Working Time of Danish Seiners during Alaska Pollack Fishery − X*

A Collective Consideration on the Hauling-brailing Time

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The time required for completing a haul by the Danish seiner consists of the laying time, the sinking-pulling time, and the hauling-brailing time. An extremely small variation of the time expended on the laying work made it hard to find a relation between the time for this step of work and any of the conditions. A collective consideration on the difference of the time expended on the sinking-pulling work under the different conditions was given in the preceding report[8]. The time required for the hauling-brailing work, occupying 57% of the time for completing a haul, showed a large variation. And the difference of the time required for completing a haul according to the conditions was chiefly due to the time for this step of work. The importance of the examination on the working time should, therefore, be given on that of the time for this step of work.

The preceding reports of this series[1)-9)] dealt with the influences of the following four factors: The amount of catch[2),4),6),9)], the depth fished[3),4)], the power of the main engine of the boats[7),9)], and the grade of wind wave during the work[5),6)]. And the following trends were found out: The amount of catch (x in tons) was the most influential factor on the time for this step of work (t_h in min.) among the factors examined. And the time for this step of work increased in accordance with the amount of catch, keeping the following relation[2)]:

$$t_h = 47.73 + 3.16\,x.$$

When the bathymetric difference of the amount of catch was not taken into consideration, the time for this step of work decreased in accordance with the depth at a rate of 3.6 min. per 100m in the range of the depth from 40m to 150m[3)]. But the influence of the depth differed in accordance with the amount of catch[4)]: When the catch was in the range from 1 to 5 tons a haul, the time for this step of work did not show any significant difference in accordance with the depth. When a catch of 6 to 8 tons was yielded by a haul, in contrast with this, the time decreased in accordance with the depth increase.

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During the latter half of this step of work, the boat receives the wind usually from her port for the purpose of preventing her from being drifted over the net. But the influence of the wind wave on the time for this step of work was far smaller than that of the amount of catch, slightly modifying the time-catch relation. And the wind wave in the range of the grades 1 to 5 did not cause any significant difference in the time for this step of work, but that over the grade 6 retarded the work[5]. The increase of the time for this step of work due to the increase in the amount of catch differed in accordance with the grade of wind wave, being the largest under the grade 2 and the second under the grade 3, although the influence of the wind wave was very small and modified slightly the time-catch relation observable before the stratification according to the grade of wind wave[6]. The time for this step of work increased in accordance with the power of the boat at a rate of 1.1 min. per 100 Hp, when the different amount of catch relating to the power was not taken into consideration[7]. But the examination after the stratification of the records according to the amount of catch showed that the time for this step of work increased slightly in accordance with the power in some of the catch classes, while the time did not show any clear relation to the power in the other catch classes, probably because of this time being more strongly affected by the individuality of the boat than by the power[9].

As stated before, the influence of each of the factors on the time expended on the hauling-brailing step of work had been clarified; and the difference of the influence of them due to the different amount of catch was examined. But there remains a collective consideration on the influence of these factor complex. And the probable difference of the influence of one of the factors under the different conditions of the factors of the rest should be examined. As the influence of the amount of catch predominated over that of the other factors, it is probable that a slight difference of the amount of catch completely modifies the relation of the time to the other factors. These possibilities were examined through the comparison among the regressive relations of the time on the amount of catch observable under the different conditions. And the results are shown in the present report.

Material and Method

The material used in the present series of reports[1)-9)] was a complete set of the routine telegrams sent from each of the 22 Danish seiners to the factory ship several times a day throughout the season of 1964. The detailed descriptions on it were illustrated in the first report[1] of this series. The season extending over April 18 to Sept. 20 was stratified into the 16 strata of ten-day interval. And from the telegrams of each of the hauls on each three days chosen randomly from each of the ten-day strata, the intervals from the start of the hauling work to the finish of the brailing work were timed, and used in the present report, after the aggregation of them into the groups of the nearest five-minute intervals. The hauling-brailing time (abbreviated to t_h) denotes this interval. The present report dealt with the relation of t_h to the following four factors: The amount of catch (x in tons a haul), the depth fished (y in meters, 10-m intervals), the grade of wind wave (w, according to the standard settled by the Japanese Meteorological Agency), and the power of the main engine of the boat (z in Hp). Among them, the height of the wind wave was not dealt with as one of the independent variables, because this was described in the grade number covering unequal range of the wave height—narrow in the lower grades and wide in the higher ones. And the influence of this factor was examined through the comparison among the regression equations of t_h on x observable among the hauls conducted under the wind wave of the different grades.

As the first approach to the examination on the influence of these factors, the multiple linear regression equations of t_h on x, y, and z observable among the hauls conducted under the wind wave of respective grades (w) were estimated. Then, the influence of y, z, and w was examined through the comparison among the regressive relations of t_h on x observable under the different conditions in respect of the factors under the consideration, for the purpose of finding out their influence after the elimination of the predominant influence of the amount of catch.

The boats fished in the zone from 40m to 150m deep, chiefly from 90m to 140m deep. The records were stratified into the depth zones of the 10-m intervals, and those of the strata in the latter range of the depth were used. The wind wave changed from the grade 1 to 9. But the boats could not fish on the days of the grades 8 and 9. The days either in the grade 1 or in the grade 7 were observable within limited seasons; consequently, the records on the days of these wave grades were within a few of the depth zones, because the boats fished pursuing the seasonal bathymetric migration of the objective fish. The sample sizes of these wave grades were not sufficiently large to be stratified according to the other factors. The records stratified into the depth zones were, accordingly, further stratified into the grades of wind wave, and those in the range from the grade 2 to 6 were used. The boats supplying the Alaska Pollack to the factory ship studied here could be classified into the nine groups according to the power of their main engine. But the records of the 250 Hp, the 270 Hp, and the 320 Hp groups were used, because the sample sizes of the other power groups were too small to get sufficient samples for examining the regressive relation on the amount of catch after the double stratification according to the depth and the wave grade. The linear regression equations of t_h on x observable among the records thus chosen and stratified were estimated, and compared with one another.

To simplify the representation, the strata were expressed by $(y.z.w)$. Here, y and z were described omitting the numeral in the unit's place. The present report dealt with the difference among the regression coefficients under the different conditions. For convenience' sake, the constants and the regression coefficients of the equations were expressed in the following way:

a_{iw} ....the constant or the coefficient of the multiple linear regression equation of t_h on x,y, and z observable in the wind wave of the grade w. The notation of the first suffix was as follows:

$$t_h = a_{0w} + a_{1w}x + a_{2w}y + a_{3w}z$$

b_{iyzw}......the constant or the coefficient of the linear regression equation of t_h on x observable among the records of the stratum $(y.z.w)$. The notation of the first suffix was as follows:

$$t_h = b_{0yzw} + b_{1yzw}x$$

The suffix y, z, or w, left intact denotes either the constant or the coefficient of the equation for indefinite stratum in respect of the factor represented by that suffix.

Results

1. The multiple linear regression equation

In order to find an outline of the collective relation of t_h to x, y, and z, the multiple linear regression equations of t_h on them under the wind wave of respective grades were shown in Table 1. These equations revealed the following facts: The amount of catch, x, was the most influential factor among x, y, and z. The regression coefficient on the amount of catch, a_{1w}, was significant in all the grades of wind wave including the grades 1 and 7. And t_h increased in accordance with x at a rate of 2.5 to 3.7 min. per ton of catch. But it was hard to find a clear relation between a_{1w} and w at the present state of the examination. The influences of the depth fished and the power of main engine were very weak. And t_h showed significant decrease in accordance with the depth fished in one of the wave grades and in accordance with the power of the main engine in two of the wave grades out of the seven ones.

