Advisory Committee on Fisheries Management **ICES CM 2001/ACFM:10**

REPORT OF THE

STUDY GROUP ON THE HERRING ASSESSMENT UNITS IN THE BALTIC SEA

ICES Headquarters
22–25 January 2001

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

https://doi.org/10.17895/ices.pub.9187

Palægade 2–4 DK–1261 Copenhagen K Denmark

TABLE OF CONTENTS

Section **Page**

1 INTRODUCTION

1.1 Terms of Reference

At the 2000 Annual Science Conference it was decided to establish a **Study Group on Herring Assessment Units in the Baltic Sea** [SGHAUB] (Co-Chairs: E. Ojaveer, Estonia and G. Kornilovs, Latvia) to meet at ICES Headquarters from 22–25 January 2001 to:

a) update, review and evaluate the available information on herring stock components and their migration in the Main Basin of the Baltic Sea (Sub-divisions 25-29, 32);

b) propose an assessment structure for the herring stocks in Sub-divisions 25-29+32 based on the review done under a); finalise the compilation of data required for assessing stock components defined under b).

1.2 Participants

Robert Aps	Estonia
Tomasz Linkowski (part-time)	Poland
Georgs Kornilovs (Co-Chair)	Latvia
Evald Ojaveer (Co-Chair)	Estonia
Jukka Pönni	Finland
Tiit Raid	Estonia
Bengt Sjöstrand	Sweden

2 GENERAL

2.1 Historical overview of herring assessment and management units in the Baltic Sea

The assessment and management units used have been decided in of the WG on Assessment of Pelagic Stocks in the Baltic and Baltic Fisheries Assessment WG meetings in 1974 - 2000. The existing assessment and management units have not been the same.

Meetings of ICES Assessment Working Group and IBSFC held in 1974

In its first report the Working Group on Assessment of Pelagic Stocks in the Baltic (ICES C.M. 1974/H:3) considered the state of Baltic herring and sprat stocks by various areas or subdivisions.

International Baltic Sea Fishery Commission (IBSFC) divided Sub-division 29 into two parts along the 59^{o}30'N (29S and 29N). The partition was used for implementation in these parts of different regulation measures (fishing rules, etc.).

The information on herring assessment and management units is summarised in Table 2.1.

1975

Due to the differences in the vital population parameters observed in the various herring stocks in the Baltic Sea, in 1975 the Working Group suggested the following four herring management units (CM 1975/P:18):

MU 1: subdivisions 22, 23, 24, 25 and 26
MU 2: 27, 28 and 29S
MU 3: 30, 31 and 29N
MU 4: 32.

No TACs were accepted in 1975.

1976

Management Units 1 - 4 were used by the Working Group (C.M. 1976/P:3).

IBSFC recommended TACs for the Gulf of Bothnia (Sub-divisions 30 and 31) and for the other Convention areas.

1977

The Baltic herring stocks were assessed by the Working Group as follows (C.M. 1977/P:3):

Sub-divisions 22, 23 and 24
25-29S
29N, 30 and 31
32

IBSFC recommended herring quotas for Management Unit 3 (=Sub-divisions 29N, 30 and 31) and for the other Convention areas.

1978

The Working Group assessed following Baltic herring stocks (ICES C.M. 1978/J:4):

22-24
25 and 26
27, 28 and 29S (Gulf of Riga excluded)
Gulf of Riga
29N, 30 and 31
32

IBSFC recommended herring TACs for Management Unit 3 (=Sub-divisions 29N, 30 and 31) and for the other Convention areas.

1979

The assessment units of the Working Group were the same (ICES C.M. 1979/J:3) as in 1978.

IBSFC recommended herring TACs for Management Unit 3 (=Sub-divisions 29N, 30 and 31) and for the other Convention areas.

1980

The Working Group assessed (ICES C.M. 1980/J:4) following Baltic herring stocks:

22-24
25, 26 and 27
28 and 29S (Gulf of Riga excluded)
Gulf of Riga
29N, 30 and 31, eastern part
29N, 30 and 31, western part
32

IBSFC recommended herring TACs for Management Unit 3 (=Sub-divisions 29N, 30 and 31) and for the other Convention areas.

1981

The assessment units of the Working Group were the same (ICES C.M. 1981/J:4) as in 1980. There was some intention to split assessment in Sub-divisions 25, 26 and 27 into the southern coastal and northern stocks, based on the otolith types.

IBSFC recommended herring TACs for Management Unit 3 (=Sub-divisions 29N, 30 and 31) and for the other Convention areas.

1982

The Baltic herring stocks were assessed by the Working Group (C.M. 1982/Assess:16) as follows:

22-24
25, 26 and 27
28 and 29S (Gulf of Riga excluded)
Gulf of Riga
29N and 30, eastern part
31, eastern part
29N, 30 and 31, western part
32

IBSFC recommended herring TACs for Management Unit 3 (=Sub-divisions 29N, 30 and 31) and for the other Convention area.

1983

The assessment units of the Working Group were the same (ICES C.M. 1983/Assess:13) as in 1982. The Working Group made an attempt to prepare data for separate assessments of the coastal herring and the open sea herring separately.

IBSFC recommended herring TACs for Management Unit 3 (=Sub-divisions 29N, 30 and 31) and for the other Convention areas.

1984

The Baltic herring stocks were assessed by the Working Group (C.M. 1984/Assess:14) as follows:

22-24
25, 26 and 27 (two assessments were carried out – one for the total stock and one for the southern coastal herring)
28 and 29S (Gulf of Riga excluded)
Gulf of Riga
29N, eastern part
30, eastern part
31, eastern part
29N, 30 and 31, western part
32

IBSFC recommended herring TACs for Management Unit 3 (=Sub-divisions 29N, 30 and 31) and for the other Convention areas.

1985

The Baltic herring stocks were assessed by the Working Group (C.M. 1985/Assess:16) as follows:

22-24 and Division IIIa
25, 26 and 27 (no assessment for coastal herring)
28 and 29S (Gulf of Riga excluded)

Gulf of Riga
29N and 30, eastern part
31, eastern part
29N, 30 and 31, western part
32

IBSFC recommended herring TACs for Management Unit 3 (=Sub-divisions 29N, 30 and 31) and for the other Convention areas.

1986 - 1988

The assessment units of the Working Group were the same (ICES C.M. 1986/Assess:20, 1987/Assess:20, 1988/Assess:18) as in 1985, except the assessment for coastal herring in Sub-divisions 25-26 was made again in 1987 and 1988. In 1986 the WG stated that in the future changes on boundaries of the assessment units should be done only if satisfactory scientific evidence (preferably published) had been presented. In addition, in 1986 the WG listed five possible evidence for differentiation of populations:

1) structures reflecting life history of individuals (e.g., otolith structure);
2) frequency of different types of morphological features in specimens by areas;
3) infestation rate with characteristic parasites;
4) structure of body proteins, erythrocyte antigens, etc.;
5) biological differences of stocks in different sea areas (maturation cycle and reproduction, migration pattern, growth pattern, etc), taking into account their variations.

IBSFC recommended herring TACs for Management Unit 3 (=Sub-divisions 29N, 30 and 31) and for the other Convention areas.

1989

The Baltic herring stocks were assessed by the Working Group (C.M. 1989/Assess:14) as follows:

22-24 and Division IIIa
25, 26 and 27
28 and 29S (Gulf of Riga excluded)
Gulf of Riga
29N and 30, eastern part
31, eastern part
29N, 30 and 31, western part
32
25-29 combined

IBSFC recommended herring TACs for Management Unit 3 (=Sub-divisions 29N, 30 and 31) and for the other Convention areas.

1990

The Baltic herring stocks were assessed by the Working Group (C.M. 1990/Assess:18) as follows:

22-24 and Division IIIa
25-29, 32 (this combination was used for the first time)
Gulf of Riga
30
31
32 (Gulf of Finland herring was assessed separately for the last time)

IBSFC recommended herring TACs for Management Unit 3 (=Sub-divisions 29N, 30 and 31) and for the other Convention areas.

1991

The Baltic herring stocks were assessed by the Working Group (C.M. 1991/Assess:18) as follows:

22-24 and Division IIIa
25-29, 32
25-26 coastal herring (this unit was assessed separately for the last time)
Gulf of Riga
30
31

IBSFC recommended herring TACs for Management Unit 3 (=Sub-divisions 29N, 30 and 31) and for the other Convention areas.

1992 - 1993

The assessment units of the Working Group were the same (ICES C.M. 1992/Assess:13, 1993/Assess:17) as in 1991. No separate assessment of Gulf of Riga herring was performed in 1992.

IBSFC recommended herring TACs for Management Unit 3 (=Sub-divisions 29N, 30 and 31) and for the other Convention areas.

1994

Since this year the assessment of herring in Sub-divisions 22-24 and Division IIIa has been performed at the Herring Assessment Working Group. The Baltic herring stocks were assessed by the Working Group (C.M. 1994/Assess:18) as follows:

25-29, 32
Gulf of Riga
30
31

IBSFC recommended herring TACs for Management Unit 3 (=Sub-divisions 29N, 30 and 31) and for the other Convention areas.

