29

International Council for
the Exploration of the Sea

C.M. 1986/H:51
Pealegic Fish Committee

THE EFFECTS OF A MINIMUM LANDING SIZE REGULATION IN THE FISHERY OF NORWEGIAN SPRING-SPAWNING HERRING

by

Johannes Hamre and Reidar Toresen
Institute of Marine Research
P.O. Box 1870, N-5011 Bergen, Norway

Abstract

Effects of minimum landing size (l_c) in the fishery of Norwegian spring-spawning herring have been investigated. The herring is assumed to be a unit stock, in which the growth of immatures differs according to the distribution area. Two immature stock components are distinguished. One distributed in Norwegian coastal waters south of 70 degrees north and one off Northern Norway and in the Barents Sea. Stock and yield per recruit for two corresponding stock components were calculated (ICES standard programmes) using input parameters as observed in the respective areas. The weight in catch by age of immatures is set equal to that observed in autumn catches (expected to be the main fishing season of immatures) whereas the weight in catch of adults is the average over the year. The weight by age in the stock equals observed weight of prespawners. The maturity ogive by component is calculated by using the length dependent maturing scale described by Toresen (1986).

The assessment shows that if this stock is managed at $F_{0.1}$, there is little to gain in yield and stock per recruit by introducing a minimum landing size above 20 cm in Norwegian coastal waters (south of 70^0 N), whereas some increase in yield may be obtained in the Barents Sea.

Introduction

The Atlanto-Scandian Herring and Capelin Working Group considered the effects of a minimum landing size of herring (l_c) at its 1985 meeting (Anon 1986). Based on an assumed average growth pattern similar to that observed in the strong yearclasses 1959 and 1960 and a natural mortality rate of 0.13 for all agegroups, the Working Group calculated stock and yield per recruit for minimum landing sizes of 20 cm, 25 cm, 27 cm and 30 cm. The results shoved that some gain could be obtained in the potential yield by increasing the minimum landing size from 20 cm to 25 cm at an exploitation level of $F_{0.1}$, but practically no gain in yield can be expected by increasing l_c above 25 cm. The growth pattern and natural mortality rate of immature herring may differ according to the distribution area of the immatures. The juvenile herring off northern Norway and in the Barents Sea has a slower growth rate than the juvenile herring distributed on the Norwegian coast further to the south. It is also reasonable to assume that natural mortality of herring is higher in the Barents Sea than in the coastal area due to preadation by cod. The aim of the present paper is to investigate the effects of minimum landing sizes of herring for the two herring components separately, regarding the two groups of immatures to be recruits to one unit adult stock.

Material and methods

Sustained yield (Y) and corresponding spawning stock (S) per recruit have been calculated by using the ICES standard programmes. The input parameters of weight by age, fishing pattern, maturation ogive and natural mortality are determined as follows:

Weight by age

The weights by age in catch and stock by component are given in Table 1. The weights in catch are calculated mean weight in the catches in August-October for herring younger than 6 years and mean weight in the catches throughout the year for fish 6 years or older. The weights by age in stock are calculated mean weight by age of stock samples from the the first three months of the year.

Fishing pattern

The programme determines fishing pattern as relative F by age groups. The minimum landing size may determines the fraction of an age group of immatures being recruited to the catchable stock and the relative F is estimated as the proportion of herring within the age groups beeing above the l_c . The fishing pattern will therefore depend on the growth and is different for the two stock components. The calculated values are shown in Table 2.

Maturity ogive

The programme calculates mature stock as the sum of the proportions of mature herring in all age groups. Toresen (1986) has shown that the maturity ogive of herring is length dependent, and therefore depends on the growth rate. The proportion of mature herring by age groups have been estimated as it's proportion in the spawning stock while maturing (at 3, 4 and 5 years) relative to it's proportion when fully recruited (mean prop. at 6, 7 and 8 years). These proportions varies according to the growth of the immatures. The input figures of mature herring of the coastal component are estimated to 10%, 25%, 60% and 90% for the age groups 3 to 6 respectively and 100% above 6 years. For the Barents Sea component the maturing is calculated to be delayed by one year. The figures are based on values from the respective components of the yearclasses 1959 and 1960.

