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Report on an Experimental Fishery with Salmon Drift-Nets

by

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According to a recommendation made at the first meeting of the Permanent Commission of the Baltic Salmon Fisheries Convention (Report on the first meeting in Stockholm January 18th, 1967: 6 (c) drift-nets) the size-composition of salmon caught by nets with long and short strops should be compared.

The reason for the recommendation is, that a considerable number of salmon below the enacted minimum size of 60 cm are caught in drift-nets in the beginning of the salmon fishing season, August-September. This inexpedient loss is said to be caused by a change of the net mounting, which has taken place during the last few years. The strops connecting the floating line and the head line (Figure 1) have been shortened from 40 cm to 15 cm, 10 cm or even less in order to raise the net closer to the sea surface, which according to the fishermen gives higher yield in the beginning of the season.

The proposed experiment was carried out by Danmarks Fiskeri- og Havundersøgelser in the months of August and September 1967. In connection with the experiment the vertical distribution of the salmon in the nets was examined. Also the survival of netted salmon below 60 cm to be released into the sea was estimated.

The experiment took place on board a commercial salmon vessel mainly during two fishing trips: August 26th - September 2nd and September 8th - 15th, on the position 20-25 NM NE of Gotska Sandön and 20-40 NM SW of Gotska Sandön respectively. The original intention was to accomplish the research fishery by means of nets mounted with 10 cm and 40 cm strops in equal numbers. This plan had to be abandoned as salmon nets with long strops are practically not used anymore in the Baltic. However, we succeeded in finding a vessel carrying nets with different lengths of strops, but of a highly varying number. Nets with the following lengths of strops were represented: 10 cm, 15 cm, 20 cm, 30 cm and 40 cm. Unfortunately nets with 30 cm and 40 cm strops were few in number. Moreover the latter had just been dyed and were therefore very stiff at the beginning of the fishery. The possibility exists that on the first few days their ability of fishing were not quite as good as the other nets used.

On the homeward passage from Gotland on board another salmon vessel the investigation was continued on September 15th - 18th, 30 NM W of Visby and 25 NM SW of Hoburg. This vessel only carried nets with about 15 cm strops.

The number of nets in use differed from one night to the other owing to loss and destructions of nets, but on the former vessel about 400 were used during the first trip and about 430 on the second trip. The vessel, on which the third or homeward trip was made, carried about 480 nets. The nets were set in groups of 30, fastened to a buoy at both ends of the group.

The main part of the nets with 15 cm strops were 350 meshes long, the remaining nets had a length of 300 meshes. All the nets were $47\frac{1}{2}$ mesh deep. The net material

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was spun synthetic fibres, but of different manufacture. The mesh size of the nets was 160 mm except for the meshes formed by the head line and the uppermost part of the net. These so-called headmeshes had a size of 120-130 mm.

The fishery was carried out during the nights. The nets were set between 17.00 and 19.30 hrs. and hauled between 1.00 and 10.00 hrs. roughly speaking. As the nets last set, are hauled first and vice versa, the fishing time of the individual nets is varying about 6 - 16 hours. This difference in time of fishing, however, does not seem to have much effect as to the size of the catch in the individual nets. Nevertheless the nets were set in casual order, which means that nets with long and short strops had the same chance of catch regarding the time of fishing.

The material for the investigation was collected in connection with the hauling of the nets. The order and eventual catch of individual nets was noted, the vertical position in the net and the length of each salmon retained was recorded, and in case the salmon was below the minimum size, its chance of survival was estimated. The material examined comprises 802 salmon. Sea trout are not dealt with, as they are not subject to the rules of the Convention. While retained in the nets several salmon were more or less destroyed by seals, and therefore their length and distribution in the net could not always be established. In appendices I - IV are quoted the basic data of the experiment.

The Relation between Catch and Strop Length

As stated in the introduction the main purpose of the experiment was to compare the size-composition of salmon caught by nets with different lengths of strops, in order to find out, whether nets with short strops catch more salmon below 60 cm proportionally to nets with long strops. Furthermore it was the intention to confirm or reject the statement of the fishermen that in the beginning of the season nets with short strops also catch more salmon in total than the nets with long strops previously used. Table 1 shows for each of the four groups of nets mounted with 10 cm, 15-20 cm, 30 cm and 40 cm strops respectively: (1) the total number of salmon caught, (2) the number of salmon caught per 100 nets and (3) the number of salmon below 60 cm in percent of the total catch. The figures are given separately for the two experimental trips, during which nets with different length of strops were used.