1995 - 1998

The assessment units of the Working Group on the Assessment of Demersal and Pelagic Stocks in the Baltic (ICES CM 1995Assess:18) and assessment units of the Baltic Fisheries Assessment Working Group (1996/Assess:13, 1997/Assess:12, 1998/ACFM:16,) were the same as in 1994.

IBSFC recommended herring TACs for Management Unit 3 (=Sub-divisions 29N, 30 and 31) and for the other Convention areas.

1999

The Baltic herring stocks were assessed by the Baltic Fisheries Assessment Working Group (C.M. 1999/ACFM:15) as follows:

25-29, 32
25-29 excluding Gulf of Riga, 32
Gulf of Riga
30
31

IBSFC recommended herring TACs for Management Unit 3 (=Sub-divisions 29N, 30 and 31) and for the other Convention areas.

2000

The assessment units of the Working Group were the same (ICES CM 2000/ACFM:14) as in 1999.

IBSFC recommended herring TACs for Management Unit 3 (=Sub-divisions 29N, 30 and 31) and for the other Convention areas.

2.2 The present status, situation in the assessment, and management of herring stocks in the Central Baltic Sea (Sub-divisions 25-29, 32, including Gulf of Riga)

The IBSFC manages all herring in the Baltic Proper (Sub-divisions 22-29S, 32) as one unit, whereas the ICES assesses the herring stocks and gives the advice for two units in this area (Sub-divisions 22-24 and sub-divisions 25-29,32). The stock status for the SD 22-24 (including Div. IIIa) is uncertain and the stock in SD 25-29,32 (Gulf of Riga included) is considered to be at a historic low level even if the estimation of the stock level is surrounded with uncertainty.

The assessment unit 25-29, 32 was created in 1990. In the 1980s herring in this area was assessed as components of 4-6 assessment units. The condition of the herring stocks has caused concern to ACFM as the results of assessments in the early 1990s were not confirmed in the late 1990s (Figure 2.1). The uncertainty in the assessment of herring in SD 25-29, 32 (incl. Gulf of Riga) is manifested through the marked retrospective pattern giving over-estimations of stock sizes from one assessment to the next. The causes for this instability are connected to the quality of the data used. The combination of several stock components with different weight/size at age makes it difficult to estimate a meaningful common weight at age array. This heterogeneity in weight/size is illustrated in Figure 2.2, which gives the weight at age for 6 year-classes by sub-division. Also the used data on catch/landings by nations are most likely influenced by the difficulties to correctly report the species composition in the mixed herring-sprat fisheries.

The assessment results have made it difficult to determine biological reference points for stock biomass.

The combination of several stock components precludes the possibility to monitor and manage separate components. It is, however, likely that exploitation and status is differing in stock components. An example is the herring in Gulf of Riga, which when assessed separately does not show the same downward trend in stock size as the combined stock.

The existing system – both regarding management and assessment – makes it difficult to develop a plan for a sustainable use of the resource.

The background for creation of the SGHAUB has been given in the Scientific Justification of the corresponding Council Resolution as follows:

The recent assessment of herring in Sub-divisions 25-29, 32 (including the Gulf of Riga) revealed that spawning stock biomass of this herring stock is at present at an historic low level. However, the exact stock level is uncertain and the regular overestimation of spawning stock biomass impedes the management of this stock. Moreover, the separate assessment of Gulf of Riga herring and the stable catches in some parts of this area indicate that some stock units are in a good state contradicting to the results of the combined assessment. The assessment of herring in Sub-divisions 25-29, 32 by separate stock units, which were used previously (until 1990), could provide more effective tools for Management.

Table 2.1. Assessment and management units for Baltic herring in 1975-2000

Year	Assessment units by Sub-divisions	Management units by IBSFC	TAC recommendation by IBSCF
1975	22, 23, 24, 25 and 26 27, 28 and 29S 29N, 30 and 31 32	MU 1: 22, 23, 24, 25 and 26 MU 2: 27, 28 and 29S MU 3: 29N, 30 and 31 MU 4: 32	No TAC
1976	22, 23, 24, 25 and 26 27, 28 and 29S 29N, 30 and 31 32	MU 1: 22, 23, 24, 25 and 26 MU 2: 27, 28 and 29S MU 3: 29N, 30 and 31 MU 4: 32	TAC for SDs 22-29,32 TAC for SDs 30 and 31
1977	22, 23 and 24 25-29S 29N, 30 and 31 32	Other area: 22-29S, 32 MU 3: 29N, 30 and 31	TACs for SDs 22-29S, 32 TAC for SDs 29N, 30 and 31
1978-1979	22-24 25 and 26 27, 28 and 29S 29N, 30 and 31 32	Other area: 22-29S, 32 MU 3: 29N, 30 and 31	TACs for SDs 22-29S, 32 TAC for SDs 29N, 30 and 31
1980-1981	22-24 25, 26 and 27 28 and 29S excluding Gulf of Riga Gulf of Riga 29N, 30 and 31, eastern part 29N, 30 and 31, western part 32	Other area: 22-29S, 32 MU 3: 29N, 30 and 31	TACs for SDs 22-29S, 32 TAC for SDs 29N, 30 and 31
1982-1983	22-24 25, 26 and 27 28 and 29S excluding Gulf of Riga Gulf of Riga 29N and 30, eastern part 31, eastern part 29N, 30 and 31, western part 32	Other area: 22-29S, 32 MU 3: 29N, 30 and 31	TACs for SDs 22-29S, 32 TAC for SDs 29N, 30 and 31
1984	22-24 25, 26 and 27 (total stock and southern coastal stock separately) 28 and 29S excluding Gulf of Riga Gulf of Riga 29N, eastern part 30, eastern part 31, eastern part 29N, 30 and 31, western part 32	Other area: 22-29S, 32 MU 3: 29N, 30 and 31	TACs for SDs 22-29S, 32 TAC for SDs 29N, 30 and 31
1985	22-24 and Division IIIa 25, 26 and 27 28 and 29S excluding Gulf of Riga Gulf of Riga 29N and 30, eastern part 31, eastern part 29N, 30 and 31, western part 32	Other area: 22-29S, 32 MU 3: 29N, 30 and 31	TACs for SDs 22-29S, 32 TAC for SDs 29N, 30 and 31
1986-1988	22-24 and Division IIIa 25, 26 and 27 (total stock and southern coastal stock separately) 28 and 29S excluding Gulf of Riga Gulf of Riga 29N and 30, eastern part 31, eastern part 29N, 30 and 31, western part 32	Other area: 22-29S, 32 MU 3: 29N, 30 and 31	TACs for SDs 22-29S, 32 TAC for SDs 29N, 30 and 31
1989	22-24 and Division IIIa 25, 26 and 27 28 and 29S excluding Gulf of Riga Gulf of Riga 29N and 30, eastern part 31, eastern part 29N, 30 and 31, western part 32 25-29 combined	Other area: 22-29S, 32 MU 3: 29N, 30 and 31	TACs for SDs 22-29S, 32 TAC for SDs 29N, 30 and 31
1990	22-24 and Division IIIa 25-29, 32 Gulf of Riga 30 31 32	Other area: 22-29S, 32 MU 3: 29N, 30 and 31	TACs for SDs 22-29S, 32 TAC for SDs 29N, 30 and 31

Table 2.1 (continued)

Year	Assessment units by Sub-division	Management units by IBSFC	TAC recommendation by IBSFC
1991	22-24 and Division IIIa 25-29, 32 25-26 coastal herring Gulf of Riga 30 31	 Other area: 22-29S, 32 MU 3: 29N, 30 and 31	 TACs for SDs 22-29S, 32 TAC for SDs 29N, 30 and 31
1992	22-24 and Division IIIa 25-29, 32 30 31	 Other area: 22-29S, 32 MU 3: 29N, 30 and 31	 TACs for SDs 22-29S, 32 TAC for SDs 29N, 30 and 31
1993	22-24 and Division IIIa 25-29, 32 Gulf of Riga 30 31	 Other area: 22-29S, 32 MU 3: 29N, 30 and 31	 TACs for SDs 22-29S, 32 TAC for SDs 29N, 30 and 31
1994-1998	25-29, 32 Gulf of Riga 30 31	 Other area: 22-29S, 32 MU 3: 29N, 30 and 31	 TACs for SDs 22-29S, 32 TAC for SDs 29N, 30 and 31
1999-2000	25-29, 32 25-29 excluding Gulf of Riga, 32 Gulf of Riga 30 31	 Other area: 22-29S, 32 MU 3: 29N, 30 and 31	 TACs for SDs 22-29S, 32 TAC for SDs 29N, 30 and 31

Figure 2.1 ICES advice For Sd 25-29,32 (in 1994: 317-463 thou t), TACs agreed by the IBSFC for Sd 22-29, 32 and actual catches in Sd 25-29, 32 (ICES,2000)