Natural mortality

In accordance with the same basic consideration as descibed in the Working Group report (Anon. 1986), the effects of minimum landing sizes are calculated for the following values of M:
(1) M = 0.15 for all ages in both components;
(2) $M_1 = M_2 = 0.35$ and $M_{>2} = 0.15$ in both components and (3) $M_1 = M_2 = 0.50$, $M_3 = 0.35$ and $M_{>3} = 0.15$ in The Barents Sea. The M-values of 0.35 on juveniles in the coastal component are derived from acoustic stock abundance estimates, whereas the M-values of juvenile herring in the Barents Sea are judged according to expected predation pressure from cod.

Results

Sustainable yield (Y) and corresponding spawning stock (S) per recruit as one year olds (R_1) are calculated as function of F for l_c-values of 20 cm, 25 cm, 27 cm (recommended by ACFM) and 30 cm. The results are shown in Figures 1 to 5. For the coastal component (Figure 1 and 2) there is little to gain in the Y/R_1 for F-values below 0.5 even if M on immatures should be as low as 0.15. A restriction on the small herring fishery is on the other hand of much more importance for the recruitment to the spawning stock. For F = 0.5 an increase in l_c from 20 to 27 cm may double the spawning stock if M on immature herring is less than 0.35.

For The Barents Sea component a considerable gain in yield can be expected by a minimum landing size regulation when the exploitation is high. For F = 0.5 the gain in Y/R_1 is calculated to some 30% if the effective l_c is increased from 20 to 27 cm in the case of low M (Figure 3), and even in the case of the highest M-value (Figure 5) the gain in yield is above 15%. In addition, this regulation is expected to increase the spawning stock by some 300%.

ACFM has as a guidline of exploitation rate recomended that herring stocks should preferably be exploited at $F_{0.1}$. The equilibrium state of stock and yield per recruit for this referent point of F are summarized in Table 3.

The assessment shows that if this stock is fished at $F_{0.1}$, there is practically nothing to gain in yield and stock per recruit by introducing a minimum landing size above 20 cm in Norwegian coastal waters (south of 70^0 N), whereas some increase in yield may be obtained in the Barents Sea provided that the M-value on the immatures is below 0.35.

Norway has introduced a 25 cm minimum landing size of herring fished in her fishery zone north of 62^0 north. Based on the present study it seems fair to conclude that this is a sufficient restriction on the small herring fishery in case the overall fishing mortality is regulated to a reasonably low level. This fishery is regulated by catch quotas and the F is cept below $F_{0.1}$. The propost minimum landing size by ACFM of 27 cm is therefore regarded as overcautious.

References

Anon. 1986. Atlanto-Scandian Herring and Capelin Working Group Report, 29 October-1 November 1985. ICES C.M. 1986/Assess:7.

Toresen, R. 1986. Length and age at maturity of Norwegian Spring-spawning herring for the year-classes 1959-61 and 1973-78. ICES C.M. 1986/H:42.

Table 1. Input parameters of weight (gram) in catch and stock by component.

	Weight i catch		Weight in stock	
Age	Coast	Barents Sea	Coast	Barents Sea
0	10	10	1	1
1	48	27	15	10
2	109	58	80	20
3	160	96	140	50
4	195	143	190	90
5	225	200	225	140
6	250	240	250	210
7	275	275	275	240
8	300	300	290	270
9	318	318	310	300
10	330	330	325	325
11	340	340	335	335
12	350	350	345	345
13	360	360	355	355
14	378	378	365	365
15	400	400	390	390

Tabel 2. Input parameters of fishing pattern by component and minimum landing sizes. The figures denote relative Fs by age.
C = coast component
B = Barents Sea component

	minimum landing size							
	20 cm		25 cm		27 cm		30 cm	
Age	C	B	C	B	C	B	C	B
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.91	0.64	0.16	0.00	0.00	0.00	0.00	0.00
3	1.00	0.92	0.92	0.12	0.63	0.00	0.03	0.00
4	1.00	1.00	0.96	0.77	0.73	0.26	0.32	0.04
5	1.00	1.00	1.00	1.00	0.97	0.98	0.76	0.56
6	1.00	1.00	1.00	1.00	1.00	1.00	0.82	0.82
≥ 7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 3. Yield and spawning stock per recruit estimates (gram) at $F_{0.1}$.

