

**FISHERIES RESEARCH BOARD
OF CANADA**

MANUSCRIPT REPORTS OF THE BIOLOGICAL STATIONS

No.

429

Title

Report of Analysis of the British Columbia
Pilchard Catch for 1926-46

Author

Dorothy M. Furk Manzer

1951

Report of Analysis of the British
Columbia Pilchard Catch for 1926 - 46.

The study was initiated in an attempt to define the circumstances surrounding the decline in pilchards off the British Columbia coast to determine if there was an actual decline in abundance or perhaps only a decline in availability.

An attempt was made to follow the course of the fishery from catch records. The data was available from two sources a) plant records of daily pilchard landings for the period 1926 - 1946 supplied by the fishing companies, and b) pilot house log books of detailed fishermen's catches for the period 1942 - 1946. As only the former set of data covered the entire period, it was the one used to determine an index of the catch over the years. The ideal basis for the index would be the annual catch by skipper using the same boat and the same tender from year to year. This, however, was impossible, because neither 1) complete and accurate data on the tenders, nor 2) complete data on which skipper captained what boat, was available. Instead, the data was only sufficient to allow the use of a) those boats which were used in two consecutive years regardless of skipper and b) those skippers which fished in two consecutive years regardless of boat used.

Total tonnage figures were used for the annual fishing seasons from June 1 to October 15, although the majority of catches were landed from July 15 to September 15.

Unless an individual boat or skipper landed at least one third of the total catch of the largest tonnage of pilchards caught in a certain season, the boat or skipper was eliminated from the data. This was based on the assumption that even the smallest boats or poorest skippers should be able to catch at least one third of the catch of the largest boat or highest skipper if they fished all season.

Data for the 1933 season was lacking but estimates were obtained by using proportions of the 1932 and 1934 catches in relation to the total tonnage figures for 1932, 1933 and 1934. In this way it was possible to estimate the 1933 catches,

thereby making the calculations of regression lines possible.

The data for the 1939 season (a season of near failure) was accepted because it was felt that the records were as accurate and complete as it was possible to obtain.

The use of the chain link relative technique was suggested by the data. This is the method of comparing the catch of fleet A in one year with that of the same fleet A in the second year, and the catch of fleet B in the second year with the catch of the same fleet B in the third year. In this way, only the catches of those boats that were fishing in two consecutive years could be utilized.

The base year of 1942 was chosen because 1) it was an average year and 2) it was the first year for which the detailed log books kept by the fishermen were collected.

The indices resulting from the chain link relatives were calculated on the basis:

- 1) skippers fishing in two consecutive seasons, regardless of boat, using
 - a) annual catch tonnages and b) catch per day tonnages.
- 2) boats fishing in two consecutive seasons, regardless of captain, using
 - a) annual catch tonnages and b) catch per day tonnages.

The number of fishing days was determined from the plant records for the individual skippers or boats by arbitrarily adding two days before the first landing and three days after the last of the season, with a minimum number of 62 days per boat per season. This method makes no allowances for scouting time nor time lost through damage to nets, engine breakdown, etc. (See table I and figure 1) the resultant indices follow on page 3.

Regression lines were fitted to the indices by the method of Least Squares. They were calculated for the entire period 1926 to 1946; for the period 1926 to 1939 (to see if any decline was evident prior to 1939); and for the period 1934 to 1938 (those years prior to 1939, yet after the failure of 1933). (Also on page 3)

Skippers boat

Season	Annual Catch	Catch Per Day	Annual Catch	Catch Per Day
1926	1.1857	1.0162	.9100	.8314
1927	1.2889	1.3073	1.1054	1.0964
1928	1.0905	.9887	.9788	.9145
1929	1.1025	1.1195	1.0060	1.0551
1930	.9053	1.1096	.8464	1.0849
1931	1.1329	1.1445	1.2791	1.3048
1932	.9143	1.0156	1.0167	1.1367
1933	.0831	1.069	.0984	1.201
1934	1.0654	1.3641	1.0723	1.3853
1935	1.0723	1.2169	1.1049	1.2860
1936	.7301	.7783	.7665	.8142
1937	.9158	.9956	.8809	.9416
1938	.9434	.9828	.8718	.9007
1939	.0951	1.1404	.0892	1.298
1940	.5738	.6679	.5914	.6857
1941	1.0008	1.0000	1.0030	.9929
1942	1.0000	1.0000	1.0000	1.0000
1943	1.4355	1.8737	1.3506	1.6159
1944	.9451	1.0149	.8698	.9600
1945	.4220	.5274	.3770	.4988
1946	.0577	.0806	.0598	.0929

1926-1946 1926-1938 1934-1938

Skippers, using annual tonnage figures	-0.0256	-0.0306	-0.0401
Skippers, using average catch per day figures	-0.0199	-0.0121	-0.0984
Boats, using annual tonnage figures	-0.0212	-0.0145	-0.0625
Boats, using average catch per day figures	-0.0255	-0.0036	-0.1314

It is evident from this tabulation that there is a decline over the whole period and also for the periods 1926-1938 and 1934-1938. None of these coefficients proved to be significant at the probability level of $P = .05$, although the regression lines for the period 1934-1938 for both the skippers using annual catches and the boats using daily catches approached significance at that level.

It was thought that the index for skippers calculated on a basis of annual tonnage was the most representative of the four indices. The individual skippers vary greatly and if this variable is eliminated, the remaining variability should be accredited, more or less, to the variability in the fishing from year to year. It is hoped by this method that a picture of the actual availability has been procured. It was to this representative index that the several measures of oceanographic conditions were compared. The results follow:

The total tonnage of pilchards landed by all boats during the fishing season (June 1 to October 15) was plotted on a graph on which the fishing index (skippers' annual tonnages) had already been plotted. The annual catch per boat was also plotted on the same graph. (See table II and figure 2) The greater divergence between the total tonnage and the catch per boat lines during the earlier years of the fishery as compared to that during the later years, might be partly accounted for by the much smaller boats whose smaller carrying capacity necessitated more frequent trips into port. The inexperience of some of the captains may also account for some of the discrepancy indicated.

It was thought perhaps the winds blowing off Vancouver Island might have had an appreciable effect on the pilchard catches from year to year. In order to assess the effect, if any, the percentage frequency of northwest and west winds combined, off Estevan was calculated for several sets of months: Mar. Apr.; Apr. May; May June; Mar. Apr. May; Mar. Apr. May June; Apr. May June; June July Aug; as well as similar sets for the southeast winds. (See Table III) But none of the results were useful in assessing the fluctuations in the annual catch. A correlation coefficient was calculated for the percentage frequency of northwest and west winds during April, May and June as against the index of fishing (skippers' annual tonnages) with the result that $r = -.0662$, indicating negligible negative association.

The total monthly amount of precipitation measured at Estevan, Vancouver

Island, was tabulated in an attempt to determine whether rainfall made any appreciable contribution, but the resulting totals for April, May and June; and June, July and August; had no clear significance. (See Table IV)

The total number of hours of sunshine at Victoria (nearest point of record to Ketevan) for the months June July August was calculated but showed no reasonable association. (See Table V and Figures 3,4,5.)

The average monthly sea water temperatures and salinity readings for the months of April May June and June July August at Cape St. James and Williams Head Race Rocks, together with the sea water temperatures at Kains Island, Quatsino Sound, for the same months, were plotted against the fishing index but none of these produced any successful results. (See Table VI & VII and Figures 6 & 7)

Data concerning sea water temperatures taken at the blunts' Reef Lightship off Cape Mendocino, California and off North Farallon Island, California, were available from 1923 until 1941. (See Table VIII) The average monthly temperatures were grouped and averaged in several combinations from November of the year preceding a certain season through to August of said season for both stations during the years 1926 to 1941 inclusive. This was done to ascertain if the temperature of the surface waters off California had any apparent effect on the pilchard fishery of British Columbia. It was noted that the average sea water temperatures off Cape Mendocino for the months of March and April appeared to be associated with the pilchard catches for the same year, especially for the ten year period 1932 to 1941. (See Figures 8,9,10 & 11) The disassociation noted for the first six years (1926 to 1931) may, in part, be attributable to the fact that the British Columbia pilchard fishery was only developing during those years and therefore may not have fished the migrating stock to any great extent. No data were available for the years following 1941 and even if these were available it is unlikely that any correlation of temperature data and fishing index would be indicative of the true situation because of the abnormal recruitment and subsequent above

normal fishing during the first few years of the period which were followed by failure of the fishery due, in part, to a series of unsuccessful brood years.

The data covering the North Farallon Island temperatures did not indicate any associations, unless they were masked by other factors. (See Table XI and Figures 12 & 13.)

A correlation coefficient was calculated for the sea water temperature data off Cape Mendocino for the months of March and April as against the fishing index (skippers' annual tonnages) for the period 1926 to 1941, with the result that $r = 0.3509$. This coefficient did not prove to be significant. But on the other hand, the correlation coefficient calculated from the data, covering the ten year period 1932 to 1941 inclusive, yielded $r = 0.7281$ which proved to be significant at $P = .05$.

This high correlation suggests that the sea water temperatures off Cape Mendocino have some influence on the migrating stock and it is noticeable that the warmer sea water temperatures in March and April were associated with the relatively higher indices. Apparently the warmer temperatures off Cape Mendocino encourage an earlier and hence more complete migration northward into British Columbia waters.

It is probable that one or more of the oceanographical or weather factors previously indicated would, in association with the sea water temperatures off Cape Mendocino, result in a more accurate appraisal of the conditions governing the fluctuations of the British Columbia pilchard fishery.

The records from the pilot house log books (sent in by the fishermen) constituted the second set of data previously referred to. These books were supplied to the fishermen on the understanding that they would record the data required and return the sheets to the Biological Station for analysis. During the first year of the survey (1942) only 42 percent of the fleet cooperated, and the last year (1946) 52 percent, while the remaining three years (1943, 1944, 1945) had the cooperation of nearly 90 percent of the fishermen.

In calculating the chain link relative index from these records, it was hoped that it would have been possible to use only those skippers who had fished for two consecutive seasons, using the same tenders in both seasons. However, this was not possible and the skippers were selected on the basis of fishing two consecutive seasons without regard to tender. A comparison of the indices (based on the skippers' annual tonnages) from the two sources, i.e., plant records and pilot house records, follow: (Also see Table X)

Year	Plant Records	Pilot House Records
1942	1.0000	1.0000
1943	1.4355	1.4983
1944	.9451	1.0651
1945	1.4280	.6093
1946	.0577	.2680

The widening divergence between the two sets of indices could be due, in part, to the fact that the pilot house data are not as complete as that of the plant records. The 1946 index from the former set of data was calculated on the basis of 10 fishermen catching a total of 2220 tons, whereas the corresponding index from the latter set was calculated on the basis on 19 fishermen with a total of 2647 tons. One of the causes that the two tonnages tend to approximate each other yet with the greater number of contributing fishermen might be the fact that several fishermen did not catch any tonnage during 1946--their names with zero catches are recorded in the plant records but the men did not turn in their pilot house record sheets, even though many fished through most of the season.

