Informational Leaflet 147

A SURVEY OF THE POPULATION DYNAMICS OF KING CRAB IN ALASKA WITH PARTICULAR REFERENCE TO THE KODIAK AREA

By:

Brian J. Rothschild, Guy Powell, James Joseph, Norman J. Abramson, James A. Buss, and Peter Eldridge

October 15, 1970

STATE OF ALASKA
KEITH H. MILLER - GOVERNOR

DEPARTMENT OF FISH AND GAME

SUBPORT BUILDING, JUNEAU 99801

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PREFACE

The intent of this work is to survey various data sources pertinent to the dynamics of the king crab in Alaska with particular emphasis on the Kodiak region. The work described herein was supported by the King Crab Institute, the Sea Grant Program (NSF Grant GH-40) and the Alaska Department of Fish and Game. The great majority of the data used has been collected over the years by the Alaska Department of Fish and Game. Dr. William Smoker of the Bureau of Commercial Fisheries provided helpful comments on the manuscript and we extend our acknowledgments.

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I. INTRODUCTION

The king crab (Paralithodes camtschatica, Tilesius) resource of the North Pacific Ocean supports a valuable international fishery. This fishery is prosecuted in the Bering Sea (primarily by Japanese and Russian fishermen) and in the waters south of the Aleutian Islands and in the Gulf of Alaska (primarily by U.S. fishermen). These areas are indicated in Figure I.1. The temporal distribution of the catches is indicated in Table I.1 and depicted in Figure I.2. We can see from Figure I.2 that the U.S. catches were small during the late 1950's but in the early 1960's catches increased. These increased catches were evident in the Kodiak Island, Peninsula-Adak-Aleutians, and the Bering Sea areas. The Kodiak region contributed most heavily to U.S. catch until 1968. After 1968 the South Peninsula-Adak-Aleutians fishery contributed most heavily to the U.S. catch.

Declines in king crab harvests during the mid-1960's were evident throughout the eastern North Pacific Ocean; furthermore the declines have continued since that time. The total U.S. catch decreased from 159 million pounds in 1966 to 58 million pounds in 1969 (Table I.1).

These declines are of great concern to the community of fishermen, processors, and scientists involved in the harvest and study of the king crab. In order to participate in an explanation of these declines and provide a basis for future king crab research and management - particularly in the area that is presently of greatest concern to U.S. fishermen, i.e., the waters of the Aleutian Islands, the shelf waters south of the Alaska Peninsula, and the shallower waters of the Gulf of Alaska - we have initiated a systems study of the Alaska king crab fishery. The present report represents a partial accounting of that portion of work accomplished on catch, catch-per-unit-of-effort (CPUE), and effort during the first phase of the systems study. We view this report as presenting a survey of available data and an indication of what might be expected from more detailed analyses.

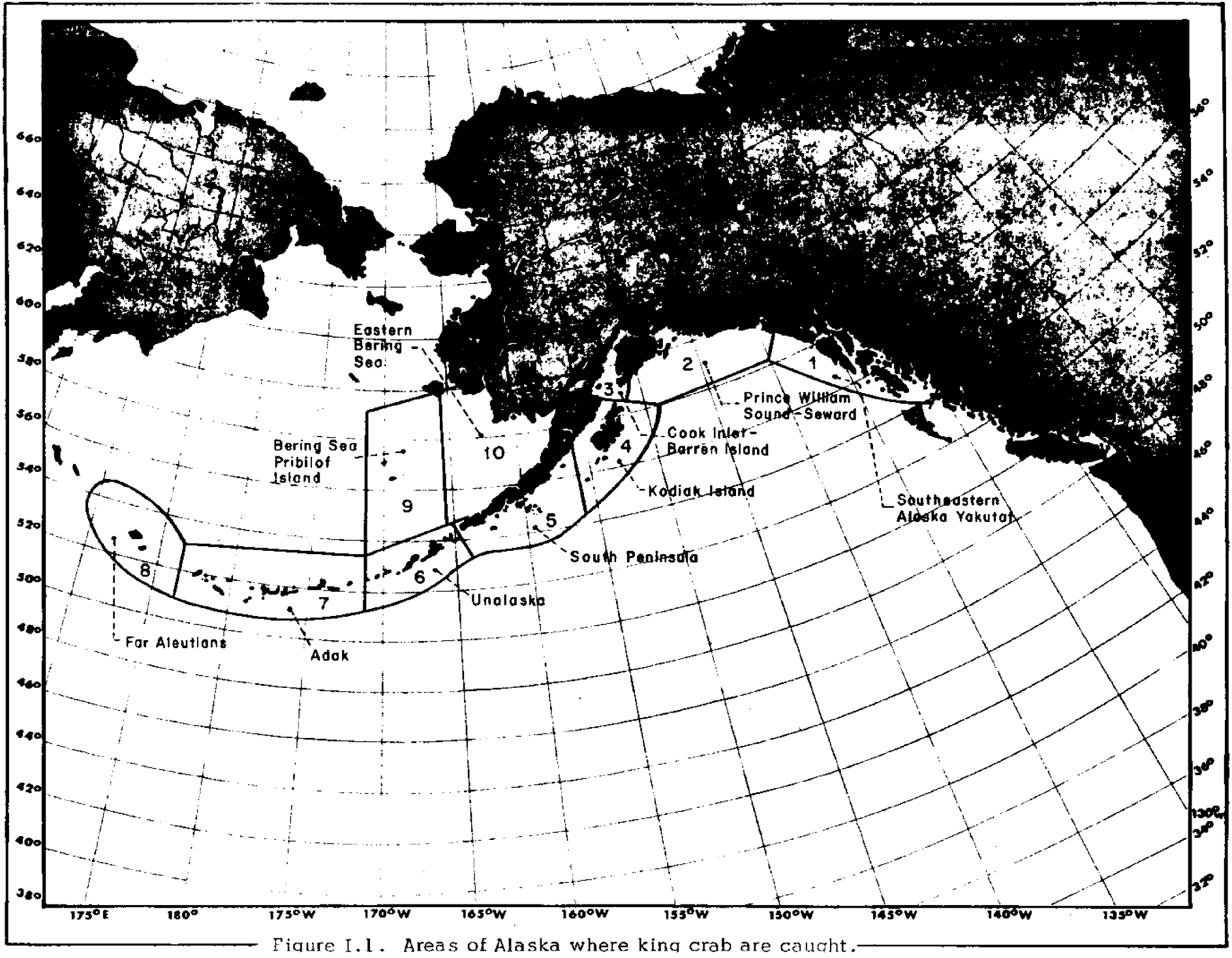

Figure I.1. Areas of Alaska where king crab are caught.

Table I.1. Annual commercial catch (in pounds round weight) of king crabs from Alaska for the years 1957-1969. Statistics obtained from various published and unpublished reports. Catches for 1969 are preliminary.

Year	Kodiak Island	So. Peninsula Unalaska - Adak	Total U. S. A. catch	Total Bering Sea[1/]
1957	5,000,000	6,687,092	13,076,565	8,193,434
1958	5,200,000	7,245,947	11,211,554	7,691,200
1959	10,200,000	6,166,974	18,839,470	11,268,380
1960	16,800,000	6,750,400	28,570,016	22,682,695
1961	28,900,000	6,220,126	43,411,600	38,955,284
1962	35,300,000	8,906,290	52,782,200	47,101,851
1963	42,300,000	23,124,916	78,740,300	52,228,998
1964	29,600,000	47,272,783	86,720,700	47,224,423
1965	76,600,000	48,982,780	131,670,700	34,364,443
1966	90,800,000	62,387,144	159,201,696	36,630,932
1967	62,900,000	58,304,064	127,715,890	31,095,728
1968	22,000,000	44,125,000	85,000,000	34,017,983
1969	12,000,000	19,170,000	58,000,000	25,000,000

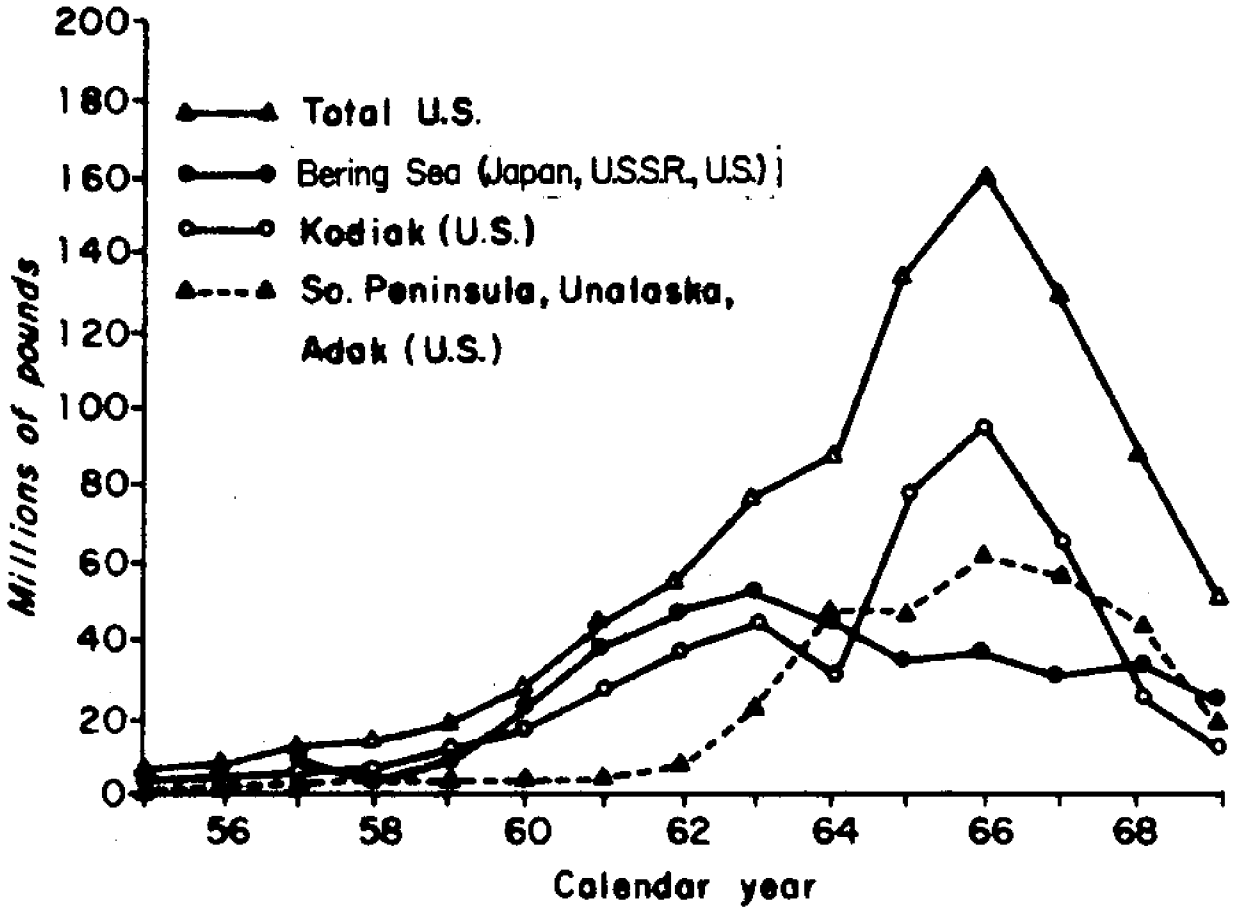

Figure I.2. Annual commercial catch of king crabs from Alaska.

In addition to the introduction, the report consists of two parts. The first is a consideration of production from the Kodiak region, and the second is a survey of the existing data from the non-Kodiak region.

II. PRODUCTION

Our consideration of the problem of production involves assembling data on catch, CPUE, and effort in order to ascertain the nature of fluctuations in abundance.

In discussing the CPUE (defined above) data, we will consider the Kodiak area and the non-Kodiak area separately. This is because much better statistics are available for the Kodiak area than for the non-Kodiak areas, and, for this reason, the Kodiak statistics can be examined in greater detail than those of the non-Kodiak areas.1/

II.A. Production from the Kodiak Region

The data used in this section are derived from (1) a logbook program (this program began in 1964 and is continuing), which has been conducted by the Alaska Department of Fish and Game (ADF&G), (2) a captain interview program conducted by ADF&G (begun in 1962), (3) a small-scale logbook program conducted by the Fisheries Research Institute (FRI) in 1957 and 1958, and (4) fish ticket data obtained on a regular basis by ADF&G. A detailed report of the king crab catch for the Kodiak region is being developed, Powell and Gray (in process).

II.A.1 Logbook program

The logbook program was started by ADF&G as an outgrowth of its "captain interview" program. The captain interview program began in June, 1962, and consisted of interviews conducted by ADF&G personnel with captains of king crab-boats. The interview program is briefly discussed in

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1/ Throughout this report, we designate certain areas or stocks for statistical convenience. We consider these as unit fisheries, and do not wish to imply, unless otherwise stated, that these areas contain homogeneous, genetically distinct, populations. The six Kodiak stocks are delineated in Figure II-12.

section II.A.2. Two years after initiation of the captain interview program, printed logbooks (Figure II.1) were issued to all fishermen willing to personally record their fishing activities. The new system provided considerably more data and simultaneously enabled acquisition of data on the number of crabs taken and pot configuration for individual pot lifts. Logbooks were designed to be compatible with ADP systems.

Captain interviews were continued in addition to the distribution of logbooks so that those vessel captains that were not interested in completing logbooks could be interviewed and catch data recorded. In this report only the captain interview data for fishing years 1963-64 will be used (Section II.A.2). The captain interview data for 1964-69 will be examined in subsequent reports.

We wished to derive from the logbook data CPUE indices that are proportional to population abundance. A difficulty with arriving at CPUE indices based on simply summing numbers of crabs in the catch and dividing this statistic by the number of pots is that the nominal unit of effort (the number of pots set) varies in effectiveness with the number of days that the pots are left in the water (soak time) and with the dimensions of the pot. Thus, if appropriate adjustments were not made, it would be possible to obtain, erroneously, an apparent trend in abundance with a fixed population size by pooling effort data without respect to pot size and soak time.

II.A1.a Distribution of Data and Coding

In order to express the distribution of logbook records of effort, we have compiled in Table II.1, the number of pot lifts recorded in the logbooks for each fishing year, pot size, and soak time. From Table II.1, we can see that (1) the recorded lifts increased until 1966-67 and subsequently decreased (the coverage was approximately 10 per cent for 1964-65, 12 per cent for 1965-66, 36 per cent for 1966-67, 24 per cent for 1967-68, and 20 per cent for 1968-69); (2) that the 7' x 7' pot size is most frequently used; and (3) the 4-10 day soak times are an important component of the recorded effort.

In Table II.2, we have outlined our coding formats. The format outline in Table II.2 indicates those quarters, populations, and areas for which logbook data exists. In Table II.2, it will be noted that we have combined certain environmental zones into areas. This was done to facilitate analysis. A more detailed study will be undertaken in which we will consider each of the zones separately.

CRAB LOG

MO. 2	DAY 4	YEAR 6

VESSEL A. D. F. & G. NO. 11

FILE NO. 17	POT NO. 20	NO. OF CRABS 23	DAYS SOAK 25	DEPTH 28	AREA 31	NO. TAGS 33	POT TYPE 35	COMMENTS REGARDING FEMALES SMALL MALES, SOFT CRABS, HALIBUT, OTHER CRABS & GEAR
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								

Figure II.1. Standard log book page for recording king crab catch.

Table II.1. Number of pot lifts recorded in Kodiak logbooks by pot size and soak time for each fishing year.

Year	Pot size	1 day	2 day	3 day	4-10 days	Total lifts (all strata)	Recorded catch (numbers)
1964-65	6' x 6'	291	292	103	534		
	7' x 7'	1,784	894	401	1,383	7,029	
	8' x 8'	263	372	241	469		464,652
1965	6' x 6'	827	982	375	1,142		
	7' x 7'	3,965	2,807	1,757	5,373	19,940	
	8' x 8'	438	584	654	1,036		1,312,103
1966-67	6' x 6'	3,323	4,371	2,268	3,487		
	7' x 7'	14,676	17,852	8,850	16,760	85,724	
	8' x 8'	2,067	4,157	2,393	5,520		3,056,888
1967-68	6' x 6'	1,351	1,240	570	920		
	7' x 7'	8,753	10,450	5,959	10,209	47,401	
	8' x 8'	1,483	2,234	1,648	2,584		1,238,787
1968-69	6' x 6'	430	570	201	430		
	7' x 7'	3,518	3,943	2,535	4,456	19,151	
	8' x 8'	863	833	289	1,083		374,991

Table II.2. Stock, quarter, year, and areas for which logbook data were available. These were used in CPUE analysis. "X" indicates cells which contained data.

Quarter	Stock*	Area	Year 1	2	3	4	5	Quarter	Stock*	Area	Year 1	2	3	4	5
1	1	1	-	X	X	X	X	2	3	1	-	X	-	X	-
1	1	2	-	X	X	X	X	2	3	2	-	-	-	-	-
1	1	3	-	-	-	X	-	2	3	3	-	-	X	X	-
1	1	4	-	X	X	X	X	2	3	4	X	X	X	X	X
1	2	1	-	X	X	X	X	2	4	1	-	-	-	X	X
1	2	2	-	X	X	X	X	2	4	2	-	-	X	X	X
1	2	3	-	-	X	X	X	2	4	3	-	-	-	-	-
1	2	4	-	X	X	X	X	2	4	4	-	-	-	-	-
1	3	1	-	X	X	X	X	2	5	1	-	-	X	X	X
1	3	2	-	-	-	-	-	2	5	2	-	-	X	X	X
1	3	3	-	X	X	X	X	2	5	3	-	-	-	-	-
1	3	4	-	X	X	X	X	2	5	4	-	-	-	-	-
1	4	1	-	-	X	X	X	3	1	1	X	X	X	X	X
1	4	2	-	-	-	X	-	3	1	2	X	X	X	X	X
1	4	3	-	-	-	-	-	3	1	3	-	X	X	X	X
1	4	4	-	-	-	-	-	3	1	4	-	-	X	-	X
1	5	1	-	-	X	X	X	3	2	1	X	X	X	X	X
1	5	2	-	-	-	X	X	3	2	2	X	X	X	X	X
1	5	3	-	-	-	-	-	3	2	3	X	X	X	X	X
1	5	4	-	-	-	-	-	3	2	4	-	-	X	X	-
2	1	1	X	X	X	X	X	3	3	1	X	X	X	X	X
2	1	2	-	X	X	X	X	3	3	2	-	-	-	-	-
2	1	3	-	X	X	X	X	3	3	3	-	X	X	X	-
2	1	4	X	-	X	X	X	3	3	4	-	X	X	X	-
2	2	1	X	X	X	X	X	3	4	1	X	-	X	X	X
2	2	2	X	X	X	X	X	3	4	2	-	-	-	-	-
2	2	3	X	X	X	X	X	3	4	3	-	-	-	-	-
2	2	4	-	X	X	X	X	3	4	4	-	-	-	-	-

Table II.2. Stock, quarter, year, and areas for which logbook data were available. These were used in CPUE analysis. "X" indicates cells which contained data (continued).

Quarter	Stock*	Area	Year 1	2	3	4	5	Quarter	Stock*	Area	Year 1	2	3	4	5
3	5	1	X	X	X	X	X	4	3	1	X	X	-	-	-
3	5	2	-	-	-	-	-	4	3	2	-	-	-	-	-
3	5	3	-	-	-	-	-	4	3	3	-	-	-	-	-
3	5	4	-	-	-	-	-	4	3	4	-	X*	-	-	-
4	1	1	X	-	X	-	-	4	4	1	X	X	X	-	-
4	1	2	X	X	X	-	-	4	4	2	X	-	-	-	-
4	1	3	-	X	X	-	-	4	4	3	-	X	-	-	-
4	1	4	-	X	-	-	-	4	4	4	-	-	-	-	-
4	2	1	X	X	-	-	-	4	5	1	-	-	-	-	-
4	2	2	-	-	-	-	-	4	5	2	-	-	-	-	-
4	2	3	-	X	-	-	-	4	5	3	-	-	-	-	-
4	2	4	-	-	-	-	-	4	5	4	-	-	-	-	-

Year	Fishing year
1	1964-1965
2	1965-1966
3	1966-1967
4	1967-1968

Fishing year quarter	Calendar months
1	July-Sept
2	Oct-Dec
3	Jan-March
4	April-June

Area***	Environmental zones
1	1-4 (inshore shallow)
2	5-6 (inshore deep)
3	7 (offshore shallow)
4	8-9 (offshore deep)

* Cells where effort was expended, but no crabs were caught. In these cases, ln CPUE was set to - 6.90776 in the analysis.

** Stock "5" includes Stocks 5 and 6.

*** These areas are those mapped in Figure II.12. See remarks on p. 37.

II.A1.b Incomplete Data Approach

In order to avoid the difficulty of dealing with different pot sizes and soak times, we examined the CPUE (catch-per-pot in numbers of crabs) for the most prevalent pot-size soak-time combination - the 7' x 7' pot size and the 2-day soak time. We assume that the CPUE so derived is proportional to actual abundance and is, of course, unconfounded by different pot sizes and soak times. Since, in this approach, not all of the data are used, we will refer to this procedure as the incomplete data approach. The CPUE's from the incomplete data approach are set forth in Table II.3 for quarter-years and stocks 1, 2 and 3. Table II.3 shows that the CPUE is cyclic, exhibiting high apparent abundance for the first two quarters of the fishing year and low apparent abundance during the last two quarters of the fishing year. This periodicity may reflect declines owing to fishing, and especially in the fourth quarter, a possible lack of feeding associated with molting and mating. This lack of feeding would reduce the vulnerability of the crabs to the pot gear. Furthermore, Table II.3 shows that the CPUE tends to decline over the series of years.

II.A1.c Complete Data Approach

The incomplete data approach, while simple and easy to apply, has a deficiency in that it does not use all of the data and is, therefore, inefficient. As an alternative, we used the method of fitting constants in a generalized ANOVA routine as prescribed by Robson (1961). We shall call this method the complete data approach. The model we used is:

$$y_{ijk} = \mu + \alpha_i + \beta_j + \gamma_k + (\alpha\beta)_{ij} + \epsilon_{ijk}$$

where y_{ijk} = log CPUE for

α_i = 1, 2, 3 pot sizes,

β_j = 1, 2, 3, 4 soak time,

γ_k = 1, 2, ..., p time-area-stock entities.

The $(\alpha\beta)_{ij}$ is an interaction term.

We apply the usual restrictions that the $\Sigma \alpha_i = \Sigma \beta_j = \Sigma \gamma_k = 0$, and that $\sum_i \alpha_i\beta_j = 0$ for j = 1, 2, 3, 4 and $\sum_j \alpha_i\beta_j = 0$ for i = 1, 2, 3. The parameters of the model are then estimated to obtain the weighting constants,

Table II.3. Catch-per-unit-of-effort by population and quarter of fishing year, using only 7' x 7', 2-day soak pot lifts (incomplete data approach).

Fishing year	Fishing year quarter	Stock 1	Stock 2	Stock 3
1964-65	1	-	-	-
	2	69.375	51.862	-
	3	44.471	73.295	-
	4	1.429 1/	24.463	-
1965-66	1	35.768	78.403	128.607
	2	63.392	89.433	98.839
	3	40.708	58.206	34.816
	4	14.721	20.703	-
1966-67	1	28.795	47.219	65.332
	2	27.394	51.344	79.504
	3	13.321	22.462	33.155
	4	12.484	-	-
1967-68	1	18.837	21.187	36.819
	2	20.023	18.292	17.671
	3	6.448	9.770	19.496
	4	-	-	-
1968-69	1	17.992	22.874	33.414
	2	9.278	11.748	13.837
	3	3.743	15.096	-
	4	-	-	-

1/ Based on 7 pot lifts.

$$\hat{\rho}_{ij} = \frac{\exp\left(\hat{\alpha}_i + \hat{\beta}_j + \widehat{\alpha\beta}_{ij}\right)}{\exp\left(\hat{\alpha}_i + \hat{\beta}_j + \widehat{\alpha\beta}_{ij}\right)^*}$$

where the * notation refers to the unit arbitrarily chosen as the standard unit, and is, in this study, the 7' x 7' pot, 2-day soak. If we assume no interaction, the $\alpha\beta_{ij}$'s are dropped from the above formula, and the model is refitted without the $(\alpha\beta)_{ij}$ term.

The resulting ρ_{ij}'s, without interaction, were computed for each fishing year and are given in Table II.4. Several interesting features are evident from Table II.4 and these can be seen in Figure II.2. In Table II.4, we can see that the "effectiveness" of any size pot increases with days' soak, but not in proportion to days' soak; that the 8' x 8' pots tended to be more efficient in the early years of this data set and less efficient in the later years. Figure II.2 also shows that the effects of including an interaction term do not materially affect these conclusions.

We should comment at this point, that our remarks concerning the effectiveness of the gear should be viewed with caution because the correction factor was obtained by assuming that 7' x 7' pots with a 2-day soak had a constant fishing power of one. We really do not know, however, whether the 7' x 7' pots were increasing in efficiency or whether the 8' x 8' pots were decreasing in efficiency. There seems to be a general agreement that the 8' x 8' pots were decreasing in efficiency. It is possible that the apparent changes in efficiency are due to changes in the variances of the estimates rather than changes in fishing power. Under the assumption that X is N (μ, σ^2), then $E[\exp(X)] = \exp(\mu + 1/2\ \sigma^2)$. From this it is clear that even when fishing powers remain constant between years, either a decreasing trend in the variances of 8' x 8' estimates or an increasing trend in the variances of 7' x 7' estimates would create an illusion of relative change in the efficiencies of the gears.

The CPUE, using all data, was derived by multiplying the effort by the appropriate effort correction factors from Table II.4. Thus for the 1964-65 fishing year, 10 units of 7' x 7', 2-day soak would be equivalent to 10 units of standardized effort, but a 3-day soak of 10 8' x 8' pots would be equivalent to 21.6 units of standard 7' x 7', 2-day soak. Table II.5 contains the resulting standardized CPUE for each quarter-year and stock as well as for the combination of the three most important populations. These data, as well as the incomplete 7' x 7', 2-day soak CPUE are displayed in Figure II.3. We note that the CPUE from the incomplete approach closely approximates the CPUE from the complete approach, but in some instances, the complete approach tends to yield higher CPUE indices than those from the incomplete approach. Thus the complete data approach may tend to reflect less of a decline in abundance than the incomplete data approach.

Table II.4. Effort correction factors ρ_{ij} for pot size and soak time by fishing year (without pot size-soak time interaction).

Fishing year	Days soaked	Pot size		
		6' x 6'	7' x 7'	8' x 8'
1964-65	1	.6782	.6941	1.2522
	2	.9771	1.0000	1.8041
	3	1.1985	1.2265	2.2127
	4-10	1.2862	1.3163	2.3746
1965-66	1	.3744	.5909	.8110
	2	.6336	1.0000	1.3725
	3	.7588	1.1976	1.6437
	4-10	.7728	1.2197	1.6740
1966-67	1	.5184	.7172	.7445
	2	.7229	1.0000	1.0382
	3	.8924	1.2345	1.2816
	4-10	.9481	1.3115	1.3616
1967-68	1	.1969	.5375	.3650
	2	.3663	1.0000	.6790
	3	.3448	.9414	.6393
	4-10	.3638	.9934	.6745
1968-69	1	.3602	.6608	.3364
	2	.5451	1.0000	.5091
	3	.3955	.7256	.3694
	4-10	.6584	1.2079	.6149

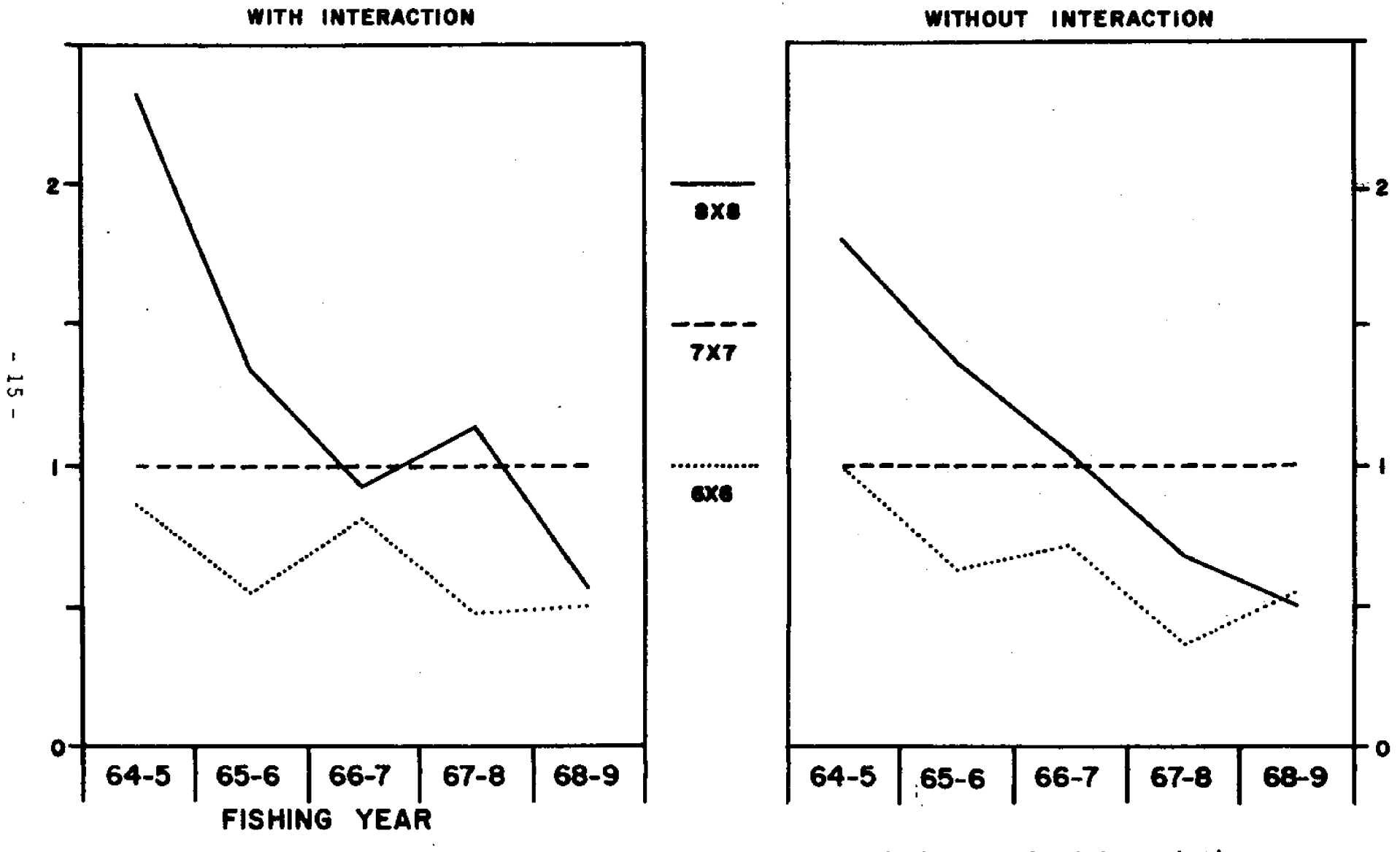


Figure II.2. Effort correction factors by pot size and fishing year for 2-day soak time, with and without pot size by soak time interaction (Kodiak).

Table II.5. Standardized logbook CPUE, without interaction, by fishing year and stock.

Fishing year	Quarter	Stock 1	2	3	4	5	6	Combined stocks 1-3
1964-65	1	-	-	-	-	-	-	-
	2	56.7583	86.5125	53.3650	-	-	-	73.377
	3	34.9960	69.0527	54.8019	17.1835 5/	7.1905	-	55.004
	4	6.8447	37.8477	23.7143	12.1416	-	-	24.542
1965-66	1	44.4401	77.6447	106.0133	-	-	-	71.739
	2	57.3259	95.3284	75.2667	-	-	-	81.196
	3	33.8986	73.3961	43.5889	-	-	-	56.908
	4	14.3717	28.7285	10.2456	60.3166	-	-	16.384
1966-67	1	28.9629	52.8437	69.2953	9.4018 4/	23.0988	-	49.526
	2	23.2568	52.1177	68.4454	18.0530 3/	14.2596	-	43.593
	3	15.6299	29.7398	32.4914	35.2732	7.2169	-	24.370
	4	15.6664	-	-	14.5117	-	-	15.666
1967-68	1	33.2942	36.2203	54.1242	33.0013	21.6062	27.2610	47.592
	2	26.6747	19.6998	25.4649	32.9405	12.1938	16.2641	22.993
	3	10.2071	13.3895	16.2878	32.1821	9.0910	-	12.514
	4	-	-	-	-	-	-	-
1968-69	1	22.9523	59.1317	36.3847	6.8786	26.1576	16.6462 1/	38.450
	2	14.3861	15.7983	18.9473	19.3101	10.4880	-	15.736
	3	7.3933	26.0222	1.2826	6.3877	3.0669	0.5000 2/	11.976
	4	-	-	-	-	-	-	-

1/ Based on 5 pot lifts.
2/ Based on 8 pot lifts.
3/ Based on 7 pot lifts.
4/ Based on 1 pot lift.
5/ Based on 2 pot lifts.

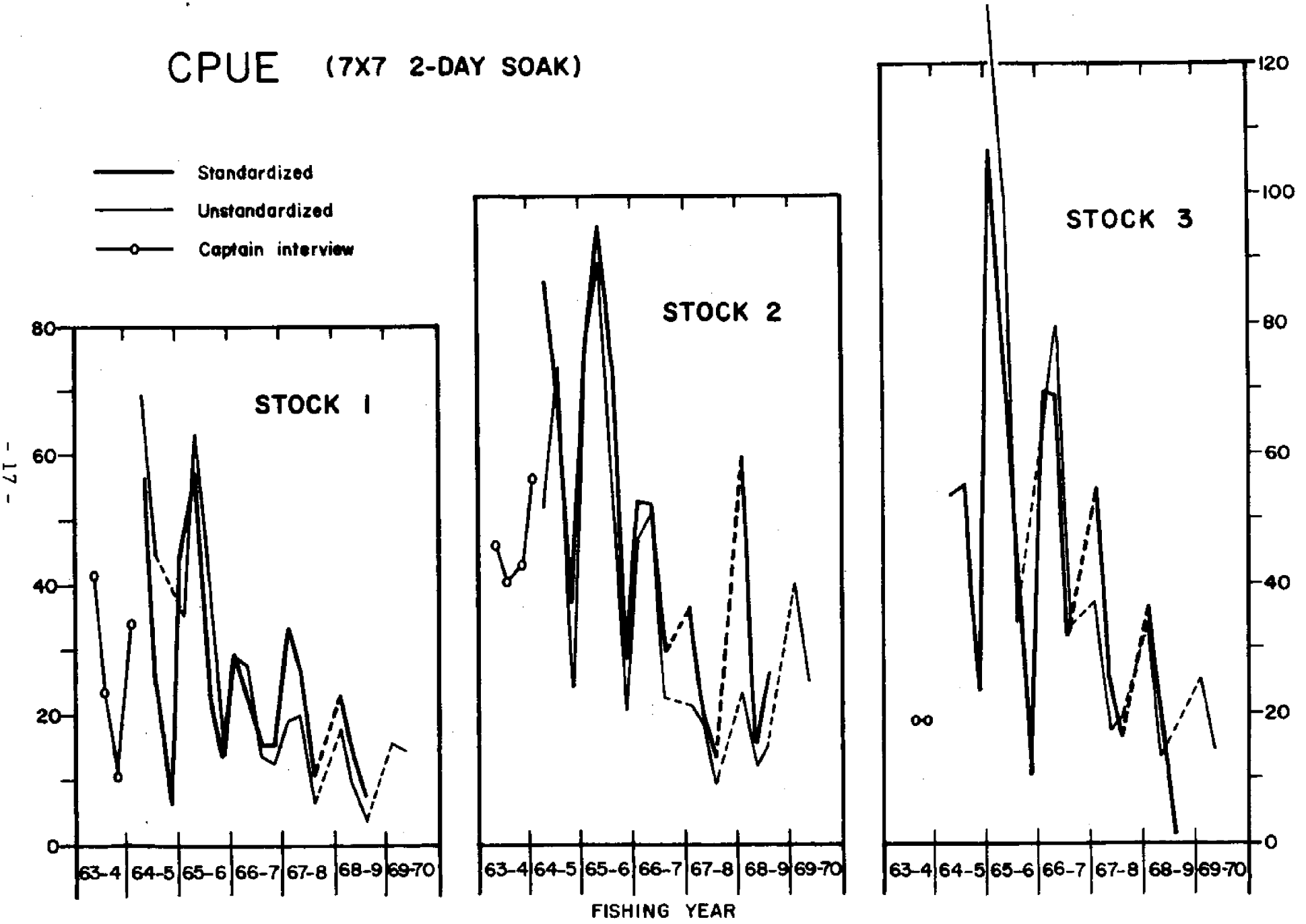


Figure II.3. Comparison of CPUE in number of crabs per pot lift from incomplete data approach (unstandardized 7' x 7', 2-day soak), complete data approach (standardized), and captain interview (unstandardized), by fishing year for Kodiak stocks 1, 2, and 3.

It should be emphasized that alternative formulations of the linear ANOVA model used above can be obtained. For example, it might have been useful to examine some of the location-soak time interactions. Our intent is to study other formulations and their interpretations at a later date.

The complete data approach or the method of fitting of constants also yields an analysis of variance (ANOVA). In order to meaningfully interpret the ANOVA, from the point of view of making probability statements, we need to evaluate whether the required ANOVA assumptions have been fulfilled. At this point in our study, we assume (as did Beverton and Holt, 1957, and Robson, 1961) that the assumptions are fulfilled by virtue of, among other things, the log transformation of the CPUE data. We feel that any departure from the assumptions will not materially affect our conclusions.

The ANOVA which resulted from our work on fitting constants is displayed in Table II.6. From this table we can see that, as one would expect, the time-location, pot size, and soak time tend to be significant and that the interaction terms tend to be not significant. The time-location significance is expected from the point of environmental variability. The pot size and soak time significance levels reflect the need for effort adjustment and the lack of significant interaction reflects that the relative difference between the pot sizes is "constant" over all levels of soak time and vice versa.

Despite the general trend of significant differences among time-location, pot sizes, and soak times, and no significant interactions, the 1968-69 data reflect that the two variables (pot size and soak times) are not significantly different. This suggests that varying either pot size or soak time in 1968-69 had no detectable effect on CPUE. It is probable that this lack of effect was associated with decreased abundance and thus at low levels of abundance any pot size and soak time should, on the average, be equally profitable.

II.A.2 Captain Interview Data

As indicated in Section II.A.1, the captain interview program was initiated in 1962. In the early stages of the program, an interview form was developed; this form underwent several modifications. The presently used form, which has been in use since 1964, is shown in Figure II.4. The interview procedure is still currently used in those instances where boat captains do not fill out logbooks.

The boat captain interview data (1963-1964) has been assembled in Table II.7. We note from these data, which are provisional, pending more

Table II.6. Summary of analysis of variance tests which resulted from determining fishing power.

		Fishing year				
		1964-65	1965-66	1966-67	1967-68	1968-69
Time-location	F	15.83	29.05	18.89	2.36	2.69
	df	19	36	41	41	35
	p	.01	.01	.01	.01	.01
Pot size	F	13.38	21.75	17.63	12.03	2.41
	df	2	2	2	2	2
	p	.01	.01	.01	.01	ns
Soak time	F	9.56	16.49	29.90	4.58	0.97
	df	3	3	3	3	3
	p	.01	.01	.01	.01	ns
Interaction	F	1.85	0.36	1.03	1.29	0.63
	df	6	6	6	6	6
	p	ns	ns	ns	ns	ns
Error	df	61	159	283	240	175

Figure II.4. Example of data page for captain interview.

In September 1964 columns 2 and 3 were changed to read Maximum depth difference rather than range in depth enabling recording of depth-range in two columns rather than four or more.

BOAT CHECK-LIST FORM

KRC-4

Date of info				Last day of fishing			Location		Average depth 17	Number of crabs 22	Recorder	Number of pots fished 26	Days fished 28	soaked 30	Total Tags 32	No. of Tag types 33
Month	Day	Year	Max. Depth Difference 3	Month 5	Day 7	Year 9	Area 12	Sub Area [illegible]								

# J 35	# E 37	# YH 39	# [illegible] 41	# YO Chiniak 43	# W[illegible] 45	# D 47	# YO Marmot 49	Tampering 60	ADF & G number for boats 65	Boat 78

IMPORTANT QUESTIONS TO ASK BOAT SKIPPERS

(1) What boats are fishing? (2) Are you catching many new shells, remains, or juveniles? (3) Would you please help us by completing tag capture forms each trip?

Table II.7. CPUE's from the captain interview data by soak time and quarter of fishing year for Kodiak stocks, 1, 2, and 3.

Fishing year	Fishing quarter	Stock	Soak 1	Soak 2	Soak 3	Soak 4-10	All combined*
1963-64	1	1	-	-	-	-	27.4
1963-64	2	1	26.5	41.3	37.9	32.6	30.7
1963-64	3	1	19.7	23.4	29.6	22.9	22.2
1963-64	4	1	10.4	10.6	20.2	9.6	11.0
1964-65	1	1	34.6	34.5	30.1	41.2	32.6
1963-64	1	2	-	-	-	-	32.4
1963-64	2	2	46.6	46.5	50.3	58.5	41.3
1963-64	3	2	33.6	40.0	48.7	43.0	36.0
1963-64	4	2	32.2	44.9	33.3	47.7	33.7
1964-65	1	2	42.9	56.3	44.4	62.5	48.9
1963-64	1	3	-	-	-	25.0	28.7
1963-64	2	3	32.4	14.2	9.2	35.3	29.8
1963-64	3	3	20.2	19.2	19.3	25.2	21.0
1963-64	4	3	15.4	19.4	-	28.9	17.4

* This column includes data for which no soak time was available.

detailed examinations, that the CPUE tended to be lower than the following fishing year 1965-66 (see Figure II.3). We have not, for these data, computed weighting factors as we have done in Table II.4; we can assume that the pots tended to be smaller than 7' x 7' and thus the weighting factor is probably somewhat greater than the 1964-65 factor for 6' x 6', 2-day soak[2/]. If this is true, the CPUE in Table II.7 would be increased only slightly and still would not exceed the CPUE's for 1965-66.

II.A.3 FRI Logbook Program

The FRI logbook program was conducted in 1957 and 1958. Details of this program are described by Burgner (MS). The program collected information on catches of crabs using both pot and trawl gear. Our analysis considers only those data which are based on pot gear.

Our initial examination of the FRI data revealed a considerable number of obvious reporting errors. These errors were common for certain boats and when data from these boats were eliminated, the remaining data appeared reasonable. The CPUE's synthesized from these data are recorded in Table II.8. A comparison of the data in Table II.8 with that depicted in Figure II.6 (Table II.9) shows that, in general, the CPUE's in 1958-59 were less and, in some instances, considerably less than the corresponding indices in 1964-65.

Since fishing in 1958-59 was restricted more to the inshore bay areas, whereas that for the mid 1960's was centered in more offshore waters, we were interested in determining whether the lower CPUE in 1958-59 could be attributed to the location of fishing. Accordingly, we examined the CPUE in 1958-59 and 1964-65 through 1968-69 for just those areas which were recorded as fished in FRI logbooks in 1958-59. These areas are indicated in Figure II.5. The 1958 data are presented in Table II.9 and plotted in Figures II.6. Figure II.6 shows that for most areas, the unstandardized CPUE in 1958-59 was less than that for most areas in the mid 1960's. While we have no way of estimating the relative fishing powers in 1958-59[3/], we could, judging by Table II.4, pick a high weighting factor which would effectively double the CPUE. This

---

2/ Future analyses will examine the correction factors for the interview data. The 6' x 7' pots were first used in 1961 by the vessel Primus. The 7' x 7' pots were first used in 1962 by the larger vessels. The 8' x 8' pots were first used in 1963. The 7' x 7' pots were used in many instances by 1964.

3/ Most gear in 1958-59 was round, 6'-diameter pots which were generally less efficient than the gear used in later years.

Table II.8. Adjusted and unadjusted CPUE from FRI logbooks data by soak time and quarter of fishing year (Kodiak).

Stock	Fishing year	Fishing quarter	Days soaked 1	2	3	4-10	Weighted total**
1	1958-59	2	5.0	9.2	-	7.0	6.2
		3	4.4	22.2	12.6	23.1	14.9
2	1958-59	3	15.7	20.3	33.3	31.9	23.2
		4	23.6	8.9	31.6	31.7	24.1
3	1958-59	3	7.9	11.4	10.5	-	9.9
		4	2.1	29.5	19.0	74.5	33.2
6	1958-59	3	6.6	7.0	-	-	8.0
		4	3.8*	-	-	-	-

* Based on a single observation.

** Weights used are 1-day soak, 0.83; 2-day soak, 0.87; 3-day soak, 1.5; 4-10 day soak, 1.1.

Table II.9. CPUE's from 1958-59 FRI logbook data and from 1964-69 ADF&G logbook data (standardized), by quarter of fishing year, for 1958-59 Kodiak fishing areas.

Statistical areas		25181 25182 25190 25210	25820	25852	25851 25854 25855	25860	25880	25720 25770	25150
Stock		1	1	2	2	2	2	3	6
1958-59 area designations		25172	25853	25875	25872 25873	25883	25881	25721 25722	25142
Fishing year	Fishing quarter								
58-59	2	5.24	-	-	-	-	-	-	-
	3	4.35	27.92	8.66	22.63	17.65	73.29	10.97	6.70
	4		-	-	20.20	-	-	33.09	-
64-65	2	-	-	-	35.50	-	97.31	-	-
	3	26.67	33.63	-	47.44	75.80	77.85	56.73	-
	4	-	4.53	-	24.16	-	56.86	23.71	-
65-66	1	6.99	-	-	64.08	81.73	67.76	52.71	-
	2	80.80	-	-	-	82.80	115.23	-	-
	3	33.90	24.01	26.75	66.53	69.78	72.77	43.15	-
	4	15.48	-	-	-	-	33.51	11.17	-
66-67	1	11.26	-	-	29.75	59.20	56.63	82.14	-
	2	17.67	10.95	-	23.64	25.08	42.64	-	-
	3	16.06	4.15	-	19.90	15.71	21.49	20.86	-
	4	7.74	-	-	-	-	-	-	-
67-68	1	24.62	-	-	23.63	36.27	27.28	-	-
	2	17.54	-	-	0.57	1.69	27.36	8.98	-
	3	11.22	-	-	-	0.29	12.19	7.45	-
	4	-	-	-	-	-	-	-	-
68-69	1	-	-	-	-	-	16.89	16.89	-
	2	-	-	-	-	-	-	-	-
	3	-	-	-	-	-	1.43	1.28	-
	4	-	-	-	-	-	-	-	0.50

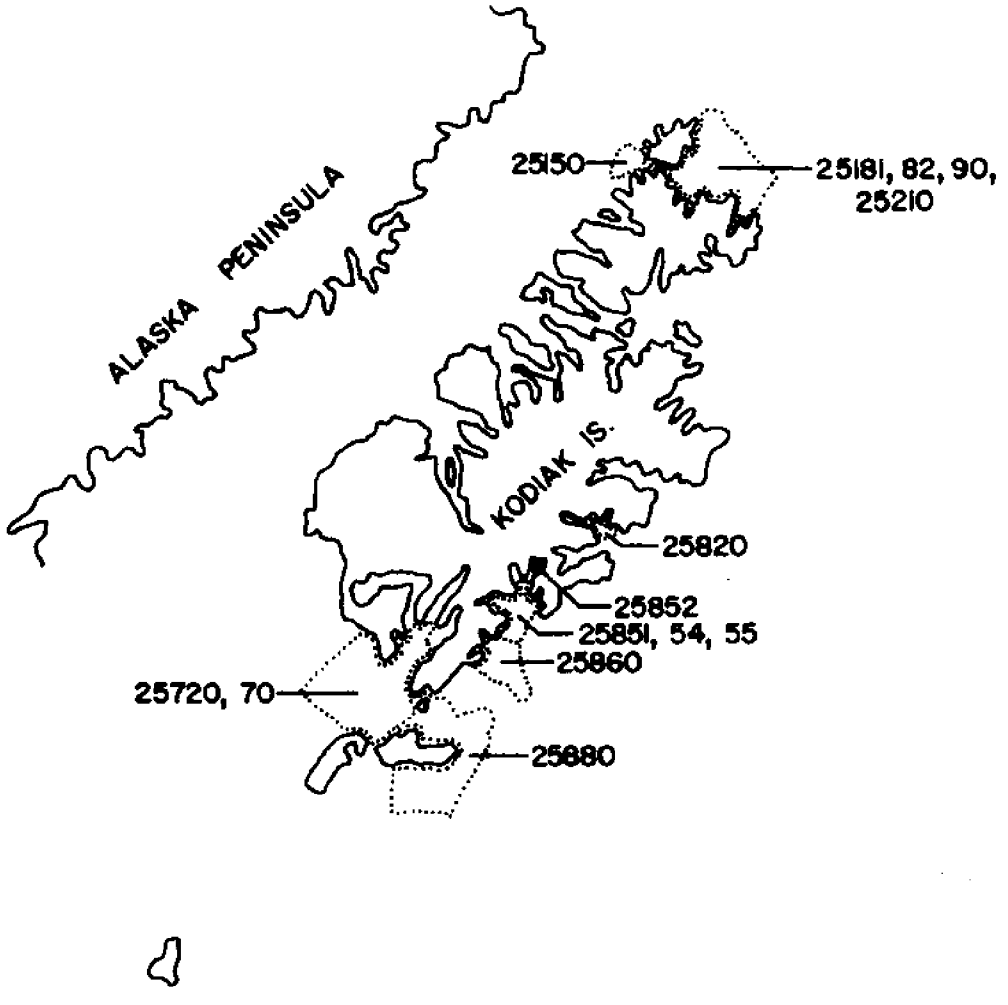


Figure II.5. Map of statistical areas recorded as fished in FRI logbooks in 1958-59 (Kodiak).

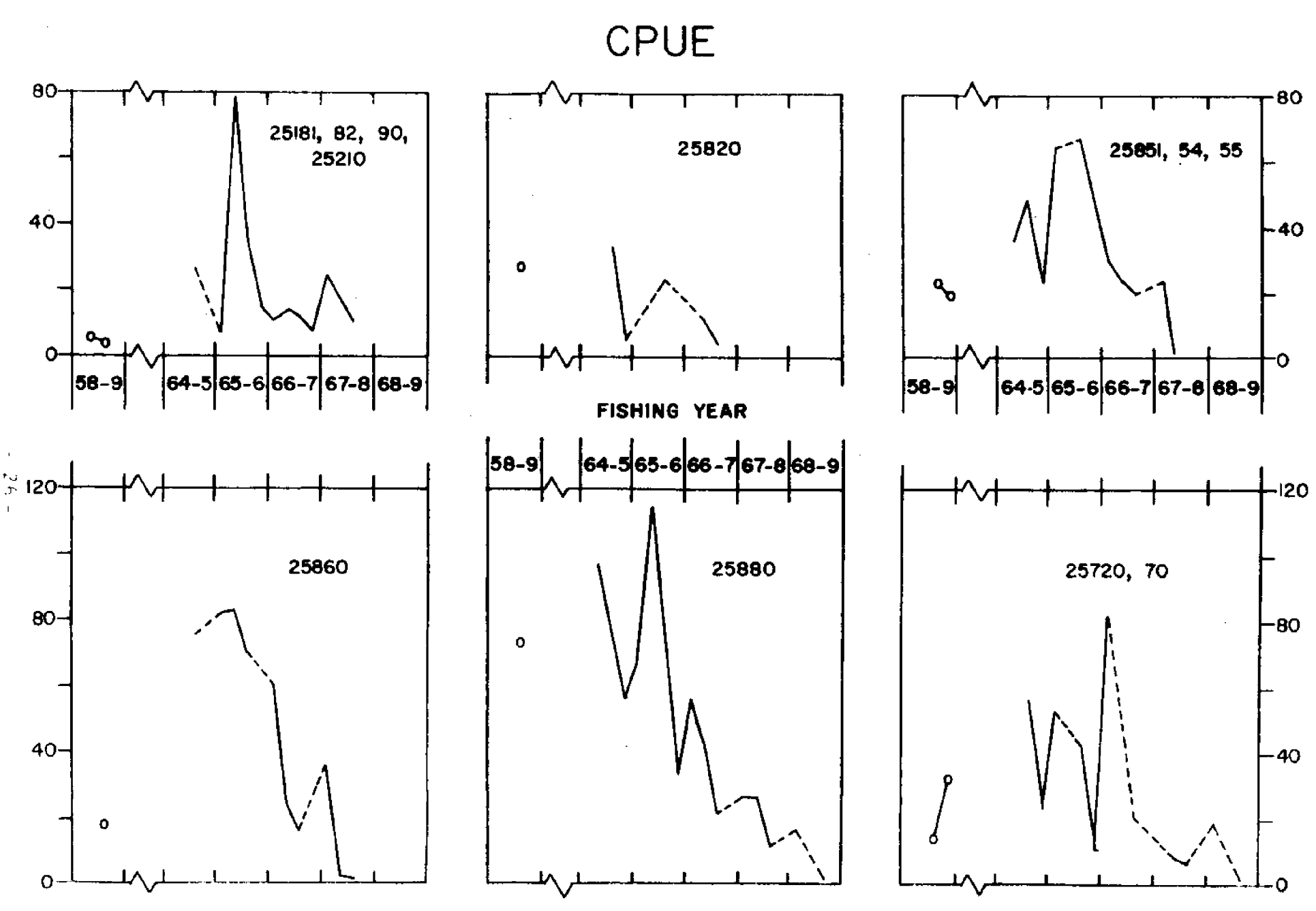


Figure II.6. Comparison of CPUE from 1958-59 FRI logbooks and from 1964-69 ADF&G logbooks (standardized), for the 1958-59 Kodiak fishing areas.

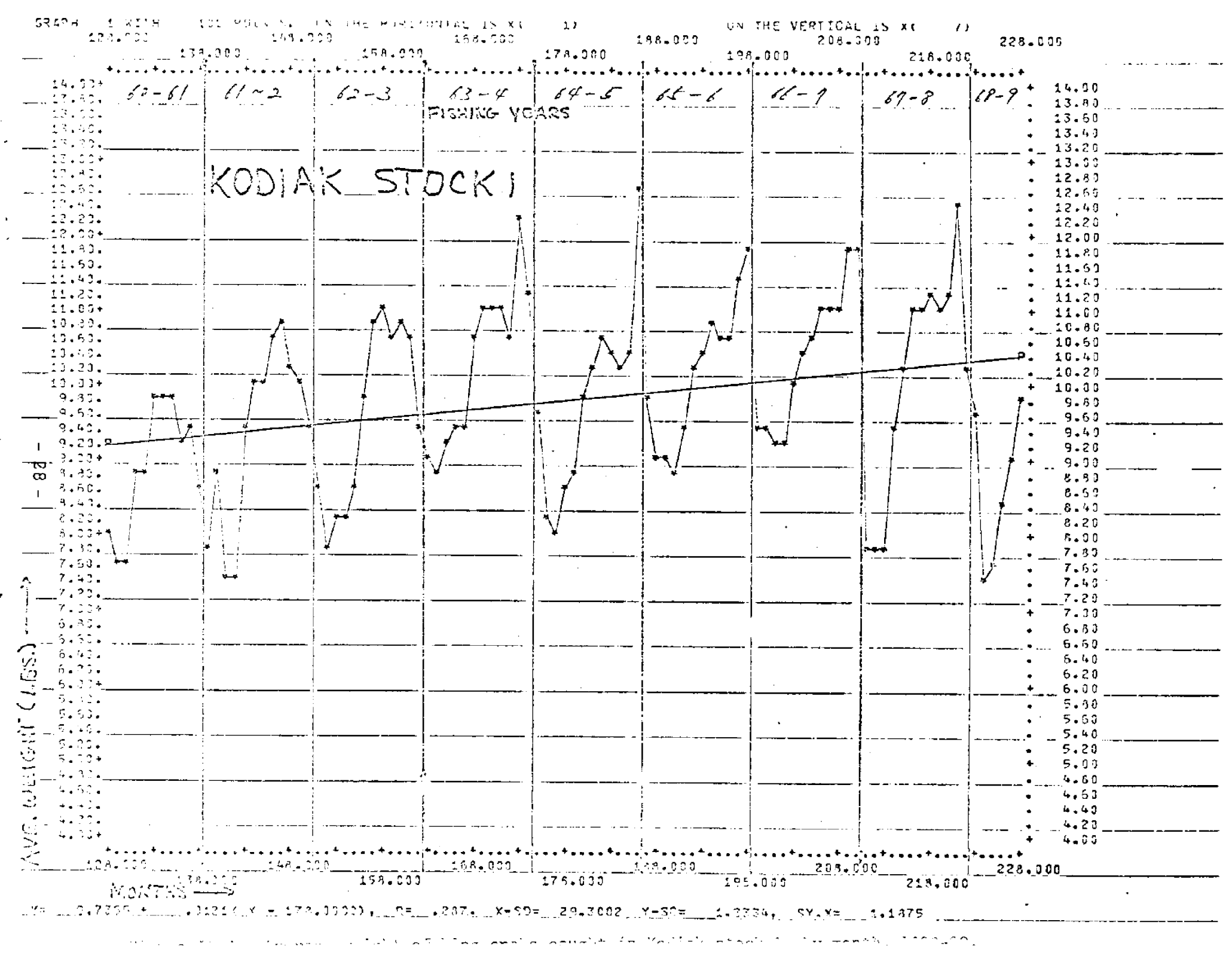
would not seriously affect the above conclusion that the abundance of crabs in 1958-59 was, for the same localized areas, less than in the mid-1960's. Furthermore it is of interest to note that the apparent abundance in 1958-59 and 1959-1960 (as suggested by the FRI data) appears to be less than in previous years, further suggesting fluctuations in apparent abundance 4/.

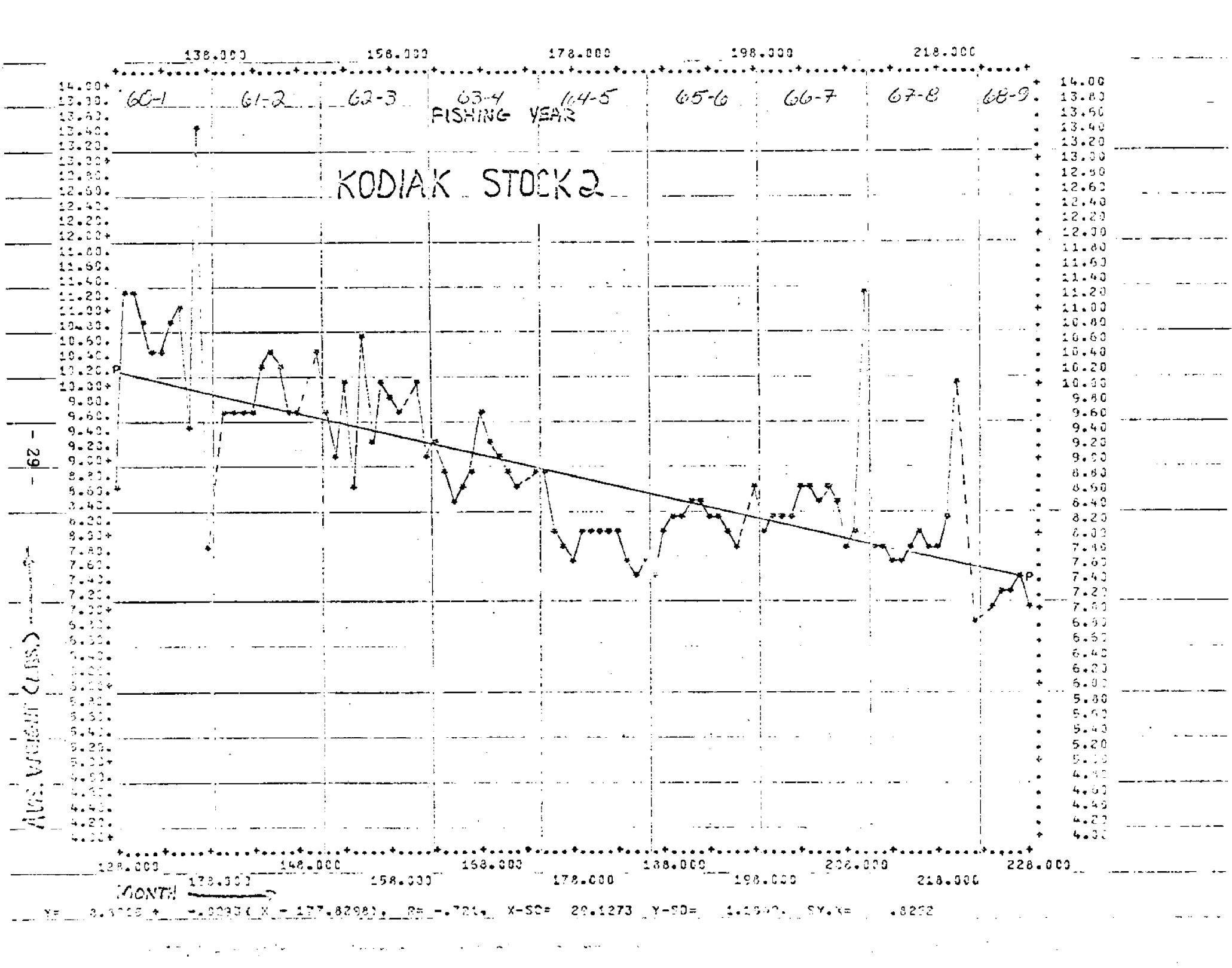
II.A.4 Fish Ticket Data - Kodiak

This section utilizes the information recorded on ADF&G fish tickets for the Kodiak region. The use of fish ticket data enables us to examine apparent abundance (expressed as catch-per-landing) over a longer series of years and from a much wider area than the logbook data, since the logbooks were maintained only during the late 1960's and only for the Kodiak area, whereas, the fish ticket data that we used provide information beginning in 1960 and covering the entire state of Alaska. The fish ticket data are, however, somewhat limited since the only effort information available is the number of landings. The fish tickets report the magnitude of each landing in terms of both weight and number. We believe that the reported weights are reasonably accurate. The reported numbers, although crude, are probably reasonably unbiased estimates of the actual number in the catch (an analysis of fish ticket accuracy for the Kodiak area is presented by Powell and Gray, in press). In this section we present only the fish ticket data from the Kodiak region (Figure II.7) and reserve reporting the fish ticket data from the other regions of Alaska for Section II.B.