		Coastal comp.				Barents Sea comp.			
	l_c	20	25	27	30	20	25	27	30
case 1	Y/R_1	90	91	92	89	71	80	83	83
M=0.15	S/R_1	300	340	360	430	320	300	300	320
	$F_{0.1}$	.17	.19	.21	.23	.15	.19	.21	.23
case 2	Y/R_1	60	62	62	60	48	55	56	56
$M_1=M_2=0.35$	S/R_1	220	230	240	290	210	200	200	230
$M_{>2}=0.15$	$F_{0.1}$	.17	.19	.21	.23	.15	.19	.21	.23
case 3	Y/R_1					30	32	33	34
$M_1=M_2=0.5$	S/R_1					120	130	130	140
$M_3=0.35, M_{>3}=0.15$	$F_{0.1}$					.15	.19	.21	.23

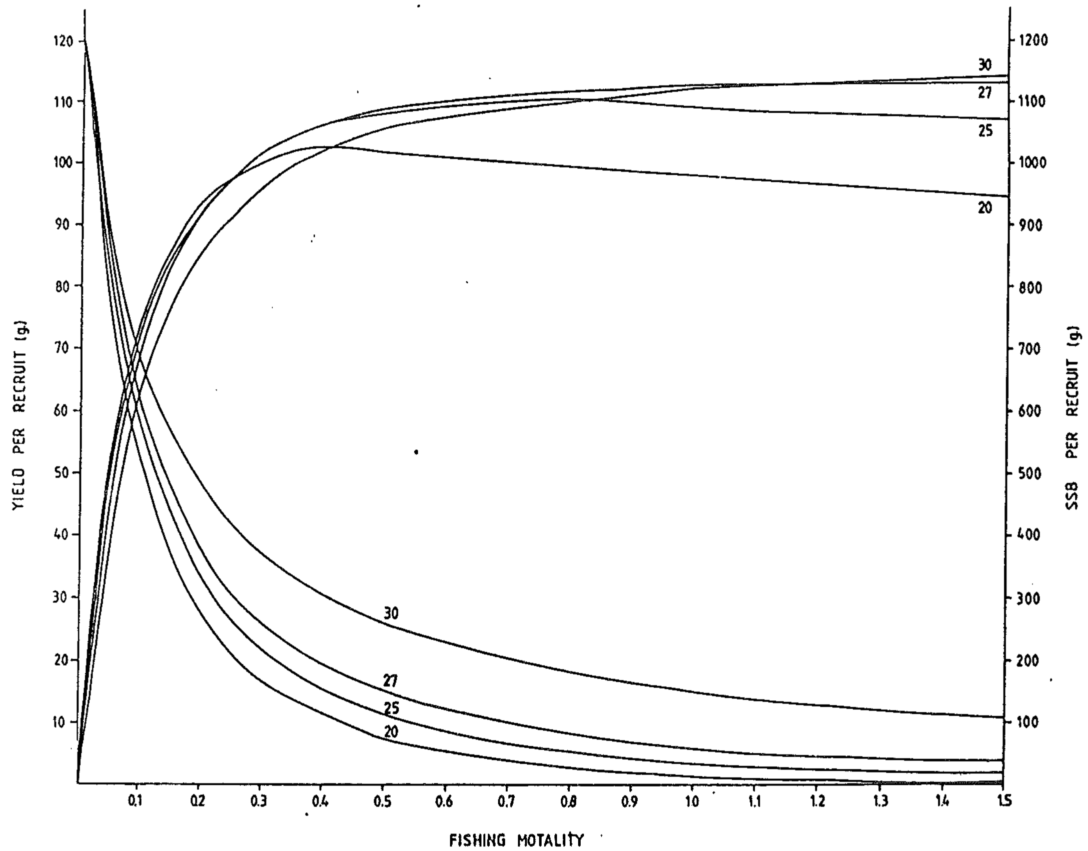

Figure 1. Coastal component of Norwegian spring spawning herring. Yield and spawning stock per recruit (SSB) for 20 cm, 25 cm, 27 cm and 30 cm minimum landing size. M=0.15