Table 1. The multiple linear regression equations of the hauling-brailing time (t_h in min.) on the catch (x in tons), the depth fished (y in m), and on the power of main engine of the boats (z in horse power) under the wind wave of respective grades.

$$t_h = a_{0w} + a_{1w}x + a_{2w}y + a_{3w}z$$

Grade of wind wave (w)	a_{0w}	a_{1w}	a_{2w}	a_{3w}	F_x	F_y	F_z	n_2
1	47.41	2.52	0.171	−0.062	98.89**	1.54	9.92**	93
2	49.95	3.70	−0.013	−0.011	1157.6 **	2.79	3.69	1095
3	54.28	3.19	−0.020	−0.017	1318.8 **	10.36**	9.38**	1281
4	48.04	3.00	0.021	−0.009	639.9 **	2.69	1.62	627
5	49.22	2.96	0.014	−0.009	1673.7 **	1.88	2.22	900
6	51.56	3.18	−0.001	−0.008	1357.2 **	0.01	1.68	1003
7	44.61	3.29	0.024	0.017	102.2 **	0.02	0.49	148

Note: df ..... $n_1 = 1$ n_2 = the value shown in the table
*significant at 0.05 level **significant at 0.01 level

2. The regression on the amount of catch

As t_h was strongly affected by the amount of catch, the influence of the other factors was examined through the comparison among the regression lines of t_h on x observable among the records in each of the 91 groups stratified according to y, z, and w. The regression coefficient of t_h on x, b_{1yzw}, was significant in the 82 strata out of the 91 ones, as shown in Table 2. But the distribution of the nine strata showing insignificant regression was restricted neither within a few of the depth zones, nor one of the power groups, nor within the wind wave of a few of the grades, nor within some particular combinations of two of the factors. The relations in the four of them—the strata (9.32.2), (11.32.4), (12.25.4), and (13.27.6)—were similar to those in the strata showing a significant regression, but the five strata—(11.27.6), (11.32.6), (12.25.5), (12.27.2), and (14.32.2)—took larger value of t_h at poor catch than the others, although any noteworthy difference could not be found in the time for the hauls yielding a catch of more than three or five tons, because of the large constant and the small coefficient. The regression coefficients in the three strata—(9.32.2), (12.25.4), and (12.25.5)—were insignificant because of the small sample size and the narrow range of x; those in the two of the strata—(11.27.6) and (14.32.2)—were because of the narrow range of x; and those in the three of them—(11.32.4),

Table 2. The linear regression equations of the hauling-brailing time (t_h in min.) on the catch (x in tons), observable among the hauls in respective depth zones (y in 10-m intervals) conducted by the boats of respective power groups (z in 10-Hp intervals) under the wind wave of respective grades (w).

$$t_h = b_{0yzw} + b_{1yzw}\, x$$

Power group (z)		250				270				320			
Grade of wind wave (w)	Depth zone (y)	b_{0y25w}	b_{1y25w}	F_b	n_2	b_{0y27w}	b_{1y27w}	F_b	n_2	b_{0y32w}	b_{1y32w}	F_b	n_2
2	90	43.43	4.51	82.40**	7	42.95	4.09	7.45*	10	47.14	3.57	1.25	4
	100	44.99	3.07	103.53**	81	45.85	3.33	130.84**	100	45.51	3.60	99.66**	61
	110	40.75	5.44	123.13**	60	45.37	3.45	114.44**	76	47.53	2.64	9.78**	23
	120	47.19	2.84	7.14*	33	52.85	1.65	2.46	33	47.76	2.85	12.33**	21
	130	46.39	3.06	6.04*	19	49.91	2.38	20.60**	40	49.27	2.67	13.52**	12
	140	47.35	2.66	6.51*	40	50.46	2.29	12.91**	36	53.63	1.13	0.23	12
3	100	47.72	3.10	144.18**	41	45.84	3.15	149.58**	57	49.28	3.19	60.51**	40
	110	46.40	3.48	60.10**	29	47.35	3.47	36.82**	36	47.61	2.67	24.23**	17
	120	43.74	4.28	89.58**	60	46.80	3.00	73.23**	62	47.68	3.27	138.21**	48
	130	42.59	5.31	68.77**	12	46.81	3.23	36.58**	34	45.19	3.92	59.68**	13
	140	45.62	3.63	71.23**	93	46.62	3.41	46.80**	103	46.50	3.33	160.13**	59
4	90	47.72	2.14	14.65**	32	46.04	3.70	8.86**	33	48.04	2.59	5.89*	14
	110	45.64	4.56	83.56**	31	47.36	2.97	55.50**	33	47.32	3.23	1.92	12
	120	47.92	3.75	3.48	4	49.04	2.73	12.46**	7	56.79	2.50	11.17*	5
	130	50.85	2.53	36.54**	34	45.45	3.54	86.27**	44	48.45	2.90	22.18**	21
	140	44.20	3.76	57.92**	45	45.49	3.78	136.00**	51	51.89	2.46	53.78**	53
5	90	48.29	2.64	105.41**	75	49.92	2.32	116.26**	92	46.66	3.15	169.76**	45
	100	46.66	3.25	133.96**	52	46.60	3.13	252.35**	48	47.45	3.75	78.82**	38
	120	51.32	1.99	4.04	5	44.33	3.83	25.35**	25	46.56	3.56	14.63**	8
	130	48.19	2.79	160.49**	54	48.00	3.43	210.85**	49	47.95	3.53	42.54**	28
	140	46.93	2.89	42.66**	32	54.26	1.95	23.29**	34	47.58	3.22	146.54**	32
6	90	48.04	2.69	32.49**	48	47.93	3.19	97.95**	56	45.53	4.95	60.88**	34
	100	50.41	3.11	87.01**	72	52.56	2.75	110.22**	75	53.83	2.67	52.00**	51
	110	44.77	4.12	18.90**	10	71.63	0.22	0.004	8	72.25	0.47	0.09	10
	120	45.57	4.18	12.85**	20	46.33	3.25	30.69**	25	38.05	7.80	49.65**	8
	130	51.13	2.63	11.06*	7	50.71	3.57	4.35	12	48.33	3.96	13.81**	7
	140	49.75	2.91	129.81**	76	52.22	2.54	62.52**	81	50.73	3.08	100.95**	58

Note: df ..... $n_1 = 1$ n_2 = the value shown in the table
*significant at 0.05 level   **significant at 0.01 level

(12.27.2), and (13.27.6)—were because of a little narrow range; but it was hard to find the reason making the regression coefficient insignificant in one of the strata—(11.32.6).

3. The comparison among the regression coefficients of the hauling-brailing time on the amount of catch, b_{1yzw}

3.1 The comparison among the regression coefficients of the different wave grades

The influence of the wind wave could not be examined through the multiple linear regression equations, because its height could not be dealt with as one of the independent variables. This was, accordingly, examined through the comparison among the linear regression equations of t_h on x observable among the hauls conducted under the wind wave

Table 3. The results of the comparison between b_{1yzw} of the different grades of wind wave (w) through the t-test.