The number of landings recorded on the fish tickets is clearly not as fundamental a unit of effort as is the number of pot lifts. It is evident that the amount of fishing mortality induced by a landing unit can vary with the length of the trip, the number of pots fished per day, etc. Therefore, before using the catch-per-landing as a measure of effort, we compared this statistic with the standardized catch-per-pot lift computed from the logbook data. This is shown in terms of both weight and number in Figures II.8 and II.9 for stocks 1, 2, and 3, in the Kodiak region. In these figures, we can see correlation between the two indices. The relation for stock 2 appears to be curvilinear, suggesting a "saturation level" in the catch-per-boat statistics at an abundance level of about 40-50 crabs per standard unit (7' x 7' pot, 2-day soak). High levels of abundance occurred during the 1964-65 and 1965-66 fishing years. Landings in the vicinity of 30-40 thousand pounds and about 3-4 thousand crabs may be underestimate true abundance. Despite the saturation effect, it is clear from Figures II.8 and II.9 that the catch-per-landing is a usable measure of abundance.

4/ Anonymous. 1961. Special king crab report. ADF&G. Memorandum 3.


KODIAK STOCK I
FISHING YEARS
60-61
61-2
62-3
63-4
64-5
65-6
66-7
67-8
68-9
AVG. WEIGHT (LBS.)
MONTHS


KODIAK STOCK 2
60-1
61-2
62-3
63-4
64-5
65-6
66-7
67-8
68-9
FISHING YEAR
AVG. WEIGHT (LBS.)
MONTH
- 62 -

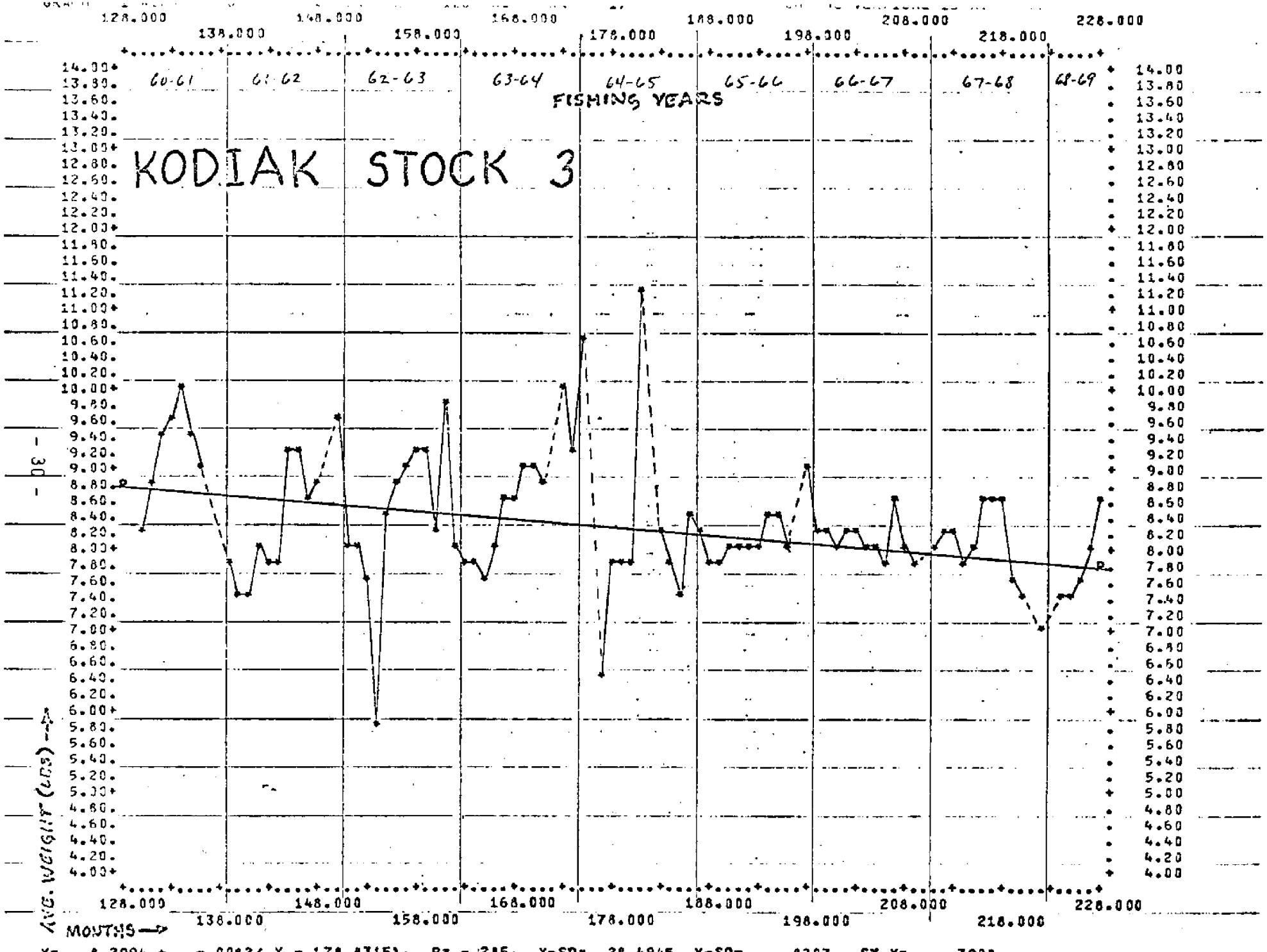
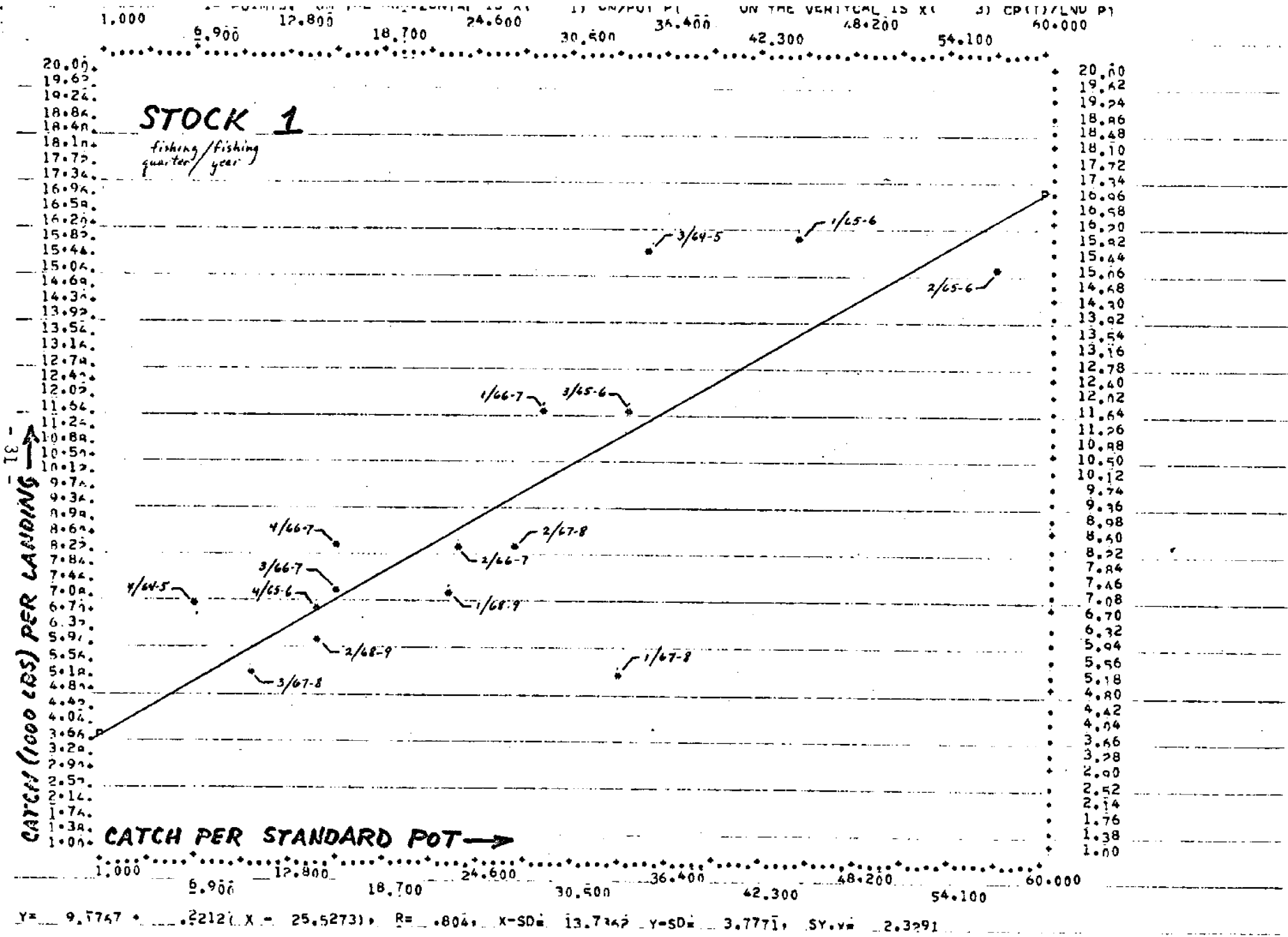
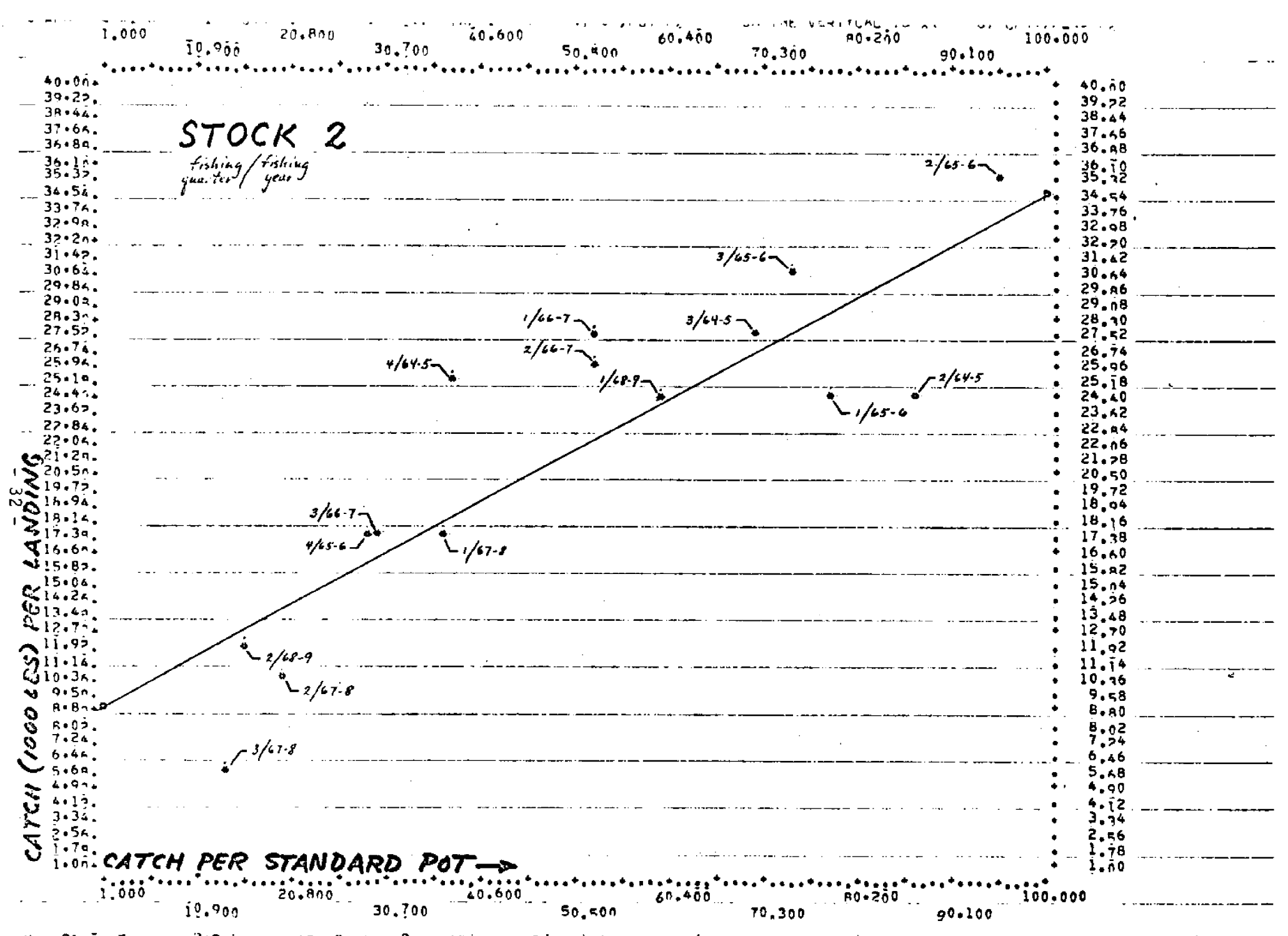


Figure II-7 - continued. Average weight of king crabs caught in Kodiak stock 3, by month, 1960-69.



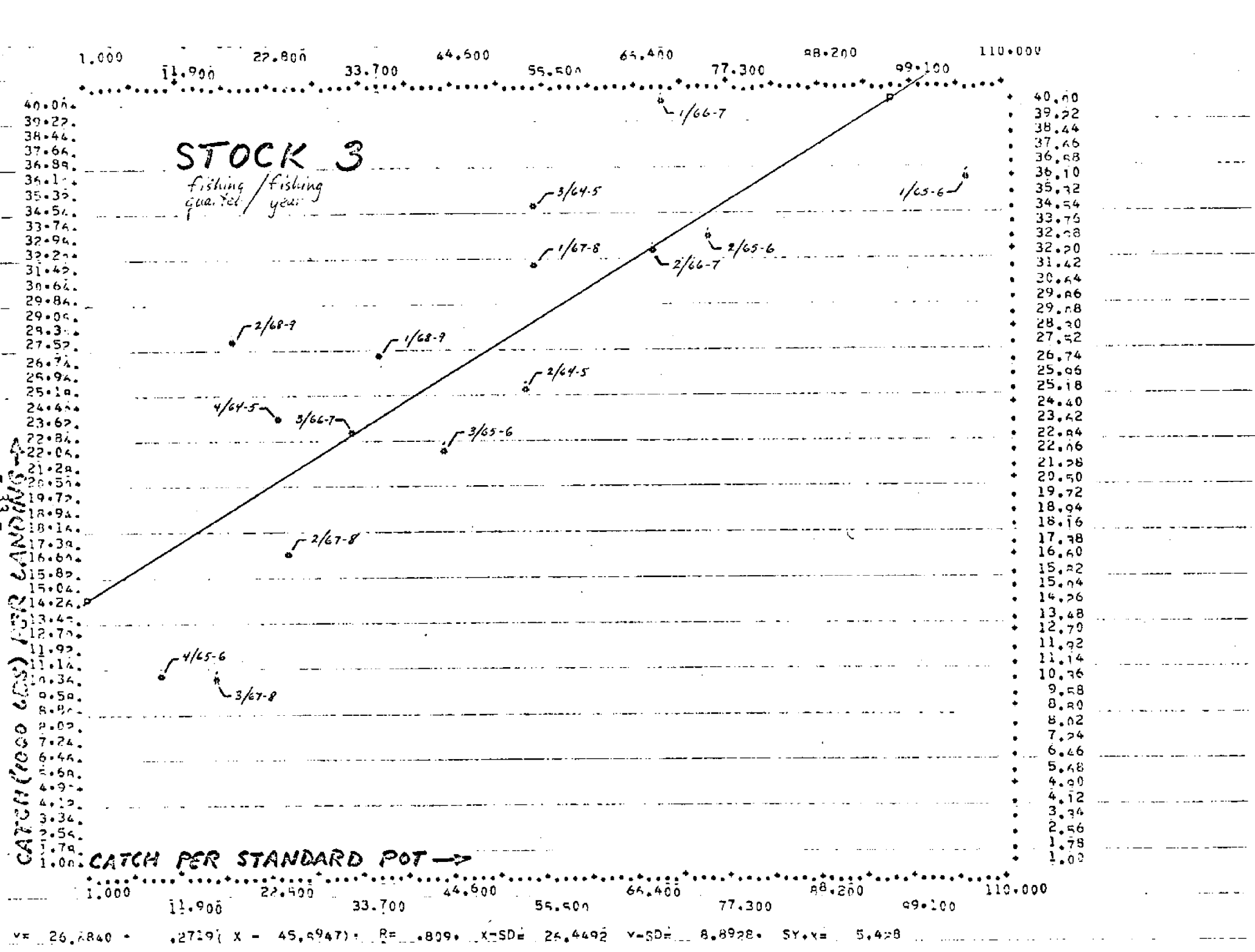
Y= 9.7747 + .2212(X - 25.5273), R= .804, X-SD= 13.7342 Y-SD= 3.7771, SY.x= 2.3291

Figure II.8. Comparison of catch in numbers per pot lift and catch in pounds per boat landing for Kodiak stock 1.



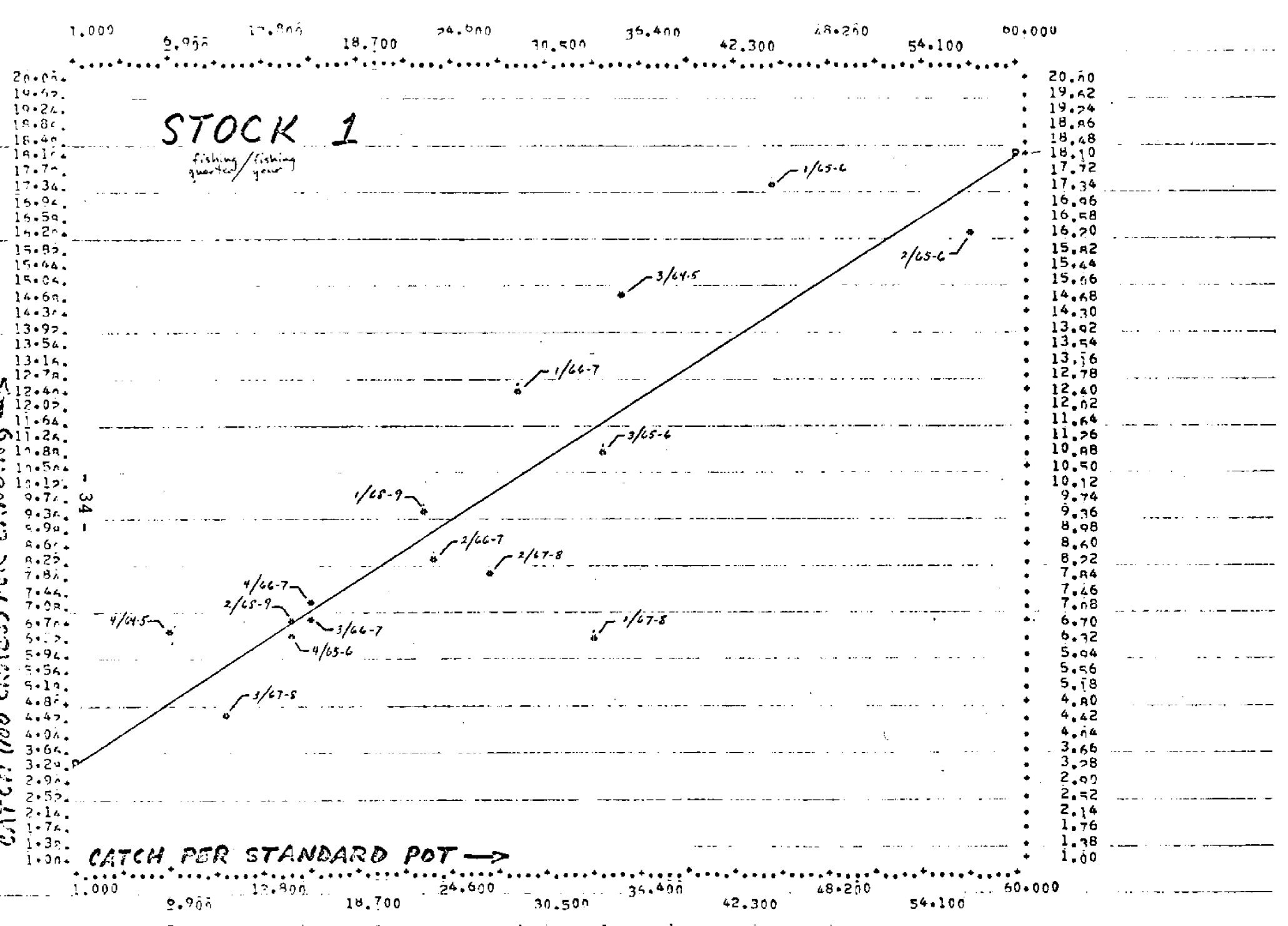
Y= 21.7047 + .2629(X - 49.8300), R= .8714, X-SD= 24.4198 Y-SD= 7.9644, SY.x= 4.0358

Figure II.8. (cont.) Comparison of catch in numbers per pot lift and catch in pounds per boat landing for Kodiak stock 2.



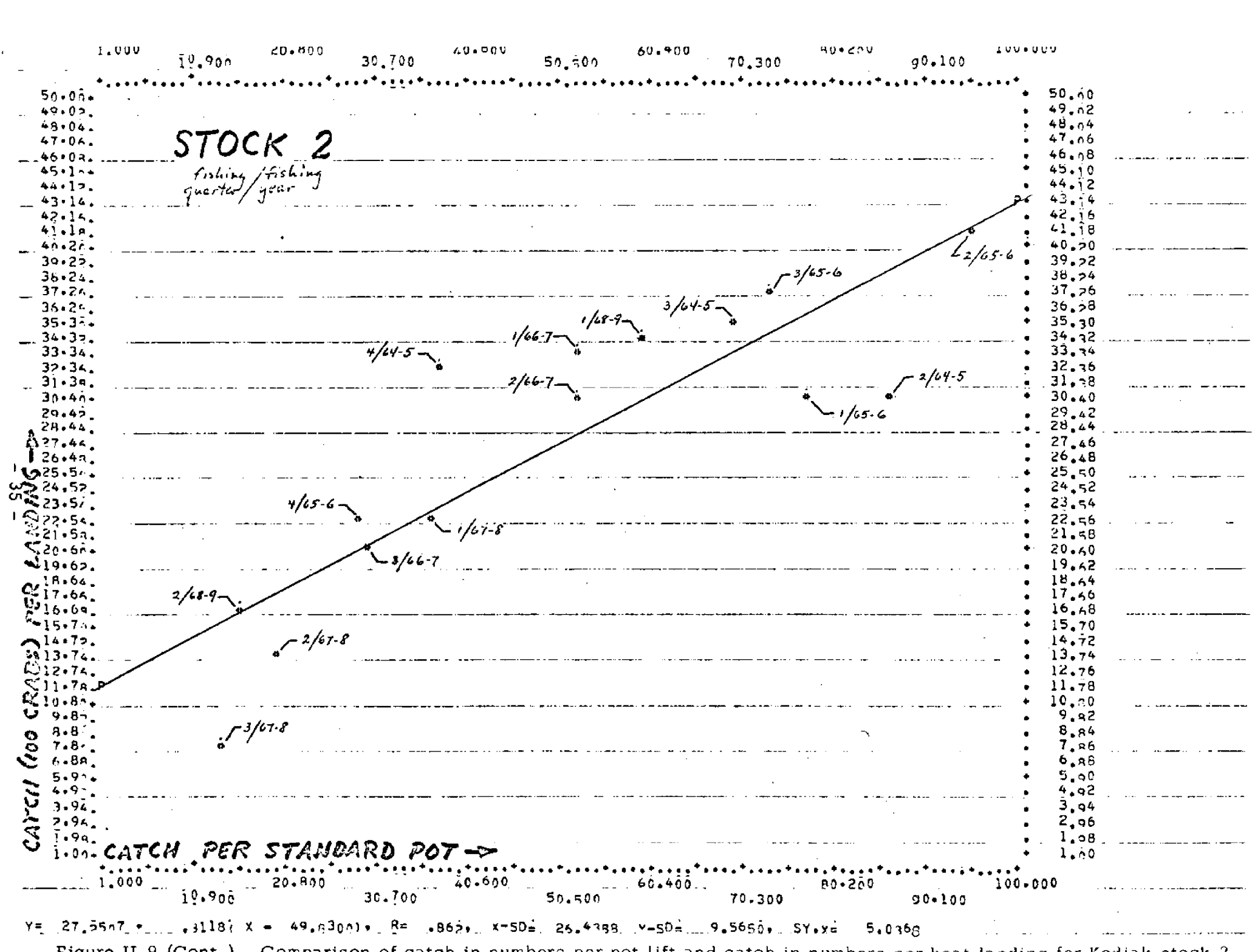
Y= 26.6840 + .2719(X - 45.8947); R= .809; X-SD= 26.4492 Y-SD= 8.8928; SY.X= 5.428

Figure II.8. (Cont.) Comparison of catch in numbers per pot lift and catch in pounds per boat landing for Kodiak stock 3.



Y= 9.4040 + .2528(X - 25.6273), R= .864, X-SD= 13.7242 Y-SD= 4.0180, SY.x= 2.0971

Figure II.9. Comparison of catch in numbers per pot lift and catch in numbers per boat landing for Kodiak stock 1.



Y= 27.3567 + .3118(X - 49.6300) R= .862 x-SD= 26.4388 y-SD= 9.5650 SY.x= 5.0368

Figure II.9 (Cont.). Comparison of catch in numbers per pot lift and catch in numbers per boat landing for Kodiak stock 2.

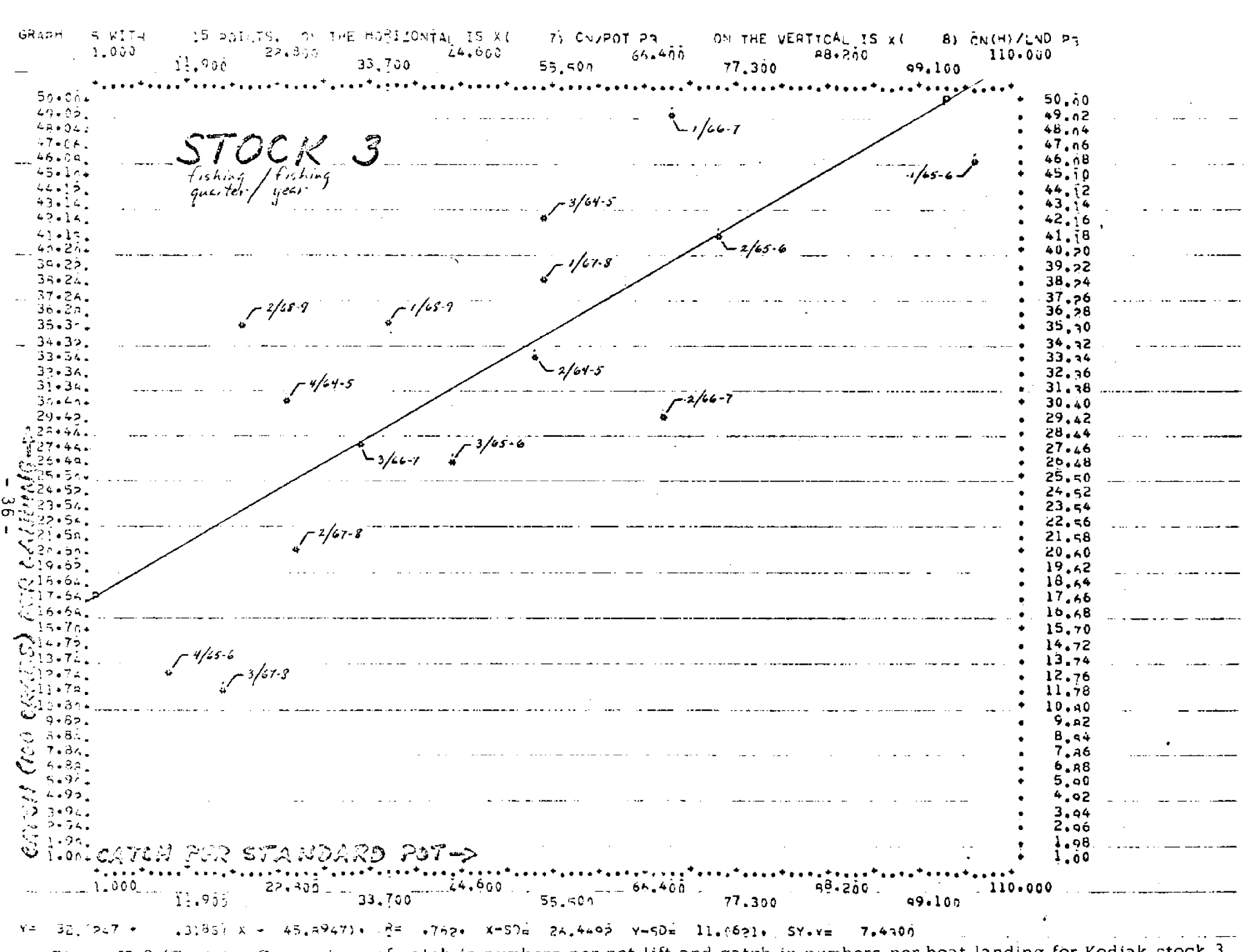


Figure II.9 (Cont.). Comparison of catch in numbers per pot lift and catch in numbers per boat landing for Kodiak stock 3.

The correlation between the catch-per-pot and the catch-per-landing suggests that, during the time when the logbook program was operating, the fish ticket data represented, fairly well, the changes in stock apparent abundance in the Kodiak region. We therefore infer that the fish ticket data for the pre-logbook years reasonably reflect trends in apparent abundance of the king crab. In Appendix A, we can see that the catch-per-landings for the early 1960's in the Kodiak area tended to be less than in the mid-1960's. Thus, the FRI logbook data, the captain interview data, and the fish ticket data all suggest that the apparent abundance of the crabs in the early 1960's was less than the apparent abundance of the crabs in the mid-1960's.

In the preceding paragraph we have been discussing apparent abundance and, in order to relate apparent abundance to actual abundance, we must assume, among other things, that within each stock the temporal-spatial distribution of the crabs is homogeneous with respect to the temporal-spatial distribution of fishing effort. That this, indeed, is not true can be seen by comparing the distribution of fishing in the 1960-69 period with the average size of the crabs for the same time period. This comparison is facilitated by the use of fish ticket data.

The distribution of fishing in the 1960-69 period was summarized by partitioning the fish ticket data into catches made in inshore and offshore shallow and inshore and offshore deep regions for each stock. (N.B. These regions are defined in Figure II.12 and are distinct from those defined by, for example, Powell and Gray.) This distribution is presented in Figures II.10 and II.11. These regions are built up from Kodiak area environment zones, abbreviated for convenience to the four region types mapped in Figure II.12. Inshore extends to thirty miles from shore, and shallow reaches down to fifty fathoms. These are the same areas as used in the ANOVA analysis of CPUE coded in Table II.2 above.

If we examine the distribution of catch and landings for stocks 1, 2, and 3, in Figures II.10 and II.11, we see that (with the exception of stock 3) in the early 1960's most of the catch was taken in the inshore shallow regions, but in the late 1960's the catch was taken from both the inshore and offshore regions (see Powell and Gray, in press). Furthermore, a seasonal periodicity is evident in which the inshore and offshore shallow catches tend to be made late in the fishing season, whereas those from the inshore and offshore deep regions tend to be concentrated in the early part of the fishing season. Thus as the years progressed, increased catches were obtained from deeper waters and tended to be early, rather than late, in the fishing season.

Now if we observe the interseasonal periodicity in average weight in

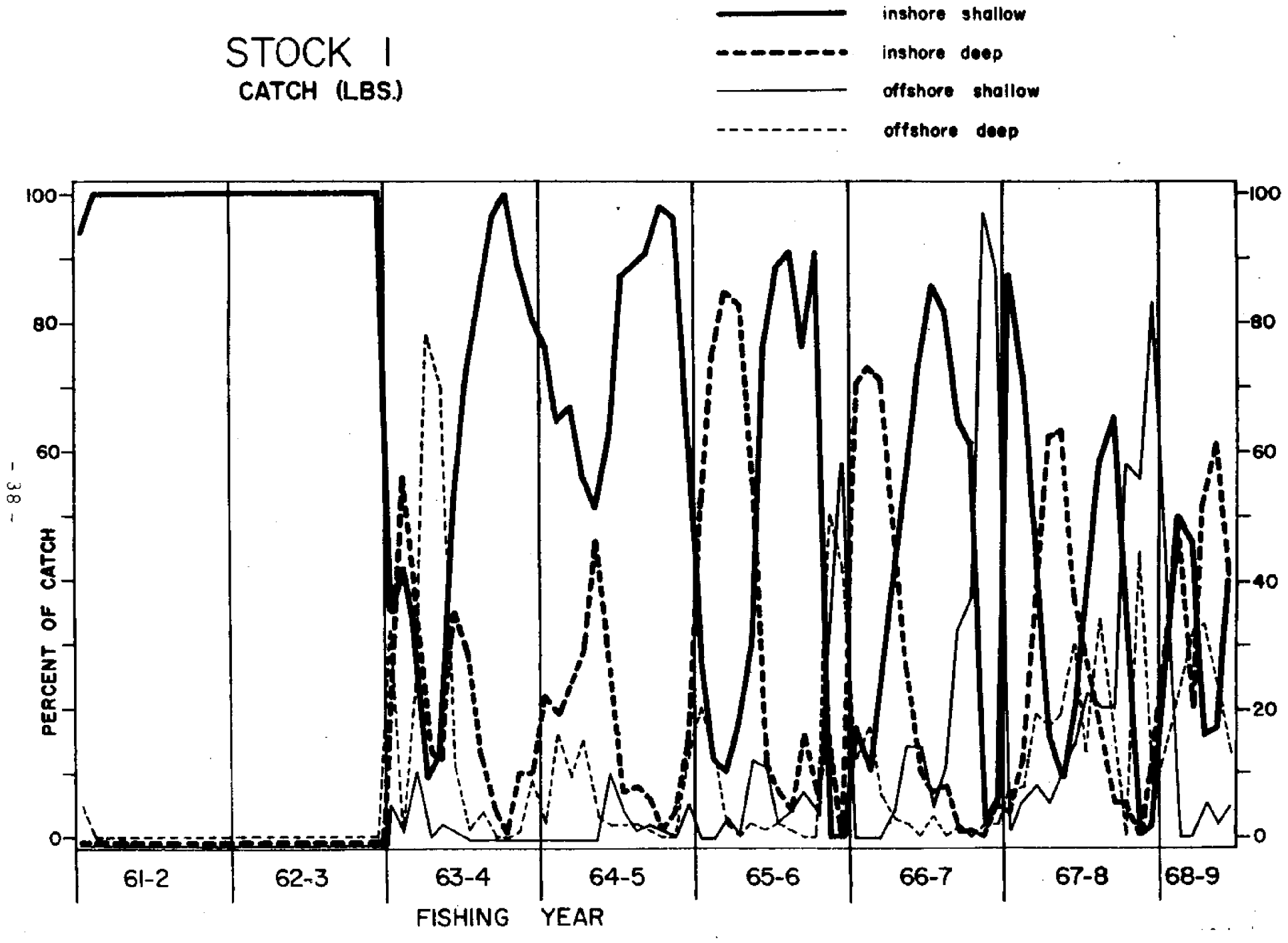


Figure II.10. Distribution of catch among inshore and offshore, shallow and deep regions of Kodiak stock 1 for 1961-68.

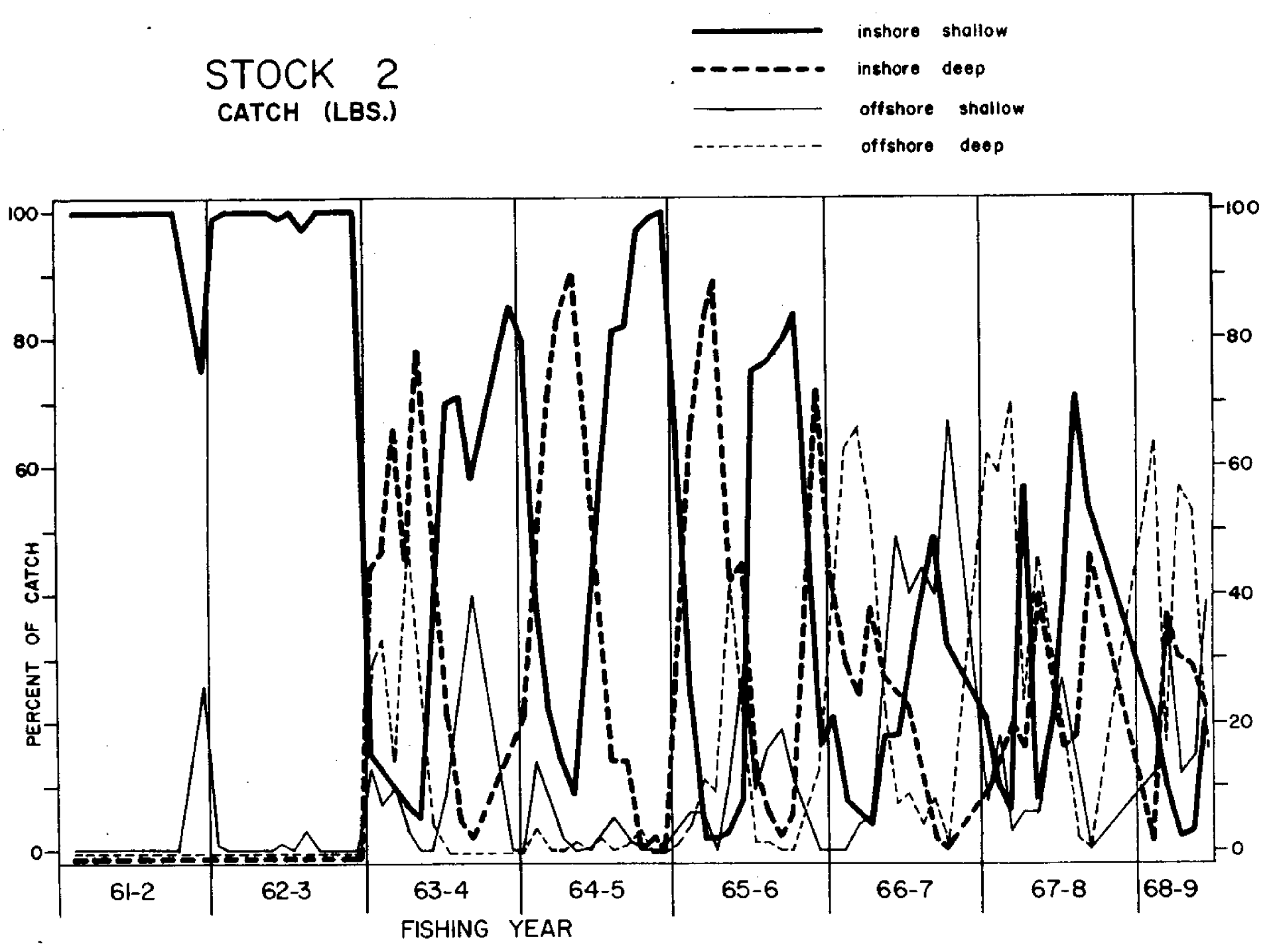


Figure II.10 - continued. Distribution of catch among inshore and offshore, shallow and deep regions of Kodiak stock 2 for 1961-68.

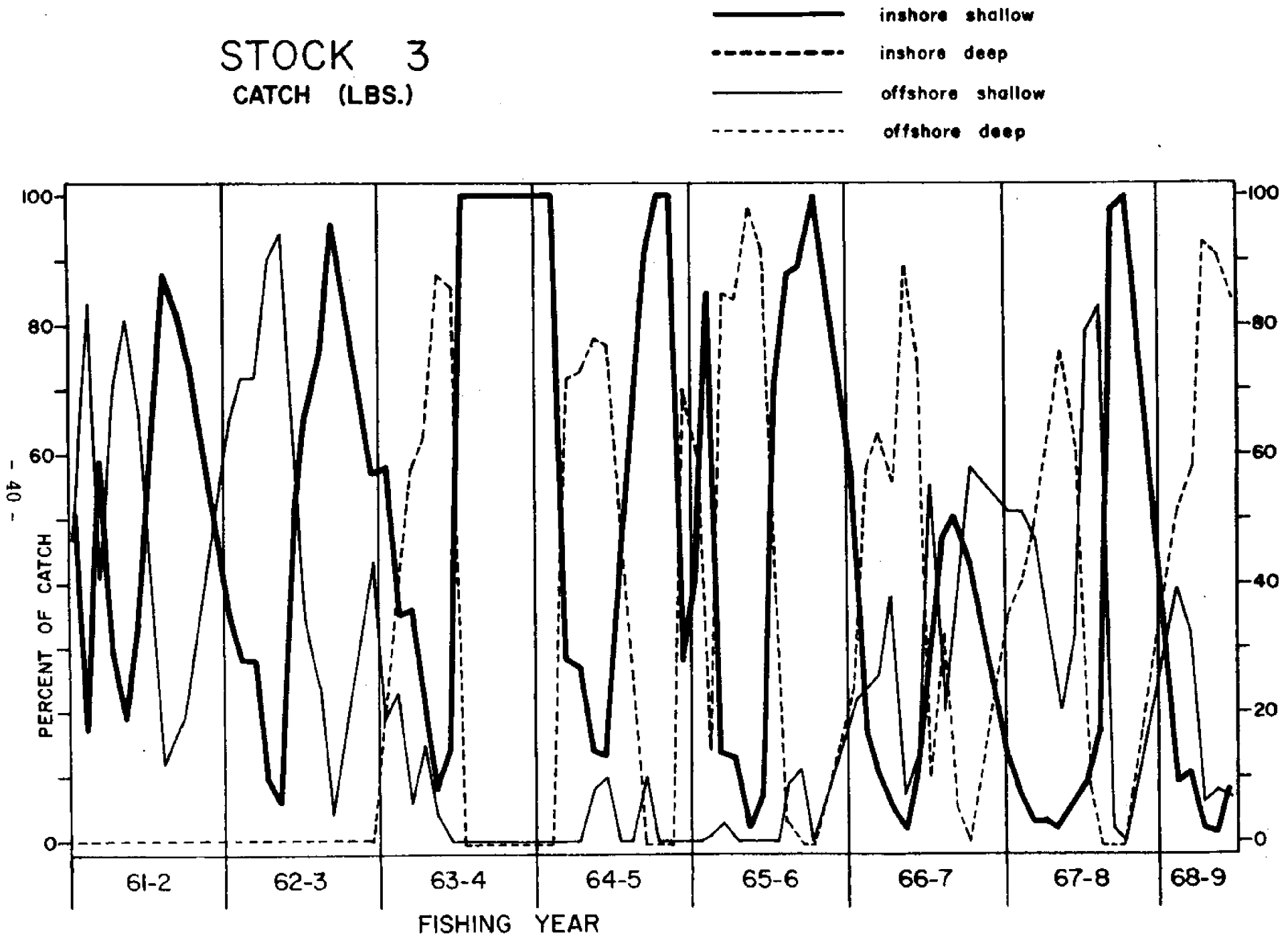


Figure II.10 - continued. Distribution of catch among inshore and offshore, shallow and deep regions of Kodiak stock 3 for 1961-68.

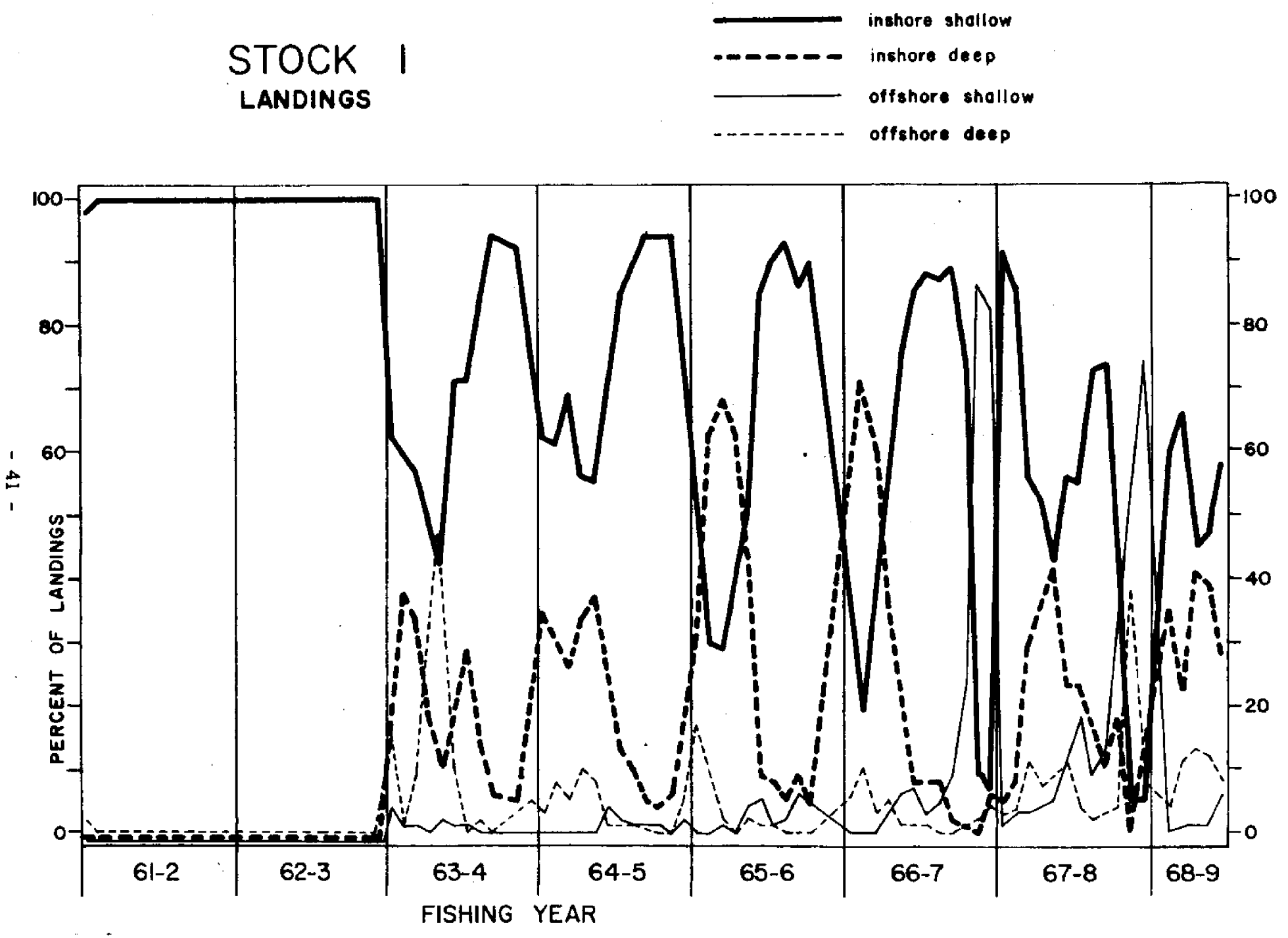


Figure II.11. Distribution of landings among inshore and offshore, shallow and deep regions of Kodiak stock 1 for 1961-68.

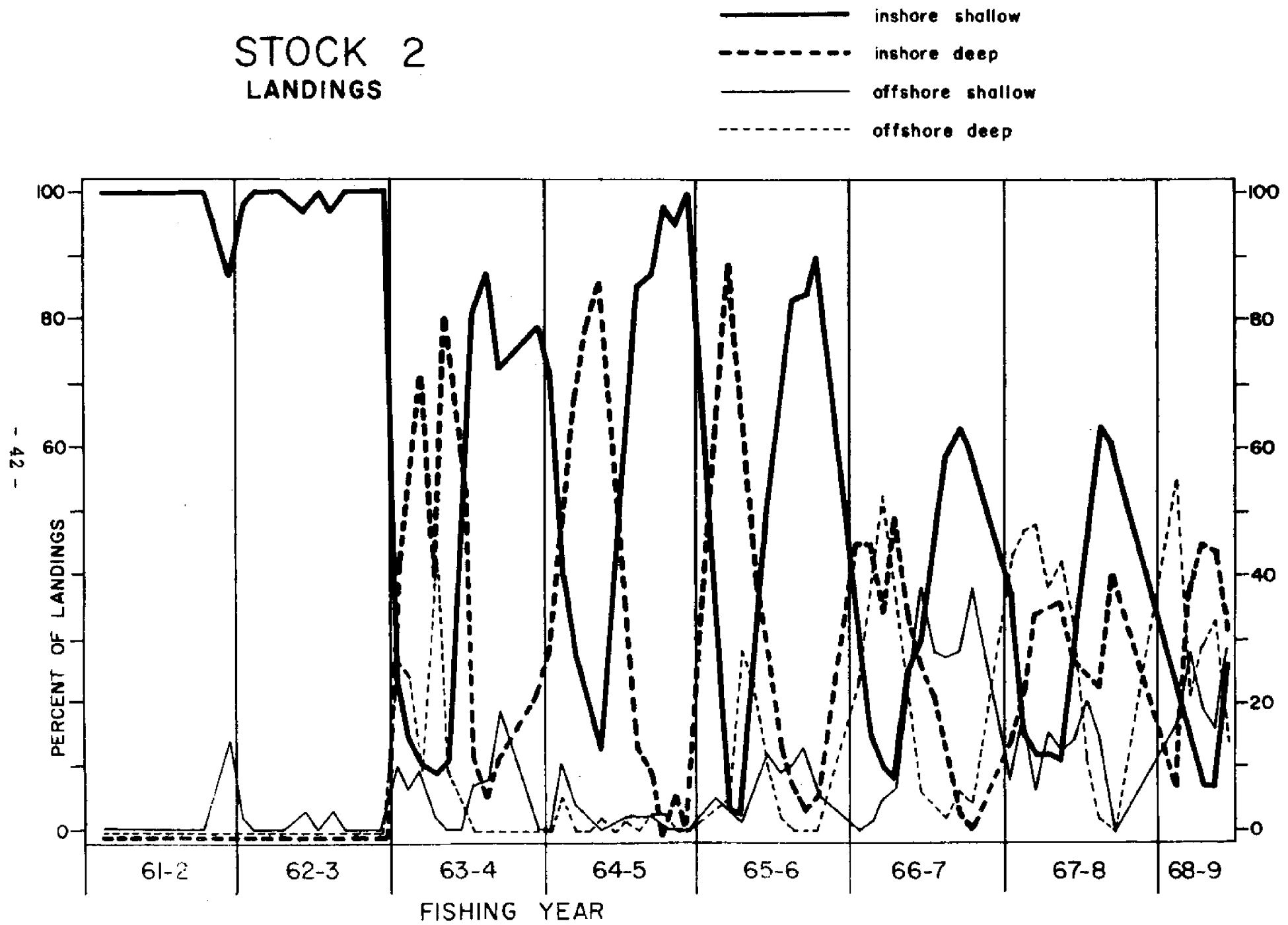


Figure II.11 - continued. Distribution of landings among inshore and offshore, shallow and deep regions of Kodiak stock 2 for 1961-68.

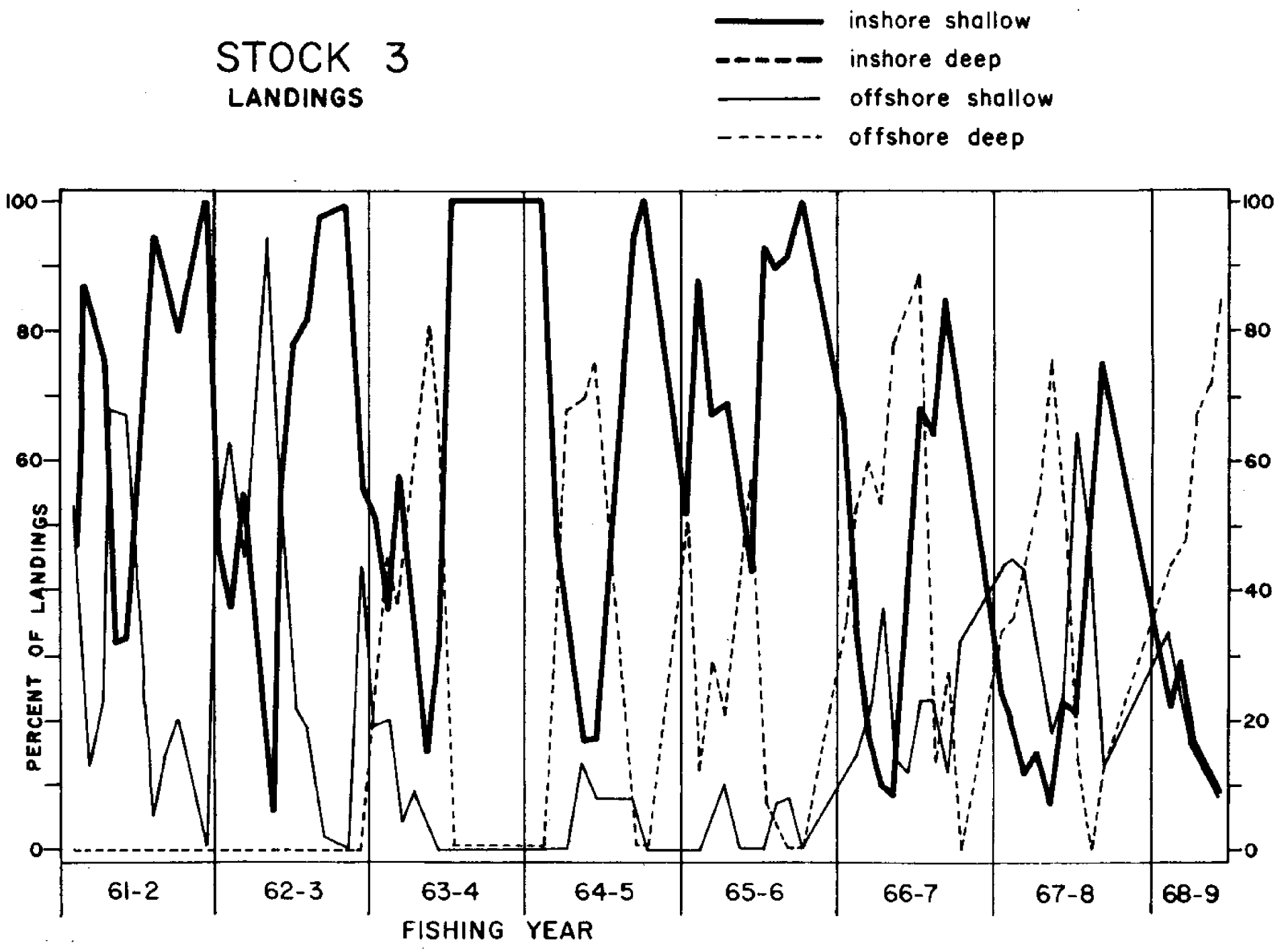


Figure II.11 - continued. Distribution of landings among inshore and offshore, shallow and deep regions

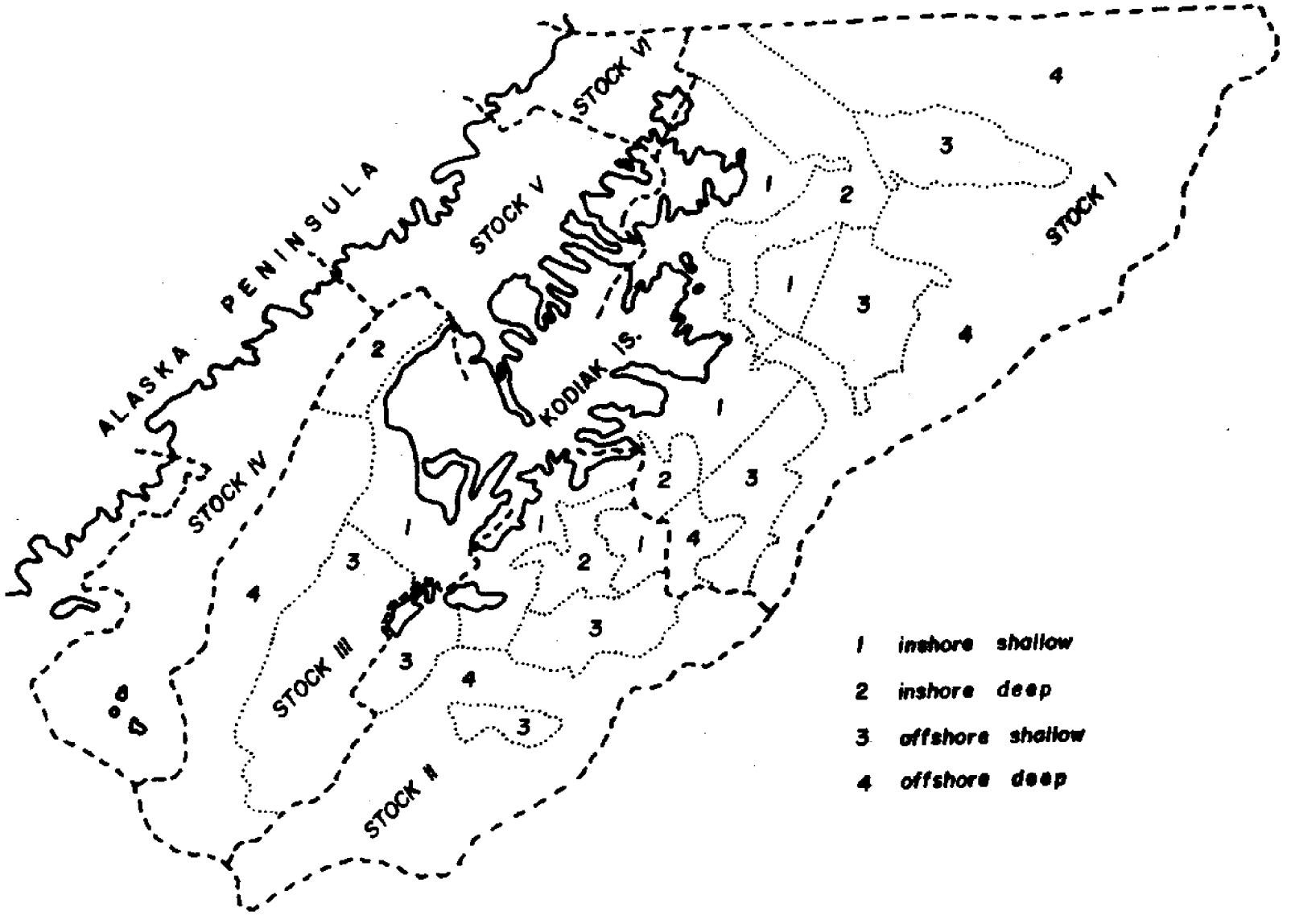


Figure II.12. Map of inshore and offshore, shallow and deep regions of Kodiak stocks 1, 2, and 3.

stock 1 (Figure II.7), we see that the crabs in the catch are lighter in weight earlier in the season than later in the season. It would appear that there is a similar tendency, although not quite as clear, for stocks 2 and 3. Thus it would also appear that crabs caught from deeper water tend to be smaller than those crabs taken from shallower water. (This, of course, refers only to catches and not necessarily to the actual distribution of the various sizes of crabs.) Furthermore, the catch of large crabs in the shallower waters later in the season might be related to the relatively large number of breeding crabs (many of which tend to be male anexuviants) which congregate on the shallow-water breeding grounds.

From this we conclude that the large increases in apparent abundance during the mid-1960's might have been associated with a shift in the distribution of fishing from shallow to deeper waters. This would tend to produce, when examining each stock in its entirety, an increase in small crabs in the catch and would tend to produce an increase in "apparent" recruitment and a dimunition in the average size of the king crab. But this depends on the maintenance of crab size-depth stratification and the rather circumstantial assumption that smaller crabs tend to be most abundant in the offshore waters during the later part of the fishing season. That this stratification is not perfect, is indicated by the interseasonal periodicity of crab size before fishing in deeper waters was prosecuted to any large extent. This discussion suggests that movement of the fishing effort into deeper water might reflect an increase in apparent recruitment and a concomitant increase in apparent abundance. It also suggests that, in order to determine the nature of increased apparent abundance of crabs in the mid-1960's, an examination of the evidence pertaining to real recruitment might be beneficial. We emphasize, at this point, the need to examine in greater detail the various inter-relations which are suggested by further collective examination of the various data sets under discussion here. This further examination may very well admit alternative interpretations.

II.A.5. Discussion of Apparent Abundance and Its Relation to Recruitment

A collective examination of data on apparent abundance reveals that apparent abundance of king crab in 1964-65 and 1965-66 fishing years was at a relatively high level. The FRI logbook data and the previously cited ADF&G Memorandum 3 are suggestive that the apparent abundance in the late 1950's was less than that in mid-1960's. The boat captain interview data indicate that the apparent abundance in 1963-64 was less than that in 1964-65 and 1965-66. The fish ticket data from the Kodiak area also indicate that there was a peak in apparent abundance in the mid-1960's. Thus, it would appear that in the Kodiak region apparent abundance increased from the early 1960's until the 1964-65 and 1965-66 fishing years and then decreased.

An interpretation of these events is required to approach an understanding of the dynamics of the Kodiak king crab fishery. Our interpretation is that these trends in apparent abundance are correlated with recruitment. We base this interpretation on examining additional evidence on (1) estimates of actual recruitment, (2) size distribution from fish tickets, (3) growth changes, (4) distribution of catch and effort, and (5) size distribution from length frequency distributions.

II.A5.a Estimates of Actual Recruitment

A description of the methods for determining a "recruit" crab and an estimate of recruitment for each year and stock are given in the paper by Jackson and Manthey (1969). They arrived at their estimates by pooling the various samples without considering the problem of representativeness. More precise estimates might be obtained by, for example, weighting by CPUE, but it is unlikely that any material differences in general trends would be obtained by an alternative scheme. The estimated number of recruits for stocks 1, 2, and 3 taken from their Table 1 is given in our Table II.10 along with the peak catch per landing and catch per standard pot for each fishing year. The data in Table II.10 are shown in Figure II.13. From these data, it would appear that the estimated recruitment for stocks 1, 2, and 3 is correlated with the peak catch per landing and the estimated recruitment is correlated with the catch per standard pot for stocks 1 and 2, but not with catch per standard pot for stock 3. The lack of correlation in the last instance occurs because, for stock 3, the second quarter which is used for the catch per pot index is not always the peak quarter in catch per landing.

Another interesting feature of Figure II.13 is a tendency toward curvilinearity in the relation between CPUE and recruits in stock 2. This can be explained in the case of the per-landing measure of effort, as was explained in Section II.A.4, as a saturation effect. The curvilinearity of the relation between estimated recruitment and CPUE might reflect a saturation level for pot-type gear at levels of about 100 crabs per pot. The above analysis then suggests that trends in CPUE in several instances tend to be correlated with trends in recruitment.