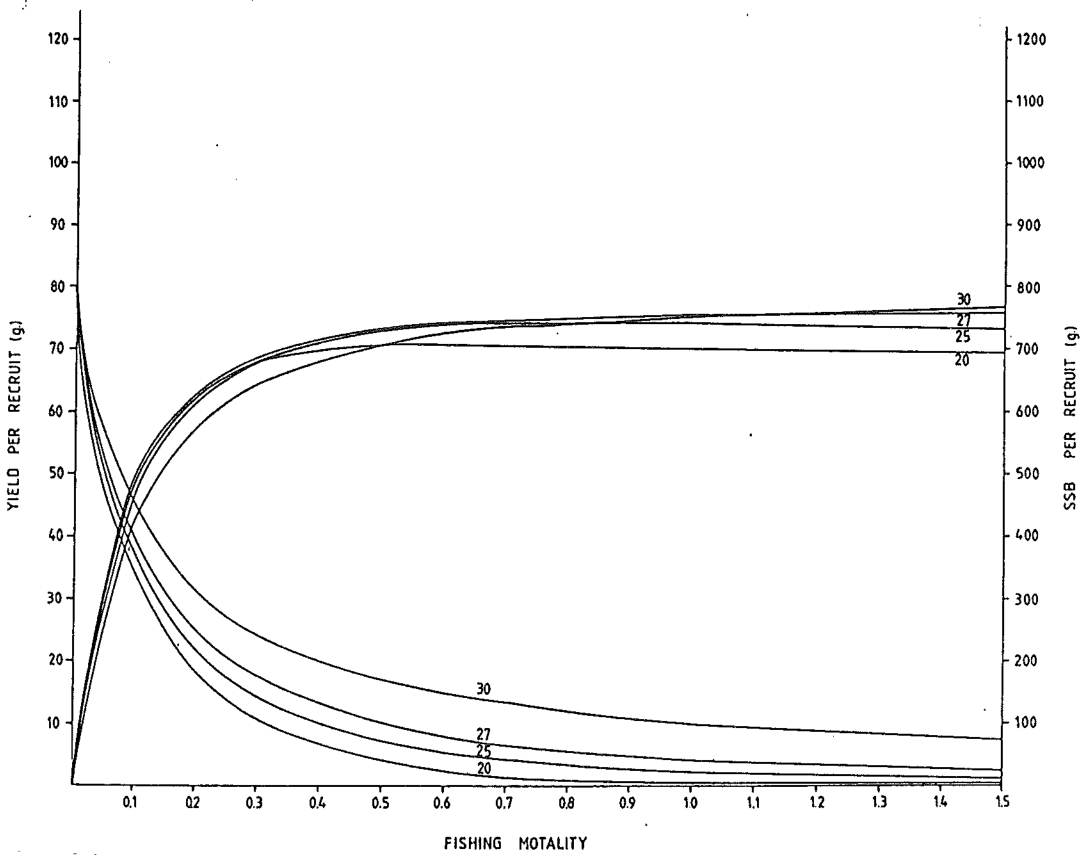

Figure 2. Coastal component of Norwegian spring spawning herring. Yield and spawning stock per recruit (SSB) for 20 cm, 25 cm, 27 cm and 30 cm minimum landing size. $M_1=M_2=0.35$. $M_{3+}=0.15$

