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**DIFFERENCES IN THE STATE OF HERRING STOCKS IN
THE NORTHERN AND SOUTHERN PART OF THE
GULF OF FINLAND**

by

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Abstract

Recaptures of taggings show that some of the herring spawning off the northern coast of the Gulf of Finland move to the southern side of the mid-line, but that the proportion of these herring is small. According to VPA, the fishing mortality in the Soviet zone has more than doubled since 1977, and the spawning stock biomass in 1982 was 40 % of that in 1977. In the Finnish fishing zone no major changes have taken place. Because of the limited mixing and the difference in their development, the herring stocks in the northern and southern areas should be assessed separately.

Résumé

Les recaptures de marquages indiquent qu'une partie du frai de hareng au large de la côte nord du Golfe de Finlande se déplace du côté sud de la ligne méridienne mais la proportion de ces harengs est faible. D'après les VPA la mortalité de pêche dans la zone soviétique a plus que doublé depuis 1977 et la biomasse du stock de frai était en 1982 40 % de celle en 1977. Aucun changement majeur n'a eu lieu dans la zone de pêche finlandaise. Dû à un brassage faible et à un développement différent, les stocks de hareng dans les zones nord et sud devraient être évalués séparément.

Introduction

The Gulf of Finland is 400 km long and 48-120 km broad, having an area of 29 600 km². The mean depth is 38 m and the maximum depth 123 m. The northern coastal area is shallow with a belt of skerries and islands. Off the southern coast the shallow zone is smaller, and islands are few. Along the middle stretches a continuous deep water area, where the depth is 50-100 m. In the east the deep water reaches the longitude 27°40'E, which is also the limit of the Finnish fishing zone.

The spawning populations of the northern and southern coasts do not differ greatly in racial characters, growth rate or the relative abundance of the year classes, and the natural conditions in these areas are very similar. There are differences, however, in the development of the fishery. This report deals with the state of the herring stocks in the Finnish and Soviet fishing areas, and considers the advisability of making separate assessments for the two areas.

Fishing rights

Up to the beginning of 1977, foreign vessels had unlimited rights to fish off the Finnish coast outside the four-mile territorial waters. In the years 1977-79, the USSR had the right to fish 7 000 t sprat in the western part of the 12-mile Finnish fishing zone in the Gulf of Finland, up to longitude 24°18'04". The largest number of vessels allowed to fish at the same time was 40. The maximum allowable herring by-catch in the sprat fishery was 20 % of the weight of the catch. If the amount of herring in the catch was bigger, sprat fishing at that place had to stop immediately. Since 1979 no foreign fishing vessels have operated in the Finnish fishing zone, which reaches to the mid-line of the Gulf of Finland. The Finnish fishing area forms about 1/3 of the total area of the Gulf.

Catch composition

In 1981, the herring catch in the Gulf of Finland was 45 211 t, of which the Finnish share was 38 % and the Soviet 62 % (Anon. 1983a). There is a big difference in age composition between the Finnish and Soviet catches (Fig. 1). The small proportion of young herring and the large proportion

of old herring in the Finnish catch is due to the large proportion of trapnet catches. In 1981 the trapnet catch was 69 % of the total Finnish herring catch (Anon. 1983a). In the Soviet area of the Gulf of Finland the proportion of the trapnet catch in 1981 was only 3.7 %. Of the total Soviet herring catch in the Gulf of Finland, 92 % is taken west of longitude 28°E (25 701 t in 1981, Anon. 1983b). In 1976 the amount of trapnets in this area was 26, but by 1982 their number had been reduced to only 2 (Anon. 1983a). In the corresponding area off the northern coast of Finland there were 637 trapnets in 1981 (Anon. 1983a). The number of Finnish trapnets has not changed during these years.