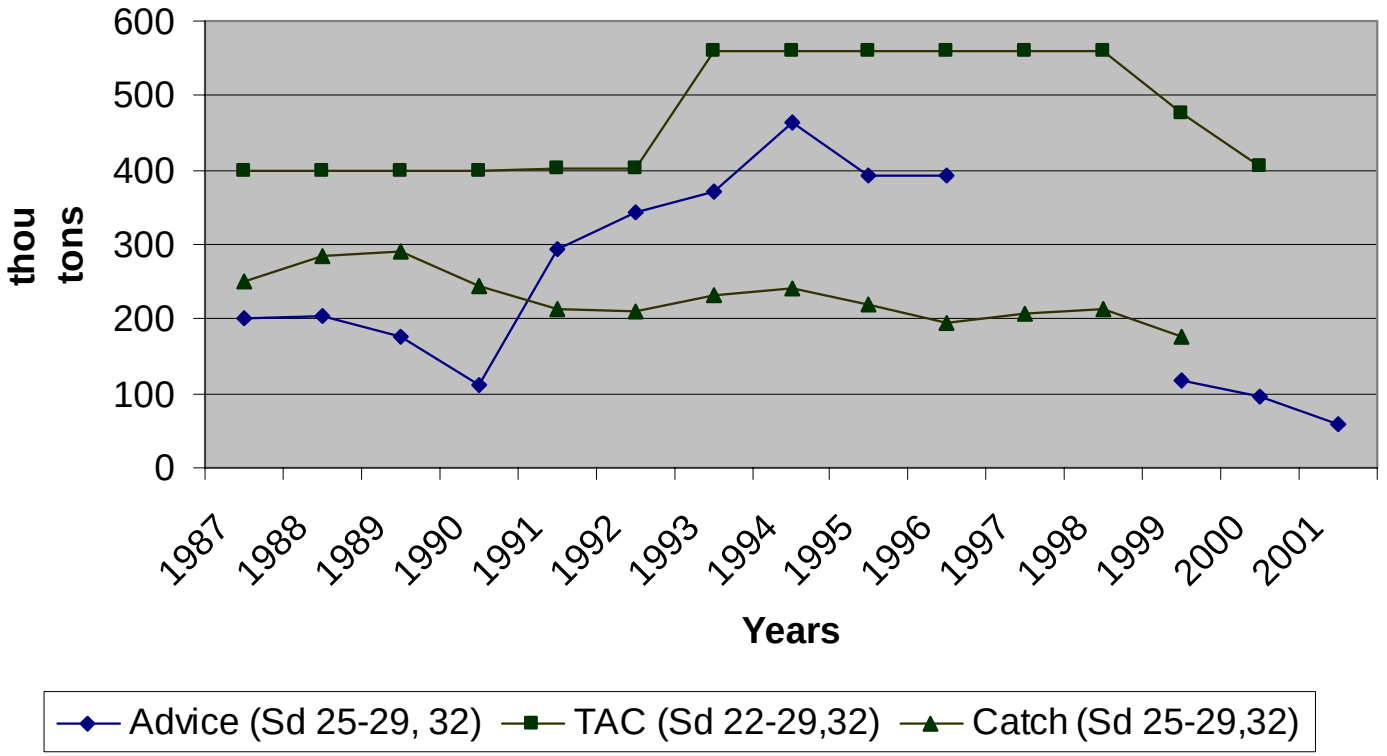
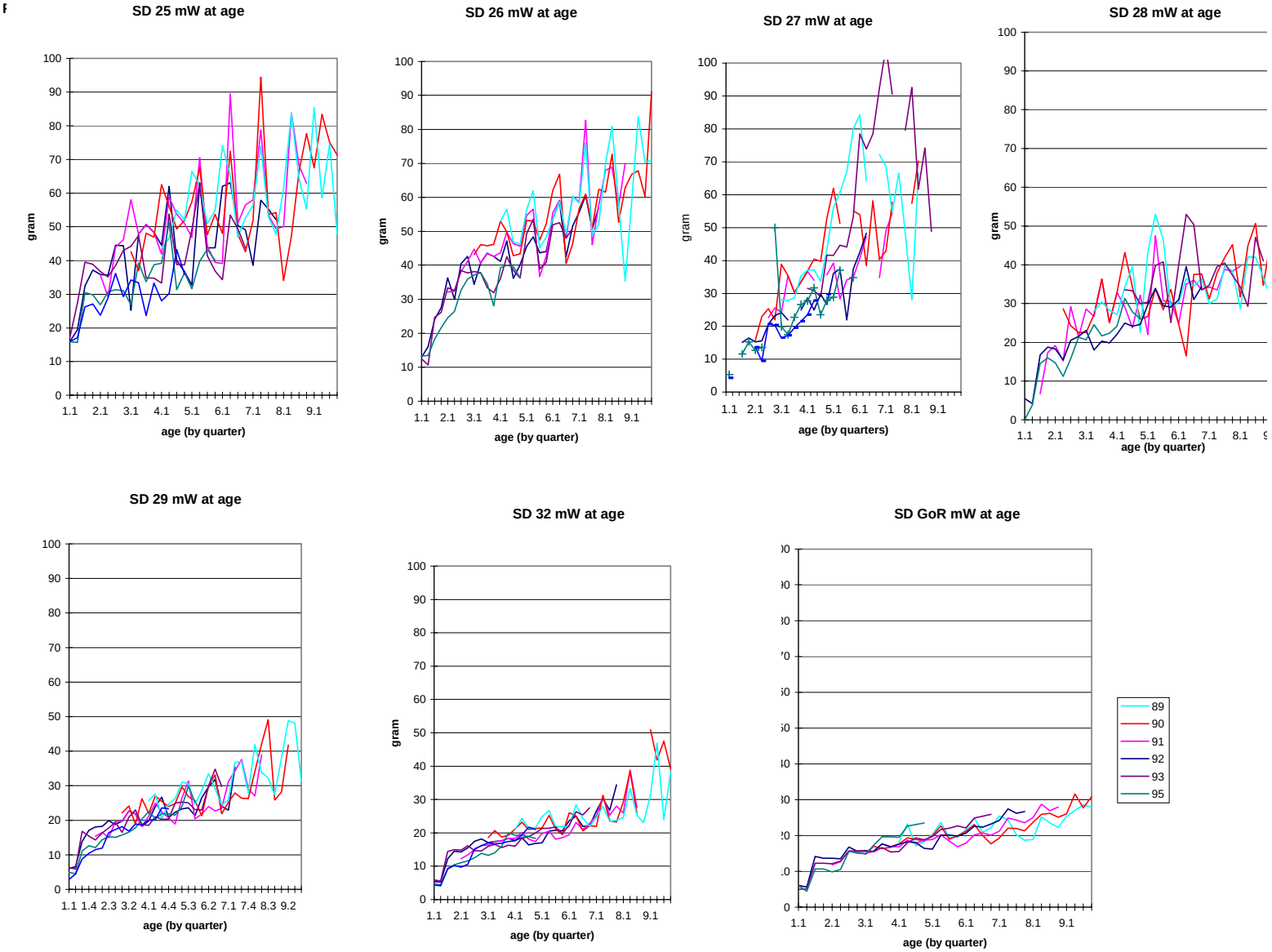


Figure 2.2 Mean weight at age (quarterly) in the catches for year-classes 1989-95 by sub-division.



3 DESCRIPTION OF HERRING STOCK UNITS AND THEIR MIGRATION PATTERN

3.1 Herring in Sub-division 22-24 (Rügen herring)

Spawning takes place around the Danish isles and along the German coast. The main spawning area is around the Rügen Island. Spawning occurs during March-April.

During feeding season the adult herring migrate to the Kattegat, Skagerrak and North-eastern North Sea. The main overwintering areas are the Sound (Sub-division 23) and the Arkona area (Sub-division 24).

It is a fast-growing herring population.

The adults, that have returned from Div.IIIa, are to a large extent infestated by *Anisakis sp*.

It is difficult to separate (specially juveniles) from herring spawning at coast of Sub-div 25.

In Div IIIa there are difficulties to separate the spring spawners from the immigrating autumn spawners of North Sea origin.

This component has since 1985 been assessed together with the spring spawners in Div. IIIa. Since 1994 the assessment for herring in Sub-divisions 22-24 and Division IIIa is performed by the Herring Assessment Working Group.

3.2 Coastal herring in Sub-divisions 25-26

The coastal spring-spawning herring stock spawns near the coast of Poland from the area east of Rügen island, in the Pomorska Bay, in the Gdansk Bay and the Vistula Lagoon, near the coast of Russia and Lithuania as far to the north as Klaipeda (Popiel, 1964). It is considered that these spawning grounds are used mainly by the coastal herring.

The feeding migration of adults occurs soon after spawning and they are in feeding areas usually from July to December. The main feeding grounds are around Bornholm and in the Gdansk Basin; sometimes they are found in the Arkona region (Sub-division 24) according to multimodal length frequencies (Popiel and Stryzewska, 1971).

Coastal herring is a fast growing short-lived spring –spawning herring population and thus differs by greater size at age from slow-growing, long living open-sea herring which is also met in Sub-divisions 25-26.