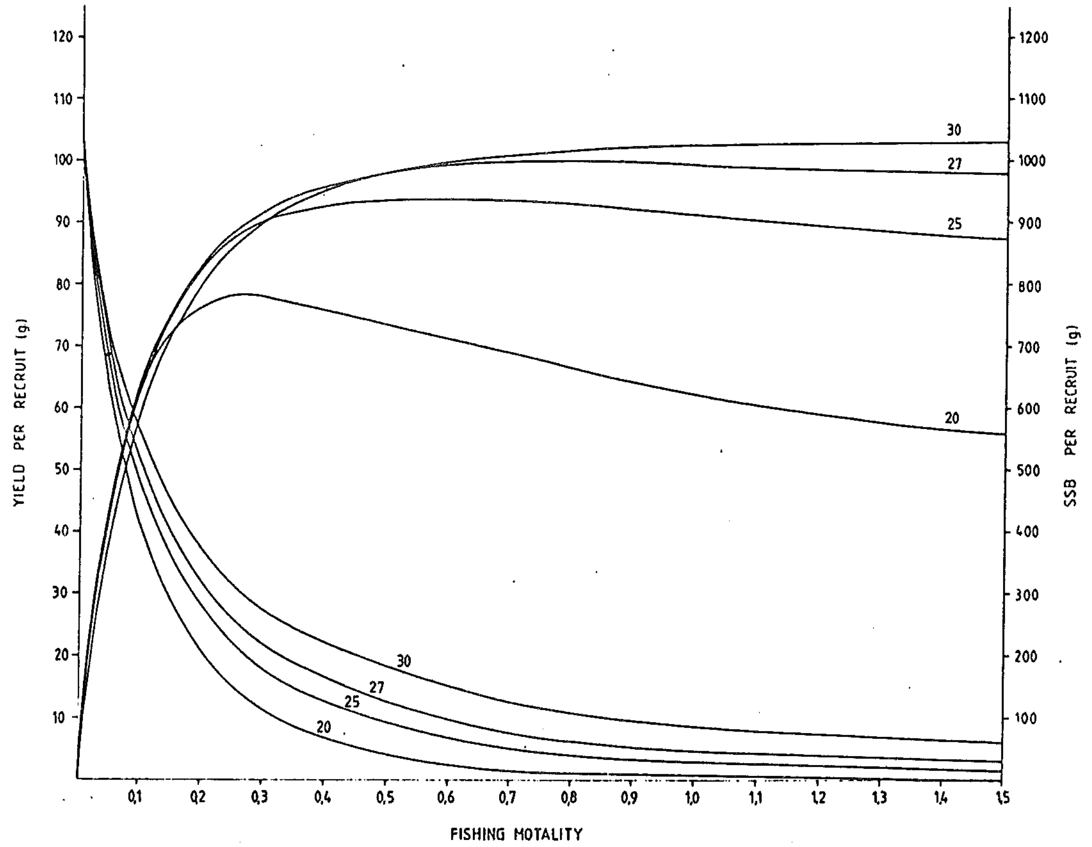

Figure 3. Barents Sea component of Norwegian spring spawning herring. Yield and spawning stock per recruit (SSB) for 20 cm,25 cm,27 cm and 30 cm minimum landing size. M=0.15

