The Journal of the Shimonoseki University of Fisheries 23(2)67-86(1974)

Shift and Catch of the Danish Seiner during the Alaska Pollack Trawling - I.*

Multiple Linear Regression of the Amount of Catch after the Shift on the Amount before the Shift and the Distance of Shift

By
Hiroshi MAÉDA and Shiro MINAMI

The recent advances in the fishing techniques are represented by the popularization of the electronic supporting devices and the application of the power source for handling the gear. The former makes the boat sparing many hours for scouting directly the schools in water; in consequence, the rate of the time for directly handling the gear is reduced. The latter makes it possible to save hands and labor for handling the gear; in consequence, the boat can repeat frequent haulings based on a result of good use of the former. Thus, the work pattern of the fishing boat changed completely in these one or two decades; and the fishing capacity of the boat of the same size was increased into an incomparable state.

Among the mobile gears, some are immobile during the hour effective for catching the fish, and it takes many hours to complete a work. The representatives are the longline and the gill-net. The others are effective to catch the fish only in moving (in being towed). And usually it does not take many hours to complete a haul. The representatives are the trawl and the seine. This group of the fishing methods is suitable for showing the change of the work pattern induced by the adaptation to the new devices. Among those for the groundfishes, it is necessary to tow the net either over long distance or short one for catching the fish with the trawl or the bull-trawl. However, there is no need to tow the net for catching the fish with the Danish seine; and the shift between the consecutive shootings is not indispensable. Accordingly, the Danish seine is chosen as the material, and the catch-shift-catch relation was examined in the present series, for the purpose of finding out the meaning of the shift which is one of the representatives of the working steps showing the complete change in the importance induced by the application of the modern techniques.

In general, the Danish seiner fishes in two ways: the anchor seining and the fly drag-

*Contribution from the Shimonoseki University of Fisheries, No. 727.
Received Oct. 17, 1974.

ging. However, our fleets fish in the intermediate way for catching the Alaska pollack in the Eastern Bering Sea. Our seiner does not use the anchor, but the propulsion during winding up and pulling together the warps is not powerful enough to make the net float up but only to prevent the seiner from being towed back towards the net working like anchor. This way of fishing makes the seiner, on one hand, shift freely, if necessary, as in the case of the fly dragging. But, it is hard, on the other hand, to hold the same position, even when a good catch is expected in the fishing at the same position. The seiner does not tow her net over long distance, but is drifted according to the current and wind after the net leaving from sea bed, i.e. during the hauling and brailing work. It took about an hour to complete these steps of work on the average, and the time for these steps increased in accordance with the amount of catch at a rate of three minutes per ton of catch[1),2)]. Accordingly, the drift was large when it was required to hold the same position. The seiners during the fleet operation exchange very frequently the information on the fishing condition throughout the working hours. When a boat yields a better catch, she may scout the school for the next shooting near the position of the preceding shooting. When she ends in an unsatisfactory result, she shifts based on the information of the catch by the fellow boats, scouts the schools, and settles the gear paying attention not only to the distribution of the objective fish and the bottom topography but also to the distribution and behavior of the fellow boats. She conducts the next shooting and yields a catch. During the Alaska pollack fishing in the Eastern Bering Sea, the Danish seiner supported by the factory ship repeats several hauls a day[1)]. And the fishing position of a boat differs more or less at every haul according to the drift or the shift. As the first step of the analyses of the relation observable in the sequence of catch-shift-catch–, the multiple linear regression of the amount of catch after the shift on the amount before the shift and on the distance of shift was examined in the present report.

Material and Method

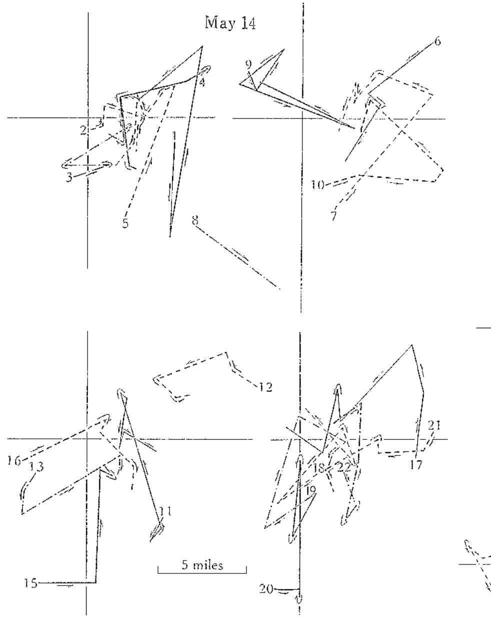
The fleet here in question consisted of the 22 Danish seiners, the three pairs of the bull-trawlers, and the factory ship. In this type of fishing, the bull-trawlers could not settle their position independently of the factory ship, because of the following reasons: the catch was very good, and they could not take inboard the codend full of catch, and they held the codends alongside and had to transship them with the assistance of the cargo winches installed on the factory ship. This work pattern makes the bull-trawler unsuitable for the present study. The Danish seiners could brail up their catch and could settle their fishing position rather independently of the factory ship. Accordingly, the records by the Danish seiners were chosen as the material of the present study.

All the seiners sent the telegrams several times a day. These telegrams during the entire season of 1964 from a fleet fishing along the outer edge of the continental shelf of the Eastern Bering Sea, were stratified into the 15 10-calendar-day groups. And the records on the three consecutive days were randomly chosen from each of the 10-day groups. Based on the suggestion by the staff of the fleet, the multiple linear regression of the amount of catch after the shift (y in tons) on the amount before the shift (x_1 in tons) and on the distance of shift (x_2 in miles) was examined, either before or after the stratification of the records according to the boat.

Results

1. The type of the frequency distribution of the distance of shift

As shown in Fig. 1, the boat shifted irregularly during the consecutive shootings. The distance of shift varied from less than one mile to more than 10 miles, mainly from one to two miles. The extent of the fishable ground and the distribution of the objective fish differ according to the location and the season. For the purpose of finding out the agreeable type of the frequency distribution, the records were stratified according to the calendar days, and the distance of shift was aggregated into the classes of the nearest one-mile intervals, and the observed series of the frequency distribution of the distance of shift was compared with the following three theoretical series: they were the $\log(x+1)$ normal distribution, the $\sqrt{x}$ normal one, and the $\sqrt{x+1}$ normal one.



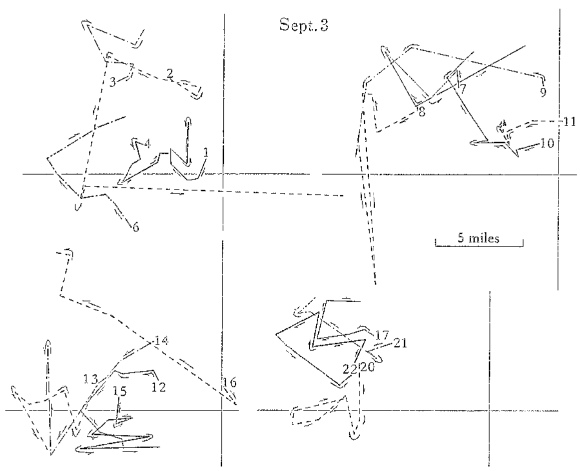


Fig. 1. Two examples of the tracks of the Danish seiners during the consecutive fishing work.

The numeral attached to the line shows the boat number. The axis shows the position of the factory ship. The fleet consisted of the 22 Danish seiners; however, the tracks are illustrated in the four separating sub-figures, because of severe overlapping.

As shown in Tables 1 to 3, the $\sqrt{x+1}$ normal distribution showed the tailing of the frequencies in the direction of the classes of long shift; and $\Pr\{\chi^2 > \chi_0^2\}$ was less than

0.05 in the 29 examples out of 41. And it was hard to regard that the observed series were agreeable to this theoretical distribution. The tailing of the estimated series of the frequency of the $\log(x+1)$ normal distribution is severer than that of the $\sqrt{x}$ normal one; $\Pr\{\chi^2 > \chi_0^2\}$ was more than 0.1 in the 28 examples for the former theoretical

Table 1. Examples of the observed and the estimated series of the frequency distribution of the distance of shift.

April 24

Class of shift distance (x in miles)	Ob.	Theoretical		
		$\log(x+1)$	$\sqrt{x}$	$\sqrt{x+1}$
0	5	3.91	3.69	7.05
1	16	14.95	17.73	10.40
2	9	13.63	11.16	10.87
3	6	9.11	8.05	9.30
4	7	5.65	5.62	7.02
5	8	3.47	3.81	4.85
6	3	2.16 } 9.75	2.53 } 10.75	3.13 } 12.36
7	1	1.37	1.64	1.91
8	0	0.87	1.05	1.12
9	1	0.58	0.66	0.63
≧10	1	1.30	1.06	0.72
χ_0^2		5.187	2.895	5.322
df		3	3	3
Pr.		0.250 - 0.100	0.500 - 0.250	0.250 - 0.100

May 14

Class of shift distance (x in miles)	Ob.	Theoretical		
		$\log(x+1)$	$\sqrt{x}$	$\sqrt{x+1}$
0	9	9.79	8.79	15.14
1	38	30.84	36.61	21.96
2	17	25.62	21.33	22.06
3	18	16.44	14.81	18.02
4	10	10.02	10.06	12.91
5	4	6.12	6.67	8.44
6	7	3.79 } 6.20	4.35	5.14
7	3	2.41	2.78	2.96
8	3	1.55 } 4.97	1.76 } 7.38	1.63 } 6.33
9	0	1.03	1.11	0.87
≧10	1	2.39	1.73	0.87
χ_0^2		8.027	4.327	19.102
df		5	5	5
Pr.		0.250 - 0.100	0.750 - 0.500	<0.005

June 19

Class of shift distance (x in miles)	Ob.	Theoretical		
		$\log(x+1)$	$\sqrt{x}$	$\sqrt{x+1}$
0	18	22.76	20.38	27.84
1	55	42.31	49.35	32.89
2	17	21.45	17.23	22.72
3	6	9.34	8.50	11.97
4	2	4.15	4.27	5.33
5	4	1.93 } 8.14	2.14 } 8.54	2.11 } 8.58
6	2	0.95	1.08	0.76
7	0	0.49	0.53	0.38
8	0	0.62	0.52	
9	0			
≧10	0			
χ_0^2		6.922	1.697	22.798
df		2	2	2
Pr.		0.050 - 0.025	0.500 - 0.250	<0.005

Sept. 3

Class of shift distance (x in miles)	Ob.	Theoretical		
		$\log(x+1)$	$\sqrt{x}$	$\sqrt{x+1}$
0	8	8.41	7.13	11.43
1	53	48.49	57.19	38.30
2	29	34.69	27.89	36.92
3	15	14.57	13.23	19.18
4	7	5.46	5.75	6.81
5	3	2.04 } 8.84	2.35 } 9.56	1.85 } 9.17
6	0	0.79	0.92	0.51
7	0	0.55	0.54	
8	0			
9	0			
≧10	0			
χ_0^2		1.538	0.714	9.356
df		2	2	2
Pr.		0.500 - 0.250	0.750 - 0.500	0.010 - 0.005

Table 2. The comparison of the three theoretical series of the frequency distributions [log $(x+1)$ normal, $\sqrt{x}$ normal, and $\sqrt{x+1}$ normal] in respect of the fitness to the observed one.