In the fisheries laboratories of Poland and Russia the coastal herring is distinguished from other herring populations on the base of otolith structure differences and the CATON, CANUM and WECA data are available separately for coastal and open sea herring stocks in Sub-divisions 25-26. However, Swedish and Danish catches in this region are not dis-aggregated in such a manner.

The assessment of coastal herring stock was performed by the Working Group on Assessment of Pelagic Stocks in the Baltic in 1984-1991. The splitting procedure of Swedish and Danish catches into coastal and open-sea herring is described in the reports of the Working Group.

3.3 Sea herring in Sub-division 27

The spawning grounds of the slow-growing long-living open-sea spring spawning herring are mainly situated along the Swedish east coast from Hanö Bay up to the Åland Sea. The spawning period lasts from April to June. In the northern areas spawning starts usually in May and lasts until the beginning of July. It is demonstrated by several tagging experiments (Otterlind, 1961, 1962, 1976) that a very large proportion of older herring of this stock migrates after spawning to their feeding grounds in the Bornholm Basin, sometimes to the regions south of Scania, also to the Gdansk Basin and offshore regions of Klaipeda (Sub-divisions 25 and 26). Some part of the population migrates along the Swedish coast and off the coast to the south and north, but the northward migration to the Bothnian Sea is insignificant (Otterlind, 1976). During the late autumn and early winter the spawning migration starts from the feeding grounds back to the spawning places where the main part of the stock is found in November and later. There is also evidence that some part of the stock does not return to their spawning area at Swedish east coast. They have been found on the spawning grounds in the Southern Baltic spawning together with the coastal spring spawning stock (Kompowski, 1969).

Since 1990, the stocks in Sub-division 27 were assessed together with other herring stocks in Sub-divisions 25-29+32. In the 1980s herring in the Sub-divisions 25-27 was assessed as a unit and separate calculations were performed for coastal and open sea spring herring units.

3.4 Open sea herring in Sub-division 28

The main bulk of the spring herring of the open part of the Sub-division 28 spawns at the coasts of Saaremaa and other islands west of Estonia, at the Latvian open sea coasts and in the Gulf of Riga. Spawning period lasts from April to June. After spawning the stock feeds in the open Baltic, probably mainly in the areas of high biological productivity west of the Irbe Sound and Saaremaa (Ojaveer, Rannak, 1980). Supposedly the stock performs only rather short migrations. However, no tagging data exists.

A certain component of the herring stock of Sub-division 28 is distributed in the near-coast areas of the Gotland Island, west of the Gotland Deep. The data on this component are insufficient.

In the 1990s the herring stock of the Sub-division 28 was assessed together with other stocks of the Sub-divisions 25-29+32. In the 1980s the stock was assessed together with the herring in the southern part of the Sub-division 29, as one unit. It has been found that differences between the open sea herrings of the Sub-divisions 28 and 29 are rather small both in otolith structure and other morphological characters as well as in biological features (Ojaveer, Rannak, 1980, Ojaveer et.al, 1981).

For differentiation of herring populations in the Central Baltic, and for individual separation of herrings in mixed catches, differences in their otolith characters have been applied. On this basis nearly full separation of spring and autumn spawning herrings can be achieved. Also, separation of spring spawning sea herring population from southern coastal spring herring and from the Gulf of Riga spring herring has given satisfactory results and has been applied, for instance, for preparation of data for assessments. Separate assessments of the Gulf of Riga herring have only been based on this method.

3.5 Gulf of Riga herring

The herring of the Gulf of Riga spawns on the spawning grounds situated in the Gulf of Riga. Spawning period lasts from May till July. In the Gulf of Riga herring spawning grounds are also used by the open sea herring stocks that enter the Gulf of Riga before spawning and leave the gulf soon after it. The mixing of the gulf herring and open sea herring stocks on the spawning grounds is avoided as follows:

1) Open sea herring starts to spawn first and after some two weeks is gradually replaced by the gulf herring. In the course of the spawning the share of open sea herring is decreasing and the share of gulf herring is increasing. At the end of the spawning period practically only gulf herring is spawning.
2) Open sea herring spawns on smaller depths near the coast, while gulf herring prefers bigger depths.
3) It is probable that some behavioural spawning peculiarities help to avoid fertilisation among populations (grouping of spawning individuals by size).

The gulf herring feeding migrations to the open part of the Baltic Sea are typical for some part of older age groups. The amount of gulf herring performing such feeding migrations depends on the stock size of gulf herring and on the feeding conditions in the Gulf of Riga in the particular year. These migrations increased in the beginning of 1990s when gulf herring stock started to increase. It is considered that gulf herring does not perform long migrations because in general migratory specimens of a species often have a greater rate than non-migratory fish from the same area (Northcote 1978), and the gulf herring has the smallest size compared to other herring populations in the Baltic Sea. However, it was one of the objections against separate assessment of the gulf herring that the amount and distance of these feeding migrations is not known as well as to what extent gulf herring is fished by other countries outside the Gulf of Riga. In the Working Paper (Fetter et al. 2001) presented to the Study Group the distribution of gulf herring in the open part of the Baltic Sea in October 1998 and 1999 is analysed on the basis of trawl catch analyses performed during the hydro-acoustic surveys. It is considered that the maximum mixing of herring populations occurs in October thus the amount of gulf herring in the Baltic Sea should be smaller in other periods. The length-at-age analysis of herring in the Gulf of Riga showed that usually the length starts to increase in November. This indicates the return of faster-growing fishes from the feeding migration. Figures 3.5.1 and 3.5.2 show that the concentrations of gulf herring and the share of the gulf herring in the catch are the highest in the Latvian economical zone and that these parameters diminish with the distance from the Gulf of Riga. Figure 3.5.3 shows the main fishing grounds of Latvian herring fleet in Sub-division 28 and they correspond to the main concentrations of gulf herring.

Gulf herring is slow-growing herring. The length and weight-at-age are the smallest among populations of herring in the Baltic Sea. Like in other herring populations the mean weight-at-age started to decrease in the mid-eighties and reached the lowest values in the mid-1990s. Since 1997 the growth of gulf herring has improved and the mean weight-at-age has considerably increased, especially in the younger age groups. It was stated that it is possible to distinguish gulf herring from the mixture with other herring populations during the spawning period in the Gulf of Riga on the base of length frequency distribution at age (Kornilovs 1994).

The assessment of gulf herring is performed since 1978. It was not performed in 1992, but restarted again in 1993 as it is used in national fisheries regulation. Gulf herring is distinguished from other herring populations on the basis of otolith structure differences, both in the catches in the Gulf of Riga and in the open part of the Baltic Sea. The population of gulf herring was distinguished already in 1950s and described by different authors (Rannak, 1971; Ojaveer, 1981; Kornilovs, 1995). It was stated that year-class strength depends on the severity of winters, and after mild winters rich year-classes appear. This feature clearly manifested itself in the period since 1989 when all year classes, except 1996, were rich, and respectively in this period only the winter of the year 1996 was severe, while the others were mild. The year class-strength dynamics clearly differs from the combined herring stock in Sub-divisions 25-29,32 (Figure 3.5.4).

3.6 Herring in Sub-divisions 29 and 32

Herring in the Sub-divisions 29 and 32 include several smaller local stocks (e.g. Gulf of Finland herring (gulf herring), Åland and Archipelago stock, Hiiumaa-Saaremaa stock).

The spawning grounds of **Gulf of Finland herring** are located along the southern and northern coasts and in the archipelago of the eastern part of the Gulf of Finland (Parmanne and Sjöblom, 1984, 1985, Raid, 1985). After the spawning period, the bulk of the stock remains in the eastern and central parts of the gulf. Still, a fraction of gulf herring (particularly older and bigger specimens) are performing feeding migrations into the western part of the gulf and partly also into the Sub-division 29. The seasonal migrations are assumed from the changes in length composition of trawl catches (e.g. Parmanne et al., 1997).

The main spawning areas of the open sea herring stocks from the **Northern Baltic** are located in the Åland Archipelago and in the Western Estonian Archipelago, but also in the western and central parts of the Gulf of Finland, and in the Gulf of Riga which is well documented by the observed structure of pound-net catches in the respective areas.

Shortly after the spawning this herring returns to the open sea for feeding in Sub-divisions 28 and 29, remaining partly also in the westernmost part of the Gulf of Finland; that is evident from the results of acoustic investigations, catch composition observations, and also from tagging experiments (Aro et al, 1990, Parmanne, 1990, Parmanne et al., 1997). The tagging experiments conducted by Otterlind have shown an extensive eastward dispersion of herring from that area. A considerable part of migration was directed also towards south. No northward migrations (to the Sub-division 30) were observed (Otterlind, 1961). Migrations and mixing occur every year, but their extent has a strong year-to-year variation. Due to the wide migrations and active mixing of herring, the western part of the Gulf of Finland can be treated as a big transition area where herrings from different stocks can be found.

Investigations of growth pattern and mean weight-at-age have shown that the herring in Sub-division 29 resembles the herring in the Gulf of Finland rather than the herring in the Bothnian Sea (Sub-division 30), having also similarities to the open sea herring in Sub-division 28 (Parmanne, 1990, Raid, 2001).