Table 1. Catch of salmon in number, number per 100 nets and the percentage of salmon below the minimum size in relation to strop length of the nets used.

Length of strops	1st trip			2nd trip		
	Actual number	Number per 100 nets	% <60 cm	Actual number	Number per 100 nets	% <60 cm
10 cm	87	16.4	16.5	96	15.2	7.4
15-20 cm	284	15.7	14.5	174	11.1	10.5
30 cm	26	6.8	20.8	24	6.7	8.3
40 cm	7	3.7	14.3	12	6.3	0

When comparing the catches in the four groups of nets, it has to be considered that different numbers of nets from each of the four groups were used as shown in Appendix I. Thus only catch per unit effort of the net groups is directly comparable and therefore the number of salmon caught per 100 nets is also stated in the table. It clearly appears from the table that both during the 1st and 2nd trip the number of salmon caught per 100 nets is inversely proportional to the strop length of the net used. This result agrees fairly well with the claim of the fishermen who as a consequence have abandoned the nets with long strops.

The second statement, however, that the introduction of nets with short strops besides increasing the yield also increase the proportion of salmon below the minimum size, cannot be verified. As shown by the table no clear relationship, direct or inverse, seems to exist between the percentage of salmon below 60 cm and the strop length of the nets. If this is the case, the percentage of small salmon retained in nets is independent of strop length. That is to say that, relatively nets with short strops do not catch more salmon below 60 cm than nets with long strops. However, as

stated before nets with short strops obviously give the highest total yield, at any rate in the beginning of the season. Therefore the actual-number of salmon below the minimum size retained by these nets will of course be greater than the number retained by nets with long strops.

The scarcity of the material especially ^{related} to the very few nets with 30 and 40 cm strops in the experiment may possibly be accounted for the low correlation between size-composition and length of strops. In the following, therefore, the distribution of the salmon in the nets will be examined in order to reveal whether small salmon averagely stay higher in the sea than bigger salmon and consequently have a greater chance of being retained by nets with short strops.

The Distribution of Salmon in the Nets

According to the fishermen the reason for nets with short strops catching more salmon in the beginning of the salmon fishing season than nets with long strops is that the salmon live very close to the sea surface during that time of the year. To ascertain if the stock of salmon is really concentrated immediately below the sea surface, the experiment also intended to localize those net meshes that retained salmon. However, as the exact position of the catches in the net was not always possible to state and time when hauling the gear was scarce for measurement, the nets were divided horizontally into sections to which the catches were referred. The divisions in net sections were referred to the distance from the sea surface as shown below:-

0 - 40 cm from the sea surface
40 - 100 " " " " "
100 - 300 " " " " "
300 - 600 " " " " "

Furthermore it was noted when salmon were retained by the head meshes.

The vertical distribution of salmon catches in nets is shown in Table 2. The table shows:-

1. The total number of salmon caught in each of the net sections.
2. As the selected sections are not of equal size, the number of salmon caught per unit of net area, in this instance per 1 million meshes, are recorded for the sake of comparing the catches of the sections. Leaving the head meshes out of account in this connection because of their special ability of retainment, it clearly appears that the catches were mainly made in the uppermost 100 cm of the sea. The number of salmon caught per 1 million meshes shows that during the 1st and 3rd trip the concentration of salmon in the nets is continuously decreasing from the head line to the bottom of the net. Whereas during the 2nd trip the highest concentration is found in a depth of 40-100 cm. This distribution of salmon in the sea of course favours the use of nets mounted with short or no strops, as according to the investigation the number of salmon caught per unit of net area is about 20-40 times higher near the surface compared to the deeper parts of the net.
3. The different concentration of salmon below 60 cm in the upper and the lower parts of the nets is even more pronounced than the total catches. Even if the decrease in the percentage of salmon below the minimum size from the head line to the bottom is not gradual, it clearly appears, that there is an essential difference in the percentage of small salmon in the upper and lower half of the nets. This means that salmon below 60 cm theoretically constitute a greater proportion of the total catch in nets with short strops than in nets with long strops. This could, however, not be proved by the experiment with nets mounted with different length of strops, most probably due to the insufficient material.