The pilot house record data provided much detailed information as to the number of actual fishing days, scouting days, and the number of days the skipper was not active due to storms, net repairs, engine breakdowns, etc. These data enabled the writer to calculate the number of days spent in actual fishing and scouting for fish. This is in contrast to the method of determining the number of fishing days for the plant record data, viz. the number of days between the first and last landings plus five days' margin (i.e., two days before the first

and three days after the last landing) with a minimum of 62 days per season. The study of the pilot house records indicate this minimum of 62 days may have been a little high for the latter five seasons of the survey, 1942, 1943, 1944, 1945 and 1946. The average number of fishing days per season (including scouting time) for the same skippers from which the chain link relative index for the pilot house records was calculated are:

Season	Number of Fishing Days	Number of Skippers Involved
1942	71.1	8
1943	64.1	16
1944	58.3	17
1945	46.6	16
1946	24.7	10

In contrast, the average number of fishing days determined from the plant records for those skippers included in the calculations of the fishing index follow:

Season	Number of Fishing Days	Number of Skippers Involved
1942	90.3	16
1943	76.8	19
1944	85.2	21
1945	74.4	20
1946	62.3	19

The difference noted in the average number of fishing days between the two methods of treatment and the fact that the index calculated from the plant records is based on a larger number of skippers for each season, might account for some of the difference in the indices based on the skippers' catch per day as calculated from a) the plant records and b) the pilot house records:

Season	Index of Skippers' Catch Per Day Plant Records	Pilot House Records
1942	1.0000	1.0000
1943	1.0737	1.4987
1944	1.0149	1.0659
1945	.5274	.6095
1946	.0806	.2689

When the indices of skippers' annual catches and of skippers' catch per day are compared for both the plant records and pilot house records, it is interesting to note that the index of catch per day is always above that of annual tonnages. It is quite noticeable in the case of the plant records, while those of the pilot house records are only slightly higher.

Season	Plant Records		Pilot House Records	
	Annual	Catch by Day	Annual	Catch by Day
1942	1.0000	1.0000	1.0000	1.0000
1943	1.4355	1.6737	1.4963	1.4987
1944	.9451	1.0149	1.0651	1.0695
1945	.4220	.5274	.6093	.6095
1946	.0577	.0806	.2680	.2689

In order to determine the changes, if any, in the tons per fishing day throughout the season, the data from the pilot house records were tabulated in ten-day periods, commencing with June 1 and continuing throughout the season. (See Table XI) The 1941 data, as included in the table, is the record of only one boat. The average tons per day for periods 4 - 14 inclusive (July 1 to October 18) for the years 1942 - 1946 inclusive agree with the trend of the fishery as shown previously--a peak in the year 1943, with a decline to 1946. In the individual years there is no one period during which the highest number of tons were taken, but rather, the peaks are spread over the periods. During 1942, 1943, 1944 and 1945 a Fall and Winter fishery took place.

Information was also available on the number of sets that were necessary to catch the tonnages recorded on the sheets. This was tabulated in ten-day periods, similar to the preceding data. (See Table XII) Again, the 1941 information was based on the performance of only one boat. The results indicate no constant increase in the tons per set throughout the seasons, although increase, in most cases was shown during the last period of the season--period 14 (October 9 - 18). This might suggest that the schools of fish tended to become larger during that and following periods, thus making it possible for the fishermen to take a greater tonnage with each set.

Time of set was also noted on the record sheets. These data were tabulated for the years 1943 - 1946 as to area, year and time of day--taken to the nearest hour. The two areas, XI and XII, were subdivided into Inside and Outside sections. The percentage tonnages were then calculated but the results were not conclusive. (See Table XIII and Figure 14) For Area XI-Inside, 10:00 and 19:00 hours were the most successful fishing times; for Area XI-Outside, 9:00 and 19:00 hours; for Area XII-Inside, 8:00 and 18:00 and 20:00 hours; and for Area XII-Outside, 11:00 and 15:00 hours. For Area XI the peak in the afternoon and evening hours came at 19:00 hours in both Inside and Outside waters; but for Area XII the Inside and Outside waters were not similar at all. The overall average for all areas and all years combined, resulted in the most productive morning fishing taking place at 11:00 hours (7.6%) with 8:00 hours (7.3%) next; the most productive evening hour was 19:00 hours (8.8%) with 18:00 hours (8.0%) next.

TABLE 11 (Part 1)

Annual Catch Per Boat - based on all boats used in calculations for Skippers Annual Catch.

1926	2039.2	2039
1927	2179.0	2179
1928	1839.6	1840
1929	1899.5	1900
1930	1732.0	1732
1931	2413.0	2413
1932	2216.4	2216
1933	206.4	206
1934	2322.9	2323
1935	2122.0	2122
1936	1527.0	1527
1937	1935.1	1935
1938	1944.0	1944
1939	207.0	207
1940	1395.4	1395
1941	2486.4	2486
1942	2573.8	2574
1943	3606.8	3609
1944	2322.0	2322
1945	1070.8	1071
1945	149.8	150

TABLE 11 (Part 2)

	80	July 1-Oct 15 *
1917-18	80	
1918-19	3,640	--
1919-20	3,280	--
1920-21	4,400	--
1921-22	990	--
1922-23	1,020	--
1923-24	970	--
1924-25	2,370	--
1925-26	15,950	15,948
1926-27	48,500	48,497
1927-28	68,430	68,429
1928-29	80,510	80,512
1929-30	86,340	86,342
1930-31	75,070	75,070
1931-32	73,600	73,604
1932-33	44,350	44,348
1933-34	4,050	3,267
1934-35	43,000	43,004
1935-36	45,320	45,325
1936-37	44,450	38,140
1937-38	46,060	46,060
1938-39	51,770	48,521
1939-40	5,523	5,523
1940-41	28,770	28,245
1941-42	60,046	51,553
1942-43	65,894	48,054
1943-44	88,739	70,054
1944-45	59,020	50,658
1945-46	34,302	22,806
1946-47	3,994	3,984
1947-48	200	--

* Taken from Pilchard Meal & Oil Production Reports issued by the Chief Supervisor of Fisheries, Vancouver.

Annual Tonnage of Pilchards Caught in British Columbia

TABLE 111 - Percentage Frequency of Winds from Ketevan Point-1935 and on changed from number of observations.

	Mar.		Apr.		May		June		July		Aug.		Sept.		Oct.	
	W+ SE	NW														
1936	44	31	32	28	10	47	60	18	47	27	39	31	43	18	23	55
1937	37	34	38	20	48	23	57	25	55	23	34	27	33	13	31	35
1938	39	18	27	47	60	19	53	18	63	29	50	24	50	28	21	42
1939	40	32	39	25	66	14	42	32	46	30	39	44	62	8	23	52
1930	43	33	26	47	64	25	45	40	72	10	53	33	56	29	26	50
1931	25	42	25	36	66	18	32	40	70	16	57	25	28	50	28	40
1932	24	54	33	42	54	35	75	30	36	48	68	17	55	24	25	35
1933	23	48	56	20	17	53	53	19	73	14	58	21	20	47	32	37
1934	26	35	43	26	42	32	52	23	50	27	40	35	38	36	23	52
1935	29	27	42	20	58	15	37	35	55	19	61	16	32	27	34	32
1936	37	23	33	35	37	34	33	28	42	18	45	23	33	28	39	24
1937	16	52	22	40	48	31	33	43	73	16	42	32	47	30	18	47
1938	26	34	27	38	56	19	72	8	63	19	60	23	42	23	15	55
1939	32	44	28	37	52	19	57	23	56	19	47	24	60	22	34	35
1940	19	47	37	23	53	23	77	7	42	29	50	26	35	32	15	50
1941	24	34	40	28	35	16	42	25	61	16	39	19	43	20	29	34
1942	24	23	28	33	39	27	55	15	31	27	52	15	37	28	29	47
1943	23	25	17	37	48	18	53	8	53	19	63	13				
1944	35	29	15	43	50	21	67	7	48	18	45	18	40	33	11	53

a No data - took averages for June over 18 years.

TABLE IV

Precipitation Per Month at Estevan.

	Apr.	May	June	July	Aug.	Sept.	Oct.	Total J.J.A.S	Total A.M.J.	Total J.J.A.
1926	3.33	12.68	1.99	5.19	2.95	2.21	9.92	12.24	18.00	10.03
1927	6.43	6.44	2.83	0.96	4.03	5.96	14.24	13.78	15.70	7.82
1928	6.77	10.69	1.47	1.26	4.15	4.06	14.08	10.96	16.93	6.88
1929	7.35	2.24	4.23	7.29	5.02	T	14.29	17.64	13.82	17.54
1930	6.60	3.56	10.67	0.40	0.68	6.16	7.77	16.11	21.03	11.95
1931	8.51	2.87	7.05	0.91	3.07	12.21	11.21	25.24	18.43	11.03
1932	8.83	3.61	2.41	6.99	0.72	6.43	12.53	16.56	14.85	10.13
1933	4.50	10.47	3.18	1.46	1.26	12.45	17.44	18.35	18.15	5.90
1934	5.05	7.73	2.17	2.44	6.20	5.99	15.81	20.10	14.95	14.21
1935	5.76	1.51	6.11	2.24	1.04	3.96	9.67	13.35	13.40	9.39
1936	0.92	5.63	9.03	5.40	5.46	4.05	4.16	26.94	23.58	22.89
1937	22.24	10.62	4.75	0.86	5.81	5.22	14.16	16.64	37.61	11.42
1938	5.59	5.35	0.51	0.46	2.07	4.64	12.47	7.68	11.43	5.04
1939	7.34	5.79	3.71	4.96	3.58	3.14	12.42	18.33	16.84	12.19
1940	8.71	5.13	0.85	6.93	2.56	3.02	16.37	16.36	14.69	11.34
1941	6.22	7.69	4.51	2.56	3.22	6.19	10.14	18.58	18.22	10.29
1942	10.00	3.54	6.97	3.78	0.45	6.10	13.60	19.28	20.51	11.18
1943	11.41	8.16	1.52	3.38	4.63	3.66	11.42	13.19	21.09	9.53
1944	8.62	3.98	1.07	2.11	1.56	6.06	11.27	10.80	13.67	4.74
1945	6.69	4.23	2.96	3.51	0.49	5.68	10.36	12.64	14.08	6.96
1946	14.21	0.90	5.28	3.69	1.51	6.52	8.73	19.00	20.39	10.48
Average	7.72	5.61	3.74	3.40	3.06	5.43	11.66	15.63	--	10.25

TABLE V

Hours of Sunshine Per Month at Victoria-nearest point to Estevan.