Depth zone (y in 10-m intervals)		90		100		110		120		130		140	
Power (z)	Grade of wind wave (w)	t	n	t	n	t	n	t	n	t	n	t	n
250	2 − 3			−0.084	122	2.836**	89	−1.445	93	−1.404	31	−0.958	133
	2 − 4	2.811**	39			1.117	91	−0.273	37	0.473	53	−1.013	85
	2 − 5	1.674	82	−0.441	133			0.381	38	0.262	73	−0.216	72
	2 − 6	1.989	55	−0.085	153	1.580	70	−0.688	53	0.208	26	−0.268	116
	3 − 4					−1.566	60	0.258	64	2.799**	46	−0.208	138
	3 − 5			−0.400	93			1.703	65	2.471*	66	1.170	125
	3 − 6			−0.017	113	−0.735	39	0.081	80	2.583*	19	1.433	169
	4 − 5	−0.581	107					0.842	9	−0.538	88	1.308	77
	4 − 6	−0.715	80			0.462	41	−0.189	24	−0.073	41	1.543	121
	5 − 6	−0.080	123	0.328	124			−1.337	25	0.118	61	−0.041	108
270	2 − 3			0.453	157	−0.030	112	−1.483	95	−1.131	74	−1.225	139
	2 − 4	0.195	43			0.975	109	−0.577	40	−1.477	84	−2.167*	87
	2 − 5	1.216	102	0.578	148			−1.360	58	−1.668	89	0.451	70
	2 − 6	0.685	66	1.423	175	1.881	84	−1.286	58	−0.829	52	−0.298	117
	3 − 4					0.721	69	0.335	69	−0.366	78	−0.605	154
	3 − 5			0.075	105			−1.006	87	−0.296	83	2.150*	137
	3 − 6			1.091	132	1.330	44	−0.393	87	−0.235	46	1.470	184
	4 − 5	1.172	125					−1.011	32	0.254	93	3.619**	85
	4 − 6	0.453	89			1.257	41	−0.481	32	−0.017	56	2.454*	132
	5 − 6	−2.108*	148	1.145	123			0.571	50	−0.095	61	−1.032	115
320	2 − 3			0.726	101	−0.030	40	−0.562	69	−1.367	25	−1.266	71
	2 − 4	0.356	18			−0.290	35	0.308	26	−0.208	33	−0.614	65
	2 − 5	0.146	49	−0.256	99			−0.575	29	−0.630	40	−1.065	44
	2 − 6	−0.402	38	1.750	112	1.160	33	−2.396*	29	−0.867	19	0.831	70
	3 − 4					−0.268	29	1.121	53	1.243	34	2.036*	112
	3 − 5			−0.947	78			−0.366	56	0.415	41	0.317	91
	3 − 6			0.945	91	1.580	27	−2.844**	56	−0.024	20	0.611	117
	4 − 5	−0.432	59					−0.882	13	−0.703	49	1.728	85
	4 − 6	−1.487	48			0.861	22	−3.260**	13	−0.539	28	−1.329	111
	5 − 6	−2.832**	79	1.925	89			−2.262*	16	−0.156	35	0.330	90

Note: *significant at 0.05 level **significant at 0.01 level of the different grades by the boats of the same power groups within the same depth zones. As shown in Tables 3 and 4, the significant difference between the regression coefficients could be found out in the 16 combinations of the wave grades out of the 144 ones. But their distribution was restricted neither within a few of the depth zones, nor within one of the power groups, nor within some particular combinations of the grades of wind wave, although the significant difference in the 10 combinations out of these 16 ones was due to the large value of either $b_{1.12.32.6}$, or $b_{1.13.25.3}$, or $b_{1.14.27.4}$.

Table 4. Number of the combinations of the grades of wind wave (w) showing the significant difference in b_{1yzw}.

Grade of wind wave (w)		2		3		4		5		6	
Power group (z)	Depth (y)	L	S	L	S	L	S	L	S	L	S
250	90	1					1				
	110	1			1						
	130			3			1		1		1
270	90								1	1	
	140		1	1		3			2		1
320	90								1	1	
	120		1		1		1		1	4	
	140			1			1				
Sum		2	2	5	2	3	4		6	6	2

Note: L ..... significantly larger than the other S..... significantly smaller than the other

3.2 The comparison among the regression coefficients of the different depth zones

As shown in Tables 5 and 6, the difference among b_{1yzw} by the boats of the same power groups (z) under the wind wave of the same grades (w) was significant in the 19 combinations of the depth zones (y) out of the 180 ones. The combinations showing significant difference were restricted neither within a few of the wave grades, nor within one of the power groups, nor within some particular combinations of the depth zones, although the significant difference in the 10 combinations of them was due to either the large value of $b_{1.9.32.6}$ and $b_{1.11.25.2}$ or the small value of $b_{1.11.32.6}$.

3.3 The comparison among the regression coefficients of the different power groups

As shown in Tables 7 and 8, the difference among the coefficients of the 250 Hp group and those of the 270 Hp one was significant in three of the y-z strata; the difference among the coefficients of the 250 Hp group and those of the 320 Hp one was significant in the same number of the strata, and the difference among the coefficients of the 270 Hp group and those of the 320 Hp one was significant in the five strata each out of the 27 ones. The distribution of the combinations of the power groups showing the significant difference did not have any clear relation to the depth fished, but the distribution had a

Table 5. The results of the comparison between b_{1yzw} of the different depth zones (y) through the t-test.

Grade of wind wave (w)		2		3		4		5		6	
Power (z)	Depth (y)	t	n	t	n	t	n	t	n	t	n
250	90−100	1.806	88					−1.586	127	−0.611	120
	90−110	−0.980	67			−3.227**	63			−1.721	58
	90−120	1.107	40			−0.840	36	0.344	80	−1.098	68
	90−130	0.979	26			−0.549	66	−0.420	129	0.042	55
	90−140	1.216	47			−1.923	77	−0.443	107	−0.386	124
	100−110	−4.248**	141	−0.628	70					−1.158	82
	100−120	0.260	114	−2.092*	101			0.731	57	−0.582	92
	100−130	0.010	100	−1.768	53			1.298	106	0.226	79
	100−140	0.464	121	−1.053	134			0.660	84	0.467	148
	110−120	2.501*	93	−1.242	89	0.472	35			−0.032	30
	110−130	2.066*	79	−1.893	41	2.966**	65			0.675	17
	110−140	2.666**	100	−0.203	122	0.951	76			1.664	86
	120−130	−0.130	52	−0.981	72	0.599	38	−0.593	59	0.973	27
	120−140	0.121	73	0.981	153	−0.000	49	−0.578	37	0.838	96
	130−140	0.237	59	1.271	105	−1.839	79	−0.216	86	−0.168	83
270	90−100	0.627	110					−2.749**	140	0.984	131
	90−110	0.545	86			0.597	66			1.528	64
	90−120	1.106	43			0.576	40	−1.382	117	−0.092	81
	90−130	1.277	50			0.115	77	−3.427**	141	−0.275	68
	90−140	1.247	46			−0.075	84	0.764	126	1.354	137
	100−110	−0.265	176	−0.494	93					1.145	83
	100−120	2.074*	133	0.262	119			−0.673	73	−0.645	100
	100−130	1.582	140	−0.110	91			−0.987	97	−0.499	87
	100−140	1.554	136	−0.457	160			2.468*	82	0.515	156
	110−120	2.100*	109	0.729	98	0.222	40			−1.329	33
	110−130	1.766	116	0.277	70	−0.951	77			−0.967	20
	110−140	1.721	112	0.077	139	−1.618	84			−1.037	89
	120−130	−0.651	73	−0.377	96	−0.556	51	0.391	74	−0.207	37
	120−140	−0.515	69	−0.594	165	−1.124	58	1.936	59	0.885	106
	130−140	0.117	76	−0.200	137	−0.456	95	3.068**	83	0.617	93
320	90−100	−0.010	65					−1.269	83	3.115**	85
	90−110	0.370	27			−0.262	26			3.409**	44
	90−120	0.273	25			0.070	19	−0.360	53	−0.978	42
	90−130	0.343	16			−0.210	35	−0.721	73	0.457	41
	90−140	0.627	16			0.099	67	−0.164	77	2.805**	92
	100−110	0.966	84	0.702	57					2.065*	61
	100−120	0.818	82	−0.136	88			0.115	46	−1.749	59
	100−130	1.053	73	−0.870	53			0.310	66	−0.601	58
	100−140	1.200	73	−0.292	99			0.976	70	−0.853	109
	110−120	−0.179	44	−1.152	65	0.298	17			−1.514	18
	110−130	−0.032	35	−1.606	30	0.163	33			−0.944	17
	110−140	0.691	35	−1.340	76	0.463	65			−2.703**	68
	120−130	0.160	33	−1.311	61	−0.337	26	0.014	36	2.408*	15
	120−140	0.769	33	−0.178	107	0.037	58	0.363	40	1.813	66
	130−140	0.687	24	1.158	72	0.662	74	0.541	60	0.463	65