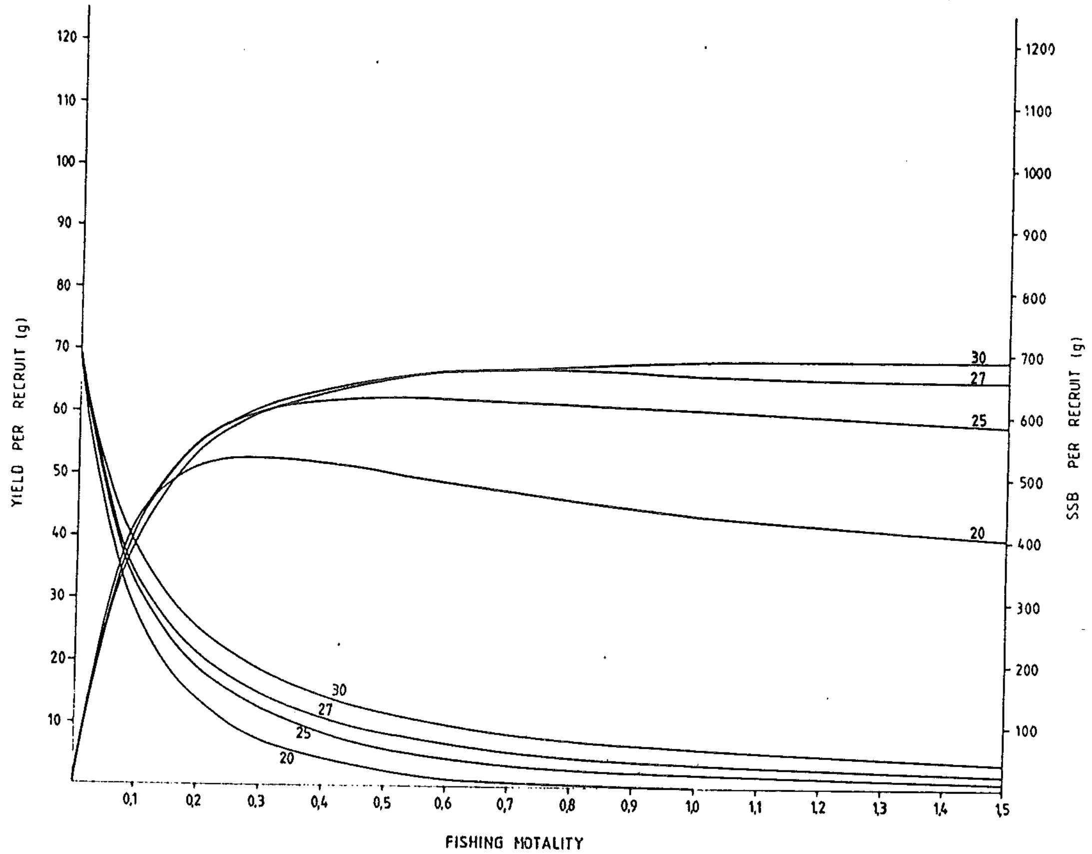

Figure 4. Barents Sea component of Norwegian spring spawning herring. Yield and spawning stock per recruit (SSB) for 20 cm,25 cm,27 cm and 30 cm minimum landing size. $M_1=M_2=0.35$. $M_{3+}=0.15$

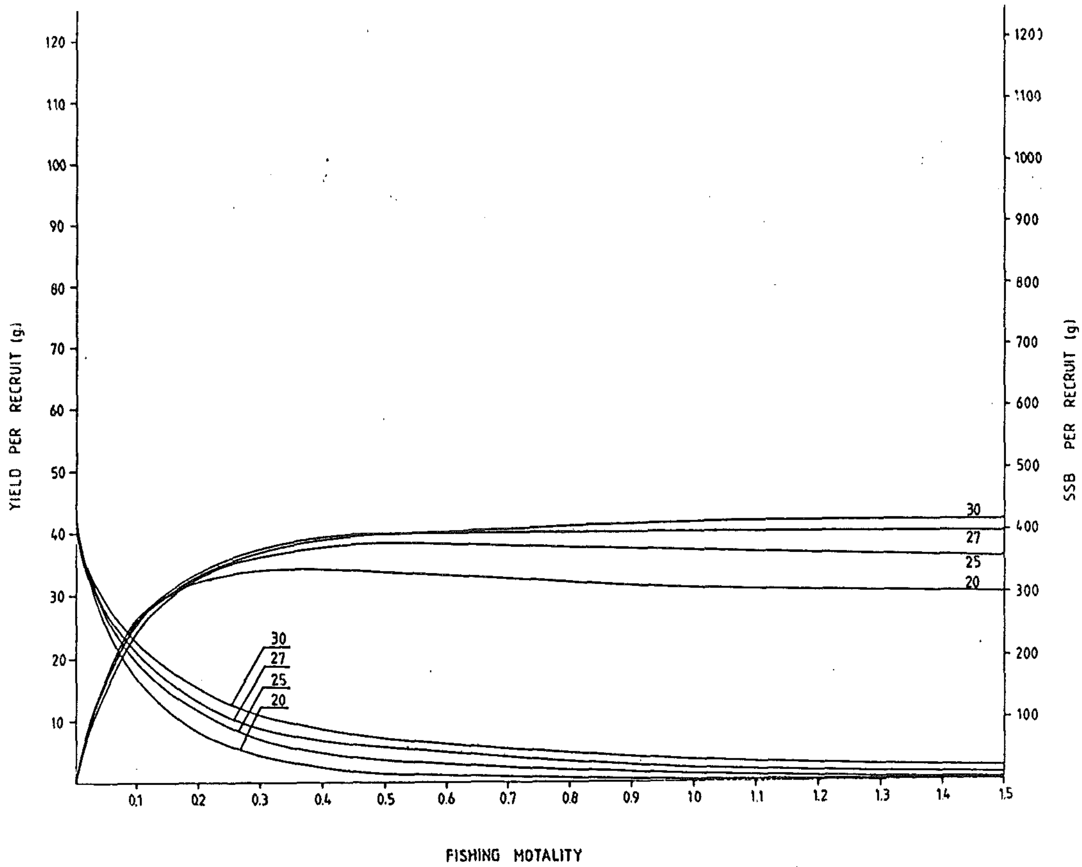

Figure 5. Barents Sea component of Norwegian spring spawning herring. Yield and spawning stock per recruit (SSB) for 20 cm,25 cm,27 cm and 30 cm minimum landing size. $M_1=M_2=0.5$. $M_3=0.35$. $M_{4+}=0.15$