Date		log $(x+1)$			$\sqrt{x}$			$\sqrt{x+1}$		
		χ^2_0	df	Pr.	χ^2_0	df	Pr.	χ^2_0	df	Pr.
April	24	5.187	3	0.250 - 1.100	2.895	3	0.500 - 0.250	5.322	3	0.250 - 0.100
	25	9.756	4	0.050 - 0.025	3.876	3	0.500 - 0.250	11.208	3	0.025 - 0.010
	26	3.106	3	0.500 - 0.250	3.665	3	0.500 - 0.250	5.453	3	0.250 - 0.100
May	3	–	–	——	–	–	——	–	–	——
	4	–	–	——	–	–	——	–	–	——
	5	4.803	3	0.250 - 0.100	2.472	3	0.500 - 0.250	19.747	3	$<$0.005
	14	8.027	5	0.250 - 0.100	4.327	5	0.750 - 0.500	19.102	5	$<$0.005
	15	4.452	3	0.250 - 0.100	9.952	3	0.025 - 0.010	3.225	3	0.500 - 0.250
	16	–	–	——	–	–	——	–	–	——
	25	2.216	4	0.750 - 0.500	1.614	4	0.900 - 0.750	11.210	4	0.025 - 0.010
	26	5.862	3	0.250 - 0.100	1.393	3	0.750 - 0.500	27.076	3	$<$0.005
	27	1.519	3	0.750 - 0.500	1.565	3	0.750 - 0.500	14.341	3	$<$0.005
	31	11.395	3	0.010 - 0.005	3.072	3	0.500 - 0.250	34.972	3	$<$0.005
June	1	5.108	3	0.250 - 0.100	6.253	3	0.100 - 0.050	5.340	3	0.250 - 0.100
	2	7.158	3	0.100 - 0.050	2.521	2	0.500 - 0.250	10.366	3	0.025 - 0.010
	17	6.962	3	0.100 - 0.050	2.028	3	0.750 - 0.500	34.153	3	$<$0.005
	18	3.634	2	0.250 - 0.100	11.343	2	$<$0.005	0.006	2	$>$0.995
	19	6.922	2	0.050 - 0.025	1.697	2	0.500 - 0.250	22.798	2	$<$0.005
	29	4.596	3	0.250 - 0.100	9.650	3	0.025 - 0.010	0.632	3	0.900 - 0.750
	30	6.574	5	0.500 - 0.250	6.008	5	0.500 - 0.250	17.443	5	$<$0.005
July	1	1.837	3	0.750 - 0.500	2.884	3	0.500 - 0250	12.485	3	0.010 - 0.005
	2	3.604	4	0.500 - 0.250	6.862	4	0.250 - 0.100	11.195	4	0.025 - 0.010
	3	6.107	4	0.250 - 0.100	4.425	4	0.500 - 0.250	22.336	4	$<$0.005
	4	3.028	4	0.750 - 0.500	0.477	4	0.990 - 0.975	13.020	4	0.025 - 0.010
	10	4.817	2	0.100 - 0.050	10.301	2	0.010 - 0.005	1.908	2	0.500 - 0.250
	11	8.616	4	0.100 - 0.050	6.371	4	0.250 - 0.100	32.648	4	$<$0.005
	12	0.672	2	0.750 - 0.500	4.396	2	0.250 - 0.100	1.700	2	0.500 - 0.250
	28	2.382	2	0.500 - 0.250	1.596	2	0.500 - 0.250	6.007	2	0.050 - 0.025
	29	4.200	3	0.250 - 0.100	3.953	3	0.500 - 0.250	7.493	3	0.100 - 0.050
	30	5.163	2	0.100 - 0.050	2.247	2	0.500 - 0.250	18.784	2	$<$0.005
Aug.	8	6.470	4	0.250 - 0.100	4.956	4	0.500 - 0.250	22.303	4	$<$0.005
	9	5.095	4	0.500 - 0.250	5.927	4	0.250 - 0.100	25.804	4	$<$0.005
	10	5.890	2	0.100 - 0.050	8.729	2	0.025 - 0.010	9.382	2	0.010 - 0.005
	15	2.762	4	0.750 - 0.500	5.601	4	0.250 - 0.100	18.425	4	$<$0.005
	16	9.106	4	0.100 - 0.050	3.846	4	0.500 - 0.250	22.845	4	$<$0.005
	17	4.376	3	0.250 - 0.100	0.923	3	0.900 - 0.750	13.909	3	$<$0.005
	23	4.748	4	0.500 - 0.250	1.484	4	0.900 - 0.750	13.784	4	0.010 - 0.005
	24	1.124	2	0.750 - 0.500	6.238	3	0.250 - 0.100	5.349	2	0.100 - 0.050
	25	2.960	2	0.250 - 0.100	2.180	2	0.500 - 0.250	4.970	2	0.100 - 0.050
Sept.	2	5.655	2	0.100 - 0.050	3.081	2	0.250 - 0.100	6.203	1	0.025 - 0.010
	3	1.538	2	0.500 - 0.250	0.714	2	0.750 - 0.500	9.356	2	0.010 - 0.005
	18	8.640	3	0.050 - 0.025	2.509	3	0.500 - 0.250	29.430	3	$<$0.005
	19	4.886	2	0.100 - 0.050	3.834	2	0.250 - 0.100	18.749	2	$<$0.005
	20	1.534	3	0.750 - 0.500	7.538	3	0.100 - 0.050	3.687	3	0.500 - 0.250

Table 3. The comparison of the three theoretical series of the frequency distributions in respect of the distribution of the strata of records in the Pr $\{\chi_0^2 < \chi_0^2\}$ - classes.

Pr $\{\chi_0^2 > \chi_0^2\}$ - class	log $(x + 1)$	$\sqrt{x}$	$\sqrt{x+1}$
$\geqq$0.75	1	4	2
0.75 - 0.50	7	5	0
0.50 - 0.25	7	17	4
0.25 - 0.10	13	8	3
0.10 - 0.05	9	2	3
0.050 - 0.025	3	0	1
0.025 - 0.010	0	3	6
0.010 - 0.005	1	1	4
<0.005	0	1	18

Note: The numerals in respective columns show the number of the strata of records.

distribution and in the 34 examples for the latter one. And it may be said that most of the observed series of the frequency distributions were agreeable to these theoretical distributions. The observed series in the 26 examples showed a closer approximation to the latter series than to the former one, and those in the 15 examples showed a closer approximation to the former one than to the latter one. Accordingly, the distance of shift was used in the further examinations after the $\sqrt{x}$ transformation.

2. The multiple linear regression (The records of all the seiners pooled and those of the accidental shootings included)

The seiners sometimes took a shift over too long distance to regard it as the consecutive work. The sets of records of these cases were excluded. And the multiple linear regression of the amount of catch after the shift (y in tons) on the amount before the shift (x_1 in tons) and on the distance of shift (x_2 in miles) observable in the records on the same days was examined, for the purpose of finding out an outline of the catch-shift-catch relation.

As shown in Table 4, the coefficient a_1, which was that of the catch before the shift, took a significantly positive value in the records on the 19 days, an insignificantly positive one in the same number of the days, and an insignificantly negative one on the six days. And the negative a_1 and the positive ones were distributed throughout the seasons. The coefficient a_2, which was that of the distance of shift, took a significantly positive value in the records on the three days, an insignificantly positive one on the 31 days, an insignificantly negative one on the eight days, and a significantly negative one on the two days. And the negative coefficients and the significant ones (including both the positive ones and the negative ones) inclined to be found before the middle of July. These findings showed the following rough trend: the catch by the shooting after either a good catch or a long shift inclined to be better than that either after a poor catch or after a short shift.