Note: *significant at 0.05 level **significant at 0.01 level

Table 6. Number of the combinations of the depth zones (y) showing the significant difference in b_{1yzw}.

Depth zone (y)		90		100		110		120		130		140	
Power group (z)	Grade of wind wave (w)	L	S	L	S	L	S	L	S	L	S	L	S
250	2				1	4			1		1		1
	3				1			1					
	4		1			2					1		
270	2			1		1			2				
	5		2	2						2			2
320	6	3		1	1		3	1			1	1	1
Sum		3	3	4	3	7	3	2	3	2	3	1	4

Note: L ..... significantly larger than the other S..... significantly smaller than the other

Table 7. The results of the comparison between b_{1yzw} of the different power groups (z) through the t-test.

Depth zone (y)		90		100		110		120		130		140	
Grade of wind wave (w)	Power group (z)	t	n	t	n	t	n	t	n	t	n	t	n
2	250—270	0.275	17	−0.636	181	3.465**	136	0.777	66	0.568	59	0.309	76
	250—320	0.396	11	−1.148	142	2.721**	83	−0.000	54	0.264	31	0.534	52
	270—320	0.150	14	−0.577	161	0.900	99	−0.772	54	−0.315	52	0.536	48
3	250—270			−0.134	98	0.020	65	2.255*	122	1.957	46	0.331	196
	250—320			−0.190	81	1.146	46	1.949	108	1.340	25	0.573	152
	270—320			−0.084	97	1.013	53	−0.585	110	−0.948	47	0.129	162
4	250—270	−1.217	65			2.124*	64	0.499	11	−1.457	78	−0.037	96
	250—320	−0.401	46			0.801	43	0.578	9	−0.520	55	2.199*	98
	270—320	0.609	47			−0.148	45	0.211	12	0.820	65	2.789**	104
5	250—270	0.947	167	0.369	100			−1.349	30	−1.969	103	1.580	66
	250—320	−1.434	120	−1.009	90			−1.035	13	−1.504	82	−0.650	64
	270—320	−2.541*	137	−1.452	86			0.237	33	−0.202	77	−2.675**	66
6	250—270	−0.860	104	0.849	147	1.228	18	0.668	45	−0.417	19	0.918	157
	250—320	−2.915**	82	0.874	123	2.001	20	−1.795	28	−1.012	14	−0.413	134
	270—320	−2.700**	90	0.180	126	−0.060	18	−2.173*	33	−0.161	19	−1.202	139

Note: *significant at 0.05 level **significant at 0.01 level

relation to the grade of wind wave: The significant difference between $b_{1.y.25.w}$ and $b_{1.y.27.w}$ was found in the wind wave of the lower grades, while that between $b_{1.y.27.w}$ and $b_{1.y.32.w}$ was in the wind wave of the higher grades. And Table 8 showed that the 10 combinations of the power groups showing significant difference out of the 11 ones were either due to the large coefficient of the 250 Hp group in the lower grades of wind wave or due to that of the 320 Hp one in the higher grades, and the coefficient of the 270 Hp group inclined to be smaller than that of the other power groups throughout the grades of wind wave.

4. The comparison among the t_h-x relation lines

The above-mentioned comparisons among the regression coefficients were not sufficient to examine the influence of one of the factors on the length of the hauling-brailing time. The constant varied stratum by stratum; and the range of the amount of catch of the records used for the estimation of the regression lines differed according to the stratum. These facts should be taken into consideration. And it was not sufficient to compare

Table 8. Number of the combinations of the power groups (z) showing significant difference in b_{1yzw}.

Power group (z)		250		270		320	
Grade of wind wave (w)	Depth (y)	L	S	L	S	L	S
2	110	2			1		1
3	120	1			1		
4	110	1			1		
	140	1		1			2
5	90				1	1	
	140				1	1	
6	90		1		1	2	
	120				1	1	
Sum		5	1	1	7	5	3

Note: L ..... significantly larger than the other S ..... significantly smaller than the other

either the coefficients or the lines with one another in respect of the different strata in one of the factors. But it was very complicated to compare those of the strata with one another taking the difference of each of the three factors into consideration. The regression lines of each of the different strata in respect of any two of the factors were, accordingly, compared with one another.

4.1 The comparison among the regression lines within the same power groups

The 250 Hp group ..... The regression lines of this power group could roughly be classified into the two types. One of them took smaller value of t_h than the other in the range of large x, because of the small coefficient. The distribution of these types had a rough relation either to the depth fished (y) or to the grade of wind wave (w). Namely, the regression lines in the 90m, 100m, 130m, and the 140m zones except those of the strata (9.25.2) and (13.25.3), and those in the wind wave of the grades 2, 5, and 6, except those of the strata (9.25.2) and (11.25.w), were included in the former type. All the regression lines in the 110m zone and the lines in the 120m zone except those of the strata (12.25.2) and (12.25.5) were included in the latter type.

The 270 Hp group ..... Among the regression lines of this power group, those in the deeper zones (the 120m, 130m, and the 140m zones) in the wind wave of the grade 2 and the