	Apr.	May	June	July	Aug.	Sept.	(June, July, Aug.)
1926	250	215	341	346	254	252	941
1927	186	237	262	351	377	174	920
1928	194	325	264	358	314	226	926
1929	216	276	208	348	323	256	881
1930	184	286	273	364	323	207	962
1931	235	311	249	387	350	166	966
1932	185	283	330	228	273	260	841
1933	254	210	268	264	357	170	959
1934	247	250	389	310	330	188	969
1935	259	234	279	303	356	270	908
1936	208	212	229	346	338	231	923
1937	127	260	229	362	269	197	870
1938	215	234	336	344	318	184	926
1939	222	279	219	320	331	227	870
1940	214	225	370	288	319	194	977
1941	232	236	245	352	264	147	861
1942	170	208	259	296	340	190	865
1943	208	220	310	342	260	253	912
1944	201	276	303	328	242	228	899
1945	168	221	292	361	322	127	975
1946	129	326	225	299	302	129	866

TABLE VI - Sea Water temperatures at Cape St. James.

Part 1	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	
1935	44.8	45.7	47.5	50.0	53.0	56.2	55.6	49.9	VI 1935
1936	44.2	44.7	46.8	50.7	55.5	56.6	55.0	51.9	
1937	44.0	46.1	47.6	50.4	52.2	54.5	55.3	51.1	
1938	44.3	46.8	47.1	48.6	51.5	51.0	50.6	--	
1939	40.5	41.1	43.6	46.2	48.1	49.9	47.8	44.6	
1940	40.0	42.5	47.4	50.7	55.1	55.8	55.9	54.5	
1941	42.4	45.8	50.2	50.2	54.7	56.9	55.2	50.4	
1942	47.0	47.2	48.6	51.3	55.5	47.7	55.8	51.1	
1943	44.3	45.5	47.4	49.9	51.7	53.9	52.7	50.2	
1944	45.9	46.8	48.9	51.2	53.8	55.9	55.2	50.3	
1945	46.1	46.1	48.2	50.2	52.2	53.7	52.7	49.6	
1946	45.2	45.6	48.6	51.5	53.0	54.1	53.2	49.6	
1947	44.2	45.7	47.9	49.6	52.0	54.9	52.1	40.6	

TABLE VI - Sea Water temperatures at Williams Head - up to June 30/40
Part 2 and at Race Hooks from May 1/41.

Part 2	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	
1926	47.6	48.6	50.2	51.3	52.1	51.6	51.0	49.7	
1927	46.1	46.5	48.0	49.7	51.0	51.9	50.7	49.5	
1928	46.2	47.5	49.6	50.5	51.5	51.8	50.7	48.6	
1929	44.9	46.1	48.3	49.7	51.5	51.5	51.4	49.8	
1930	44.9	46.9	48.8	48.4	51.2	51.6	51.2	49.1	
1931	46.8	48.0	48.2	51.1	52.8	52.1	51.3	49.4	
1932	45.2	45.9	48.8	50.8	51.5	51.7	51.3	49.4	
1933	44.6	46.6	48.5	50.5	51.0	52.7	50.2	49.4	
1934	47.1	48.6	50.1	51.6	51.7	53.0	51.3	49.5	
1935	45.5	46.3	48.6	50.4	51.0	51.0	51.4	49.5	
1936	44.7	46.2	48.2	50.8	52.3	52.4	50.9	50.2	
1937	45.9	47.7	49.9	51.7	53.2	52.7	51.6	49.9	
1938	46.7	49.0	51.1	54.2	54.9	53.4	52.0	49.9	
1939	44.6	47.6	50.6	52.6	54.0	55.0	52.6	49.5	
1940	48.3	50.2	52.7	53.0	--	--	--	--	
1941	--	--	50.1	51.0	52.3	51.9	51.2	49.9	
1942	46.1	47.5	49.4	49.7	51.1	51.2	50.6	49.1	
1943	44.9	46.6	48.0	50.4	50.6	51.2	51.0	49.3	
1944	45.2	46.5	48.7	51.1	52.0	51.6	51.0	49.4	
1945	45.7	46.4	48.0	49.7	50.3	51.0	50.2	49.1	
1946	45.8	46.7	49.0	50.5	51.4	51.4	50.6	49.1	
1947	45.9	47.3	49.1	50.9	51.2	51.8	51.0	49.8	

TABLE VI - Sea Water Temperatures at Kains Is., Gustine Id.
Part 3

	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
1935	45.6	47.4	49.6	52.9	54.1	54.2	54.6	51.7
1936	44.6	46.7	50.5	55.3	59.7	56.9	54.0	52.9
1937	45.6	47.3	50.6	52.9	54.5	55.9	55.3	52.4
1938	46.9	46.9	50.9	57.5	53.7	54.1	56.9	53.5
1939	45.6	45.7	50.3	51.0	55.0	56.4	55.8	51.5
1940	46.4	50.6	50.2	55.1	55.3	57.5	57.8	54.5
1941	50.1	51.7	50.6	55.8	57.3	57.5	57.0	53.7
1942	47.2	46.9	51.5	54.0	56.5	56.7	54.6	53.4
1943	45.7	48.0	50.0	52.8	54.6	56.0	55.4	52.6
1944	46.8	46.1	50.4	53.0	54.9	55.6	55.5	54.6
1945	46.8	47.4	49.4	51.4	53.2	54.1	52.4	51.2
1946	46.5	46.3	50.4	53.6	55.7	55.4	54.7	50.9
1947	46.1	47.9	50.6	54.0	56.6	55.2	55.1	52.2

TABLE VII - Salinities - Williams Head and Race Rocks.

Part 1

	Apr.	May	June	July	Aug.	Sept.	
1937	31.35	31.26	31.11	30.93	31.12	31.16	
1938	31.21	31.12	31.19	30.88	31.26	31.23	
1939	31.53	31.20	31.05	31.03	30.77	31.34	
1940	30.91	30.68	30.65	--	--	--	
1941	--	31.48	31.50	31.24	31.46	31.63	
1942	31.56	31.55	31.62	31.25	31.12	31.31	
1943	31.29	31.53	31.51	31.34	31.12	31.20	
1944	31.91	31.80	32.11	31.88	31.66	31.77	
1945	31.52	31.77	31.66	31.59	31.65	31.67	
1946	31.43	31.39	31.05	30.76	30.94	31.43	
1947	31.71	31.64	31.27	31.43	31.08	31.47	

TABLE VII - Salinities - Cape St. James.

Part 2

	Apr.	May	June	July	Aug.	Sept.	
1935	31.77	31.87	31.88	31.96	31.60	31.65	
1936	32.50	32.39	32.37	32.20	32.14	32.17	
1937	32.70	32.48	32.48	32.41	32.30	32.16	
1938	32.24	32.39	32.35	32.19	32.11	32.32	
1939	32.24	32.25	32.09	31.71	31.92	32.13	
1940	32.19	32.09	32.15	31.90	32.20	32.20	
1941	32.19	32.20	32.26	32.15	32.07	32.22	
1942	32.24	32.08	31.93	31.91	31.61	32.11	
1943	32.50	32.40	32.36	32.37	32.43	32.36	
1944	32.44	32.40	32.37	32.30	32.30	32.27	
1945	32.27	32.29	32.33	32.37	32.16	32.35	
1946	32.10	32.03	31.92	31.63	31.95	31.94	
1947	32.76	32.15	32.18	32.12	31.99	32.06	

TABLE VIII - Surface Temperatures at Blunt's Reef Lightship off Cape Mendocino, California.

	Dec.	Jan.	Feb.	Mar.	Apr.	May
1926	12.01	12.01	12.05	11.32	12.01	11.94
1927	10.52	11.06	10.89	9.96	9.30	9.27
1928	10.64	11.09	10.75	11.17	11.00	9.99
1929	11.48	10.50	9.71	9.07	9.14	9.17
1930	11.81	11.16	11.17	11.04	11.94	9.80
1931	11.63	12.12	12.05	10.71	10.01	10.86
1932	11.83	10.45	10.29	10.50	10.80	10.75
1933	11.22	10.43	9.98	10.16	9.00	9.96
1934	12.20	10.74	10.56	10.70	11.19	12.42
1935	11.44	12.02	11.55	11.18	10.85	10.70
1936	10.75	10.63	10.79	9.81	9.70	11.13
1937	11.35	10.32	10.55	11.07	10.52	10.48
1938	12.87	12.20	12.10	11.80	10.60	9.20
1939	11.03	10.42	9.23	9.40	9.38	10.61
1940	12.91	12.62	12.73	11.20	10.93	10.85
1941	12.69	13.10	13.42	13.10	11.39	12.43

TABLE IX - Surface Temperatures at Shore of North Farallon Is. 117

	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
1926	12.95	12.48	12.44	13.15	13.12	13.63	12.16
1927	13.24	12.42	11.71	11.77	10.57	10.20	10.24
1928	13.51	12.21	12.05	12.16	12.72	10.82	10.45
1929	12.96	11.54	10.74	10.42	9.73	9.76	10.06
1930	11.82	12.59	11.33	11.26	12.11	12.74	10.41
1931	12.02	11.72	12.35	12.66	12.04	10.76	11.94
1932	11.40	11.17	10.83	10.12	10.90	10.48	11.51
1933	11.26	10.94	9.63	9.22	10.12	10.41	10.89
1934	11.76	10.25	11.09	11.48	12.63	11.54	11.71
1935	12.42	11.47	11.31	11.73	10.63	11.43	11.90
1936	11.72	12.02	11.54	11.42	10.97	11.06	11.00
1937	13.09	12.29	10.25	10.42	11.61	11.04	11.07
1938	12.24	12.26	11.99	12.24	12.31	11.82	11.34
1939	11.07	12.19	11.86	10.20	10.64	10.94	11.85
1940	12.96	13.71	13.01	12.22	13.15	12.56	11.61
1941	13.22	13.35	13.77	--	12.96	12.63	12.73
1942	14.07	13.82	12.51	12.75	11.19	11.55	10.66
1943	12.54	12.69					