In order to avoid the complications of combining the recruitment data, and thus also avoid the possibilities of having estimates that are not representative of the population, we have examined the ADF&G recruitment and length-frequency data to determine which statistical areas had large numbers of samples over a relatively long time period. The distribution of these samples is shown in Table II.11. The six statistical areas shown in

Table II.10. Comparison of recruitment with catch-per-landing and catch per pot, all in number of crabs, by fishing year for stocks 1, 2, and 3.

	Stock 1			Stock 2			Stock 3		
		CPUE			CPUE			CPUE	
Year	R*	CPL**	CPP	R*	CPL**	CPP	R*	CPL**	CPP
1960-61	--	.9	--	.8	4.1	--	.4	0.6	--
1961-62	--	.8	--	2.6	1.0	--	4.7	2.7	--
1962-63	--	.9	--	--	2.8	--	3.5	2.2	--
1963-64	--	1.3	41	3.2	2.7	47	3.7	3.4	--
1964-65	3.2	1.7	57	15.7	3.8	86	2.9	6.1	53
1965-66	5.8	2.2	57	25.8	4.5	95	7.1	5.1	75
1966-67	2.5	1.7	23	14.4	3.5	52	6.4	5.1	68
1967-68	1.7	.8	26	3.5	2.5	20	7.7	5.1	25
1968-69	2.9	1.0	14	3.6	3.4	16	5.7	4.3	19

* Recruitment expressed as 100,000 recruit crabs in commercial catch.

** Catch per landing expressed in 1,000 crabs.

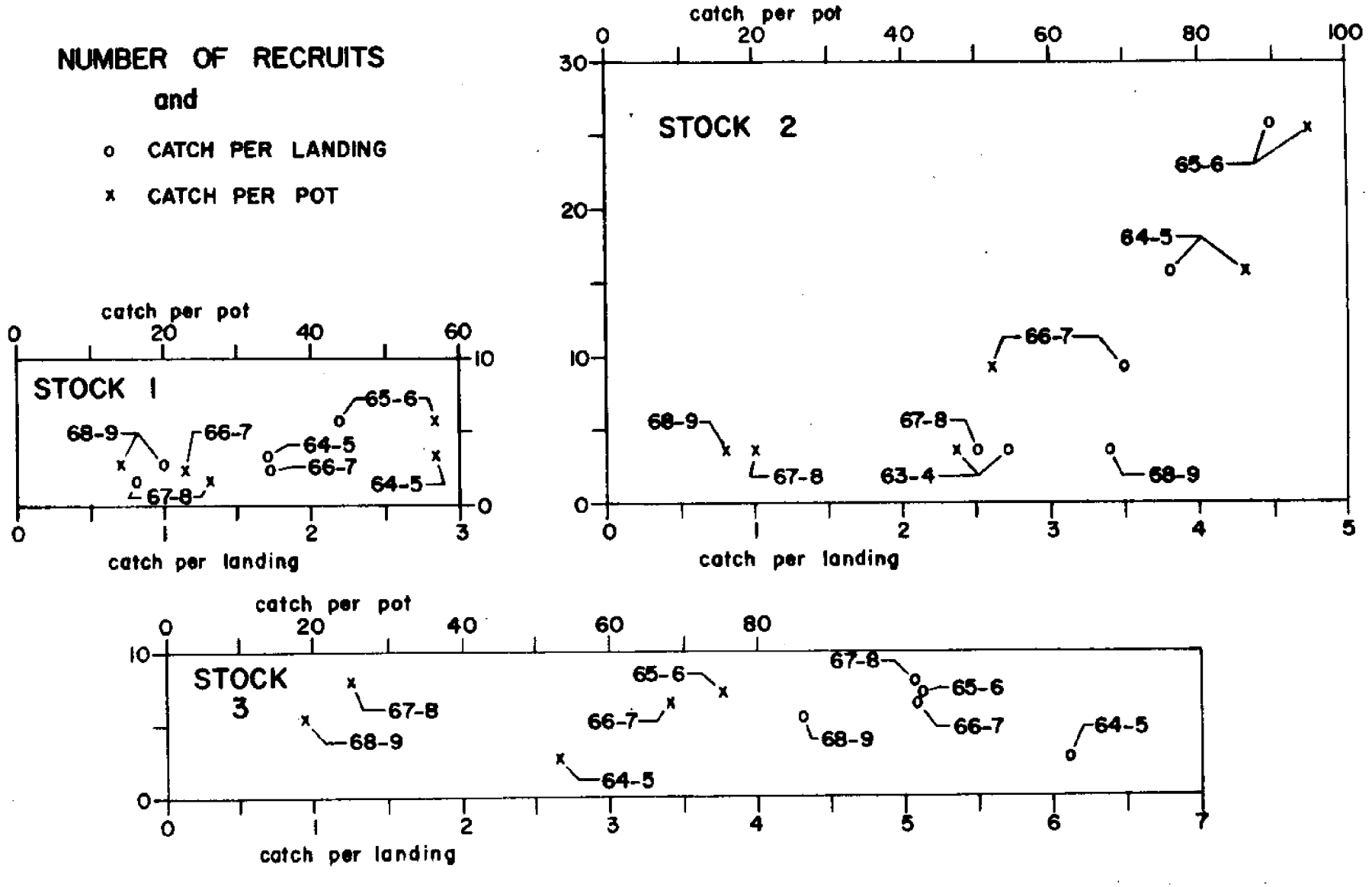


Figure II.13. Comparison of recruitment (on the ordinate) with catch per landing and catch per pot for Kodiak stocks 1, 2, and 3. Units of measurement are as in Table II.10 (p. 47).

Table II.11. Distribution of ADF&G recruitment and length-frequency data by statistical area and quarter of fishing year.

Fishing year	60-61	61-62	62-63	63-64	64-65	65-66	66-67	67-68	68-69	69-70	Stock
Fishing quarter	2 3	1 2 3	1	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3 4	1 2	1	
Statistical area											
Unknown	- -	- - -	-	- - -	- - -	- * -	- - -	- - - -	- *	-	-
25110	- -	- - -	-	- - -	- - -	- - -	- - -	- - - -	- *	-	5
25150	- -	- - -	-	- - -	- - -	- - *	- - -	- - - -	- -	-	6
25190	- -	- - -	-	- - -	- - -	- * -	- - -	- - - -	- -	-	1
25210	- -	- - -	-	- - -	- - -	- - -	- * -	- - - -	- -	-	1
25230	- -	- - -	-	- - -	- - -	- * -	* - -	- - - -	* -	-	1
25236	- -	- - -	-	- - -	- - -	- - -	- - -	- - - -	- *	-	1
25237	- -	- - -	-	- - -	- - -	- - -	- - -	- - - -	- *	-	1
25239	- -	- - -	-	- - -	- - -	- * -	- - -	- - - -	- -	-	1
25251	- -	- - -	-	- - -	- - -	- - -	- - -	- - - -	- -	*	1
25252	- -	* - -	-	- - -	- - -	- * -	- - -	- - - -	* -	*	1
25253	- -	- - -	-	- - -	- - -	* * -	- - -	- - - -	* -	*	1
25254	- -	- - -	-	- - -	- - *	- - -	- - -	- - - -	- -	-	1
25256	- -	- - -	-	- - -	- - -	- * -	- - -	- - - -	- -	-	1
25257	- -	- - -	-	- - -	- - -	- - -	- - -	- * - -	- *	*	1
25259	- -	- - -	-	- - -	- - -	- - -	- - -	- - - -	* -	-	1
25261	- -	* - -	-	- - -	- - -	- - -	- - -	- - - -	- -	-	1
25264	- -	- - -	-	- - -	- - -	- - -	* - -	- - - -	- -	*	1
25268	- -	- - -	-	- - -	- - -	- - -	- - *	- - * *	- -	-	1
25331	* -	- - -	-	- - -	* - -	* - -	- - -	- - - -	* *	*	5
25333	- -	- - -	-	- - -	- - -	- - -	- - -	- - - -	- -	*	5
25410	- -	- - -	-	- - -	- - -	- - -	- - -	- - - -	- -	*	5
25430	- -	- - -	-	- - -	- - -	- - -	- - *	- - - -	- -	-	5
+25710	* *	* * *	*	- - -	* - -	* - -	* - -	* - - -	* -	*	3
25720	- *	* * -	-	- * *	- - *	- * -	- - -	- - - -	- -	-	3
25750	* -	* * -	-	- - -	- - -	- - -	- - -	- - - -	- -	-	3
25760	- -	* - -	-	- - -	- - -	- - -	- - -	- - - -	- -	-	3
25770	- *	- - *	-	- - *	- - *	- - -	- - -	- - - -	- -	-	3
25780	- -	- - *	-	- - -	- - -	- * -	- - -	* - - -	- -	-	3
25781	- -	- - -	-	- - -	- - -	- - -	* - -	* - - -	* -	*	3
25782	- -	- - *	-	- - -	- - -	- - -	- - -	* - - -	- -	-	3
25783	- -	- - -	-	- - -	- - -	- - -	- - -	* - - -	- -	-	3
.25784	- -	- - -	-	- - -	- - -	- - -	- - -	- - - -	- -	*	2
25790	- -	- - -	-	- - *	- - *	- - *	- * *	- - - -	- -	-	2
+25791	- -	- - -	-	* * *	- - -	- * -	* * -	* * - -	* *	-	2

(Continued)

Table II.11. Distribution of ADF&G recruitment and length-frequency data by statistical area and quarter of fishing year (continued).

Fishing year	60-61		61-62			62-63	63-64			64-65			65-66			66-67			67-68				68-69		69-70	Stock
Fishing quarter	2	3	1	2	3	1	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	4	1	2	1	
Statistical area																										
25810	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	*	-	-	*	-	-	1
25851	-	-	-	-	-	-	-	-	*	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	2
25855	-	-	-	-	-	-	-	-	-	-	-	-	-	*	*	-	-	*	-	-	-	-	-	-	-	2
25860	-	*	-	-	-	-	-	-	-	-	-	*	-	-	*	-	-	-	-	-	-	-	-	*	*	2
25870	-	-	-	-	*	-	-	*	*	-	-	*	-	-	*	*	-	-	-	-	-	-	-	-	-	2
+25880	-	-	-	-	*	-	-	*	*	-	-	*	-	*	*	*	*	-	*	*	-	-	-	-	*	2
+25881	-	-	-	-	-	-	-	*	-	*	*	*	*	*	*	*	*	-	*	-	-	-	*	*	*	2
+25891	*	-	*	*	-	-	-	-	-	*	-	-	*	*	-	*	-	-	*	-	-	-	*	*	*	2
25892	-	-	-	-	-	-	-	-	-	-	-	-	*	*	-	*	-	-	-	-	-	-	-	-	*	1
25895	-	-	-	-	-	-	-	-	-	-	-	-	*	*	*	-	*	-	-	*	-	-	*	*	*	2
25896	-	-	-	*	-	-	-	*	-	-	-	-	-	-	-	*	-	*	-	-	-	-	*	*	*	2
25921	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	*	1
25923	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	1
25930	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	1
25942	-	-	-	-	-	-	-	-	-	-	-	-	*	*	-	*	-	-	-	-	-	-	-	-	*	1
25961	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	*	-	-	-	-	-	-	-	-	1
25962	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	1
25963	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	*	-	-	-	-	-	-	-	-	1
25966	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	*	1
26270	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	4
26285	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
29111	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	*	6
29112	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	*	6
29121	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
29122	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
29131	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
29132	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	*	5
29142	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	3
29152	-	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
+29153	-	-	-	*	*	-	*	*	-	*	*	-	*	-	*	*	*	-	*	*	-	-	*	-	*	3
29163	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	*	3
29173	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	*	-	-	*	*	*	3
29182	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	-	3
29183	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	*	-	*	-	-	-	*	*	-	3

\+ Statistical areas used for further analysis.
* Data present
\- Data absent

Figure II.14 contain the largest number and best distribution of samples. The per cent recruits in each sample is plotted by statistical area in Figure II.15. The figure shows that these areas are in the stock 2 and stock 3 regions. We can see that in stock 2 the percentage recruits tend to increase from the mid-1960's through to 1969. This would be expected as fishing mortality increases and this percentage of recruits can, in fact, be used to estimate mortality. The positive deviation in 1964-65 in 25881 (MORE) most likely reflects recruitment. Another way of examining the question is to estimate the catch in the various areas and to multiply this estimated catch by the percentage recruitment to arrive at an estimate of the actual number of recruits. Our method for doing this is outlined in Table II.12. The pertinent data are plotted in Figure II.16. We can see in Figure II.16 that recruitment in stock 2 was relatively high in the mid-1960's and that for stock 3, the number of recruits was relatively high in area 29153 but not in area 25170. When recruitment is placed on a density basis, it can be seen that despite the low numerical abundance of recruitment the densities of recruit crabs in 25710 and 29153 might be approximate. It is interesting to observe that the recruitment in stocks 2 and 3 is evident in the inshore shallow areas as well as in the offshore deep waters.

For convenience, since at this time we have not yet summarized the fish ticket data (i.e., catch) by individual statistical areas but have done so for small groups of areas, Table II.12 and Figure II.16 are actually based on the areas shown in Figure II.17. This should be compared to Figure II.14. It is assumed that the percentages of recruits should not be greatly different in the additional, adjacent, topologically similar statistical areas and hence we have used the combined catches for these areas.

Fish ticket data may be used to evaluate recruitment. In using this data we must recognize that the average weights of crabs are estimated by taking the total weight of the crabs and dividing this by the number of crabs. Insofar as the number of crabs is an estimate and sometimes, evidently, a crude estimate, the average weight in some instances might also be a crude estimate.

The data are set forth as a time series for each stock in Figure II.7. Several features are evident from these figures. First, stock 1 exhibits an increasing trend in average size, but stocks 2 and 3 exhibit decreasing trends in average size. These trends can reflect, all other things being equal, trends in total mortality, and this will be discussed later in our report. The trend in stock 1 might perhaps also be interpreted as an increase in average size until 1964-65, and then a decrease. It is pertinent to the question of recruitment to note that for stock 2, the majority of average weight points in 1964-65 and in 1965-66 fell below the trend line, indicating that for this stock the average size of the crabs was, for these years, less than average, even

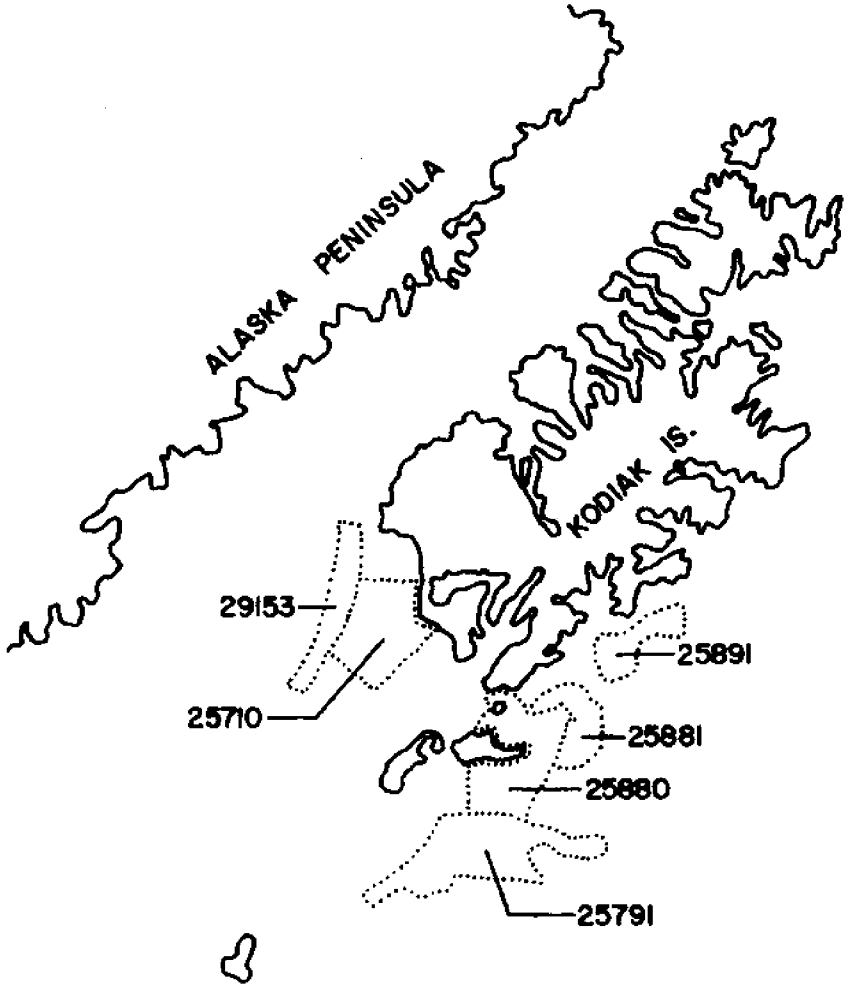
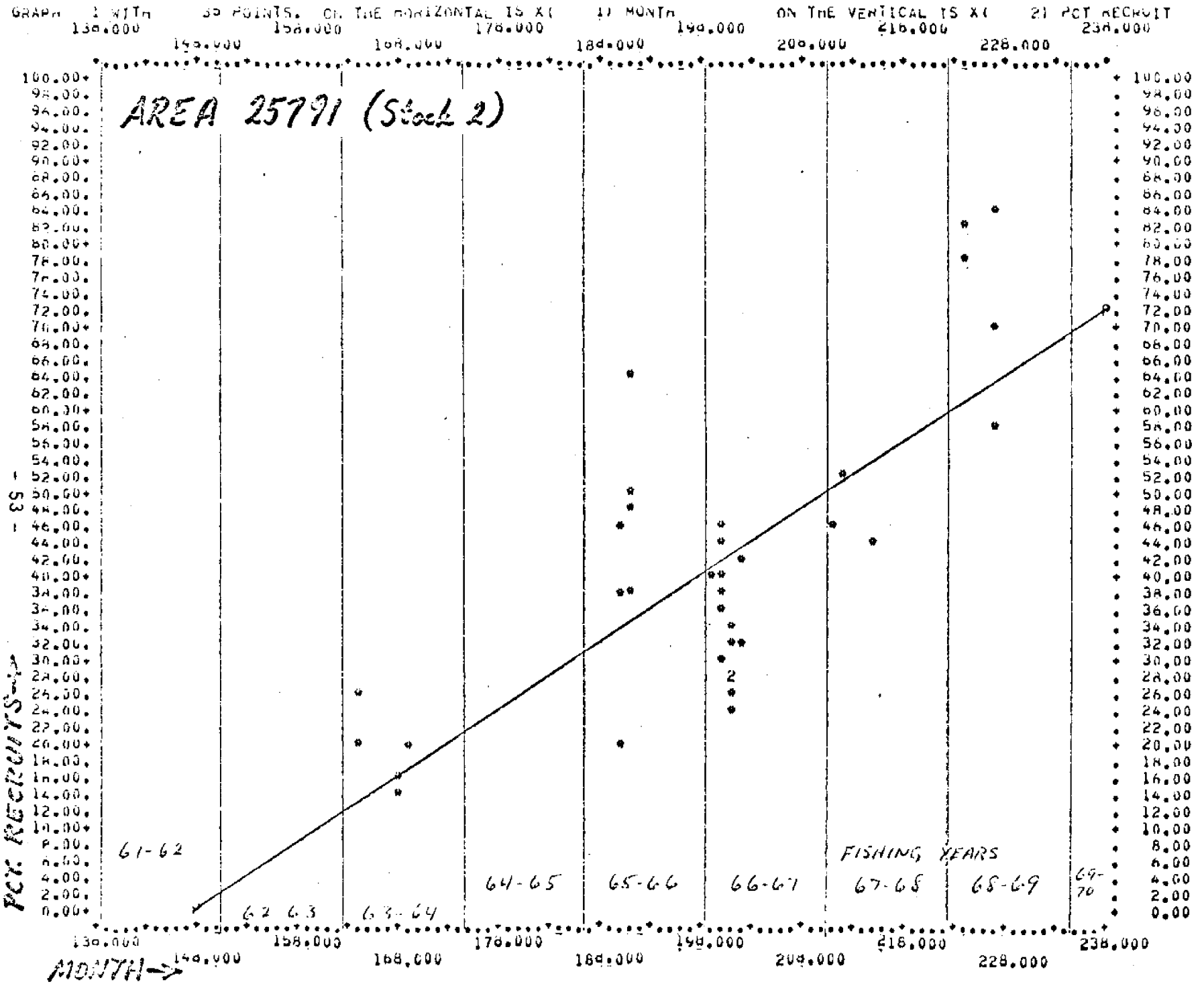


Figure II.14. Map of Kodiak statistical areas used for percentage recruits analysis from ADF&G recruitment and length-frequency data.



Y= -0.6271 + .1946(X = 196.3714)+ R= .753+ X-SD= 17.1294 Y-SD= 18.1810+ SY.X= 12.1517

Figure II.15. Percentage recruits in Kodiak Statistical Area 25791 by month (69)

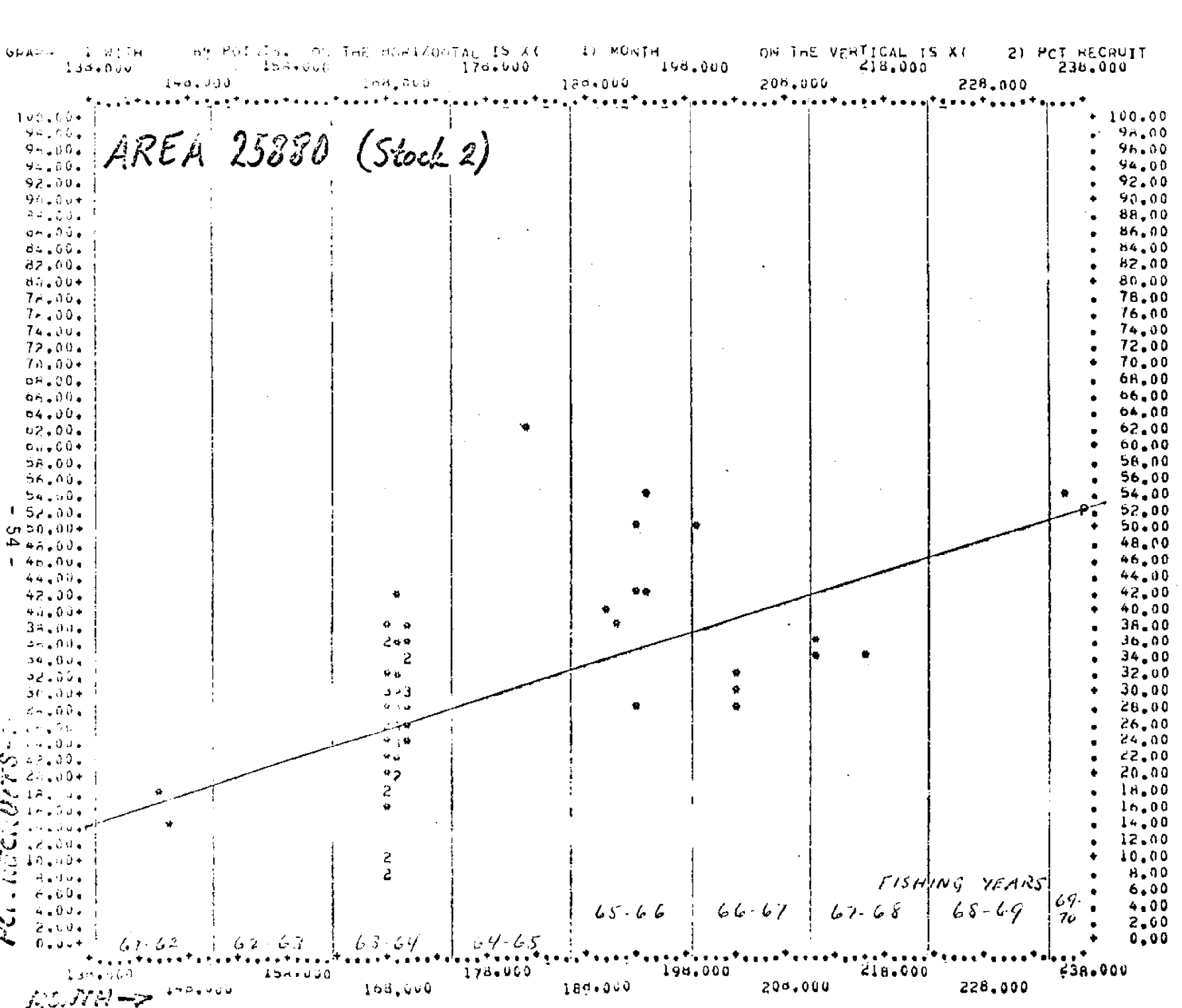
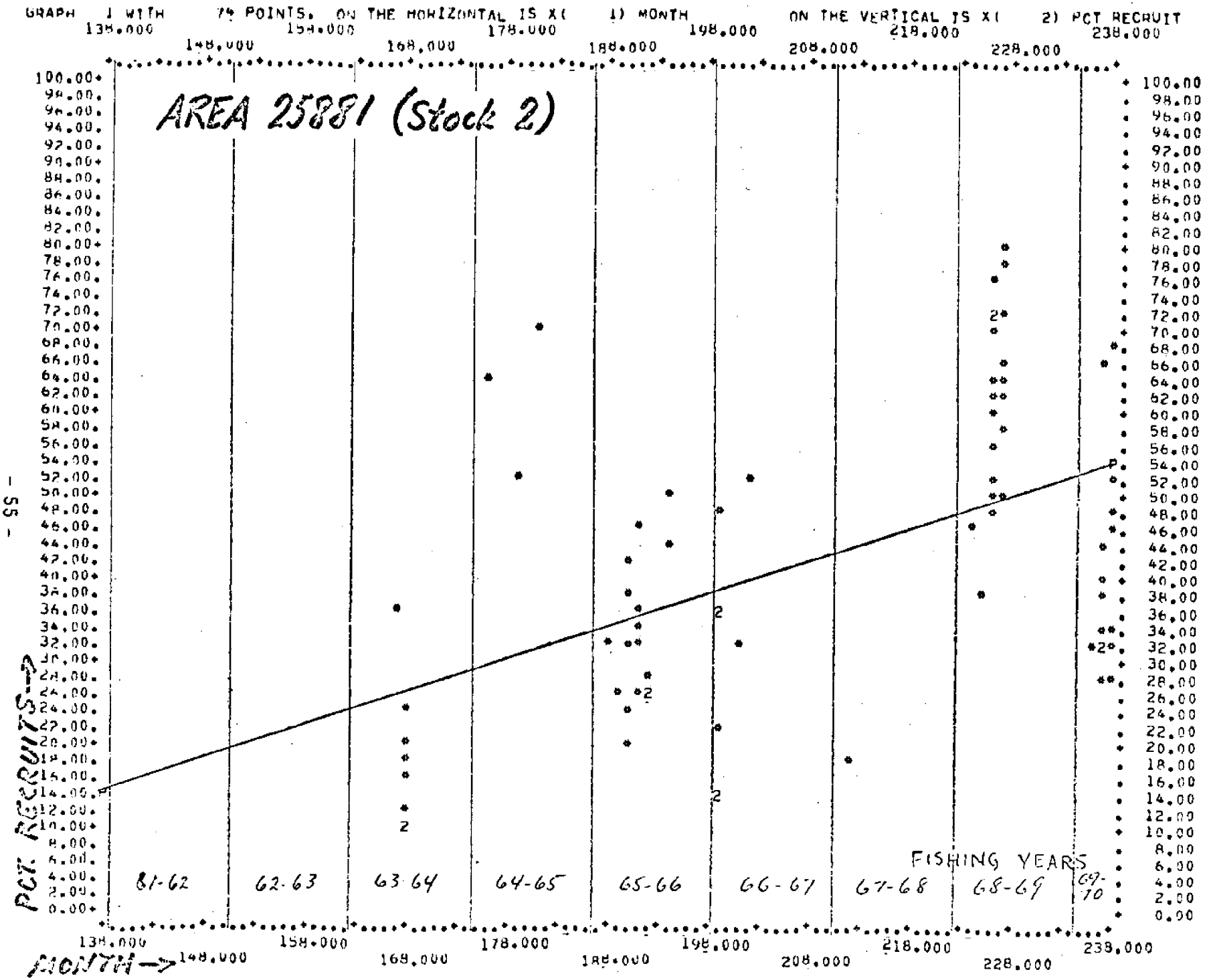
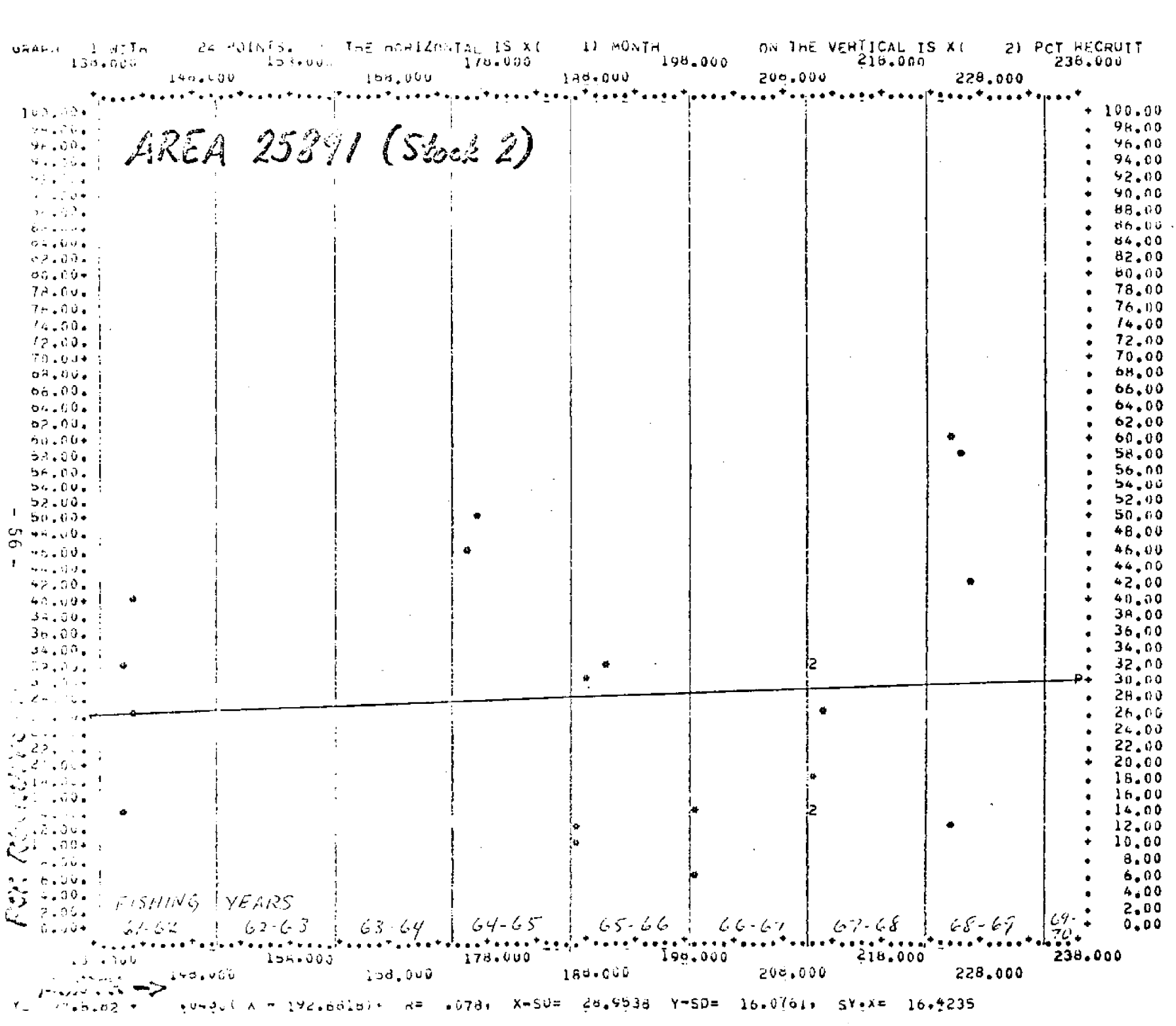


Figure 11. (cont.). Percentage recruits in Kodiak Statistical Area 25880, by sample 1961 [illegible].

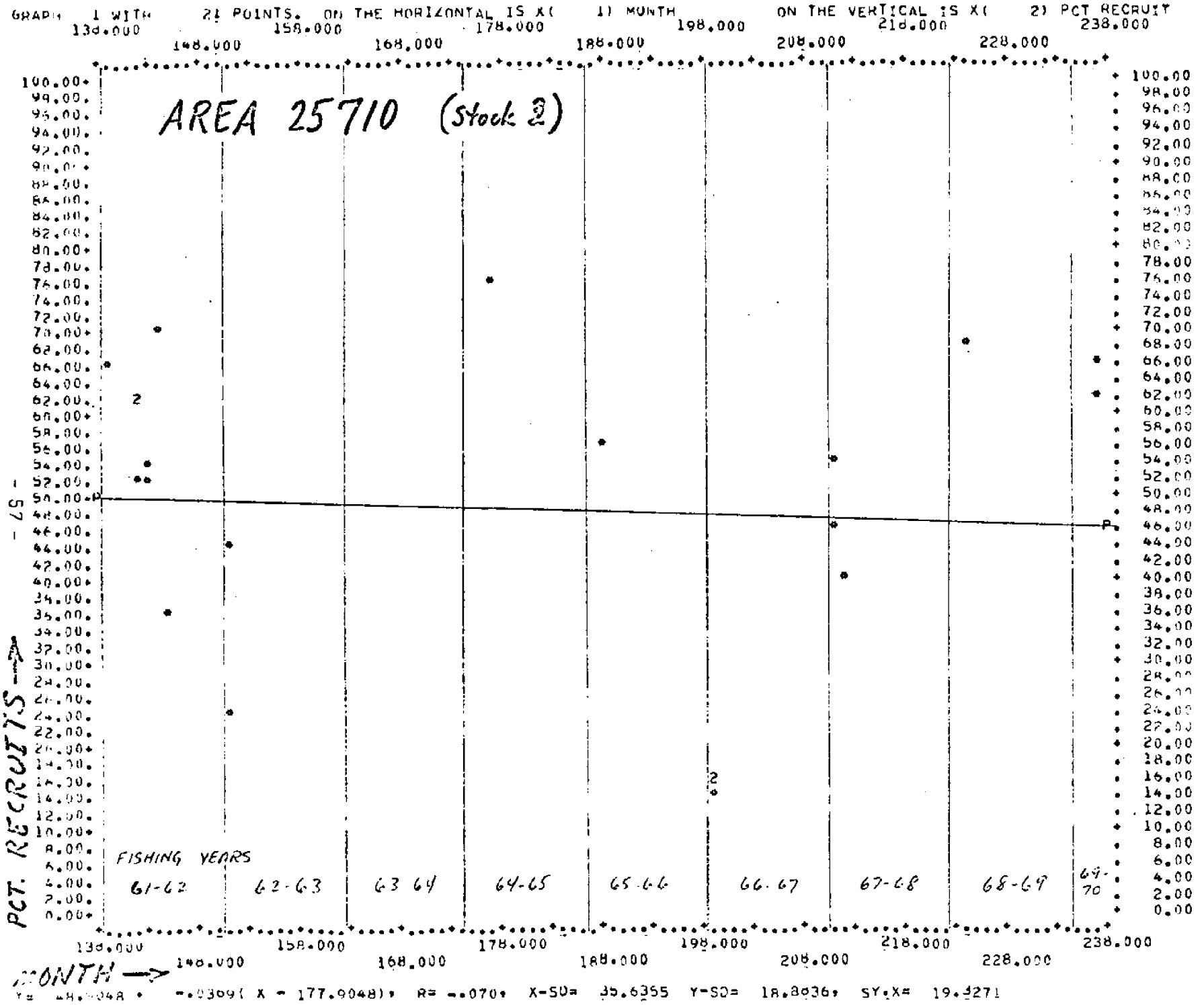


Y= 41.6049 + .3997(X - 209.2297), R= .516, X-SD= 23.9134 Y-SD= 18.5386, SY.X= 15.9939



- 56 -

Figure [illegible]. Percent recruits in Kodiak Statistical Area 25891, by sample, 1961-69.


GRAPH 1 WITH 21 POINTS. ON THE HORIZONTAL IS X(1) MONTH ON THE VERTICAL IS X(2) PCT RECRUIT
AREA 25710 (Stock 2)
PCT. RECRUITS →
MONTH →
FISHING YEARS
61-62
62-63
63 64
64-65
65-66
66-67
67-68
68-69
69-70
Y= -8.9048 + -.0309(X - 177.9048), R= -.070, X-SD= 35.6355 Y-SD= 18.8036, SY.X= 19.3271

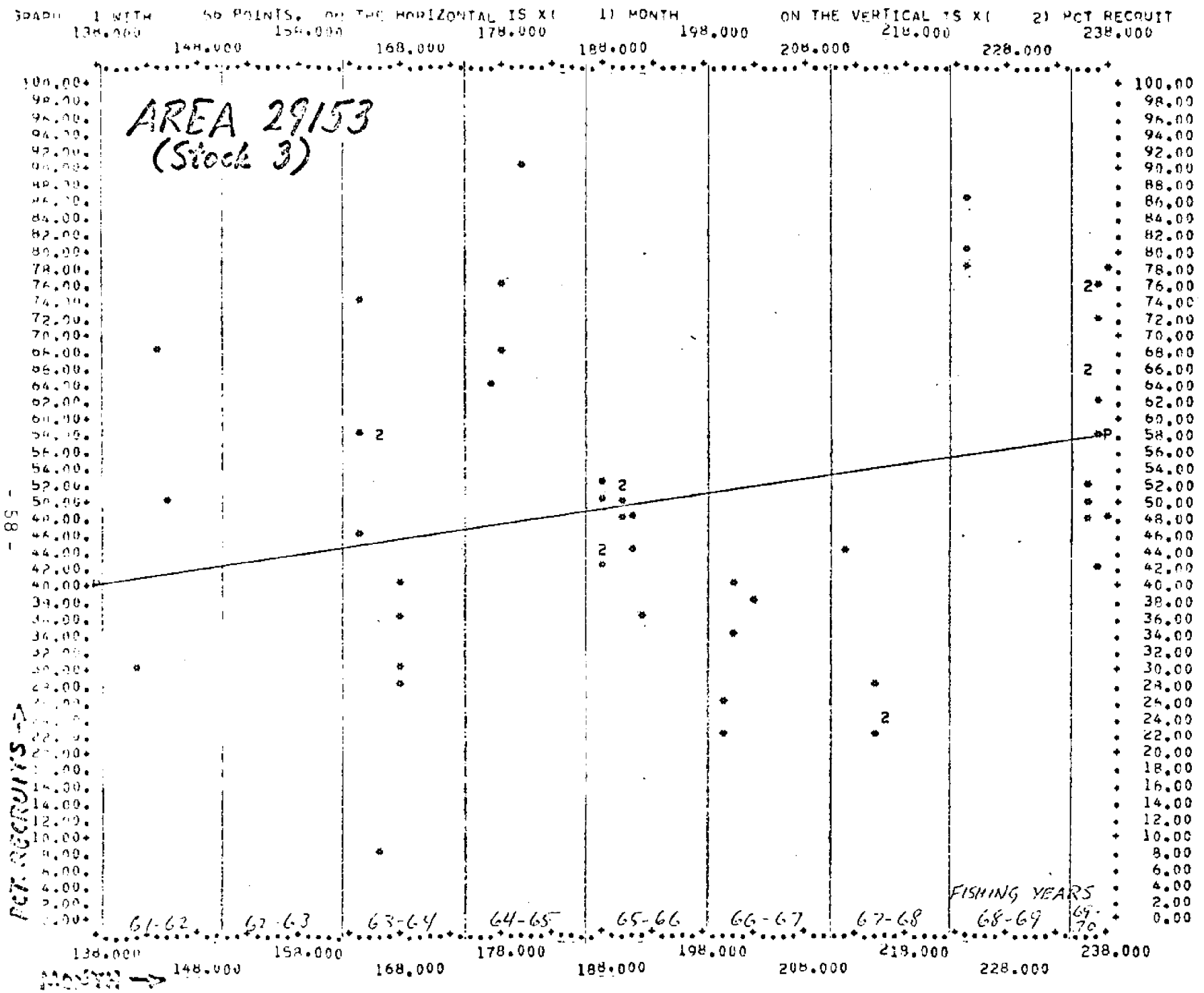

GRAPH 1 WITH 56 POINTS. ON THE HORIZONTAL IS X(1) MONTH ON THE VERTICAL IS X(2) PCT RECRUIT
AREA 29153
(Stock 3)
PCT RECRUITS
FISHING YEARS
61-62
62-63
63-64
64-65
65-66
66-67
67-68
68-69
69-70
MONTH
Y= 50.7979 + .1648(X - 199.0000)+ R= .254+ X-SD= 28.8614 Y-SD= 18.7617+ SY.X= 18.3168

Table II.12. Estimated number of recruits per quarter by selected Kodiak areas.

Area		A			B[1]			C			D[2]			E[3]		
Statistical Areas		25880			25881 + 25891			25791			25710			29153		
Stock		2			2			2			3			3		
Fish. year	Fish. qtr.	Avg. % R	Catch (1000 crabs)	R (1000 crabs)	Avg. % R	Catch (1000 crabs)	R (1000 crabs)	Avg. % R	Catch (1000 crabs)	R (1000 crabs)	Avg. % R	Catch (1000 crabs)	R (1000 crabs)	Avg. % R	Catch (1000 crabs)	R (1000 crabs)
60-61	1	-	-	-	14.0	*	*	-	-	-	-	-	-	-	-	-
	3	-	-	-	-	-	-	-	-	-	5.0	282.8	14.14	-	-	-
61-62	1	-	-	-	22.5	*	*	-	-	-	65.0	55.6	36.14	-	-	-
	2	-	-	-	33.0	*	*	-	-	-	58.0	114.7	66.55	48.5	*	*
	3	15.5	321.1	49.77	-	-	-	-	-	-	35.0	326.7	114.34	50.0	*	*
62-63	1	-	-	-	-	-	-	-	-	-	33.5	131.9	44.20	-	-	-
63-64	1	-	-	-	-	-	-	22.5	100.8	22.68	-	-	-	59.0	175.8	103.71
	2	22.6	76.4	17.32	17.9	221.0	39.49	14.0	54.0	7.57	-	-	-	36.4	61.7	22.48
	3	28.3	332.2	94.02	-	-	-	20.0	*	*	-	-	-	-	-	-
64-65	1	-	-	-	52.7	240.9	126.98	-	-	-	76.0	7.1	5.39	64.0	48.6	31.11
	2	-			51.0	+498.6	254.27	-	-	-	-	-	-	77.3	208.5	161.19
	3	62.0	565.8	350.82	69.0	290.5	200.42	-	-	-	-	-	-	-	-	-
65-66	1	-	-	-	21.2	526.9	111.70	-	-	-	56.0	109.6	61.38	45.6	433.1	197.52
	2	38.5	547.4	210.75	31.2	884.0	275.90	42.8	801.4	343.38	-	-	-	46.7	356.0	166.30
	3	42.8	1502.1	845.46	46.5	288.9	134.34	-	-	-	-	-	-	-	-	-
66-67	1	49.0	47.1	23.09	24.1	366.7	88.38	33.6	774.2	260.20	14.7	94.9	13.95	30.0	185.9	55.78
	2	22.7	249.9	56.72	51.0	528.6	269.56	35.5	332.9	111.54	-	-	-	37.0	83.1	30.75
67-68	1	34.5	38.6	11.31	22.0	81.2	17.86	49.0	208.5	102.17	46.7	158.0	73.79	44.0	83.8	36.86
	2	34.0	40.0	13.59	-	-	-	44.0	113.0	49.71	-	-	-	24.5	59.1	14.47

(continued)

Table II.12. Estimated number of recruits per quarter by selected Kodiak areas (continued).

Area		A			B[1]			C			D[2]			E[3]		
Statistical Area		25880			25881 + 25891			25791			25710			29153		
Stock		2			2			2			3			3		
Fish. year	Fish. qtr.	Avg. % R	Catch (1000 crabs)	R (1000 crabs	Avg. % R	Catch (1000 crabs)	R (1000 crabs)	Avg. % R	Catch (1000 crabs)	R (1000 crabs)	Avg. % R	Catch (1000 crabs)	R (1000 crabs)	Avg. % R	Catch (1000 crabs)	R (1000 crabs
68-69	1	-	-	-	39.0	21.5	21.53	80.0	53.5	53.52	68.0	63.0	42.85	61.3	99.2	42.85
	2	-	-	-	62.4	72.8	45.40	70.3	98.8	69.43	-	-	-	-	-	-
69-70	1	54.0	-	-	37.8	-	-	-	-	-	64.0	-	-	62.0	-	-
	2	-	-	-	44.0	-	-	-	-	-	-	-	-	63.0	-	-

* There are no fish tickets for this area in this quarter.
1 Area B also includes statistical area 25896.
2 Area D also includes statistical areas 25720 and 25770.
3 Area E also includes statistical area 29152.

\+ Estimate.

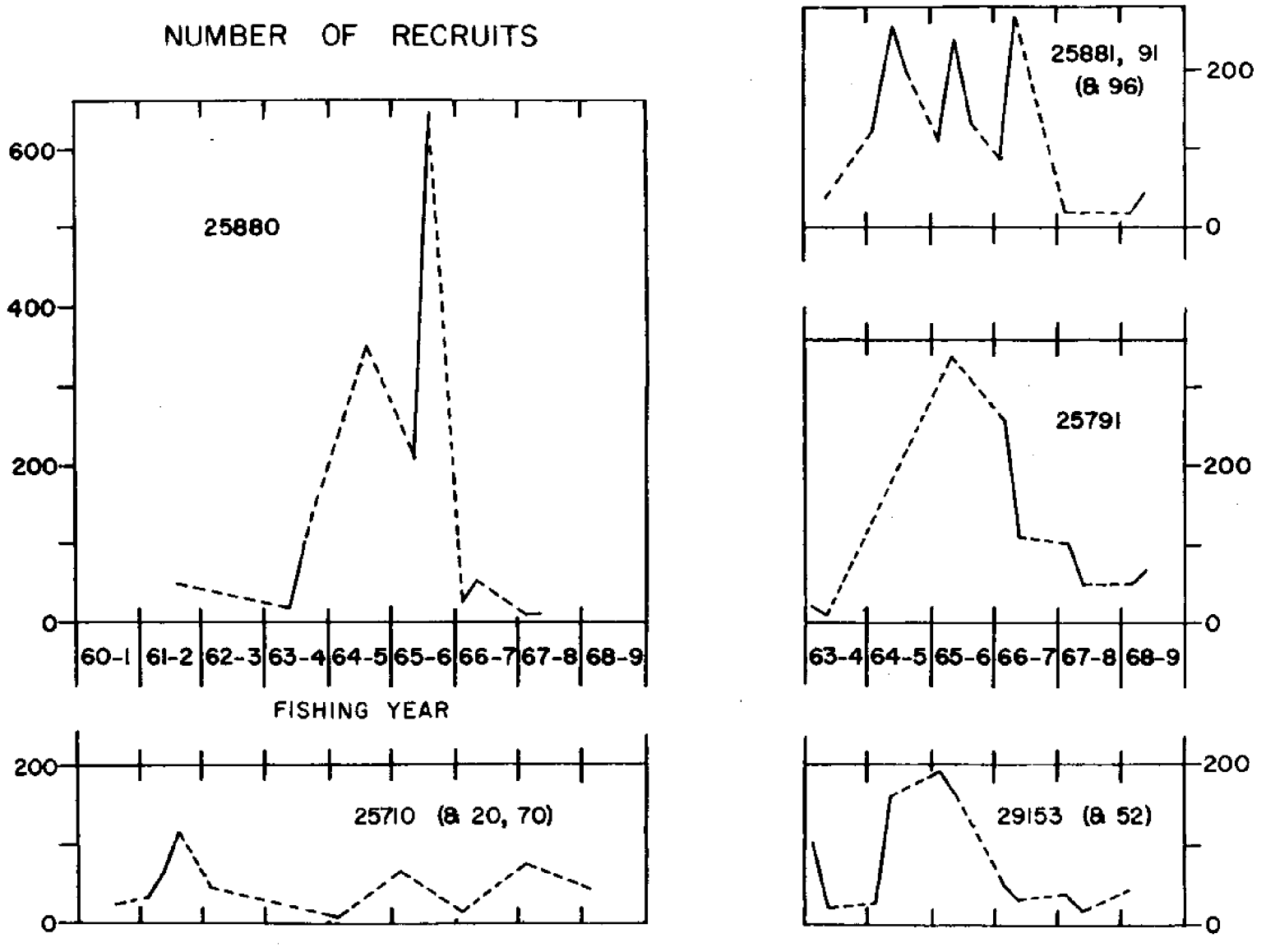


Figure II.16. Estimated number of recruits per quarter of the fishing year for selected Kodiak areas.

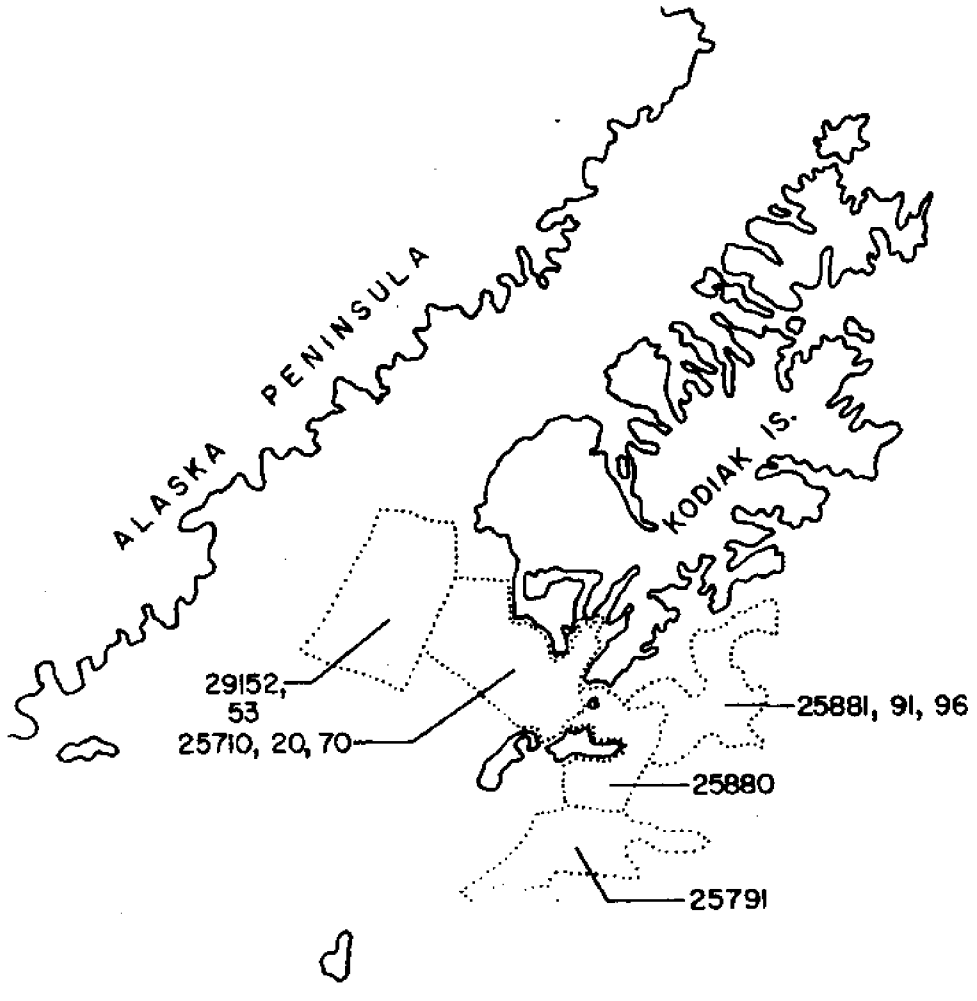


Figure II.17. Map of selected Kodiak areas used for estimated number of recruits per quarter.

accounting for the declining trend in average size. This would suggest that the crabs taken in stock 2 during 1964-65 consisted of relatively large numbers of recruits, corroborating, at least to some extent, the estimates of actual recruitment (Section II.A5.1) for stock 2. There are two interesting features. First, the largest negative deviations in stock 2 occur during 1964-65, but the largest peak in recruitment did not occur until 1965-66, possibly indicating that the 1964-65 recruits did not become fully vulnerable, as recruits, to the fishery until 1965-66. The second, is that striking negative deviations in large recruitment years did not appear for stocks 1 and 3 and perhaps this reflects that the level of recruitment is not sufficiently large in these stocks to noticeably affect the average size of the crabs. Thus, it would seem that the average weight in stock 2 exhibited a diminution, as would be expected, at the time when requirement was most evident. In considering this, however, it should always be kept in mind that there can be local differences in crab size within a stock and thus a modification in fishing effort could in itself produce a modification in size. In fact the increase in size in stock 1 might be related to a movement of the fleet within the stock 1 area (Figure II.11).

In Figure II.18, we have mapped size at shell age for areas which had a high density of sampling. These maps show a dimunition of size at shell age which appears to be centered in the 1965-66 fishing year. Since the sampling location is fixed, Figure II.18 suggests a density dependent reduction in growth during 1965-66. This, of course, directly implies that actual abundance was at a high level in 1965-66.

Thus, estimates of actual recruitment, average weight, and growth changes tend to support the hypothesis that a significantly large year class or year classes entered the fishery in the mid-1960's; the largest contribution appeared in 1965-66. It would appear that changes in the distribution of the fishery may have tended to accentuate the importance of the 1965-66 entering class, and, in fact, some of the expansion may have been directly related to the abundance of the crabs. Thus, because the fishery was changing in character both by the introduction of a large year class and a change in its distribution relative to the populations, it might be stretching assumptions to apply equilibrium-yield general production models to the data to determine the best level of fishing. On the other hand, if the present level of fishing is not placing a constraint on recruitment, then a large year class of crabs might be produced at any time and this could be predicted several years in advance and probably at a quite reasonable cost. Whether it is possible to produce a large year class of crabs depends on the environment and the nature of the stock-recruitment relation. The reproductive capacity of the stock can very well be influenced by the sex ratio and it is important to determine the optimal sex ratio for yielding high recruitment from the spawning population. Furthermore, since density dependent growth may operate, it would be important

Figure II.18

CONTOURS OF AVERAGE CARAPACE LENGTH PER SHELL AGE OVER TIME

AREA 25791 (Stock 2)

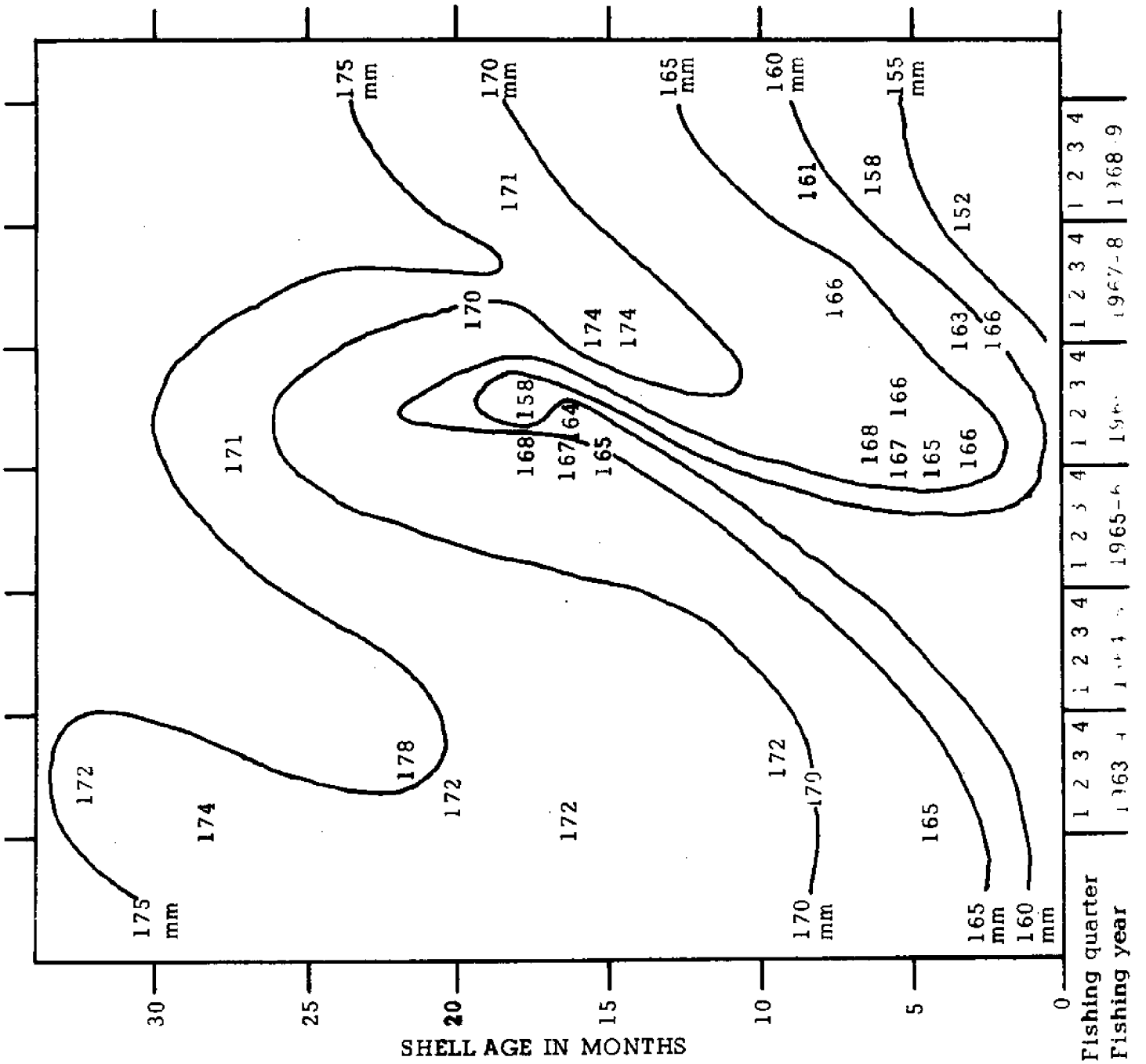


Figure II.18 (continued)

CONTOURS OF AVERAGE CARAPACE LENGTH PER SHELL AGE OVER TIME

AREA 25880 (Stock 2)

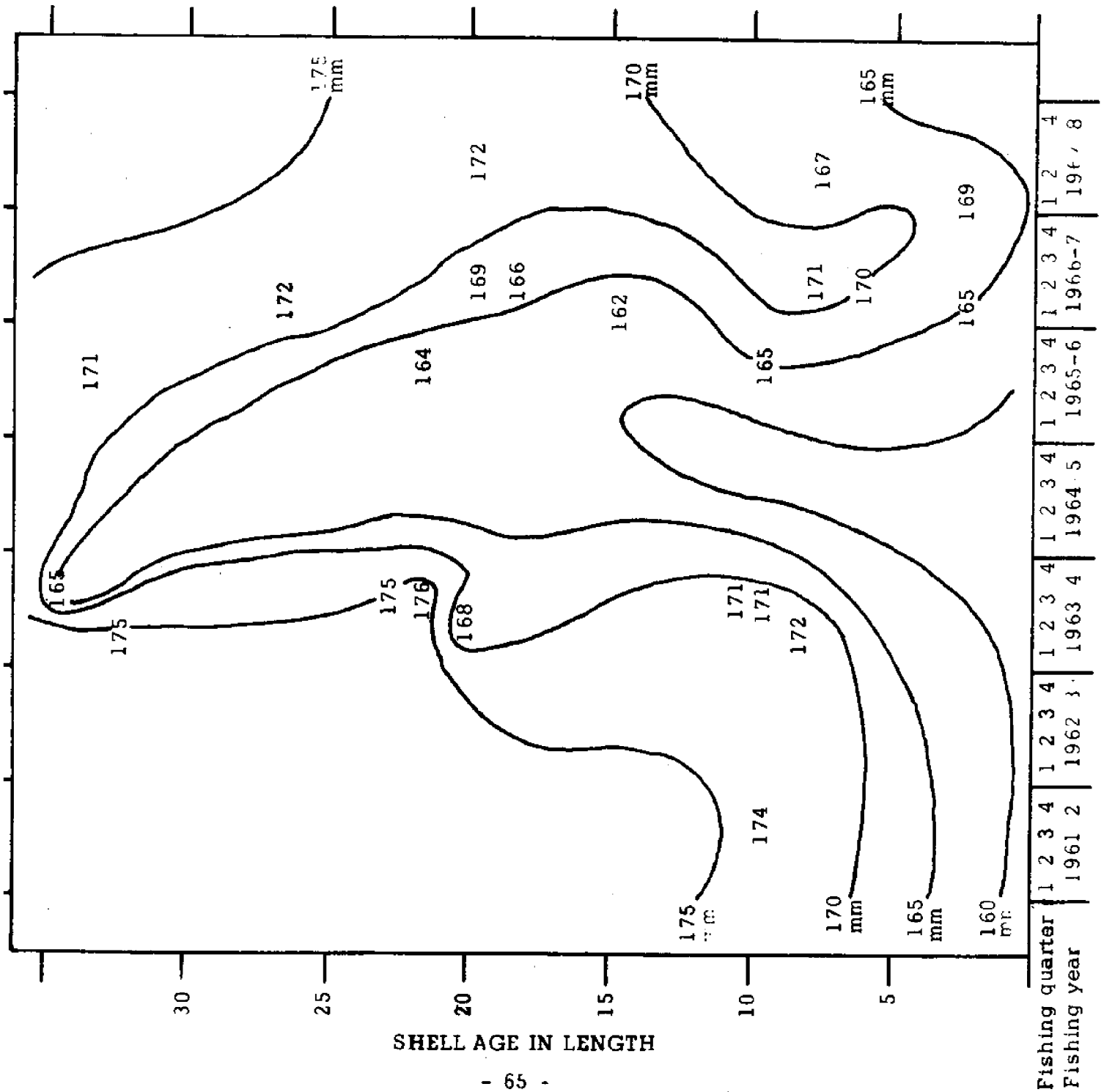


Figure II.18 (continued)

CONTOURS OF AVERAGE CARAPACE LENGTH PER SHELL AGE OVER TIME

AREA 25881 (Stock 2)