Table 4. The estimated multiple linear regression equations of the amount of catch (y in tons) after the shift on that (x_1 in tons) before the shift and the distance of shift (x_2 in miles). (The records of all the boats pooled)

$$y = a_0 + a_1 x_1 + a_2 x_2$$
or
$$y = a'_0 + a'_1 x_1 + a'_2 x_2$$

	The records of the accidental shootings included and those of the long shifts excluded						The records of the accidental shooting excluded and those of the long shifts included					
Date	a_0	a_1	a_2	F_1	F_2	n	a'_0	a'_1	a'_2	F'_1	F'_2	n'
April 24	4.92	0.07	0.17	0.33	0.14	57	4.92	0.07	0.17	0.33	0.14	57
25	5.87	0.09	0.62	0.52	0.70	74	4.90	0.21	0.65	2.54	0.82	67
26	5.41	-0.07	0.74	0.21	0.66	69	6.15	-0.08	0.32	0.25	0.12	64
May 3	5.80	0.32	0.17	1.23	0.01	14	5.80	0.32	0.17	1.23	0.01	14
4	4.75	0.17	-0.31	0.39	0.04	32	-1.15	0.76	1.80	8.03**	3.36	33
5	5.70	0.12	1.70	0.72	3.89	58	4.53	0.29	1.64	3.54	4.20*	52
14	2.02	0.29	0.44	8.01**	2.33	110	1.99	0.30	0.50	8.11**	3.16	106
15	1.22	0.35	0.10	9.42**	0.16	69	0.46	0.53	0.33	19.57**	1.80	64
16	1.90	0.48	-0.83	1.61	1.35	18	2.15	0.32	-0.55	0.65	0.56	17
25	3.15	-0.07	-0.58	0.42	5.68*	78	3.20	-0.04	-0.58	0.13	5.69*	68
26	1.37	0.18	-0.09	3.22	0.28	114	1.14	0.28	0.12	7.04**	0.47	90
27	0.76	0.36	0.19	17.55**	1.33	128	0.71	0.45	0.20	25.75**	1.85	109
31	1.08	0.38	0.03	16.90**	0.02	113	0.81	0.46	0.21	23.76**	1.25	96
June 1	3.14	0.29	-0.66	5.84*	3.78	114	2.99	0.27	-0.36	4.19*	1.08	103
2	2.25	0.26	-0.17	7.19**	0.42	129	1.54	0.39	0.20	15.47**	0.63	115
17	1.51	0.26	0.05	8.79**	0.12	136	1.26	0.35	0.15	13.20**	1.03	130
18	1.12	0.24	0.22	6.79*	1.10	115	1.31	0.24	0.07	7.11**	0.17	114
19	2.08	0.16	-0.40	2.36	4.14*	104	1.98	0.20	-0.32	3.64	2.87	97
29	1.92	0.14	0.89	1.37	3.74	80	1.89	0.16	0.86	1.70	3.37	79
30	0.44	0.77	0.44	20.71**	1.30	90	0.41	0.78	0.44	20.28**	1.28	89
July 1	2.73	0.08	0.33	0.88	0.30	93	2.62	0.10	0.38	1.25	0.36	87
2	3.65	0.03	-0.20	0.12	0.31	111	3.43	0.04	-0.05	0.18	0.02	109
3	2.03	0.11	0.78	0.84	5.00*	89	2.02	0.15	0.71	1.44	4.31*	84
4	2.11	-0.17	1.08	1.71	8.90**	93	1.92	-0.06	1.01	0.21	7.62**	88
10	1.51	0.45	0.10	8.51**	0.06	62	1.24	0.44	0.20	10.49**	0.71	81
11	2.50	0.32	0.89	9.70**	6.69*	95	1.67	0.41	1.19	14.95**	13.23**	87
12	2.43	0.33	0.95	8.40**	1.76	64	2.28	0.33	1.07	8.33**	2.49	64
28	2.02	0.21	0.69	2.05	1.67	70	1.41	0.38	0.82	5.65*	2.19	62
29	3.56	0.34	0.59	8.93**	1.09	93	3.63	0.36	0.52	11.02**	1.40	96
30	4.30	0.08	0.80	0.57	2.46	97	4.12	0.13	0.73	1.39	2.42	96
Aug. 8	5.59	-0.05	0.31	0.20	0.73	75	5.20	0.04	0.23	0.10	0.44	73
9	2.78	0.28	0.17	8.02**	0.30	105	2.21	0.33	0.49	8.84**	2.45	95
10	3.29	0.13	0.28	1.32	0.37	70	3.85	0.10	0.01	0.73	0.003	82
15	1.75	0.28	0.24	4.60*	0.74	91	1.63	0.29	0.31	4.92*	1.18	89
16	1.89	0.15	0.24	2.19	1.16	127	1.54	0.20	0.46	3.56	4.32*	118
17	1.87	0.26	0.64	3.98*	2.37	88	1.30	0.46	0.62	11.65**	2.78	77
23	2.04	0.11	0.33	0.96	1.69	105	2.04	0.11	0.33	1.20	3.84	107
24	4.27	-0.07	-0.48	0.52	2.03	124	3.78	0.07	-0.28	0.47	0.86	110
25	0.96	0.47	0.66	17.98**	2.82	98	1.19	0.55	0.35	25.52**	2.27	100
Sept. 2	0.73	0.58	0.35	17.62**	1.45	48	0.61	0.57	0.51	19.59**	3.51	47
3	1.32	0.41	0.19	17.08**	0.61	115	1.20	0.43	0.31	17.43**	2.11	107
18	4.10	0.17	0.12	1.66	0.04	68	3.72	0.21	0.39	2.33	0.46	65
19	3.88	0.19	0.37	2.37	0.30	91	3.79	0.29	0.21	5.22*	0.14	82
20	5.35	-0.12	-0.55	1.06	1.22	99	3.52	0.17	0.30	1.54	0.38	77

Note: F_1 .... The Snedecor's F value for a_1 with 1 and n - 3 degrees of freedom
F_2 .... That for a_2
F'_1 .... That for a'_1 with 1 and n' - 3 degrees of freedom
F'_2 .... That for a'_2

* Significant at 0.05 level ** Significant at 0.01 level

3. The multiple linear regression (The records of all the seiners pooled, those of the accidental shootings excluded and those of the long shift included)

The seiners sometimes committed the accidental shootings which resulted in a very poor catch and made the seiners waste their workable hours. The Danish seiner had advantages over the other net fishing for catching the fish on somewhat rough ground, because this method can catch the fish without towing the net over long distance. A concentration of groundfish is frequently found near the bottom object, and the skipper prefers to attack it. Some of the accidental shootings were for these schools. When a seiner finds a large school and yields a good catch, some of the fellow seiners shift around her and shoot their nets very closely to that position. In this case, the warp of a seiner was sometimes laid over the warp of another seiner. Some of the accidental shootings were due to this reason. In these cases, the catch was poor, but the seiner attacked again the same school without shift. The records of the accidental shootings were included in the examinations of the preceding section. However, the records of the accidental shootings were excluded from the examinations in the present section, because the meanings of the catch and the distance of shift relating to the accidental shootings differ from those of the ordinary ones. The seiner sometimes shifts over a very long distance during the hour when the fellow seiners are working. The records of these cases were excluded from the examinations in the preceding sections. However, it is probable that the short shift may be based mainly on the results of the seiner own and partly on those of the fellow ones and the long shift may be mainly on the results of the fellow seiners and partly on those of its own. And much importance should be attached to the relation including the long shift, for the purpose of evaluating the merits and the demerits of the fleet operation. In consequence, the multiple linear regression of the amount of catch after the shift on that before the shift and on the distance of shift was examined again, after the exclusion of the records of the accidental shootings and the addition of those of the long shifts. And the following results were obtained: both of the coefficients, a'_1 and a'_2, increased slightly. The coefficient a'_1 was significantly positive in the records on the 23 days, insignificantly positive on the 18 days, and insignificantly negative on the three days. And the coefficient a'_2 was significantly positive on the five days, insignificantly positive on the 33 days, insignificantly negative on the five days, and significantly negative on a day.

4. The multiple linear regression after the stratification of the records according to the seiner (The records of the long shifts excluded and those of the accidental shootings included)

The problem treated here may deeply depend on the skipper's skill and will, and may differ according to the boat. And it is necessary to examine whether the trend of a good catch after a good catch or after a long shift found in the preceding sections will be due to the boat-by-boat difference of the fishing capacity and work pattern or this trend will be true to the records by the same boats. The records on each of the days were stratified according to the seiner; then, the sample size became too small to examine the relation.

Table 5 . The estimated multiple linear regression equations of y on x_1 and x_2 (After startification of the records according to the boat).

The records of the accidental shooitngs included and those of the long shifts excluded | The records of the accidental shootings exculded and those of the long shifts included

