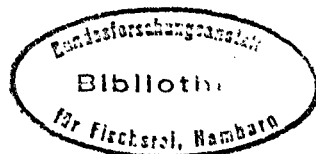


International Council for the
Exploration of the Sea

 Baltic Fish Committee
C.M.1995/J:3 Ref. H

LENGTH STRUCTURE OF HERRING IN THE GULF OF FINLAND: SPATIAL AND TEMPORAL VARIABILITY.

by

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Abstract

Length structure of Estonian herring catches in the Gulf of Finland in 1979 - 1994 show considerable spatial and temporal variability in the length distribution and mean length at age of herring in 1970s - 1990s.

The mean length at age of herring is higher and the range of length distribution is wider in the western part of the Gulf throughout of the year. In the second half of a year, the the mean length at age in catches remains unchanged or even decreases in both eastern and western parts of the Gulf. Simultaneously, the size distribution range become more narrow compared to the first half of the year. That probably indicates on existing of active migration of older (bigger) herring out to the Northern Baltic Proper after the spawning period.

The long-term dynamics in mean length at age of herring show very similar trends to those observed in the mean weight at age. So, after being rather high in the late 1970s - early 1980s, both the mean length started gradually decrease, remaining at the present below the level of 1970s.

Changes in feeding conditions and influence of cod selective predation have been pointed out as main possible factors, causing big changes in mean weight and length of Baltic herring since the second half of 1980s. Comparison of the length distributions of herring within the most abundant age groups in 1980s - 1990s did not reveal distinct deviations from the normal length distribution curve during the period of cod invasion into the Gulf of Finland in early 1980s, what could have been expected as a result of selective feeding pressure by cod, directed towards the smaller individuals.

INTRODUCTION

Despite no distinct and genetically distinguished groups of spring herring have been revealed in the northern Baltic Sea (Parmanne, 1990), the stock structure of herring and the respective assessment units have been continuously under discussion at the meetings of the ICES Working Group dealing with the assessment of the Baltic herring (e.g. Anon. 1994a). Differences in morphology and distribution pattern, empirically observed between herring in different regions of the sea provide the basis for those discussions. Still, the scheme of assessment units has remained unchanged since 1990 and several probably existing herring stocks have been assessed as one big stock (Subdivisions 25-29 +32).

In this context, the situation with the Baltic herring does not differ from that of with the Atlantic herring, where "... the lack of demonstrable differences in genetic... characteristics and weak results from traditional stock identification methods have been interpreted as indicating significant gene flow among neighbouring spawning aggregations of a larger population" (Stephenson, 1991).

The practical need for safe assessment of the Baltic herring encourages for further investigations of spatial and structural discreteness of herring stocks in the sea, to improve the quality of assessment, even if the origin of the differences found between the herring in different areas has no clearly verified genetical background.

The present paper, describing the length structure of herring in the Gulf of Finland serves as the follow-up to the overview of age and weight structure of herring in the Gulf of Finland presented at the 82nd Annual Science Conference of ICES (Raid, 1994).

MATERIAL AND METHODS

The Gulf of Finland is one of the main areas of herring fishery in the Baltic Sea and the most important operating area for Estonian herring fleet. The total catch has been about 40 - 50 000 t in 1970s-1990s, making up appr. 12 - 15% of the total landings in the Baltic main basin.

Due to the high intensity of pelagic trawl fishery in the Gulf of Finland, taking place almost all year around, the structure of Estonian landings is supposed to reflect the structure of the stock, particularly of its adult fraction.

The commercial trawl catches were sampled monthly (at least 6 samples per month, 100 fish each), in 1972-1994. Sampling covered the both of two most important fishing regions, locating in the eastern and western parts of the Gulf respectively (Fig. 1).

Altogether over 150 000 specimens of herring were analysed.

RESULTS AND DISCUSSION

Mean length at age

The annual mean length at age data of herring taken in the eastern and western parts of the Gulf of Finland are given in the Table 1.

