to southern southeast was the second largest on record at 55 million (Table 12). A run of this magnitude was unexpected, as there was a forecast for a modest catch of 14 million. The forecasted catch by ADF&G for southern southeast in 1990 is 7 million pink salmon while the forecasted catch for northern southeast is for a catch of only 2 million pinks—a very poor outlook. ADF&G kindly provided us with their forecasting data base and utilizing their statistics plus some sea temperature data, we arrived at forecasts of a 14 million pink catch in the southern region and an 11 million catch in the northern region in 1990. The forecast for the northern region seems unlikely given the typical even year runs in the past and the relatively small escapement in 1988 (Fig. 11); however, warm temperatures when the pinks from the 1988 brood went to sea projected a large return in 1990.

ICY STRAIT RUNS

A system to estimate run strength has been under development since 1985. It is based on the constant order in which the various populations of pink salmon appear each summer at Cross Sound. The main groups are classified by spawning time as early, middle and late spawners. By using a relative measure of daily passage of fish, an average cumulative performance curve can be constructed for use in future predictions.

Acoustic abundance estimates can be used as relative measures of daily passage. We have developed a method to isolate return signals from pink salmon since they have a well defined size range. This method gives the most reliable results but requires a skilled operator in the field. A second type of abundance index can be obtained from the catches of a daily test fishing program over a pre-assigned course and with fishing done at the same stage of the tide. A variation of this method is the use of daily landings of troll caught pink salmon and this method was applied in 1989.

The 1989 predictions were based on daily catches delivered to the Elfin Cove receiving station operated by the Excursion Inlet Packing Co. and faxed each morning to Juneau (Univ. of Alaska) for processing. A total of 12 predictions were issued during the season and these were faxed to operators and to ADF&G. The results are plotted in Figure 12.

In addition to the industry sponsored work in Icy Strait we also conducted a project on estimating the run timing in Dixon entrance by examining the catches of pink salmon in four traps operated by the Annette Island Packing Co. An average run timing curve has been established and is shown in Figure 13. This project was funded by the Alaska Sea Grant Program which also funded a joint research effort with the Japanese research vessel T/V *Oshoro Maru*. The 1989 cruise plan is shown in Figure 14 and the salmon catches are given in Table 13.

Table 12. Southeastern pink salmon runs and the pre-season forecasts of the catches (millions).

Year	NORTHERN SOUTHEAST				SOUTHERN SOUTHEAST			
	Run	Escapement	Catch	Forecasted Catch	Run	Escapement	Catch	Forecasted Catch
1978	6.0	3.2	2.8	2	23.9	5.5	18.4	16
1979	8.9	5.1	3.8	5	11.8	4.8	7.0	9
1980	4.1	2.7	1.4	1	19.2	6.3	12.9	4
1981	9.4	4.1	5.3	2	19.5	6.0	13.5	9
1982	16.7	4.4	11.3	4	19.0	6.1	12.9	22
1983	10.8	4.8	6.0	1	40.2	8.8	31.4	12
1984	8.9	3.9	5.0	10	28.7	9.1	19.6	20
1985	30.1	9.0	21.1	7	43.0	12.3	30.6	25
1986	4.1	2.9	1.2	6	58.4	13.9	44.5	32
1987	9.3	4.2	5.1	5	9.9	5.5	4.4	21
1988	4.8	2.7	2.1	3	13.1	4.1	9.1	38
1989	17.6	4.6	13.0	7	55.0	8.6	46.4	14
1990				2				7

Table 13. Catch records from experimental gill netting by *Oshoro Maru*, 1989.

Date (July)	Station number	Catch			
		Sockeye	Chum	Pink	Coho
1	10	127	44	416	25
2	11	126	14	160	26
3	12	236	93	347	41
4	13	397	14	125	51
5	14	292	21	152	72
6	15	270	41	109	161
7	16	182	35	60	78
8	17	275	143	119	241
9	18	140	44	44	72
10	19	349	50	101	33
11	20	277	77	67	12
12	21	309	43	39	35
13	22	252	8	14	15
14	23	414	6	7	3
15	24	43	22	46	2
16	25	6	0	12	0
17	26	0	0	2	0