Period	Boat No.	a_0	a_1	a_2	F_1	F_2	n	a_0'	a_1'	a_2'	F_1'	F_2'	n'
Late in April	1	0.74	0.30	2.82	1.18	2.69	11	0.74	0.30	2.82	1.18	2.69	11
	2	14.66	-0.75	-1.68	2.31	2.07	8	14.66	-0.75	-1.68	2.31	2.07	8
	3	2.22	-0.12	2.40	0.03	0.96	10	2.22	-0.12	2.40	0.03	0.96	10
	4	10.08	-0.23	1.79	0.30	0.71	13	10.08	-0.23	1.79	0.30	0.71	13
	5	4.02	0.21	-0.64	0.71	0.44	12	3.94	0.22	-0.64	0.46	0.38	11
	6	-2.50	0.20	5.09	0.31	7.17*	12	-1.48	0.39	3.61	1.74	7.33*	10
	7	7.52	0.06	-0.49	0.04	0.06	10	1.97	0.34	1.15	1.89	0.50	9
	8	5.15	0.19	-0.28	0.27	0.01	13	3.14	0.47	-0.30	0.88	0.02	11
	10	11.60	-0.68	-1.51	1.18	0.30	9	11.60	-0.68	-1.51	1.18	0.30	9
	11	1.88	0.46	1.67	0.18	0.24	9	1.88	0.46	1.67	0.18	0.24	9
	12	2.50	0.47	1.00	0.59	0.21	7	2.50	0.47	1.00	0.59	0.21	7
	13	12.06	-0.16	-2.59	0.20	2.96	11	12.06	-0.16	-2.59	0.20	2.96	11
	14	1.91	1.53	-2.71	46.70	2.73	4	–	–	–	–	–	–
	15	6.71	-0.11	1.08	0.18	0.51	11	6.71	-0.11	1.08	0.18	0.51	11
	16	9.21	-0.55	0.09	1.65	0.0005	8	-18.42	0.79	11.52	1.27	3.12	6
	17	5.46	0.75	-6.95	1.18	2.17	7	5.46	0.75	-6.95	1.18	2.17	7
	18	2.15	0.88	-1.58	1.83	0.22	7	2.15	0.88	-1.58	1.83	0.22	7
	19	1.02	0.07	3.46	0.25	19.41**	9	1.02	0.07	3.46	0.25	19.41**	9
	20	6.88	-0.03	0.53	0.01	0.23	11	6.88	-0.03	0.53	0.01	0.23	11
	21	-0.38	1.24	0.13	6.69*	0.01	11	-0.38	1.24	0.13	6.69*	0.01	11
	22	-1.02	0.09	4.21	0.07	2.08	7	4.61	0.05	0.22	0.01	0.01	5
Early in May	1	7.04	0.19	0.68	0.12	0.03	7	7.15	0.21	0.34	0.20	0.01	8
	3	8.26	-0.49	5.15	48.08	77.58	4	8.26	-0.49	5.15	48.08	77.58	4
	7	4.99	0.40	-1.38	3.12	1.27	6	4.99	0.40	-1.38	3.12	1.27	6
	10	1.14	0.54	1.84	2.53	2.28	8	1.14	0.54	1.84	2.53	2.28	8
	11	-2.80	1.06	2.85	4.01	1.61	7	-2.80	1.06	2.85	4.01	1.61	7
	12	5.95	-0.05	2.90	0.01	0.14	7	5.95	-0.05	2.90	0.01	0.14	7
	14	-3.53	0.16	5.38	0.05	0.81	7	3.66	0.46	-2.47	3.04	0.72	5
	15	-2.58	1.07	0.64	4.56	0.02	5	-2.58	1.07	0.64	4.56	0.02	5
	16	1.14	-0.32	8.61	0.90	1.55	9	2.82	1.00	-1.01	4.58	0.08	8
	19	10.90	-0.03	1.70	0.0002	0.01	5	10.90	-0.03	1.70	0.0002	0.01	5
	20	13.79	-0.40	-3.85	0.74	1.23	7	11.32	-0.35	-1.34	0.46	0.75	6
	21	4.50	-0.11	2.73	0.24	7.81*	9	4.50	-0.11	2.73	0.24	7.81*	9
	22	-3.98	0.75	4.06	2.77	5.46	7	-3.98	0.75	4.06	2.77	5.46	7
Middle of May	1	-2.86	1.10	1.33	6.87*	4.46	11	-1.04	0.77	1.03	2.92	2.81	10
	2	1.37	0.62	-0.29	4.70	0.09	12	1.37	0.62	-0.29	4.70	0.09	12
	3	-1.24	-0.03	4.09	0.01	10.19	7	-1.24	-0.03	4.09	0.01	10.19	7
	4	3.79	0.16	-0.32	0.19	0.05	11	3.79	0.16	-0.32	0.19	0.05	11
	5	2.38	0.38	-0.34	1.26	0.11	10	2.96	0.22	-0.35	0.26	0.11	9
	6	0.61	0.50	0.01	1.09	0.005	7	0.61	0.50	0.01	1.09	0.005	7
	7	-3.47	0.89	2.43	2.77	2.14	6	-3.47	0.89	2.43	2.77	2.14	6
	8	1.23	0.72	-0.21	1.10	0.04	7	1.23	0.72	-0.21	1.10	0.04	7
	9	2.97	0.002	0.02	0.00002	0.001	8	2.97	0.002	0.02	0.00002	0.001	8
	10	-0.24	0.63	0.57	2.64	1.00	12	-0.24	0.63	0.57	2.64	1.00	12
	11	2.58	-0.35	-0.01	0.97	0.0002	12	1.33	0.39	-0.03	1.05	0.004	9
	12	1.75	0.36	0.01	1.43	0.0001	11	0.03	0.69	0.41	3.82	0.35	10
	13	-1.41	0.90	1.49	5.69*	1.12	10	-1.41	0.90	1.49	5.69*	1.12	10
	15	-4.35	1.18	3.03	17.45*	19.17*	7	-4.35	1.18	3.03	17.45*	19.17*	7
	16	-0.23	0.42	1.80	1.34	2.69	10	-0.23	0.42	1.80	1.34	2.69	10
	17	-1.97	0.29	2.23	0.49	4.16	11	-0.87	0.22	1.84	0.27	2.55	10
	18	-2.00	0.51	2.55	0.53	2.12	5	-2.00	0.51	2.55	0.53	2.12	5
	19	3.21	-0.37	1.13	0.67	1.20	7	3.21	-0.37	1.13	0.67	1.20	7
	20	2.00	0.45	-0.19	2.94	0.12	12	2.00	0.45	-0.19	2.94	0.12	12
	21	4.93	-0.42	-0.53	1.11	0.17	11	3.21	-0.02	-0.18	0.005	0.07	9
	22	-0.22	0.09	1.28	0.05	0.61	10	1.30	-0.12	0.82	0.08	0.24	9

Table 5. – (cont'd)

	Boat No.	The records of the accidental shootings included and those of the long shifts excluded						The records of the accidental shootings excluded and those of the long shifts included					
		a_0	a_1	a_2	F_1	F_2	n	a_0'	a_1'	a_2'	F_1'	F_2'	n'
Late in May	1	2.42	-0.62	-0.05	3.34	0.01	16	2.70	-0.71	0.03	3.88	0.003	13
	2	-0.16	0.79	0.34	12.55**	1.06	20	-0.15	0.78	0.36	7.85*	1.07	18
	3	2.44	0.05	0.01	0.05	0.001	19	2.44	0.05	0.01	0.05	0.001	19
	4	1.30	0.21	-0.09	0.88	0.04	19	1.36	0.09	0.10	0.14	0.06	17
	5	1.32	0.44	-0.54	4.81*	1.38	18	1.32	0.44	-0.54	4.81*	1.38	18
	6	1.69	-0.49	0.63	6.42*	1.96	16	1.78	-0.19	0.15	1.28	0.14	14
	7	1.89	0.17	-0.41	0.95	2.30	19	2.25	0.04	-0.20	0.03	0.61	13
	8	0.88	0.13	0.36	0.52	0.61	21	0.80	0.42	0.12	9.83**	0.17	15
	10	2.31	-0.01	-0.28	0.001	0.37	18	0.28	0.71	0.49	5.91*	1.41	16
	11	2.01	-0.08	-0.08	0.05	0.004	15	4.10	-0.25	-1.15	0.30	0.41	12
	12	2.06	-0.22	-0.23	0.76	0.55	18	1.62	0.23	-0.37	1.24	2.89	16
	13	-0.99	0.60	1.31	4.03	2.02	17	0.04	0.64	0.56	6.81*	0.45	11
	15	3.32	-0.08	-0.93	0.11	1.68	18	3.34	-0.08	-0.83	0.13	1.65	16
	16	0.12	0.54	0.50	5.99*	1.40	16	1.50	0.17	0.27	0.16	0.34	10
	17	0.54	-0.07	0.62	0.09	1.43	16	0.79	-0.06	0.45	0.04	0.62	13
	19	0.98	0.71	-0.35	2.39	0.02	5	0.98	0.71	-0.35	2.39	0.02	5
	20	0.99	0.40	-0.04	2.73	0.003	16	1.02	0.38	0.001	1.53	0.000001	13
	21	1.42	0.38	0.004	2.91	0.00003	16	1.42	0.38	0.004	2.91	0.00003	16
	22	-1.00	0.46	1.16	1.59	3.74	16	-1.18	0.83	1.14	5.45*	5.94*	12
Early in June	1	6.35	-0.27	-1.89	1.06	7.53*	14	6.35	-0.27	-1.89	1.06	7.53*	14
	2	5.38	0.14	-2.37	0.35	6.50*	21	2.92	0.34	-0.49	1.00	0.14	15
	3	1.67	0.51	-0.19	3.19	0.08	20	1.67	0.51	-0.19	3.19	0.08	20
	4	0.66	0.37	0.80	2.49	1.62	19	-0.16	0.53	1.13	4.65	3.89	15
	5	-0.72	0.71	0.86	4.52	2.13	13	-0.72	0.71	0.86	4.52	2.13	13
	6	2.21	-0.07	-0.17	0.07	0.07	22	2.85	-0.11	-0.45	0.18	0.48	19
	7	5.43	-0.19	-0.99	0.45	2.21	21	3.65	0.06	-0.01	0.07	0.001	18
	8	2.93	0.29	-0.33	1.89	0.18	17	3.16	0.24	-0.34	0.94	0.18	16
	10	2.88	0.53	-1.23	6.03*	1.12	18	3.03	0.54	-1.34	6.24*	1.40	16
	11	2.06	0.41	-0.74	3.66	2.13	19	0.05	0.78	0.36	13.09**	0.50	15
	12	1.72	0.06	0.12	0.05	0.04	23	1.72	0.06	0.12	0.05	0.04	23
	13	2.33	0.11	-0.88	0.16	0.90	17	1.85	-0.18	0.73	0.38	0.32	11
	15	1.19	0.21	0.72	1.58	3.62	20	1.19	0.21	0.72	1.58	3.62	20
	16	-1.10	1.73	-0.05	8.59**	0.002	19	-1.76	2.20	-0.47	10.59**	0.20	17
	17	2.98	-0.22	-0.40	0.48	0.51	20	1.41	0.09	0.64	0.05	1.50	14
	18	2.27	0.24	0.29	0.47	0.04	11	2.27	0.24	0.29	0.47	0.04	11
	20	3.58	0.09	-0.67	0.12	1.82	19	1.98	0.52	-0.31	4.24	0.60	17
	21	2.97	-0.05	-0.21	0.04	0.12	20	2.48	0.16	-0.18	0.36	0.11	18
	22	2.05	0.30	-0.27	1.45	0.27	21	2.05	0.30	-0.27	1.45	0.27	21
Middle of June	1	3.68	-0.02	-1.31	0.01	12.01*	8	3.68	-0.02	-1.31	0.01	12.01*	8
	2	0.08	0.75	0.47	36.10**	1.86	14	0.40	0.77	0.15	23.48**	0.37	14
	3	1.56	0.17	-0.09	0.48	0.09	21	1.56	0.17	-0.09	0.48	0.09	21
	4	1.55	0.07	0.01	0.08	0.0003	21	1.55	0.07	0.01	0.08	0.0003	21
	5	1.42	0.05	-0.002	0.04	0.00002	20	1.73	-0.05	-0.03	0.03	0.005	18
	6	1.54	0.01	0.41	0.003	0.71	22	1.54	0.01	0.41	0.003	0.71	22
	7	-0.02	0.74	0.74	7.71*	6.53	7	-0.02	0.74	0.74	7.71*	6.53	7
	8	2.20	0.002	-0.37	0.0001	0.38	20	2.15	-0.05	0.14	0.04	0.18	20
	9	1.48	-0.19	0.11	0.54	0.09	21	0.93	0.25	0.26	0.95	0.98	16
	10	1.88	0.02	0.07	0.0005	0.0008	7	1.88	0.02	0.07	0.0005	0.0008	7
	11	1.41	0.39	-0.08	2.67	0.02	20	1.41	0.39	-0.08	2.67	0.02	20
	12	3.07	0.24	1.07	0.69	2.97	18	2.48	0.35	-0.69	1.35	2.11	17
	13	2.22	-0.13	-0.13	0.20	0.09	19	1.64	0.12	-0.07	0.23	0.05	19
	15	2.36	0.04	0.09	0.02	0.04	21	2.36	0.04	0.09	0.02	0.04	21
	16	1.07	0.25	0.30	1.13	0.48	22	1.07	0.25	0.30	1.13	0.48	22
	17	1.32	0.02	0.42	0.01	0.97	21	0.73	0.32	0.57	1.41	2.13	17
	18	3.42	-0.18	-1.14	0.14	0.16	7	3.42	-0.18	-1.14	0.14	0.16	7
	19	3.04	-0.04	-0.70	0.01	0.37	9	3.04	-0.04	-0.70	0.01	0.37	9
	20	0.90	0.29	0.39	1.73	0.30	23	1.19	0.31	0.13	1.83	0.03	21