The well-known feature in the Baltic ecosystem is the diminishing of growth of fishes,

including herring from south to north as a result of effect of worsening of environmental conditions, in which low temperature and salinity and short vegetation period play the key role (Ojaveer, 1988).

Therefore, the mean length at age of herring in most abundant age groups in the Gulf of Finland make up just 30-50 % of the respective values in the Baltic Proper.

Like in other regions of the Baltic, the mean length at age of herring in the Gulf of Finland has gone through the remarkable cycle of changes. In mid-1970s, the mean weight started to increase gradually, reaching the peak values in late 1970s-early 1980s. After that, in the middle of 1980s, the mean length started to decline down to the levels of 1950s-1960s in early 1990s (Figures 2 and 3).

Consequently, the mean length at age followed generally the same trend as the mean weight at age during the recent decades.

At the same time, it is remarkable, that the mean length of herring had the decreasing trend already in 1981-1982, i.e. in the years of maximum mean weights at age (Lankov and Raid, 1991, Raid, 1994).

The mean length of herring in the Gulf of Finland shows, besides the described above main trends, also rather well distinguished geographical differences in body size between the western and eastern parts of the Gulf. As it follows from the Figures 3 and 4, the mean length of herring taken in the western part of the Gulf of Finland has been higher than in the eastern part in all most abundant age groups since 1950s. The differences in mean length, being largest in the period of high values of mean length in 1980s, reach 10-12% in age groups 2-3 and over 20% in older age groups. In 1990s, simultaneously to the decrease in mean length at age the differences mentioned have also decreased. This is in good agreement with the geographical and temporal pattern of mean weight at age (Raid, 1994).

The higher mean length at age is observed in the western part of the Gulf of Finland all year around (Figure 5).

The mean length at age is highest in the first half of a year, decreasing in the 3rd quarter and increasing again in the end of a year. The seasonal changes in the mean length are the most remarkable in the older age groups, whilst in age groups 1 and 2 the mean length increases gradually throughout the year, reflecting the individual growth. Drop in the mean body length on older age groups point at the migration of essential amount of older (bigger) herring out of the Gulf shortly after the spawning period in summer, and vice versa in the end and beginning of the year (Figure 6).

Length distribution

Seasonal dynamics of the length distribution of herring also shows changes referring to the occurrence of migration activity of bigger (faster growing) fraction of the stock in the Gulf (Tables 2 and 3). So, the curves of the length distribution are usually shifted towards the bigger sizes in the first half-year, particularly in the western part of the Gulf. The seasonal differences in size distribution vary from year to year reflecting probably the differences migration activity and routes. So in 1984 and 1992 the length distribution of herring shows, that considerable fraction of herring with length over 14 cm appeared in the eastern part of the Gulf and disappeared after the spawning period. In contrast, the length distribution of herring did not change essentially in 1982, 1993 and 1994 showing low migration activity. (Figures 7

and 8).

Despite of existence of active seasonal migrations between the Gulf of Finland and the Northern Baltic Proper, a certain seasonal stability in the size differences between the two parts of the Gulf indicate, that a considerable fraction of herring, does not perform long spawning migrations, spending all year in the Gulf. That supports the assumption of existence of a local group of herring in the Gulf of Finland as it has been supposed earlier (e.r. Rannak, 1971, Ojaveer, 1991). That group consists of small, slow-growing and relatively young (Raid, 1994) herring, not performing longer migrations, owing to the limited swimming abilities. Whether those morphological peculiarities of that group have an genetical background or are simply a result of normal growth variation is unclear.

Long-term changes in growth and length distribution

Besides to the possible changes in feeding conditions due to the altered hydrological conditions, the effect of cod predation have been pointed out as one of the main factors, causing, through selective foraging of smaller individuals the big changes in mean weight and length at age of Baltic herring observed since mid-1980s (Anon., 1994).