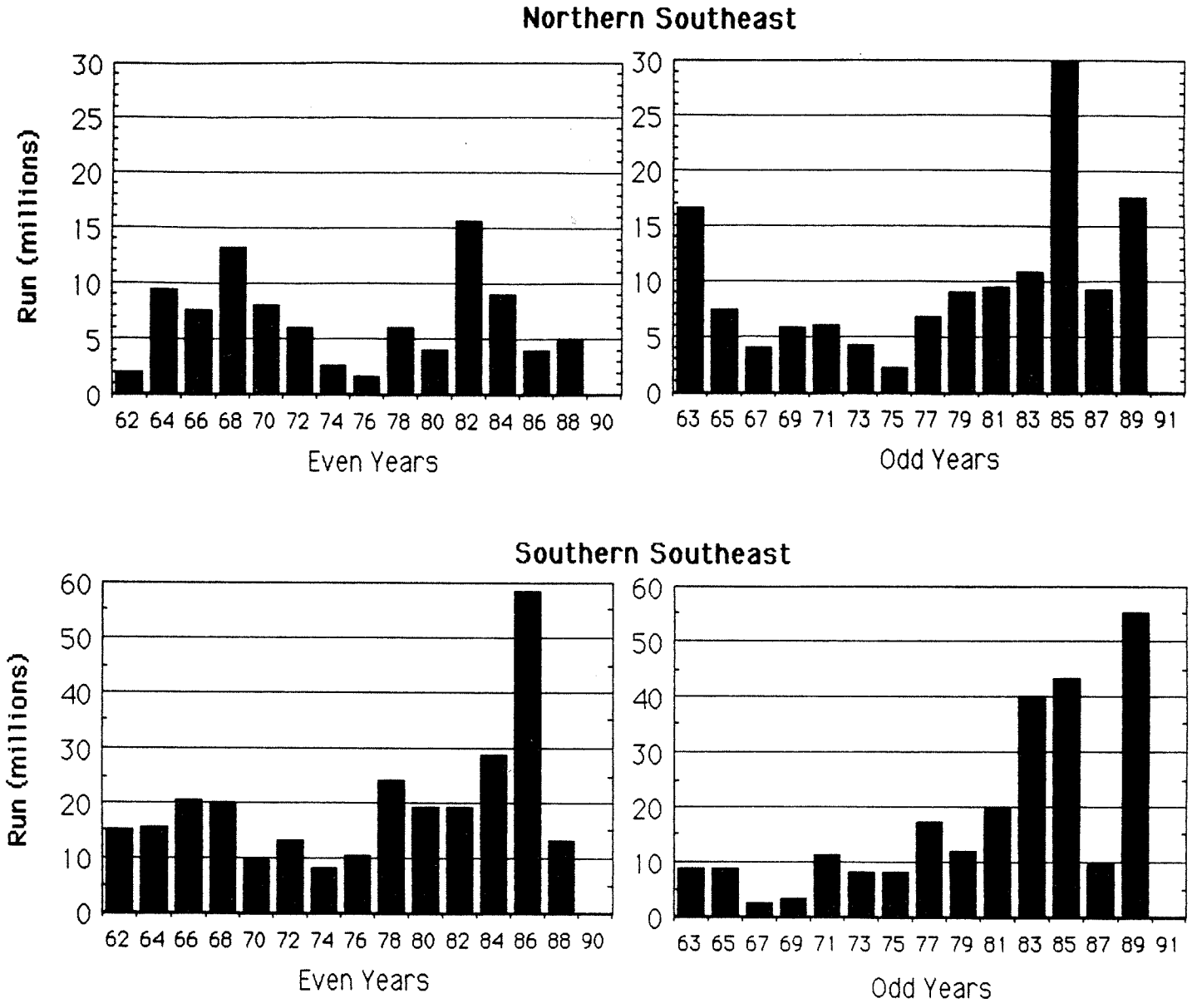

Figure 10. The estimated annual runs (catch plus escapement) of pink salmon to southeastern Alaska by region and brood line, 1962-1989.