TABLE X - Skippers
Part 1

Pilot House Landings to Oct. 15

Skipper	1942		1943		1944		1945		1946	
	Fishing Days	Tonnage								
1. O. Anderson	71	2604	64	3420	73	2015	63	675	--	--
2. M. Brevik	74	2554	59	3501	57	2038	51	326	--	--
3. C.H. Clark	65	2906	69	3758	44	3466	40	1026	14	70
4. J.E. Clark	--	--	71	3982	70	2712	52	2494	--	--
5. John Dale	74	3549	60	4691	55	3326	37	935	35	523
6. K. Fice	--	--	58	3260	61	1911	52	1131	31	318
7. Nels Fice	76	2748	67	3995	64	2476	41	837	22	120
8. Jas. Goodlad	68	3251	62	3902	--	--	--	--	--	--
9. John Goodlad	66	2104	75	3681	70	2055	51	1673	--	--
10. N. Gunderson	--	--	64	3630	60	2517	28	166	11	160
11. T. Hovden	--	--	--	--	41	1823	37	450	20	150
12. R.O. Iverson	75	2330	66	3315	64	2480	44	450	30	445
13. Geo. Knudson	--	--	68	3067	71	1970	60	1783	--	--
14. H. Larsen	--	--	66	3175	51	2190	50	1448	35	355
15. M. Magnussen	--	--	64	2753	68	1862	70	1200	26	0
16. J. Sande	--	--	71	3287	64	1705	45	1431	23	79
17. M. Skoe	--	--	42	3185	37	2257	--	--	--	--
18. A. Veljacic	--	--	--	--	51	2642	34	591	--	--
		(8)		(15)		(16)		(10)		
				522						
		22046		30263		899		745		
	569		52700		34982					
		964			37190		16616		247	
					954		9074		2220	
							444			
				1.4963						
		38,7452		57,9751		.7118				
				54,6580		38,9121		28,5721		.4398
						38,9832		28,3033		
								20,4369		8.9879
	1.00		1.4963		1.0651		.6093		.2680	

TABLE X - Skippers
Part 2

Pilot House Landings to Oct. 15

	1942	1943	1944	1945	1946
Catch per fishing day	38.7	58.0	38.9	22.3	9.0
	1.4987	.7112	.5718	.4412	
		54.7	39.0	20.4	
	1.000	1.4987	1.0659	.6095	.2689

TABLE XI - Tons and Fishing Days

Part 1

Period	1941		1942		1943		1944		1945		1946		All Years	
	Tons	Days	Tons	Days	Tons	Days	Tons	Days	Tons	Days	Tons	Days	Totals	Days
1														
2														
3														
4	134	5	48	2	1090	20	225	31	--	--	--	--	1487	58
5	418	8 $\frac{1}{2}$	2042	72	5264	101 $\frac{1}{2}$	838	96	--	27	--	--	8562	305
6	395	5 $\frac{1}{2}$	2807	83 $\frac{1}{2}$	10153	147 $\frac{1}{2}$	272	89	32	64	1184	45	14943	434 $\frac{1}{2}$
7	590	9 $\frac{1}{2}$	2535	68 $\frac{1}{2}$	9282	123	238	43	1788	114	12	70	14465	427
8	715	10	2717	73	6636	131	3385	77	3401	142	553	76 $\frac{1}{2}$	19807	509 $\frac{1}{2}$
9	1060	7 $\frac{1}{2}$	2274	67 $\frac{1}{2}$	6620	132 $\frac{1}{2}$	15049	146	2309	189	35	39	25347	641 $\frac{1}{2}$
10	105	6	4138	82	8087	154 $\frac{1}{2}$	2534	141	2766	178	1359	45	25999	606 $\frac{1}{2}$
11	400	5	3483	97	6612	124	3556	160	290	72	35	7	17366	465
12	75	8	2870	101	341	46	4617	142	95	3	0	7	7998	307
13	0	1	2129	73	958	19	1284	34	5150	60	0	9	9521	196
14	--	--	720	21 $\frac{1}{2}$	2779	45	255	13	3780	86	--	--	7534	165 $\frac{1}{2}$
15	--	--	193	14	4396	66	1186	49	676	76	--	--	6451	205
16	--	--	503	15	1633	61	774	26	2754	63	--	--	5654	165
17	--	--	1396	26	1462	71	1020	23	580	44	--	--	4458	164
18	--	--	60	17	622	42	368	12	130	40	--	--	1180	111
19	--	--	596	13	237	8	235	5	0	13	--	--	1068	39
20	--	--	125	11	0	4	135	10	275	9	--	--	535	34
21	--	--	--	--	--	--	--	--	0	1	--	--	0	1
22	--	--	--	--	--	--	--	--	--	--	--	--	--	--
23	--	--	119	4	--	--	--	--	--	--	--	--	119	4
24	--	--	12	5	--	--	--	--	--	--	--	--	12	5
25	--	--	115	8	--	--	--	--	--	--	--	--	115	8
26	--	--	117	3	--	--	--	--	--	--	--	--	117	3

Totals

(All Periods)

3892	65	29019	857	66162	1296	45971	1097	24416	1181	3178	299 $\frac{1}{2}$	172638	4794 $\frac{1}{2}$
4 - 14 incl.													
3892	65	25783	741	57812	1044	42253	972	20001	935	3178	299 $\frac{1}{2}$	152919	4055 $\frac{1}{2}$

TABLE XI - Tons and Fishing Days
 Part 1

1941 1942 1943 1944 1945 1946 All Years
 Tons Days Tons Days Tons Days Tons Days Tons Days Tons Days Totals Days

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26

Totals (All Periods)

3892 65 29019 857 66162 1296 45971 1097 24416 1181 3178 299 172638 4794

4 - 14 incl.

3892 65 25783 741 57812 1044 42253 972 20001 935 3178 299 152919 4055

TABLE XI - Pilot House Logs.

Part B Tons per day (only 1 seine per boat).

Period	1941	1942	1943	1944	1945	1946	All Years
1							
2							
3							
4	26.8	24.0	54.0	7.2	--	--	25.6
5	49.2	28.4	51.9	87.3	--	--	29.3
6	71.8	33.6	68.8	3.1	0.5	16.3	34.8
7	69.4	37.3	75.3	5.6	15.7	0.8	35.9
8	71.5	37.2	50.7	69.9	26.8	7.2	38.9
9	141.3	33.7	50.0	89.4	12.2	0.9	48.6
10	17.5	30.5	52.3	67.6	15.3	10.2	47.8
11	80.0	35.9	53.3	41.0	36.9	5.0	37.3
12	9.4	28.4	7.4	32.5	31.7	--	26.1
13	--	29.2	50.4	37.6	65.8	--	48.6
14	--	33.5	61.8	19.6	44.0	--	45.5
15	--	13.8	66.6	24.4	88.9	--	31.5
16	--	33.5	26.8	29.8	43.9	--	34.3
17	--	53.7	20.6	44.3	13.2	--	27.2
18	--	3.5	14.8	30.7	3.2	--	10.6
19	--	45.8	29.0	47.0	--	--	29.4
20	--	11.4	--	13.5	30.6	--	15.7
21	--	--	--	--	0	--	--
22	--	--	--	--	--	--	--
23	--	29.8	--	--	--	--	--
24	--	2.4	--	--	--	--	--
25	--	14.4	--	--	--	--	--
26	--	39.0	--	--	--	--	--
Average -							
(whole periods)	59.9	33.9	51.1	41.9	20.7	10.6	36.0
4 - 14 incl.	59.9	34.6	55.4	43.5	21.4	10.6	37.7

TABLE XII - Tons and number of Sets.

Period	1941		1942		1943		1944		1945		1946		All Years	
	Tons	Sets	Tons	Sets	Tons	Sets	Tons	Sets	Tons	Sets	Tons	Sets	Tons	Sets
1														
2														
3														
4	134	7	48	1	890	22	200	8	--	-	--	-	1272	38
5	418	12	1564	60	5245	112	824	52	--	-	--	-	8051	256
6	395	12	1668	63	9717	217	265	16	32	2	1164	25	13261	335
7	590	11	1727	81	8658	186	104	12	1728	37	12	3	12819	350
8	715	14	1772	71	6141	154	4564	83	3683	91	553	18	17428	431
9	1060	15	1269	41	6073	125	11800	202	2309	94	35	1	22346	538
10	105	10	2598	79	7385	224	8865	169	2656	83	1359	34	22945	599
11	400	9	1885	62	6167	166	6080	150	258	17	35	1	14825	405
12	75	8	2021	54	241	18	4139	143	95	2	--	-	6571	225
13	--	-	1644	42	498	13	1129	31	4993	68	--	-	8264	154
14	--	-	695	8	2359	31	255	5	3760	70	--	-	7089	114
15	--	-	163	4	3737	52	1186	17	676	19	--	-	5762	92
16	--	-	503	9	1645	26	774	15	2754	29	--	-	5576	79
17	--	-	1281	13	1402	37	820	14	580	6	--	-	4083	70
18	--	-	60	3	422	19	368	6	130	3	--	-	980	31
19	--	-	596	12	187	5	235	3	--	-	--	-	1018	20
20	--	-	125	11	0	7	135	4	275	4	--	-	535	26
21	--	-	--	-	--	-	--	-	--	-	--	-	--	-
22	--	-	--	-	--	-	--	-	--	-	--	-	--	-
23	--	-	119	4	--	-	--	-	--	-	--	-	119	4
24	--	-	12	1	--	-	--	-	--	-	--	-	12	1
25	--	-	75	5	--	-	--	-	--	-	--	-	75	5
26	--	-	117	3	--	-	--	-	--	-	--	-	117	3
Totals -														
(All Periods)	3692	98	19942	627	60667	1474	41743	930	23929	525	3178	82	153351	3736
4 - 14 incl.	3692	98	16691	562	53374	1528	38225	871	19514	464	3178	82	135074	3405