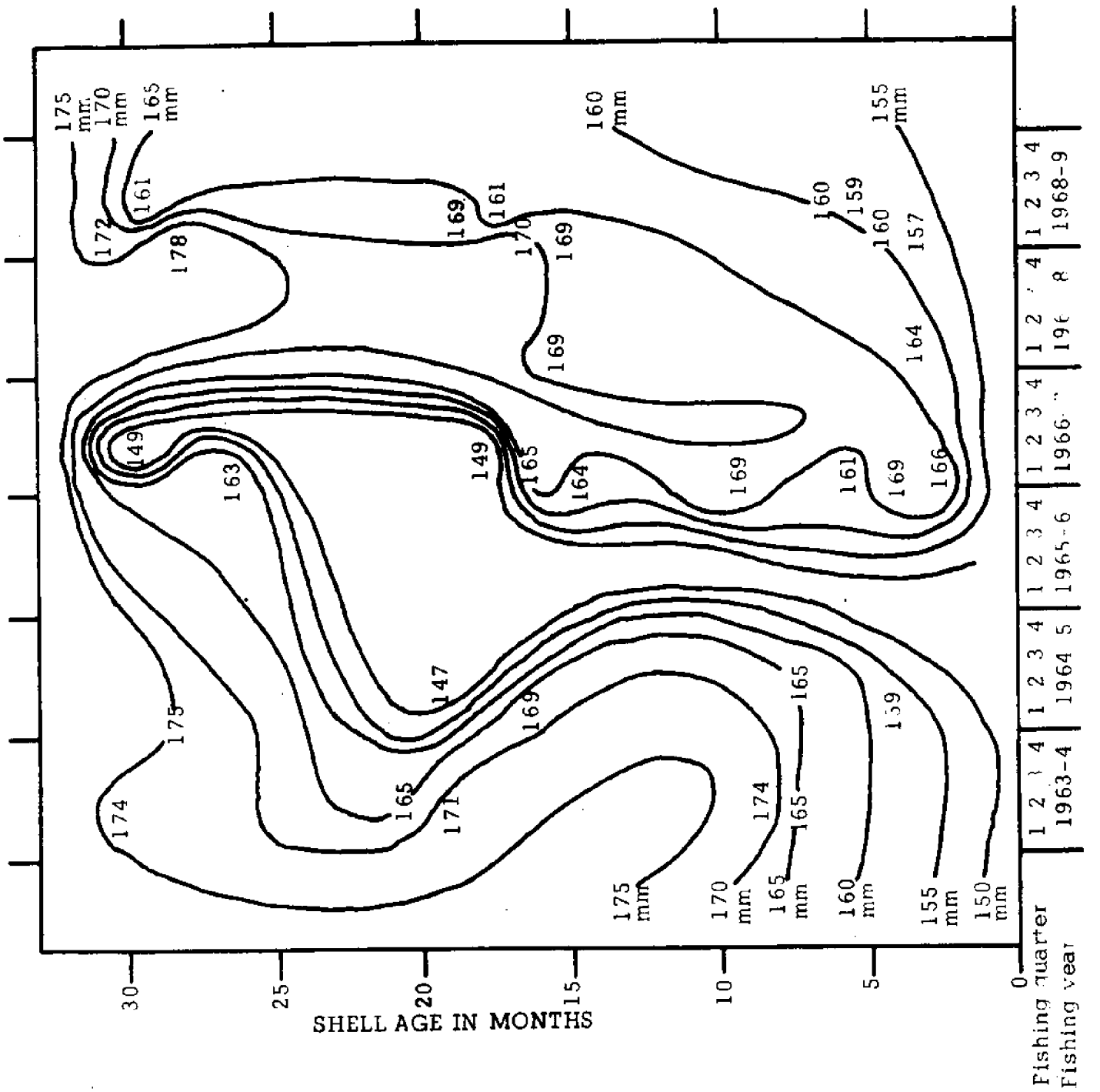


Figure II.18 (continued)

CONTOURS OF AVERAGE CARAPACE LENGTH PER SHELL AGE OVER TIME

AREA 25891 (Stock 2)

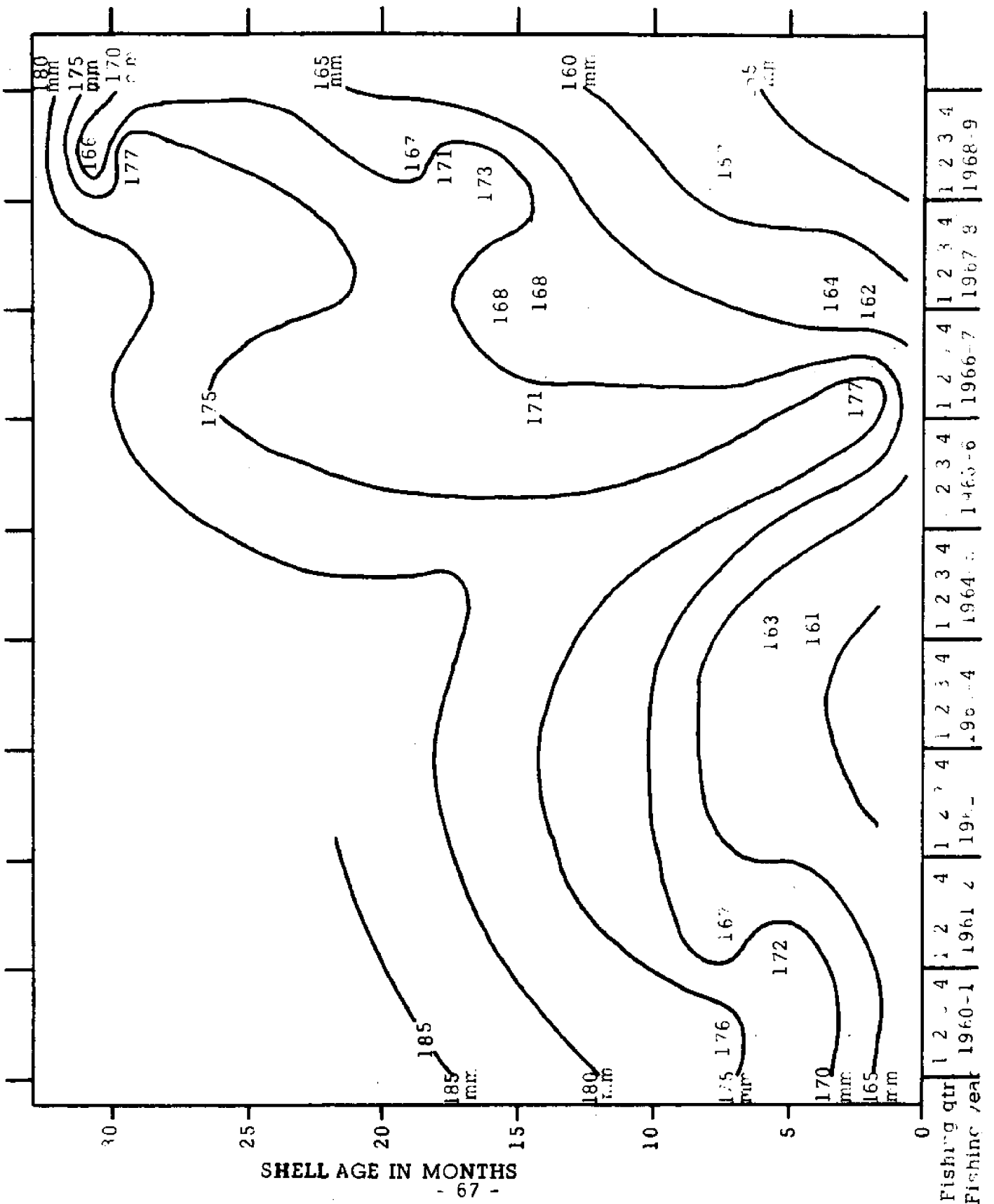


Figure II.18 (continued)

CONTOUR OF AVERAGE CARAPACE LENGTH PER SHELL AGE OVER TIME

AREA 25710 (Stock 3)

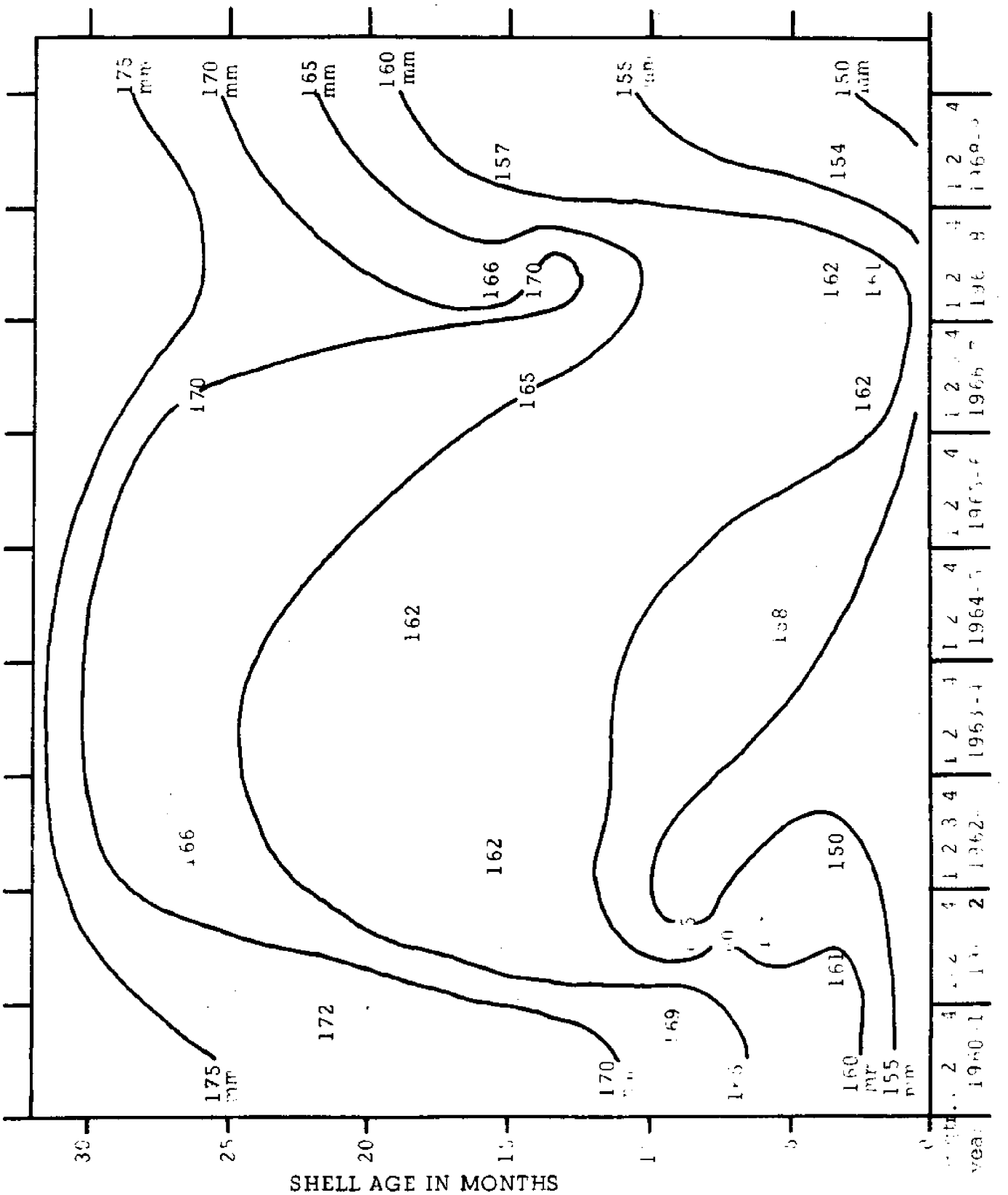
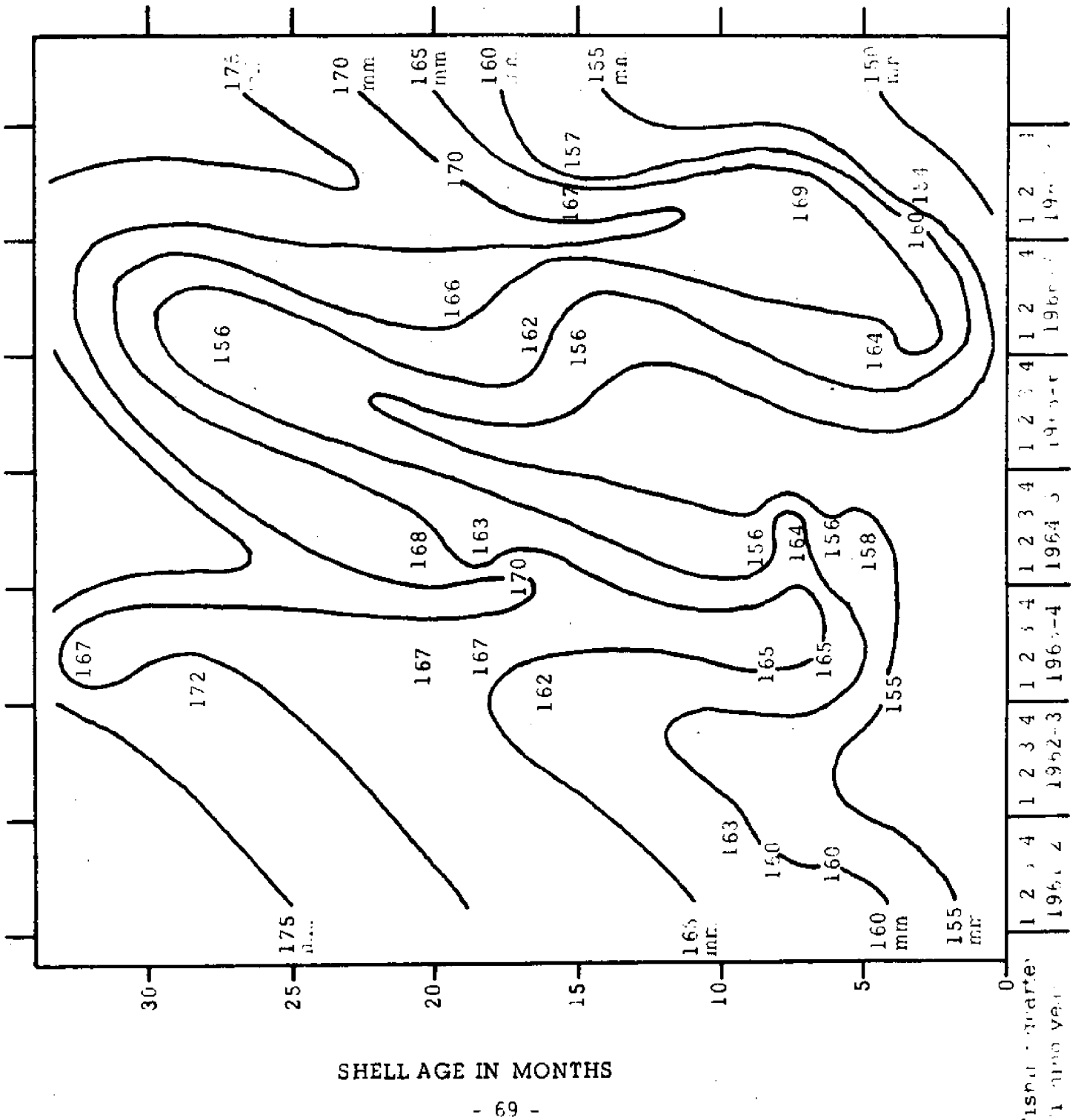


Figure II.18 (continued)

CONTOURS OF AVERAGE LENGTH PER SHELL AGE OVER TIME

AREA 29153 (Stock 3)



to havest female crabs, if utilizable, which are in excess of this optimal sex ratio. It might be useful to have records on the relative abundance of females for use in changing ratio estimates and to gain experience in collecting this statistic should it become an important consideration in management. Since a crucial element in management is recruitment size the mesh of crab pots or some other escape mechanism might be considered.

II.A.6 Production Models

Figure II.19 portrays the relation between CPUE and effort for the entire Kodiak region and shows that there is no clear relation between CPUE and effort for those years for which there is logbook data. Part of the reason for a lack of relationship is the introduction of the large year class in either a real or apparent sense into the fishery. Thus with relatively few years of data and a population that is not in an even approximately steady state, it is virtually impossible to compute an optimum level of fishing from a production type model. We are, at present, endeavoring to extend the series of years in the above models by utilizing fish ticket data.

II.B. Production from the Non-Kodiak Region

In this section we present a survey of fish ticket data on king crab for the entire State of Alaska. The good and bad points of the fish ticket data were indicated in Section II.A.4. Basically, the fish tickets provide a reasonable measure of abundance for a longer series of years and a wider area than are available for more detailed data. The data on the fish tickets are, however, as previously discussed, not as suitable for detailed population analysis as would be logbook data. Our purpose in this section is simply to provide a synthesis of the fish ticket data on king crab without an accompanying narrative. Our first step in producing this synthesis was to designate the boundaries of king crab fishing areas throughout the state. Our second step was to produce time-series graphs of the average weight, the catch (in pounds and numbers), the number of landings, and the catch-per-landing (in pounds and numbers). The fishing areas (mapped in Figure I.1) were developed from the statistical charts of the State of Alaska as outlined in Table II.13. The statistical areas included in each chart are shown in Table II.14 and the king crab areas are designated in Table II.15. The time series of average weight, landings, catch, and catch-per-landing are presented in the Appendix.

Our further analysis of these time series will be presented in future reports. For the time being, however, it is interesting to note the trends in average size and CPUE in the Adak region which is becoming an important area for king crab.

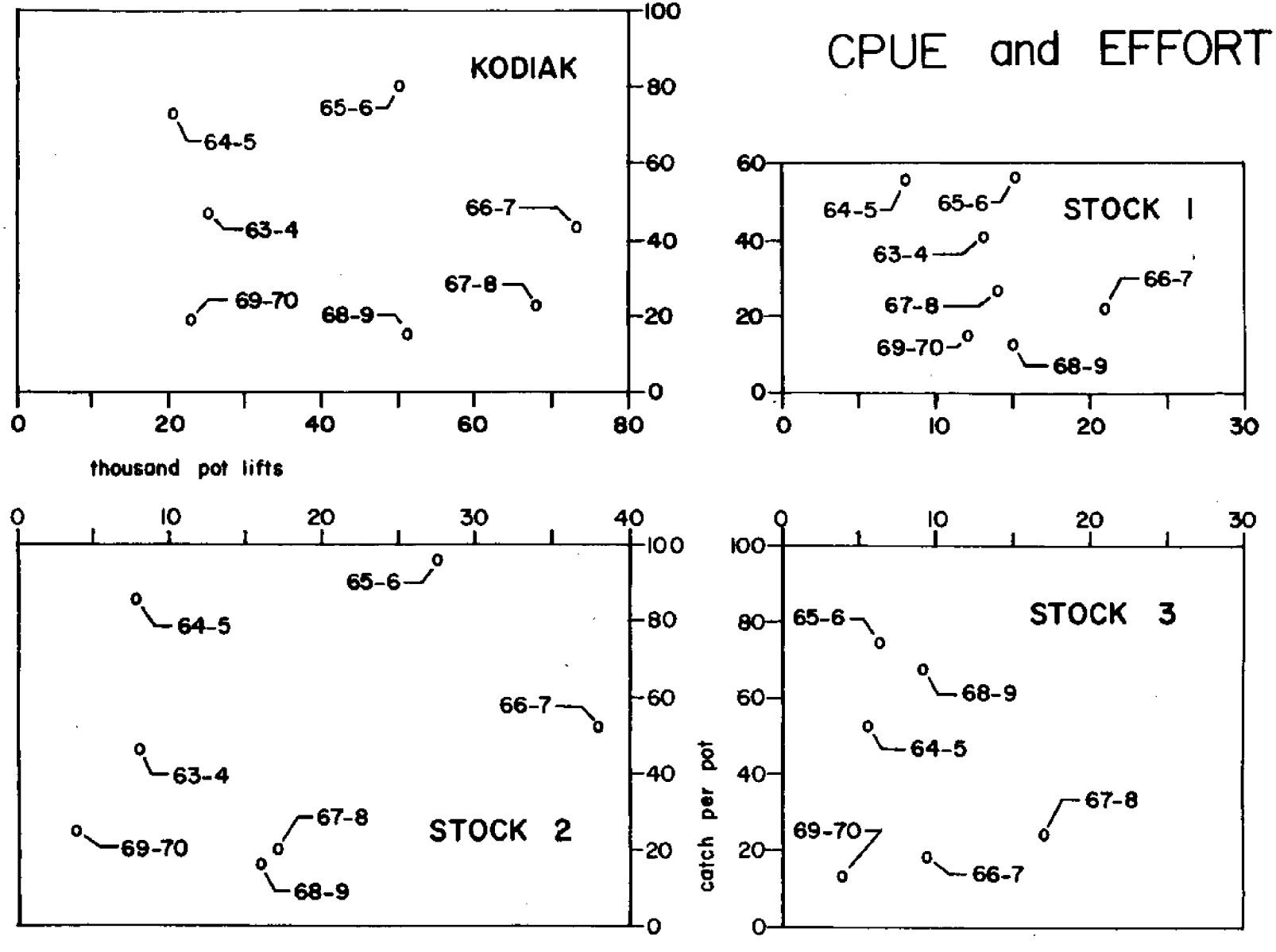


Figure II.19. Relation between catch in numbers per unit of effort for the entire Kodiak fishery and stocks 1, 2, and 3.

Table II.13. Statistical charts for Alaska fisheries.

Chart Number	Location Involved
1	Prince of Wales Island (Ketchikan)
2	Kupreanof Island
3	Chichagof-Admiralty (Juneau-Sitka-Skagway)
4	Fairweather to Suckling (Yakutat)
4 and 5 combined	Orca Inlet to Icy Bay (Shellfish only)
5	Prince William Sound (Cordova)
6	Resurrection Bay-Seward Gully (Seward)
7	Lower Cook Inlet to Barren Islands (Homer-Seldovia)
8	Upper Cook Inlet (Anchorage)
9	Kodiak Island (Kodiak)
10	Semidi's to Shumagins (Chignik)
11	Shumagins to Sanak (Sand Point)
12	Sanak to Akutan (Davidson Bank-Unimak Pass)
13	Unalaska Island to Islands of Four Mountains
14	Amukta Island to Igitkin Island
15	Igitkin Island to Semisopochnoi Island (Adak Island)
16	Semisopochnoi Island to Buldir Island (Amchitka-Kiska)
17	Buldir Island to Attu Island
18	Alaska Peninsula North Side (Unimak Pass to Ugashik River, incl. Slime Bank)
19	Bering Sea to Pribilof Island
20	Ugashik to Kuskokwim Bay (Bristol Bay System)

Table II.14. Statistical areas on statistical charts of Alaska fisheries 1/.

Statistical chart number	Statistical area numbers
1	101 to 107
2	103 to 113
3	109 to 115
4	181 to 192
4 and 5 combined	184 to 221
5	221 to 228
6	231 to 233
7	241 to 249
8	244 to 247
9	251 to 259; 262; 291
10	272 to 286
11	281 to 286
12	302; 283 to 286; 362
13	302 to 304; 362 to 364; 354
14	304 to 306; 364 to 366; 354 to 355
15	306 to 308; 366 to 368; 357 to 358
16	308 to 309; 368 to 369; 358 to 359; 369
17	309; 369; 359
18	311 to 318
19	350 to 351
20	321 to 326

1/ Prepared by Guy Powell 12/9/69.

Table II.15. Alaska king crab fisheries and component statistical areas.

	Fishery area	Statistical chart numbers	Statistical areas
1)	Southeastern Alaska Yakutat	1-3	101 to 115
2)	Prince William Sound - Seward	4-6	181 to 240
3)	Cook Inlet-Barren Island	7-8	241 to 249
4)	Kodiak Island	9	251 to 259; 262; 291
5)	South Peninsula	10-12	272 to 286
6)	Unalaska	12-14	302 to 304; 354; 362 to 364; (311-10)
7)	Adak	14-16	305 to 308; 365 to 368; 355 to 358
8)	Far Aleutians	16-17	309; 359; 369
9)	Western Bering Sea Pribilof Islands	19	351
10)	Eastern Bering Sea	18-19	350; 311 to 318 (except 311-10)

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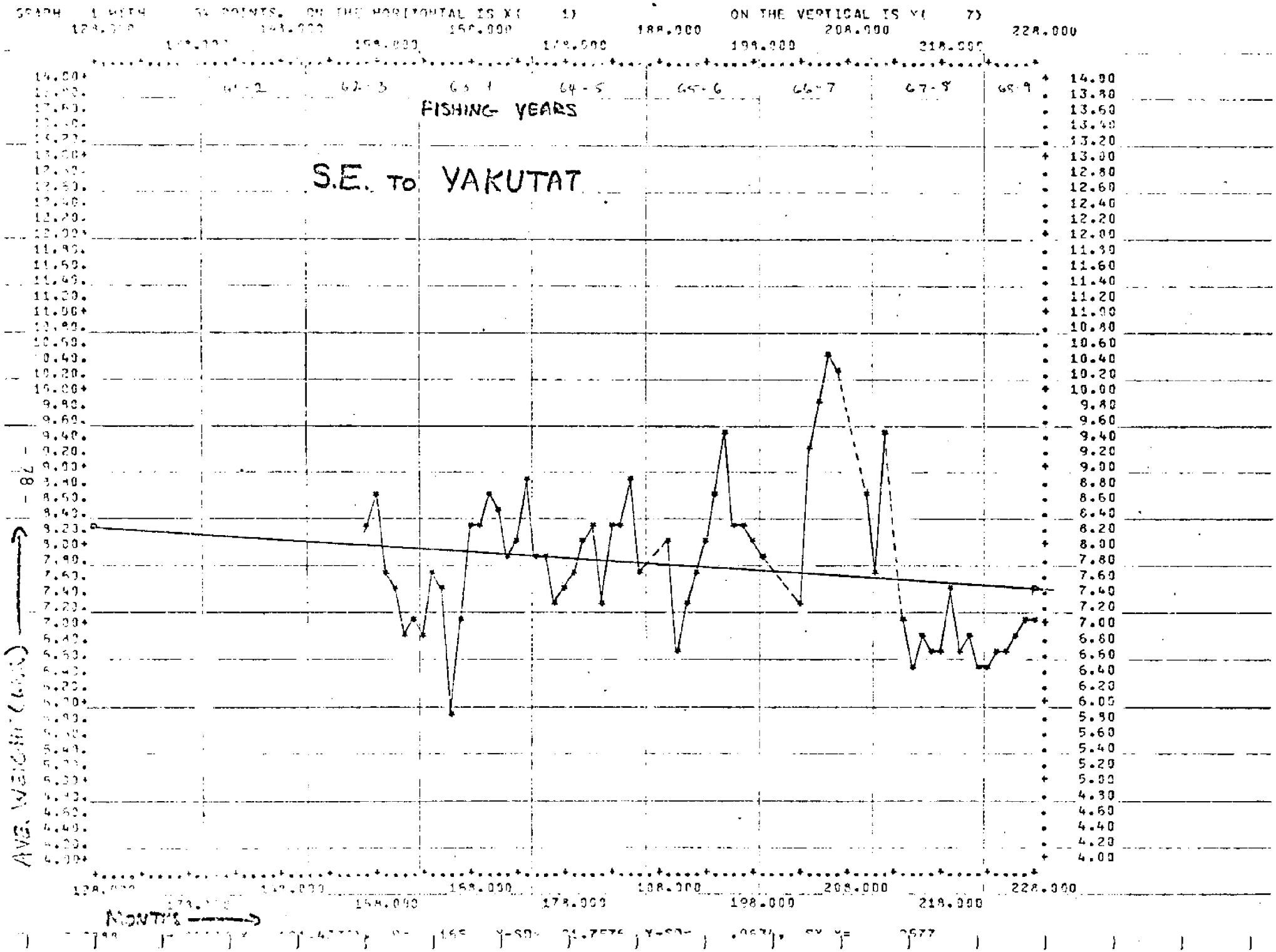
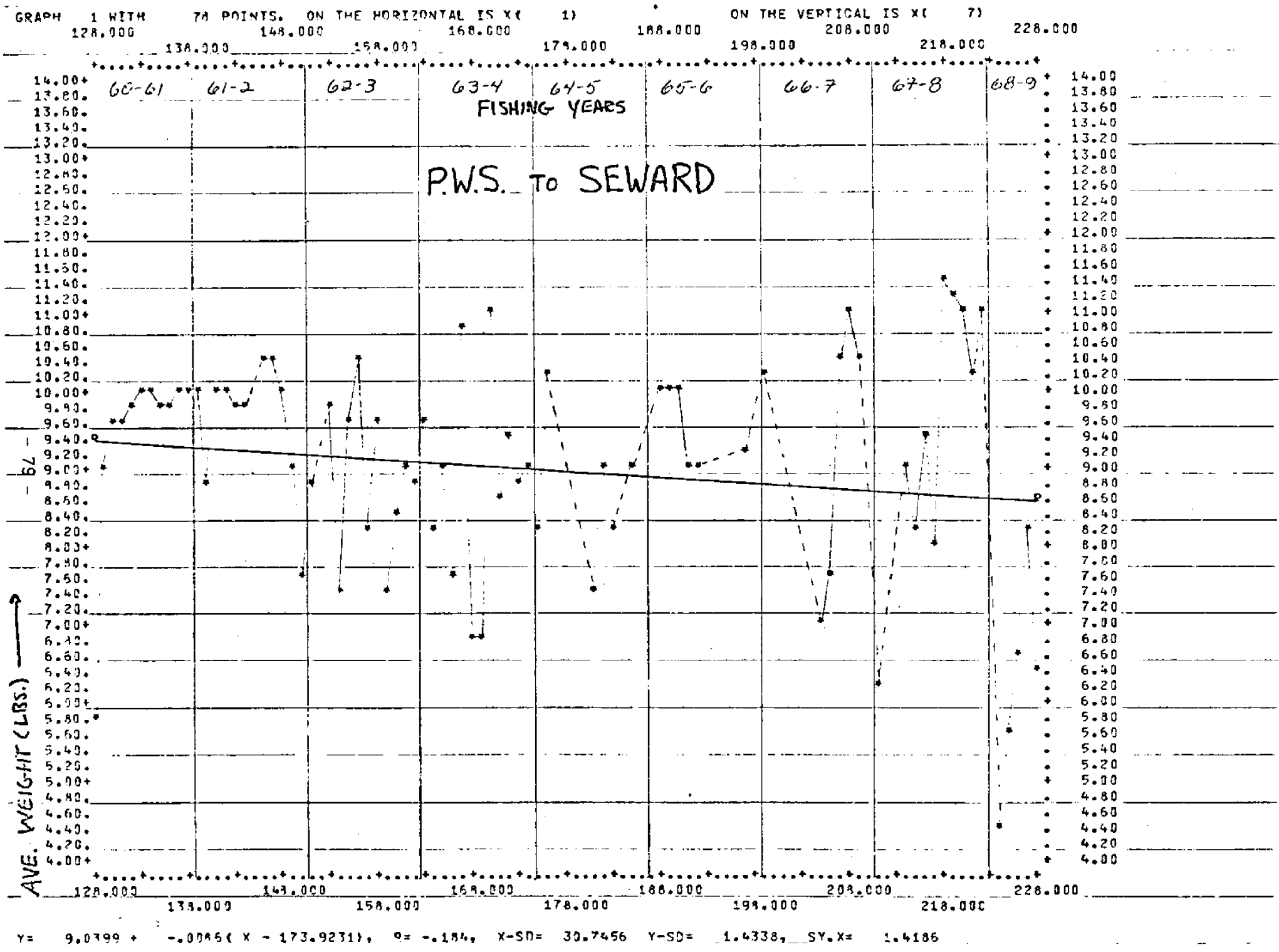
APPENDIX

CONTENTS
APPENDIX

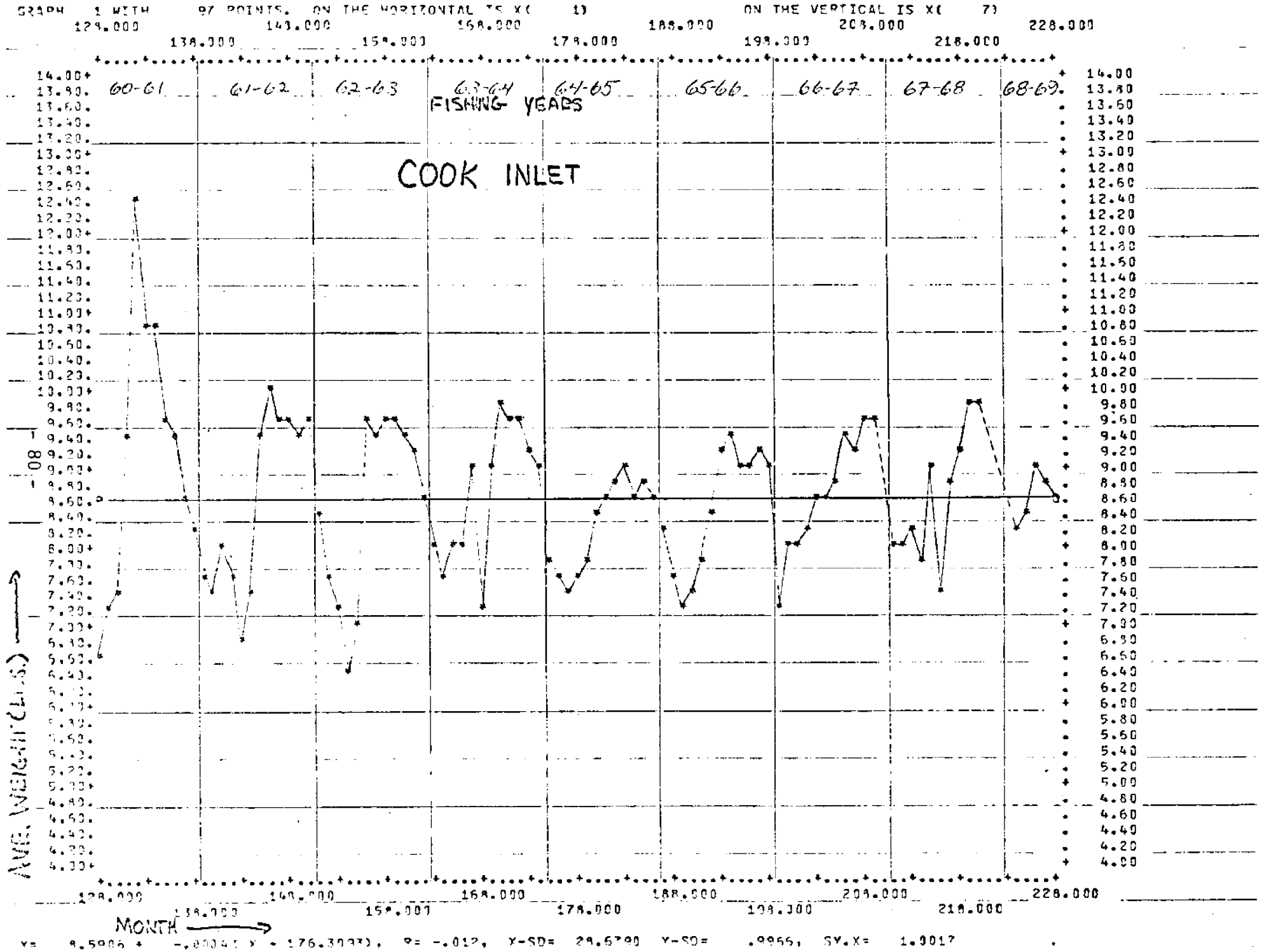
Monthly time series graphs, 1960 through 1968 OF → FOR ↓	Average weight per crab in pounds	Catch in pounds	Landings	Catch per landing in numbers of crabs	Catch per landing in pounds
	page #				
S. E. to Yakutat*	78	90	105	120	135
P.W.S. to Seward*	79	91	106	121	136
Cook Inlet*	80	92	107	122	137
Kodiak*	81	93	108	123	138
S. Alaska Peninsula*	82	94	109	124	139
Unalaska*	83	95	110	125	140
Adak*	84	96	111	126	141
E. Bering Sea*	85	97	112	127	142
Kodiak ** Stock 1	28	98	113	128	143
Kodiak ** Stock 2	29	99	114	129	144
Kodiak ** Stock 3	30	100	115	130	145
Kodiak ** Stocks 2-3	86	101	116	131	146
Kodiak ** Stocks 1-2-3	87	102	117	132	147
Kodiak ** Stocks 4-5-6	88	103	118	133	148
All Alaska	89	104	119	134	149

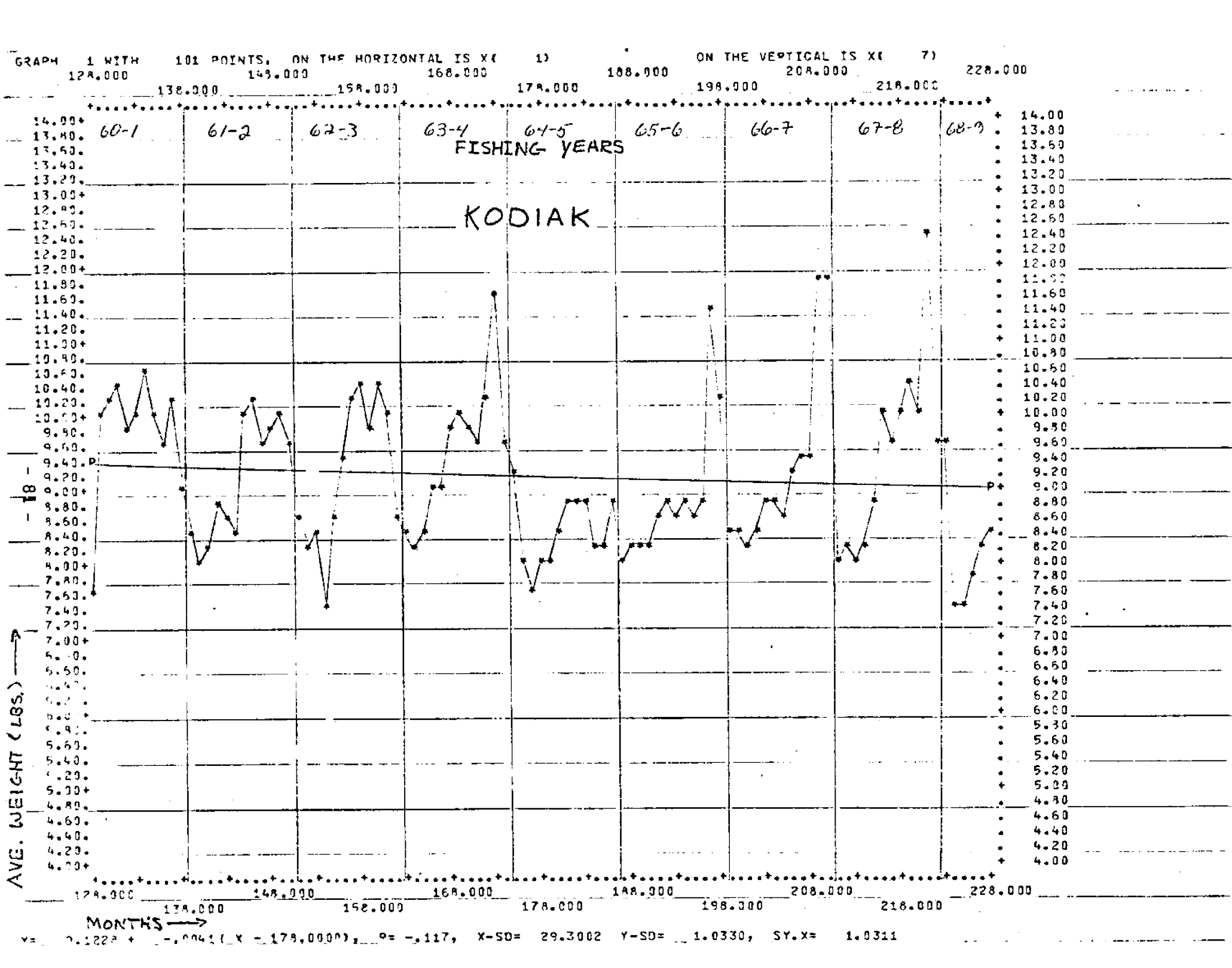
* See map, Figure I.1, p. 2.
** See map, Figure II.12, p. 44.


FISHING- YEARS
S.E. TO YAKUTAT
AVE. WEIGHT (LBS.)
MONTHS

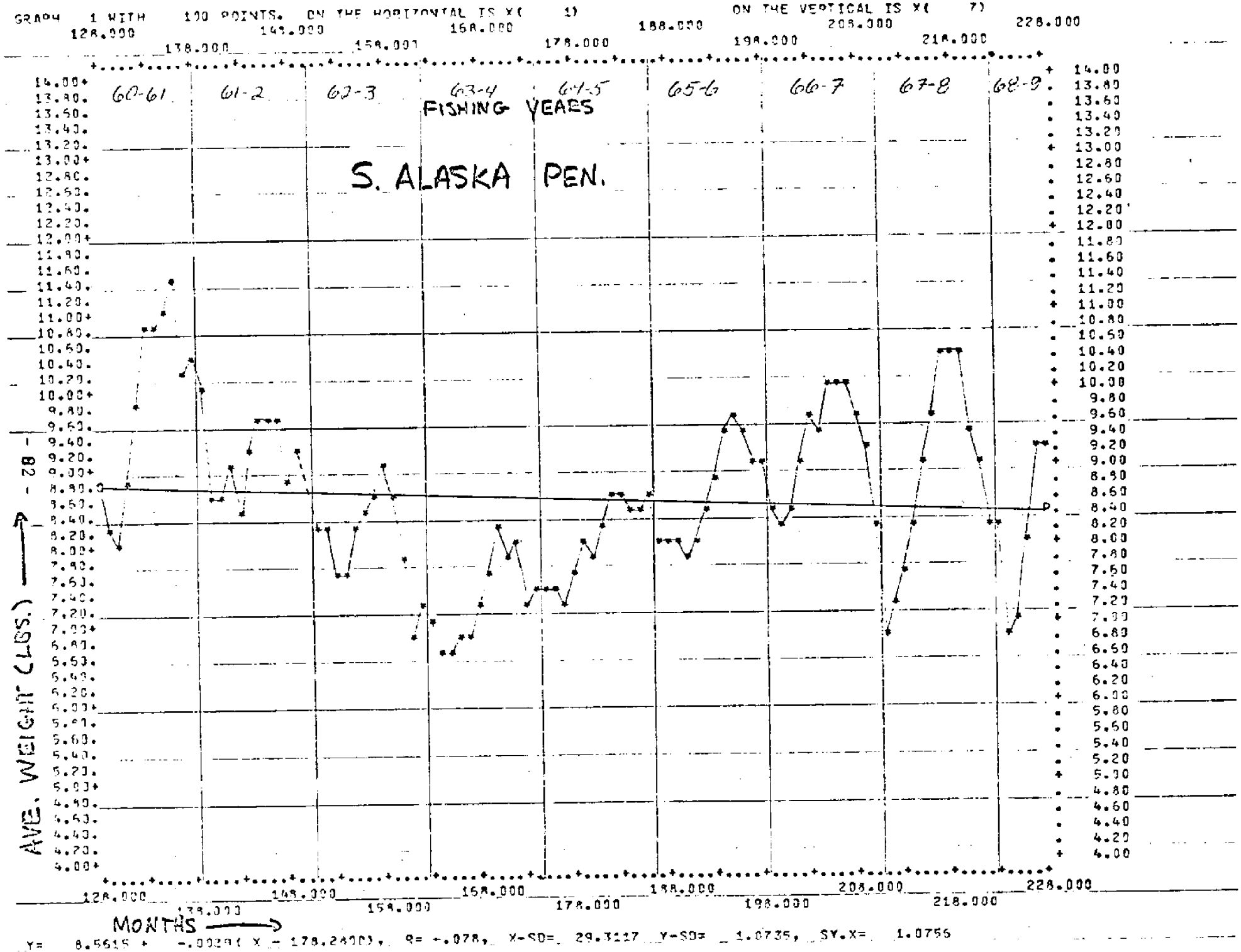


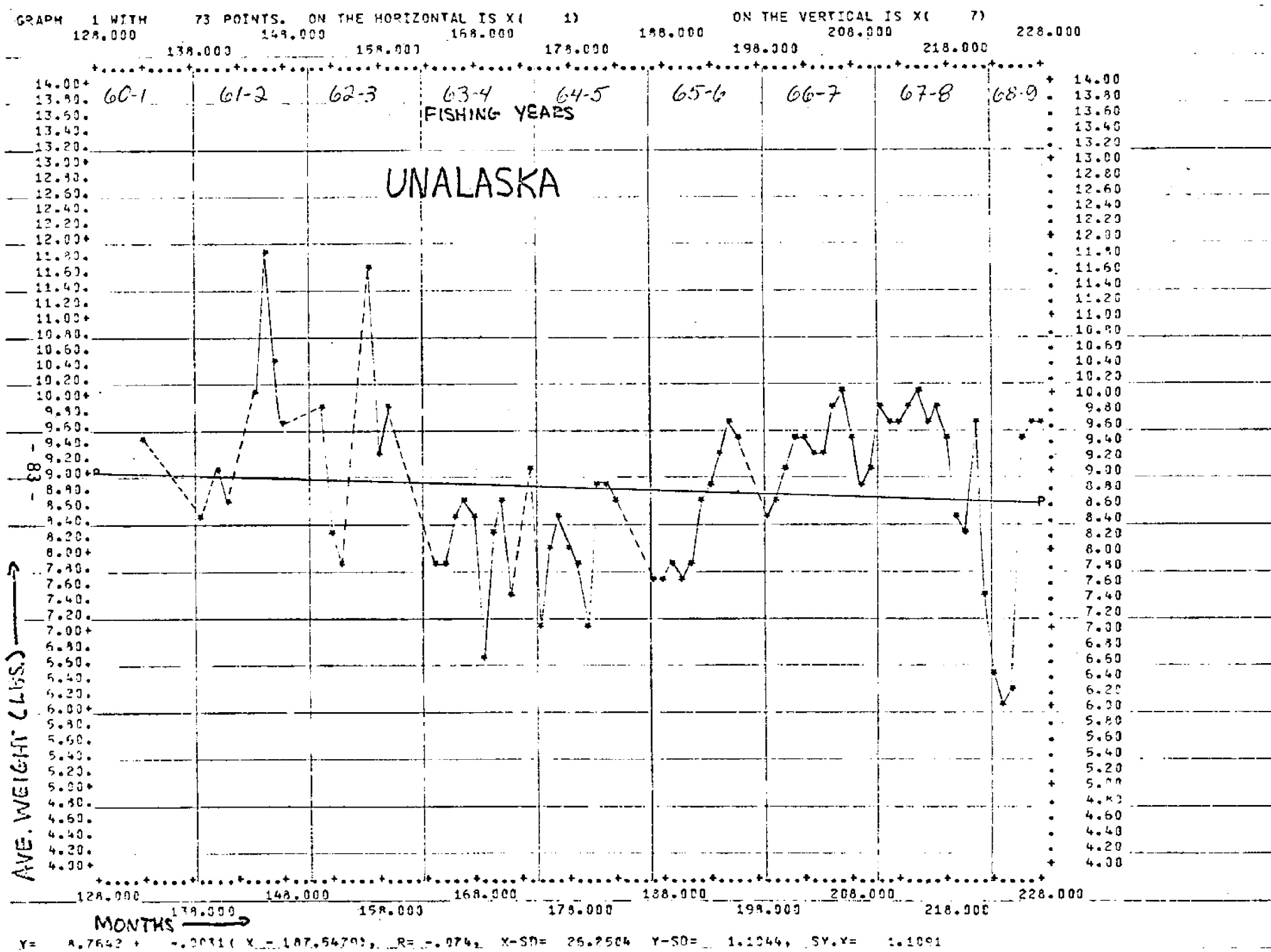
Y= 9.0799 + -.0046(X - 173.9231), R= -.184, X-SD= 30.7456 Y-SD= 1.4338, SY.X= 1.4186

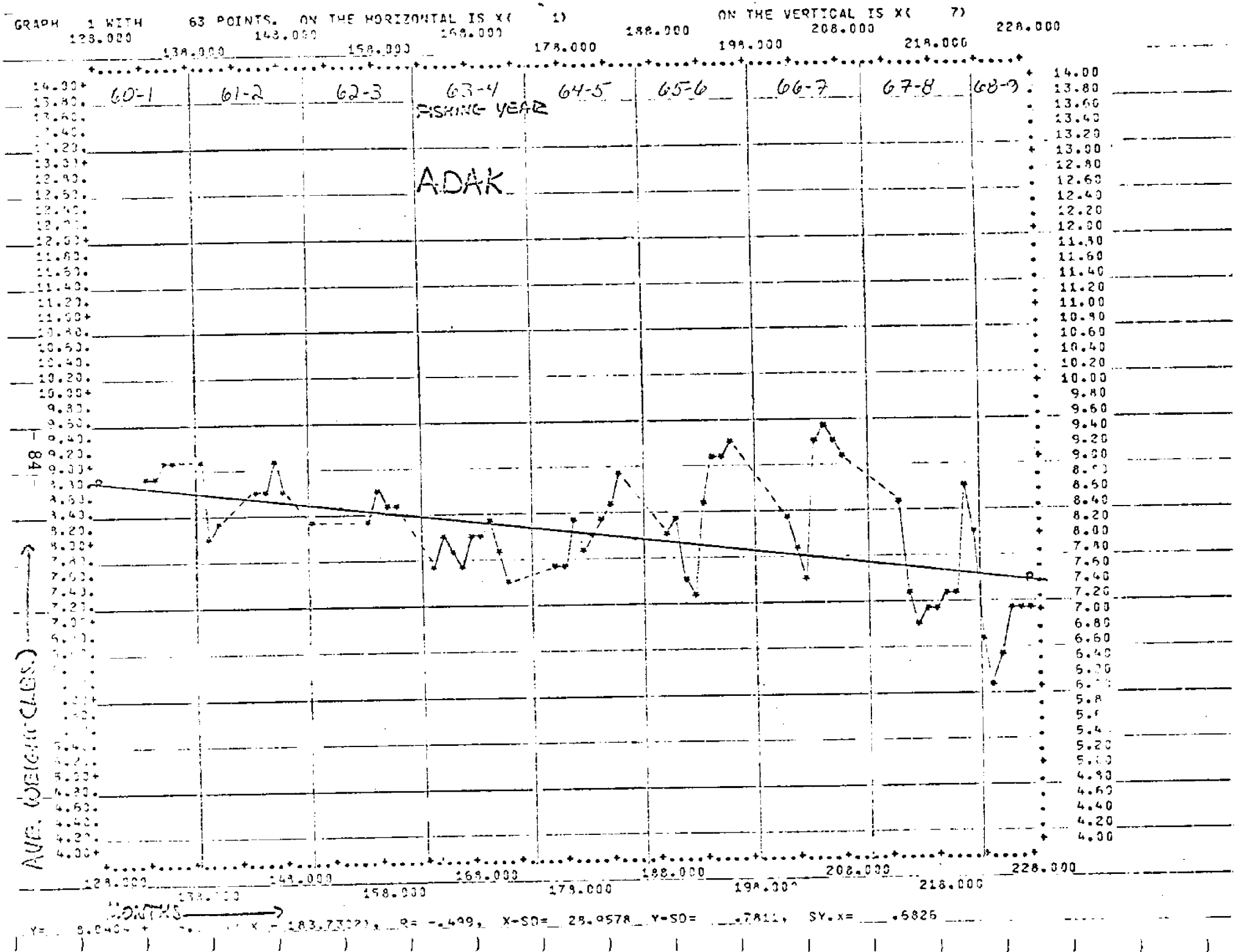

GRAPH 1 WITH 97 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(7)
129.000 141.000 153.000 165.000 177.000 189.000 201.000 213.000 225.000
60-61
61-62
62-63
63-64
64-65
65-66
66-67
67-68
68-69
FISHING YEARS
COOK INLET
AVE. WEIGHT (LBS.)
MONTH
Y= 8.5986 + -.00041 X + 176.3037), R= -.012, Y-SD= 28.6790 Y-SD= .9956, SY.X= 1.0017

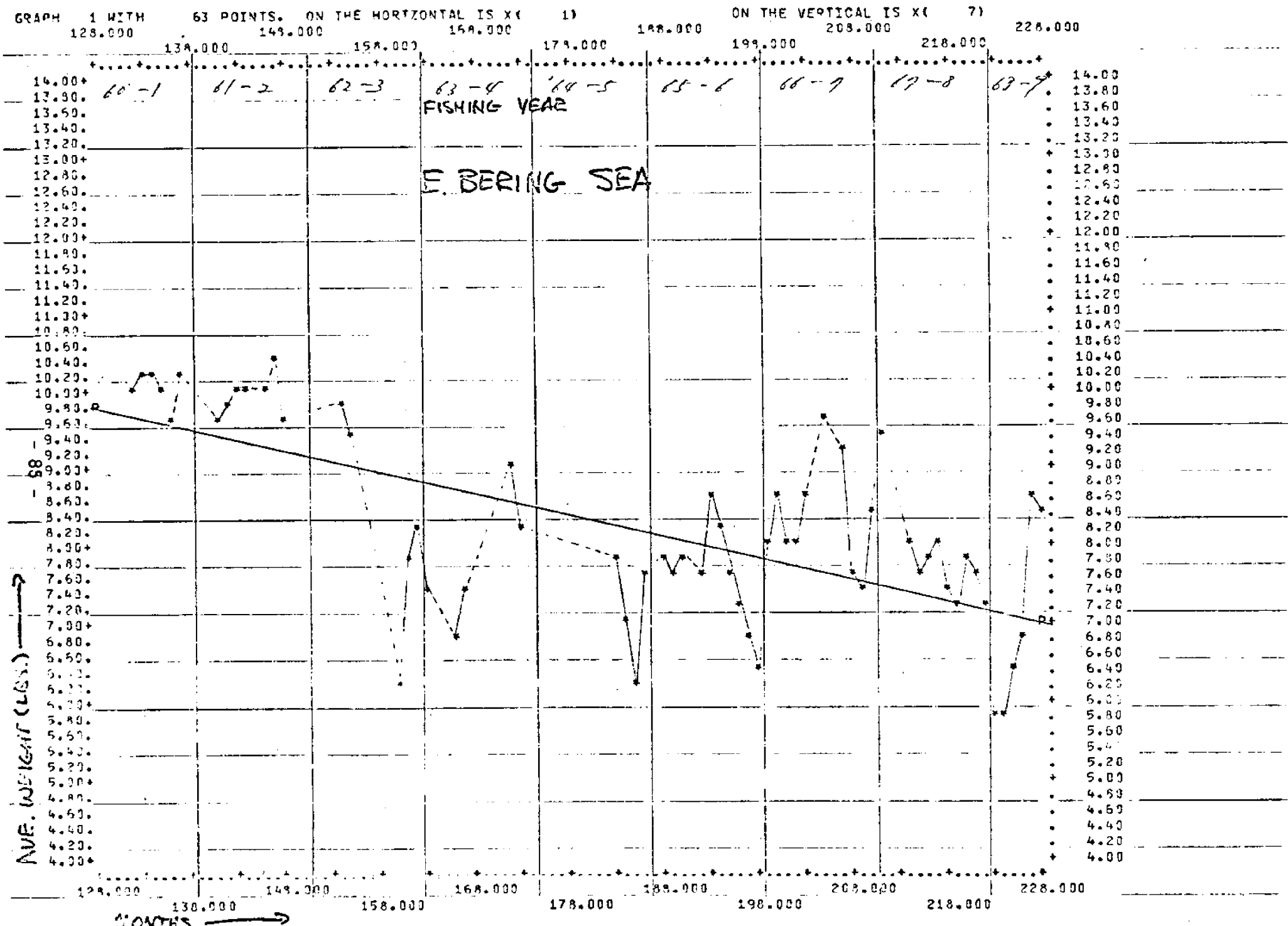


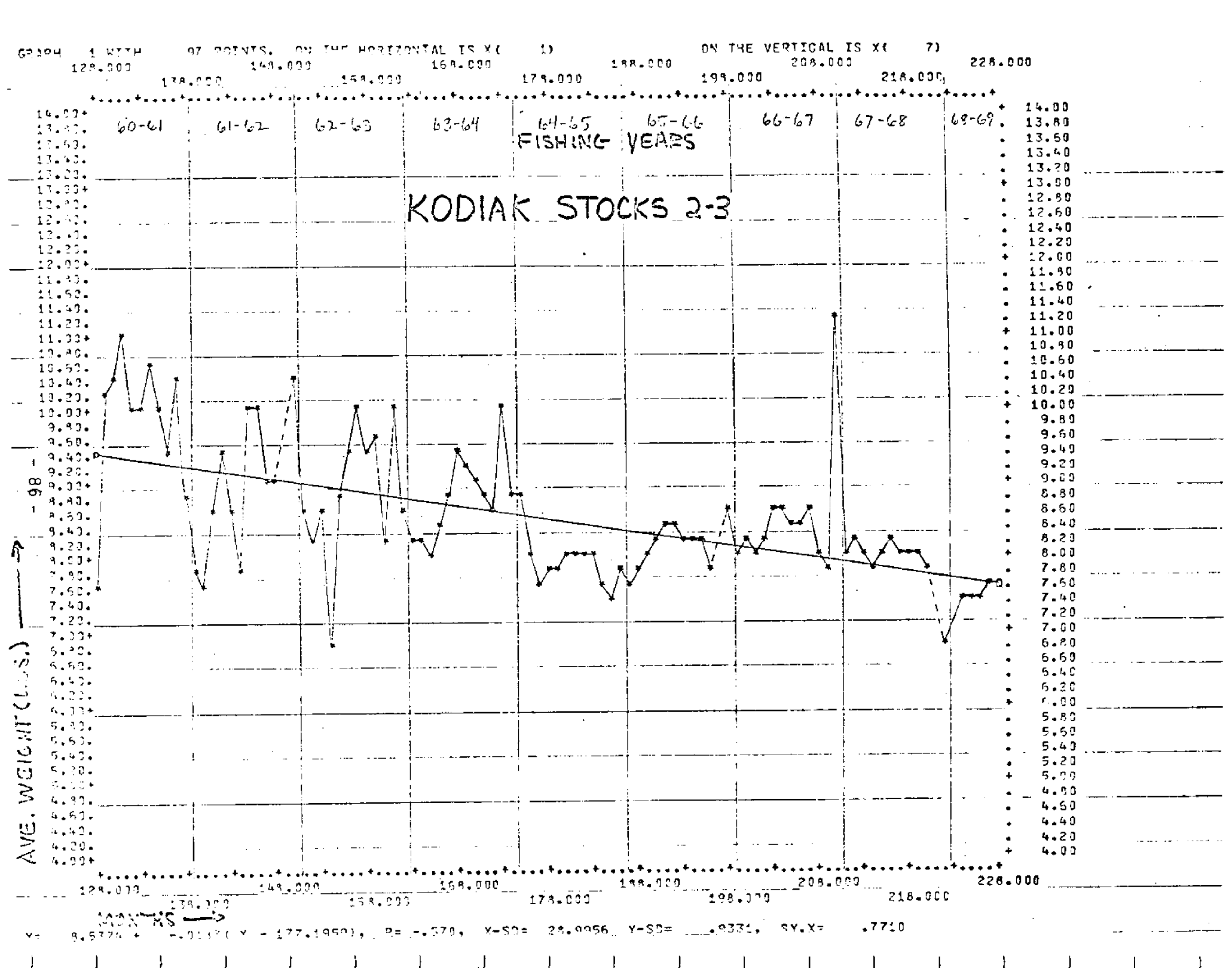
Y= 9.1223 + -.0041(X - 178.0000), R= -.117, X-SD= 29.3002 Y-SD= 1.0330, SY.X= 1.0311

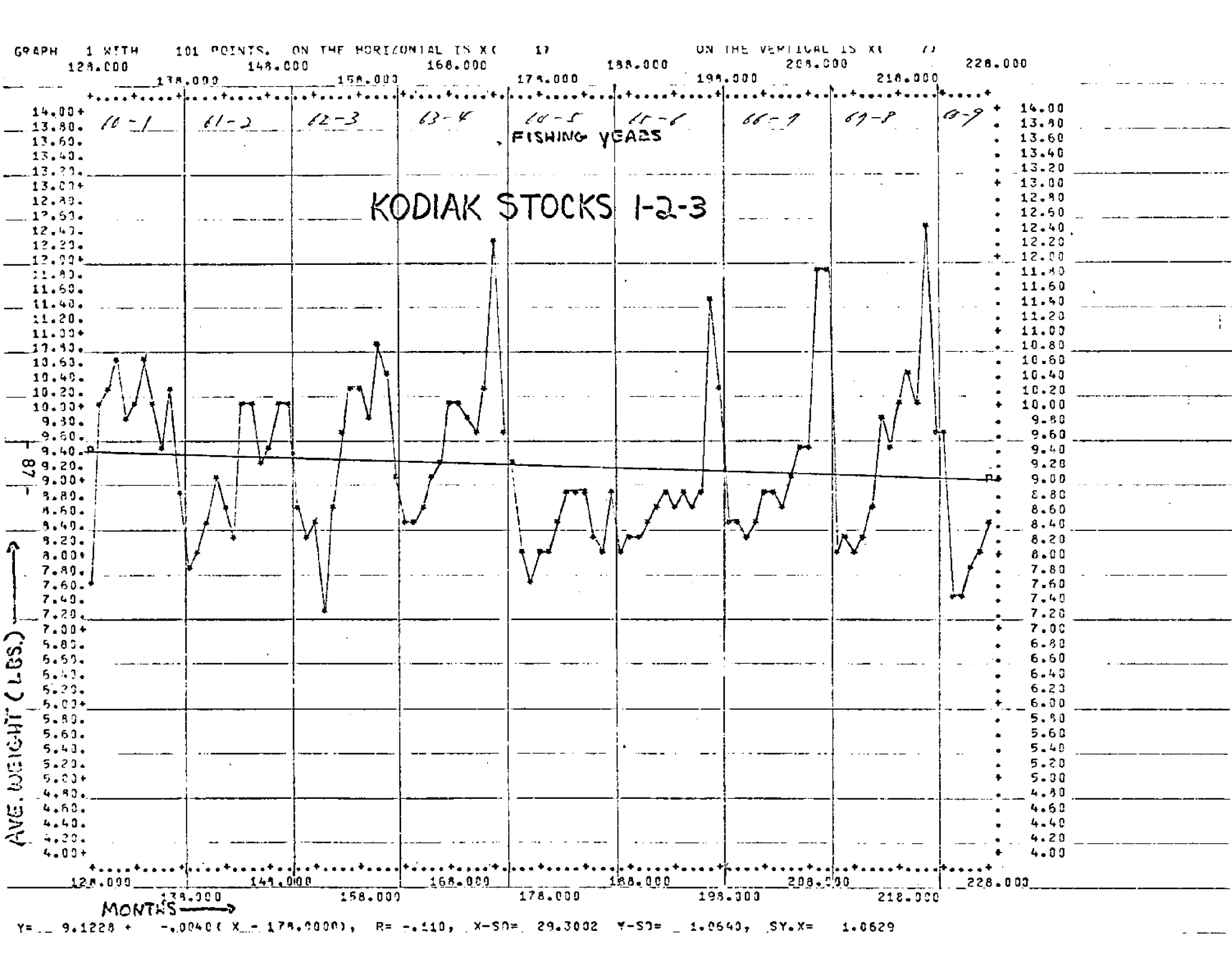

GRAPH 1 WITH 100 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(7)
60-61
61-2
62-3
63-4
64-5
65-6
66-7
67-8
68-9
FISHING YEARS
S. ALASKA PEN.
AVE. WEIGHT (LBS.)
MONTHS
Y= 8.5615 + -.0029(X - 178.2400), R= -.078, X-SD= 29.3117 Y-SD= 1.0735, SY.X= 1.0756