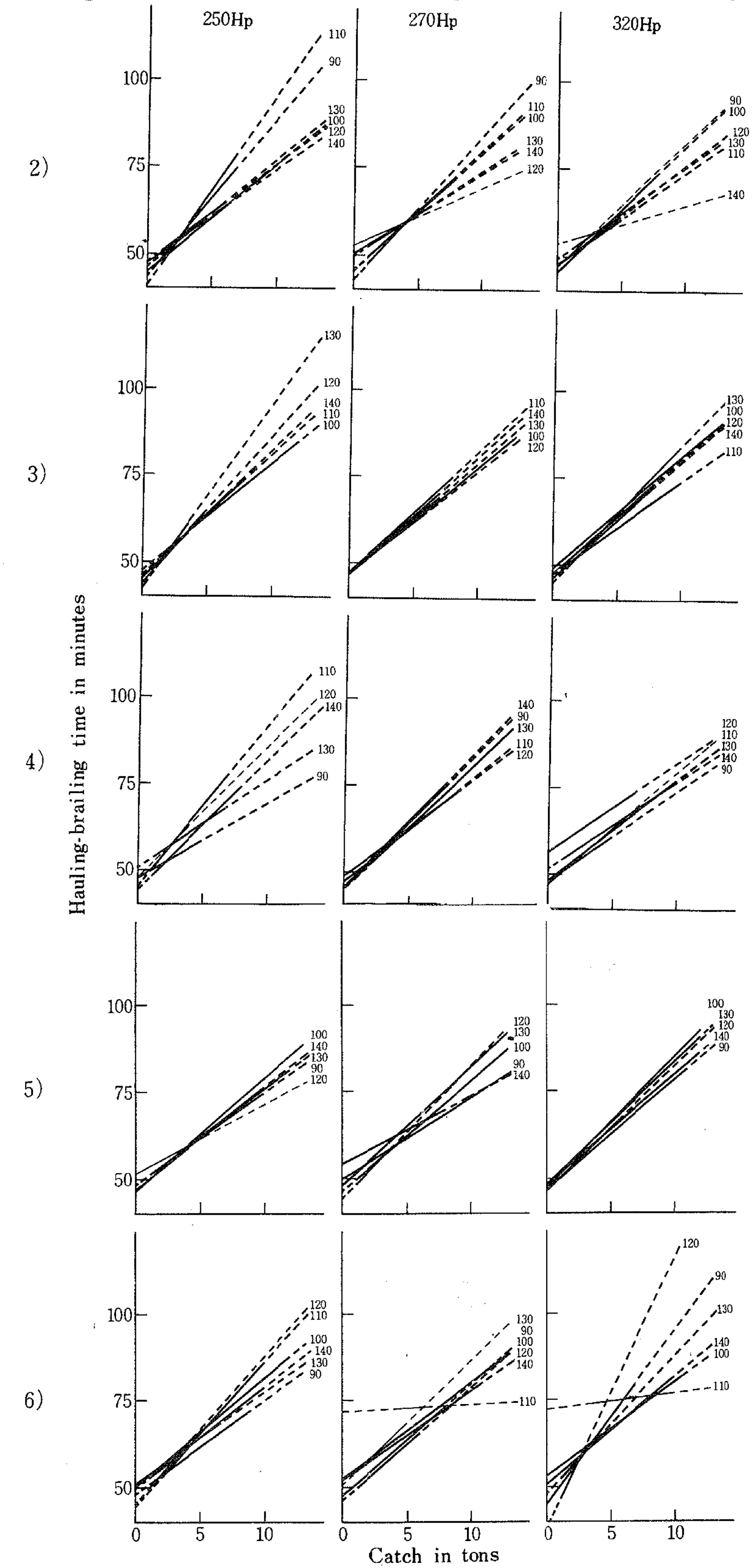

Fig. 1. The comparison among the regression lines of the hauling-brailing time on the amount of catch (1).
Note: The numeral in parenthesis is the grade of wind wave; and that attached to the line is the depth fished in m.

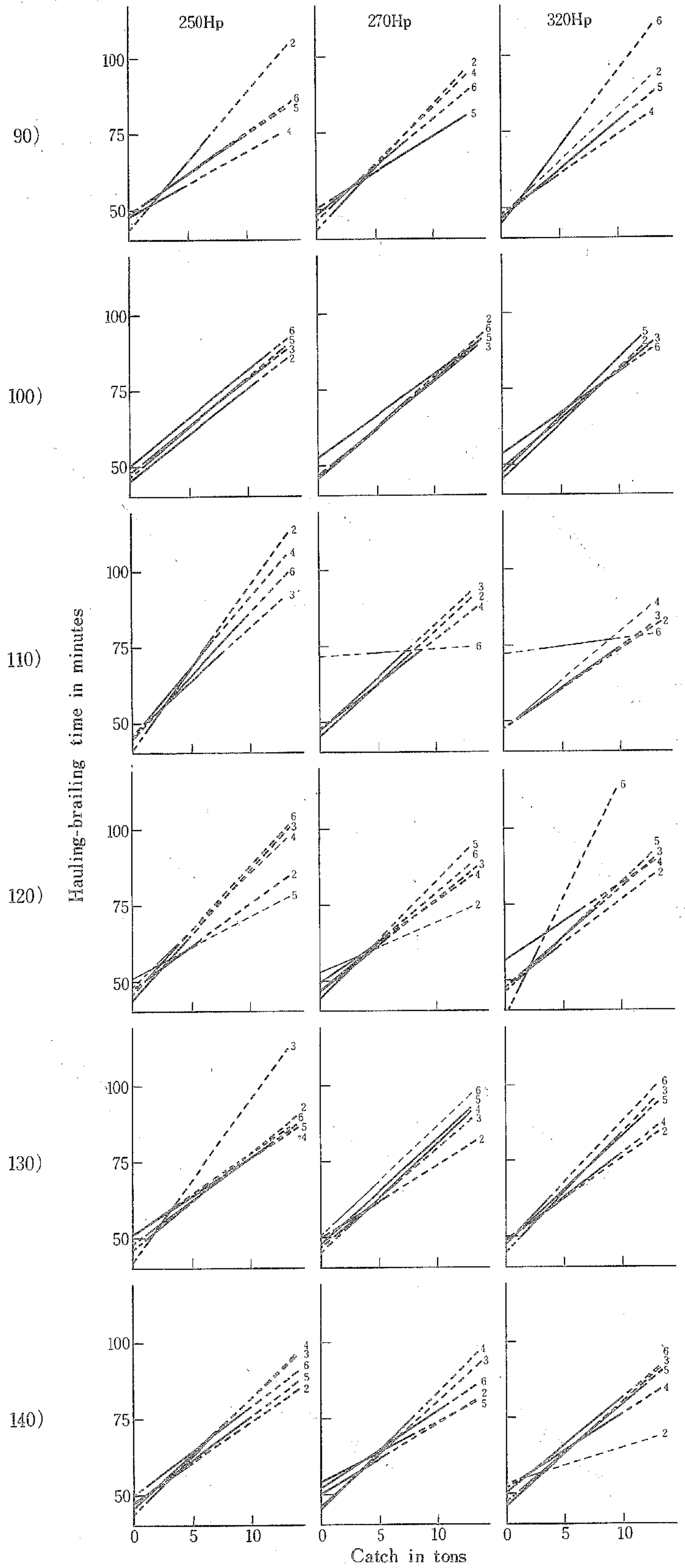

Fig. 2. The comparison among the regression lines of the hauling-brailing time on the amount of catch (2).
Note: The numeral in parenthesis is the depth fished in m ; and that attached to the line is the grade of wind wave.

extreme depth zones (the 90m and the 140m zones) in the wind wave of the grade 5 took smaller value of t_h than the lines of the other strata in the range of large x. But, all the regression lines of the strata of the rest were similar to one another.

The 320 Hp group ..... The regression lines of this power group diverged one another, neither showing a separation into a few types nor showing a concentration. But it may be said that those in the deeper zones (the 110m to the 140m zones) in the wind wave of the grade 2 and in the 110m zone took smaller t_h than the others, but those in the grades 3, 5, and 6, except those of the strata (11.32.3) and (11.32.6) and those in the shallower zones (the 90m and the 100m zones) in the wind wave of the grade 2 took larger t_h than the other strata in the range of large x.

When the regression lines within respective power groups were compared with one another, thus, the distribution of the strata taking smaller t_h than those of the other strata and those taking larger t_h had a rough relation to either the depth fished or the wave grade. But the relation of the distribution of these strata to either the depth fished or the wave grade differed in accordance with the power groups.

4.2 The comparison among the regression lines within the wind wave of the same grades

The wind wave of the grade 2 ..... Most of the regression lines of this wave grade in the shallower zones (the 90m to the 110m zones) took larger t_h than those in the deeper zones (the 120m to the 140m zones) in the range of large x. And those of the 250 Hp group took larger t_h than those of the 270 Hp and the 320 Hp groups in the range of large x.