Table 5. – (cont'd)

	Boat No.	a_0	a_1	a_2	F_1	F_2	n	a'_0	a'_1	a'_2	F'_1	F'_2	n'
		The records of the accidental shootings included and those of the long shifts excluded						The records of the accidental shootings excluded and those of the long shifts included					
	21	3.10	0.06	-0.33	0.05	0.94	19	0.90	0.56	0.49	4.83*	1.99	18
	22	5.79	-1.02	-1.78	3.58	4.93*	15	5.61	-0.98	-1.68	3.81	5.85*	16
Late in June	1	4.45	-0.13	-0.58	0.44	0.57	14	4.45	-0.13	-0.58	0.44	0.57	14
	2	1.37	0.20	1.53	0.26	0.68	12	1.37	0.20	1.53	0.26	0.68	12
	3	4.91	-0.19	-0.88	0.35	0.46	12	4.91	-0.19	-0.88	0.35	0.46	12
	4	2.32	0.06	0.49	0.03	0.68	12	2.32	0.06	0.49	0.03	0.68	12
	5	3.80	0.33	1.41	1.13	0.42	11	3.80	0.33	1.41	1.13	0.42	11
	6	4.46	0.14	-1.38	0.21	0.46	13	2.31	0.56	-0.70	1.62	0.10	11
	7	1.33	0.06	1.11	0.37	1.56	12	1.42	0.07	0.87	0.64	0.93	11
	8	2.28	0.26	0.001	0.85	0.000001	11	2.28	0.26	0.001	0.85	0.000001	11
	9	2.58	0.13	-0.35	0.24	0.10	16	2.58	0.13	-0.35	0.24	0.10	16
	10	-1.24	1.30	0.59	14.36**	0.24	12	-1.24	1.30	0.59	14.36**	0.24	12
	11	0.74	0.39	0.41	1.00	0.19	10	0.74	0.39	0.41	1.00	0.19	10
	12	2.53	0.31	0.44	0.75	0.12	17	0.73	0.56	0.97	1.93	0.56	16
	13	-2.28	0.57	2.59	3.31	5.34*	17	-2.28	0.57	2.59	3.31	5.34*	17
	14	0.66	-0.06	2.53	0.03	1.53	11	0.66	-0.06	2.53	0.03	1.53	11
	15	5.93	-0.08	-0.25	0.01	0.01	13	5.93	-0.08	-0.25	0.01	0.01	13
	16	0.46	0.91	0.39	1.04	0.01	7	0.33	1.07	0.07	0.72	0.0002	6
	17	5.70	0.20	-0.91	0.29	0.13	11	5.70	0.20	-0.91	0.29	0.13	11
	18	-1.17	-0.54	1.78	0.58	10.00	4	-1.17	-0.54	1.78	0.58	10.00	4
	19	7.70	-0.20	-1.85	0.42	2.81	14	7.71	-0.20	-1.85	0.42	2.81	14
	20	2.40	0.22	0.15	0.41	0.01	11	2.40	0.22	0.15	0.41	0.01	11
	21	5.59	0.91	-3.17	3.09	3.32	10	6.27	1.05	-3.53	3.94	6.38	8
	22	3.47	0.002	-0.32	0.00004	0.11	13	3.47	0.03	-0.36	0.01	0.13	12
Early in July	1	1.81	-0.06	1.67	0.01	0.98	9	1.81	-0.06	1.67	0.01	0.98	9
	2	3.80	-0.20	0.57	0.45	0.21	18	6.90	-0.38	-0.77	1.66	0.43	14
	3	1.18	-0.06	1.35	0.03	0.44	11	1.18	-0.06	1.35	0.03	0.44	11
	4	4.10	-0.54	1.05	5.60*	0.71	10	5.97	-0.89	0.58	9.67*	0.26	9
	5	-1.82	0.52	2.66	0.85	1.15	8	-1.82	0.52	2.66	0.85	1.15	8
	6	3.73	-0.37	-0.37	1.50	0.51	16	1.59	-0.04	0.69	0.01	1.11	14
	7	1.97	0.13	1.33	0.32	2.18	19	1.97	0.13	1.33	0.32	2.18	19
	8	2.12	0.13	-0.09	0.19	0.04	17	2.12	0.13	-0.09	0.19	0.04	17
	9	-0.56	0.03	2.70	0.01	2.79	15	-0.56	0.03	2.70	0.01	2.79	15
	10	0.45	0.45	1.02	0.87	0.75	14	0.45	0.45	1.02	0.87	0.75	14
	11	-0.29	0.39	1.53	1.03	3.46	15	-0.29	0.39	1.53	1.03	3.46	15
	12	2.24	0.04	0.56	0.03	0.79	15	2.24	0.04	0.56	0.03	0.79	15
	13	2.90	-0.30	1.35	0.77	0.99	15	2.90	-0.30	1.35	0.77	0.99	15
	14	2.99	0.10	0.06	0.10	0.003	17	1.27	0.53	0.46	2.13	0.16	15
	15	3.10	-0.12	0.57	0.13	0.26	16	3.92	-0.28	0.22	0.70	0.04	15
	16	2.44	-0.15	0.82	0.59	2.85	9	2.44	-0.15	0.82	0.59	2.85	9
	17	3.52	0.05	-0.21	0.04	0.06	16	3.52	0.05	-0.21	0.04	0.06	16
	18	2.01	-0.19	2.11	0.37	6.04*	13	2.01	-0.19	2.11	0.37	6.04*	13
	19	3.84	-0.55	1.43	2.90	2.84	8	2.93	-0.12	0.99	0.11	1.46	6
	20	1.39	0.34	0.25	1.48	0.20	10	1.39	0.34	0.25	1.48	0.20	10
	21	2.86	0.08	-0.04	0.05	0.003	12	2.86	0.08	-0.04	0.05	0.003	12
	22	6.77	-0.09	-1.93	0.07	1.71	10	6.77	-0.09	-1.93	0.07	1.71	10
Middle of July	1	-0.17	0.11	2.09	0.08	1.48	10	2.19	0.45	-0.34	0.82	0.10	9
	2	-0.09	0.55	1.68	4.49	6.43*	11	0.21	0.48	1.79	3.78	7.64*	12
	3	-1.29	0.83	1.28	17.43**	0.90	11	-0.97	0.85	0.91	19.88**	0.62	12
	4	-1.81	1.13	2.07	11.84*	2.68	10	-3.03	1.15	2.10	14.29**	3.10	11
	5	–	–	–	–	–		-2.47	1.87	-2.87	12.10	1.06	4
	6	5.59	-0.29	0.26	0.59	0.03	10	5.58	-0.28	0.27	0.63	0.04	11
	7	8.07	-0.24	-1.30	0.36	0.63	10	2.71	0.09	1.72	0.03	0.53	9
	8	1.12	0.72	0.36	2.13	0.20	10	0.78	0.83	0.25	4.11	0.16	12
	9	2.85	0.15	0.53	0.19	0.33	15	1.84	0.45	0.39	2.08	0.19	14
	10	-2.38	0.61	3.76	7.53*	8.02*	9	0.91	0.66	0.29	5.06	0.11	12
	11	-1.43	0.70	3.08	12.28**	20.22**	10	-0.56	0.85	1.58	7.51*	3.36	11

Table 5. – (cont'd)