GRAPH 1 WITH 73 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(7)
128.000 138.000 148.000 158.000 168.000 178.000 188.000 198.000 208.000 218.000 228.000
60-1
61-2
62-3
63-4
64-5
65-6
66-7
67-8
68-9
FISHING YEARS
UNALASKA
AVE. WEIGHT (LBS.)
MONTHS
Y= 8.7643 + -.0031(X-187.5479), R= -.074, X-SD= 25.2504 Y-SD= 1.1044, SY.X= 1.1091


GRAPH 1 WITH 63 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(7)
60-1
61-2
62-3
63-4
64-5
65-6
66-7
67-8
68-9
FISHING YEAR
ADAK
AVE. WEIGHT (LBS.)
POINTS
Y= 8.0404 + X * 183.73021, R= -.499, X-SD= 28.9578 Y-SD= .7811, SY.x= .6825


GRAPH 1 WITH 63 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(7)
60-1
61-2
62-3
63-4
64-5
65-6
66-7
67-8
68-9
FISHING YEAR
E. BERING SEA
AVE. WEIGHT (LBS.)
MONTHS


KODIAK STOCKS 2-3
60-61
61-62
62-63
63-64
64-65
65-66
66-67
67-68
68-69
FISHING YEARS
AVE. WEIGHT (LBS.)
MONTHS


GRAPH 1 WITH 101 POINTS. ON THE HORIZONTAL IS X(1)
ON THE VERTICAL IS X(2)
128.000
148.000
168.000
188.000
208.000
228.000
138.000
158.000
178.000
198.000
218.000
60-1
61-2
62-3
63-4
64-5
65-6
66-7
67-8
68-9
FISHING YEARS
KODIAK STOCKS 1-2-3
AVE. WEIGHT (LBS.)
MONTHS
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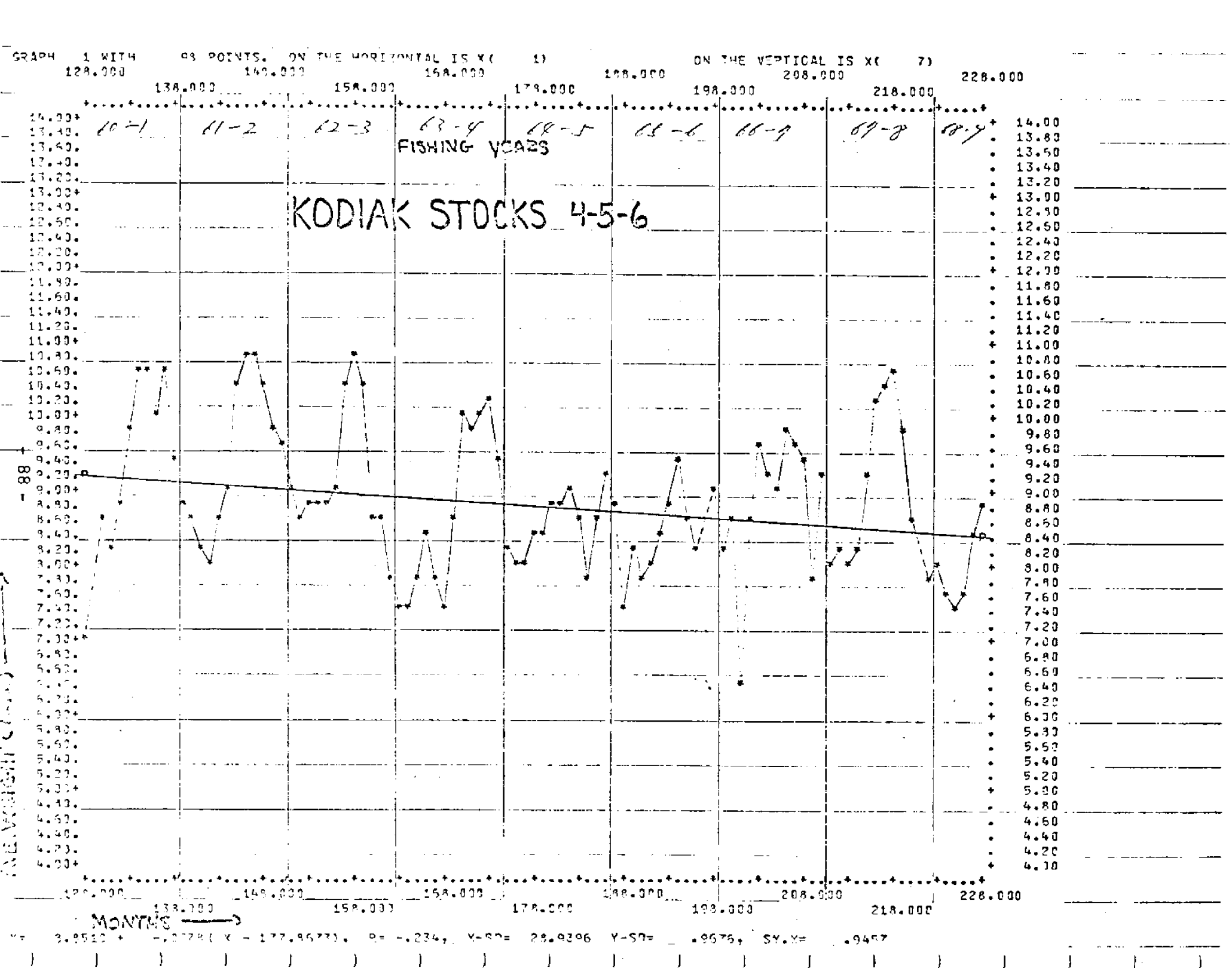
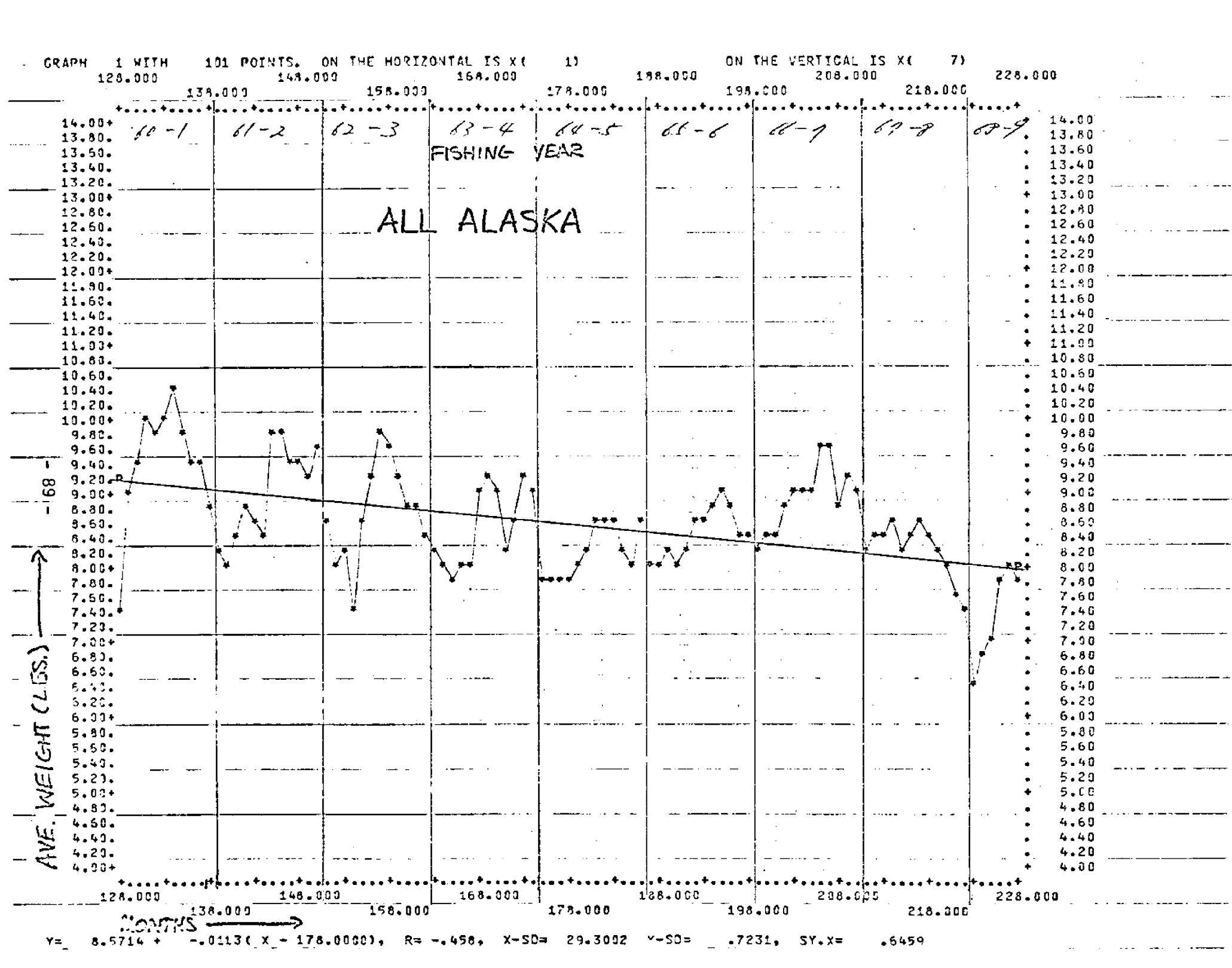
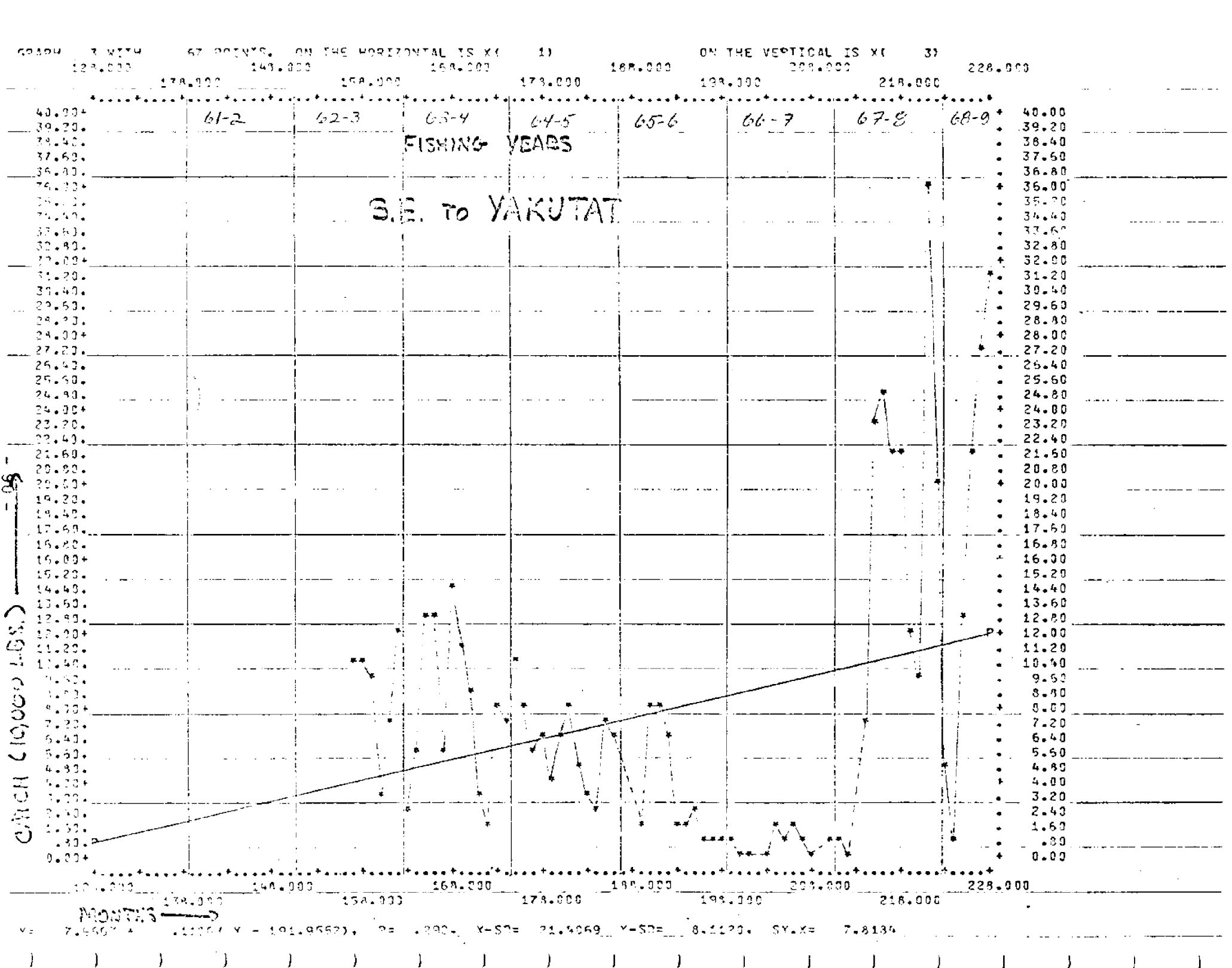
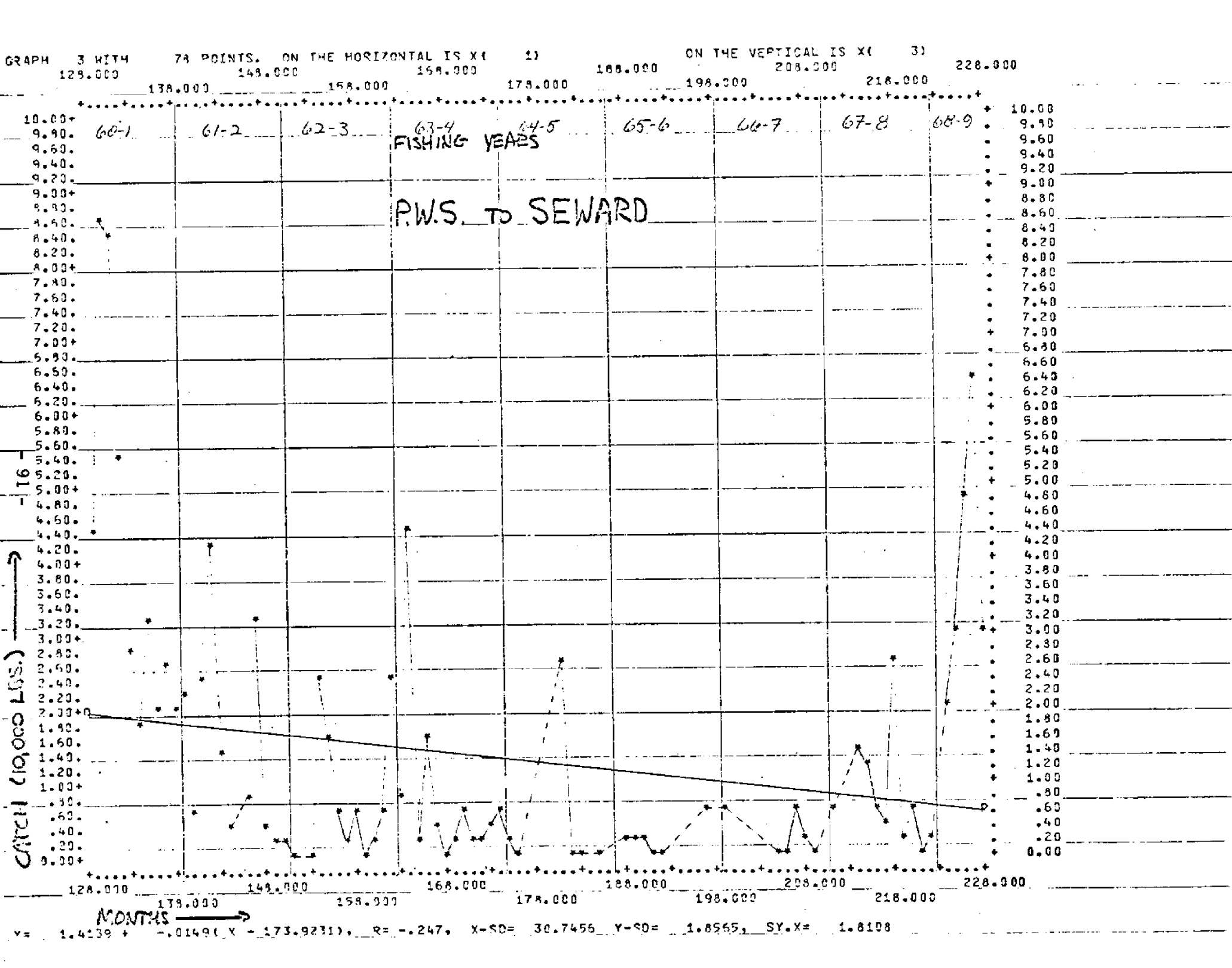
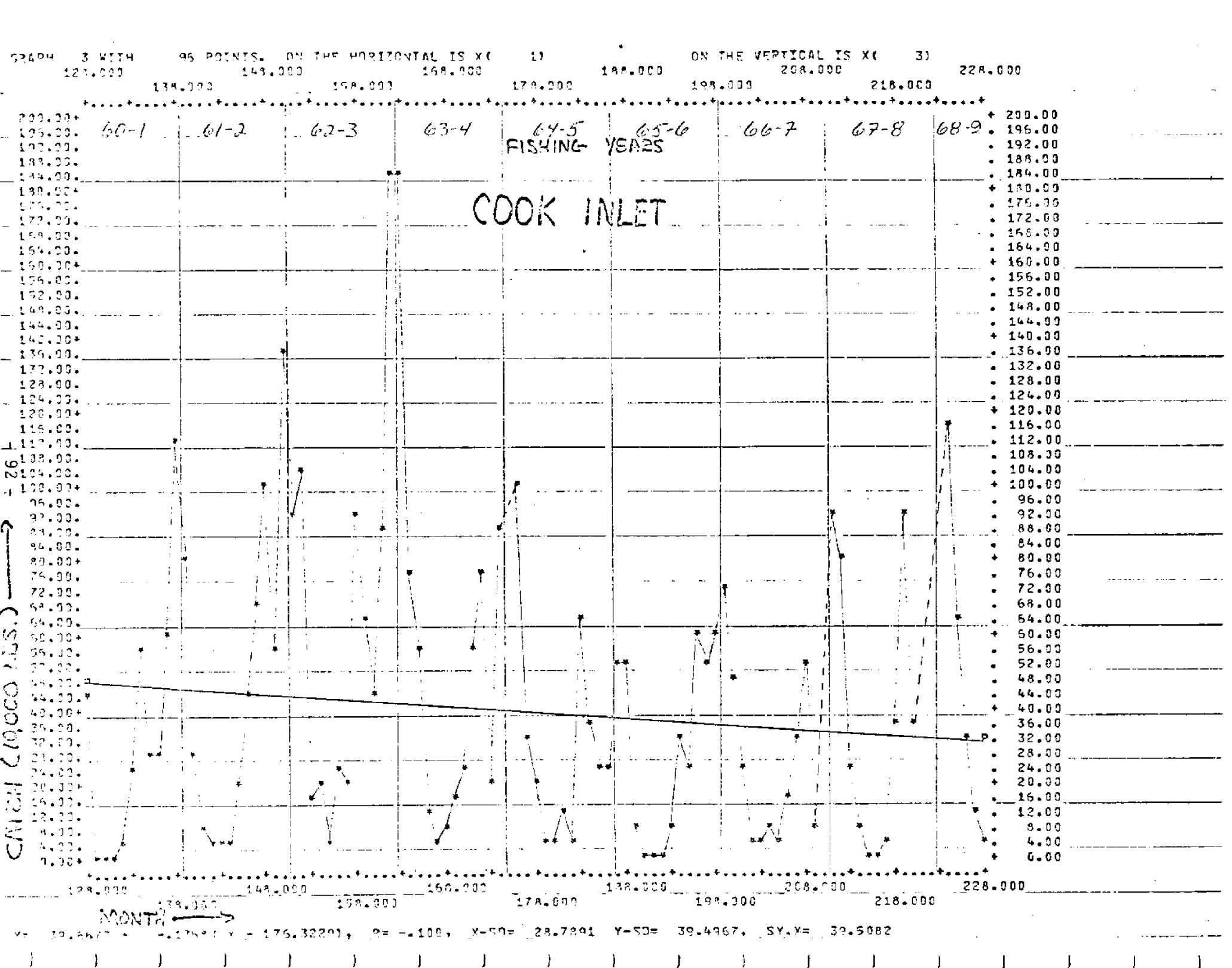
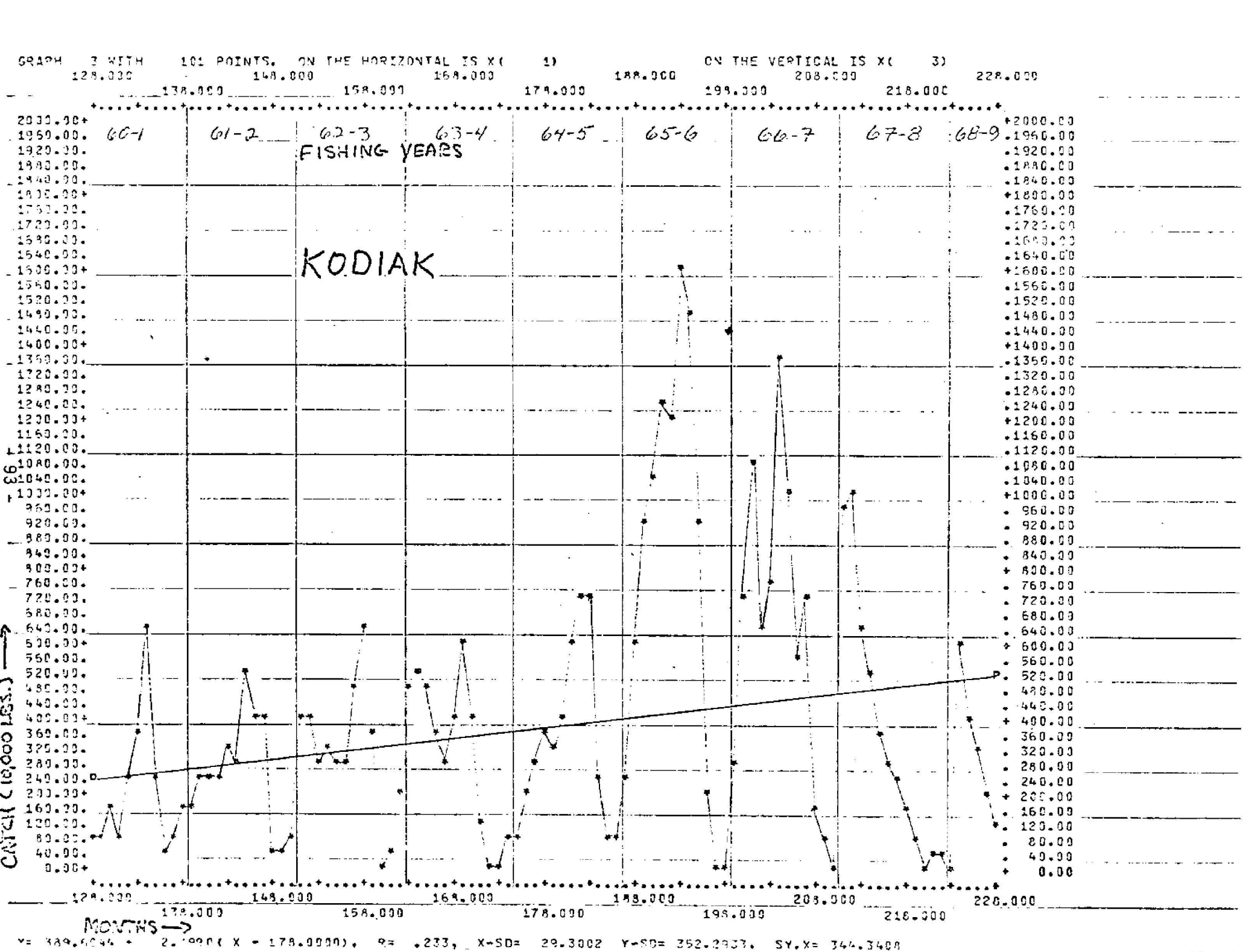

GRAPH 1 WITH 93 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(7)
128.000 138.000 148.000 158.000 168.000 178.000 188.000 198.000 208.000 218.000 228.000
60-1 61-2 62-3 63-4 64-5 65-6 66-7 67-8 68-9
FISHING YEARS
KODIAK STOCKS 4-5-6
MONTHS
Y= 3.8513 + -.0278(X - 177.9677), R= -.234, X-SD= 28.9396 Y-SD= .9675, SY.X= .9457

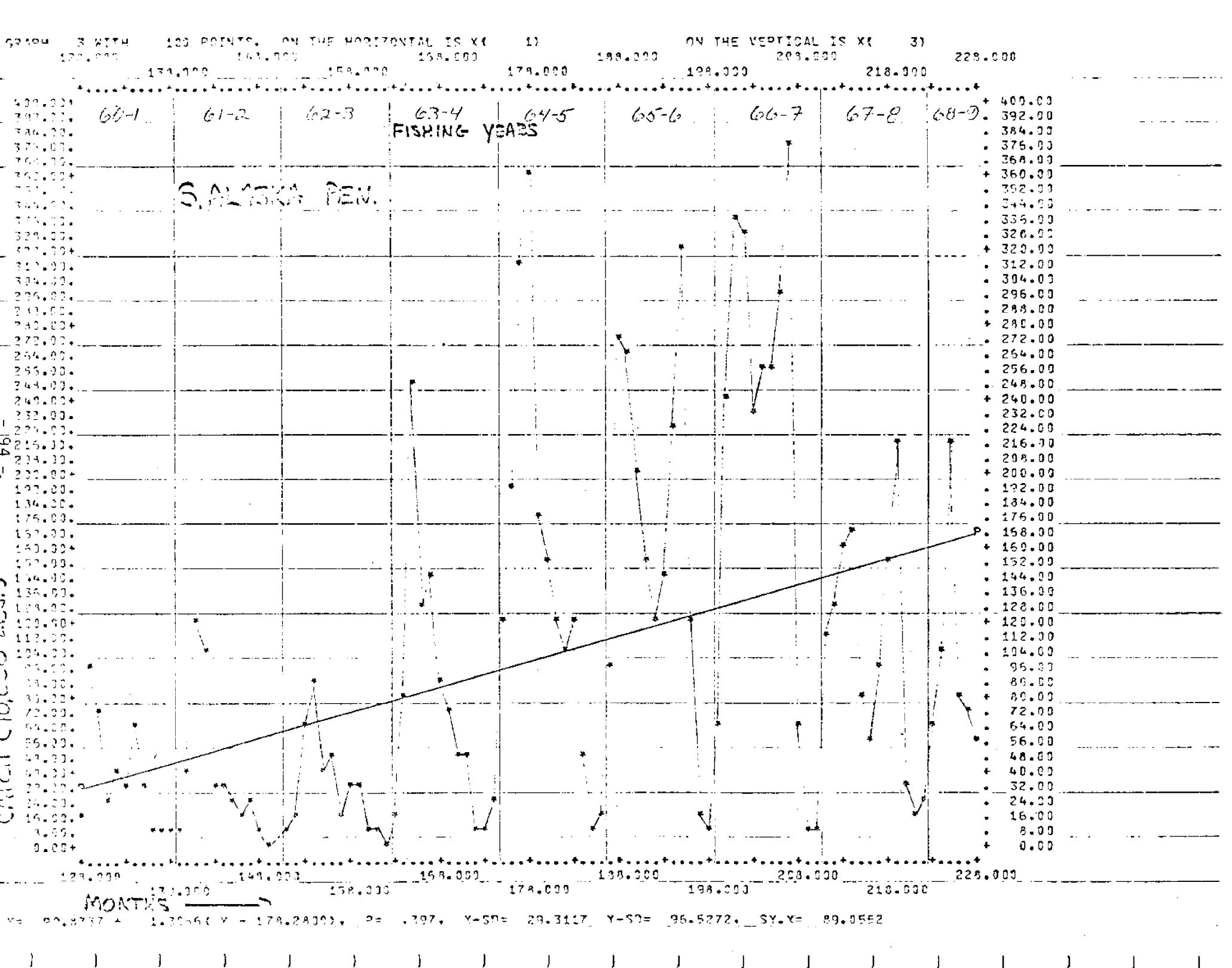

GRAPH 1 WITH 101 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(7)
60-1
61-2
62-3
63-4
64-5
65-6
66-7
67-8
68-9
FISHING YEAR
ALL ALASKA
AVE. WEIGHT (LBS.)
MONTHS
Y= 8.5714 + -.0113(X - 176.0000), R= -.458, X-SD= 29.3002 Y-SD= .7231, SY.X= .6459

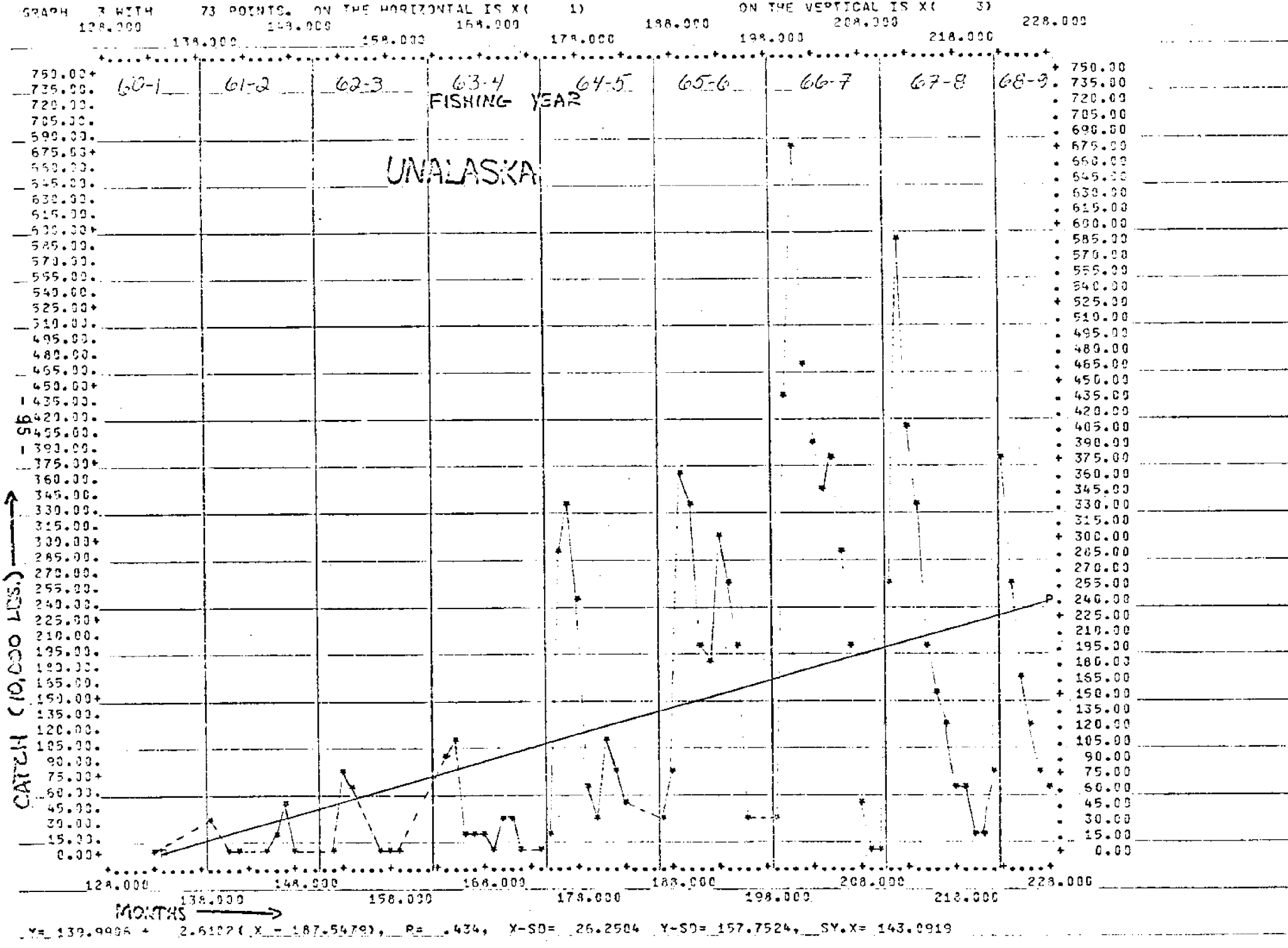

61-2
62-3
63-4
64-5
65-6
66-7
67-8
68-9
FISHING YEARS
S.E. to YAKUTAT
CATCH (1000's LBS.)
MONTHS


GRAPH 3 WITH 78 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(3)
60-1
61-2
62-3
63-4
64-5
65-6
66-7
67-8
68-9
FISHING YEARS
P.W.S. TO SEWARD
CATCH (1000 LBS.)
MONTHS
Y= 1.4139 + -.0149(X - 173.9231), R= -.247, X-SD= 30.7456 Y-SD= 1.8565, SY.X= 1.8108

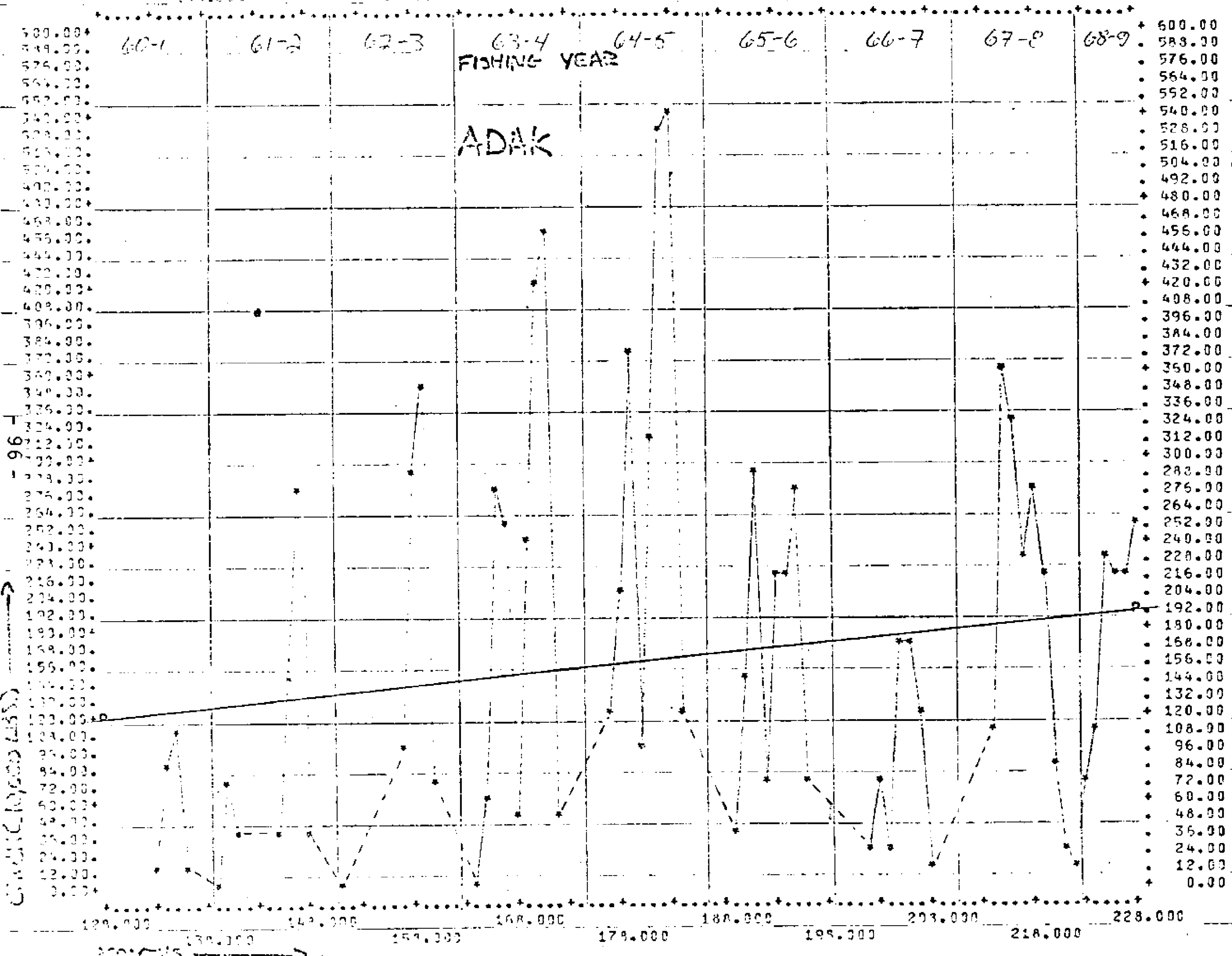

GRAPH 3 WITH 96 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(3)
60-1
61-2
62-3
63-4
64-5
65-6
66-7
67-8
68-9
FISHING YEARS
COOK INLET
CATCH (10,000 LBS.)
MONTH
Y= 39.6567 + -.1782 X + 176.3220), R= -.100, X-SD= 28.7891 Y-SD= 39.4967, SY.X= 39.5082


GRAPH 3 WITH 101 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(3)
60-1
61-2
62-3
63-4
64-5
65-6
66-7
67-8
68-9
FISHING YEARS
KODIAK
CATCH (10,000 LBS.)
MONTHS
Y= 389.6044 + 2.1990(X - 178.0000), R= .233, X-SD= 29.3002 Y-SD= 352.2837, SY.X= 344.3408

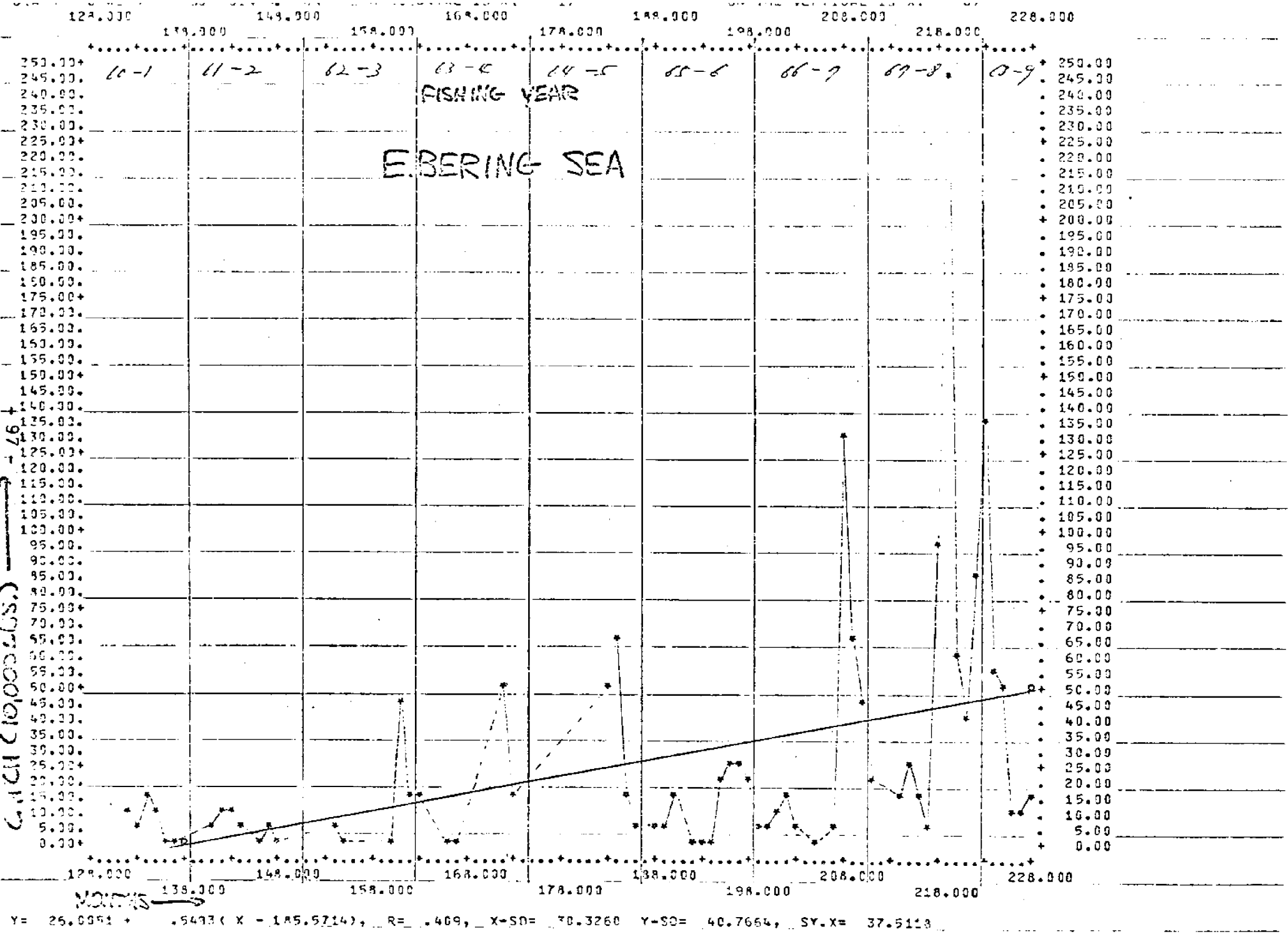

60-1
61-2
62-3
63-4
64-5
65-6
66-7
67-8
68-9
FISHING YEARS
S. ALASKA PEN.
MONTHS

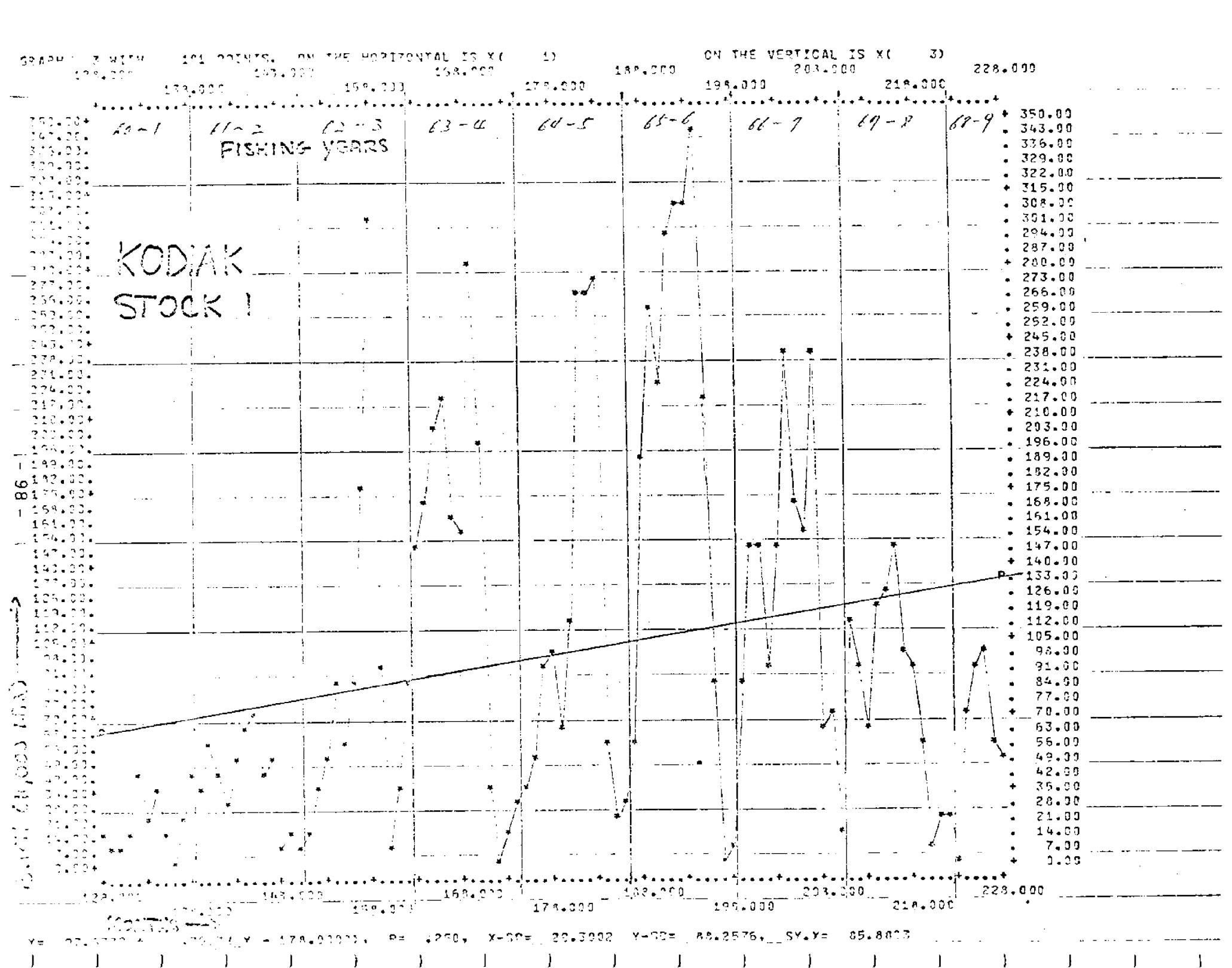

GRAPH 3 WITH 73 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(3)
60-1
61-2
62-3
63-4
64-5
65-6
66-7
67-8
68-9
FISHING YEAR
UNALASKA
CATCH (10,000 LBS.)
MONTHS
Y= 139.9906 + 2.6102(X - 187.5479), R= .434, X-SD= 26.2504 Y-SD= 157.7524, SY.X= 143.0919

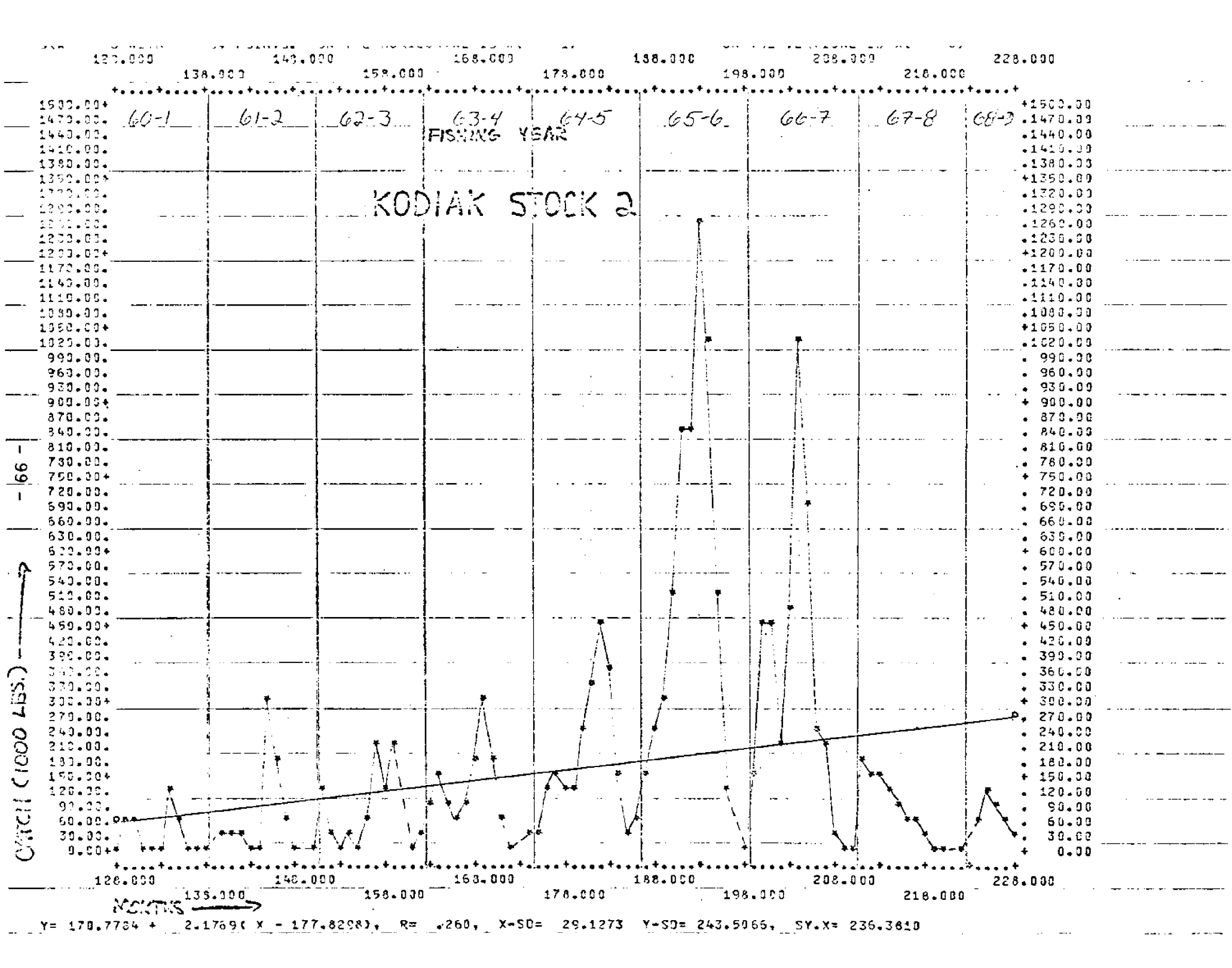
GRAPH 3 WITH 51 POINTS, ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(3)

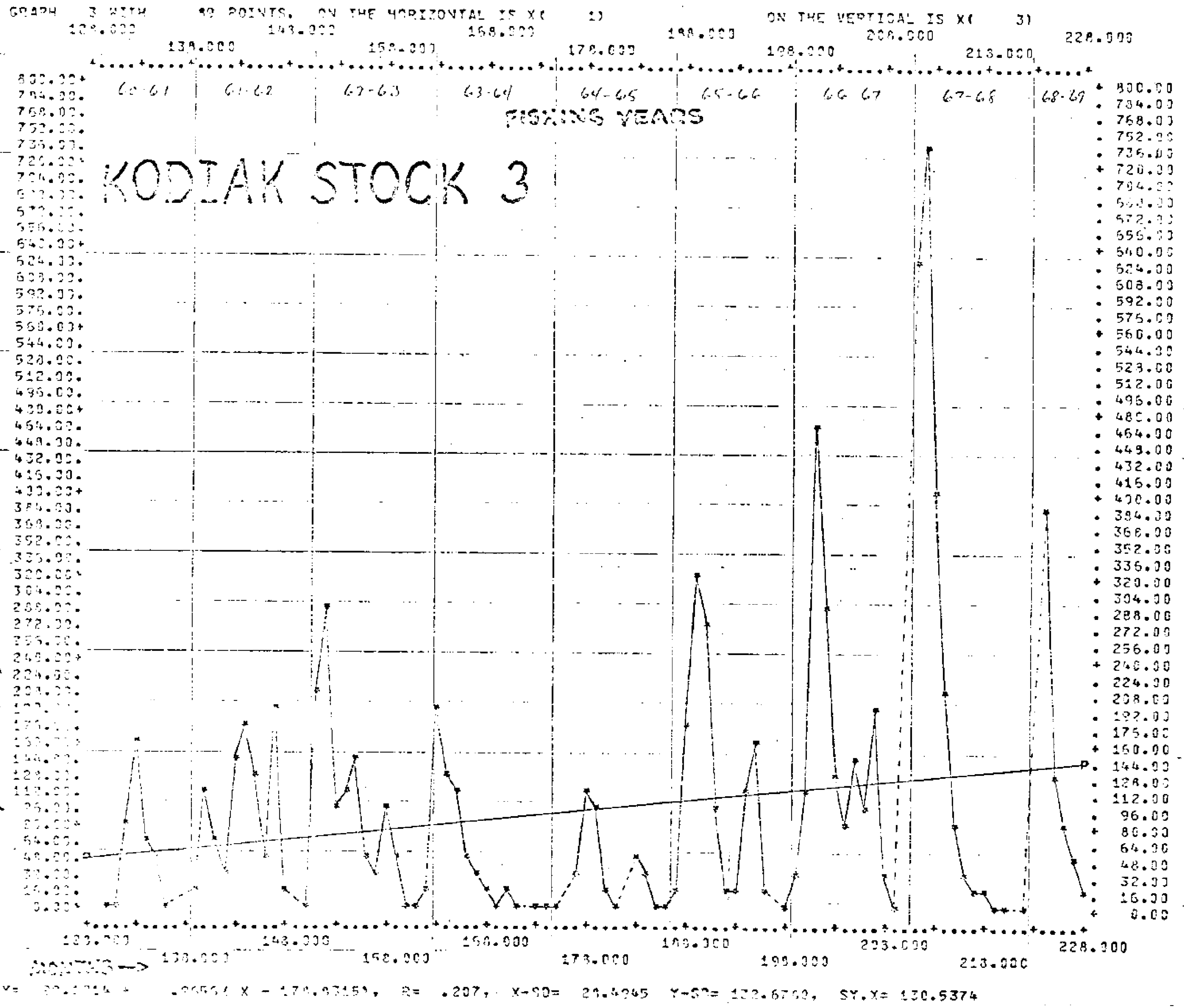


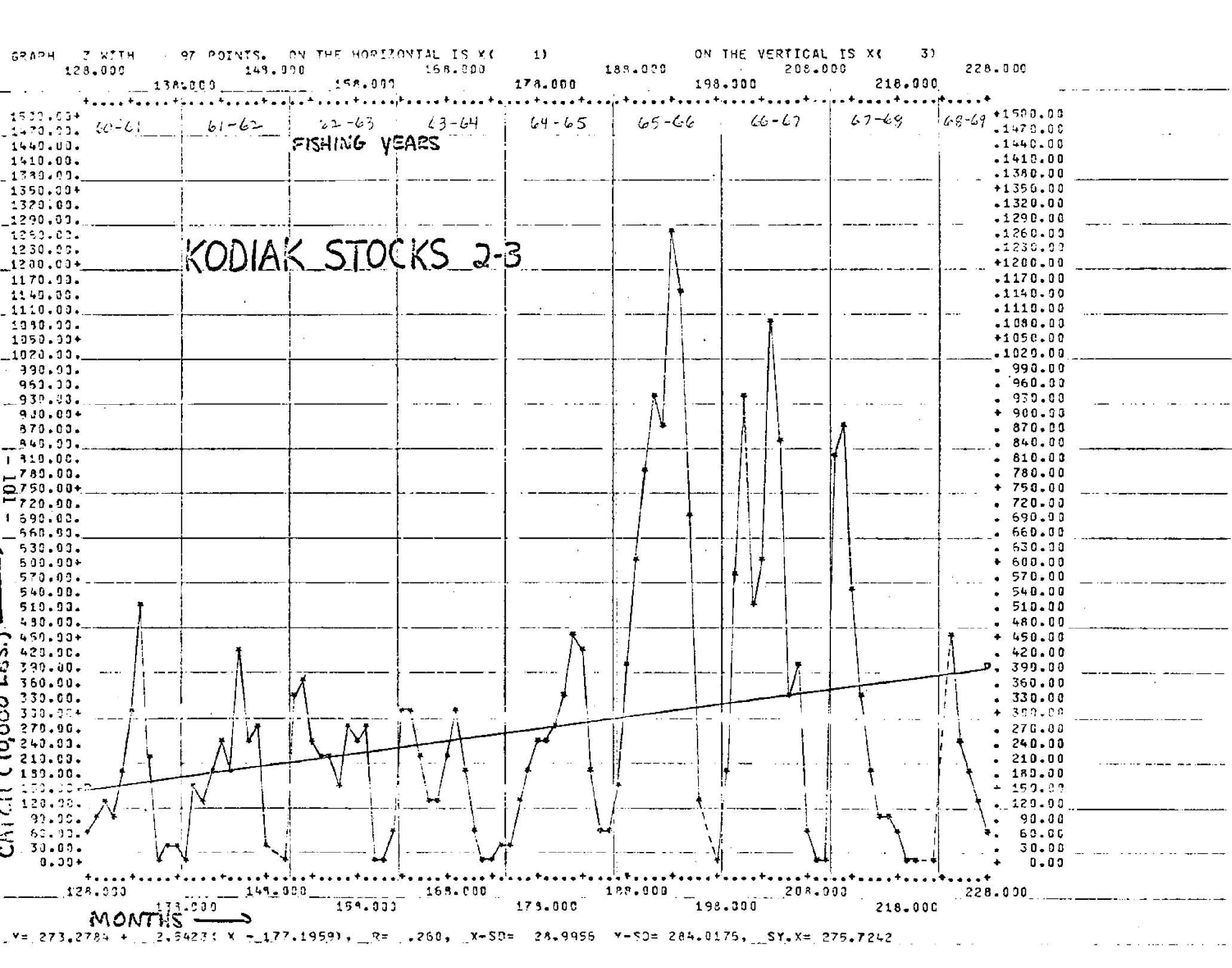
Y= 102.5043 (.7215 (- 133.7322), R= .157, Y-SD= 28.9578 Y-SD= 135.8247, SY.X= 135.2255


60-1
61-2
62-3
63-4
64-5
65-6
66-7
67-8
8-9
FISHING YEAR
E.BERING SEA
CATCH (1000 LBS.)
NOTES
Y= 26.0091 + .5493(X - 185.5714), R= .409, X-SD= 30.3260 Y-SD= 40.7664, SY.X= 37.5113

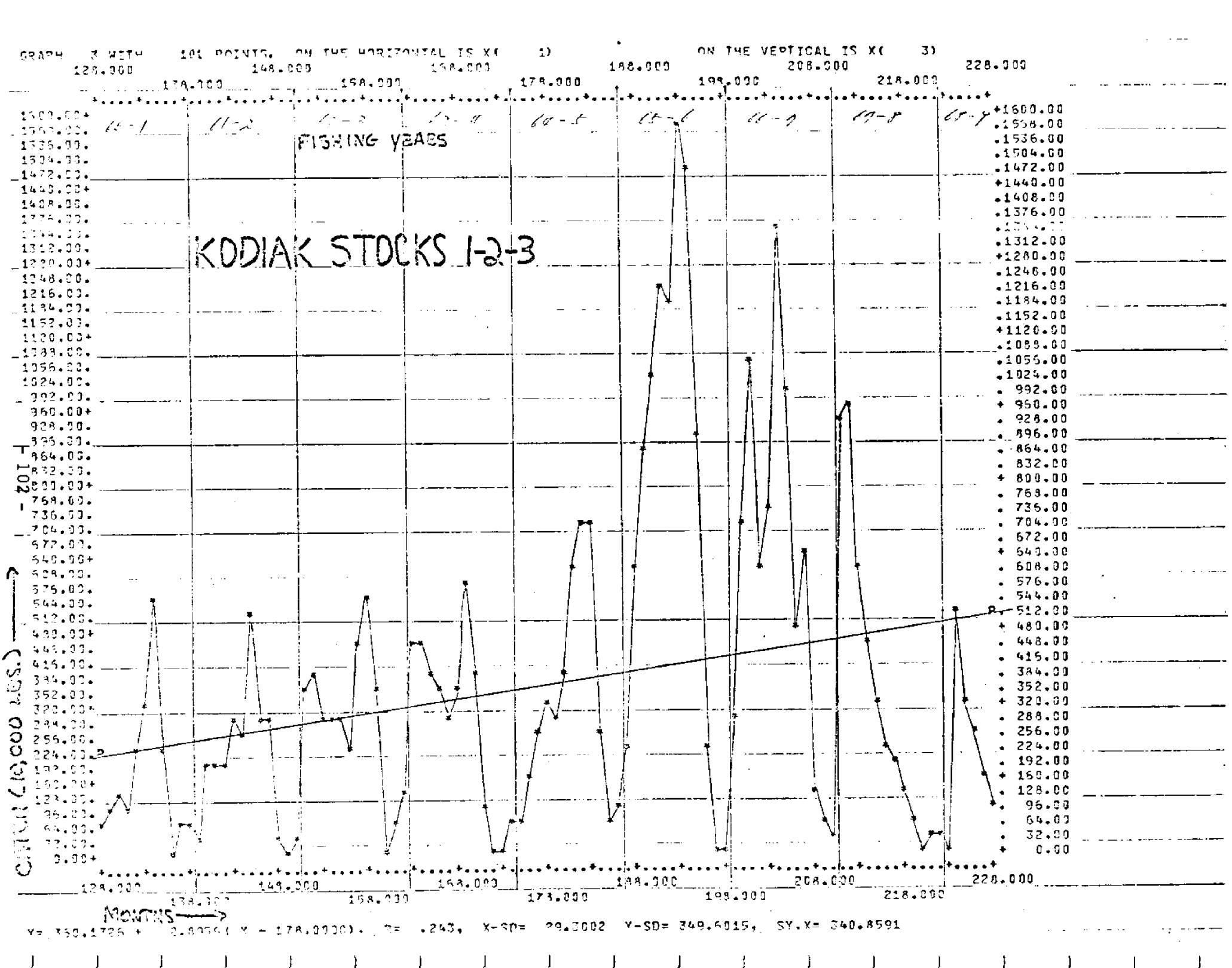

KODAK
STOCK 1
FISHING YEARS
60-1
61-2
62-3
63-4
64-5
65-6
66-7
67-8
68-9
- 86 -

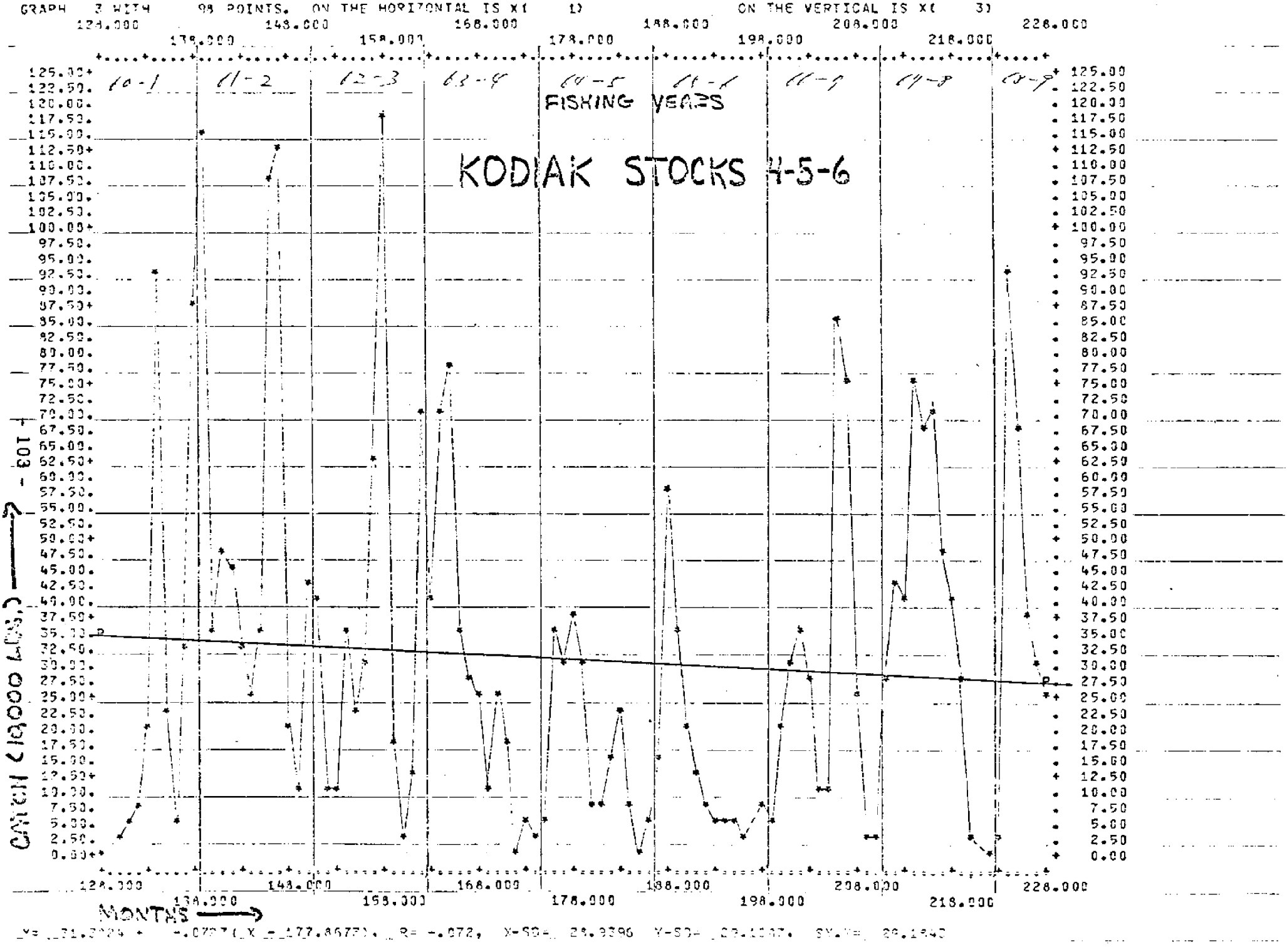

KODIAK STOCK 2
60-1
61-2
62-3
63-4
64-5
65-6
66-7
67-8
68-9
FISHING YEAR
CATCH (1000 LBS.)
MONTHS
- 96 -
Y= 170.7784 + 2.1769(X - 177.8298), R= .260, X-SD= 29.1273 Y-SD= 243.5066, SY.X= 236.3610