In the Finnish pelagic trawl catch, the proportion of young age groups nowadays corresponds to that in the Soviet herring catches. There may still be differences in the composition of the fish stocks, because the regulations concerning trawls and their use differ in the Finnish and Soviet fishing zones. According to the rules of the International Baltic Sea Fishery Commission, the smallest allowable mesh size of the trawl is 10 mm bar length. Other regulations referring to the use of the trawl have not been considered to be necessary in the Finnish herring fishery. In the Soviet fishing zone the smallest allowable mesh size of the trawl has been 14 mm. In addition, in the Soviet fishing zone the smallest legal size of herring is 10 cm standard length, corresponding to about 11 cm total length. Trawling is also forbidden in places with a depth of less than 20 m. In spite of these regulations, the Soviet fishing is directed to small herring to a greater extent than the Finnish (Fig. 1).

Taggings

Baltic herring spawn in spring off the northern and southern coasts of the Gulf of Finland, and perform feeding and wintering migrations to the middle part of the Gulf (Anon. 1978). In 1975-79 herring were tagged during the spawning time off the northern coast of the Gulf of Finland (PARMANNE & SJÖBLOM 1982a). A large part of the recaptures were obtained soon after tagging, and cannot be used to investigate the movements of the herring stocks in the Gulf of Finland. The latest recaptures, however, were made more than one year from the tagging.

Of 21 recoveries obtained at least one month after tagging, five were received from the Soviet fishery. The mean Finnish catch in the Gulf of Finland in 1975-80 was 15 773 t and the mean Soviet herring catch 31 358 t (Anon.

1983a). The recaptures in the two fisheries can thus be compared:

$$\frac{\frac{5}{31\,358\text{ t}}}{\frac{16}{15\,773\text{ t}}} = 0.16$$

The recoveries of herring tagged off the Finnish coast in the Soviet fishery have been 16 % of the recoveries in the Finnish fishery.

Differences in fishing methods make comparison of recaptures difficult. Off the coast of Finland part of the recaptures have been made in large-meshed gillnets, part in the non-commercial fishery. All the Soviet recaptures are from trawl catches. The yearly Soviet herring catch in 1976-80, after subtraction of the mean trapnet catch of 3 092 t, is 28 266 t (Anon. 1983a). Of the recaptures in the Finnish fishery, six are from trawl catches. The yearly Finnish trawl catch in 1975-80 was 4 890 t (Anon. 1983a). This gives:

$$\frac{\frac{5}{28\,266\text{ t}}}{\frac{6}{4\,890\text{ t}}} = 0.14.$$

Thus, calculated in this way the recaptures in the Soviet fishery are 14 % of those in the Finnish fishery.

The material available is small, however, and there are no data concerning the proportion of possible unreported recaptures in different areas. For instance, about half of the Finnish herring catch is used for animal fodder. In this catch tags easily remain unobserved and unreturned. The recaptures show, however, that some of the herring spawning off the northern coast of the Gulf of Finland move south of the mid-line for feeding and wintering, but that the proportion of these herring is small. Of the herring tagged in the USSR none has been recovered in the Finnish fishery.

The numbers of Baltic herring larvae

Comparable data concerning the numbers of Baltic herring larvae off the coast of Finland are available from 1974 onwards (SJÖBLOM & PARMANNE 1975, 1976, 1977, 1978, 1979, PARMANNE & SJÖBLOM 1980, 1981, 1982b). In the central part of the Gulf of Finland the abundance of larvae has been higher than earlier since 1977, and in the western part since 1980 (Fig. 2). The

abundance of bigger larvae is dependent on mortality. The numbers of small (< 10 mm) herring larvae off the Finnish coast in the Gulf of Finland have been higher than earlier in recent years (Fig. 3). The herring spawning stock size is correlated with larval abundance (e.g. WOOD 1982). According to the preliminary data, larvae have been abundant in summer 1983, as well.

The data available from the Soviet coast concerning the abundance of herring larvae in June-July indicate that the amount of larvae has diminished in 1979-81 (Fig. 4-5) (RAID 1982).

Copepod nauplii are important for the survival for herring larvae (RANNAK & SIMM 1979, PARMANNE & SJOBLUM 1982b). Although the numbers of herring larvae have increased in the northern part of the Gulf of Finland, no corresponding rise can be observed in the abundance of zooplankton in May-August (Fig. 6), or in the abundance of copepod nauplii in June (Fig. 7). The correlations between the abundance of herring larvae and the zooplankton are not statistically significant (Table 1).