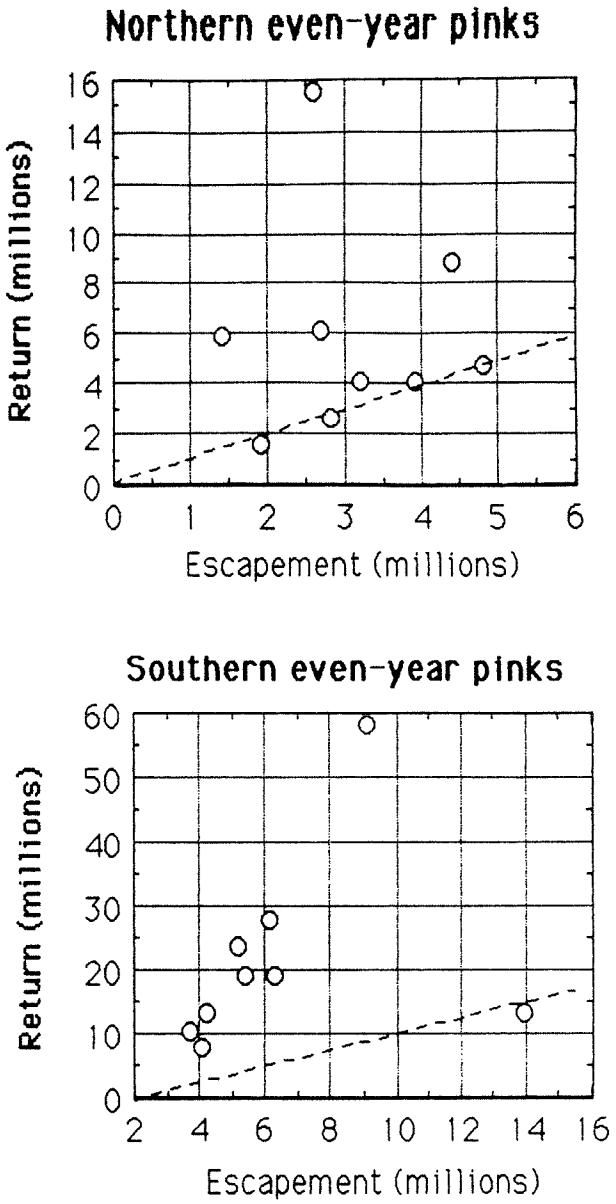

Fig. 11. Plots of returns on escapements for southeastern Alaskan pink salmon for even years since the 1970 brood year. Escapements for the 1990 returns were 2.7 million in the northern region and 4.1 million in the southern region

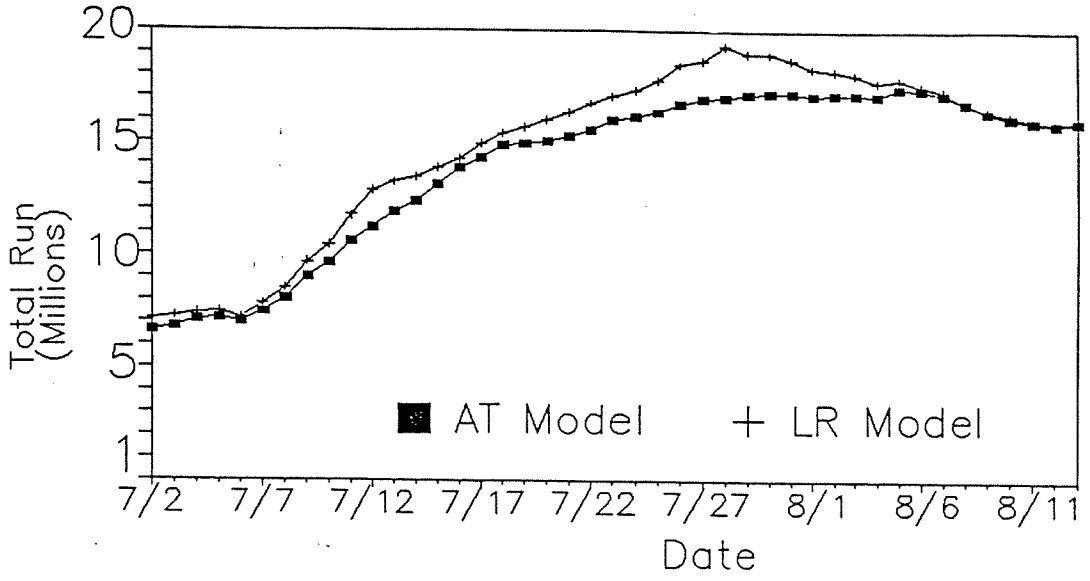

Figure 12. Forecast of the Icy Strait pink salmon run in 1989.