The biomass of cod in the Eastern Baltic reached its maximum level in 1979-1984(5). According to the official catch statistics, the invasion of cod into Gulf of Finland took place in same years, after what the abundance of cod became negligible (Anon., 1994a, Larsson, 1994). So the effect of selective feeding of cod should have been expected particularly in those years. D. Uzars (1994), investigating the feeding of cod in the Central and Eastern Baltic, has revealed, that the share of herring in diet of cod over 30cm in length remained virtually unchanged in the first half of a year in 1963-1990. In the second half-year herring made up 14-19% of diet of cod in 1963-1975, but in 1976-1979 the share dropped to 7%. Since 1980 the share of herring has stabilised at 12-14%. The above indicates, that cod did not face big difficulties in preying on herring in the years of high abundance. According to the simulations by Bundgaard and Sparholt (1992), the predation mortality of herring is highest in length groups 7-15 cm, i.e. in age groups below 3. Comparison of the length distributions of the Gulf of Finland herring in age group 2 from 1973 to 1993 did not reveal any big deviations from the normal length distribution over the years investigated (Figure 9). Indeed, the absence of the fraction below 14 cm in 1981 and 1985 seem to support the theory of selective feeding. But, at the same time, the presence of the fraction over 17 cm already in 1973 and 1978, i.e. in the years without cod and its total absence after the end of cod invasion indicate the shift of the total length range towards the bigger sizes in late 1970s-early 1980s.

The migration of herring from the southern areas into the Gulf of Finland under the pressure of cod could be regarded as one possible reason of occurrence of bigger size fraction of herring in the Gulf of Finland in late 1970s-early 1980s.

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Table 1 . Mean length (L, cm) at age of herring in the Gulf of Finland.
w = western part, e = eastern part