The wind wave of the grade 3 ..... The regression line of the 110m zone by the 320 Hp group took smaller t_h than the others. A large coefficient of the line for the 130m zone by the 250 Hp group suggested a sharp increase of t_h in accordance with x; but t_h within the range of the observed value of x did practically not show any large difference from those of the others. The other lines were similar to one another.

The wind wave of the grade 4 ..... All the regression lines of this wave grade except those in the following three strata were similar to one another. The large coefficient of the stratum (11.25.4) made t_h of this stratum larger than that of the others in the range of large x; the small coefficient of the stratum (9.25.4) resulted in a little smaller t_h near the largest limit of the observed value of x (5 tons). The large constant in the stratum (12.32.4) made t_h of this stratum a little larger than those of the other strata. No other noteworthy difference could be observed.

The wind wave of the grade 5 ..... When the catch was poor, most of the regression lines took the similar value of t_h to one another regardless of the power and the depth. When a good catch was yielded, in contrast with this, t_h varied according to the power groups. Namely, the 320 Hp group needed slightly longer time to haul up the net and to brail out the catch than to do so by the boats of the 250 Hp one. The length of the time needed to do so by the boats of the 270 Hp group varied according to the depth fished, but it was neither longer than the time needed by the 320 Hp group nor shorter than that by the 250 Hp one.

The wind wave of the grade 6 ..... The regression lines for the strata (9.32.6) and (12.32.6) differed from those of the other strata in this wave grade because of the large coefficient. Any other noteworthy difference could not be found out.

The position of the regression lines on the t_h-x graph had, thus, a relation to the depth fished in the wind wave of the grade 2 and to the power of the boats in the wind wave of the grade 5. Under the wind wave of the other grades, the regression lines were similar to one another with a few exception. The regression lines showing different relations from the others were by the boats of the 250 Hp group and the 320 Hp one. But they were restricted neither within a few of the depth zones, nor within the wind wave of a few of the grades, nor within some particular combinations of them.

4.3 The comparison among the regression lines within the same depth zones

The 90m zone ..... The regression lines of the strata (9.25.2) and (9.32.6) differed from the others because of the large coefficient; but all the others were similar to one another, although the variation of them was slightly large.

The 100m zone ..... The variation of the amount of catch was large in most of the strata. All the regression lines were rather closely similar to one another.

The 110m zone ..... The difference of the regression lines due to the power difference was large: In most of the grades of wind wave, the 250 Hp group needed longer time to haul up the net and to brail out the catch than the boats of the other power groups. The regression lines of the strata (11.27.w) and (11.32.w) were similar to one another within the same power groups, except those in the strata (11.z.6). But because the coefficients of the strata (11.27.6) and (11.32.6) were insignificant, the noteworthy difference could not be found out between the coefficients of the different w. The coefficient of the stratum (11.25.2) was significantly larger than that of the stratum (11.25.3); but because of the small constant of the stratum (11.25.2), the difference in t_h was not noteworthy.

The 120m zone ..... The coefficient of the stratum (12.32.6) was larger, but those for the strata (12.25.2), (12.25.5), (12.27.2), and (12.32.4) were smaller than the others, although the difference of the latter group from the others was insignificant. But the narrow range of the observed value of x made t_h in this range, practically, not different from those of the others, except that of the stratum (12.32.4) which was larger than the others. The regression lines for the other strata were similar to one another.

The 130m zone ..... The regression line for the stratum (13.25.3) seemed to differ from the others; but t_h of this stratum in the range of the observed value of x did, practically, not differ from the others, because of the narrow range of the observed value of x and the small constant. As the consequence, all the regression lines were similar to one another.

The 140m zone ..... The difference of the wave grades did not cause any significant difference in the regressive relation in the 250 Hp group. In the 270 Hp group, the significant difference of the coefficients could be seen between the wave grade 4 and either of the wave grades 2, 5, and 6 and between the wave grades 3 and 5. But the constant was small in the wave grades 3 and 4; and t_h between the wave grades within the range of the observed value of x did not cause any large difference. In the 320 Hp group, the relation in the wave grade 2 seemed to be different from the others. But the extremely narrow range of x in this wave grade made t_h within this range of x not showing any large difference from the values of the different wave grades. The coefficient of the wave grade 3 was significantly larger than that of the grade 4; but t_h of these wave grades at respective values of x did not show any large difference from one another, because the constant of the wave grade 3 was smaller than that of the wave grade 4.

From all the results, it may be said that the difference of t_h due to the power difference could be found only in the 110m zone: The 250 Hp group needed longer time than the other power groups. The other noteworthy difference could be found in the following parts:

Large value of t_h near the largest limit of the observed value of x ..... Strata (9.25.2) and (9.32.6)

Large value of t_h in the range of small value of x ..... Strata (11.27.6) and (11.32.6)

Small value of t_h near the largest limit of the observed value of x ..... none

Small value of t_h in the range of small value of x ..... none

Namely, it was hard to find any clear difference in the regression line due to the depth difference.

Discussion

The examination through the multiple linear regression equations revealed the following facts: The amount of catch had a strong influence of the length of the time expended on the hauling and brailing work, but the influences of the depth fished and of the power of the boats were very weak, and it was hard to examine the influence of the wind wave because this factor could not be dealt with as one of the independent variables. As already mentioned in the preceding report[2], it is natural that the hauling-brailing time was strongly affected by the amount of catch, because the brailing work consists of a repetition of the brailing by the stalked hoop net and its length may be in proportion to the amount of catch. This resulted in the highly significant regression of the length of the hauling-brailing time on the amount of catch observable in the 82 y-z-w strata out of the 91 ones. The time expended on the hauling and brailing work under the same conditions showed a large variation; accordingly, it is natural that the time for this step of work in the strata of either the small sample size or the narrow range of the observed amount of catch hardly shows any significant regression on the amount of catch. Most of the strata showing insignificant regression fit to either or both of these conditions. And it is hard to consider that the insignificant regression is due to the different t_h-x relation of these strata from those of the others.

Concerning the influence of the depth fished, the multiple linear regression equations revealed that the regression on the depth fished was significant in the wind wave of the grade 3 but insignificant in the other grades. But any clear symptom supporting the above-mentioned results could not be found out in the change of the position of the regression lines in the t_h-x relation graph, except a slight decrease of t_h in accordance with the depth fished observable within the range of small x (not larger than three tons). The other fact supporting this trend could be found in Table 6: The value of Student's t in this table was negative in the 22 combinations of the depth zones out of the 30 ones, although the difference between the coefficients was insignificant in either of the combinations of the depth zones. In the wind wave of the grade 2, the following trend could be found out through the comparison of the regression lines: t_h of the shallow zones inclined to be larger than that of the deeper zones. But a_{22} was insignificant. This may be because of the following reasons: The lines crossed one another at a catch of two tons in the 250 Hp group, at a catch of four tons in the 270 Hp one, and at a catch of three tons in the 320 Hp one. The trend in the large x and that in the small x offset each other. This made a_{22} insignificant. For the other grades of wind wave, the comparison of the regression lines did not show any clear relation of the position of the line to the depth fished. The comparison among the regression coefficients of t_h on x observable in the different depth zones revealed the presence of the significant difference in all the wave grades except the grade 3. But the regression coefficient a_{2w} was insignificant, because as shown in Table 6 the depth zones showing a significantly larger (or smaller) coefficient than the others did not have any clear relation to the depth but they had rather irregular relation to it.