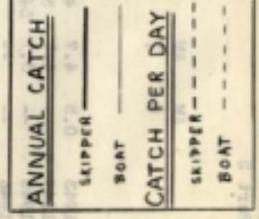
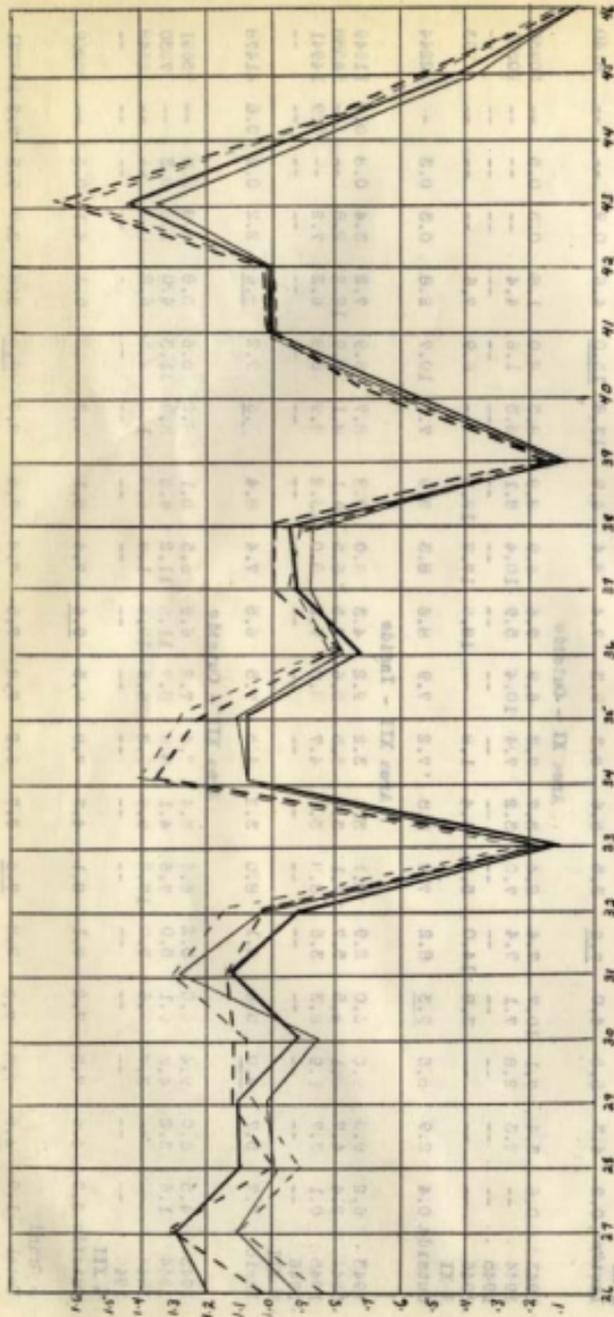
TABLE XII - Tons Per Set.
Part 2

Period	1941	1942	1943	1944	1945	1946	All Years
1							
2							
3							
4	19.1	<u>48.1</u>	40.4	25.0	--	--	33.5
5	34.8	26.1	<u>46.8</u>	15.8	--	--	34.1
6	32.9	26.5	44.8	16.6	16.0	47.4	39.6
7	53.6	21.3	46.5	8.7	46.7	4.0	38.8
8	51.1	25.0	39.9	55.0	40.5	30.7	40.4
9	70.7	31.0	32.8	<u>58.4</u>	34.6	35.0	41.9
10	10.5	32.9	33.0	52.4	31.8	40.0	39.3
11	44.4	30.4	37.2	40.5	15.2	35.0	36.6
12	9.4	37.4	13.4	28.9	47.5	--	29.2
13	--	39.1	38.3	36.4	73.4	--	53.7
14	--	<u>86.9</u>	<u>76.1</u>	51.0	<u>54.0</u>	--	62.2
15		40.8	71.9	69.8	35.6		62.6
16		55.9	59.4	51.6	95.0		70.6
17		98.5	37.9	58.6	96.7		56.3
18		20.0	22.2	61.3	43.3		31.6
19		49.7	37.4	78.3	--		50.9
20		11.4	0	33.8	68.8		20.6
21		--	--	--	--		--
22		--	--	--	--		--
23		29.8	--	--	--		29.8
24		12.0	--	--	--		12.0
25		15.0	--	--	--		15.0
26		39.0	--	--	--		39.0
Average -							
(All periods)	39.7	31.8	41.2	44.9	45.6	38.8	41.0
4 - 14 incl.	39.7	30.1	40.2	43.9	42.1	38.8	39.7

Year XII - Orefield
Year XI - Orefield
Year X - Orefield
Year IX - Orefield
Year VIII - Orefield
Year VII - Orefield
Year VI - Orefield
Year V - Orefield
Year IV - Orefield
Year III - Orefield
Year II - Orefield
Year I - Orefield

TABLE XIII - Total Tonnage Caught at Hour of Day Per Year, July 1 - Oct. 18, Periods 4 - 14 incl.
Part 1

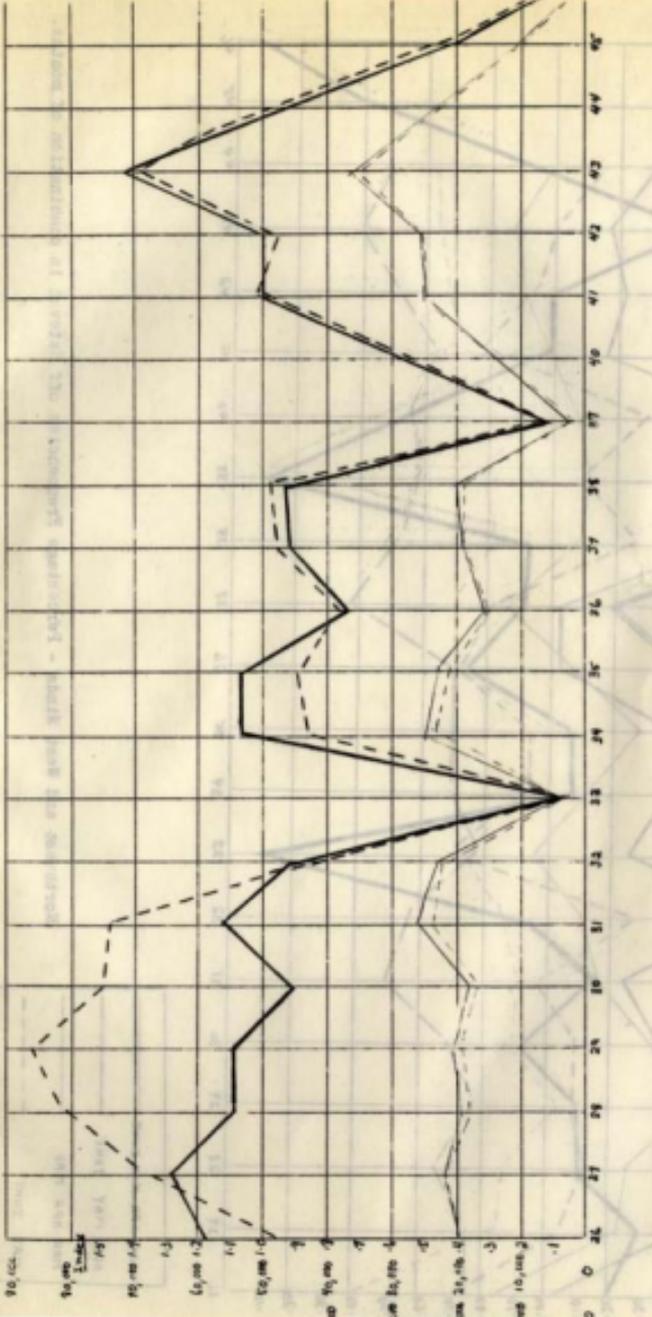
	Time of Day																Total		
	AM 6	AM 7	AM 8	AM 9	AM 10	AM 11	12	PM 13	PM 14	PM 15	PM 16	PM 17	PM 18	PM 19	PM 20	PM 21		PM 22	PM 23
Area XI - Inside																			
1943	15	150	150	153	227	150	120	110	350	270	310	195	544	271	151	--	--	--	3166
1944	--	192	150	171	318	125	339	325	403	333	364	200	581	927	200	75	--	--	4703
1945	--	10	147	--	40	8	--	--	8	--	13	--	--	25	20	--	--	--	271
1946	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total XI Inside	15	352	447	324	585	283	459	435	761	603	687	395	1125	1223	371	75	--	--	8140
Area XI - Outside																			
1943	136	705	1488	2233	1544	1764	766	1530	1442	2001	1446	1868	1749	1677	386	110	105	--	20950
1944	--	245	290	745	990	740	335	775	1095	621	1190	855	553	1707	460	--	--	--	10501
1945	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1946	--	--	--	30	111	45	35	14	0	148	140	155	--	55	60	--	--	--	793
Total XI Outside	136	950	1778	3008	2645	2549	1136	2319	2537	2770	2676	2878	2302	3439	906	110	105	--	32244
Area XII - Inside																			
1943	735	1158	1070	719	349	952	405	378	1094	510	950	332	1039	823	858	403	90	95	11949
1944	356	696	1182	662	829	1030	460	802	824	1096	945	1177	1135	1155	1785	414	--	--	14588
1945	10	555	1477	940	536	1318	457	707	1188	1077	1194	1974	1327	1009	924	108	--	140	14941
1946	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total XII Inside	1101	2379	3729	2321	1714	3310	1322	1887	3106	2683	3089	3433	3531	2986	3567	926	90	235	41478
Area XII - Outside																			
1943	709	941	1476	935	823	1043	535	1158	1122	1087	1018	799	1293	685	913	909	45	--	15691
1944	120	239	323	689	376	573	306	606	652	871	840	350	293	854	299	120	20	--	7530
1945	--	--	98	227	132	172	262	247	174	519	48	179	40	65	165	20	--	--	2548
1946	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total XII Outside	829	1180	1897	1850	1331	1693	1103	2011	1948	2477	1906	1328	1626	1804	1377	1049	65	--	26869
Grand Total -	2081	4861	7851	7503	6275	5230	4020	6652	8352	8533	8358	8084	9604	9452	6221	2159	260	235	107731



Fishing Indices as Determined by Link Relative Calculations. Base Year 1942 in all cases.