| Year | Age | | | | | | | | | |
|--------|------|------|------|------|------|------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10+ |
| 1979w | 13 | 14.9 | 17.8 | 18.8 | 19.5 | 19.7 | 19.9 | 20.2 | 20.2 | 21.4 |
| 1979e | 12.9 | 15.4 | 16.6 | 17.4 | 18.2 | 18 | 17.9 | 18.3 | 18 | 18.8 |
| 1980w | 13.2 | 16.1 | 17.7 | 18.9 | 22.8 | 20.3 | 21.3 | 21 | 22.9 | 22.3 |
| 1980e | 12.8 | 15.6 | 16.5 | 17.5 | 17.8 | 18.2 | 18.3 | 18.1 | | 19 |
| 1981w | 12.9 | 15.6 | 17.4 | 18.9 | 20.5 | 21.4 | 21.8 | 21.7 | 22.9 | 22.6 |
| 1981e | 11.7 | 14.5 | 16.3 | 17 | 18.1 | 18.2 | | 18.5 | 18.5 | 19.5 |
| 1982w | 12.8 | 16 | 18.2 | 19.8 | 20.6 | 21.3 | 21.1 | 21 | 26.8 | 23.2 |
| 1982e | 12.3 | 14.9 | 16.3 | 17.4 | 17.7 | 18.5 | 18.8 | | | 20.5 |
| 1983w | 12.3 | 15.5 | 17.4 | 19.1 | 19.9 | 21.3 | 20.1 | 22.3 | 21.6 | 24.7 |
| 1983e | 11.7 | 15.1 | 16.5 | 17.3 | 18.7 | 18.5 | 19.7 | 18.8 | 16.7 | |
| 1984w | 11.6 | 14.6 | 16.8 | 17.9 | 19 | 20.4 | 19.8 | 21 | 22.2 | 22.3 |
| 1984e | 11.2 | 14.1 | 16.3 | 17.3 | 18.1 | 19.2 | 18.8 | | 18.6 | 18 |
| 1985w | 11.7 | 14.2 | 15.8 | 17.8 | 19.8 | 20.3 | 21.1 | 19.8 | 20.4 | 24.2 |
| 1985e | 12.2 | 13.8 | 15.3 | 16 | 17.7 | 19.1 | | | 18.1 | |
| 1986w | 11.7 | 14.3 | 15.3 | 16.7 | 18.2 | 20.3 | 21.1 | 24.4 | 25.4 | |
| 1986e | 11.2 | 13.8 | 14.5 | 15.8 | 16.3 | 16.4 | 19.9 | | | |
| 1987w | 11.8 | 14.9 | 16 | 16.4 | 17.8 | 18.6 | 19.9 | 21 | 21.9 | 23.8 |
| 1987e | 11.8 | 14.1 | 15 | 15.4 | 15.5 | 16.8 | 18.2 | 17.2 | | 21.7 |
| 1988w | 12.4 | 14.2 | 16.1 | 16.7 | 17.4 | 19 | 19.6 | 21.4 | 21.1 | 24.7 |
| 1988e | 11.9 | 13.6 | 15 | 15.4 | 16.3 | 15.9 | 16 | 16.1 | 16.3 | |
| 1989w | 13.1 | 14.8 | 15.6 | 16.8 | 17.6 | 17.7 | 19.2 | 21.7 | 21.6 | 26.1 |
| 1989e | 12.9 | 14.2 | 14.8 | 15.6 | 15.8 | 16.1 | 16.7 | 17.5 | 17 | |
| 1990w | 12.4 | 14.8 | 15.8 | 16.5 | 16.8 | 18 | 19.8 | 20 | 20.4 | 22.7 |
| 1990e | 12.5 | 14.1 | 15 | 15.8 | 15.9 | 16.1 | 16.6 | 16.6 | 16.7 | 20.3 |
| 1991w | 12 | 14.6 | 15.5 | 16.1 | 16.5 | 17.2 | 18.5 | 18.9 | 20.3 | 22.6 |
| 1991e | 11.8 | 14 | 15 | 15.5 | 16 | 16.1 | 17.1 | 17.5 | 17.4 | 20.2 |
| 1992w | 11.5 | 14.6 | 15.7 | 16.5 | 16.5 | 17 | 18.2 | 18.2 | 19.1 | 20.1 |
| 1992e | 11.6 | 13.8 | 14.7 | 15.4 | 15.2 | 16 | 16.2 | 16.9 | 16.4 | 17.6 |
| 1993w | 12 | 13.8 | 15.2 | 16 | 16.5 | 16.9 | 17.4 | 18 | 18.6 | 19.8 |
| 1993e | 11.6 | 13.2 | 14.6 | 15.2 | 15.8 | 16.4 | 16 | | 16.7 | 17.3 |
| 1994w | 12.1 | 14.2 | 14.8 | 15.8 | 16.4 | 16.5 | 16.9 | 18.2 | 17.8 | 18.4 |
| 1994e | 11.9 | 13.5 | 14 | 15 | 15.7 | 16 | 15.6 | 15.5 | | |
| 79-81w | 13.0 | 15.5 | 17.6 | 18.9 | 20.9 | 20.5 | 21.0 | 21.0 | 22.0 | 22.1 |
| 79-81e | 12.5 | 15.2 | 16.5 | 17.3 | 18.0 | 18.1 | 18.1 | 18.3 | 18.3 | 19.1 |
| 82-84w | 12.2 | 15.4 | 17.5 | 18.9 | 19.8 | 21.0 | 20.3 | 21.4 | 23.5 | 23.4 |
| 82-84e | 11.9 | 14.9 | 16.5 | 17.5 | 18.5 | 19.1 | 19.4 | 18.8 | 19.5 | 21.4 |
| 85-87w | 11.7 | 14.5 | 15.7 | 17.0 | 18.6 | 19.7 | 20.7 | 21.7 | 22.6 | 24.0 |
| 85-87e | 11.7 | 13.9 | 14.9 | 15.7 | 16.5 | 17.4 | 19.1 | 17.2 | 18.1 | 21.7 |
| 88-90w | 12.6 | 14.6 | 15.8 | 16.7 | 17.3 | 18.2 | 19.5 | 21.0 | 21.0 | 24.5 |
| 88-90e | 12.4 | 14.0 | 14.9 | 15.6 | 16.0 | 16.0 | 16.4 | 16.7 | 16.7 | 20.3 |
| 91-94w | 11.9 | 14.3 | 15.3 | 16.1 | 16.5 | 16.9 | 17.8 | 18.3 | 19.0 | 20.2 |
| 91-94e | 11.7 | 13.6 | 14.6 | 15.3 | 15.7 | 16.1 | 16.2 | 16.6 | 16.8 | 18.4 |