These results suggested that it should be not reasonable to give much importance on the significant regression on the depth fished found among the hauls conducted under the wind wave of the grade 3. In any case, it was hard to find any trends of the influence of the depth fished either common to all the grades of wind wave or changing in accordance with the wave grades. The possibility of this fact being due to the offsetting by the influence of the other factors was denied by the examination on the relations after manifold stratification. These facts may suggest that the influence of the depth fished on the length of the hauling-brailing time should be very weak. This may be due to the shallow grounds and the small depth variation, as already mentioned in the preceding reports of this series[3),4)]. Namely, in the present case, the boats fished in the zone from 40m to 150m deep, chiefly from 90m to 140m deep, because the fishable depth was legally restricted within a depth of 150m. But the Danish seine is the fishing method for deep ground, and the boats were constructed suitable for fishing in far deeper grounds than those in the present case. They used, accordingly, the warp of the minimum length throughout the depth zones and fished with sufficient surplus of the power.

The other trend found in the multiple linear regression equations was the significant regression of the hauling-brailing time on the power of the boats in the wind wave of the grades 1 and 3 and insignificant regression in the other wave grades. But the comparison among the regression lines of t_h on x after the stratification of the records according to y, z, and w, showed somewhat different results. Namely, the clearest trend found through the comparison of the regression coefficients was the large coefficients of the 250 Hp group in the wind wave of the lower grades and those of the 320 Hp one in the wind wave of the higher grades. The comparison of the regression lines revealed the following trends: In the wave grade 5, the boats of the 320 Hp group needed a slightly longer time for the hauling and brailing work than the boats of the 250 Hp one when they yielded a good catch, although the differences of the power and the depth fished did not cause any noteworthy difference in the hauling-brailing time for the hauls with poor catch. And the time needed for this step of work by the boats of the 270 Hp group varied according to the depth fished, but the time needed by the boats of this power group was neither longer than the time needed by the boats of the 320 Hp group nor shorter than the time required by the boats of the 250 Hp one. The trend in the wave grade 1 could not be examined through this method because of small sample size. And this method could not find out any noteworthy trend suggesting the relation of the length of the hauling-brailing time to the power in the wave grade 3. The same could be said to the relation in the other wave grades.

The comparison of the results of the present report with those of the preceding ones revealed that the results differed in accordance with the stratification. Namely, the examination before the stratification showed that the more powerful boats needed a slightly longer time to this step of work than the less powerful ones, although the increase of the time due to the power regression was as small as one min. per 100 Hp[7]. The examination after the stratification according to the amount of catch revealed that this was due to the increase of the amount of catch relating to the power. And the hauling-brailing time of the hauls with the same amount of catch either decreased, as expected, in accordance with the power of the boat or showed insignificant regression, but there were no catch classes showing significant increase in accordance with the power[9]. The multiple linear regression equations provided us with the trends supporting the results found after the stratification. But the linear regression equations on the amount of catch after the manifold stratification added the following information: The trend of the decrease of the hauling-brailing time in accordance with the power was neither common to all the depth-wave grade strata nor changed in accordance with the depth or the wave grade. The results were thus unstable. This may partly be due to the following reason: The multiple linear regression equations and the linear regression equations before the manifold stratification were estimated from all the records; but those after the manifold stratification were from the records of the three power groups out of the nine ones. But this may not be the sufficient reason of making the results unstable. And it is hard to neglect the possibility of these results being due to the following reasons: The fishing grounds were shallow, but the boats were constructed suitable for fishing in deep grounds. The boats worked, accordingly, with sufficient surplus of the power, and the power difference like in the present case did not cause any significant difference in the length of the hauling-brailing time. Regardless of the fishing depth and the power of the boats, it is probable that the length of the hauling-brailing time depends on the construction and the performance of the hauling and brailing system of the boats. And there remains a doubt in the following two points: 1) whether the speed of these mechanical systems has any direct relation to the power of main engine or not, and 2) whether the boats used the full power during this step of work, especially during the latter half and in the shallow ground, or not.

Concerning the influence of the wind wave, the preceding reports revealed the following trends: When the influence of all the other factors were not taken into account, the hauling-brailing step of work was the least resistive against the wind wave, and the maximum difference between the average times for this step of work under different wave grade attained as large as 20%[5]. But this was due to the different amount of catch relating to the wave grade, and the regressive relation of the time on the amount of catch showed that the wind wave in the range from the grade 1 to the grade 5 did not cause any significant difference in the length of the hauling-brailing time but that over the grade 6 retarded this step of work[6]. In the multiple linear regression equations shown in the present report, this factor could not be dealt with as one of the independent variables, because the wave height was described in the grade number covering unequal range. The influence of this factor could be examined through the change of the constant and the coefficient in accordance with the wave grade. But any clear trends of their change could not be found out. The comparison among the regression coefficients on the amount of catch after the stratification of the records according to the three factors–the depth fished, the power of the boats, and the wave grades–revealed that the significant difference between the regression coefficients could be found in the 16 combinations of the wave grades out of the 144 ones; and among them the 10 were due to the large value in the three *y-z-w* strata–(12.32.6), (13.25.3), and (14.27.4). But their distribution neither had any clear relation to these factors nor was restricted within some particular combinations of them. The comparison among the regression lines of respective *y-z-w* strata did not show any clear trends of the change of their positions either in accordance with the wave grade and common to all the *y-z* strata or in accordance with *y* or *z* and common to the combinations of *w* to the factor of the rest. The examination of the regressive relation on the amount of catch before the stratification according to *y* and *z* showed that the wind wave over the grade 6 retarded the work of this step[6]. The regression lines of the wave grade 6 took larger value of t_h than the others in the six *y-z* strata out of the 18 ones. But the distribution of these strata had any clear relation neither to *y* nor to *z*. Namely, the trend found before the manifold stratification was not common to all the *y-z* strata. These facts may suggest that the difference of the hauling-brailing time due to the difference of the wave grade should be so small that the results differed in accordance with the factors for the stratification.

As pointed out in the preceding reports[5),6)], the fishing work on deck under rough sea is very heavy and the splashing water and the rolling of the boat disturb the smooth work of the fishermen, although the very calm water is also not convenient for smooth handling of the net. But the results of the examination did not show the trend coinciding with our impression of difficulty in working on deck.

The very small retardation of the work found out through the examinations and the difference between these results and the impression of work on deck are thought to be derived from the following reasons: The work handling the net in deep layer is hardly affected by the surface condition, but the work handling the net onor near the surface is easily affected by it. Some of the steps of work are conducted chiefly at the working pace of the mechanical systems and the crew assists it. The others are at the pace of the crew to handle the mechanical systems. The former is hardly affected by the rough sea, but the latter is easily affected by it. During the former type of work, the crew pays much attention and effort to keep up themselves with the progress of the work. And most of the probable retardation of their work due to the difficulty in working smoothly may be filled up by the effort expended. And the retardation found out through the examinations may be the parts not covered by the efforts. But the impression of the difficulty in working on deck under rough sea may be derived from the effort expended. Accordingly, it is natural that the retardation found out is far smaller than our impression. The hauling work, especially its earlier half, may be the work of this type. The pace of the other type of work has a possibility of depending chiefly on the working pace of the crew. But the temperament of our fishermen do not allow them to work at their own pace which is disturbed by the surface conditions. They may work as quick as possible with an intention of not disturbing the mechanical systems in fulfilling their full capacity which is suffered not so severely as the pace of the fishermen. They unconsciously intend to finish the work as soon as possible and want to take rest under the shelter. This may accelerate the work under rough sea making considerable effort. It is, accordingly, probable that the pace of even this type of work is not largely reduced by the surface conditions, but the effort made may be far larger than that for the former type of work. This emphasizes the impression of the difficulty in smooth working being far stronger than the actual, and the difference between the results found out and the impression becomes far larger than in the former type of work. The latter half of the hauling work and the brailing work may be the work of this type.