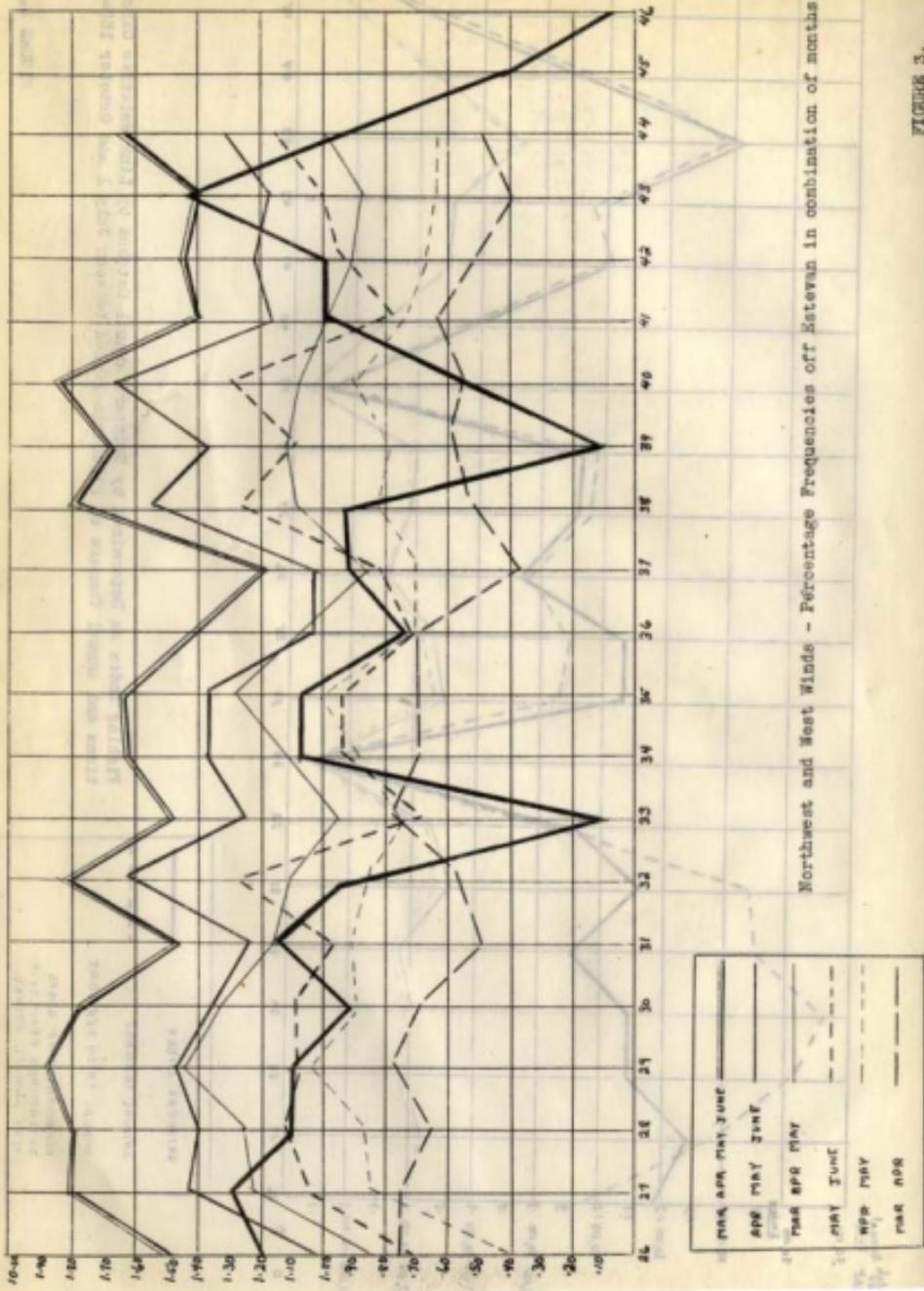
FIGURE 1.

Date 1948
 Annual Tonnage
 \$0.00



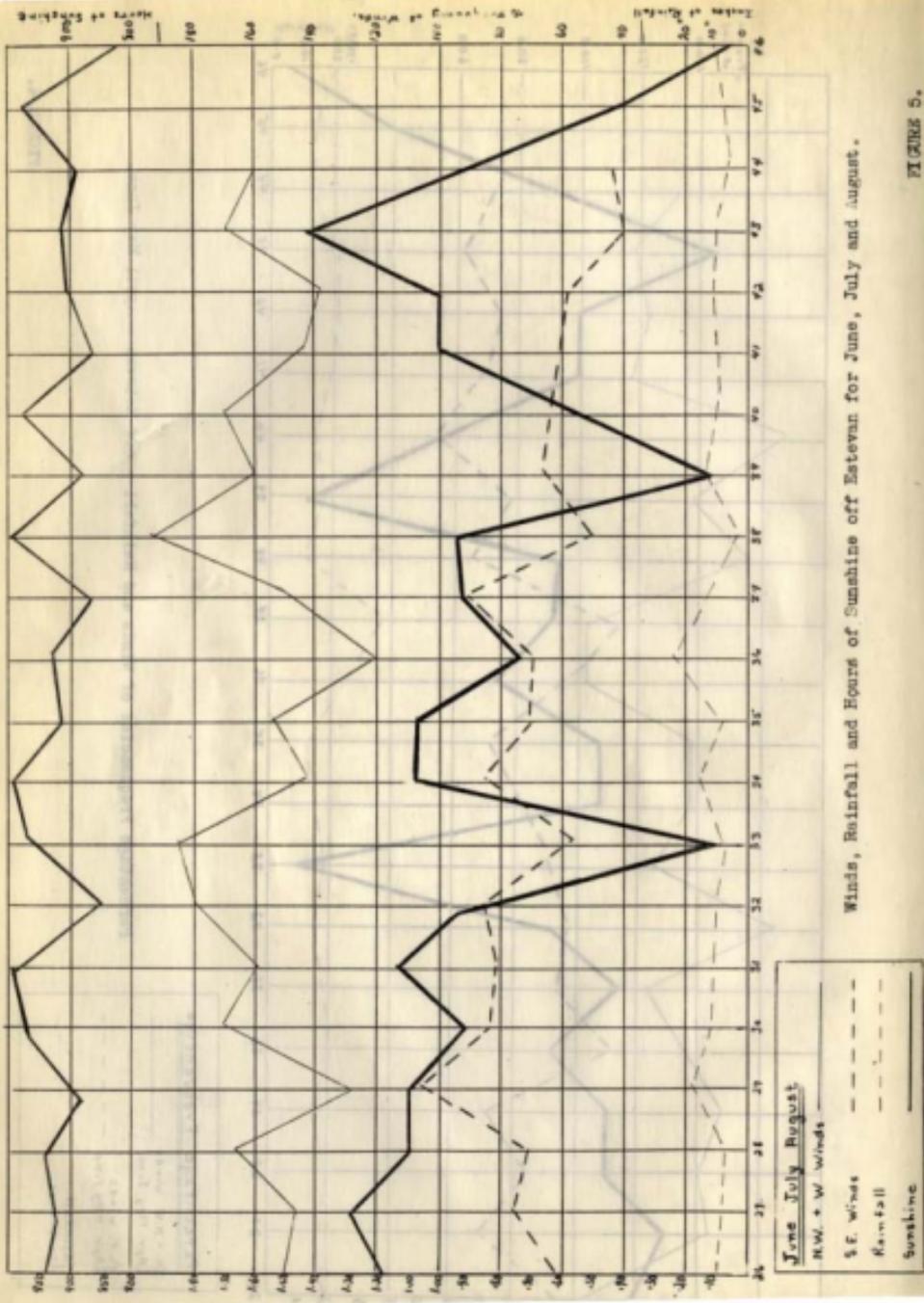
— SKIPPER'S INDEX
 - - - ANNUAL TONNAGE
 . . . ANNUAL CATCH PER BOAT
 REPRESENTATIVE BOATS
 DETERMINED FROM SKIP
 PER'S ANNUAL RECORDS.

Fishing Index as Determined by Skippers Annual Catches by Link Relative Calcula
 tions and Annual Tonnage of Pilchard landed between July 1 and October 15/appr

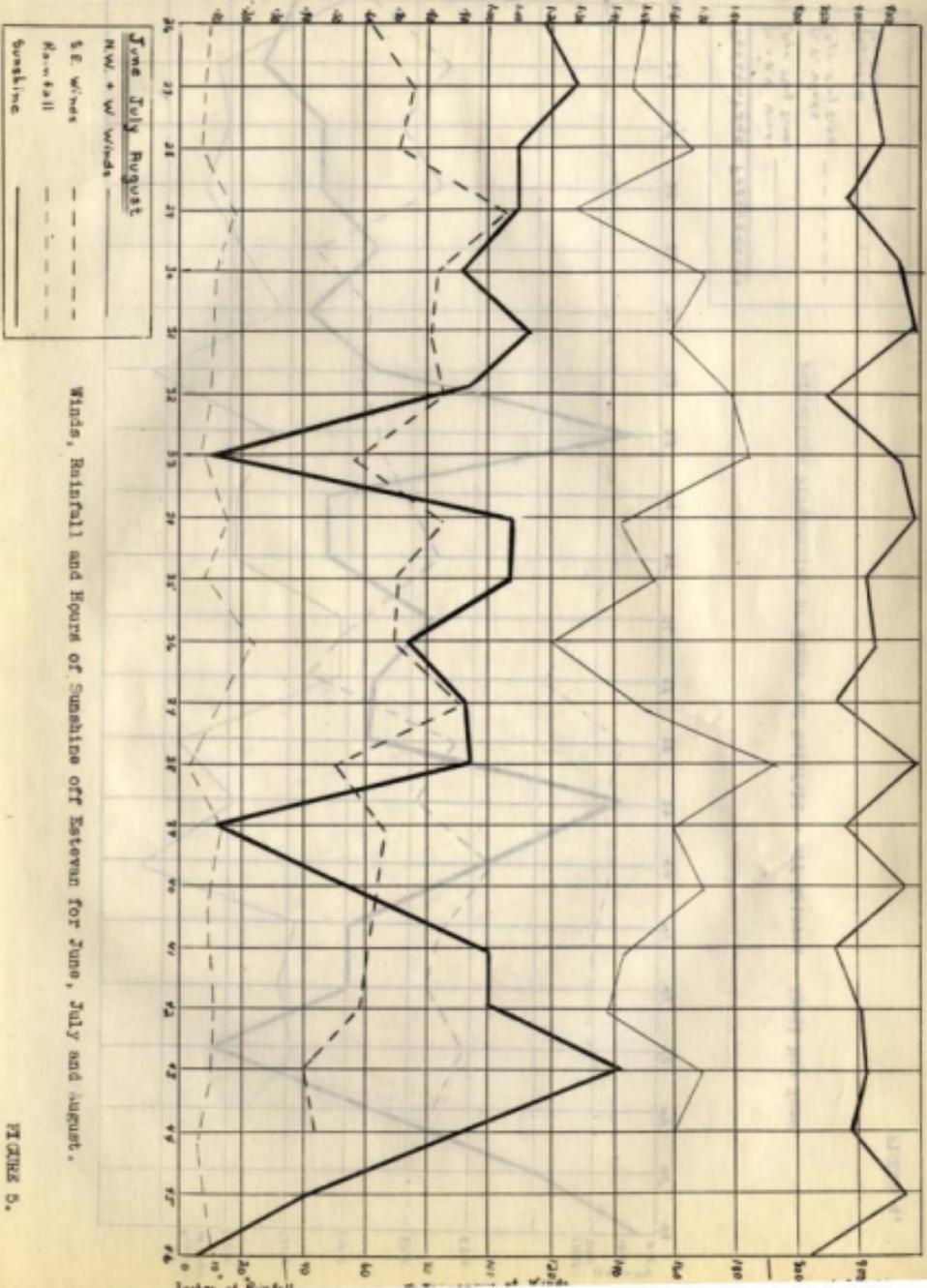


Northwest and West Winds - Percentage Frequencies off Kewan in combination of months.