Table 2 . Length distribution of herring catches in the Gulf of Finland in 1982 - 1984.

| Length, cm | 1982 w | | | | Length, cm | 1982 e | | | |
|---------------|--------|------|------|------|---------------|--------|------|------|------|
| | 1 qrt | 2qrt | 3qrt | 4qrt | | 1 qrt | 2qrt | 3qrt | 4qrt |
| 7 | | | | | 7 | | 1 | | 2 |
| 8 | 2 | 2 | | 6 | 8 | 4 | 2 | 2 | 3 |
| 9 | 2 | 2 | | 16 | 9 | 4 | 4 | 1 | 10 |
| 10 | 10 | 4 | | 17 | 10 | 8 | 16 | 2 | 6 |
| 11 | 17 | 12 | 1 | 5 | 11 | 14 | 25 | 1 | 1 |
| 12 | 11 | 14 | 13 | 28 | 12 | 10 | 29 | 18 | 9 |
| 13 | 14 | 30 | 45 | 136 | 13 | 81 | 79 | 104 | 110 |
| 14 | 45 | 164 | 73 | 175 | 14 | 244 | 270 | 130 | 224 |
| 15 | 81 | 198 | 37 | 158 | 15 | 122 | 153 | 29 | 116 |
| 16 | 78 | 81 | 46 | 97 | 16 | 61 | 77 | 13 | 62 |
| 17 | 57 | 54 | 35 | 90 | 17 | 24 | 22 | | 33 |
| 18 | 60 | 48 | 15 | 76 | 18 | 12 | 14 | | 11 |
| 19 | 45 | 40 | 16 | 33 | 19 | 4 | 1 | | 8 |
| 20 | 29 | 26 | 11 | 23 | 20 | 1 | 2 | | 3 |
| 21 | 17 | 13 | 5 | 12 | 21 | 2 | 3 | | |
| 22 | 10 | 5 | 2 | 7 | 22 | 1 | 1 | | |
| 23 | 10 | 3 | | 6 | 23 | | | | |
| 24 | 4 | 1 | 1 | 3 | 24 | | 1 | | |
| 25+ | 8 | 3 | | 2 | 25+ | 8 | | | |
| n | 500 | 700 | 300 | 890 | n | 600 | 700 | 300 | 598 |