VPA

In the report of the working group on assessment of pelagic stocks in the Baltic, the stock of herring in the Gulf of Finland is treated as one unit (Anon. 1983a). The 1982 fishing mortality rate was supposed to be at the level of the 1979-80 values. The shift of the herring fishery to the younger age groups was taken into account by increasing F for 1- and 2-year-old herring by 20 % in 1982 compared with the level in 1979-80.

In the present study the stocks of the Finnish and USSR fishing areas were treated as separate units, to see whether differences were revealed in the state of the stocks. Such differences would be evidence that they are in fact separate. As no data were at hand about the Soviet herring catch from the northern side of the mid-line before 1977, only the years 1977-82 were included in the VPA.

For the VPA the following data used by the working group on assessment of pelagic stocks in the Baltic were applied (Anon. 1983a):

- As input data the catch numbers (Tables 2 and 3) of each country were used. However, the herring catch taken by the Soviet in the Finnish fishing zone in connection with the sprat fishery in 1977-79 was counted for Finland. This herring by-catch was 943 t in 1978 and 1 320.7 t in 1979 (Anon. 1981). As no data were available on the herring by-catch in 1977, it was taken as the mean for 1978-79 (1 132 t). The composition of

the Soviet herring catch in the Finnish fishing zone was supposed to be the same as that of the total Soviet herring catch in the Gulf of Finland.

- Natural mortality $M = 0.2$.
- Fishing mortality for the oldest age group is 0.5 in 1977-79 and 0.6 in 1980-82.
- The 1982 fishing mortality rate was supposed to be the mean of the 1979-80 values.
- The F values for 1- and 2-year-old herring were increased by 20 % for 1982 compared with the level in 1979-80.
- The mean weights at age were taken from the working group report (Anon. 1983a).
- 60 % of the two-year-old and 80 % of the three-year-old herring were considered to be mature.
- The 1982 year class strength was supposed to be 75 % of the mean in 1977-81.

The results of these two analyses show, that in the Soviet fishing area the fishing mortality coefficient has increased since 1977 (Fig. 8, Table 4). In 1977, \bar{F}_{3-7} was 0.42 and in 1980 it was 0.94. In the Finnish fishery the corresponding values (Table 5) were 0.35 and 0.45. Calculated from the number of fishing days and nets, the total effort has not increased in the Finnish herring fishery in the Gulf of Finland (Anon. 1983a). Thus the slight increase in F in the Finnish fishery may be explained by the mixing of fish between the fishing zones.

In the Soviet fishing zone, there has been a change in the spawning stock size. The spawning stock biomass in 1977 was 76 678 t (Fig. 8, Table 6), whereas in 1982 it was only 40 % of that value. In the Finnish fishing zone the spawning stock biomass was at the same level in 1977 and 1982 (Fig. 8, Table 7).

Conclusions

The development of the herring stocks differs between the northern and southern part of the Gulf of Finland. Combining the data from the two fisheries does not take into account the different character of the herring stocks. This may cause risks for the fish stock which is in a poor condition. Therefore it is recommended that the Gulf of Finland herring stocks should be assessed separately.