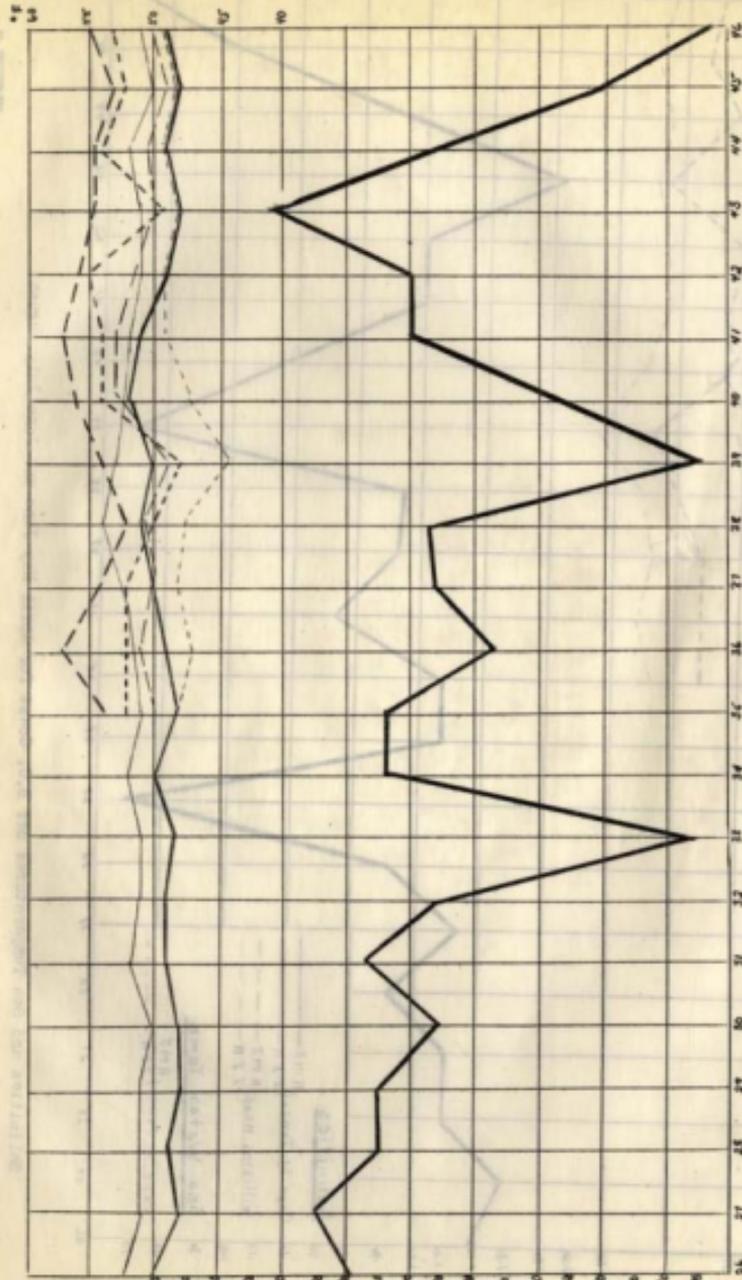
FIGURE 3.



Winds, Rainfall and Hours of Sunshine off Estevan for June, July and August.

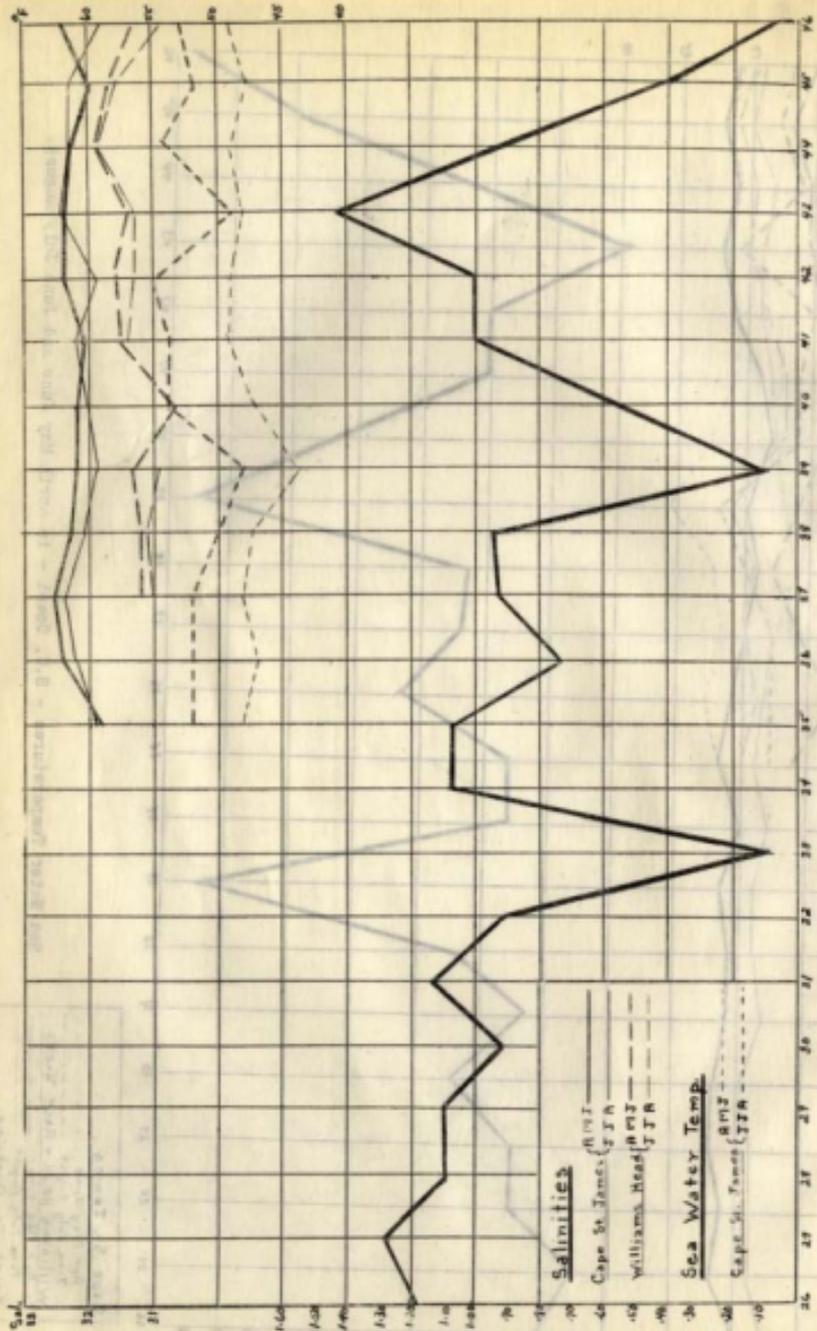


Winds, Rainfall and Hours of Sunshine off Stevan for June, July and August.

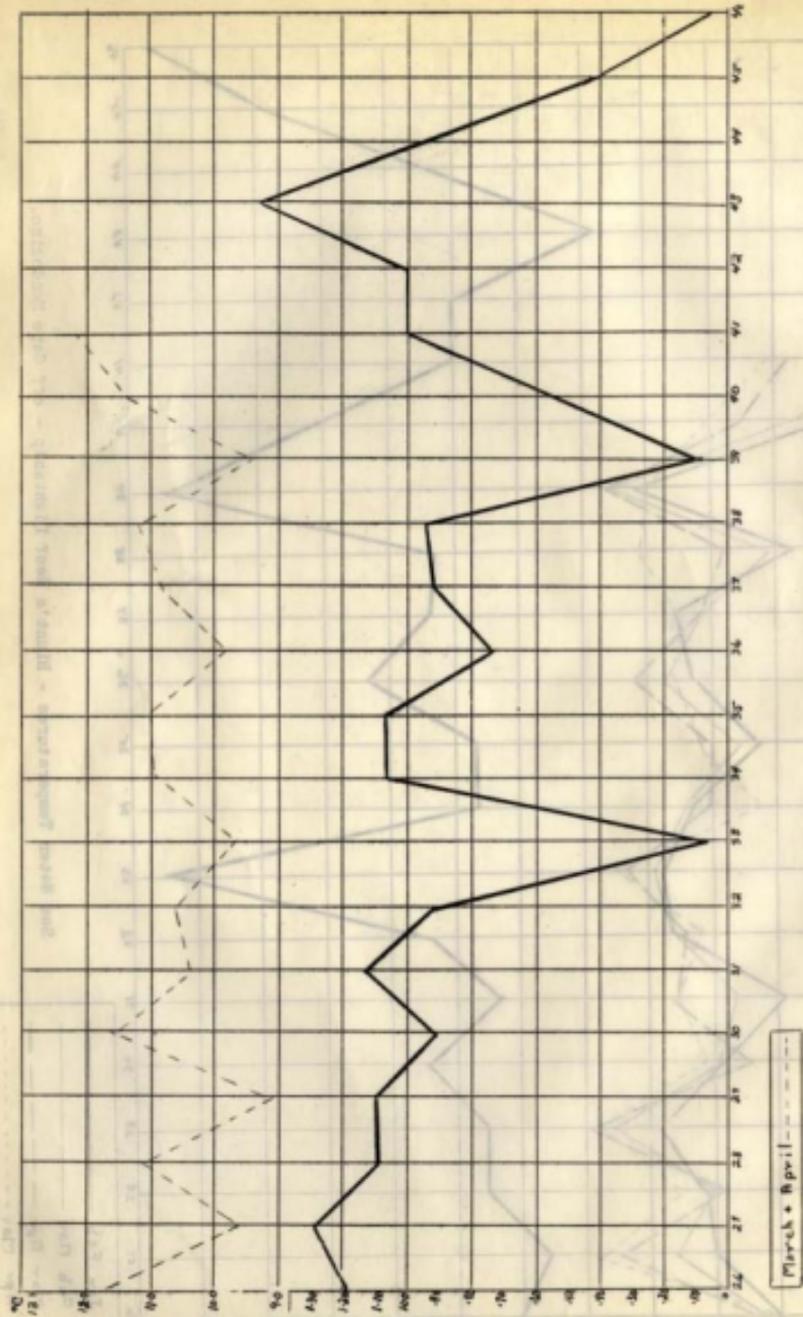


Sea Water Temperatures - B.C. Coast - in April May June and June July August.