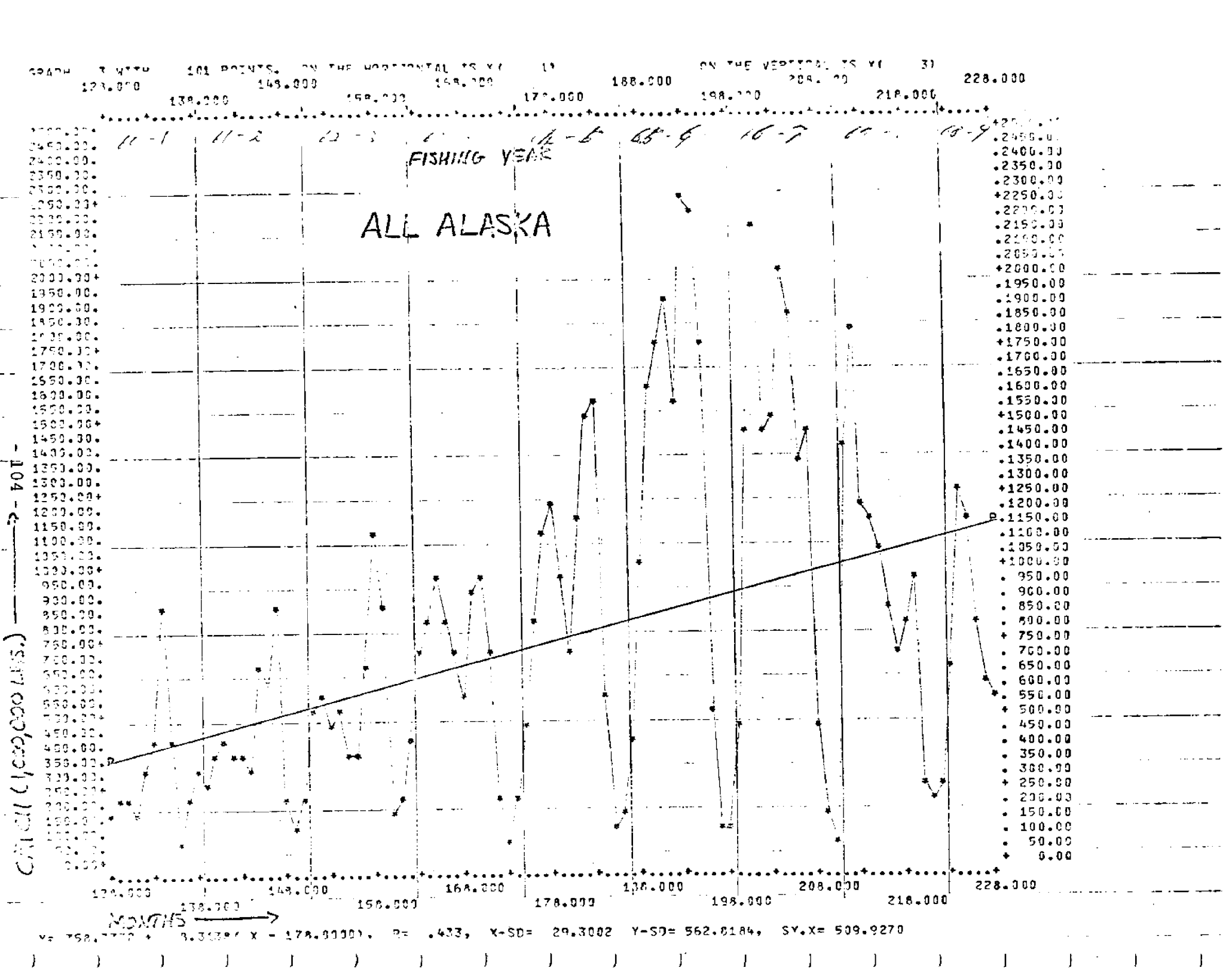

ON THE VERTICAL IS X(3)
60-61
61-62
62-63
63-64
64-65
65-66
66 67
67-68
68-69
KODIAK STOCK 3
178.000
198.000
206.000
213.000
228.000
800.00
784.00
768.00
752.00
736.00
720.00
560.00
512.00
496.00
480.00
464.00
448.00
432.00
416.00
400.00
384.00
368.00
352.00
336.00
320.00
304.00
288.00
272.00
256.00
240.00
224.00
208.00
192.00
176.00
160.00
144.00
128.00
112.00
96.00
80.00
64.00
48.00
32.00
16.00
0.00
143.000
158.000
160.000
173.000
198.000
203.000
213.000
228.000
MONTHS
SY.X= 130.5374

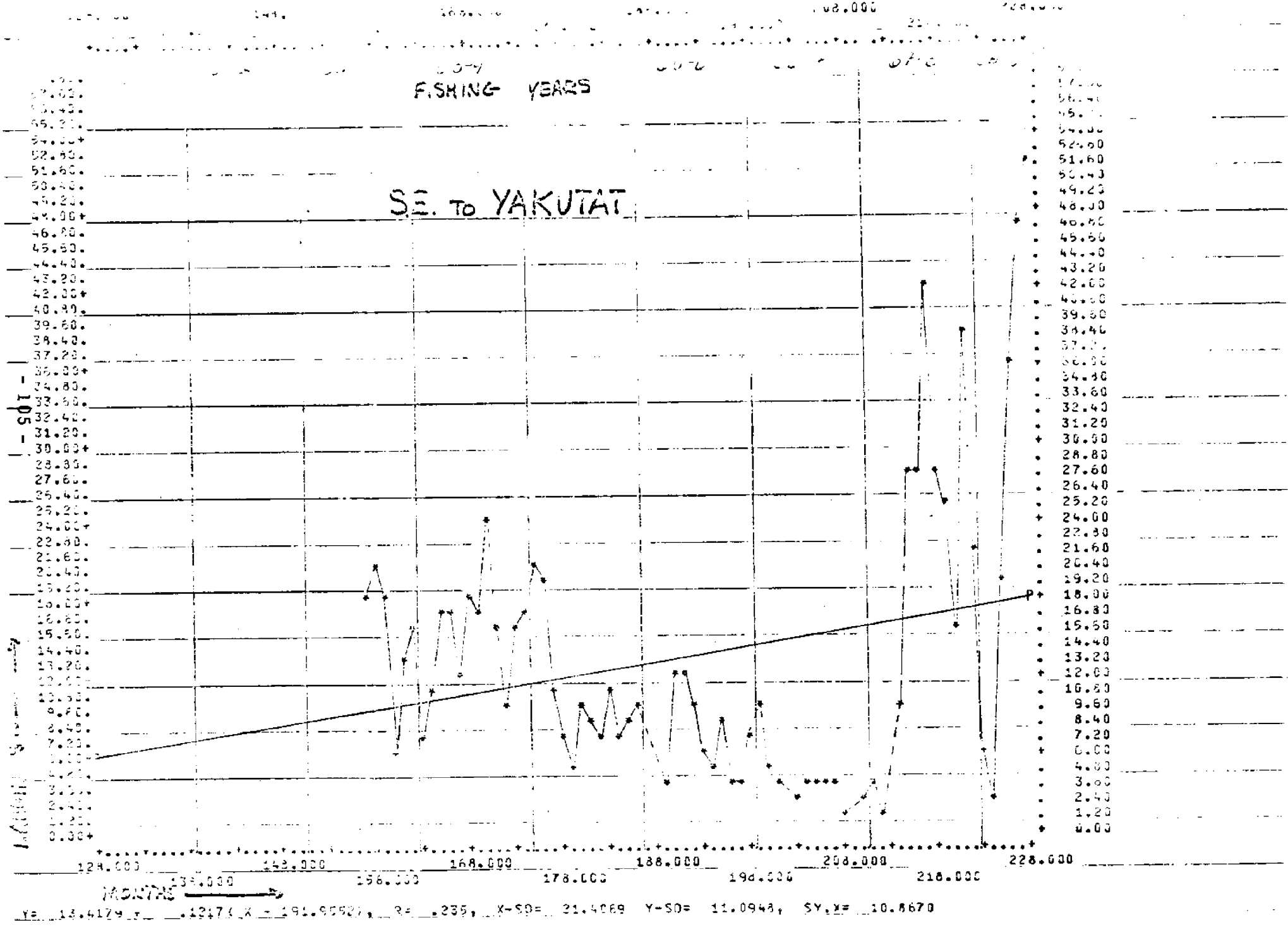


Y= 273.2784 + 2.5423(X - 177.1959), R= .260, X-SD= 26.9956 Y-SD= 284.0175, SY.X= 275.7242

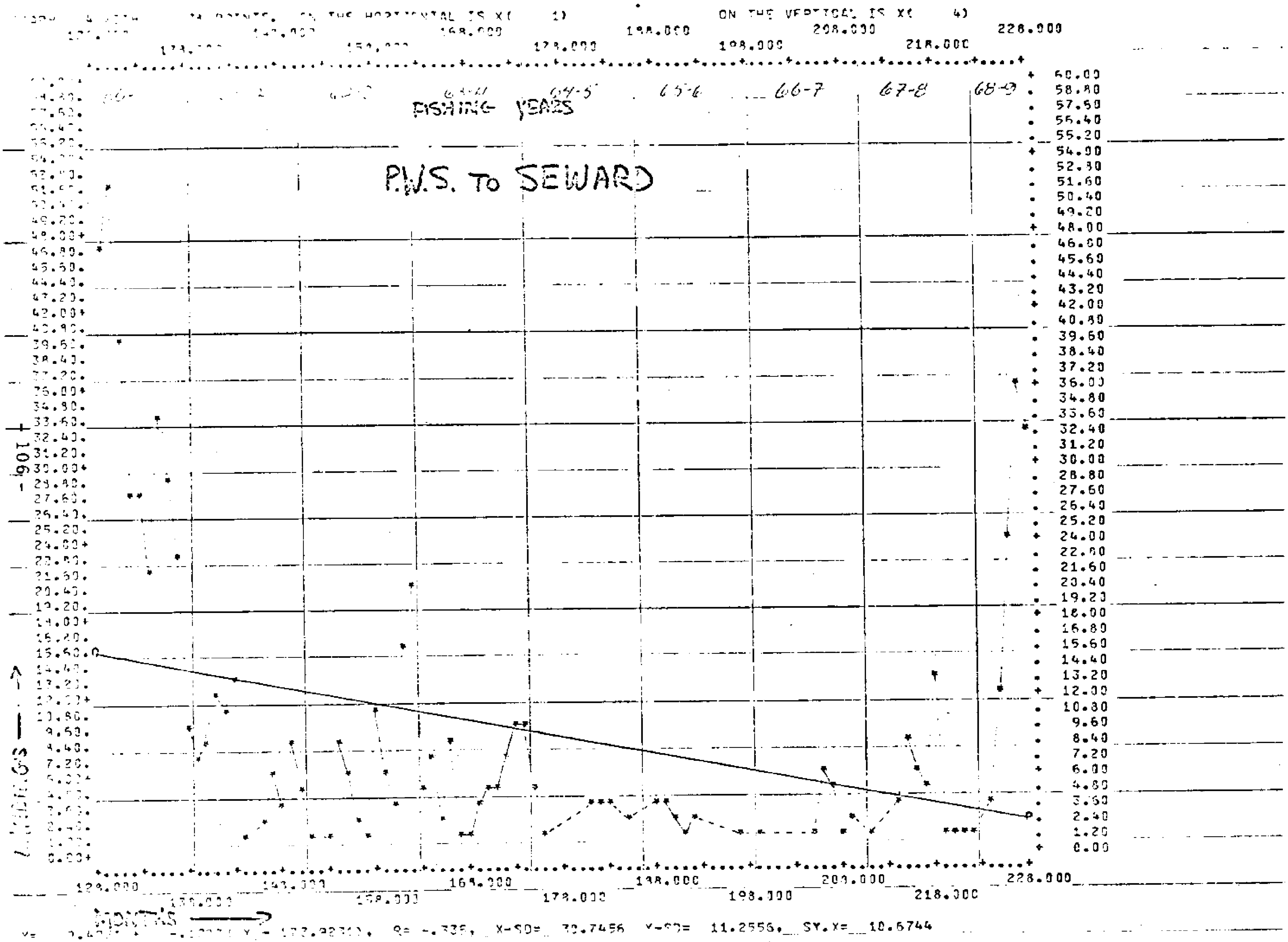

KODIAK STOCKS 1-2-3
FISHING YEARS
CATCH (10,000 LBS.)
MONTHS
GRAPH 3 WITH 101 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(3)
Y= 390.1726 + 0.8056(X - 178.0000). R= .243, X-SD= 29.3002 Y-SD= 349.6015, SY.X= 340.8591

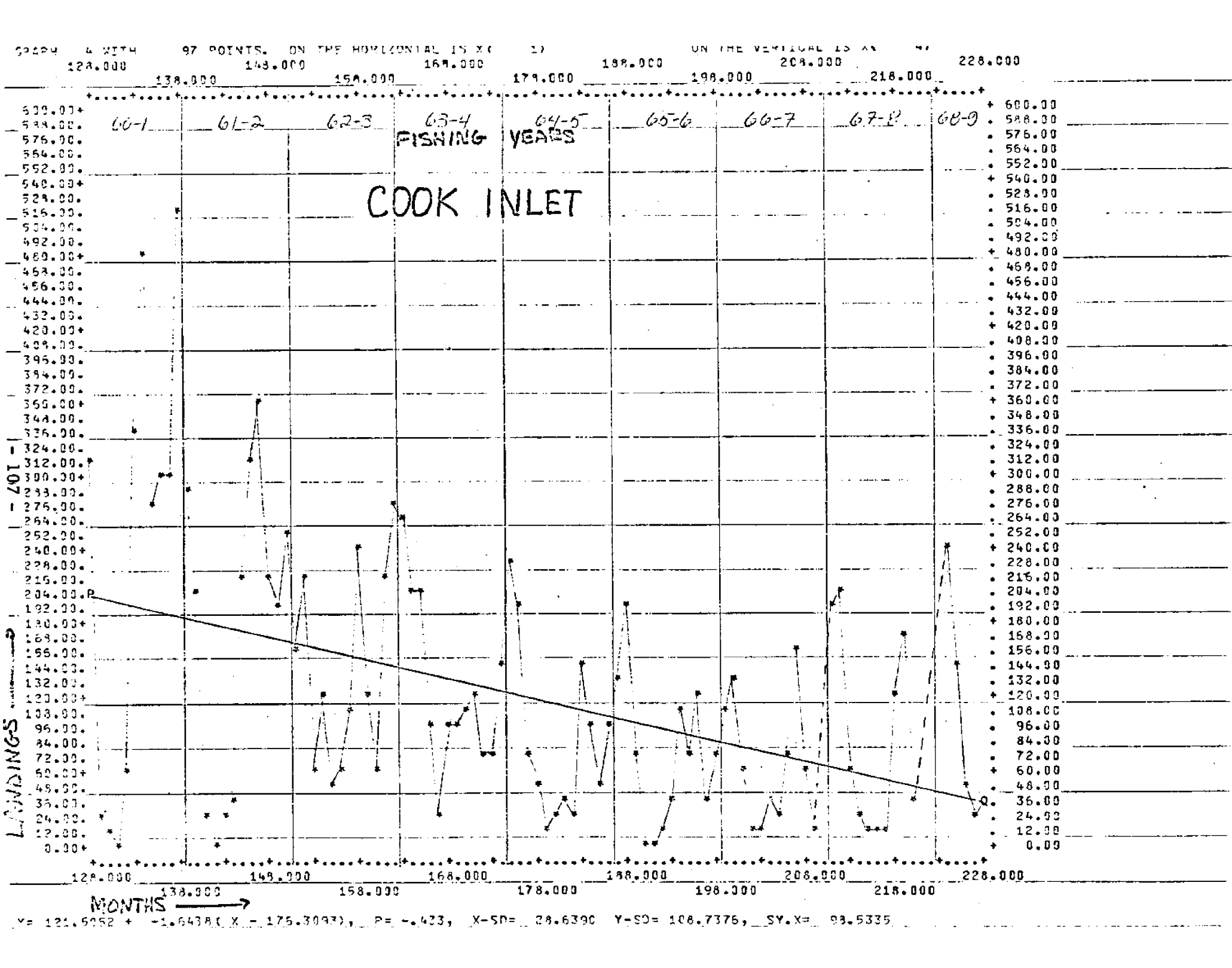

GRAPH 3 WITH 98 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(3)
FISHING YEARS
KODIAK STOCKS 4-5-6
CATCH (10000 LBS.) → - 103 -
MONTHS →


ALL ALASKA
FISHING YEAR
MONTHS
CATCH (1,000,000 LBS.)
Y= 758.7772 + 3.3138(X - 178.0000), R= .433, X-SD= 29.3002 Y-SD= 562.6184, SY.X= 509.9270

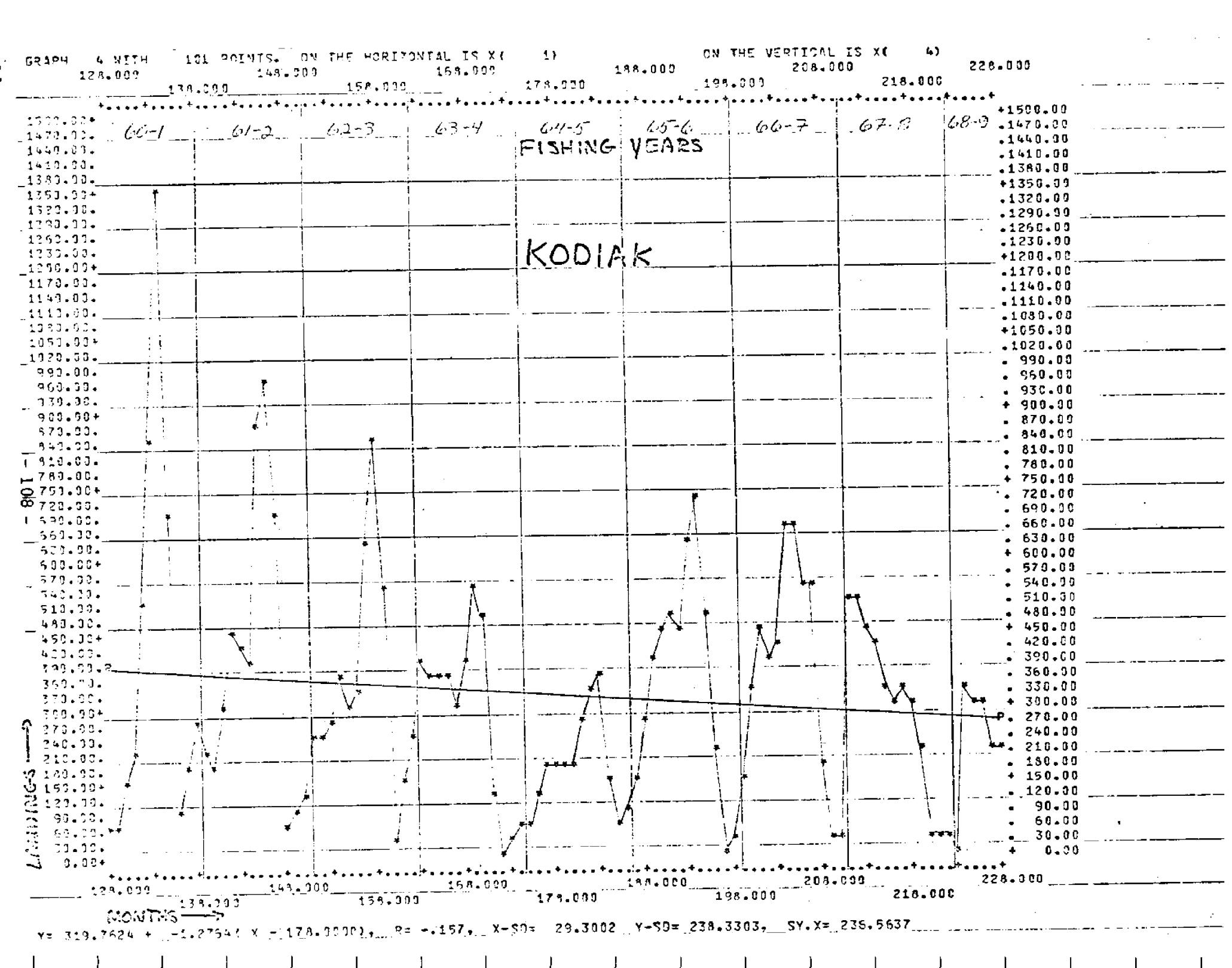


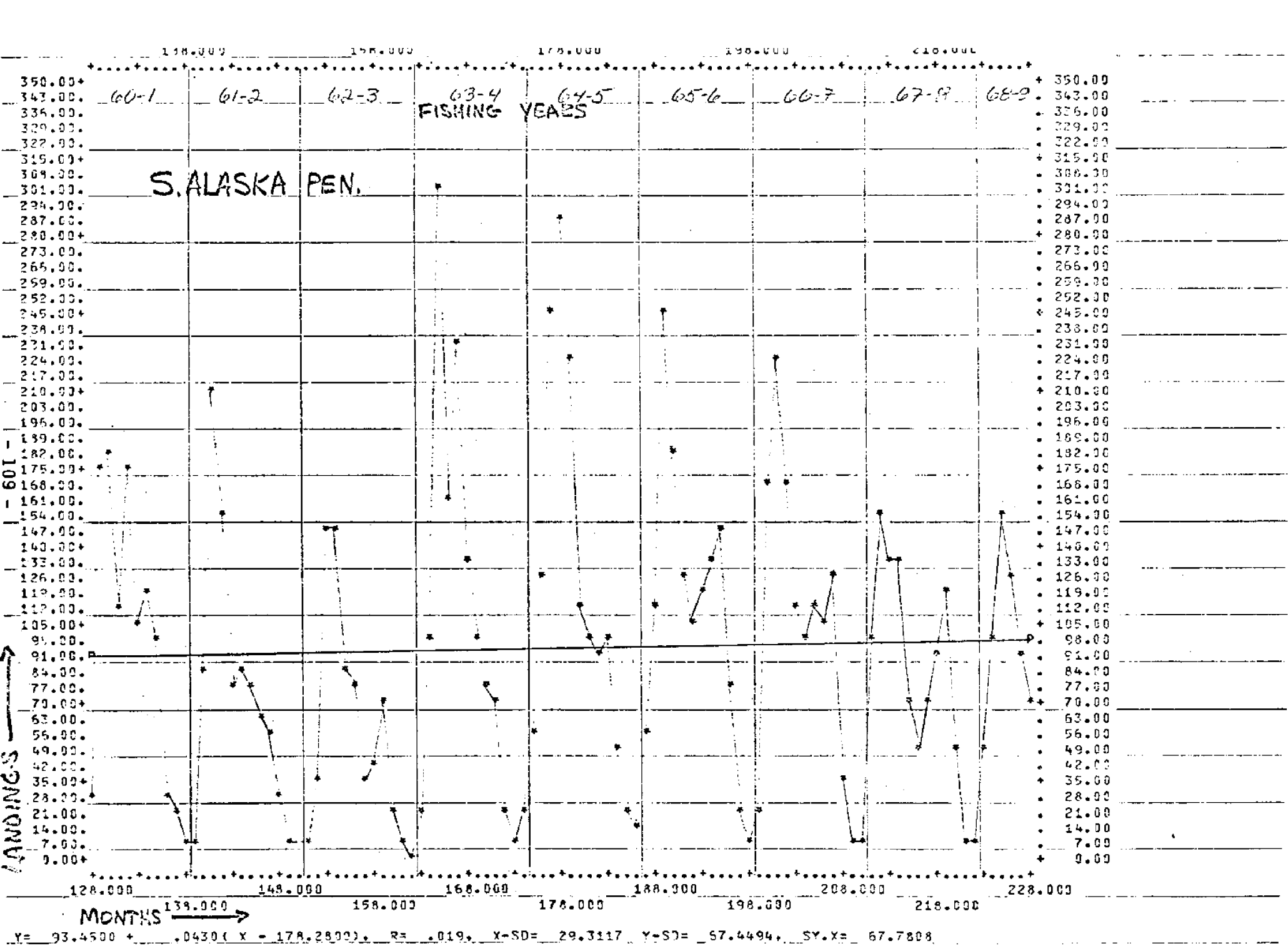
Y= 14.6179 r= .1217(X = 191.9552), B= .235, X-SD= 21.4069 Y-SD= 11.0948, SY.X= 10.8670


ON THE VERTICAL IS X(4)
FISHING YEARS
64-5
65-6
66-7
67-8
68-9
P.W.S. TO SEWARD
MONTHS
CATCHES
R= -.335, X-SD= 32.7456 Y-SD= 11.2556, SY.X= 10.6744

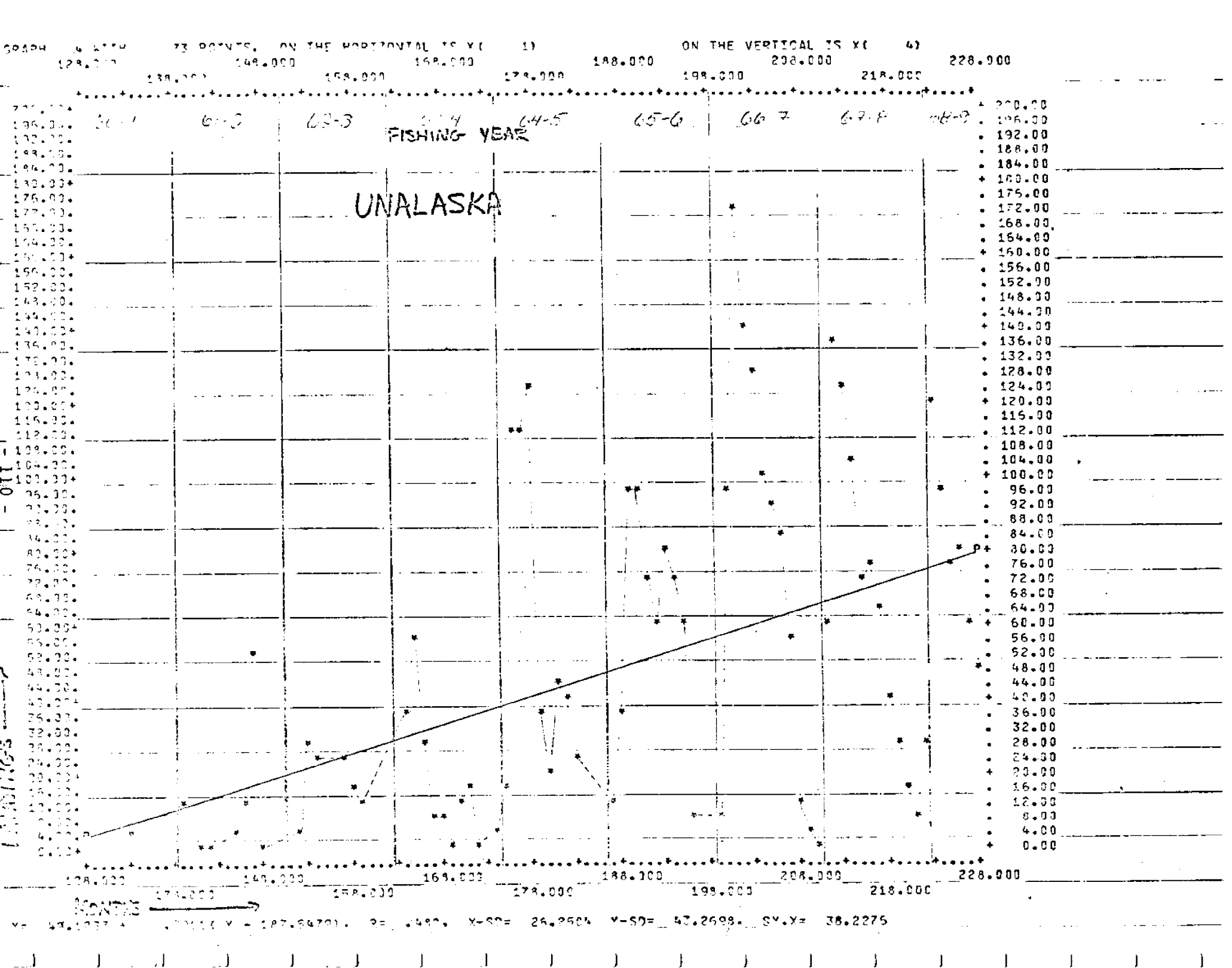


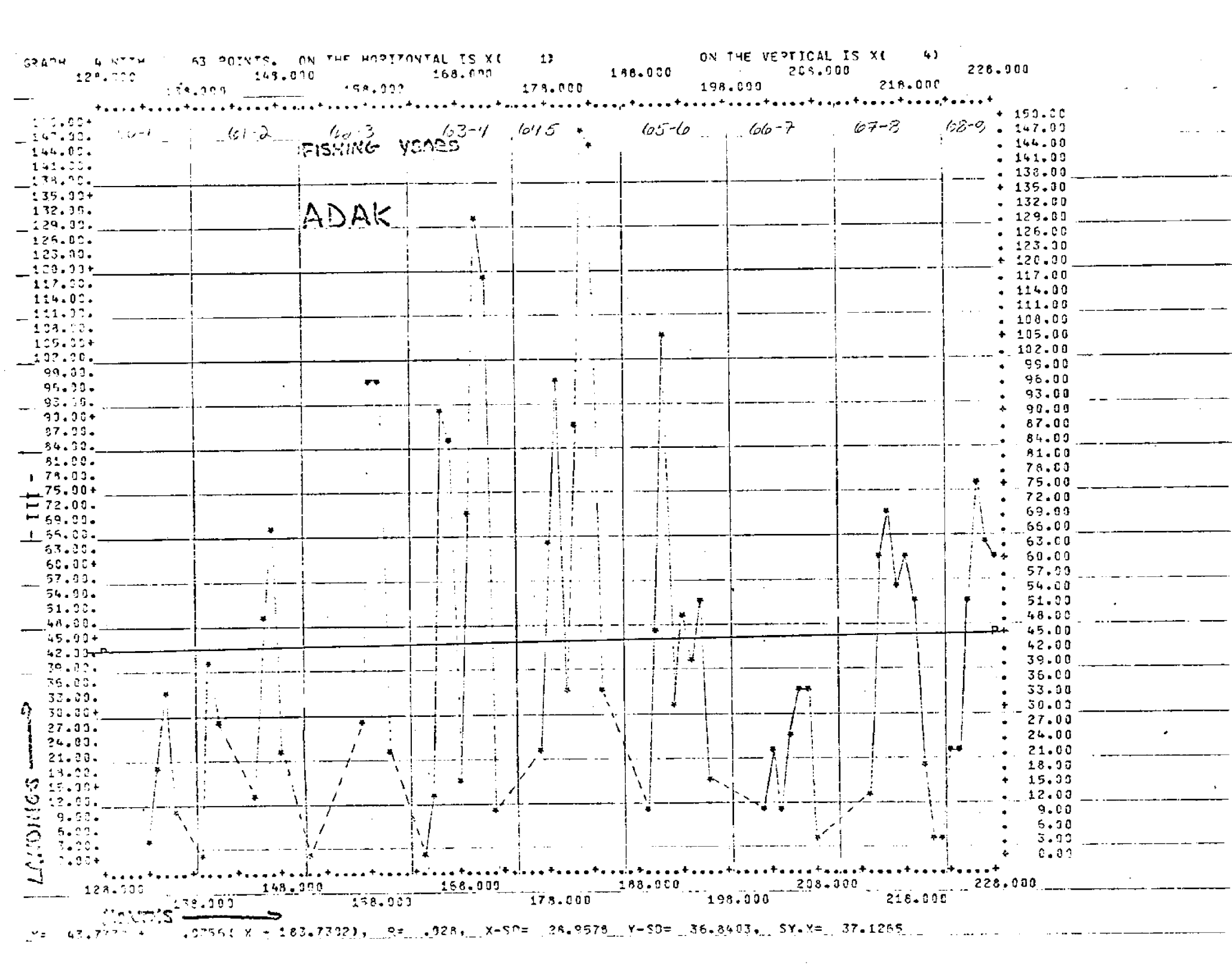
Y= 121.6052 + -1.6438(X - 175.3093), R= -.423, X-SD= 28.6390 Y-SD= 108.7376, SY.X= 98.5335

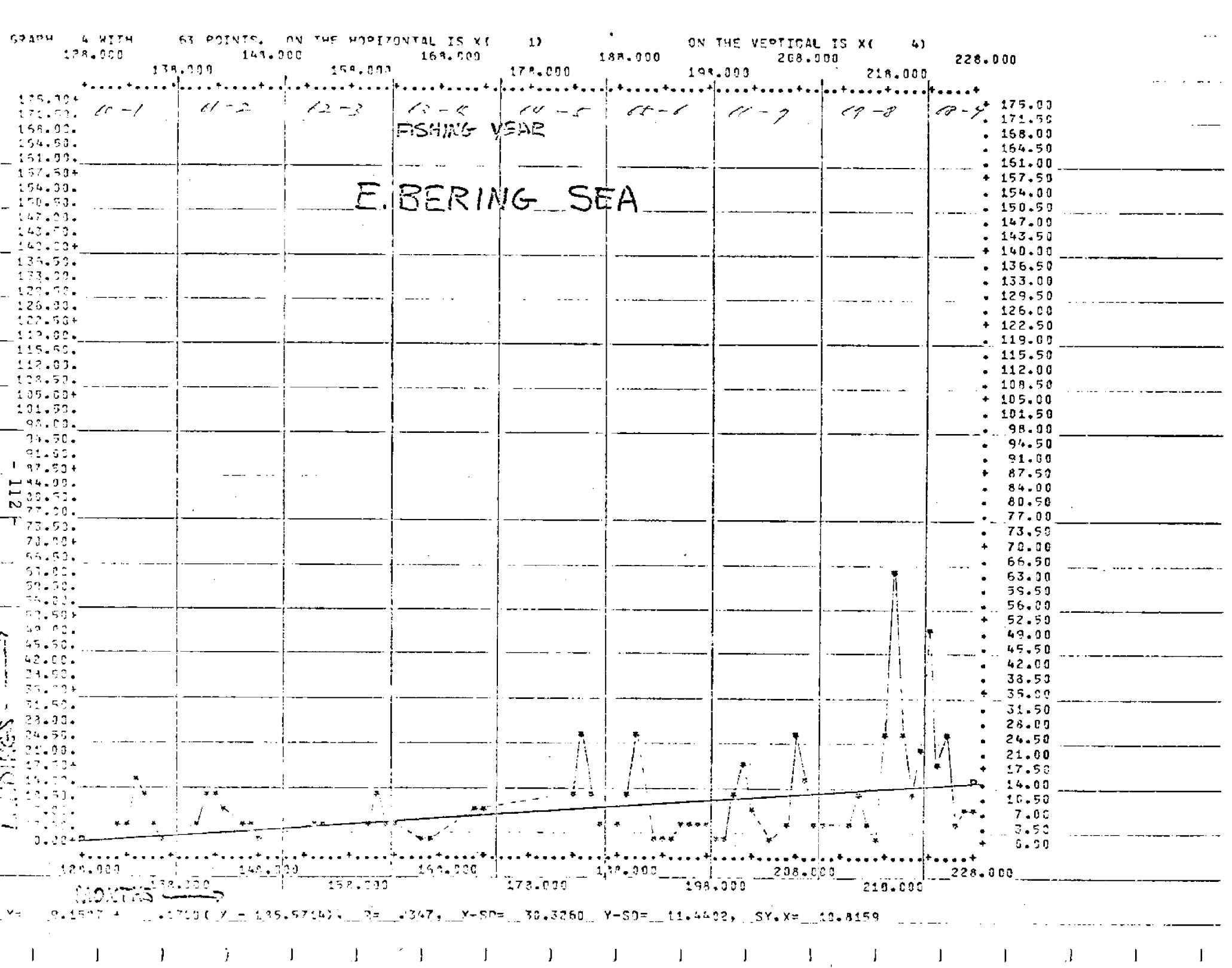

GRAPH 4 WITH 101 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(4)
60-1
61-2
62-3
63-4
64-5
65-6
66-7
67-8
68-9
FISHING YEARS
KODIAK
LANDINGS-3 ——>
MONTHS ——>
Y= 319.7624 + -1.2754(X - 178.0000), R= -.157, X-SD= 29.3002 Y-SD= 238.3303, SY.X= 236.5637



Y= 93.4500 + .0430(X - 178.2800), R= .019, X-SD= 29.3117 Y-SD= 67.4494, SY.X= 67.7808


ON THE HORIZONTAL IS X(1)
ON THE VERTICAL IS X(4)
FISHING YEAR
UNALASKA
MONTHS
128.000
148.000
168.000
188.000
208.000
228.000


ADAK
FISHING YEARS
LANDINGS
61-2
62-3
63-4
64-5
65-6
66-7
67-8
68-9


GRAPH 4 WITH 63 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(4)
128.000
138.000
148.000
158.000
168.000
178.000
188.000
198.000
208.000
218.000
228.000
FISHING YEAR
E. BERING SEA
175.00
171.50
168.00
164.50
161.00
157.50
154.00
150.50
147.00
143.50
140.00
136.50
133.00
129.50
126.00
122.50
119.00
115.50
112.00
108.50
105.00
101.50
98.00
94.50
91.00
87.50
84.00
80.50
77.00
73.50
70.00
66.50
63.00
59.50
56.00
52.50
49.00
45.50
42.00
38.50
35.00
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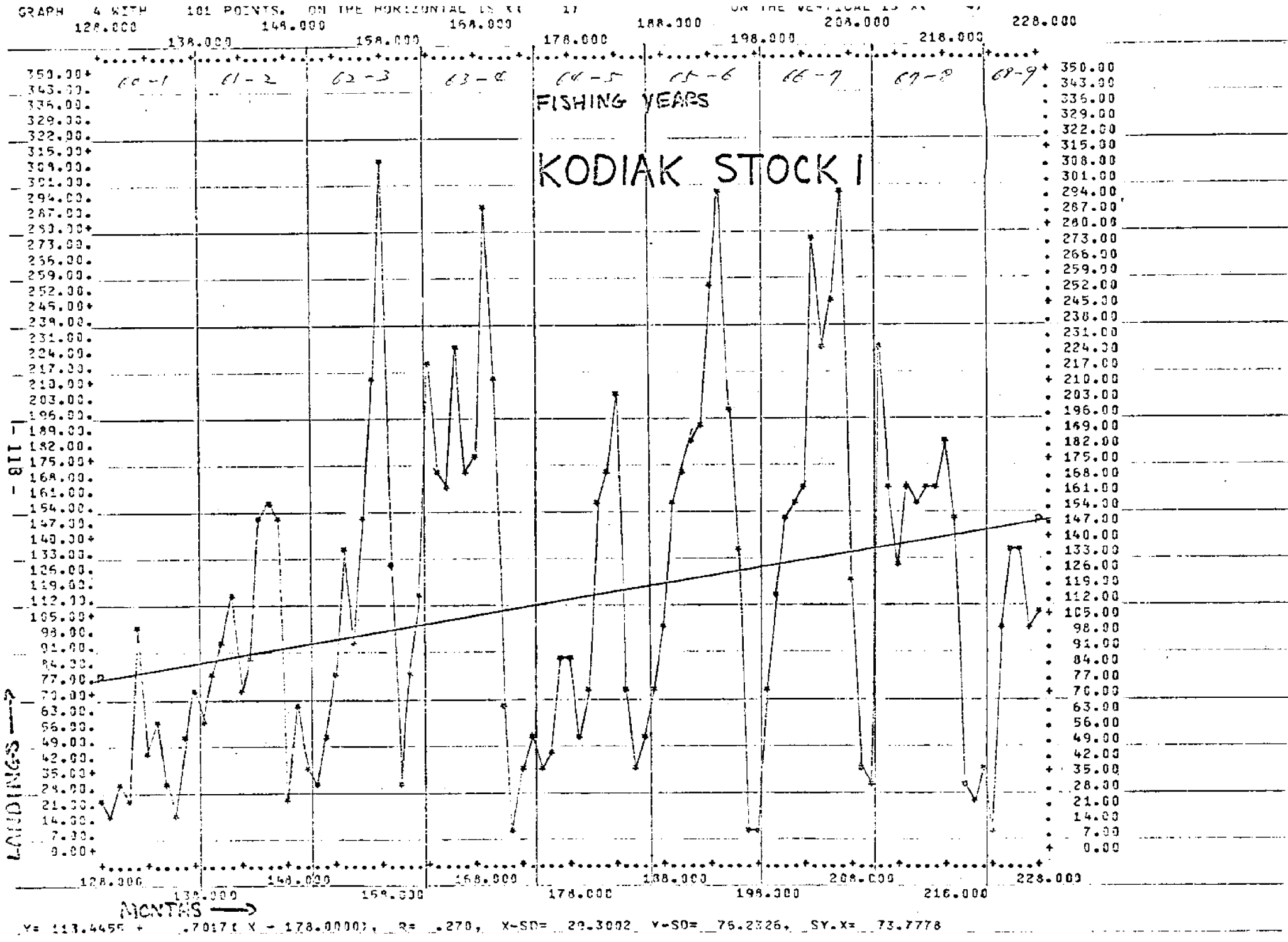
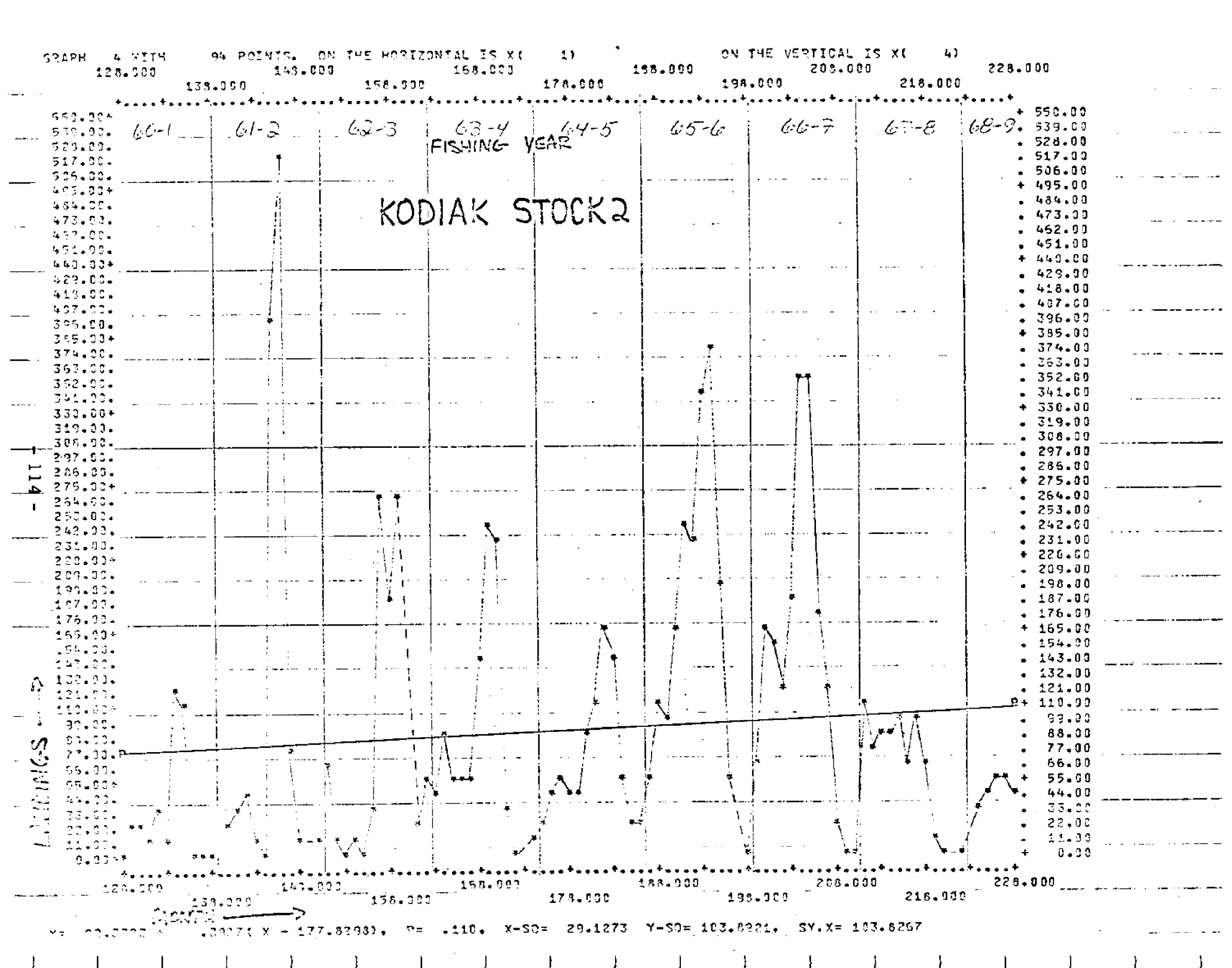
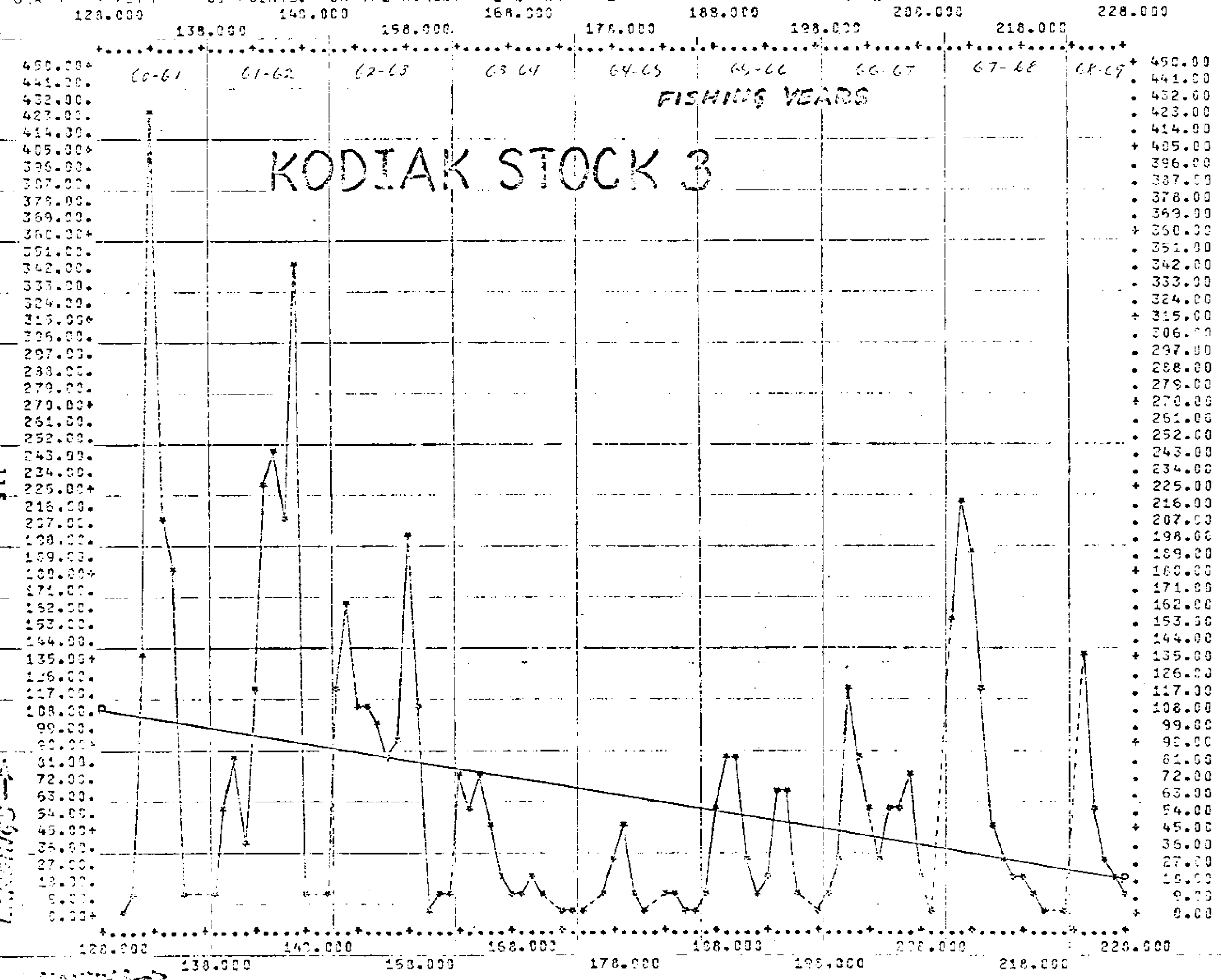
28.00
24.50
21.00
17.50
14.00
10.50
7.00
3.50
0.00
- 112 -

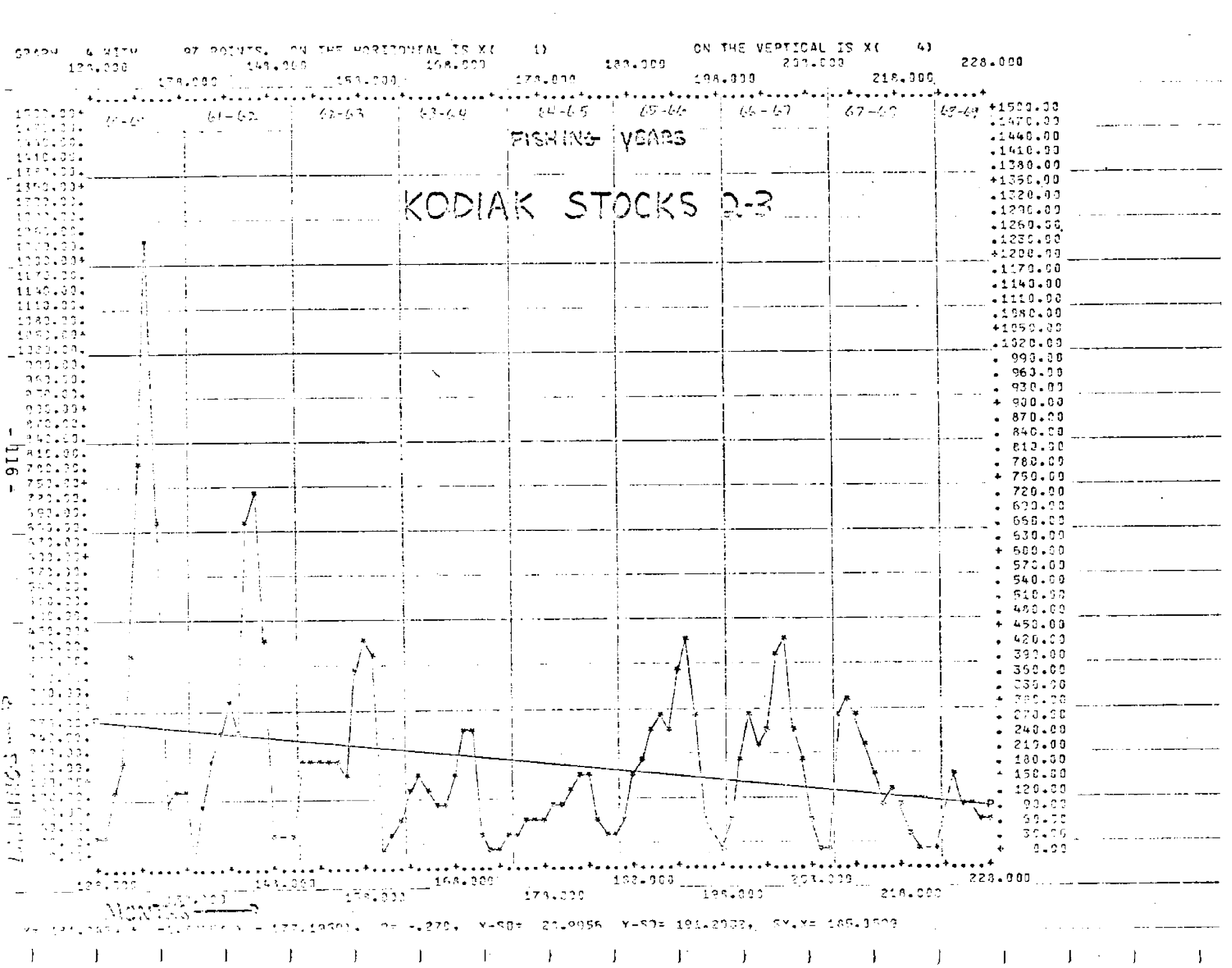

GRAPH 4 WITH 101 POINTS. ON THE HORIZONTAL IS XX 17
128.000 138.000 148.000 158.000 168.000 178.000 188.000 198.000 208.000 216.000 228.000
60-1 61-2 62-3 63-4 64-5 65-6 66-7 67-8 68-9
FISHING YEARS
KODIAK STOCK I
I - 118 - SPAWNERS
MONTHS
Y= 113.4455 + .7017(X - 178.0000), R= .270, X-SD= 29.3002 Y-SD= 75.2326, SY.X= 73.7778

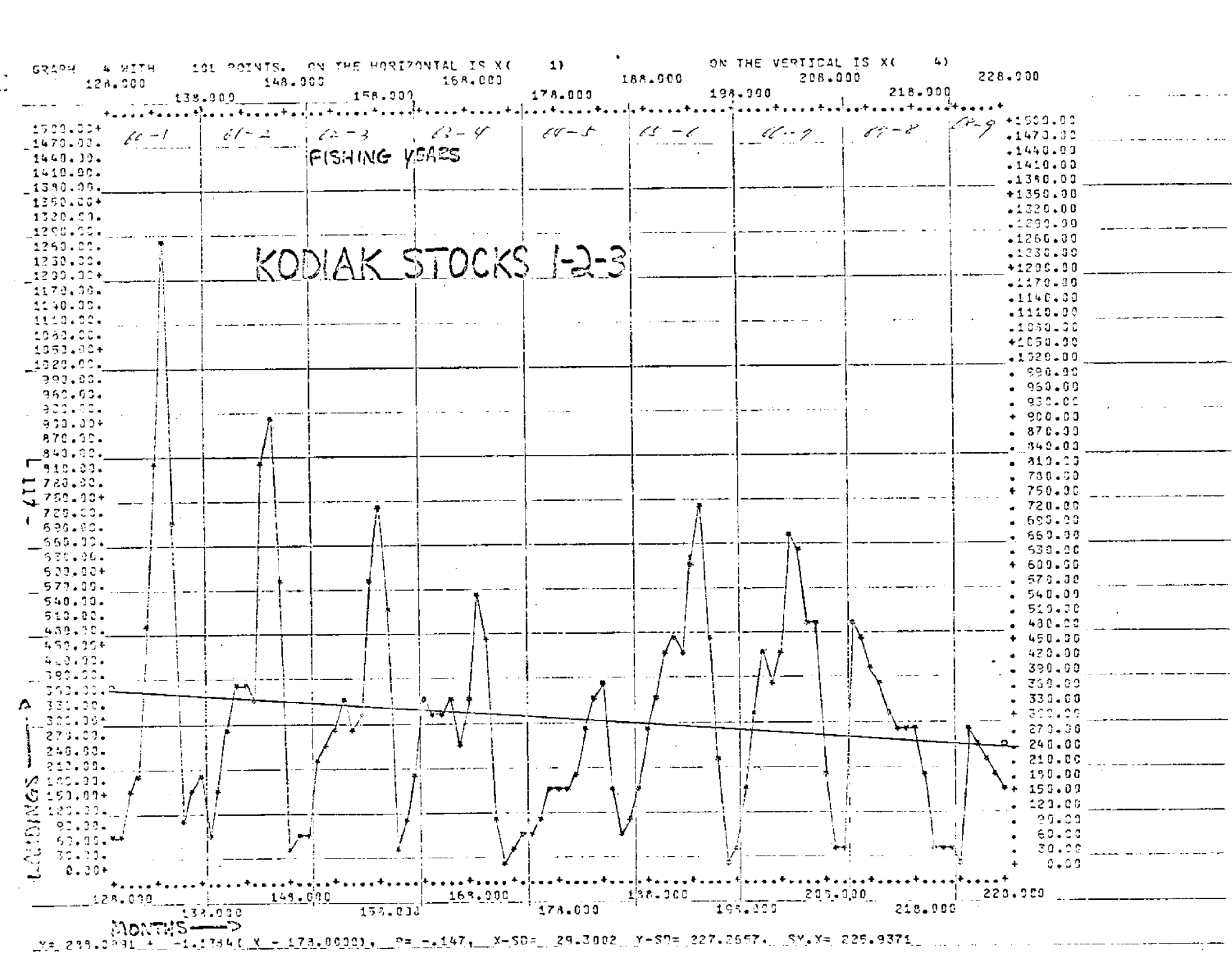

GRAPH 4 WITH 94 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(4)
60-1
61-2
62-3
63-4
64-5
65-6
66-7
67-8
68-9
FISHING YEAR
KODIAK STOCK2
114 -
SPAWNERS
Y= .0927(X - 177.8298), R= .110, X-SD= 29.1273 Y-SD= 103.8921, SY.X= 103.8267

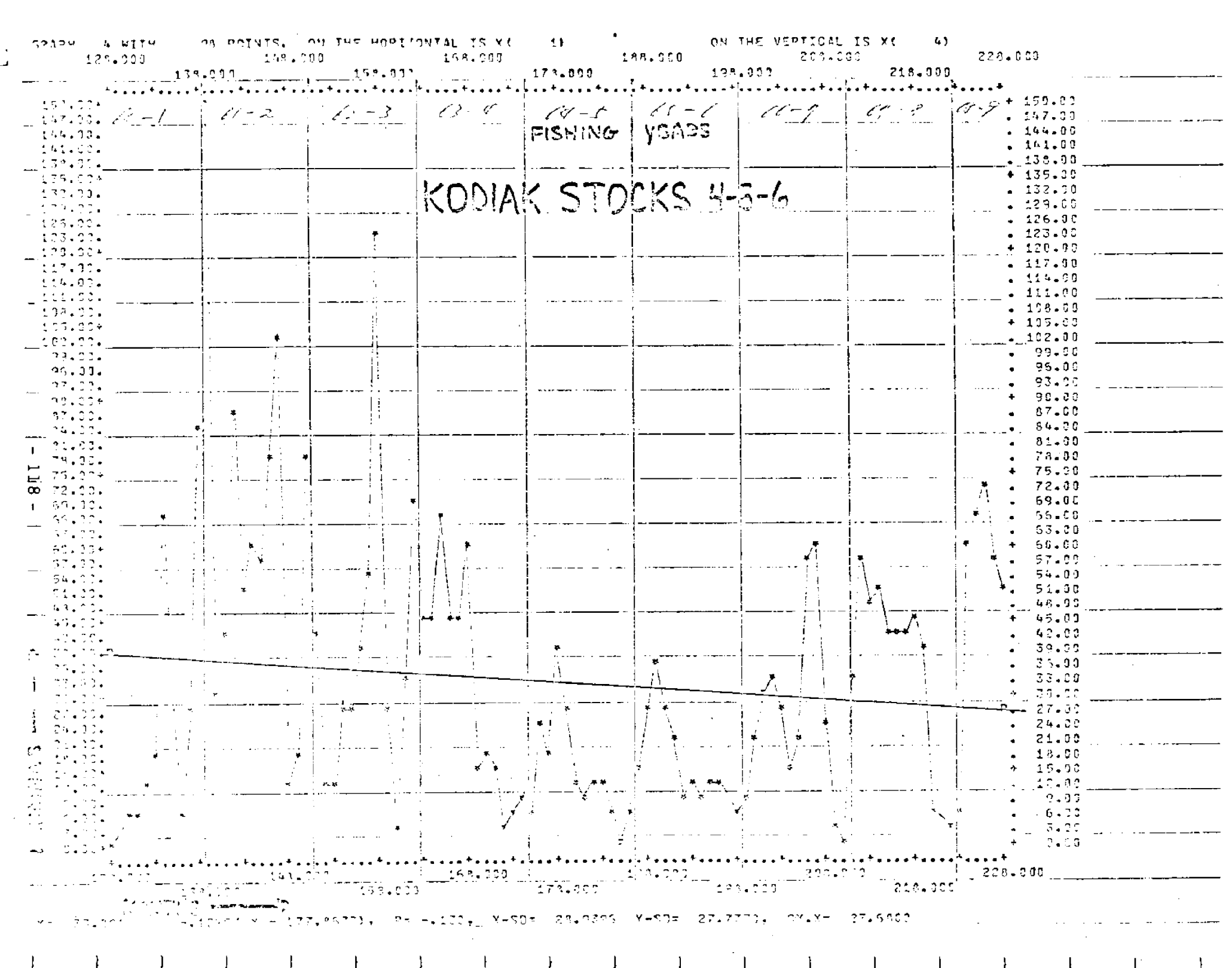
GRAPH 4 WITH 89 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(4)