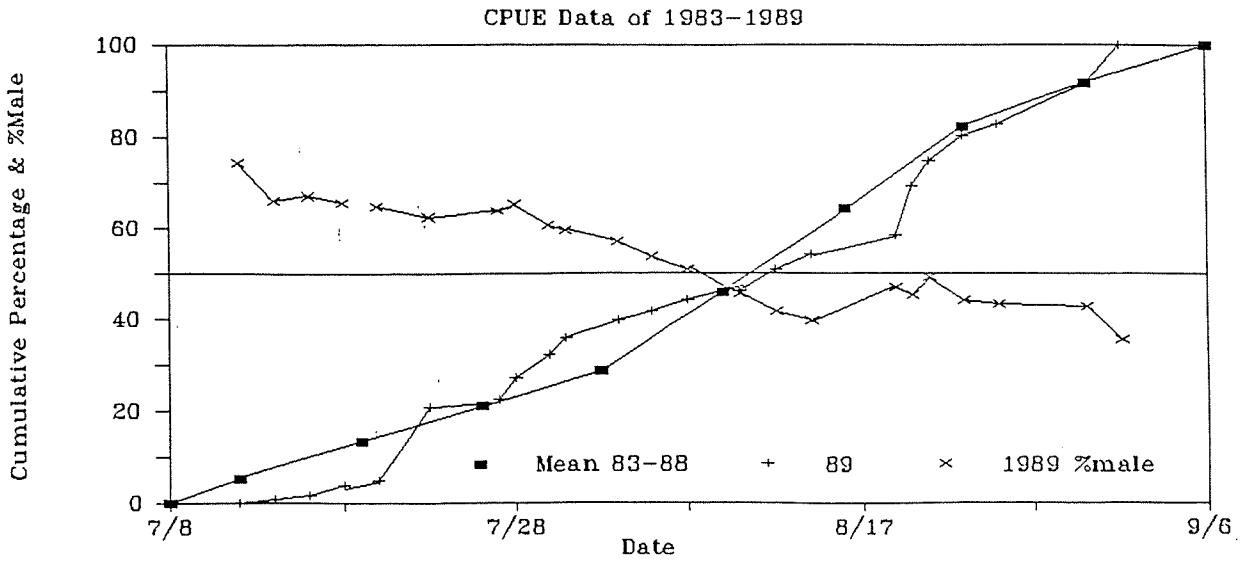

Figure 13. Pink salmon catches and percent males in Annette Island traps.

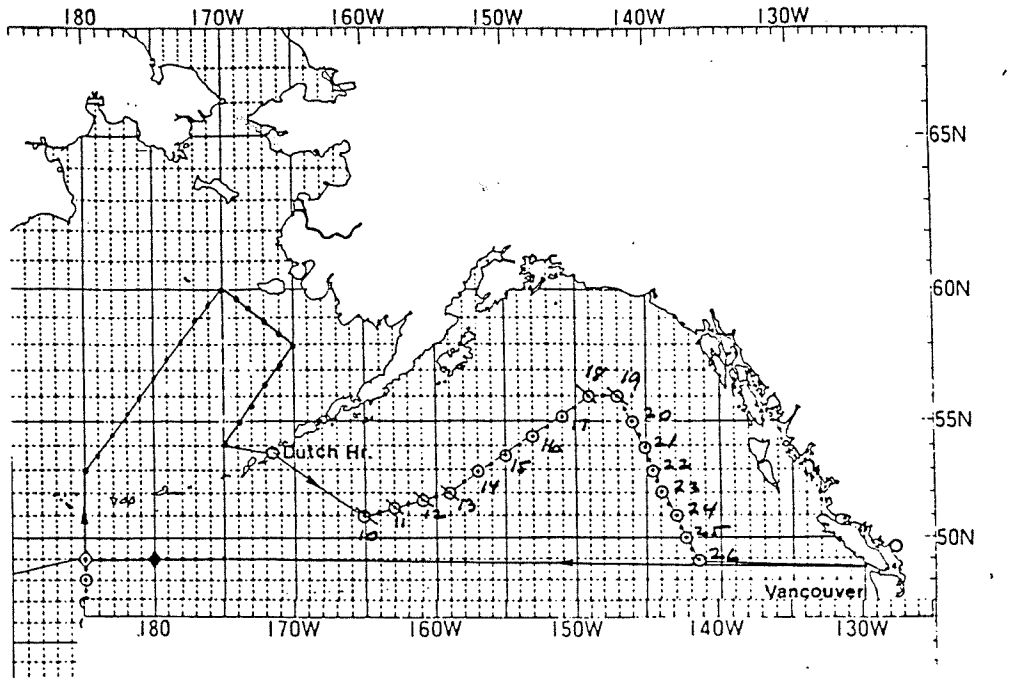

Figure 14. The cruise plan of the Oshoro Maru in the Gulf of Alaska, 1989.