The Gulf of Finland herring was treated by ICES as a separate assessment unit in the 1970s and 1980s, while the herring in the Sub-division 29 was partly (29-South) combined with herring in Sub-division 28 and partly (29-North) with the herring in the Sub-division 30 (Aro and Pönni, 2001). The division of herring in Sub-division 29 into two parts was not performed on the biological background.

3.7 Herring in the Bothnian Sea (Sub-division 30)

In the Bothnian Sea (Sub-division 30) two spring spawning herring populations have been identified (Hannerz, 1955, 1956; Otterlind, 1957, 1962b, 1976; Sjöblom, 1961; Parmanne and Sjöblom, 1982, 1986): the spring-spawning herring along the Swedish (western) coast and the spring-spawning herring along the Finnish (eastern) coast.

The separation into the coastal and open sea components are not applied to these populations, although different spawning groups have been presented (Ehnholm, 1951). The migration pattern on both sides of the Bothnian Sea is the same and a mirror image of each other.

In both populations spawning occurs in May-July in the coastal areas, starting in the most shallow areas and shifting with a rising water temperature to deeper waters (Neuman, 1982). The spawning occurs along the whole coastline in both sides of Bothnian Sea, although there are some areas which are more preferred.

The feeding migration starts soon after spawning and both stocks intermix during feeding period in the open sea area. The main feeding areas are the slopes of the Bothnian Sea Basin and the outer Archipelago.

The feeding migration of the specimens occurs mainly along the coast to the south and north and there seem to be some connections to the Åland Sea and to the Quark (Otterlind, 1957, 1962b), which are transition areas for the neighbouring stocks. According to tagging experiments migrations from Gulf of Bothnia to Baltic Sea proper are uncommon (Parmanne, 1990). Mixing of the Bothnian Sea stocks and Bothnian Bay (Sub-division 31) stocks occur, but on annual basis the amount is small.

The growth of herring in the Bothnian Sea resembles that in the Bothnian Bay and differs from the growth in Sub-divisions 29 and 32 (Parmanne, 1988).

The herring stocks of Sub-division 30 have been assessed as a unit stock since year 1990. The history of assessments of these stocks is described in working documents for SGHAUB by Parmanne (2000) and Aro & Pönni (2001).

3.8 Herring in the Bothnian Bay (Sub-division 31)

The spawning grounds of the spring spawning herring in the Bothnian Bay are similarily situated along the coastline as in the Bothnian Sea. Spawning starts in late May and is over by late July. The annual migration pattern is similar to the migration pattern of Bothnian Sea stocks and the general pattern observed in other areas.

The feeding migration occurs mainly inside the Bothnian Bay. There is to a certain extent an exchange between the Swedish and Finnish coasts, especially near the Quark (Otterlind, 1962b; Parmanne and Sjöblom, 1986). Tagging experiments suggest that herring in northern areas are rather stationary and the mixing of Bothnian Bay stock with Bothnian Sea stock is of minor importance (Parmanne and Sjöblom, 1982, 1986).

The growth of the Bothnian Bay herring resembles that in the Bothnian Sea, and both differ from the growth in other areas (Parmanne, 1988). The herring in the Bothnian bay also differ morphologically from the fish in other parts of the northern Baltic Sea although no distinct group separable from other areas cant be defined (Parmanne, 1990).

The herring stocks of Sub-division 31 have been assessed as a unit stock since year 1990. The history of assessments of these stocks is described in working documents for SGHAUB by Parmanne (2000) and Aro & Pönni (2001).

3.9 Autumn spawning herring

In addition to the spring spawning herring, autumn spawning herring is distributed in the Baltic Sea. In general, the abundance of autumn herring is higher in the south-western regions of the sea. However, the abundance of autumn herring very substantially fluctuates and in certain periods this stock may be important up to the Bothnian Sea. Spring and autumn herrings differ in their biological and morphological characters and in abundance dynamics. Since the mid-1970s the abundance of the autumn spawning herring has been low in the Baltic Sea. Therefore, no separate assessments of autumn herring has been performed in the Baltic. New information on formation of spring and autumn spawning herring, on otolith structure differences depending on the time of the birth is presented in the working paper by Linkowski at al. (2001).

Figure 3.5.1 The share (%) of the gulf herring (values) in each trawl catch and gulf herring mean density (relative size of dots) in the same area in October 1998.

Size of dot is proportional to gulf herring mean density in mln/nm^2.

Minimum of the mean density is 0 mln/nm^2.

Maximum of the mean density is 2.19 mln/nm^2.

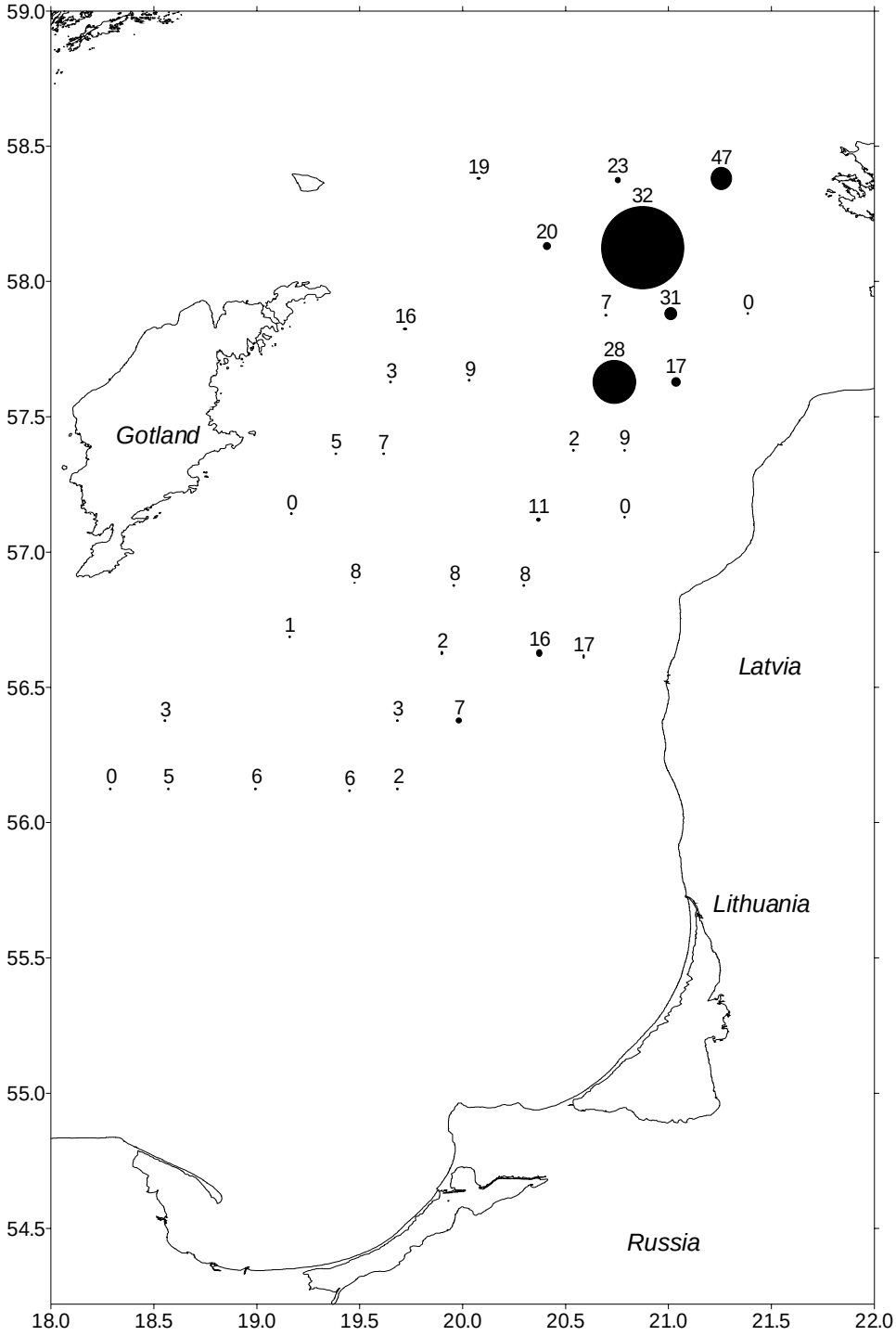


Figure 3.5.2 The share (%) of the gulf herring (values) in each trawl catch and gulf herring mean density (relative size of dots) in the same area in October 1999.

Size of dot is proportional to gulf herring mean density in mln/nm^2.

Minimum of the mean density is 0 mln/nm^2.

Maximum of the mean density is 0.8 mln/nm^2.