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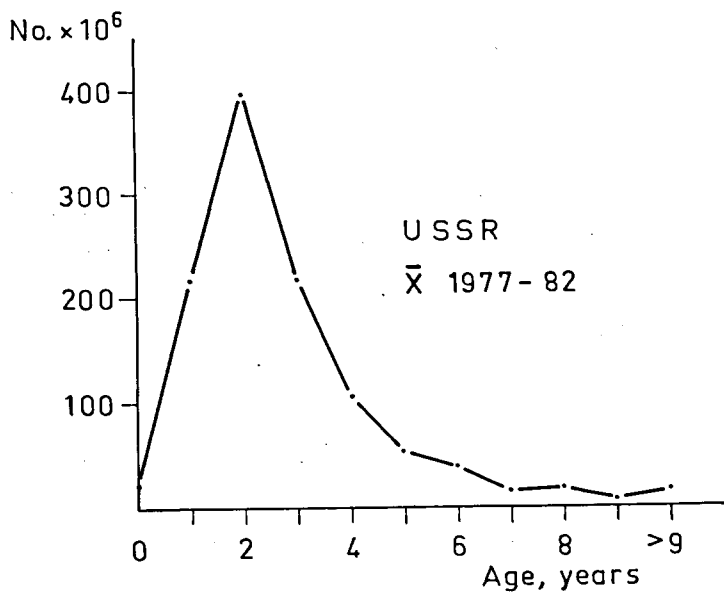
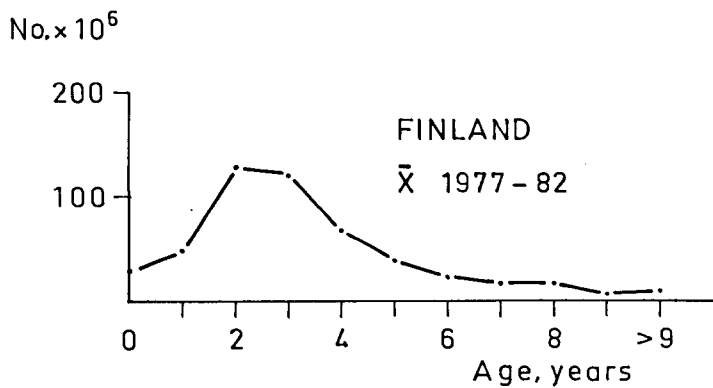


Figure 1. Age distribution of mean yearly herring catch in numbers in the Gulf of Finland, according to the ICES working group on assessment of pelagic stocks in the Baltic.



Figure 2. The abundance of herring larvae in the Gulf of Finland off the Finnish coast.

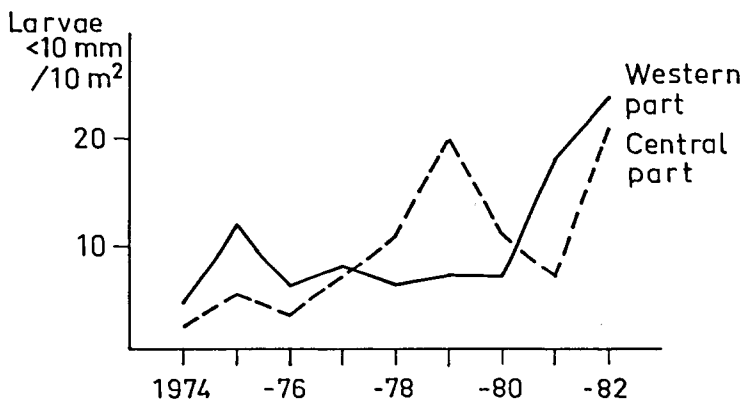


Figure 3. The abundance of small (< 10 mm) herring larvae in the Gulf of Finland off the Finnish coast.

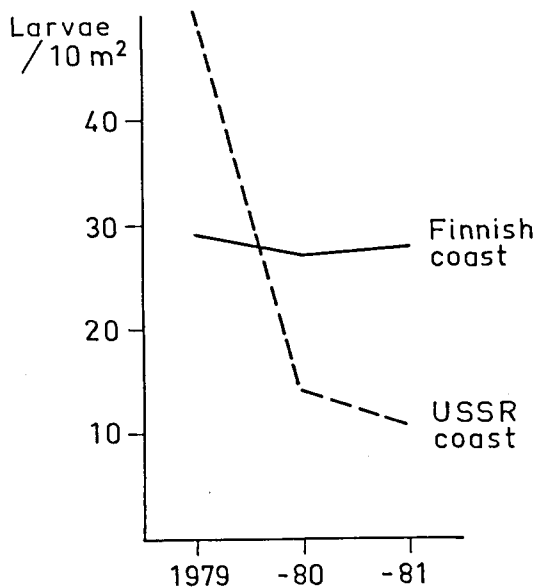


Figure 4. The abundance of herring larvae in June-July in the Gulf of Finland.