	Boat No.	a_0	a_1	a_2	F_1	F_2	n	a'_0	a'_1	a'_2	F'_1	F'_2	n'
		The records of the accidental shootings included and those of the long shifts excluded						The records of the accidental shootings excluded and those of the long shifts included					
	12	0.79	0.79	0.14	4.19	0.01	13	0.57	0.82	0.17	5.32*	0.01	14
	13	-3.07	0.54	2.81	1.80	3.32	9	-3.07	0.54	2.81	1.80	3.32	9
	14	-1.23	0.15	1.89	3.53	3.49	10	0.46	0.42	0.88	1.87	0.84	11
	15	5.73	0.42	-1.09	2.46	0.54	11	3.93	0.46	-0.25	1.39	0.02	11
	16	0.37	0.16	2.43	0.51	6.46*	13	2.96	0.06	0.79	0.05	1.29	14
	17	2.24	0.35	0.21	2.13	0.03	15	1.05	0.39	0.85	2.63	0.53	16
	18	14.78	-0.75	-1.51	0.08	0.04	4	14.78	-0.75	-1.51	0.08	0.04	4
	19	2.06	-0.04	1.89	0.02	0.45	6	2.06	-0.04	1.89	0.02	1.45	6
	20	2.47	0.26	0.77	1.22	0.80	11	0.28	0.63	1.04	3.54	1.50	11
	21	-1.69	0.68	2.72	11.03*	2.88	11	0.26	0.46	2.50	2.41	2.65	9
	22	0.79	0.55	1.08	1.21	0.12	9	-0.24	0.87	0.64	9.71*	0.62	9
Late in July	1	4.06	0.18	0.48	0.33	0.11	14	4.06	0.18	0.48	0.33	0.11	14
	2	1.95	0.48	1.42	3.40	1.04	14	1.95	0.48	1.42	3.40	1.04	14
	3	2.65	0.34	0.50	1.68	0.16	15	2.65	0.34	0.50	1.68	0.16	15
	4	-3.75	1.09	2.67	13.79**	2.31	13	-1.64	0.99	1.59	8.02*	2.10	12
	5	–	–	–	–	–		0.21	0.62	0.52	1.15	0.22	4
	6	0.11	0.84	0.40	9.02*	0.17	14	0.11	0.84	0.40	9.02*	0.17	14
	7	2.34	-0.09	4.42	0.10	3.27	11	5.30	-0.11	2.03	0.16	2.35	12
	8	5.10	0.50	-1.29	4.46	0.38	13	5.10	0.50	-1.29	4.46	0.38	13
	9	2.42	0.54	-0.45	3.79	0.07	15	2.42	0.54	-0.45	3.79	0.07	15
	10	9.78	-0.60	-0.62	1.48	0.09	13	7.23	-0.33	0.49	1.19	0.14	14
	11	3.39	0.08	0.51	0.05	0.14	12	3.39	0.08	0.51	0.05	0.14	12
	12	1.77	0.41	1.51	1.16	1.23	10	2.00	0.39	1.46	0.28	0.50	9
	13	1.43	0.26	1.25	0.54	1.59	14	4.20	-0.01	0.31	0.001	0.09	13
	14	-2.18	0.95	2.48	19.79**	4.39	10	2.07	0.63	0.08	15.43**	0.03	12
	15	1.56	0.34	2.20	0.74	0.85	13	3.26	0.22	1.84	0.18	0.52	12
	16	0.54	-0.28	2.85	1.24	11.15**	14	-0.98	0.17	2.88	0.25	10.38*	11
	17	9.08	-0.47	-1.41	3.51	0.71	13	-1.87	0.66	2.82	9.00*	7.61*	10
	18	3.95	0.18	1.49	0.44	0.18	7	3.95	0.18	1.49	0.44	0.18	7
	19	-1.54	0.72	2.45	1.75	1.05	6	-1.54	0.72	2.45	1.75	1.05	6
	20	2.08	0.28	2.16	0.66	0.97	11	2.08	0.20	3.17	0.43	5.16	9
	21	6.48	-0.15	-1.27	0.20	1.66	11	6.07	-0.13	-0.95	0.14	1.11	12
	22	2.38	0.65	0.03	7.59*	0.001	14	2.38	0.65	0.03	7.59*	0.001	14
Early in August	1	2.29	-0.07	1.68	0.03	1.10	13	-3.32	0.82	3.07	2.41	5.66*	11
	2	10.95	-1.46	1.77	4.23	1.18	9	4.76	0.16	0.07	0.12	0.01	9
	3	2.96	0.17	0.28	0.17	0.11	8	2.96	0.17	0.28	0.17	0.11	8
	4	3.01	0.16	0.14	0.31	0.03	12	3.01	0.16	0.14	0.31	0.03	12
	6	-0.88	0.37	2.25	2.47	4.79	13	0.86	0.47	0.69	3.68	0.81	15
	7	2.29	0.20	1.32	0.73	2.90	13	2.83	0.15	1.04	0.24	1.88	13
	8	5.41	-0.04	0.62	0.02	0.44	12	5.41	-0.04	0.62	0.02	0.44	12
	9	5.48	0.10	-1.56	0.15	3.50	11	1.84	0.43	0.21	1.58	0.06	10
	10	5.88	-0.001	-0.38	0.000003	0.09	14	5.88	-0.001	-0.38	0.000003	0.09	14
	11	7.06	-0.11	-0.29	0.08	0.05	11	7.44	-0.07	-0.86	0.03	0.50	12
	12	11.69	-0.84	-1.38	3.49	1.38	11	11.69	-0.84	-1.38	3.49	1.38	11
	13	4.17	0.22	-0.82	0.55	1.56	11	4.37	-0.10	-0.12	0.09	0.03	12
	14	-2.17	0.61	2.59	14.29**	17.11**	13	-2.44	0.56	3.05	9.70**	21.09**	14
	15	6.52	0.01	-0.63	0.003	0.26	9	7.42	-0.07	-1.07	0.04	3.02	10
	16	1.03	0.47	1.01	2.75	2.07	12	1.19	0.52	0.73	4.05	2.06	13
	17	3.00	-0.09	1.00	0.10	0.59	14	3.28	0.43	-0.62	5.38	1.09	10
	18	5.58	-0.03	-0.47	0.02	0.44	12	5.58	-0.03	-0.47	0.02	0.44	12
	19	1.73	0.24	1.26	0.55	0.99	14	1.73	0.24	1.26	0.55	0.99	14
	20	2.00	0.56	-0.001	4.25	0.000002	13	2.10	0.47	0.29	2.14	0.13	12
	21	1.97	0.69	-0.32	0.87	0.20	11	4.44	0.11	-0.08	0.08	0.01	12
	22	9.07	-0.22	-2.80	0.35	2.83	12	9.07	-0.22	-2.80	0.35	2.83	12
	1	2.05	-0.05	0.44	0.04	0.65	18	1.09	0.21	0.64	0.43	1.27	15

Table 5. – (cont'd)

		The records of the accidental shootings included and those of the long shifts excluded						The records of the accidental shootings excluded and those of the long shifts included					
	Boat No.	a_0	a_1	a_2	F_1	F_2	n	a_0'	a_1'	a_2'	F_1'	F_2'	n'
Middle of August	2	0.26	0.78	0.63	14.60**	0.76	17	0.26	0.78	0.63	14.60**	0.76	17
	3	2.24	-0.23	0.87	0.67	1.86	11	2.24	-0.23	0.87	0.67	1.86	11
	4	0.94	0.64	0.05	5.61*	0.003	17	-1.39	0.90	1.30	10.03**	1.47	15
	6	2.00	0.05	0.06	0.02	0.01	16	2.34	0.02	-0.06	0.004	0.01	14
	7	-1.02	0.23	2.77	1.10	33.55**	17	-1.02	0.23	2.77	1.10	33.55**	17
	8	5.11	-0.32	-1.10	1.20	4.05	13	5.11	-0.32	-1.10	1.20	4.05	13
	9	0.12	0.12	1.44	0.16	2.79	17	-0.96	0.64	1.55	4.02	4.59	16
	10	-0.88	0.80	1.28	4.56	0.84	17	-0.88	0.80	1.28	4.56	0.84	17
	11	2.70	-0.20	0.58	0.54	0.49	18	2.70	-0.20	0.58	0.54	0.49	18
	12	1.85	0.02	0.15	0.004	0.27	15	1.85	0.02	0.15	0.004	0.27	15
	13	2.65	0.44	-0.52	0.64	0.40	15	2.65	0.44	-0.52	0.64	0.40	15
	14	6.86	-0.99	-0.96	2.72	0.58	18	2.42	0.09	0.05	0.06	0.005	16
	15	3.83	0.10	-0.29	0.06	0.04	15	3.25	0.09	0.32	0.03	0.04	12
	16	3.56	0.31	-0.60	1.40	0.48	15	4.17	0.30	-0.80	1.10	0.73	13
	17	3.48	0.34	-0.63	0.98	0.34	17	3.48	0.34	-0.63	0.98	0.34	17
	20	2.48	-0.09	0.59	0.16	1.75	18	2.04	-0.02	0.84	0.01	3.03	16
	21	2.65	0.02	0.11	0.004	0.03	14	2.46	0.07	0.18	0.02	0.04	12
	22	2.16	0.19	-0.04	0.32	0.004	18	2.28	0.05	0.34	0.02	0.53	15
Late in August	1	5.80	-0.47	-0.45	4.36	0.14	20	2.68	-0.06	1.03	0.04	0.63	19
	2	2.07	0.32	-0.01	1.12	0.001	15	2.18	0.34	-0.05	1.26	0.03	16
	3	4.86	0.05	-1.85	0.04	6.16*	16	2.19	0.42	-0.42	1.23	0.09	14
	4	4.43	-0.56	-0.43	1.76	0.30	13	3.91	-0.48	0.04	1.01	0.004	12
	5	5.16	-0.28	0.79	0.20	0.03	6	5.16	-0.28	0.79	0.20	0.03	6
	6	1.04	-0.54	2.08	2.65	4.80*	15	3.29	-0.49	0.75	0.88	0.79	12
	7	2.95	0.13	-0.42	0.29	0.23	17	3.08	0.17	-0.64	0.63	0.92	18
	8	3.98	-0.003	-0.85	0.0002	1.37	16	2.89	0.19	-0.12	0.48	0.06	15
	9	0.58	0.20	1.26	0.67	1.01	15	1.87	0.46	-0.32	5.41	0.15	10
	10	1.94	0.17	0.94	0.08	0.54	15	3.25	0.005	0.36	0.0001	0.23	16
	11	1.22	0.54	0.22	2.28	0.09	15	1.29	0.55	0.12	2.80	0.04	17
	12	1.45	0.45	0.35	2.58	0.32	16	1.45	0.45	0.35	2.58	0.32	16
	13	4.59	-0.41	-0.34	1.91	0.18	18	1.20	0.17	0.86	0.23	0.94	16
	14	0.67	0.71	0.70	3.07	0.38	16	0.37	0.74	0.92	3.73	1.21	17
	15	-0.46	0.72	1.22	5.52*	2.46	17	-0.19	0.72	0.98	5.84*	4.52	18
	16	2.60	0.36	-0.57	1.72	1.64	15	2.60	0.36	-0.57	1.72	1.64	15
	17	1.20	0.35	0.50	1.42	0.32	18	2.55	0.28	-0.01	0.93	0.001	14
	18	12.29	-0.96	-3.31	5.80	0.68	6	10.19	-0.73	-1.54	0.31	0.02	4
	19	1.06	0.27	0.73	0.18	0.18	8	2.33	0.15	-0.05	0.11	0.01	10
	20	2.14	0.36	0.41	1.56	0.14	18	2.95	0.31	-0.18	1.28	0.06	19
	21	1.03	0.66	0.07	7.65*	0.01	13	0.41	0.52	1.19	4.33	5.08*	14
	22	3.24	0.10	-0.08	0.23	0.03	19	3.24	0.10	-0.08	0.23	0.03	19
Early in September	1	2.19	-0.001	0.74	0.000002	0.17	9	2.19	-0.001	0.74	0.000002	0.17	9
	2	4.42	0.16	-2.05	0.22	4.32	9	3.73	-0.12	-0.21	0.23	0.43	8
	3	1.62	0.19	1.08	0.34	3.92	9	1.62	0.19	1.08	0.34	3.92	9
	4	2.15	0.13	0.04	0.09	0.001	10	4.71	-0.44	-0.61	1.52	0.80	8
	6	-0.96	0.68	1.07	3.29	0.83	9	-0.96	0.68	1.07	3.29	0.83	9
	7	1.91	0.69	-0.56	2.90	0.54	8	1.91	0.69	-0.56	2.90	0.54	8
	8	0.44	0.34	1.49	1.28	3.03	6	0.44	0.34	1.49	1.28	3.30	6
	9	1.56	0.39	-0.09	0.41	0.01	8	-2.17	2.21	-0.23	5.12	0.21	6
	10	1.76	0.57	-0.48	2.78	0.59	10	1.76	0.57	-0.48	2.78	0.59	10
	11	1.60	-0.14	0.67	0.13	0.57	10	1.60	-0.14	0.67	0.13	0.57	10
	12	1.94	0.09	0.26	0.07	0.19	9	1.94	0.09	0.26	0.07	0.19	9
	13	2.63	0.06	0.25	0.13	0.51	9	2.63	0.06	0.25	0.13	0.51	9
	14	2.68	0.02	-0.74	0.01	1.75	6	2.68	0.02	-0.74	0.01	1.75	6
	15	0.41	0.46	0.82	0.98	0.28	9	0.74	0.73	-0.02	1.01	0.0001	7
	16	-1.56	0.91	0.93	1.61	0.78	6	-1.50	0.78	1.18	1.93	2.59	7
	17	3.49	0.26	-1.30	0.19	0.83	8	0.24	0.67	0.76	3.38	0.10	5