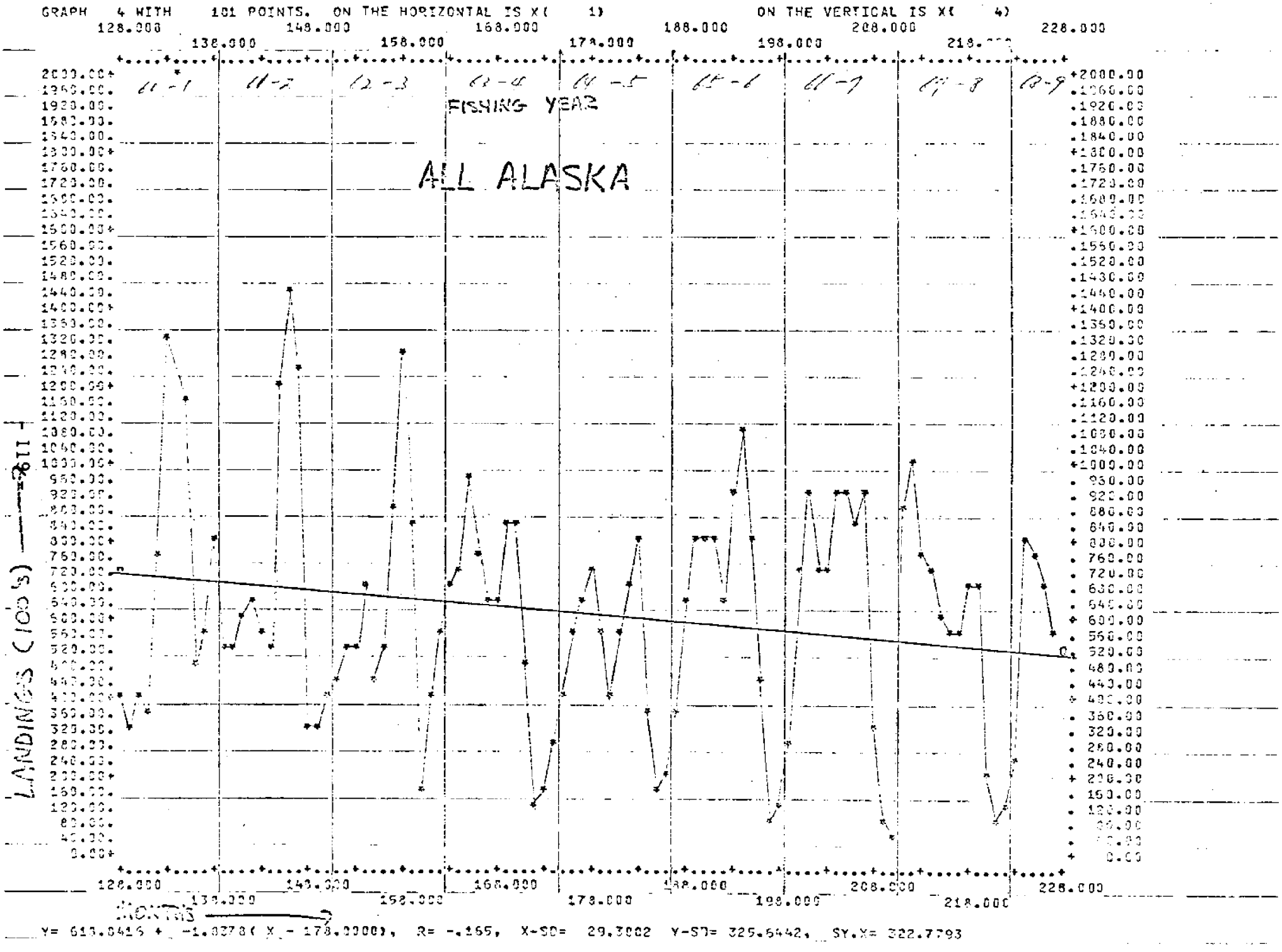


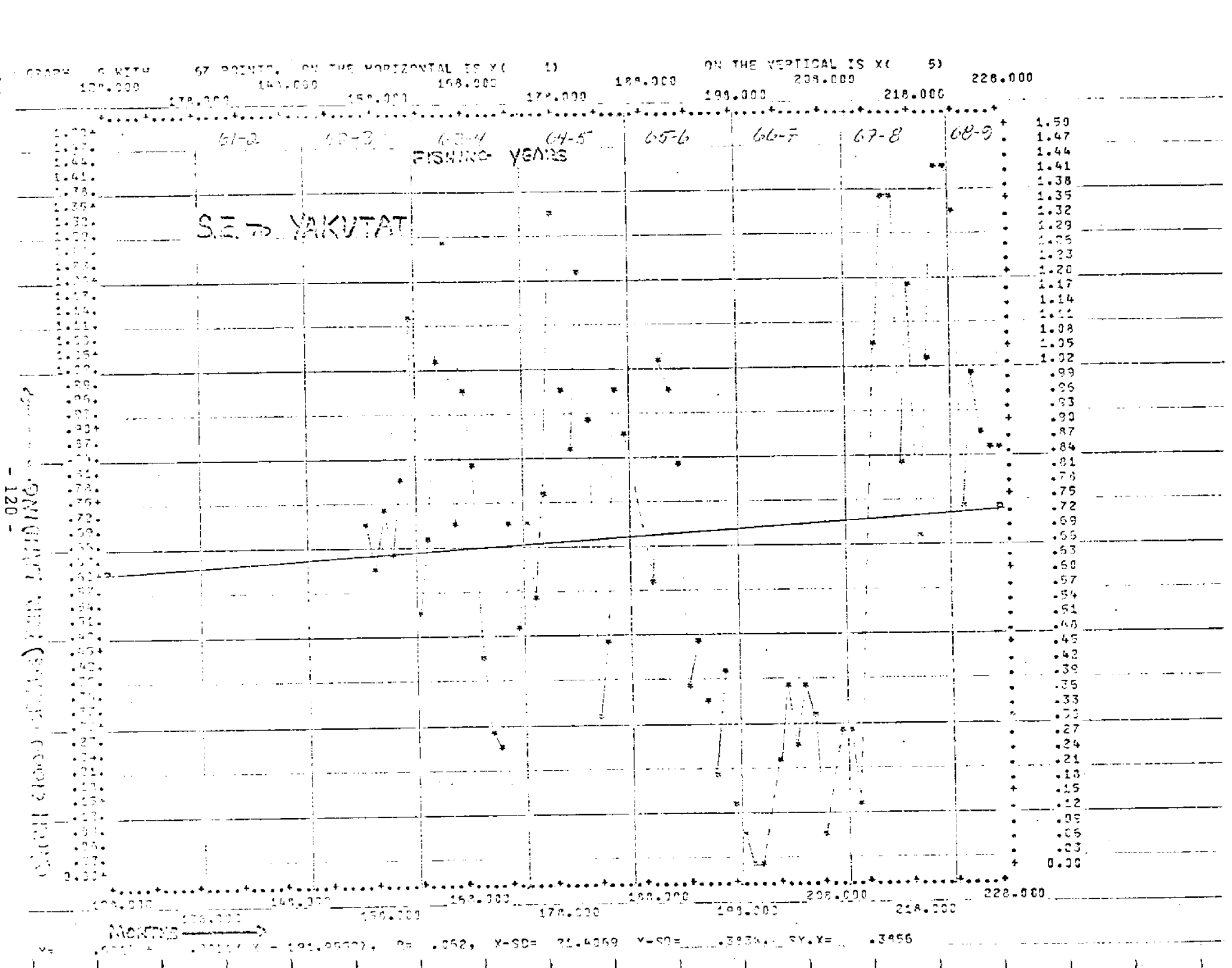
Y= 55.1905 + -.8050(X - 178.8315), R= -.315, X-SD= 28.4945 Y-SD= 79.9720, SY.X= 75.2905


KODIAK STOCKS 2-3
FISHING YEARS
60-61
61-62
62-63
63-64
64-65
65-66
66-67
67-68
68-69
MONTHS

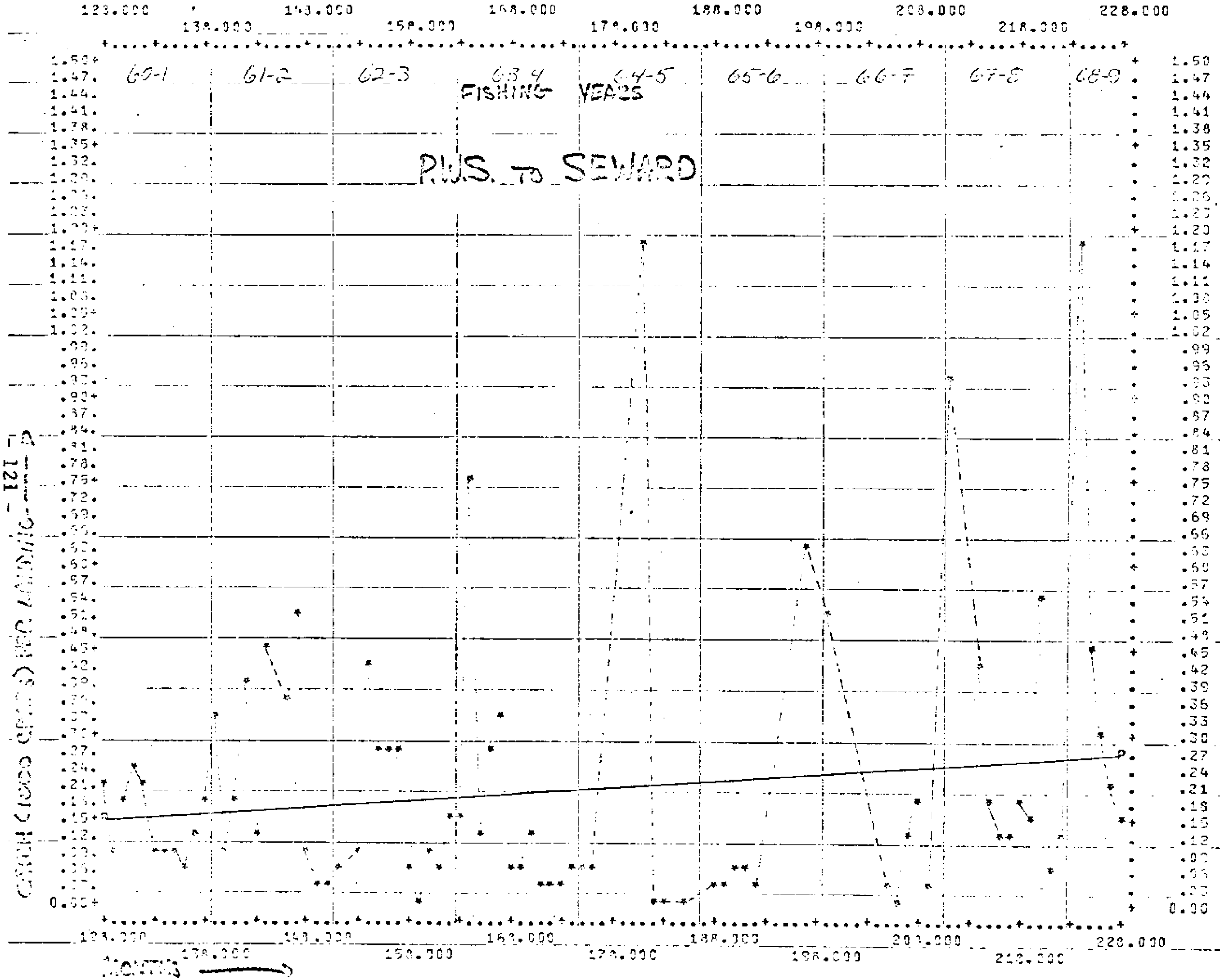

GRAPH 4 WITH 101 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(4)
128.000 148.000 168.000 188.000 208.000 228.000
138.000 158.000 178.000 198.000 218.000
FISHING YEARS
KODIAK STOCKS 1-2-3
LANDINGS
MONTHS
Y= 239.0991 + -1.1764(X - 178.0000), r= -.147, X-SD= 29.3002 Y-SD= 227.2657, SY.X= 225.9371


KODIAK STOCKS 4-5-6
FISHING
YSADS

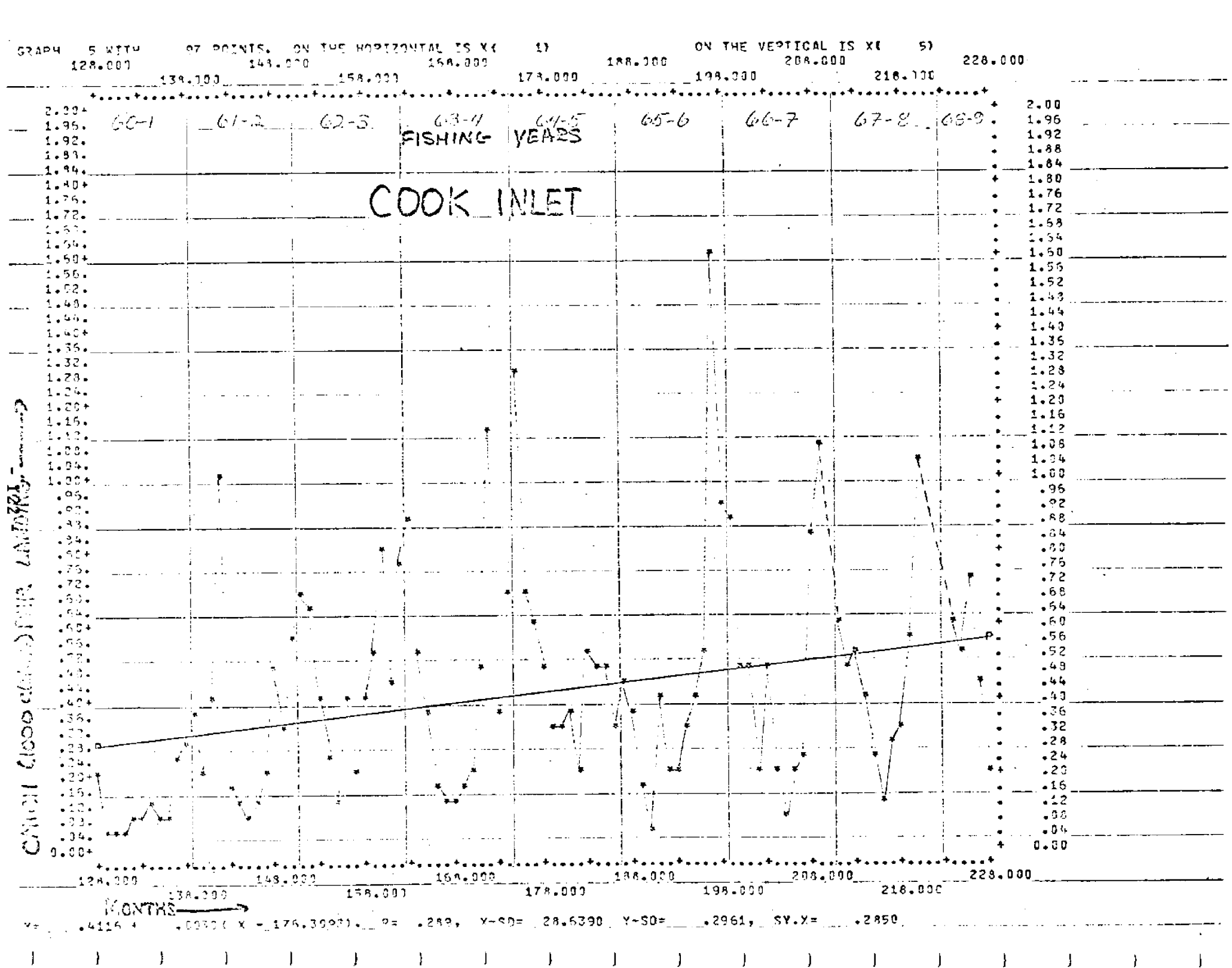

GRAPH 4 WITH 101 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(4)
128.000
138.000
148.000
158.000
168.000
178.000
188.000
198.000
208.000
218.000
228.000
61-1
61-2
62-3
63-4
64-5
65-6
66-7
67-8
68-9
FISHING YEAR
ALL ALASKA
LANDINGS (100's)
MONTHS
Y= 615.0416 + -1.0378(X - 178.0000), R= -.165, X-SD= 29.3002 Y-SD= 325.6442, SY.X= 322.7793

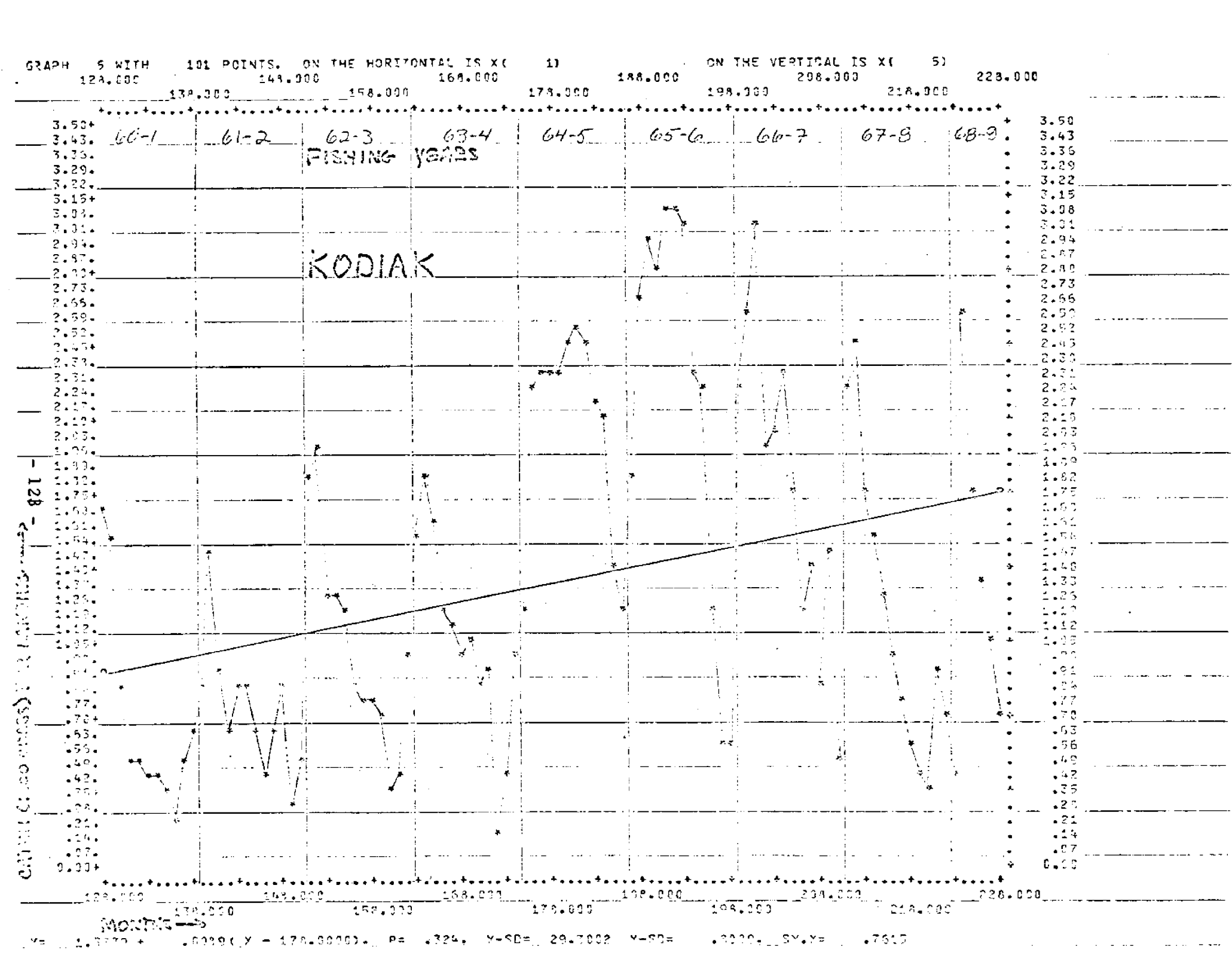

GRAPH 5 WITH 67 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(5)
FISHING YEARS
S.E. to YAKUTAT
- 120 -
INCHES
R= .052, X-SD= 21.4369 Y-SD= .3834, SY.X= .3956

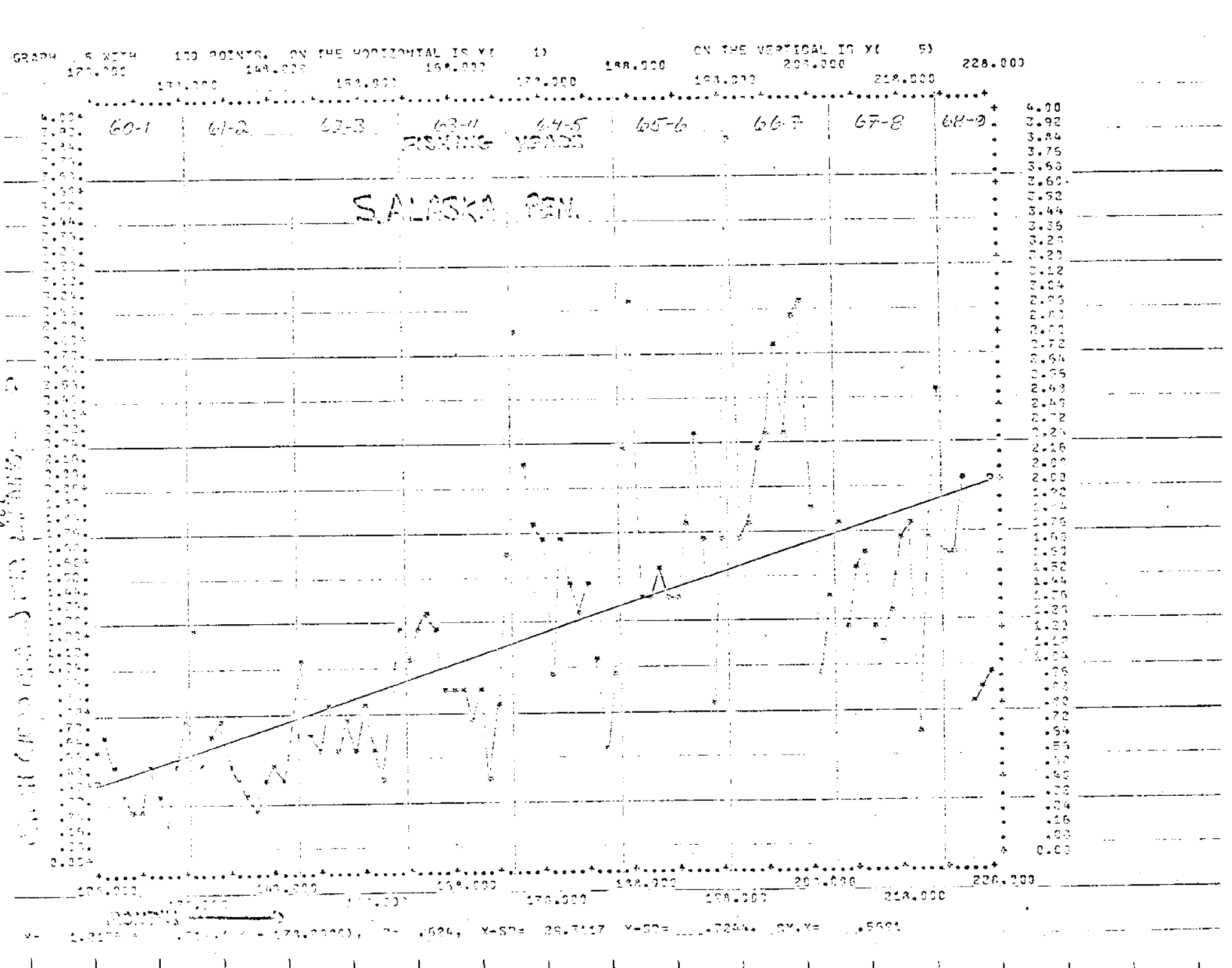
GRAPH 5 WITH 78 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(5)

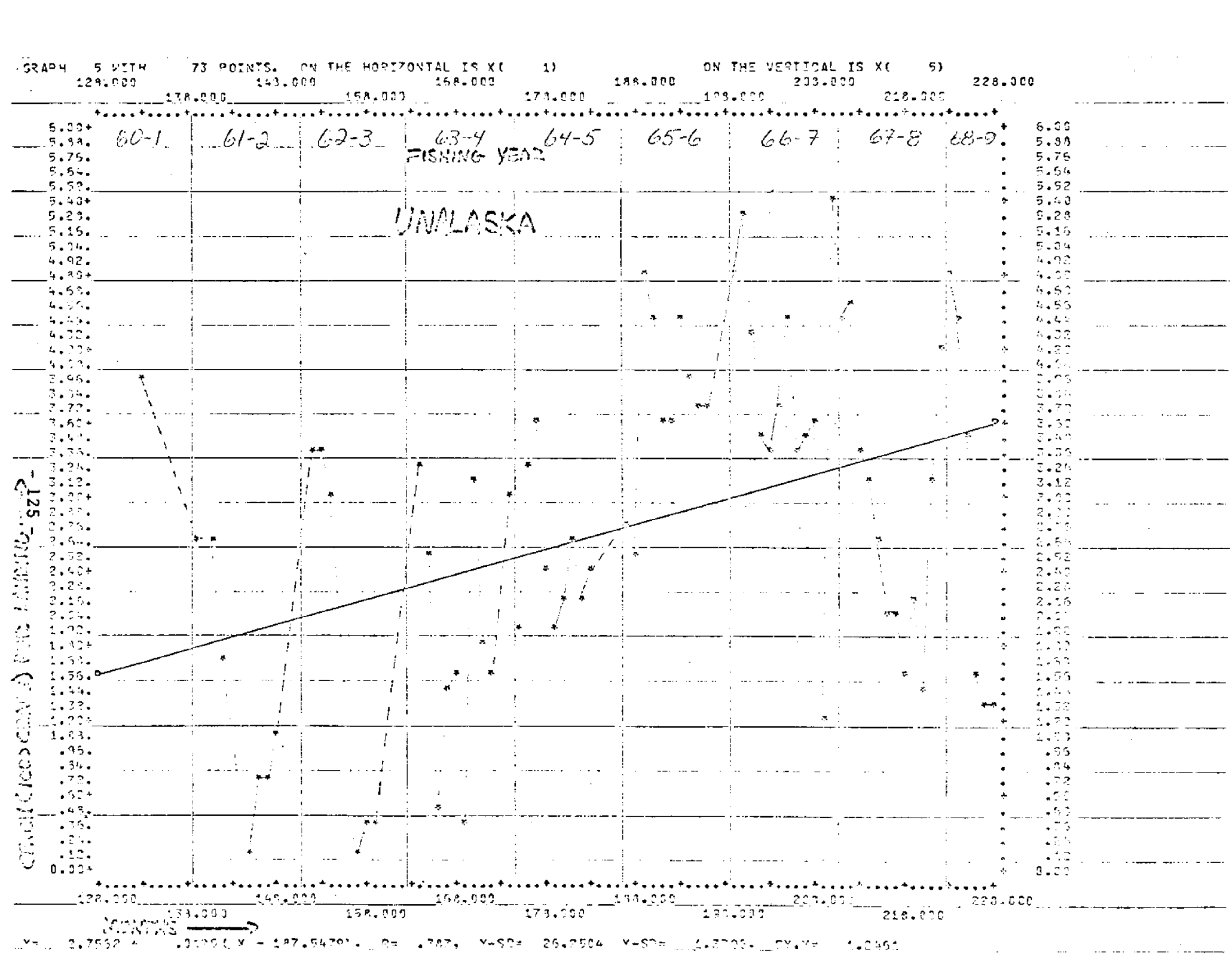


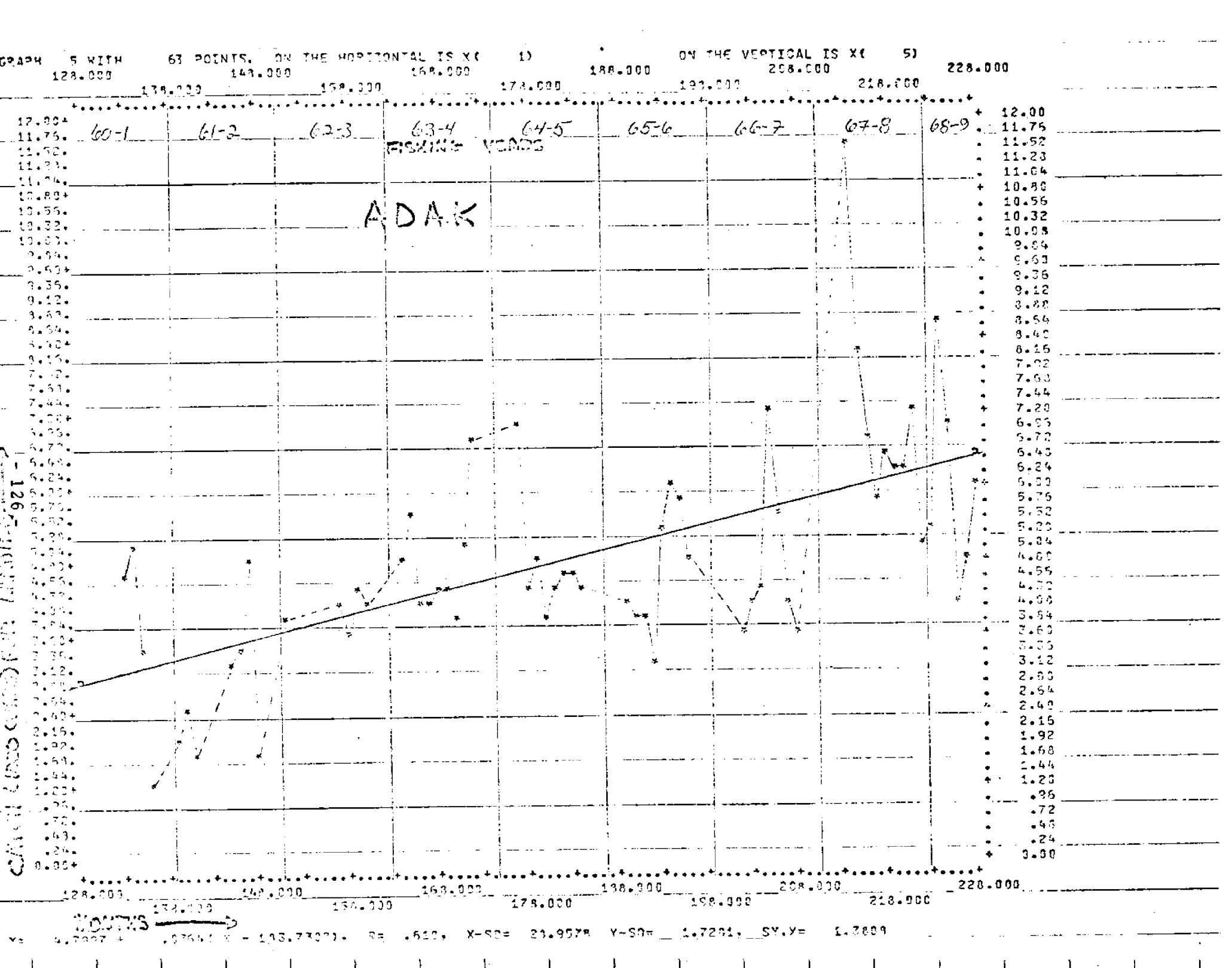
Y= .2051 + .00131(X - 173.92311), R= .169, X-SD= 30.7456 Y-SD= .2737, SY.X= .2364


GRAPH 5 WITH 97 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(5)
128.000 148.000 168.000 188.000 208.000 228.000
138.000 158.000 178.000 198.000 218.000
60-1 61-2 62-3 63-4 64-5 65-6 66-7 67-8 68-9
FISHING YEARS
COOK INLET
CATCH (000 POUNDS)
MONTHS
Y= .4116 + .0030(X - 176.3990) R= .289, X-SD= 28.6390 Y-SD= .2961, SY.X= .2850

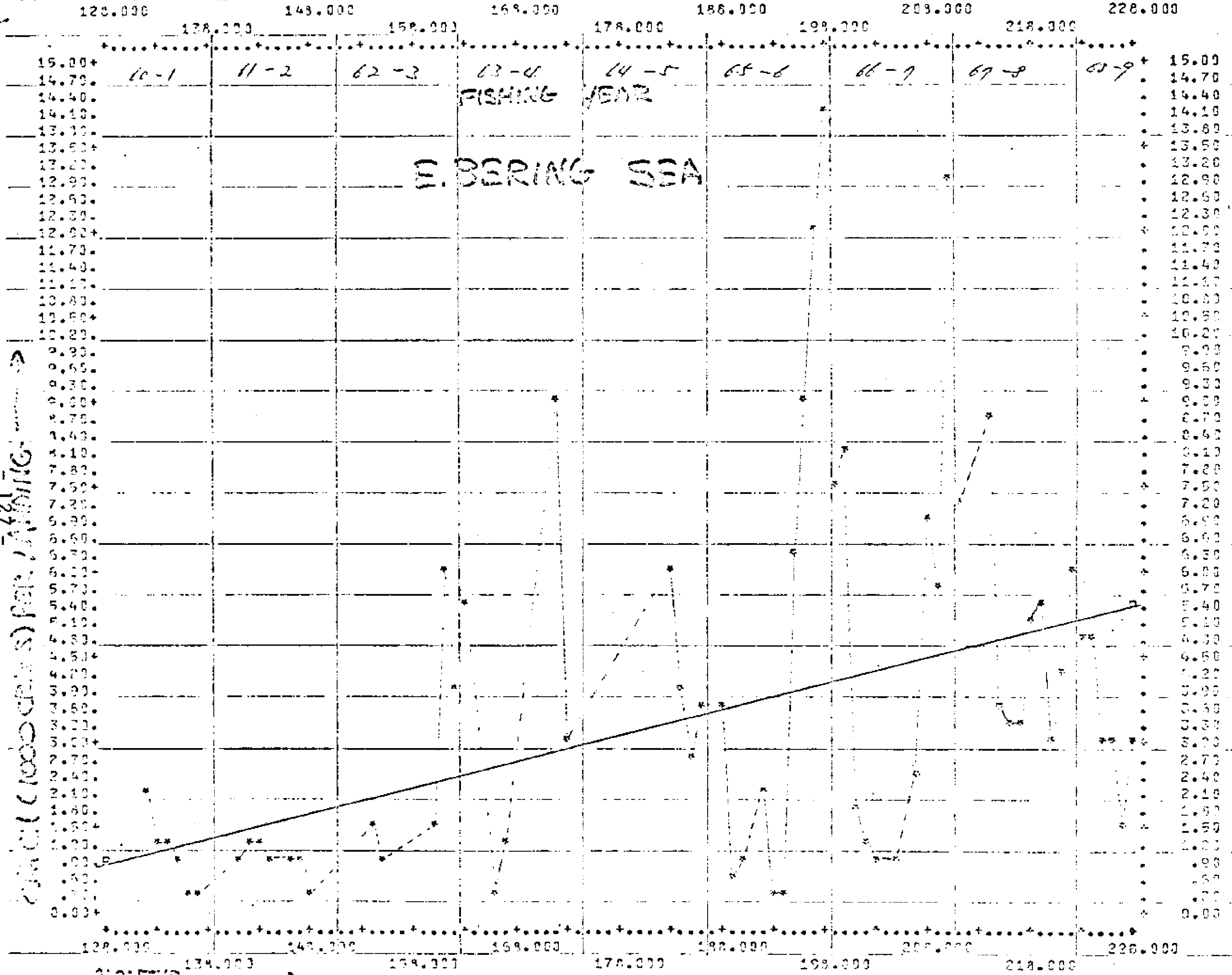

GRAPH 5 WITH 101 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(5)
66-1
61-2
62-3
63-4
64-5
65-6
66-7
67-8
68-9
FISHING years
KODIAK
Months


60-1
61-2
62-3
63-4
64-5
65-6
66-7
67-8
68-9
FISHING YEARS
S.ALASKA PEN.


GRAPH 5 WITH 73 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(5)
60-1
61-2
62-3
63-4
64-5
65-6
66-7
67-8
68-9
FISHING YEAR
UNALASKA
CRAB CAUGHT PER POT LANDING - 125
POINTS

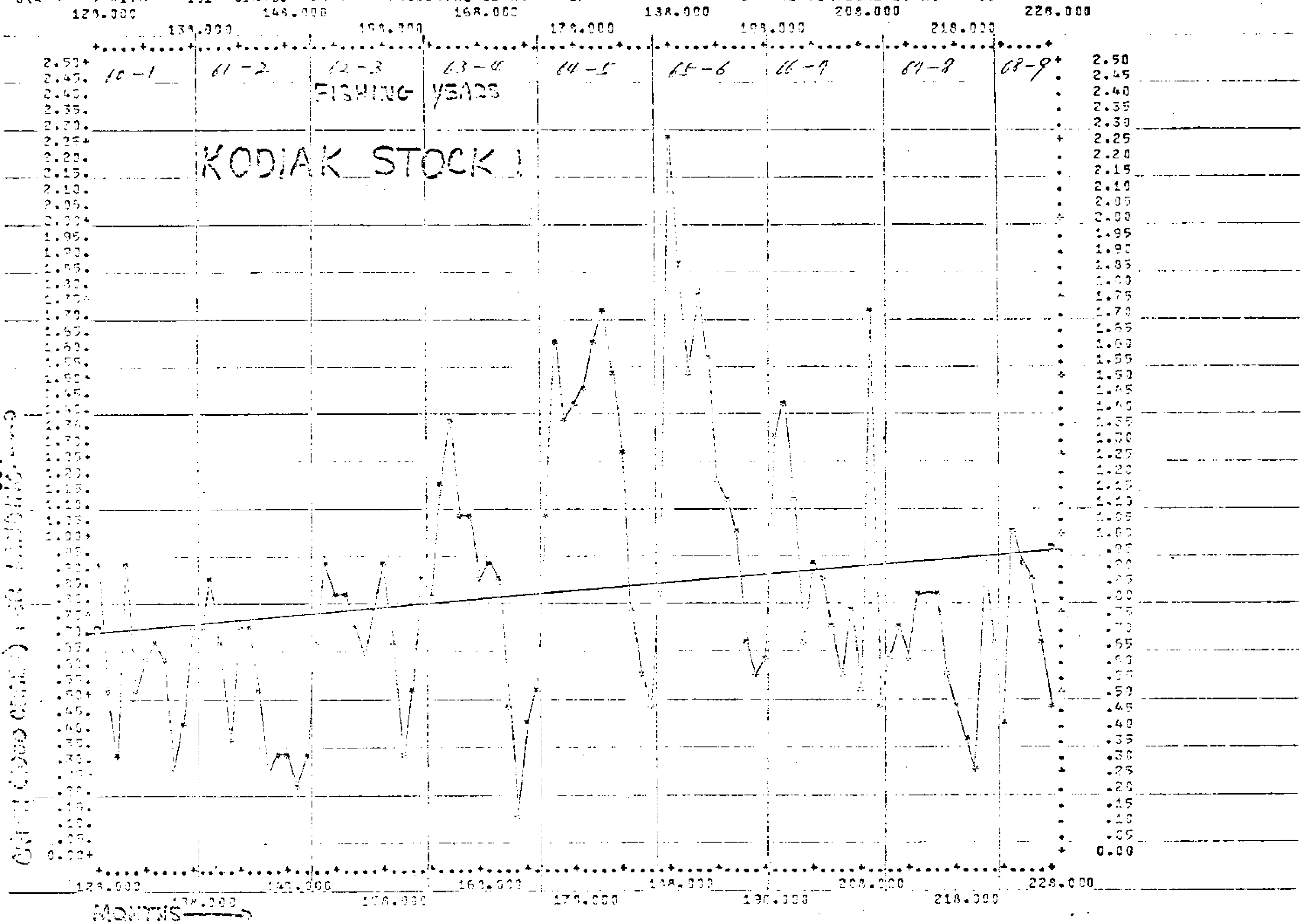

GRAPH 5 WITH 63 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(5)
128.000
140.000
150.000
160.000
170.000
180.000
190.000
200.000
210.000
220.000
60-1
61-2
62-3
63-4
64-5
65-6
66-7
67-8
68-9
RISING YEARS
ADAK
12.00
11.76
11.52
11.28
11.04
10.80
10.56
10.32
10.08
9.84
9.60
9.36
9.12
8.88
8.64
8.40
8.16
7.92
7.68
7.44
7.20
6.96
6.72
6.48
6.24
6.00
5.76
5.52
5.28
5.04
4.80
4.56
4.32
4.08
3.84
3.60
3.36
3.12
2.88
2.64
2.40
2.16
1.92
1.68
1.44
1.20
.96
.72
.48
.24
0.00
MONTHS
R= .610,
X-SD= 31.9577
Y-SD= 1.7201,
SY.X= 1.3609

GRAPH 5 WITH 63 POINTS, ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(5)



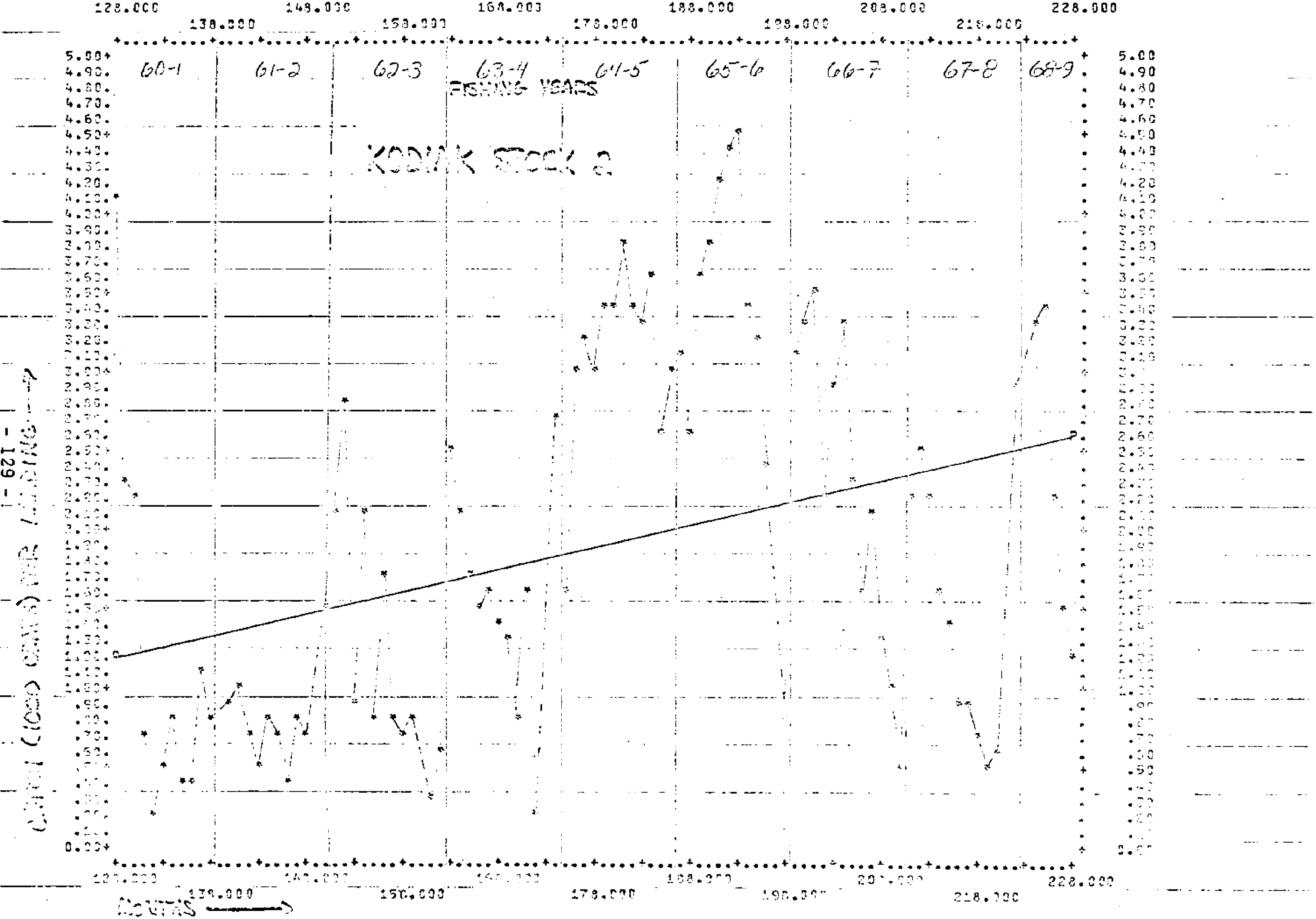
Y= 3.6194 + .04534 X - 185.67141, R= .420, X-SD= 33.3260 Y-SD= 3.2471, SY.X= 2.9706

GRAPH 5 WITH 101 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(5)

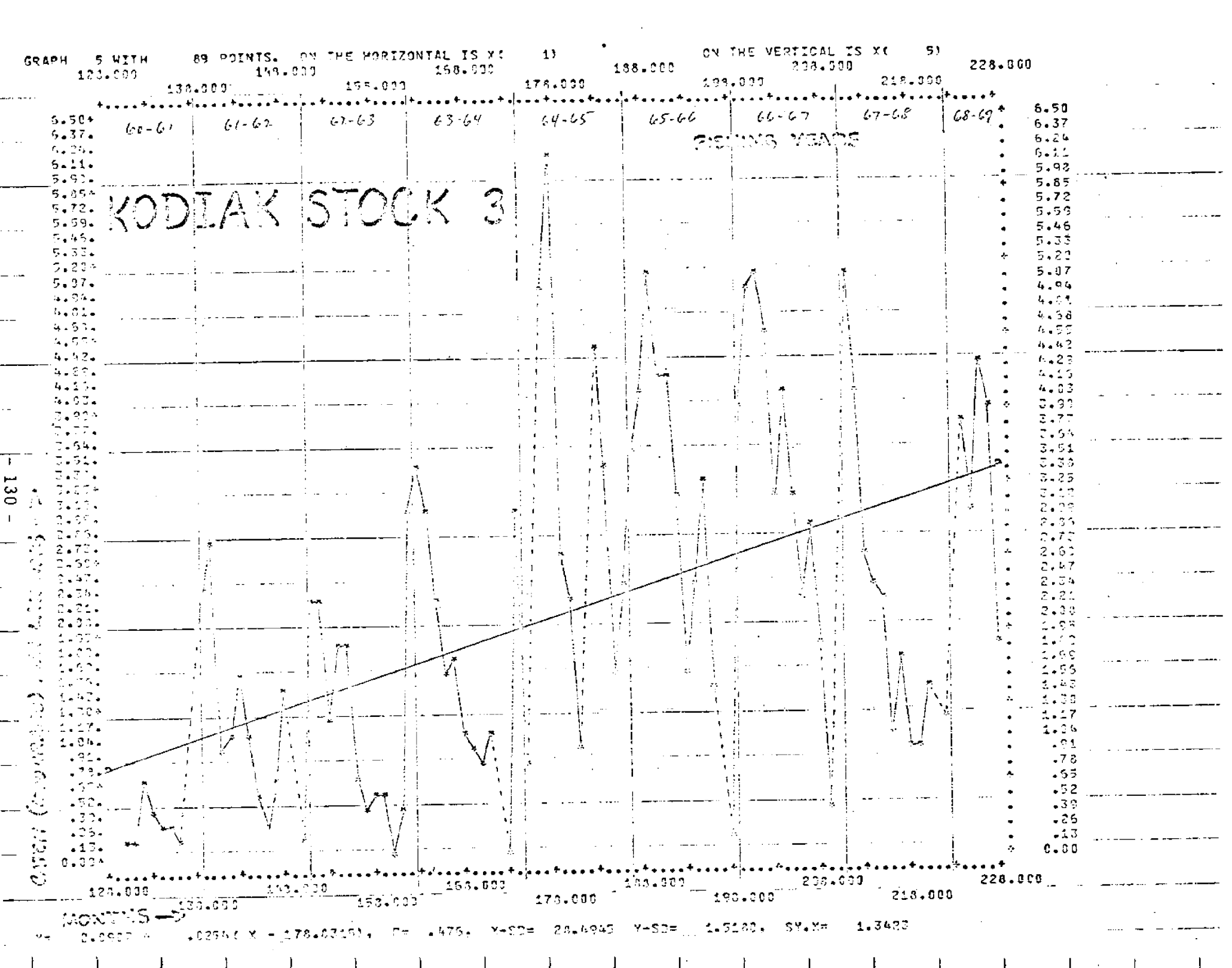


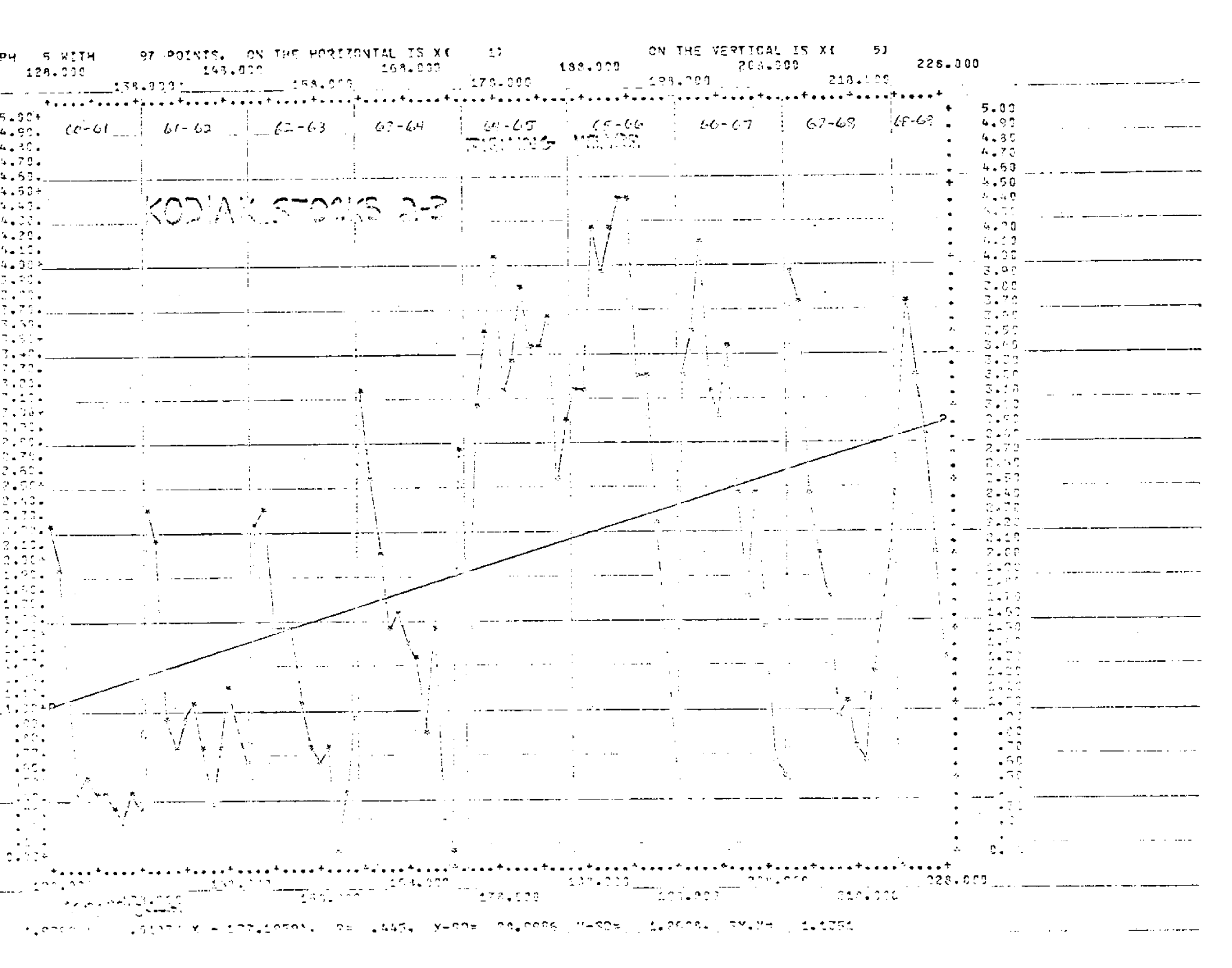
R= .185, Y-SD= 29.3002 Y-SD= .4163, SY.Y= .4117

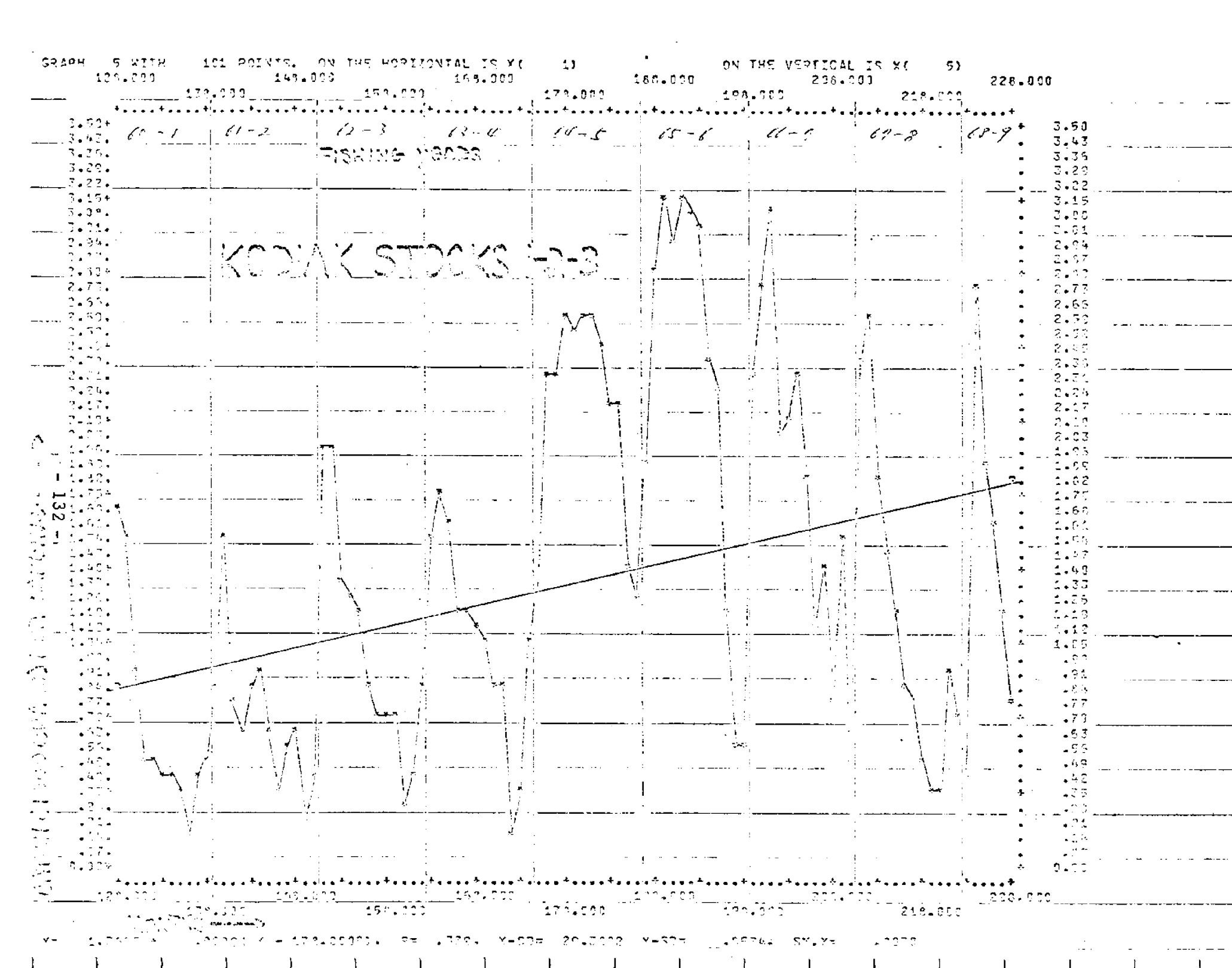
GRAPH 5 WITH 94 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(5)

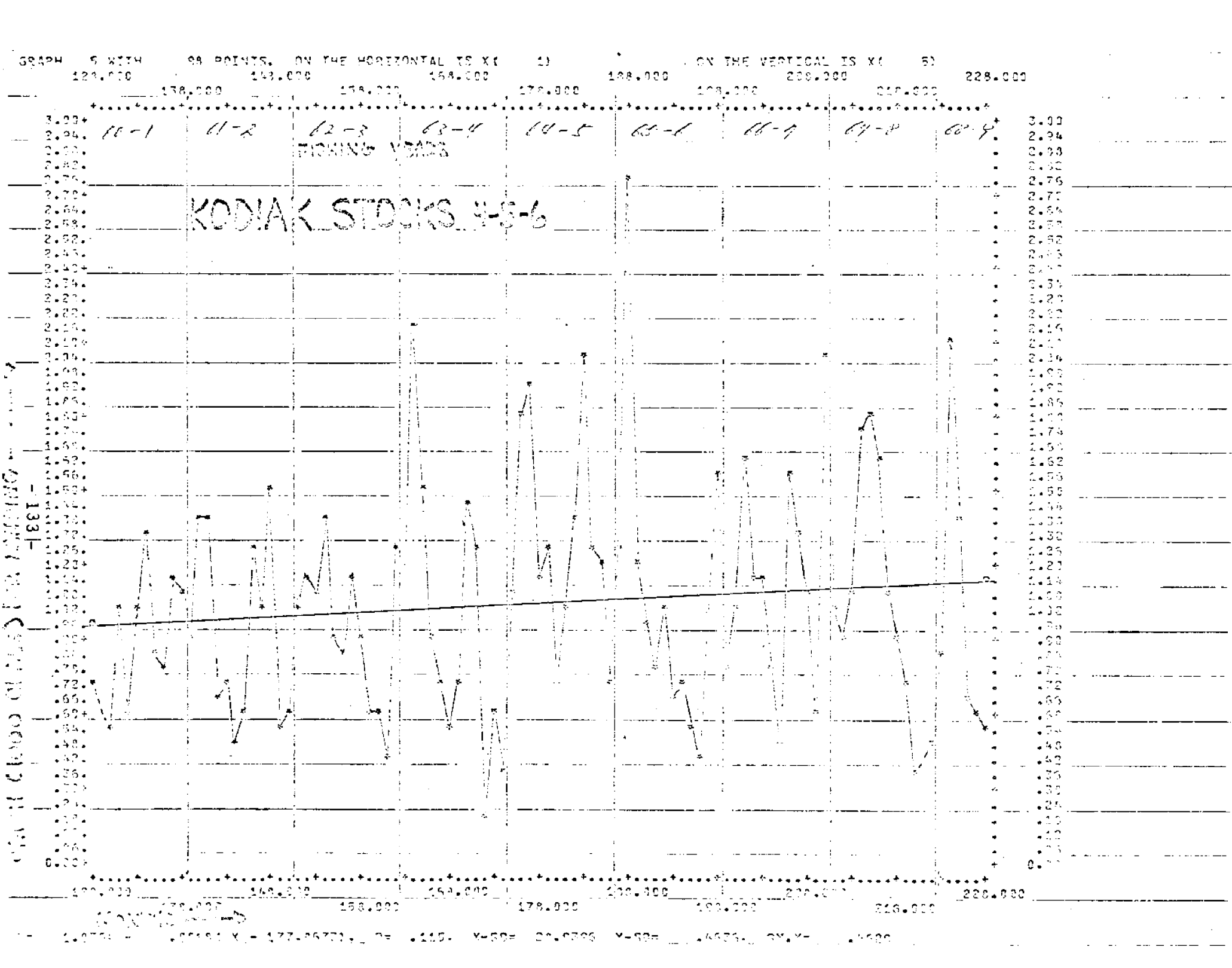


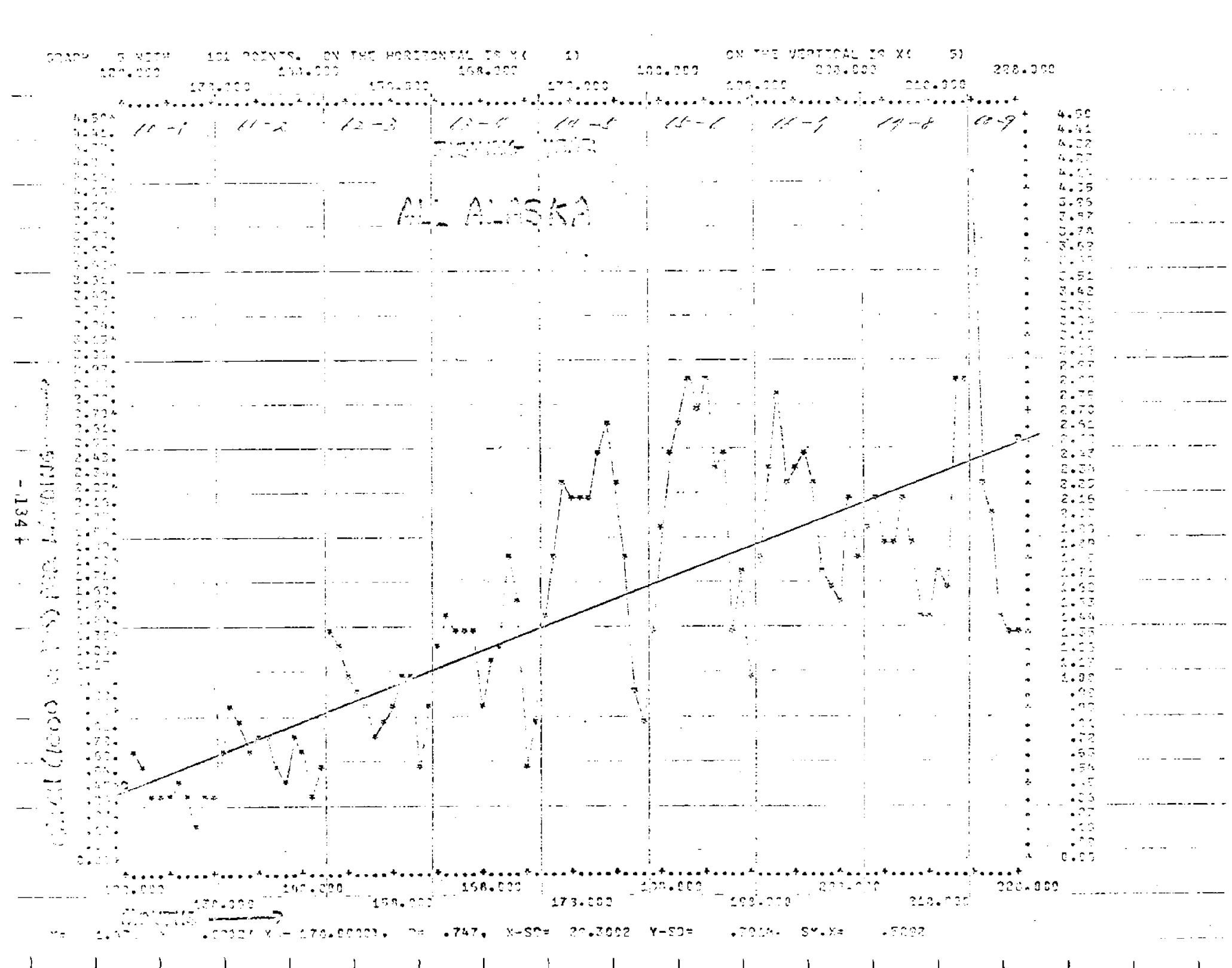
Y= 1.9212 + .0136(X - 177.8290), R= .335, X-SD= 29.1273 Y-SD= 1.1826, SY.X= 1.1201