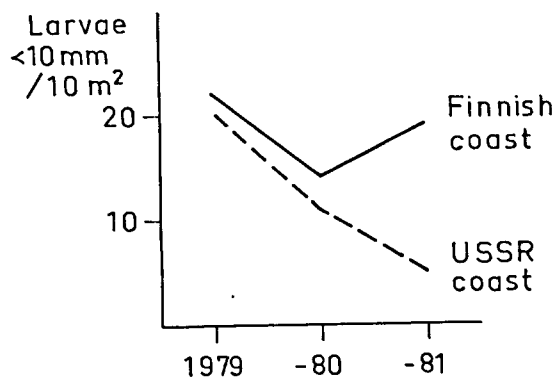


Figure 5. The abundance of small (< 10 mm) herring larvae in June-July in the Gulf of Finland.

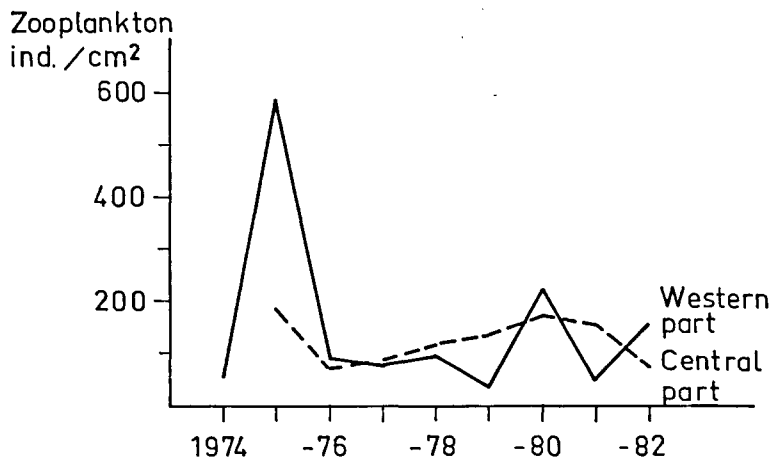


Figure 6. The abundance of zooplankton in May-August in the Gulf of Finland off the Finnish coast.

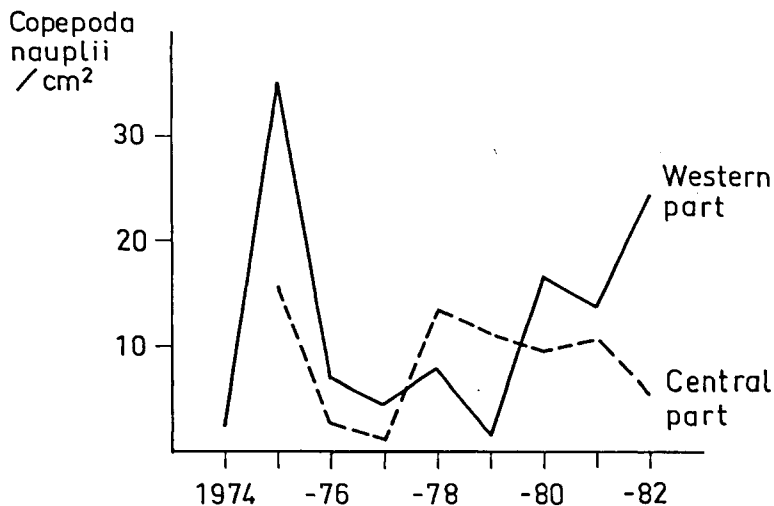


Figure 7. Numbers of copepod nauplii in June in the Gulf of Finland off the Finnish coast.