Table 5. – (cont'd)

	Boat No.	a_0	a_1	a_2	F_1	F_2	n	a'_0	a'_1	a'_2	F'_1	F'_2	n'
		The records of the accidental shootings included and those of the long shifts excluded						The records of the accidental shootings excluded and those of the long shfits included					
	20	-0.18	0.19	1.53	0.29	4.25	10	-0.18	0.19	1.53	0.29	4.25	10
	21	-1.43	1.18	0.98	8.45*	2.31	8	-1.43	1.18	0.98	8.45*	2.31	8
	22	3.52	-0.63	0.30	0.93	0.10	9	3.52	-0.63	0.30	0.93	0.10	9
Middle of September	1	7.63	-0.32	-1.98	0.76	2.92	9	8.37	-0.55	-1.50	2.75	3.32	5
	2	1.14	0.41	0.91	1.03	0.48	14	7.16	-0.06	-0.90	0.02	0.55	10
	3	2.94	0.30	0.56	0.51	0.16	10	2.94	0.28	0.68	0.60	0.54	11
	4	6.80	-0.33	-1.16	1.25	0.55	12	6.30	-0.18	-0.57	0.29	0.35	8
	5	4.33	-0.05	-0.23	0.02	0.02	13	1.45	0.41	0.67	1.23	0.14	11
	6	7.00	-0.35	-1.97	1.14	1.47	11	5.06	-0.20	-0.58	0.25	0.05	10
	7	4.85	-0.16	0.75	0.26	0.31	13	3.88	0.12	0.65	0.10	0.26	11
	8	3.08	0.23	-0.28	0.52	0.02	14	4.52	0.35	-1.12	1.56	1.12	12
	9	5.09	-0.24	-0.21	0.26	0.04	8	5.09	-0.24	-0.21	0.26	0.04	8
	10	5.38	0.26	-0.81	0.11	0.05	11	5.38	0.26	-0.81	0.11	0.05	11
	11	3.23	-0.63	2.43	3.49	5.00	12	2.03	-0.03	1.97	0.001	1.58	6
	12	4.47	0.01	-0.41	0.001	0.03	10	4.51	0.09	-0.42	0.03	0.03	8
	13	8.50	-0.11	-2.03	0.18	1.67	15	8.26	-0.34	-0.003	1.08	0.000003	11
	14	-2.48	0.80	3.91	1.15	1.32	11	-2.48	0.80	3.91	1.15	1.32	11
	15	2.11	0.77	1.01	1.11	0.14	11	2.00	0.80	0.92	0.88	0.09	10
	16	5.99	0.12	-1.03	0.14	0.12	15	5.99	0.12	-1.03	0.14	0.12	15
	17	3.95	0.03	0.92	0.01	0.04	12	18.20	-0.48	-8.32	2.15	3.70	10
	18	3.96	0.30	1.18	1.26	0.38	15	3.51	0.35	1.21	0.94	0.36	14
	19	5.02	-0.43	1.85	1.50	0.83	14	6.62	-0.37	0.32	0.64	0.04	12
	20	1.97	-0.02	2.07	0.01	5.64*	10	3.68	-0.04	1.19	0.04	2.67	9
	21	10.59	-0.20	-3.65	0.30	2.29	9	10.18	-0.55	-0.38	1.05	0.02	8
	22	-2.26	0.80	2.93	2.39	1.58	11	-2.26	0.80	2.93	2.39	1.58	11

Accordingly, the records on the three consecutive days were pooled, and the multiple linear regression of the amount of catch after the shift on that before the shift and on the distance of shift was examined. As shown in Tables 5 to 7, the coefficient a_1 was significantly positive in the 27 strata of the records while it was significantly negative in the two strata. The significantly positive coefficients a_1 were distributed in the two thirds of the seiners and throughout the seasons. About the two thirds of the coefficients a_1 were positive (including the insignificant ones). The rate of the strata taking the positive a_1 varied according to the seiner from 5/15 by the Seiner 1 to 9/11 by the Seiners 9 and 14, but it was hard to say that the rate differed according to the seiner (χ_0^2=22.36 with 21 degrees of freedom; $0.50 > \Pr\{\chi^2 > \chi_0^2\} > 0.25$; some of the frequencies in the 2 x 22 table were smaller than 5; this fact prevented us from estimating the χ^2 value exactly). And it was hard to say that the rate of the strata taking the positive a_1 differed according to the season [The Snedecor's F value of the i-th order regression coefficient in the i-th order regression equation of the rate (after the arc sin transformation) on the season (number of the 10-calendar-day strata counted from the late in April) were as follows: F_3 = 0.00, F_2 = 0.77, and F_1 = 0.03, n = 15].

Table 6. The seiner-by-seiner difference of the coefficients of the multiple linear regression equations.

1) The records of the accidental shootings included and those of the long shifts excluded

		Seiner No.																					Sum
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
a_1	+	1	3	1	3	1	1	1	0	0	3	1	0	1	2	2	2	0	0	0	0	4	1	27
	(+)	4	8	8	7	6	7	10	11	9	8	8	12	8	7	9	9	10	5	5	11	6	10	178
	(-)	10	3	6	3	2	5	4	3	2	4	6	3	5	2	4	4	4	6	7	4	5	4	96
	-	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Sum		15	14	15	14	9	14	15	14	11	15	15	15	14	11	15	15	14	11	12	15	15	15	303
a_2	+	0	1	0	0	0	2	1	0	0	1	1	0	1	1	1	2	0	1	1	1	1	0	15
	(+)	9	8	11	10	4	8	7	5	6	7	9	12	6	7	9	9	7	5	8	9	6	8	170
	(-)	4	4	3	4	5	4	7	9	5	7	5	3	7	3	5	4	7	5	3	5	8	6	113
	-	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5
Sum		15	14	15	14	9	14	15	14	11	15	15	15	14	11	15	15	14	11	12	15	15	15	303

2) The records of the long shifts included and those of the accidental shootings excluded

		Seiner No.																					Sum
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
a_1'	+	0	3	1	3	1	1	1	1	0	3	2	1	2	2	2	1	1	0	0	0	3	3	31
	(+)	7	7	8	6	8	7	13	10	10	9	8	12	6	7	8	13	11	5	5	11	8	7	186
	(-)	8	4	6	4	2	6	1	3	1	3	5	2	6	1	5	1	2	6	7	4	4	5	86
	-	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Sum		15	14	15	14	11	14	15	14	11	15	15	15	14	10	15	15	14	11	12	15	15	15	304
a_2'	+	1	1	0	0	0	1	1	0	0	0	0	0	1	1	1	1	1	1	1	0	2	1	14
	(+)	9	6	11	11	6	9	9	5	6	10	11	11	8	7	9	9	6	5	7	11	6	8	180
	(-)	3	7	4	3	5	4	5	9	5	5	4	4	5	2	5	5	7	5	4	4	7	5	107
	-	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3
Sum		15	14	15	14	11	14	15	14	11	15	15	15	14	10	15	15	14	11	12	15	15	15	304

Note: The numerals in respective columns show the number of the groups of records stratified according to the seiner and the season (the 10-calendar-day intervals).