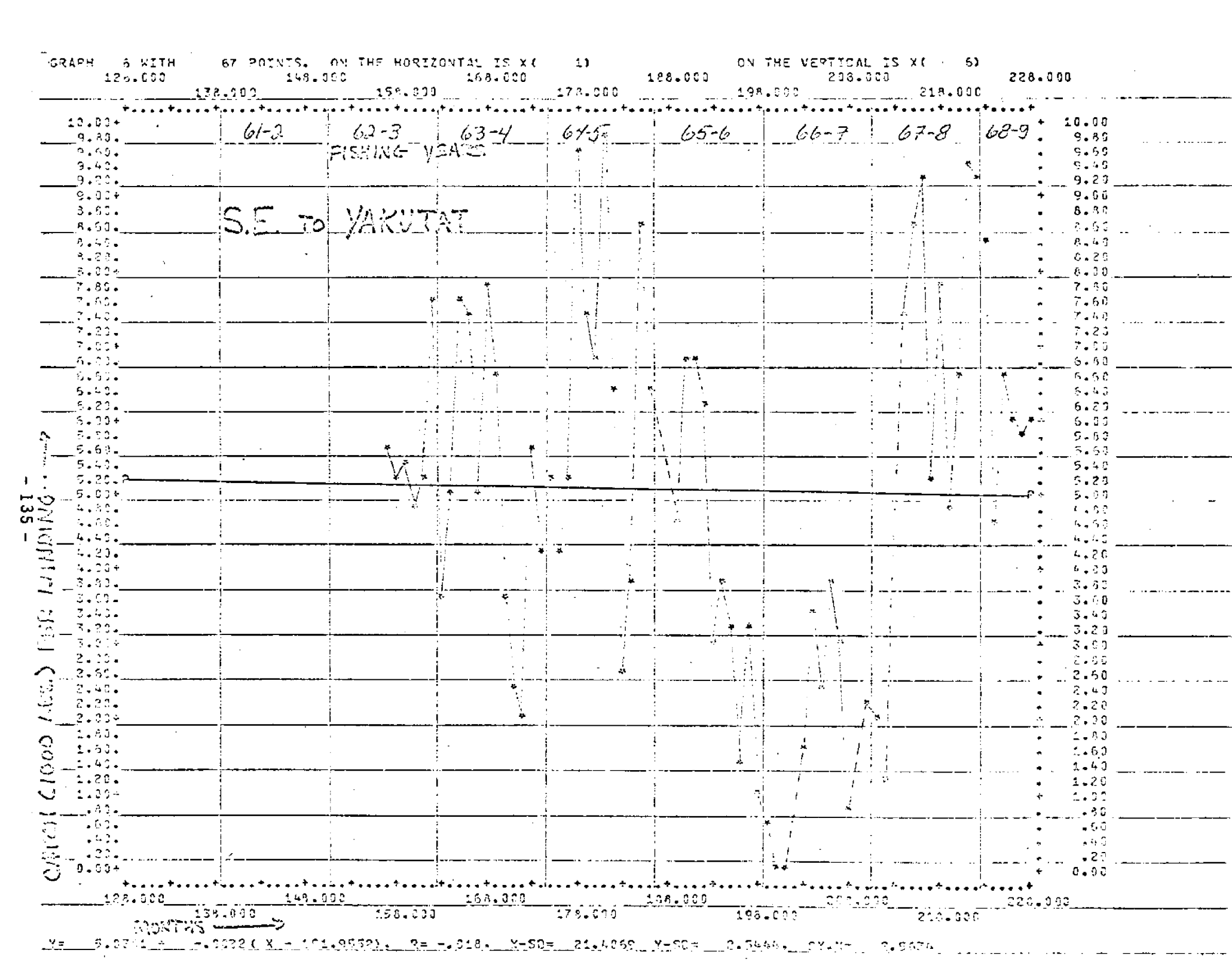

GRAPH 5 WITH 89 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(5)
120.000 130.000 140.000 150.000 160.000 170.000 180.000 190.000 200.000 210.000 220.000
60-61
61-62
62-63
63-64
64-65
65-66
66-67
67-68
68-69
KODIAK STOCK 3
MONTHS
Y= 0.0000 + .0294(X - 178.0316), R= .479. Y-SD= 28.4943 Y-SD= 1.5180. SY.X= 1.3483


PH 5 WITH 97 POINTS. ON THE HORIZONTAL IS X(1)
ON THE VERTICAL IS X(5)
120.000
140.000
160.000
180.000
200.000
220.000
60-61
61-62
62-63
63-64
64-65
65-66
66-67
67-68
68-69
5.00
4.90
4.80
4.70
4.60
4.50

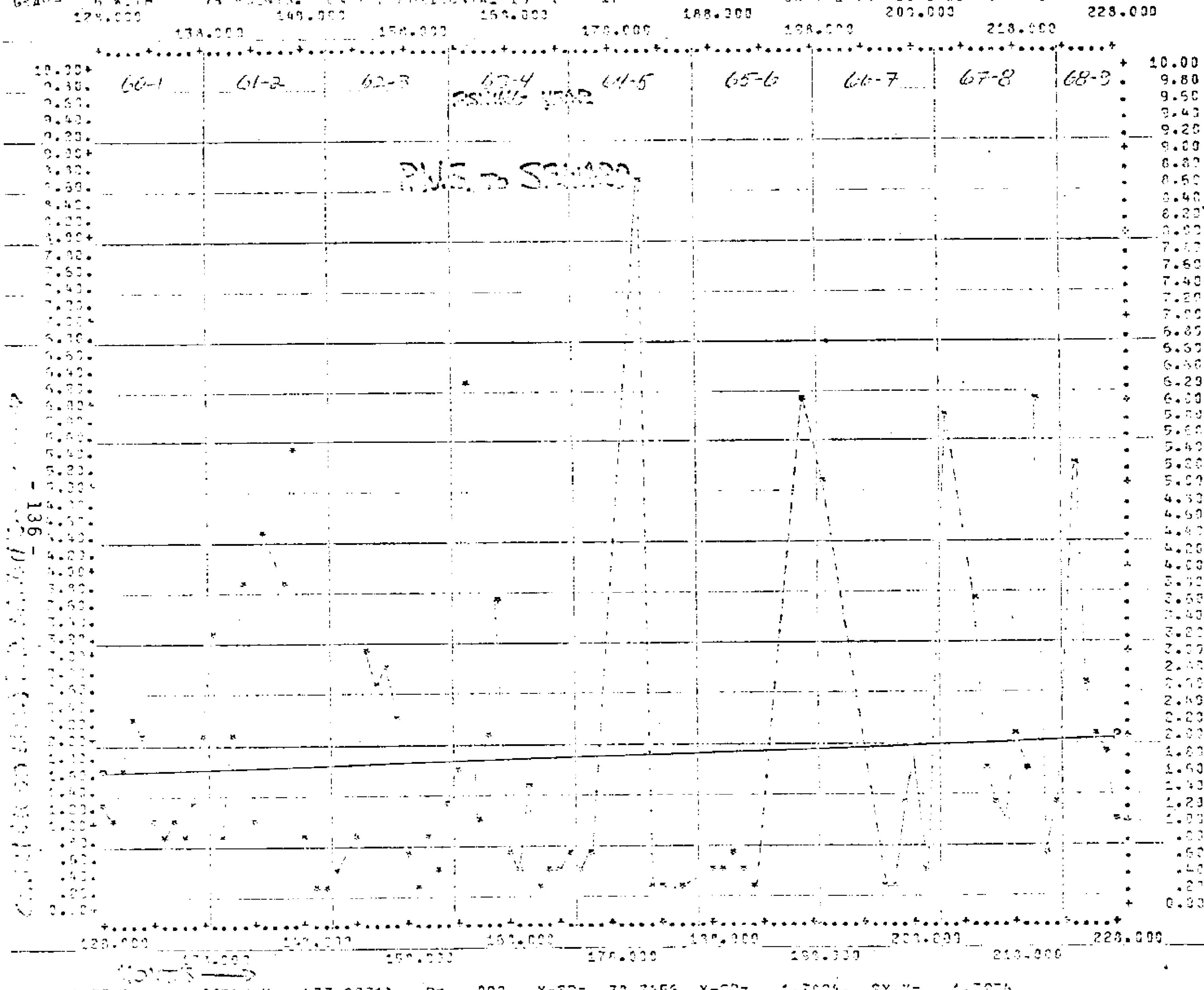

GRAPH 5 WITH 101 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(5)
140.000
150.000
160.000
170.000
180.000
190.000
200.000
210.000
220.000
60-1
61-2
62-3
63-4
64-5
65-6
66-7
67-8
68-9
FISHING YARDS
KODAK STOCKS 62-3
- 132 -

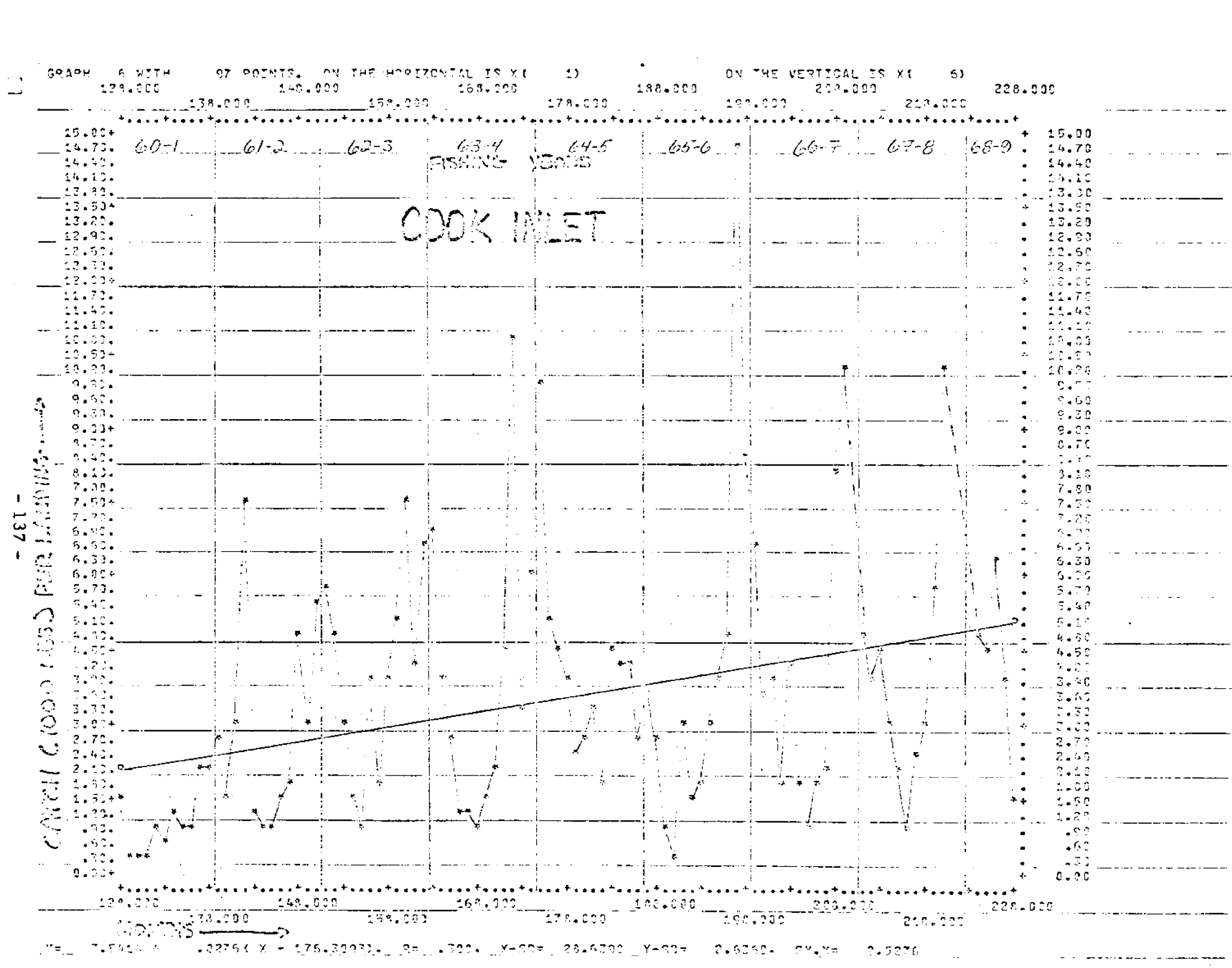

KODIAK STOCKS 4-5-6
FISHING YEARS
- 133 -

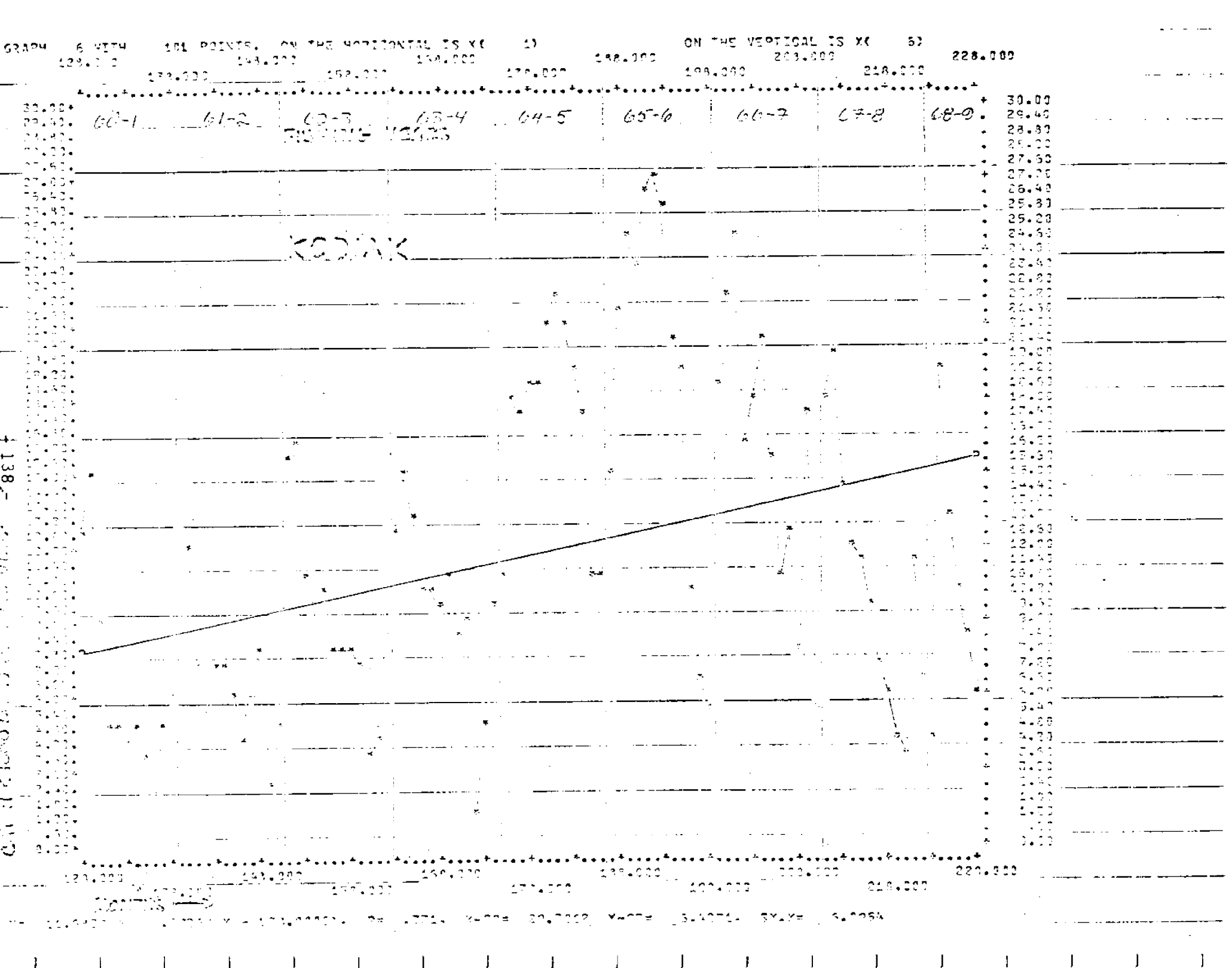

ALL ALASKA

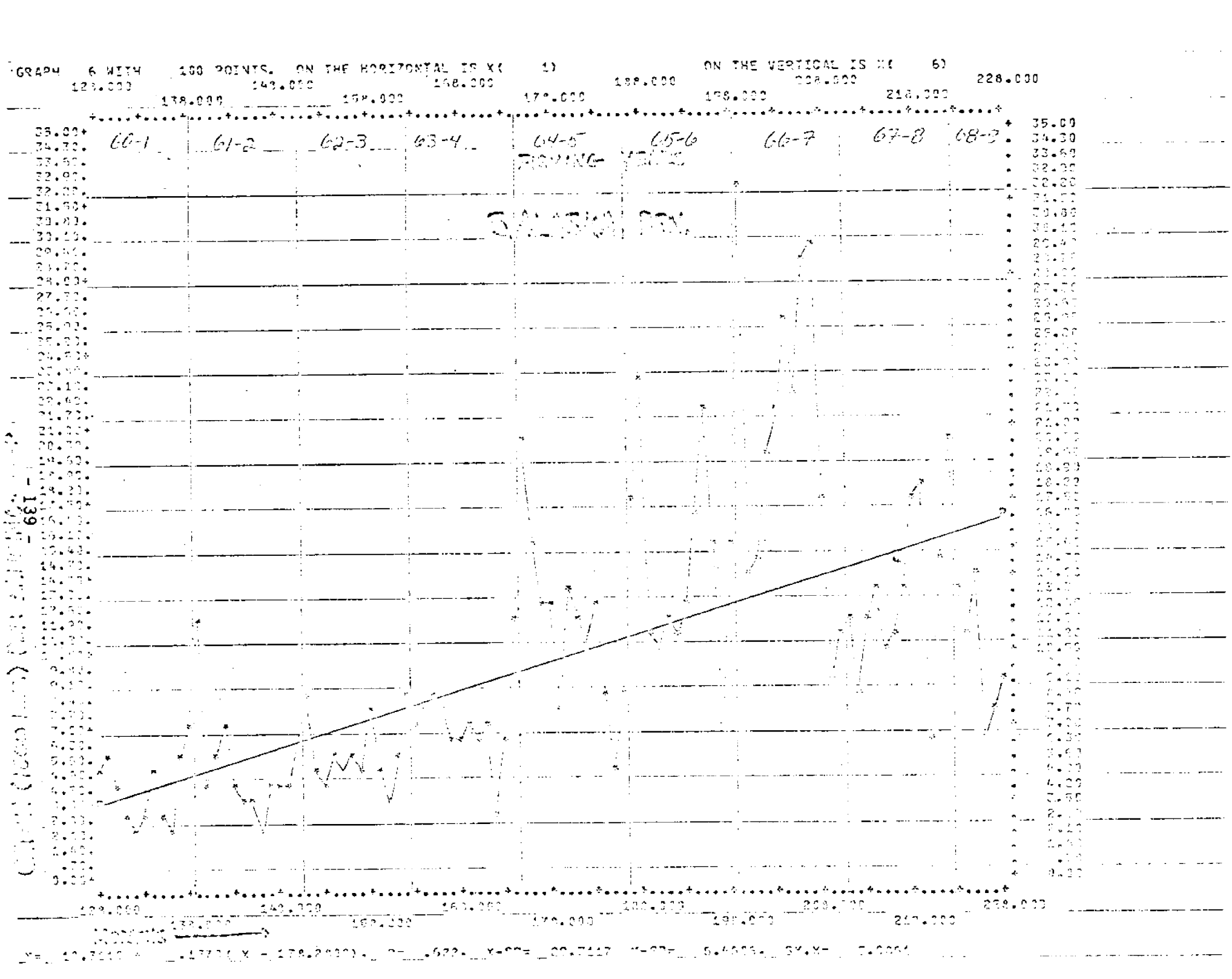

GRAPH 6 WITH 67 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(6)
61-2
62-3
63-4
64-5
65-6
66-7
67-8
68-9
FISHING YEARS
S.E. TO YAKUTAT
MONTHS
- 135 -

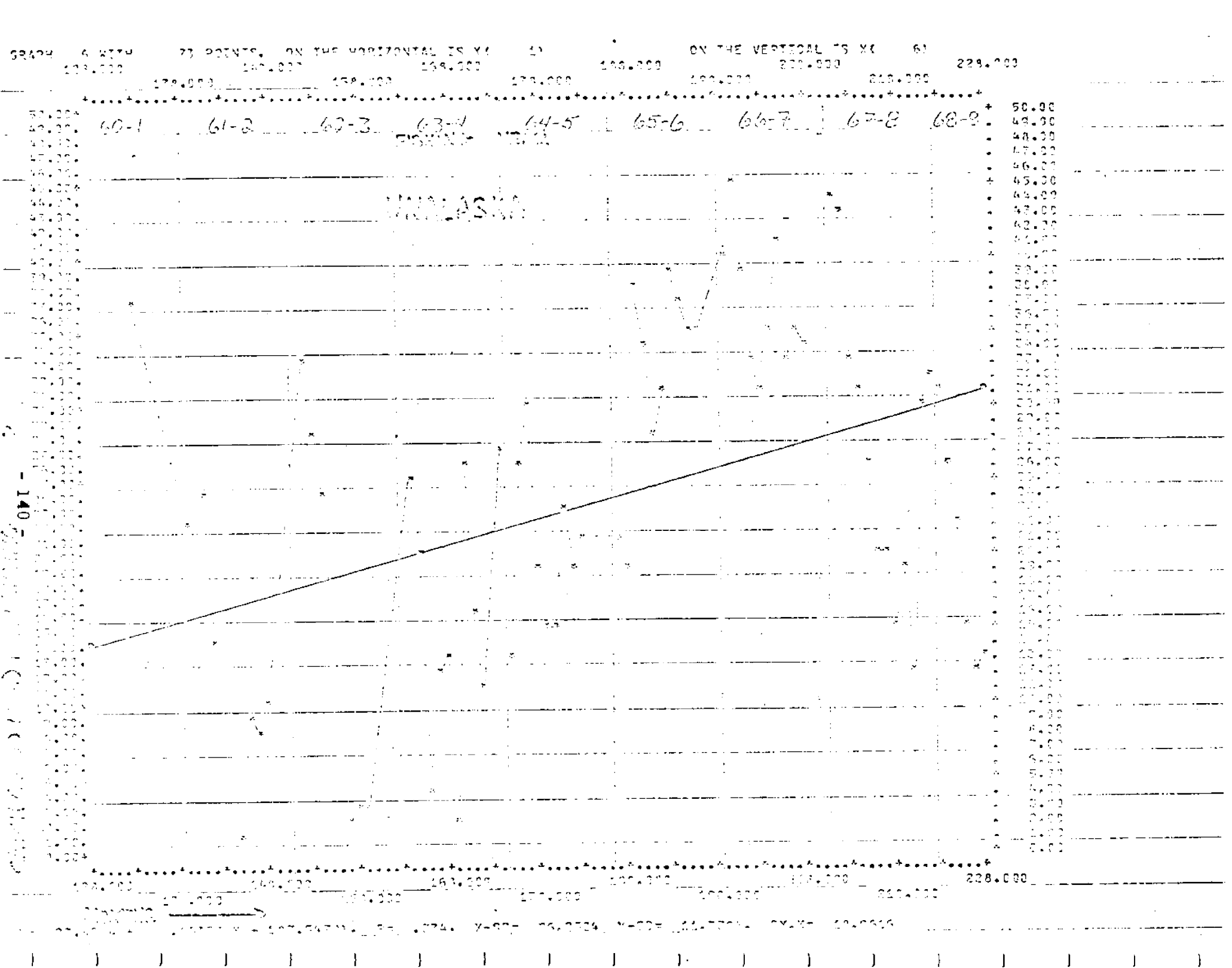
GRAPH 6 WITH 75 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(6)

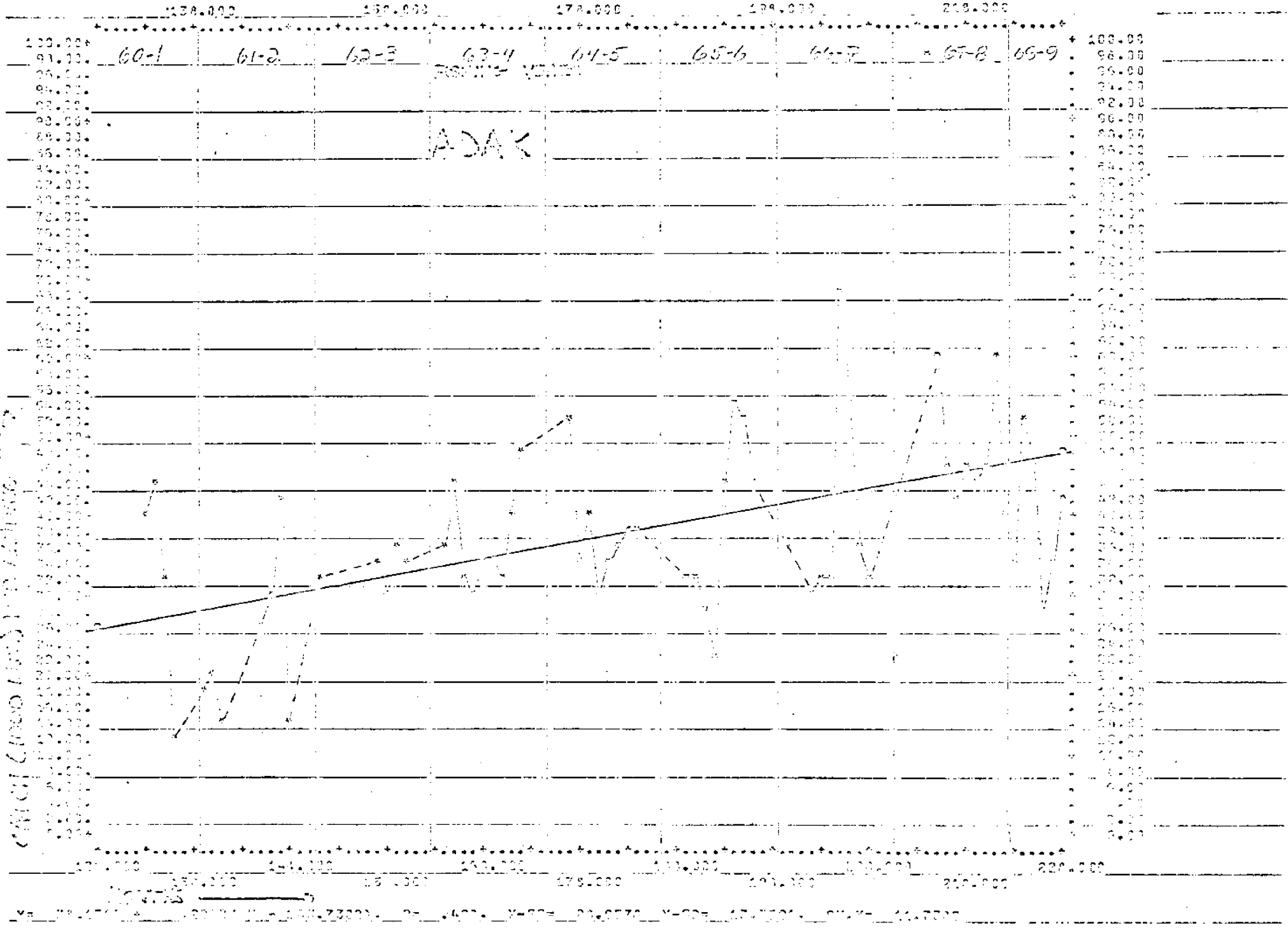


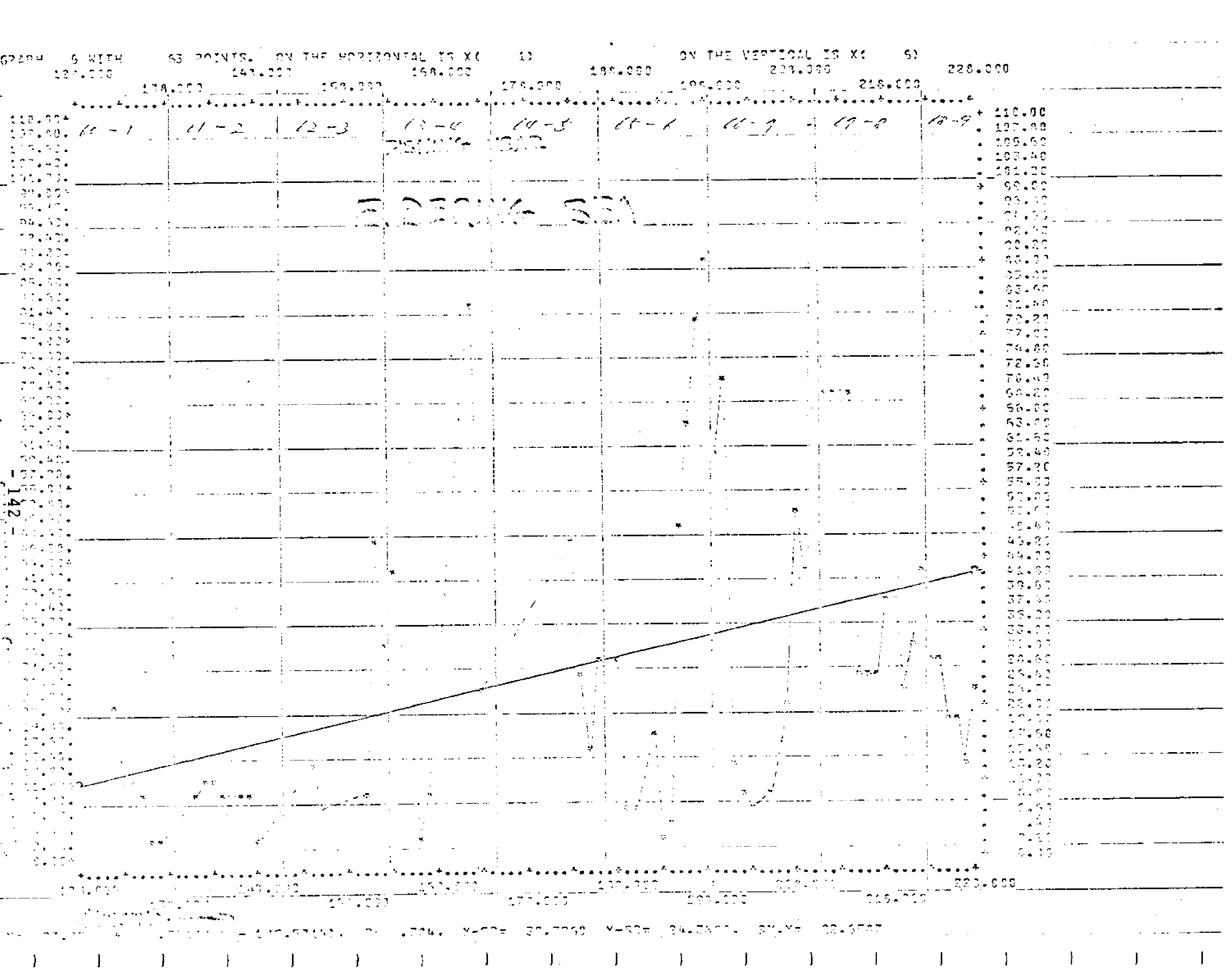

GRAPH 6 WITH 97 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(6)
60-1
61-2
62-3
63-4
64-5
65-6
66-7
67-8
68-9
PASSING YEARS
COOK INLET
CANNELL (COOK INLET) PINK SALMON
YEARS

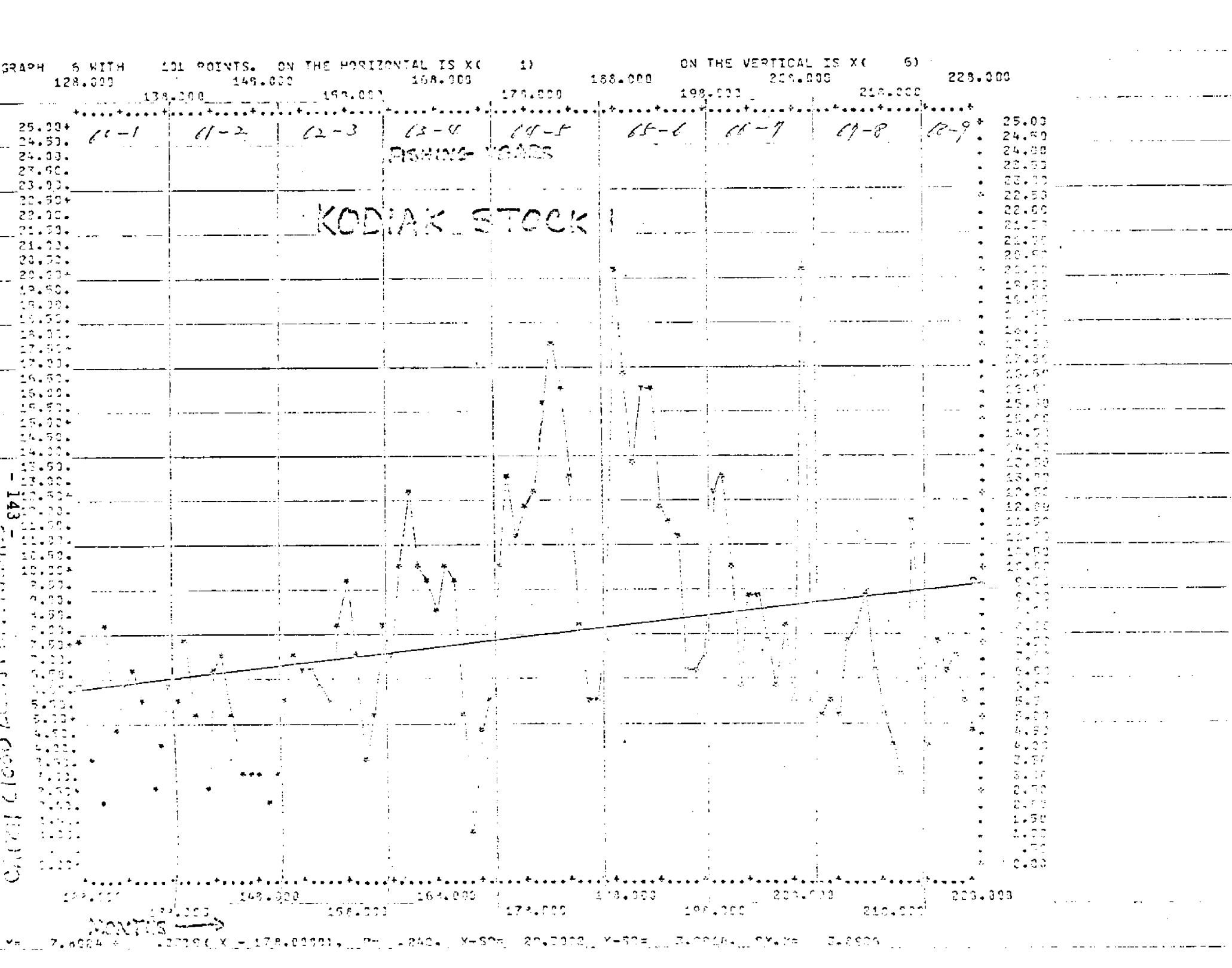

GRAPH 6 WITH 181 POINTS. ON THE HORIZONTAL IS X(1)
ON THE VERTICAL IS X(5)
60-1
61-2
62-3
63-4
64-5
65-6
66-7
67-8
68-9
KODAK

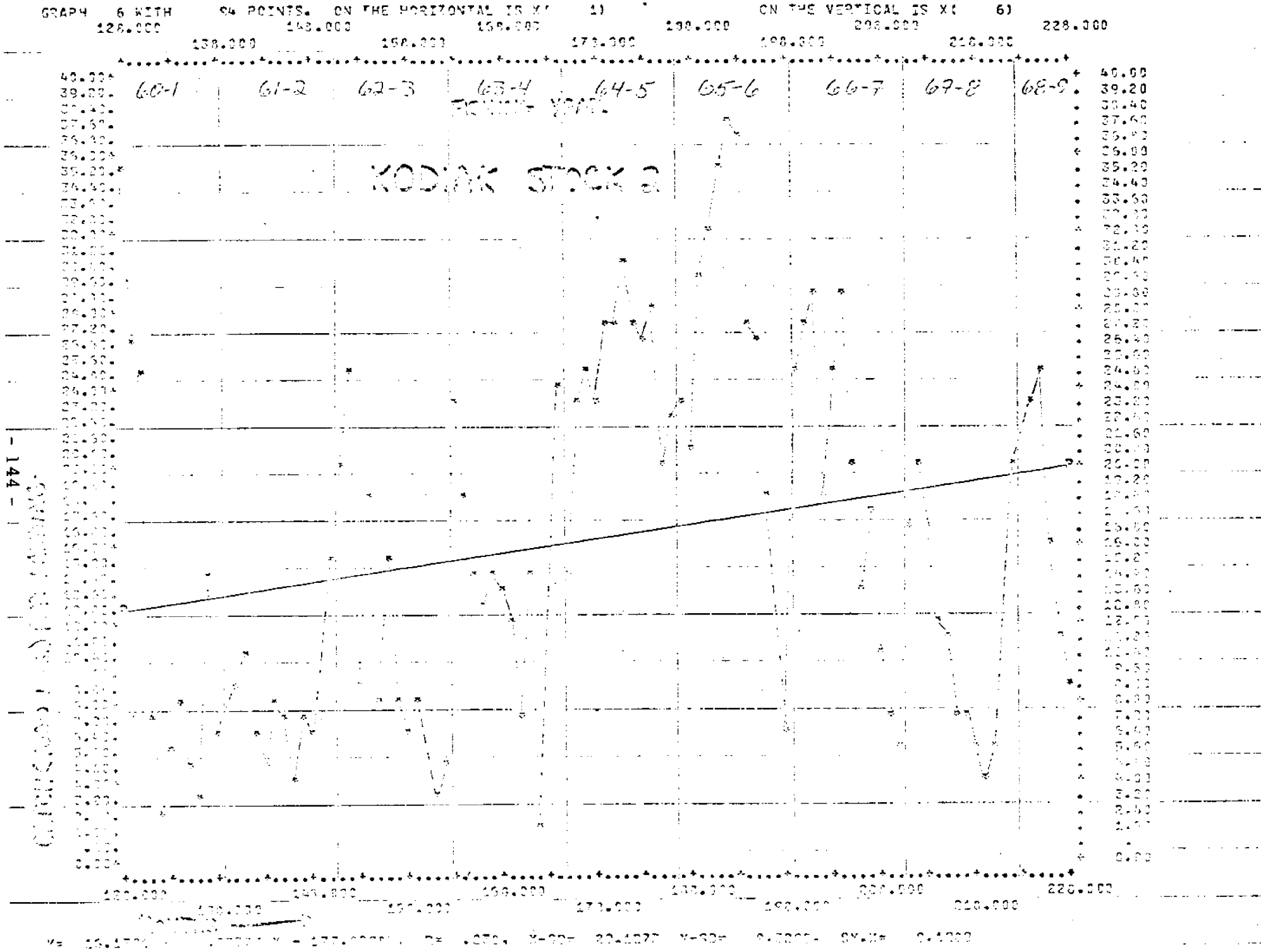

GRAPH 6 WITH 100 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS Y(6)
120.000
130.000
140.000
150.000
160.000
170.000
180.000
190.000
200.000
210.000
220.000
60-1
61-2
62-3
63-4
64-5
65-6
66-7
67-8
68-9
35.00
34.00
33.00
32.00
31.00
30.00
29.00
28.00
27.00
26.00
25.00
24.00
23.00
22.00
21.00
20.00
19.00
18.00
17.00
16.00
15.00
14.00
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
120.000
130.000
140.000
150.000
160.000
170.000
180.000
190.000
200.000
210.000
220.000


60-1
61-2
62-3
63-4
64-5
65-6
66-7
67-8
68-9
ALASKA

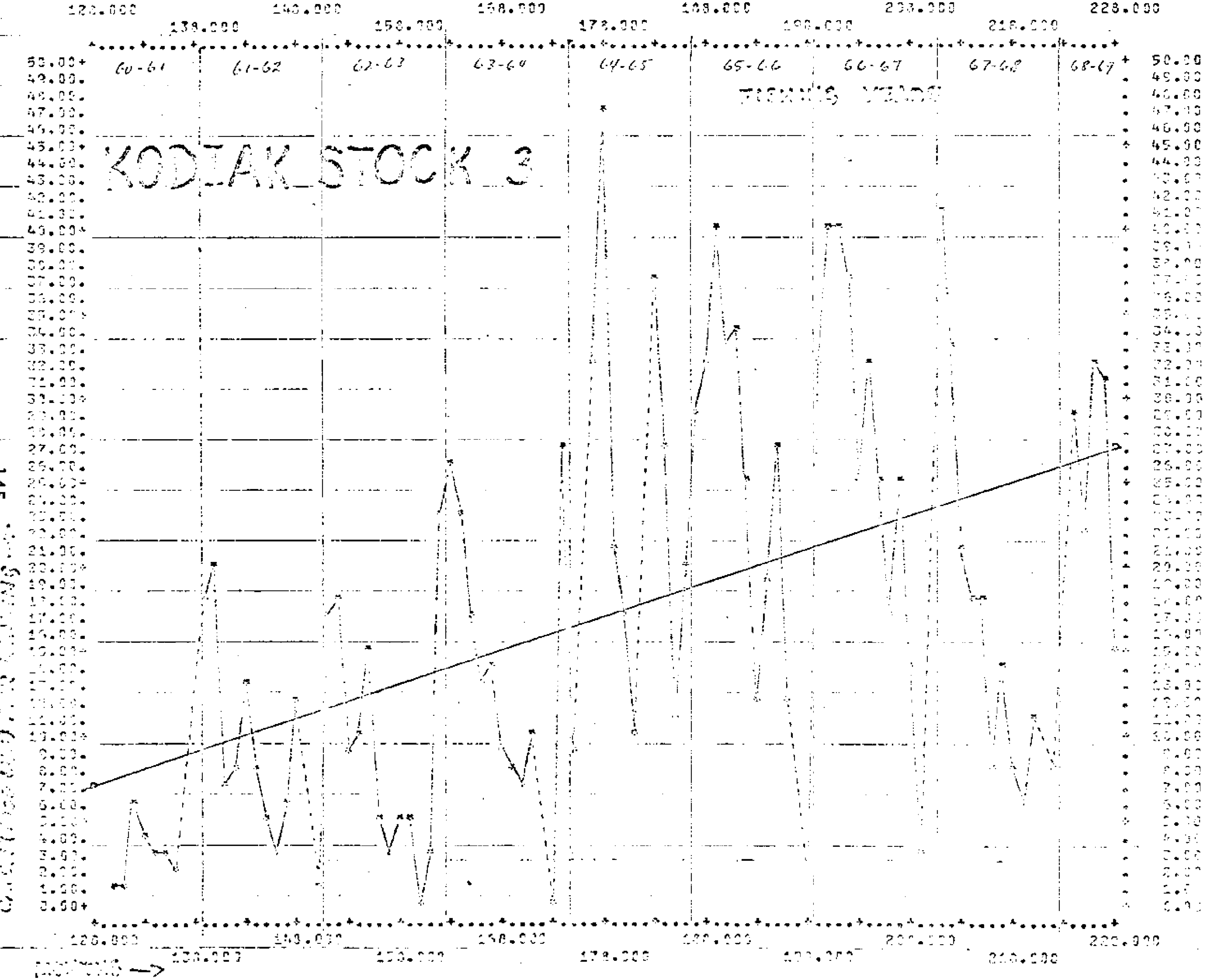

GRAPH 6 WITH 63 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(6)
125.000
130.000
135.000
140.000
145.000
150.000
155.000
160.000
165.000
170.000
175.000
180.000
185.000
190.000
195.000
200.000
205.000
210.000
215.000
220.000
60-1
61-2
62-3
63-4
64-5
65-6
66-7
67-8
68-9
ADAK


GRAPH 6 WITH 63 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(6)
120.000
140.000
160.000
180.000
200.000
220.000
110.00
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00

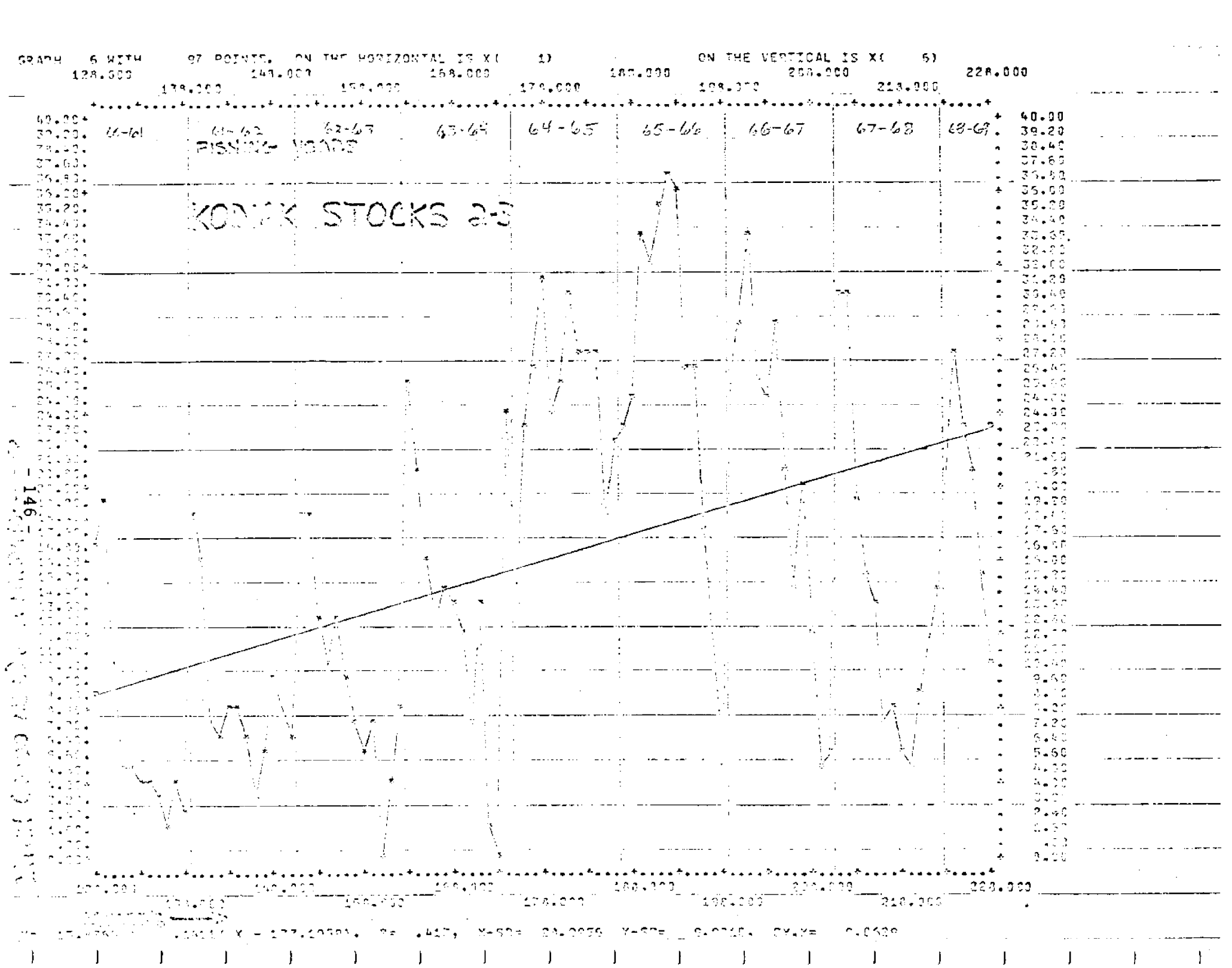

GRAPH 6 WITH 101 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(6)
128.000
149.000
168.000
188.000
208.000
228.000
KODIAK STOCK
FISHING YEARS
MONTHS


GRAPH 6 WITH 94 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(6)
60-1
61-2
62-3
63-4
64-5
65-6
66-7
67-8
68-9
KODAK STOCK

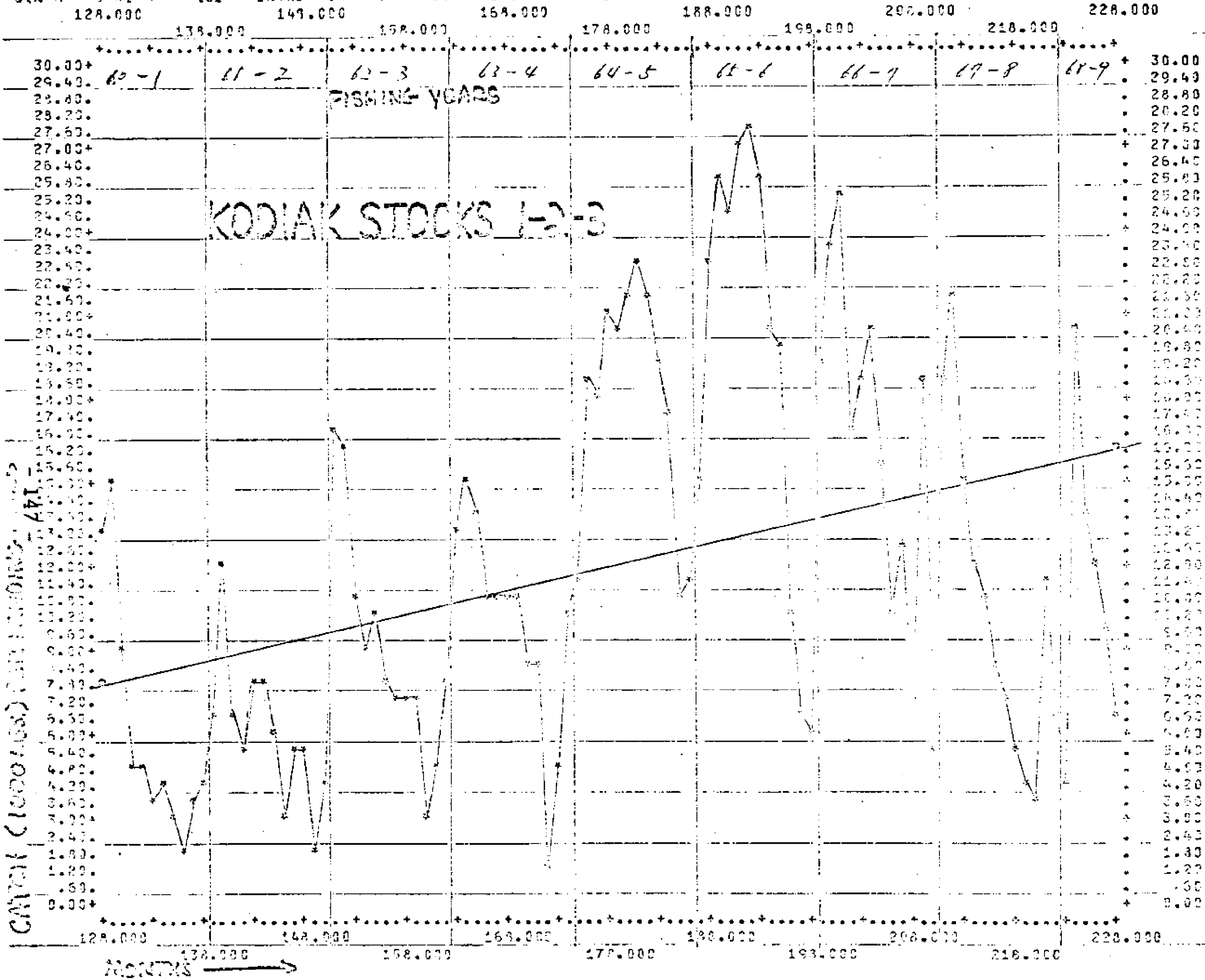
GRAPH 6 WITH 89 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(6)



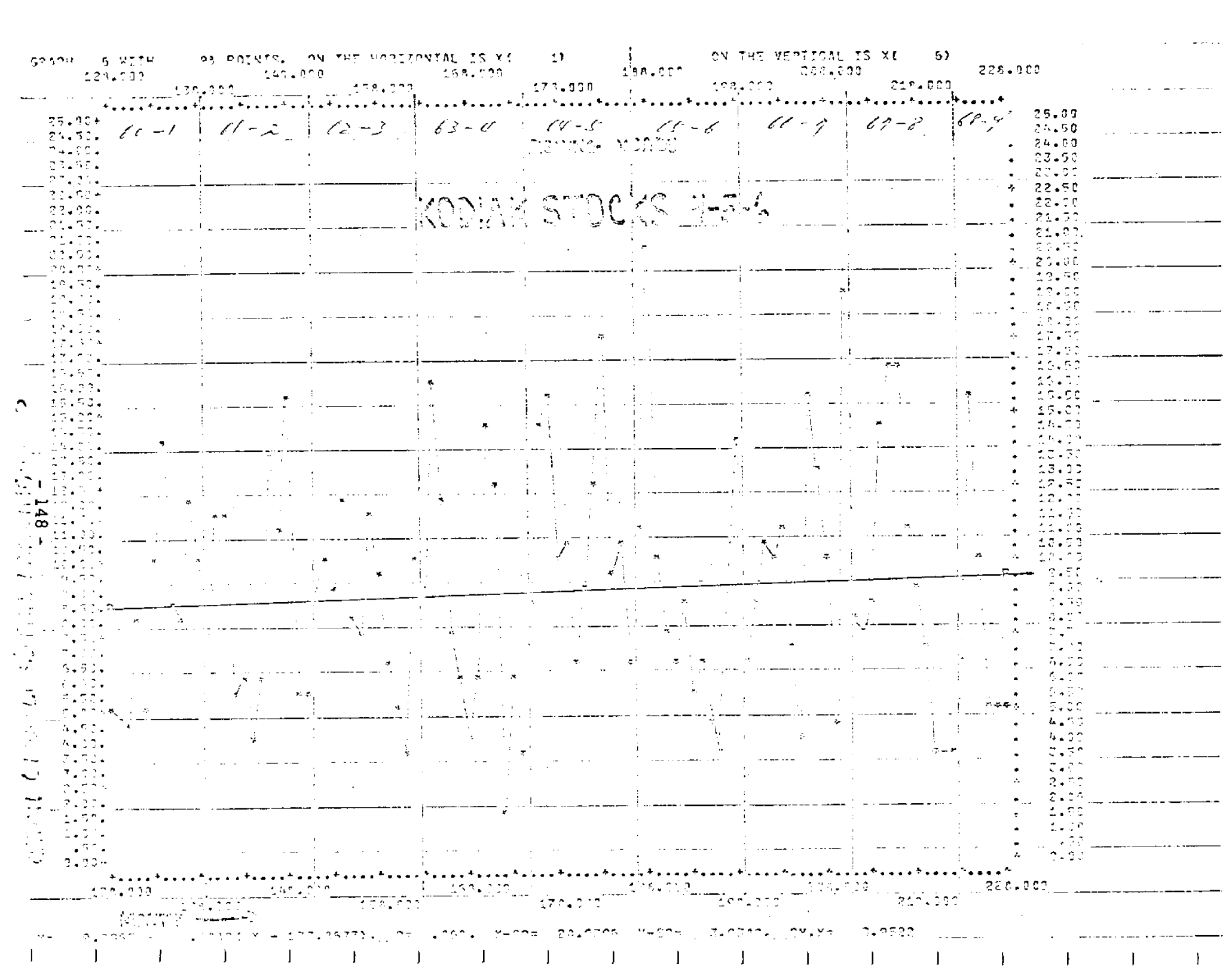
Y= [illegible] + .2913(X - 170.0315). R= .607, X-SD= [illegible] Y-SD= [illegible] SY.X= [illegible]


GRAPH 6 WITH 97 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(6)
61-62
62-63
63-64
64-65
65-66
66-67
67-68
68-69
KODAK STOCKS 2-3

GRAPH 6 WITH 101 POINTS. ON THE HORIZONTAL IS X(1) ON THE VERTICAL IS X(6)



Y= 11.9491 + .5813(X - 178.0000), r= .347, X-SD= 29.3002 Y-SD= 6.8755, SY.X= 6.4775


KODAK STOCKS
25.00
24.50
24.00
23.50
23.00
22.50
22.00
21.50
21.00
20.50
20.00
19.50
19.00
18.50
18.00
17.50
17.00
16.50
16.00
15.50
15.00
14.50
14.00
13.50
13.00
12.50
12.00
11.50
11.00
10.50
10.00
9.50
9.00
8.50
8.00
7.50
7.00
6.50
6.00
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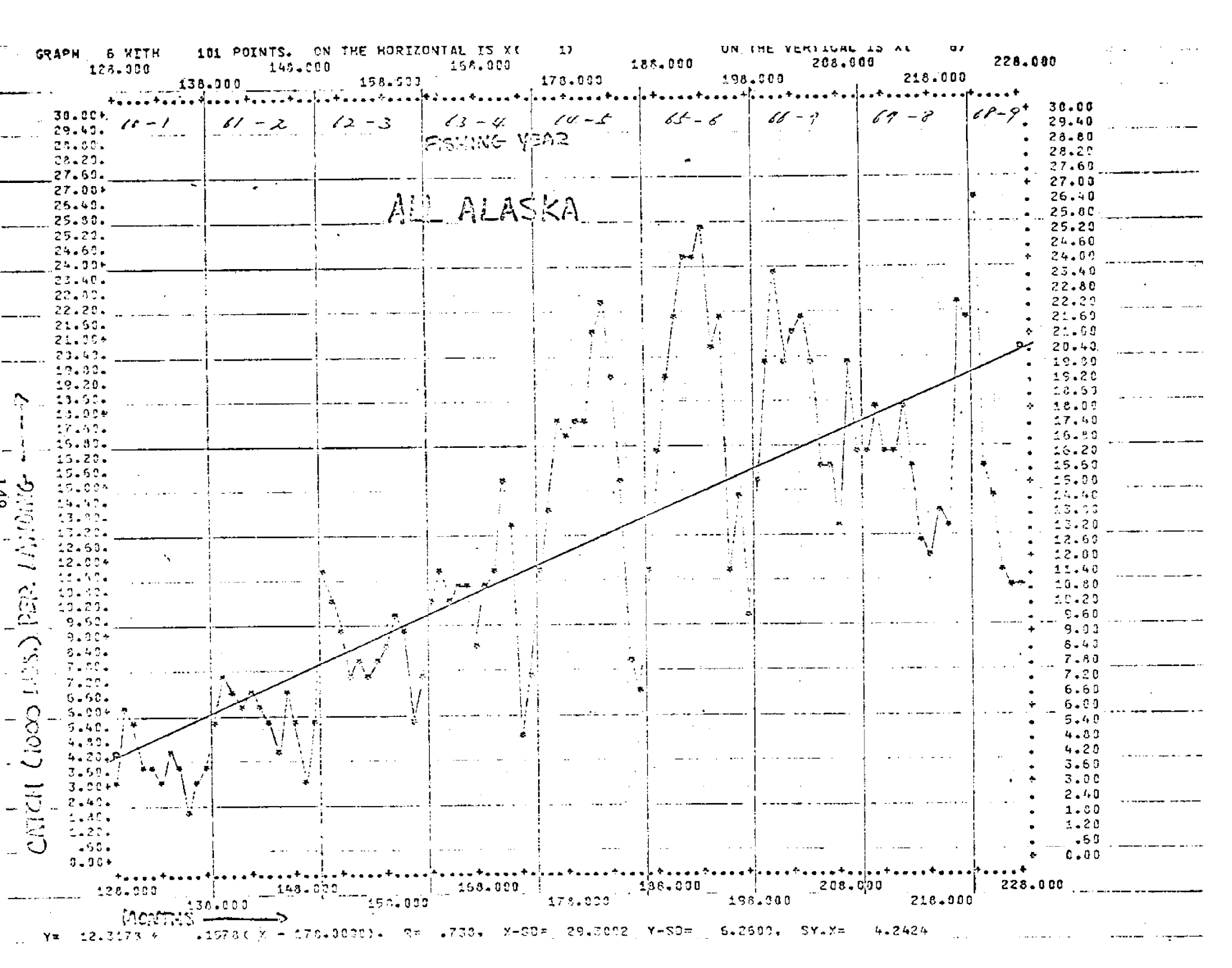
2.50
2.00
1.50
1.00
.50
.00


GRAPH 6 WITH 101 POINTS. ON THE HORIZONTAL IS X(1)
126.000 136.000 146.000 156.000 166.000 176.000 186.000 196.000 206.000 216.000 226.000
60-1
61-2
62-3
63-4
64-5
65-6
66-7
67-8
68-9
FISHING YEAR
ALL ALASKA
CATCH (1000 LBS.) PER LANDING
MONTHS
Y= 12.3173 + .1978(X - 170.0000). R= .738. X-SD= 29.3002 Y-SD= 6.2600. SY.X= 4.2424