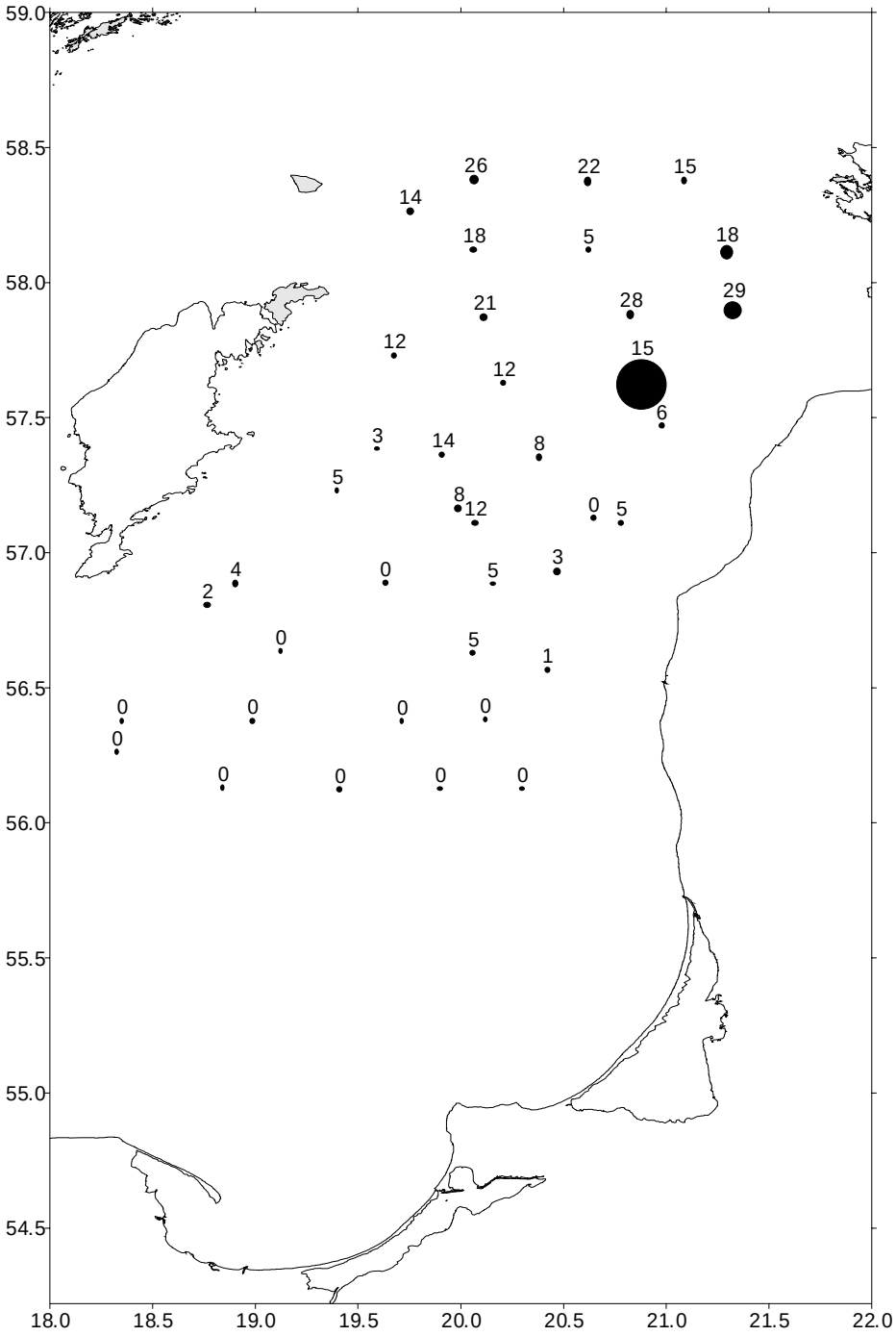


Fig.3.5.3 Location of the commercial catches in the Latvian zone in 1999

(according to IBSSP project)

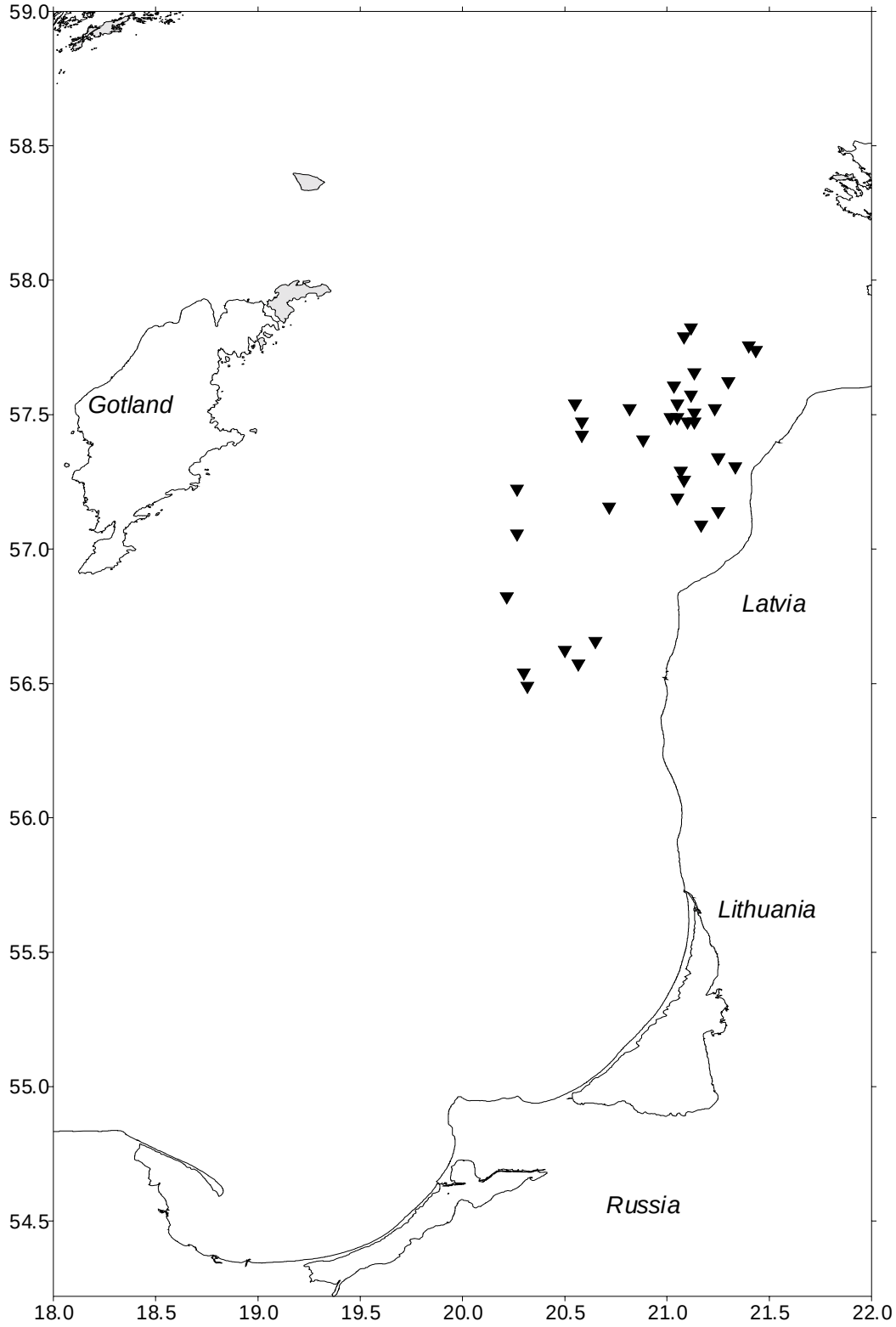
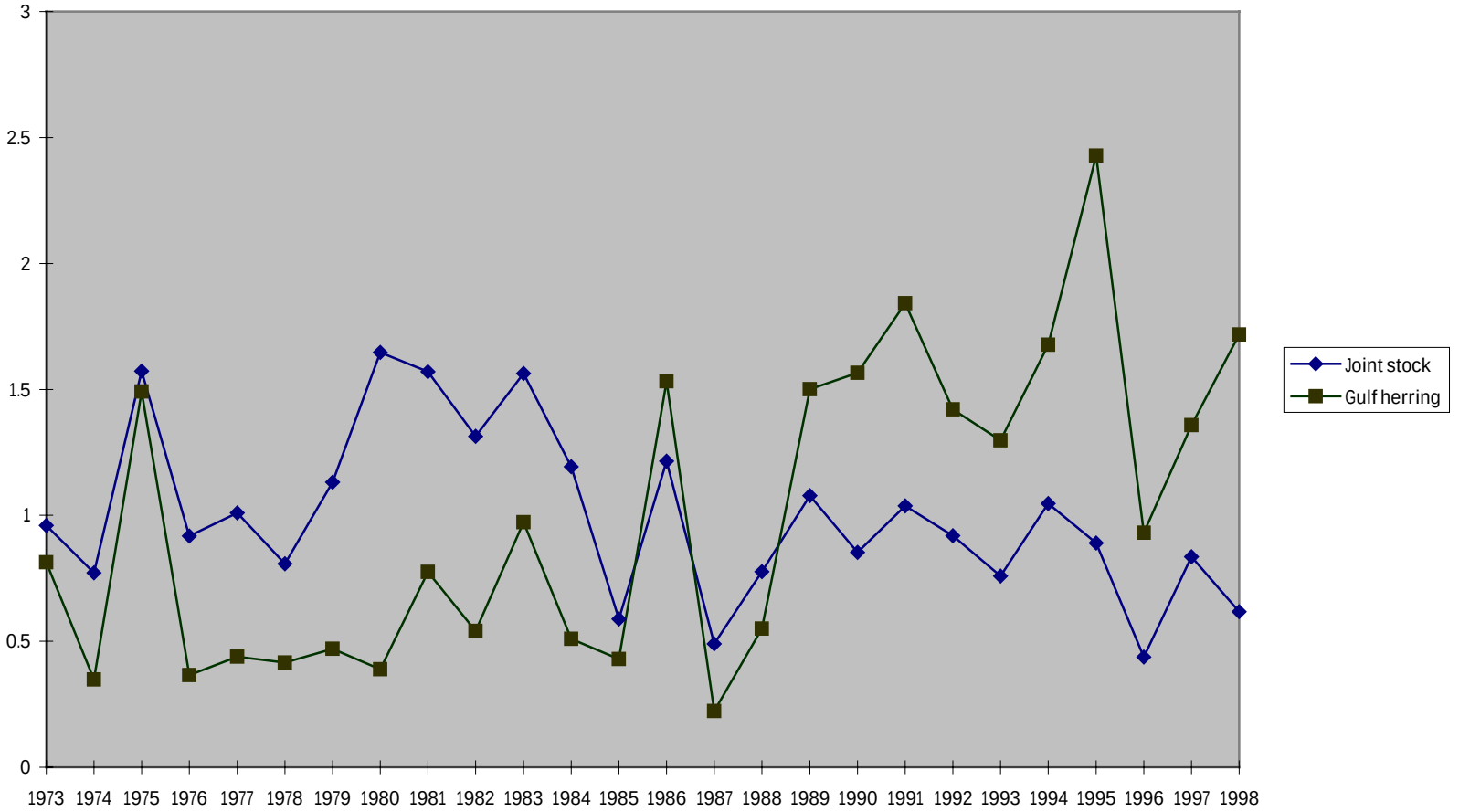