Table 2. Catch of salmon in number, number per unit of net area and percentage of salmon below the minimum size in relation to the distribution in the nets.

Distance from the sea surface	1st trip			2nd trip			3rd trip		
	Actual number	Number per 10 ⁶ meshes	% <60 cm	Actual number	Number per 10 ⁶ meshes	% <60 cm	Actual number	Number per 10 ⁶ meshes	% <60 cm
<40 cm (Head meshes)	60	68.7	<u>60.0</u>	14	17.0	<u>57.1</u>	15	34.7	<u>26.7</u>
(normal)	98	41.2	9.5	28	12.3	14.3	16	12.3	6.3
40-100 cm " "	94	11.0	9.8	139	17.4	6.5	34	7.9	8.8
100-300 cm " "	74	2.5	7.1	93	3.4	5.4	19	1.3	0
300-600 cm " "	61	1.5	0	29	0.7	3.6	7	0.3	0

In this connection the attention should be drawn to Appendix IV, from which it appears that the length groups above 70 cm constitute a significant greater percentage of the catches in the bottom section of the net, than in the upper sections. This, however, does not involve catches of a greater number of big salmon, if the nets were lowered viz. using longer strops, as after all the concentration of salmon, also the big individuals is higher near the sea surface at the time of the year in question.

Quite naturally weather conditions are of importance for the results of the salmon fishery. Even if the weather was rather uniform during the period of investigation, an attempt has been made to relate direction and strength of wind with the size of the catches and their distribution in the nets. However no significant correlation could be found.

The Catches in the Head Meshes

As previously mentioned the head meshes are formed by the head line and the uppermost part of the net. In Table 2 the normal meshes of the upper section, measuring 160 mm and the head meshes measuring 120-130 mm can be compared in respect to total catch of salmon and percentage of salmon below 60 cm. The table shows that the total number of salmon caught per 1 million head meshes is greater than the yield per 1 million normal meshes. An important part of the catch in the head meshes is however constituted by salmon below the minimum size. On account of the selection by the head meshes bigger salmon will only be retained to a slight degree. The biggest salmon caught in the head meshes during the experiment was only 72 cm.

The main result of this investigation is, that the number of salmon below 60 cm retained by 1 million head meshes is 5 to 12 times greater than that retained by 1 million normal meshes immediately below the head meshes. Owing to the concentration especially of small salmon near the sea surface in the beginning of the season, the head meshes are no doubt to a great extent responsible for the relative numerous catches of salmon below the minimum size.

The Survival of Netted Salmon below 60 cm

According to the Baltic Fisheries Convention, Article 6, salmon below 60 cm caught in the area of Convention should immediately be released in the sea. If all salmon below 60 cm retained by nets were returned to the sea as provided in the rules, and if they were able to survive after the liberation, no inexpedient loss of small salmon would be caused by the drift-net fishery. The fishermen, however, state that very few small salmon caught in nets are able to survive after liberation. This is confirmed by another investigation carried out in connection with the net experiment. On basis of appearance, among others, loss of scales and behaviour after returning to the sea, salmon below the minimum size were classified in one of the following three groups: (1) dead, (2) doubtful survivors and (3) probable survivors. According to this division the numerical distribution of salmon was as follows

dead	59	individuals
doubtful	20	"
probable	15	"

This means that only about 15% of the salmon below 60 cm had a fair chance to survive netting.

The Length Distribution of Netted Salmon below the Minimum Size

The length distribution of salmon below 60 cm caught during the experiment shows that the majority were just below the minimum size; in fact more than half of these salmon ranged from 57 cm to 59 cm. A percentage distribution on 5 cm length groups gives the following result:-