| Length, cm | 1983 w | | | | Length, cm | 1983 e | | | |
|---------------|--------|------|------|------|---------------|--------|------|------|------|
| | 1 qrt | 2qrt | 3qrt | 4qrt | | 1 qrt | 2qrt | 3qrt | 4qrt |
| 7 | 2 | | | 1 | 7 | 2 | | | |
| 8 | 2 | 2 | 1 | 1 | 8 | 5 | 1 | | 9 |
| 9 | 8 | 13 | 5 | 7 | 9 | 12 | 4 | 2 | 9 |
| 10 | 11 | 14 | 4 | 12 | 10 | 12 | 13 | 3 | 8 |
| 11 | 2 | 13 | 2 | 18 | 11 | 1 | 1 | 2 | 6 |
| 12 | 7 | 7 | | 2 | 12 | 9 | 14 | 19 | 26 |
| 13 | 21 | 25 | 26 | 28 | 13 | 97 | 127 | 94 | 115 |
| 14 | 55 | 77 | 53 | 118 | 14 | 230 | 268 | 62 | 136 |
| 15 | 107 | 147 | 73 | 117 | 15 | 187 | 194 | 8 | 97 |
| 16 | 92 | 111 | 24 | 96 | 16 | 174 | 131 | 9 | 85 |
| 17 | 80 | 93 | 6 | 79 | 17 | 97 | 97 | 1 | 59 |
| 18 | 49 | 82 | 3 | 56 | 18 | 58 | 31 | | 27 |
| 19 | 30 | 34 | 1 | 28 | 19 | 14 | 10 | | 8 |
| 20 | 13 | 31 | 1 | 19 | 20 | 1 | 7 | | 9 |
| 21 | 10 | 17 | 1 | 7 | 21 | 1 | 1 | | 5 |
| 22 | 4 | 17 | | 4 | 22 | | 1 | | 1 |
| 23 | 4 | 5 | | 3 | 23 | | | | |
| 24 | 2 | 4 | | 2 | 24 | | | | |
| 25+ | 1 | 8 | | 2 | 25+ | | | | |
| n | 500 | 700 | 200 | 600 | n | 900 | 900 | 200 | 600 |