$y = a_0 + a_1x_1 + a_2x_2$

x_1 .... The amount of catch by the shooting before the shift (in tons)

x_2 .... The distance of shift (in miles)

y .... The amount of catch by the shooting after the shift (in tons)

\+ .... Significantly positive at 0.05 level

(+) .... Insignificantly positive

(-) .... Insignificantly negative

\- .... Significantly negative

Table 7. The seasonal change of the coefficients of the multiple linear regression equations.
1) The records of the accidental shootings included and those of the long shifts excluded

		April	May			June			July			Aug.			Sept.		Sum
		l	e	m	l	e	m	l	e	m	l	e	m	l	e	m	
a_1	+	1	0	3	3	2	2	1	0	5	4	1	2	2	1	0	27
	(+)	12	7	14	9	12	13	15	11	12	12	11	11	13	15	11	178
	(-)	8	6	4	6	5	6	6	10	4	5	9	6	7	3	11	96
	-	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	2
Sum		21	13	21	19	19	21	22	22	21	21	21	19	22	19	22	303
a_2	+	2	1	1	0	0	0	1	1	4	1	1	1	1	0	1	15
	(+)	10	10	13	9	5	11	12	16	14	15	10	11	11	13	10	170
	(-)	9	2	7	10	12	8	9	5	3	5	10	7	9	6	11	113
	-	0	0	0	0	2	2	0	0	0	0	0	0	1	0	0	5
Sum		21	13	21	19	19	21	22	22	21	21	21	19	22	19	22	303

2) The records of the long shifts included and those of the accidental shootings excluded

		April	May			June			July			Aug.			Sept.		Sum
		l	e	m	l	e	m	l	e	m	l	e	m	l	e	m	
a'_1	+	1	0	2	6	3	3	1	0	5	5	1	2	1	1	0	31
	(+)	12	8	15	8	13	12	15	11	14	13	12	13	16	13	11	186
	(-)	7	5	4	5	3	6	6	10	3	4	8	4	5	5	11	86
	-	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Sum		20	13	21	19	19	21	22	22	22	22	21	19	22	19	22	304
a'_2	+	2	1	1	1	0	0	1	1	1	2	2	1	1	0	0	14
	(+)	11	8	13	12	8	11	12	16	17	17	10	13	10	12	10	180
	(-)	7	4	7	6	10	8	9	5	4	3	9	5	11	7	12	107
	-	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	3
Sum		20	13	21	19	19	21	22	22	22	22	21	19	22	19	22	304

In regard to the influence of the distance of shift, the one fifteenth of the coefficients a_2 was significantly positive and the one 45-th was significantly negative; the formers were scattering over the 13 seiners and the latters were the four seiners. The coefficient a_2 was positive (either significantly or insignificantly) in about 60% of the strata. The rate of the strata taking the positive a_2 varied according to the seiner from 5/14 by the Seiner 8 to 12/15 by the Seiner 12, but it was hard to say that the rate differed according to the boat ($\chi_0^2 = 16.80$ with 21 degrees of freedom; $0.75 > \Pr\{\chi^2 > \chi_0^2\} > 0.50$). The strata taking the significantly negative one were scattering over throughout the season.

The rate of the strata taking the positive a_2 (including the insignificant one) showed a significant seasonal difference (χ_0^2= 27.77 with 14 degrees of freedom; 0.025 > Pr $\{\chi^2>\chi_0^2\}$ >0.010), but it was hard to find any significant change in accordance with the passing of the season (F_3 = 2.15, F_2 = 0.07, and F_1 = 0.00; n = 15).

5. The multiple linear regression after the stratification of the records according to the seiner (The records of the long shifts included and those of the accidental shootings excluded)

The exclusion of the records of the long shift and the addition of those of the accidental shootings caused the following changes: the obscure trend of yielding a good catch by the shooting after a good catch became clearer: the strata taking the significantly positive a_1 increased from 27 to 31 and the insignificant one from 178 to 186. The difference of the rate of the strata taking the positive a_1 according to the boat became significant (χ_0^2 = 33.35 with 21 degrees of freedom; 0.050 > Pr $\{\chi^2>\chi_0^2\}$ >0.025). The rates by the Seiners 7 and 16 (14/15) were significantly higher and those by the Seiner 19 (5/12) and the Seiner 1 (7/15) were significantly lower than those of the other seiners; namely, this trend was less clear in the seiners with the powerful engine than in those with the less powerful one[3]. However, the rate did not show any clear seasonal change (F_3 = 0.12, F_2 = 1.86, and F_1 = 0.08; n = 15). In regard to the influence of the distance of shift, the strata taking the positive a_2 increased from 185 to 194, although those taking the significant one showed a slight change (positive.....from 15 to 14, negative .... from 5 to 3). It was hard to find any significant seiner-by-seiner difference in the rate of the strata taking the positive a_2 (χ_0^2= 14.21 with 21 degrees of freedom; 0.90 > Pr $\{\chi^2>\chi_0^2\}$ > 0.75). And the rate did not show any clear seasonal change (F_3 = 4.00 F_2 = 1.29, and F_1 = 0.14; n = 15).

The results of these four sections revealed the following facts: a very rough trend of yielding a better catch by the shooting after a good catch than by that after a poor catch was found within the records by the same seiners. Accordingly, the same trend found before the stratification was not due to the seiner-by-seiner difference of the fishing capacity. A very rough trend of yielding a better catch after a long shift than after a short one was found within the records by the same seiners. And the same trend found before the stratification was not due to the different preference of the shift according to the seiner, but was the trend observable in the work of the same seiners. The former trend was less clear in the seiners with the powerful engine than in those with the less powerful one; however, it was hard to find the seiner-by-seiner difference of the latter trend, in spite of the fact that the problem treated here may differ according to the different skill and choice according to the skipper.

Discussion

Regardless of the fishing method, it is very rare that the boat repeats shooting the gear exactly at the same position during the consecutive work, but the location of shooting the gear more or less differs haul by haul; and the catch also fluctuates haul by haul. One of the principal aims of the present examinations is to clarify an outline of the relation of the fluctuation of catch through examining the multiple linear regression of the amount of catch after the shift on the amount before the shift and on the distance of shift. And the results showed, in regard to the relation to the catch before the shift, that the amount of catch by a shooting after a good catch inclined to be better than that by the shooting after a poor catch, when the catches after the shifts of the same distance were compared with one another. And, in regard to the relation to the distance of shift, it was found out that the catch after a long shift inclined to be better than that after a short one, when the catches by the shootings after those yielding the same amount of catch were compared with one another. These results may be due to the following reasons: the amount of catch depends mainly on the two groups of factors. One is the population size of the detected schools. The other is the fact that the skipper interprets exactly the distribution and the behavior of the objective fish, the current drift, and the local topography around the position of shooting the gear and that he shoots and handles the gear effectively to catch the fish. The boat may yield a good catch when she scouts successfully a dense school and attacks it along a suitable pattern; but the poor catch may be due to the fact that the pattern of scouting and gear-handling is not suitable for the conditions. And it is hard to consider that the pattern of interpretation of the conditions and that of the gear-handling differ easily according to the conditions, but it is probable that they are rigid. It is also hard to consider that the conditions including the difficulty of finding out a dense school change abruptly. Accordingly, it is natural that the boat inclined to yield a good catch after a good catch while she inclined to yield a poor catch after a poor catch, namely, the coefficient a_1 is positive. As shown in the haul-by-haul fluctuation of catch, the catch is unstable, and this fact may hardly make the coefficients a_1 take any significant value. The distance of shift depends on the evaluation of the catch by the preceding hauls in relation to those by the fellow seiners and their spatial distribution. And the seiner shifts when the skipper decides that the probable increase of catch after the shift brings the seiner better catch filling up the loss of working time during the shift and scouting in the new ground. Accordingly, it is natural that the long shift is done when a remarkable rise of catch is expected and she shifts only a short distance when a remarkable rise is hardly expected. This may make the coefficient a_2 positive; however, it is also natural that the unstableness of the catch makes the coefficient a_2 insignificant.

In regard to the seiner-by-seiner difference, it was hard to find any clear result, except that the obscure trend of yielding a good catch after a good catch was less clear in the powerful seiner than in the less powerful one, in spite of high possibility of the results differing according to the temperament of the skipper. The obscuring trend of the correlation between the catch by the succeeding shootings in accordance with the increase of power may be due to the following reason: the powerful seiner was commanded by a more experienced skipper; and he may be able to adjust the working pattern according to the conditions. While the less powerful seiner was commanded by a less experienced skipper, and he may work along more rigid pattern. Accordingly, when his pattern fit to the conditions, he may yield a good catch; while when his pattern did not fit to the conditions, he ended in yielding a poor catch. And it is probable that the result represents the different catch pattern indebted to the skill of the skipper. The difficulty in finding out clear results in regard to the other points in the seiner-by-seiner difference may partly be due to the same reason of making either a_1 or a_2 insignificant. However, it is hard to consider that this is sufficient to explain the results. And the seiner-by-seiner difference should be examined in detail in the succeeding reports.

The above-mentioned discussion aroused the necessity of examining the following possibilities:

1. Among the three factors chosen, the two factors including one of the dependent variables were the amount of catch, in spite of the fact that the catch was not stable. And it is probable that the influence of the unstableness of catch is lessened and somewhat clear results may be obtained, when the catch-shift-catch relation is examined by sectioning it into the relations between the catch and the shift and between the shift and catch.
2. It is probable that the seiner may stick to the position of the preceding shooting, when she yields a good catch. Then, it is probable that the catch after a very short shift is good; in the other words, the catch after the shift shows a quadratic relation to the distance of shift.

For the purpose of sweeping out the doubts in the above-mentioned points, accordingly, the relation observable in the sequence of the catch-shift-catch-shift is sectioned into the relation between the catch and the shift and that between the shift and catch; and the quadratic and linear regressions of the latter on the former, either before or after the stratification of the records according to the seiner, will be examined in the succeeding reports.

Summary

In most of the mobil gears, it is very rare that the boat repeats shootings exactly at the same position during the consecutive work. For the purpose of finding out the mechanism and the effect of the shift, accordingly, the outline of the catch-shift-catch relation during the consecutive work was examined through the multiple linear regression of the amount of catch after the shift on the amount before the shift and on the distance of shift observable in the records of the fleet operation of the Danish seiners for Alaska pollack during the entire season of 1964 along the outer edge of the continental shelf of the Eastern Bering Sea after the stratification of the records according to the day and either before or after the stratification of the records according to the seiner. And the following rough trends were found out:

1. The catch by a shooting after a good catch inclined to be better than that by a shooting after a poor catch, when the catches after the shift of the same distance were compared with one another. This trend was less clear in the powerful seiner than in the less

powerful one.

2. The catch by a shooting after a long shift inclined to be better than that after a short one, when the catches by the shootings after those yielding the same amount of catch were compared with one another.

3. These trends were not due to the seiner-by-seiner difference in the fishing capacity and the work pattern, because the similar results were observable after the stratification of the records according to the seiner.

References

1) MAÉDA, H. and S. MINAMI, 1969: *Bull. Jap. Soc. Sci. Fish.*,35, 964-969.
2) MAÉDA, H. and S. MINAMI, 1969: *ibid.*,35,971-974.
3) MAÉDA, H. and S. MINAMI, 1967: *ibid.*, 33, 176-180.