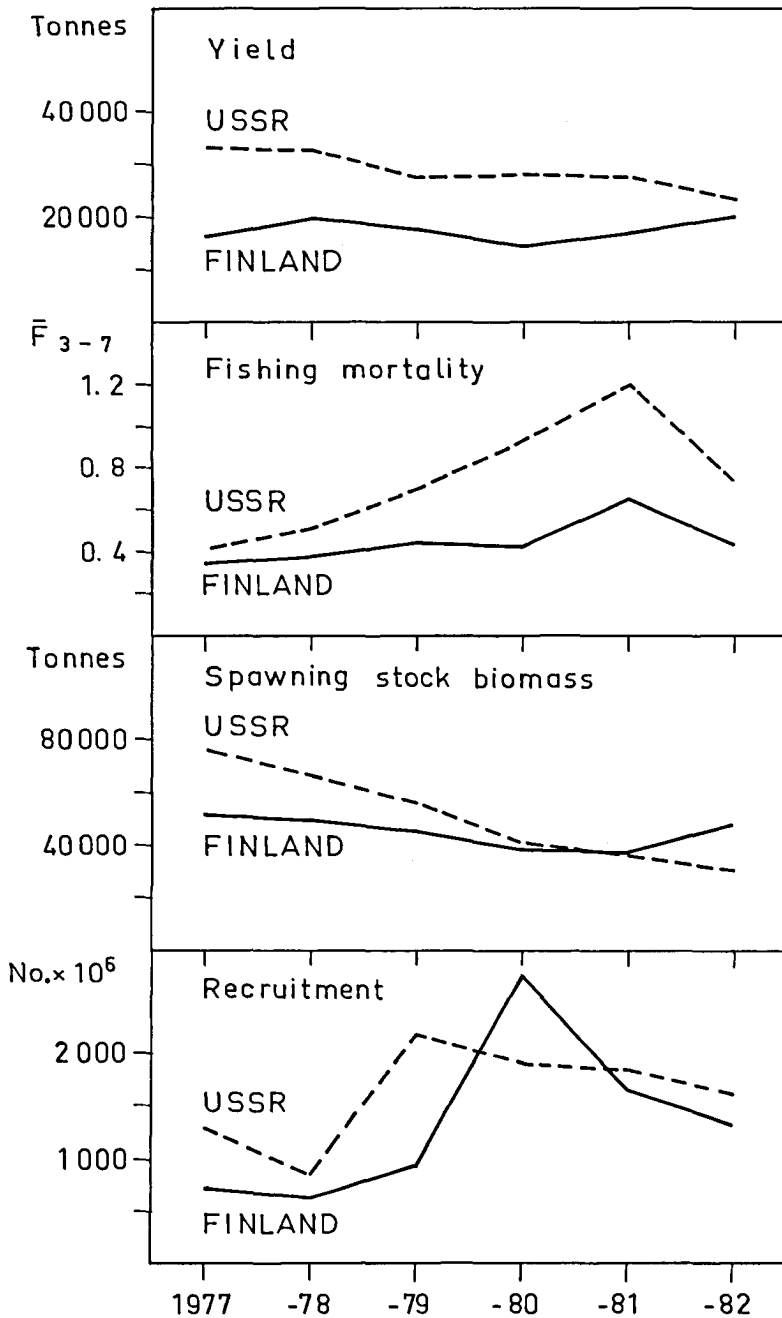


Figure 8. State of the herring stocks in the Finnish and USSR fishing zones in the Gulf of Finland in 1977-82.

Table 1. The coefficient of the correlation (r) between the abundance of Baltic herring larvae and zooplankton in the Gulf of Finland in 1974-82 off the Finnish coast.

		The abundance of zooplankton in May-August	Number of copepod nauplii in June
Abundance of small (< 10 mm) herring larvae in May-August	Western part	0.157	0.600
	Central part	0.135	0.078

Table 2. Herring catch in numbers $\times 10^6$ in the Finnish fishing zone in the Gulf of Finland.

Age	1977	1978	1979	1980	1981	1982
0	1	34	19	43	20	50
1	27	47	35	37	56	95
2	119	70	74	75	95	385
3	158	216	91	74	89	130
4	65	66	150	54	62	37
5	43	37	36	67	34	29
6	31	27	18	15	50	10
7	28	23	18	12	11	16
8	29	43	12	14	9	2
9	8	7	21	5	8	3
10+	12	10	9	13	16	5

Table 3. Herring catch in numbers $\times 10^6$ in the Soviet fishing zone in the Gulf of Finland.