Figure 3.5.4 Relative year-class strength of herring in Sub-divisions 25-29,32 (joint stock) and in the Gulf of Riga



4 PROPOSED HERRING ASSESSMENT UNITS

4.1 Principles

In the process of adaptation to the conditions of substantially and consistently different ecological subsystems of the Baltic Sea (Ojaveer and Elken, 1997) herring has developed local populations.

The herring local populations have been grouped for the assessment purposes in different combinations in 1974-2000. The main idea behind the creation of a large herring assessment unit in 1990 (Sub-divisions 25-29+32) was to eliminate the influence of both demonstrated and not well enough documented migrations of herring in the Baltic. However, neglecting the differences in basic biological parameters of herring populations resulted in increase of uncertainty of the combined assessment, and in the real problems with management advice.

Necessary amendments to the herring stock assessment scheme have been elaborated in order to achieve a better correspondence with biological data available. The amendments are based on the following principles:

1) The components of combined assessment units should be reasonably similar in respect of such basic biological parameters as the relative year-class abundance, the age of maturation, mean weight at age etc.
2) The documented and assumed herring migrations between the proposed assessment units should not be of critical magnitude for the quality of the results.
3) The proposed herring stock assessment units should be subject to further amendments if necessary (e.g. concerning autumn herring populations).

4.2 Proposed herring assessment units in SD 25-29, 32

The proposed assessment units for the Baltic herring are as follows:

4.2.1 Herring in Sub-divisions 25, 26 and 27

In this region fast-growing coastal herring and slow-growing open sea herring are met. These populations spawn on separate spawning grounds, but they mix to a high extend during the feeding season. The Study Group recommends to assess these stocks separately if the necessary biological data for separating the mixed catches of these populations are available.

4.2.2 Herring in Sub-divisions 28 (excluding Gulf of Riga), 29 and 32

In this region several populations of herring are met. However, they have similar biological parameters that might allow to combine them into one assessment unit. It is known that these stocks strongly mix during the feeding season and at present there are no biological data for separating these stocks, however, in the future a separate assessment of Gulf of Finland herring could be carried out. It is also assumed that herring of this assessment unit does not perform extensive migrations to the Southern Baltic.

4.2.3 Gulf of Riga herring (Sub-division 28)

This assessment unit includes one well-defined population of Gulf of Riga spring-spawning herring. The biological parameters of gulf herring allow to separate it from the other neighbouring populations with which gulf herring mix during spawning and feeding seasons. It was a general opinion of the Study Group that gulf herring should be assessed separately and should not be included in other assessment and management units.

5 COMPILATION OF INPUT DATA FOR ASSESSMENTS.

The Study Group performed several attempts to recompile the data available in ICES for performing the assessments by the suggested assessment units.

- Herring in SD 25-27

The Group found several inconsistencies in the available input data sets for coastal herring in SD 25-26, open sea herring in SD 25-27, and therefore, also for the combined stock in Southern Central Baltic for the 1970s and 1980s, pointing at the necessity for inspection and recompilation of the historical national datasets.

The group has compiled the input data for this assessment of herring in the SD 25-27 for the years 1991-1999 using the available national reported data by sub-divisions (Table 5.1).

- Herring in SD 28, 29 and 32

An attempt was made to create the input data from the available assessment data for the herring in SD 25-29, 32 incl. the Gulf of Riga, herring in the Gulf of Riga and the herring in the SD 25-27 (Southern Central Baltic). However, the results for the 1980s approved to be rather unrealistic (calculated catches for the SD 28 were too low, having in one case even negative value). Therefore, the Group decided to recompile the input data for that assessment unit from the original resources prior to the meeting of the WGBFAS 2001. The Group found the input data for 1991-1999 acceptable for performing the preliminary assessment and also compiled the respective dataset (Tables 5.2. – 5.4.).

- Herring in the Gulf of Riga

All necessary assessment data for the period of 1970 – 1999 are available on the system and, together with new data for the year 2000, available by the meeting of WGBFAS, the assessment of that unit should not create any problems.

Table 5.1 HERRING in SD 25, 26, 27

Catch in numbers (millions)

	Year								
AGE	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
O	71.91	28.60	28.47	79.29	30.66	3.94	34.04	14.27	97.49
1	147.40	187.37	110.80	191.19	390.73	347.35	161.96	404.50	354.30
2	397.74	255.27	543.66	220.63	269.81	416.64	233.21	285.16	319.84
3	495.94	416.98	668.44	517.61	581.75	351.64	568.53	774.56	241.66
4	265.48	417.01	654.71	533.37	619.21	388.67	407.10	824.56	462.81
5	220.73	185.34	350.59	557.23	280.08	305.13	312.57	344.42	386.26
6	171.98	152.28	152.69	274.47	184.17	189.38	172.81	197.64	155.68
7	103.35	109.95	69.54	137.45	78.28	89.60	83.02	58.09	71.14
8	62.92	51.35	30.28	55.06	29.35	29.44	31.57	33.96	27.88
9	27.59	34.90	10.62	14.27	11.60	10.25	6.04	6.59	10.25
10	12.30	8.37	5.09	9.44	6.68	3.43	3.25	2.64	5.89
Total N	1977.34	1847.41	2624.89	2590.02	2482.33	2135.48	2014.09	2946.41	2133.18
CATON	**109.2**	**100.0**	**114.0**	**126.0**	**97.7**	**76.4**	**74.6**	**93.5**	**67.4**

Mean weight at age (g)

AGE	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
O	12.12	13.38	10.39	9.07	11.85	9.24	11.15	11.17	11.41
1	32.91	24.44	23.92	20.92	13.88	16.71	16.25	15.66	15.30
2	40.05	43.10	33.07	37.54	32.34	26.75	28.44	25.92	29.83
3	52.27	51.31	39.10	44.92	35.26	33.67	30.04	25.40	33.90
4	65.59	58.09	44.62	48.43	46.72	40.69	37.34	34.63	30.02
5	64.74	66.27	53.16	52.44	53.42	47.45	43.42	44.10	36.49
6	71.41	71.55	61.21	63.72	54.72	51.30	55.98	49.90	44.88
7	73.52	75.55	68.49	69.98	66.89	55.64	62.96	59.89	51.20
8	79.78	84.46	76.62	85.38	73.79	69.18	63.40	57.40	66.34
9	93.84	86.01	89.22	87.51	79.89	74.58	78.50	67.71	74.72
10	102.08	99.35	98.18	102.95	78.45	88.22	84.84	68.14	86.65
All	54.63	54.80	42.97	48.39	39.42	36.02	36.32	31.64	30.94
Sum n*w	**108.0**	**101.2**	**112.8**	**125.3**	**97.8**	**76.9**	**73.1**	**93.2**	**66.0**

Table 5.2 Herring in Baltic Fishing Areas 28, 29 and 32, CATON

	1	1
	1990	1999
	0	0
	5	
1990	-1	
1991	88760	
1992	80611	
1993	95923	
1994	96278	
1995	90275	
1996	92310	
1997	92312	
1998	92842	
1999	78516	