Capt. St. James
 Apr. May Temp -----
 June Temp -----
Williams Head + Race Rocks
 Apr. May Temp -----
 June Temp -----
Kains Is. Quashino
 Apr. May Temp -----
 June Temp -----



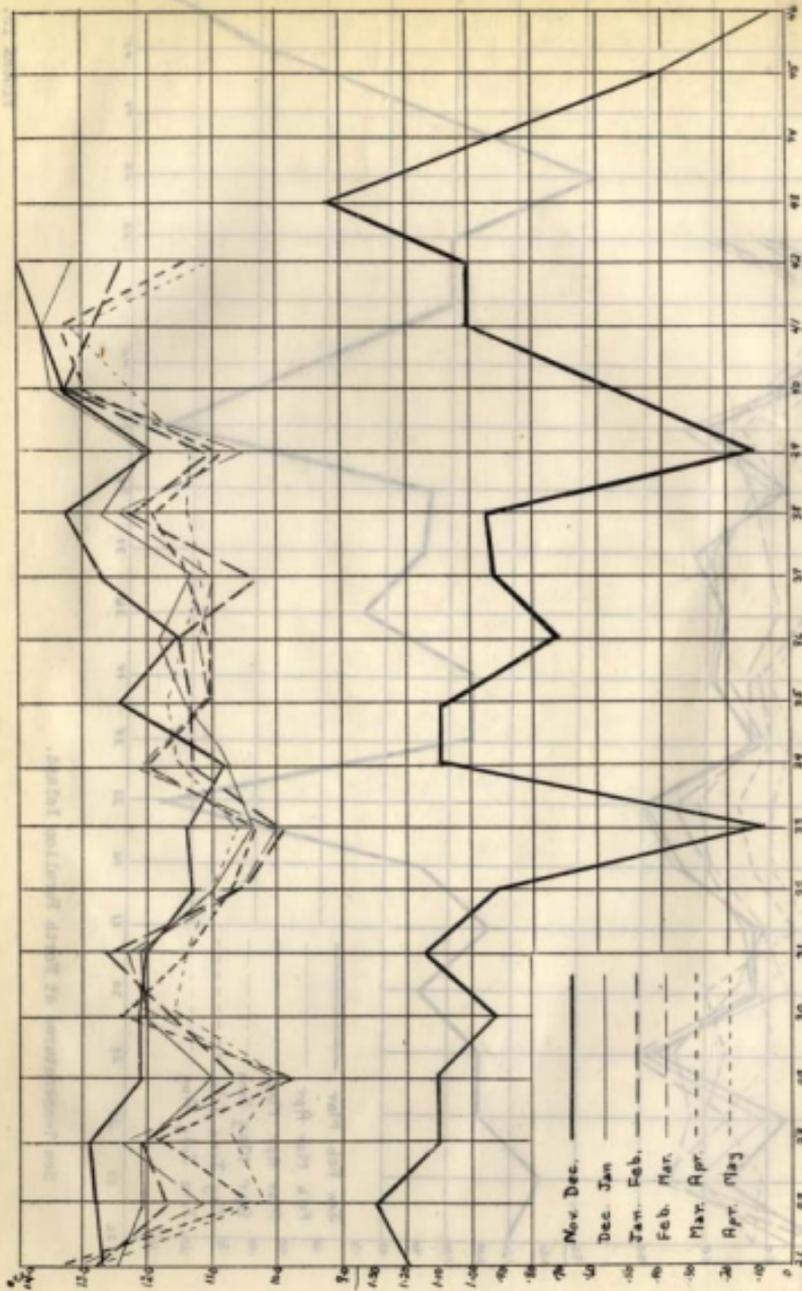
Salinities and Sea Temperatures off B.C. Coast for April May June and June July August.



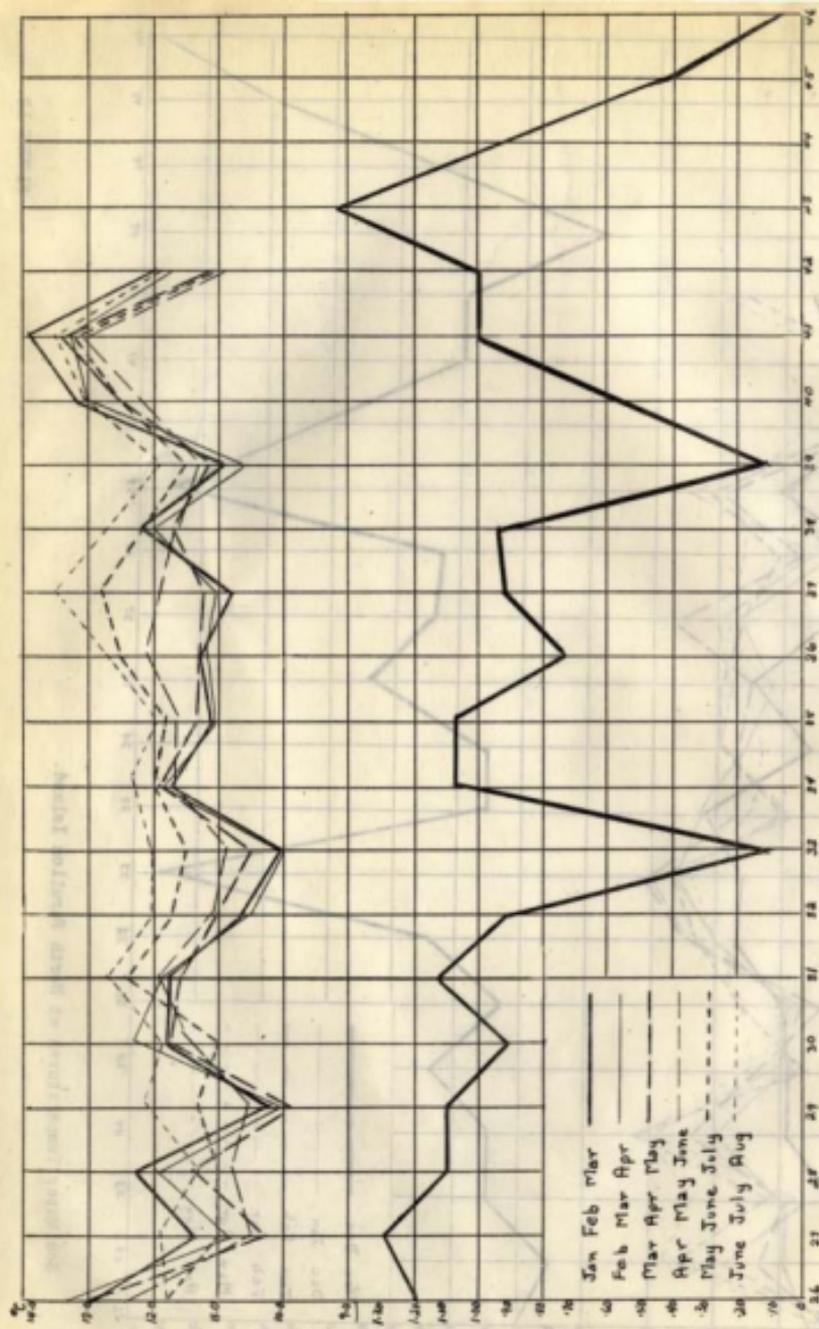
Average Sea Water Temperatures off Bunt's Reef Lightship - Cape Mendocino for March and April

FIGURE 11.

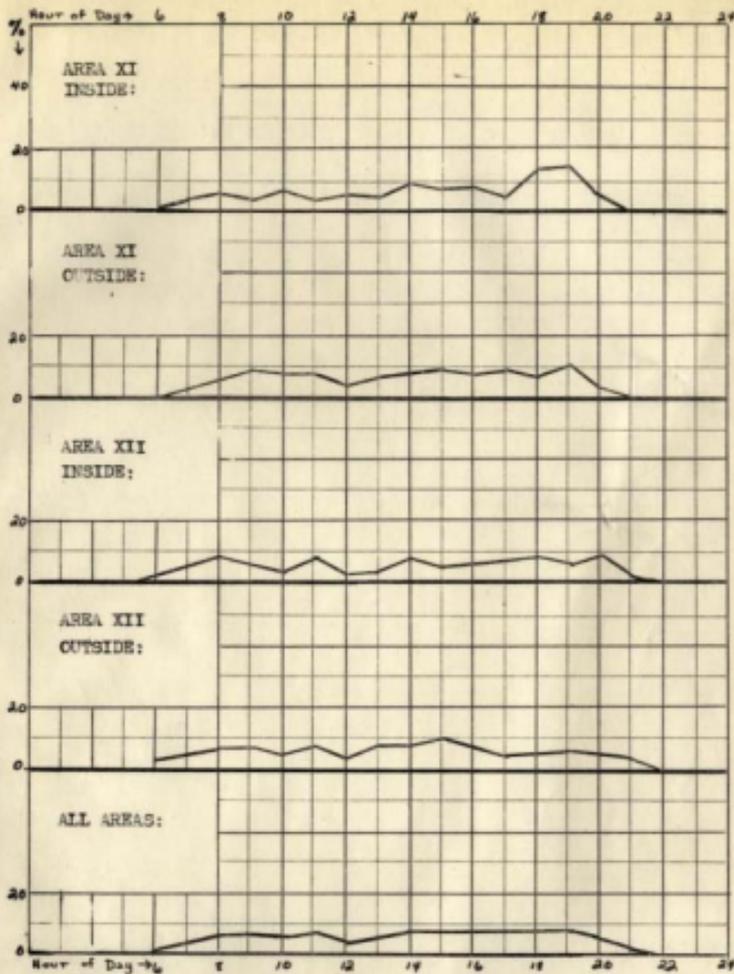
March + April - - - - -



Sea Water Temperatures at North Parallon Island.



Sea Temperatures at North Farallon Island.



Percentages of Tonnages Caught at Hours of Day Per Area. Data for four years combined.

FIGURE 14.