55 - 59 cm	70 %
50 - 54 cm	23 %
45 - 49 cm	4 %
40 - 45 cm	2 %
35 - 39 cm	1 %

The Monthly Proportion of Netted Salmon below the Minimum Size

The extremely high growth rate of salmon ⁱⁿ the sea is the reason, why drift-net catches of salmon below 60 cm are only a problem at the beginning of the season. In August-September a new year-class (the age-group A.1+), having spent about 1 1/3 year in the sea, is introduced in the fishery. The size of salmon of this age-group range from about 50 cm to about 75 cm in August, varying a few cm from one year to another. The following April the dispersion of the same age-group, which is now two years old, has changed to about 55-85 cm. According to this growth the number of salmon below 60 cm which belongs to the age-group in question, is decreasing during the season. As shown in Table 3 such a decline is clearly reflected by the monthly percentage of salmon between 40 and 60 cm retained by drift-nets. The table is based on measurements of nearly 28,000 salmon from unsorted drift-net catches during the seasons 1957/58 - 1967/68. It should be noted, however, that especially in the last period of the season, an essential part of the salmon below the minimum size is constituted by larger individuals within the age-group (A.+), which is one year younger than the above-mentioned.

Table 3. The monthly percentage of salmon between 40 and 60 cm caught in drift-nets during the seasons 1957/58 - 1967/68.

Seasons	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May
1957/58								0.2	<0.1	
1958/59			0				0	< 0.1	0.2	0
1959/60							1.9	1.1	1.0	
1960/61			0						0	
1961/62										
1962/63								1.2		
1963/64			0.5			0.3			0.4	
1964/65				1.1		0.2			1.1	
1965/66		11.5	2.2			2.0				
1966/67	14.5	5.3	1.9							

In the season 1964/65 the previously used hemp nets were replaced by nets of synthetic fibres, but whether this change of net material has effected the catch of small salmon, cannot be ascertained.

Conclusions

1. The fishing experiment with nets mounted with strops of different length confirmed the statement of the fishermen that in August - September nets with short strops give higher yields of salmon than nets with long strops.

On the other hand possibly owing to scarcity of the material it could not be proved whether nets with short strops catch proportionally more salmon below the minimum size, than nets with long strops.

2. The distribution of the catches in the nets showed that the main part of the salmon was retained in the uppermost 100 cm of the net. This distribution of the catches is in accordance with the observations of the fishermen and is the reason for their use of nets mounted with short strops.

The percentage of salmon below 60 cm is essentially higher in the upper half of the net than in the lower half. Nets with short strops therefore theoretically catch proportionally more salmon below the minimum size than nets with long strops.

3. In the beginning of the season, when the salmon stock is staying very close to the sea surface, the head meshes are responsible for an important part of the catches of salmon below 60 cm. The relation between the number of salmon below the minimum size retained per head mesh and per normal mesh immediately below the head mesh is estimated to 5-12:1.
4. The survival of netted salmon below 60 cm which according to the rules of the Convention should be released in the sea is estimated to 15%. This survival rate agrees fairly well with the statement of the fishermen.
5. The length distribution of salmon below the minimum size shows that more than half of the individuals range between 57 and 60 cm.
6. The catch of salmon below 60 cm in drift-nets seems to be chiefly a problem in August - September, when the smallest individuals of the newly introduced year-class in the fishery are still below the minimum size.

Already in October the main part of these small salmon has grown to 60 cm or more.

Appendix I. Information on the nets used for the experimental fishery.

Length of strops		Length of nets number of meshes	Number of meshes per horizontal net section (distance from sea surface)					Number of nets used		
terned (cm)	real (cm)		Head meshes	N o r m a l m e s h e s				1st trip	2nd trip	3rd trip
				0-40 cm	40-100 cm	100-300 cm	300-600 cm			
10	8-10	300	300	1,200	2,700	9,900	14,400	530	630	
	(15-17	300	300	900	3,000	9,900	14,400	214	182	1,440
15-20	(14-17	350	350	1,050	3,500	11,550	16,800	+ ⁾ 1,181	+ ⁺)1,006	
	(20-24	300	300	900	3,000	9,900	14,400	217	211	
30	29-33	300	300	600	3,000	10,500	14,400	380	356	
40	39-41	300	300	-	3,000	11,100	14,400	190	192	

+⁾ and +⁺) correspond to 1,380 and 1,176 nets respectively with lengths of 300 meshes.

Appendix II. Information on the experimental fishery.