Table 5.3 Herring in Baltic Fishing Areas 28, 29 and 32, CANUM

	1	2									
	1990	1999									
	0	10									
	1										
1990	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1991	23190	222220	1164800	777590	240940	582350	103600	160840	66620	27380	39860
1992	109740	848510	752490	1116860	346110	113490	232280	42770	37520	39700	18740
1993	80910	716600	1310700	835430	818920	265120	121350	127930	30620	32830	30580
1994	79680	294820	916280	1038530	528210	488020	214910	73790	149680	24050	29320
1995	21000	429700	689980	1160940	936170	365600	256280	126930	54030	82080	28420
1996	54530	670240	1055060	751970	845570	505460	302650	210460	93900	22250	59690
1997	109700	417520	1167890	1205680	785860	603960	324420	162650	90220	31760	25270
1998	58550	1495140	677170	1048300	972620	478110	289790	156610	81320	35450	31520
1999	116360	247520	1340490	707630	844960	563900	184580	114810	35070	25010	15860

Table 5.4 Herring in Baltic Fishing Areas 28, 29 and 32, WECA

	1	3									
	1990	1999									
	0	10									
	1										
1990	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1991	0.00587	0.01454	0.01861	0.0241	0.02921	0.03106	0.04055	0.0457	0.05389	0.05699	0.05577
1992	0.00535	0.0118	0.01711	0.02269	0.0292	0.03825	0.03509	0.04769	0.05392	0.05099	0.06149
1993	0.00594	0.01114	0.0161	0.02493	0.02788	0.03086	0.03604	0.04004	0.05108	0.05795	0.0648
1994	0.00449	0.01209	0.01769	0.02036	0.02786	0.03116	0.03645	0.04666	0.05004	0.05966	0.06895
1995	0.00422	0.00902	0.01619	0.01956	0.02254	0.03061	0.03462	0.03668	0.04393	0.04939	0.05371
1996	0.00369	0.00886	0.01328	0.01859	0.02102	0.02379	0.02913	0.03435	0.03878	0.04492	0.0567
1997	0.00417	0.00929	0.01343	0.01654	0.01982	0.02327	0.02468	0.02861	0.03248	0.04179	0.04834
1998	0.00432	0.00901	0.01412	0.01825	0.02144	0.02452	0.02836	0.0338	0.03892	0.04662	0.05908
1999	0.00436	0.00956	0.0133	0.01844	0.02184	0.02434	0.02872	0.03077	0.03539	0.04766	0.05417

6 ACKNOWLEDGEMENT

The Study Group is willing to express its gratitude to Dr Eero Aro and Dr Raimo Parmanne from the Finnish Game and Fisheries Research Institute whose Working papers proved to be an essential contribution to the work of the Study Group.

7 REFERENCES

Aro, E., Pushkin, S., Kotilainen, P., Mamylov, V., Flinkman, J. and Diogtev, A. 1990. Estimation of changes in abundance of Baltic herring and sprat stocks by combined hydroacoustic-trawl survey in the Gulf of Finland in autumn, winter and spring. ICES C.M. 1990/J:25, 21 pp.

Hannerz, L. 1955. Strömmingsmärkningen i Bottenhavet 1954. Ostkusten 1: 14-15.

Hannerz, L. 1956. Preliminary results of the herring investigations in the Bothnian Sea 1954. Annls.Biol., Copenh. 11: 156-158.

ICES, 2000. Extract of the Report of the Advisory Committee on Fishery Management on Stocks in the Baltic to the International Baltic Sea Fishery Commission. 136 pp.

Kompowski, A., 1969. Types of otoliths of southern Baltic herring. ICES C.M.1969/H:12, 17 pp.(mimeogr.).

Kornilovs, G. 1994. Yearly length distribution of herring in the Gulf of Riga in relation to populational structure of the stock. ICES C.M. 1994/J:9, Ref.H.

Kornilovs, G. 1995. Analysis of Baltic herring year-class strength in the Gulf of Riga. ICES C.M. 1995/J:11.

Neuman, E. 1982. Species composition and seasonal migrations of the coastal fish fauna in the southern Bothnian Sea. In Coastal Research in the Gulf of Bothnia. pp. 317-351. (Eds.. by K. Müller). Dr. W. Junk Publishers, The Hague-Boston-London 1982.

Northcote, T.G. 1978. Migratory strategies and production in freshwater fishes. In: Gerking, S.D. (ed.), Ecology of freshwater fish production, Blackwell Scientific Publications. Oxford, London, Edinburgh, Melbourne, p. 326-359.

Ojaveer, E. !981. Marine pelagic species. In: The Baltic Sea. Elsevier Oceanography series No. 30, pp. 276-292. Ed. by A.Voipio. Elsevier Scientific Publishing Company, Amsterdam-Oxford-New-York.

Ojaveer, E., and Elken, J. 1997. On regional subunits in the ecosystem of the Baltic Sea. Proc. 14th BMB Symp, 5-8 August 1995, Pärnu. Tallinn: Estonian Academy Publishers, 156-169.

Ojaveer, E., Jevtjukhova, B., Rechlin, O. and Strzyzewska, K., 1981. Results of investigations of population structure and otoliths of Baltic spring spawning herring. ICES C. M. 1981/J:19 (mimeogr.).

Ojaveer, E. and Rannak, L., 1980. Dynamics of some parameters of herring populations in the northeastern Baltic in 1948-1979. ICES C. M. 1980/H:22, 20 pp. (mimeogr.).

Otterlind, G. 1957. Från strömmingsmärkningarna på ostkusten. Ostkusten, 3: 24-30.

Otterlind, G., 1961. On the migration of the Baltic herring. ICES C. M. 1961/Herring Committee, No 121, 6 pp.

Otterlind, G., 1962. Sillens/strömmingens vandringsvanor i Östersjön. Ostkusten, 1:15-21.

Otterlind, G., 1976. Fish stocks and fish migration in the Baltic Sea environment. Ambio Spec. Rep. 4: 89-101.

Parmanne, R. 1988. Herring growth in the northern Baltic Sea in 1974-87. ICES C.M. 1988/J:19. (Mimeogr.)

Parmanne, R. 1990. Growth, morphological variation and migrations of herring (*Clupea harengus)* in the northern Baltic Sea. *Finnish Fish. Res*. 10, 48 p.

Parmanne, R., Popov, A., Raid, T. 1997. Fishery and biology of herring (*Clupea harengus* L.) in the Gulf of Finland: A review. *Boreal Environment Research*, 2: 217-227.

Parmanne, R., and Sjöblom, V. 1982. Recaptures of Baltic herring tagged off the coast of Finland in 1975-81. ICES C.M. 1982/J:19, 12 pp.

Parmanne, R., and Sjöblom, V. 1986. Recaptures of Baltic herring tagged off the coast of Finland in 1982-85. ICES C.M. 1986/J:28, 12 pp.

Popiel, J. 1964: Some remarks on the Baltic herring. ICES CM 1964, Herring Committee, 6 pp.

Popiel, J., and Stryzewska, K. 1971. Recent changes in the herring stocks of the southern Baltic. ICES CM 1971/ Special meeting on cod and herring in the Baltic, No. 8, 17 pp.

Raid, T. 1985. The reproduction areas and ecology of Baltic herring in the early stages of development found in the Soviet zone of the Gulf of Finland. *Finnish Fish. Res.*, 6: 20-34.

Raid, T. 2001. On geographical differences in herring mean weight at age between assessment units used prior to the 1990s. Working Paper to ICES Study Group on Baltic Herring Assessment Units. Copenhagen, 22-25 January 2001.

Rannak, L. 1971. On recruitment to the stock of spring herring in the north eastern Baltic. Rapp. Et proc.-verb. Reun. Cons. Perm. Int. explor. Mer. Vol. 160, pp. 78-82.

Sjöblom, V. 1961. Wanderungen des Strömlings (Clupea harengus L.) in einigen Schären- und Hochseegebieten der nördlichen Ostsee. Ann. Zool. Soc. Zool. Bot. Fenn. Vanamo, 23(1): 1-193.

Working Papers

Aro, E. and Pönni, J. 2001. Baltic herring stock units in ICES Sub-divisions 25-32: How to define stock units, which meet assessment and management requirements? Working Paper to ICES Study Group on Baltic Herring Assessment Units. Copenhagen, 22-25 January 2001.

Fetter, M., Tchervontsev, V. and Kornilovs, G. 2001. The distribution of Gulf of Riga herring in the open part of the Baltic Sea during the feeding migrations. Working Paper to ICES Study Group on Baltic Herring Assessment Units. Copenhagen, 22-25 January 2001.

Linkowski, T.B., Fey, D.P. and Wyszynski, M. 2001. Spring vs. autumn spawners of the Baltic herring on the basis of otolith microstructure and morphology. Working Paper to ICES Study Group on Baltic Herring Assessment Units. Copenhagen, 22-25 January 2001.

Parmanne, R. 2000. Assessment and Management Units for Baltic Herring. Working Paper to ICES Study Group on Baltic Herring Assessment Units. Copenhagen, 22-25 January 2001.

Wenne, R. 2001. Genetic characteristics of the Baltic herring populations with particular emphasis on Polish waters. Working Paper to ICES Study Group on Baltic Herring Assessment Units. Copenhagen, 22-25 January 2001.