From all the results of the examinations and the consideration, it may be concluded as follows: The wind wave over a certain grade may have a possibility of making the hauling-brailing work retarded. But this was filled up by the fishermen's effort. And the results of the examinations indicate the part of the probable retardation not covered by it.

All the above-mentioned discussions were concerned chiefly with the influence of the single factors. But one of the principal aims of the present report is to examine the possibility of the influence of one of the factors to be different in accordance with the other factors. The possibility like this was examined through the comparison among the regression coefficients of t_h on x observable in the different strata in respect of one of the factors and the comparison of the regression lines of the different strata in respect of two of the factors. And many trends could be found out. But it was hard to find any trend common to all the strata in respect of the factors of the rest or any trend changing in accordance with the change of the factors of the rest, except the trend found in the comparison among the regression coefficients of the different power groups. Namely, the coefficients of the 250 Hp group in the lower wave grades and those of the 320 Hp one in the higher wave grades were larger than those of the other power groups in the same depth zones under the wind wave of the same grades. But they were not common to all the depth zones, and the former trend could be found in the four y-w strata out of the 19 ones in the three wave grades, and the latter was in the same number of the y-w strata out of the 11 ones in the two wave grades. The depth zones showing the above-mentioned trends were neither common to all the wave grades nor having a clear relation to the wave grade. The same could be said to the relation to the depth zone. Through the comparison between the regression lines of the y-w strata by the boats of the same power group, the presence of the lines showing a different t_h-x relation to those of the other strata was found out. But the y-w strata showing the different relations differed in accordance with the power groups. And it was hard to find any relation of either y or w of these strata to the power. The similar could be said to the results of the comparison among the regression lines of the different y-z strata under the same wave grades and among those of the different z-w strata in the same depth zones. These patterns of the influence of the factor complex made it hard to find any trend of the change of the time-catch relation in accordance with the combinations of the conditions. These pattern of the influence may result in the following findings of the preceding reports of this series: The difficulty in finding out the influence of either of the factors except the amount of catch, the faint influence of them found out, and the unstable results.

Conclusion

From all the results found out in the present and the preceding reports of this series, it may be concluded that——

1. The difficulty in finding out the clear influence of the depth fished, the power of main engine of the boat, and the grade of wind wave, was neither due to the different amount of catch relating to the other factors nor due to the offsetting by the influence of the other factors.

2. The unstable results of the influence of the factors on the time-catch relation according to the combinations of the conditions for the stratification was not due to the different trends of the influence of one of the factors according to the factors of the rest, but it was due to such possibility that each of the factors except the amount of catch was faintly influential on the length of the time expended on the hauling-brailing work.

3. All these results may be due to the shallow ground and the temperament of the fishermen.

Summary

The time required for the hauling and brailing steps of work, occupying 57% of the time for completing a haul, showed a large variation. And the importance of the examination should be given on that of the time for this step of work, because the difference

of the latter time according to the conditions was chiefly due to that of this step of work. Accordingly, the influence of the following four factors on the length of the hauling-brailing time was examined through the multiple linear regression equations and through the comparison of the regression lines of the time on the amount of catch after the stratification according to the factors of the rest: The amount of catch (x in tons), the depth fished (y in m, 10-m intervals), the power of main engine of the boats (z in Hp), and the wind wave (w in grade number). And the results obtained were summarized as follows:

1. The multiple linear regression equations of the hauling-brailing time on x, y, and z observable among the records in respective w showed that (1) the amount of catch was the most influential factor on the length of the hauling-brailing time, and the time for this step of work significantly increased at a rate of 2.5 to 3.7 min. per ton, but (2) the influences of the depth fished and the power of the boats were very weak and the former was significant in one of the wave grades and the latter was significant in two of them out of the seven ones.

2. In order to find the influence of the other factors rather than the amount of catch after elimination of it's predominant influence, the linear regression equations of the time on the amount of catch were estimated. The regression coefficient was significant in most of the y-z-w strata.

3. The comparison among the regression coefficients, b_{1yzw}, of the different w showed that the significant difference could be found out in the 16 combinations of w. But their distribution was neither restricted within a few of the depth zones, nor within one of the power groups, nor within some particular combinations of the grades of wind wave, although the significant difference in the 10 combinations out of these 16 ones was due to the large value of either $b_{1.12.32.6}$, or $b_{1.13.25.3}$, or $b_{1.14.27.4}$.

4. The coefficients, b_{1yzw}, of the different y were compared with one another. And the significant difference was found out in the 19 combinations of y. But the combinations showing significant difference were restricted neither within a few of the wave grades, nor one of the power groups, nor within some particular combinations of the depth zones, although the significant difference in the 10 combinations of them was due to either the large value of $b_{1.9.32.6}$ and $b_{1.11.25.2}$ or the small value of $b_{1.11.32.6}$.

5. The coefficients, b_{1yzw}, of the different z showed a significant difference in the 11 combinations of z. And the 10 combinations of them were either due to the large coefficient of the 250 Hp group in the lower grades of wind wave or due to that of the 320 Hp group in the higher grades, and the coefficient of the 270 Hp group inclined to be smaller than that of the other power groups throughout the grades of wind wave.

6. When the regression lines within respective power groups were compared with one another, the distribution of the strata taking smaller value of t_h than the other strata and those taking larger value had a rough relation to either the depth fished or the wave grade. But the relation of the distribution of these strata to either the depth fished or the wave grade differed in accordance with the power group.

7. The position of the regression lines on the t_h-x graph had a relation to the depth fished

in the wind wave of the grade 2 and to the power of the boats in the wind wave of the grade 5. Under the wind wave of the other grades, the regression lines were similar to one another with a few exception. The regression lines showing different relations from the others were by the boats of the 250 Hp group and the 320 Hp one. But they were restricted neither within a few of the depth zones, nor the wind wave of a few of the grades, nor some particular combinations of them.

8. The difference of the length of the hauling-brailing time due to the power difference could be found only in the 110m zone. The 250 Hp group needed longer time than the other power groups.

9. The above-mentioned results were compared with the results of the preceding reports of this series. And the discussions were given to the influence of these factors. And the following three conclusions were obtained:

(1) The difficulty in finding out the clear influence of the three factors–the depth fished, the power of main engine of the boat, and the grade of wind wave–was neither due to the different amount of catch relating to the other factors nor due to the offsetting by the influence of the other factors.

(2) And the unstable results of the influence of one of the factors on the time-catch relation in accordance with the combinations of the conditions for the stratification were not due to the different trends of the influence of one of the factors according to the factors of the rest, but they were due to such possibility that each of the factors except the amount of catch was faintly influential on the length of the time expended on the hauling-brailing work.

(3) All these results may be due to the shallow ground and the temperament of the fishermen.

References

1) MAÉDA, H. and S. MINAMI, 1969: *Bull. Jap. Soc. Sci. Fish.*, 35, 964-969.
2) ——————, 1969: *ibid.*, 35, 970-974.
3) ——————, 1969: *ibid.*, 35, 1043-1048.
4) ——————, 1970: *ibid.*, 36, 455-461.
5) ——————, 1970: *ibid.*, 36, 549-555.
6) ——————, 1970: *ibid.*, 36, 1115-1121.
7) ——————, 1971: *ibid.*, 37, 592-597.
8) ——————, 1971: *This Jour.*, 20, 1-12.
9) ——————, 1971: *ibid.*, 20, 67-79.