Date	Position of fishing	Wind direction and strength (Beaufort)	Time of fishing (number of hours)	+) Number of nets used	Catch in number of	
					Sea trout	Salmon
Aug. 26th-27th	18 NM NEtE of Gotska Sandön	2-3 WSW	6.00-16.10	432	-	50
" 27th-28th	24 " NEtE " " "	3 N	6.05-16.20	432	-	60
" 28th-29th	21 " NtE " " "	3 NNW	6.20-16.40	431	3	89
" 29th-30th	20 " NtE " " "	2 NNE-SSE	6.10-16.10	431	2	30
" 30th-31st	23 " NEtN $\frac{1}{2}$ N " " "	3 WSW	6.30-16.30	431	3	53
" 31st-Sept. 1st	23 " NEtN $\frac{1}{2}$ N " " "	4 SW-SSE	6.35-17.25	430	2	89
Sept. 1st- 2nd	25 " NEtN " " "	3-5 SW-W	6.50-13.30	324	1	33
				<hr/>		
				2911	11	404
				<hr/>		
Sept. 8th- 9th	13 NM NWtN of Hallshuk	5 N	5.35-16.50	468	2	74
" 9th-10th	18 " N $\frac{1}{2}$ W " "	3 WSW	5.45-15.45	462	3	67
" 10th-11th	24 " NW $\frac{1}{2}$ W " "	0-3 N	7.10-17.10	456	4	65
" 11th-12th	32 " NW " "	4 NNE	6.00-17.10	453	3	67
" 13th-14th	21 " SWtS $\frac{1}{2}$ S " Gotska Sandön	3 E	5.25-15.15	456	-	16
" 14th-15th	23 " WtN $\frac{5}{8}$ N " "	3 SSE-ESE	6.00-15.50	452	-	18
				<hr/>		
				2747	12	307
				<hr/>		
Sept. 15th-16th	30 NM W of Visby	2 E-ENE	6.00-14.40	480	1	33
" 16th-17th	25 " SW " Hoburg	3 E	6.00-15.30	480	3	44
" 17th-18th	25 " SW " "	1 NE	6.10-14.10	480	-	14
				<hr/>		
				1440	4	91
				<hr/>		

+) Number of nets with length of 350 meshes is converted to number of nets with length of 300 meshes by the factor $\frac{350}{300}$

Appendix III. Number of salmon caught per day in relation to strop length of the nets and size composition of the catches.

Strop length	10 cm					15-20 cm					30 cm					40 cm				
	<60	60-69	70-79	80-	total	<60	60-69	70-79	80-	total	<60	60-69	70-79	80-	total	<60	60-69	70-79	80-	total
Aug. 26th-27th	1	9	1	1	12	6	19	2	7	34	1	-	2	1	4	-	-	-	-	-
" 27th-28th	1	7	1	1	10	5	29	4	6	44 + 2	2	2	-	-	4	-	-	-	-	-
" 28th-29th	5	17	-	-	22	9	32	9	5	55 + 1	1	7	-	-	8	1	1	1	-	3
" 29th-30th	1	1	-	-	2	3	12	6	1	22 + 6	-	-	-	-	-	-	-	-	-	-
" 30th-31st	2	9	1	-	12 + 1	2	25	3	3	33 + 3	-	1	-	-	1 + 2	-	1	-	-	1
" 31st-Sept. 1st	3	16	1	1	21	10	39	9	1	59	1	6	-	-	7	-	1	1	-	2
Sept. 1st- 2nd	1	4	-	1	6 + 1	4	12	3	3	22 + 3	-	-	-	-	-	-	1	-	-	1
Aug. 26th-Sept. 2nd	14	63	4	4	85 + 2	39	168	36	26	269 + 15	5	16	2	1	24 + 2	1	4	2	-	7
Sept. 8th- 9th	5	13	2	-	20 + 2	4	30	6	1	41	2	5	1	-	8	-	2	-	-	2
" 9th-10th	-	19	4	1	24	1	27	6	3	37	-	4	-	-	4	-	1	1	-	2
" 10th-11th	-	19	1	1	21	3	23	9	2	37	-	2	1	1	4	-	2	1	-	3
" 11th-12th	2	13	4	2	21	7	22	5	2	36	-	4	1	1	6	-	3	1	-	4
" 13th-14th	-	-	-	-	-	2	11	1	-	14 + 1	-	1	-	-	1	-	-	-	-	-
" 14th-15th	-	7	-	1	8	1	5	1	-	7 + 1	-	-	1	-	1	-	1	-	-	1
Sept. 8th-15th	7	71	11	5	94 + 2	18	118	28	8	172 + 2	2	16	4	2	24	-	9	3	-	12
Sept. 15th-16th						3	22	6	2	33										
" 16th-17th						3	20	7	14	44										
" 17th-18th						2	8	3	1	14										
Sept. 15th-18th						8	50	16	17	91										