Age	1977	1978	1979	1980	1981	1982
0	18	8	17	40	31	15
1	183	143	77	335	281	270
2	771	120	231	218	570	434
3	140	473	113	210	137	210
4	110	64	283	57	79	30
5	41	58	44	137	14	18
6	80	56	30	15	46	1
7	15	19	20	13	5	14
8	8	61	13	17	10	1
9	2	4	27	2	3	1
10+	21	18	13	26	12	4

Table 4. Fishing mortality of herring in the Soviet fishing zone in the Gulf of Finland.

Age	1977	1978	1979	1980	1981	1982	1979-80
0	.02	.01	.01	.02	.02	.02	.02
1	.34	.16	.13	.23	.22	.22	.18
2	.43	.39	.43	.62	.77	.63	.53
3	.56	.52	.79	.88	1.07	.73	.84
4	.51	.54	.69	1.35	1.05	.73	1.02
5	.24	.56	.92	.88	1.92	.73	.90
6	.70	.61	.63	.98	.87	.73	.81
7	.08	.35	.46	.63	1.13	.73	.55
8	.24	.57	.43	.93	1.65	.73	.68
9	.07	.18	.53	.11	.41	.73	.32
10+	.50	.50	.50	.60	.60	.60	.55
\bar{F}_{2-7} unweighted	.42	.50	.65	.89	1.14	.71	
\bar{F}_{3-7} unweighted	.42	.52	.70	.94	1.21	.73	

Table 5. Fishing mortality of herring in the Finnish fishing zone in the Gulf of Finland.

Age	1977	1978	1979	1980	1981	1982	1979-80
0	.00	.06	.02	.02	.01	.02	.02
1	.06	.09	.08	.05	.03	.08	.07
2	.13	.20	.20	.25	.19	.27	.23
3	.58	.38	.43	.32	.53	.44	.38
4	.39	.51	.49	.50	.48	.44	.50
5	.31	.40	.59	.42	.69	.44	.51
6	.27	.32	.35	.52	.65	.44	.44
7	.22	.34	.37	.41	.95	.44	.39
8	.75	.63	.29	.56	.63	.44	.43
9	.41	.40	.73	.19	.73	.44	.46
10+	.50	.50	.50	.60	.60	.60	.55
F_{2-7} unweighted	.32	.36	.41	.40	.58	.41	
F_{3-7} unweighted	.35	.39	.45	.43	.66	.44	

Table 6. Herring stock size in numbers $\times 10^6$ in the Soviet fishing zone in the Gulf of Finland at the beginning of the year.

Age	1977	1978	1979	1980	1981	1982
0	1299	879	2200	1934	1870	836
1	696	1048	712	1786	1547	1503
2	2400	406	729	514	1161	1014
3	357	1273	224	390	226	442
4	302	167	619	83	132	63
5	208	149	80	254	18	38
6	174	133	70	26	86	2
7	205	71	59	30	8	29
8	41	154	41	30	13	2
9	33	27	72	22	10	2
10+	29	25	18	35	16	5
Total no.	5744	4332	4824	5104	5087	4736
Spawning stock no.	2718	1988	1575	1100	1161	1103
Total biomass, t	115582	100330	87400	92129	82607	79246
SSB, t	76678	67623	57226	41858	36963	30862

Table 7. Herring stock size in numbers $\times 10^6$ in the Finnish fishing zone in the Gulf of Finland at the beginning of the year.

Age	1977	1978	1979	1980	1981	1982
0	727	638	956	2789	1685	2785
1	546	595	492	765	2245	1361
2	1054	423	444	371	593	1787
3	393	756	283	297	236	400
4	221	180	425	150	177	114
5	178	123	88	214	75	89
6	142	107	67	40	115	31
7	154	88	64	39	19	49
8	60	101	52	36	21	6
9	26	23	44	32	17	9
10+	17	14	13	17	21	7
Total no.	3518	3048	2928	4750	5204	5212
Spawning stock no.	1744	1495	1245	989	990	1697
Total biomass, t	76215	72156	64197	77353	86776	97654
SSB, t	53572	50867	45975	38990	38178	48634