The additional figures to the total figures represent salmon, which cannot be distributed on length groups.

Appendix IV. Number of salmon caught per day in relation to position in the nets and size composition of the catches.

Horizontal net section	Head meshes					Normal meshes																			
						0-40 cm					40-100 cm					100-300 cm					300-600 cm				
Length groups (total length in cm)	<60	60-69	70-79	80-	total	<60	60-69	70-79	80-	total	<60	60-69	70-79	80-	total	<60	60-69	70-79	80-	total					
Aug. 26th-27th	4	3	-	-	7	2	8	1	3	14	1	9	1	3	14	1	6	-	1	8	-	2	3	2	7
" 27th-28th	5	2	-	-	7	1	15	2	1	19	-	6	2	-	8	2	6	-	1	9	-	5	1	4	10
" 28th-29th	12	12	1	-	25	1	16	-	2	19	-	7	3	1	11	3	12	2	-	17	-	10	4	2	16
" 29th-30th	1	-	-	-	1	-	2	-	-	2	3	2	-	1	6	-	2	2	-	.4 + 1	-	7	4	-	11
" 30th-31st	4	2	-	-	6	-	12	-	-	12 + 2	-	7	1	2	10 + 3	-	13	1	-	14	-	2	2	1	5 + 1
" 31st-Sept. 1st	8	2	-	-	10	4	18	3	-	25	1	10	2	1	14	1	23	5	1	30	-	6	1	-	7
Sept. 1st- 2nd	2	2	-	-	4	1	2	-	1	4 + 1	-	5	2	-	7 + 1	2	6	1	1	10 + 1	-	2	-	2	4
Aug. 26th-Sept. 2nd	36	23	1	-	60	9	73	6	7	95 + 3	5	46	11	8	70 + 4	9	68	11	4	92 + 2	-	34	15	11	60 + 1
Sept. 8th- 9th	2	1	1	-	4	1	6	-	-	7	4	21	3	-	28	4	19	3	1	27	-	3	2	-	5
" 9th-10th	-	1	-	-	1	-	4	2	-	6	-	19	1	1	21	-	24	8	2	34	1	3	-	1	5
" 10th-11th	1	1	-	-	2	1	4	-	1	6	-	16	5	1	22	1	24	7	-	32	-	1	-	2	3
" 11th-12th	4	2	-	-	6	2	4	1	1	8	-	8	-	3	11	3	25	6	-	34	-	2	4	1	7
" 13th-14th	-	-	-	-	-	-	-	-	-	-	1	5	-	-	6	1	2	1	-	4	-	5	-	-	5 + 1
" 14th-15th	1	-	-	-	1	-	-	-	1	1	-	4	1	-	5	-	7	-	-	7 + 1	-	2	1	-	3
Sept. 8th-15th	8	5	1	-	14	4	18	3	3	28	5	73	10	5	93	9	101	25	3	138 + 1	1	16	7	4	28 + 1
Sept. 15th-16th	-	2	-	-	2	1	5	2	1	9	-	5	1	-	6	2	7	2	1	12	-	3	1	-	4
" 16th-17th	2	7	-	-	9	-	2	1	1	4	-	5	1	7	13	1	5	4	5	15	-	1	1	1	3
" 17th-18th	2	2	-	-	4	-	3	-	-	3	-	-	-	-	-	-	3	3	1	7	-	-	-	-	-
Sept. 15th-18th	4	11	-	-	15	1	10	3	2	16	-	10	2	7	19	3	15	9	7	34	-	4	2	1	7

The additional figures to the total figures represent salmon, which cannot be distributed on length groups.

Fig. 1. Section of a Danish drift net with 10 cm strops.