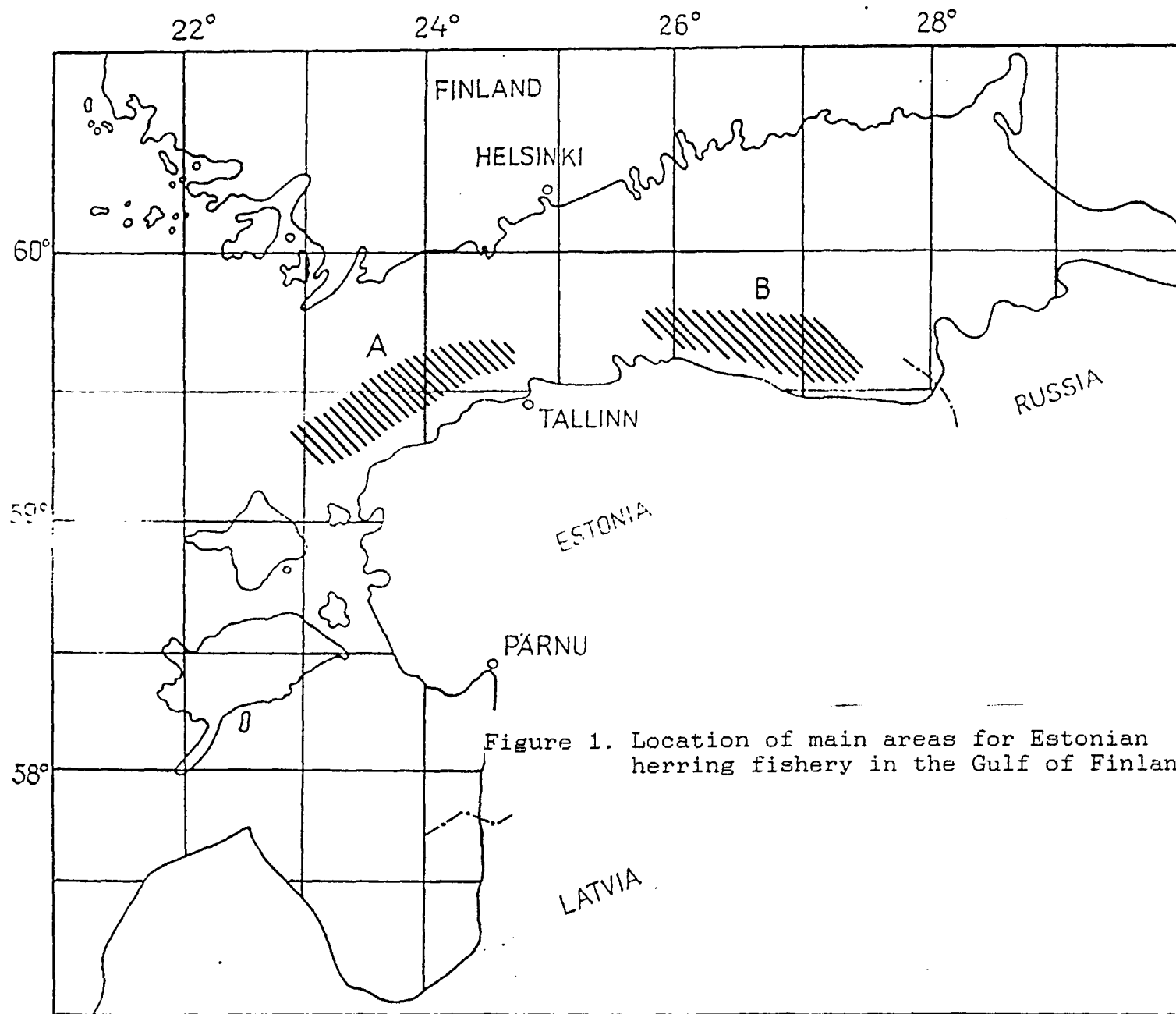
| Length, cm | 1984 w | | | | Length, cm | 1984 e | | | |
|---------------|--------|------|------|------|---------------|--------|------|------|------|
| | 1 qrt | 2qrt | 3qrt | 4qrt | | 1 qrt | 2qrt | 3qrt | 4qrt |
| 7 | 1 | 1 | | | 7 | | | | |
| 8 | | 1 | | 3 | 8 | 1 | | | |
| 9 | 6 | 1 | 1 | 8 | 9 | 7 | 3 | 1 | 2 |
| 10 | 2 | 4 | | 10 | 10 | 11 | 5 | 1 | 12 |
| 11 | 7 | 14 | | 12 | 11 | 12 | 2 | | 5 |
| 12 | 7 | 8 | 4 | 47 | 12 | 10 | 7 | 13 | 50 |
| 13 | 11 | 17 | 12 | 108 | 13 | 88 | 86 | 52 | 102 |
| 14 | 50 | 142 | 17 | 58 | 14 | 129 | 113 | 18 | 19 |
| 15 | 67 | 136 | 18 | 23 | 15 | 97 | 89 | 6 | 5 |
| 16 | 53 | 99 | 6 | 12 | 16 | 73 | 83 | | 3 |
| 17 | 50 | 69 | 17 | 8 | 17 | 52 | 61 | 5 | 2 |
| 18 | 45 | 52 | 10 | 5 | 18 | 15 | 23 | 2 | |
| 19 | 46 | 22 | 4 | 3 | 19 | 3 | 12 | | |
| 20 | 24 | 13 | 4 | 2 | 20 | | 12 | 1 | |
| 21 | 15 | 8 | 2 | | 21 | 1 | 4 | 1 | |
| 22 | 6 | 4 | 3 | 1 | 22 | 1 | | | |
| 23 | 4 | 4 | 1 | | 23 | | | | |
| 24 | 2 | 3 | | | 24 | | | | |
| 25+ | 4 | 2 | 1 | | 25+ | | | | |
| n | 400 | 600 | 100 | 300 | n | 500 | 500 | 100 | 200 |

Table 3. Length distribution of herring in the Gulf of Finland in 1992 - 1994.

| Length, cm | 1992 w | | | | Length, cm | 1992 e | | | |
|---------------|--------|------|------|------|---------------|--------|------|------|------|
| | 1 qrt | 2qrt | 3qrt | 4qrt | | 1 qrt | 2qrt | 3qrt | 4qrt |
| 7 | 1 | | | | 7 | | | | |
| 8 | | | 2 | | 8 | 2 | | 1 | 12 |
| 9 | 2 | 8 | 6 | 11 | 9 | 7 | 2 | 1 | 51 |
| 10 | 10 | 7 | 20 | 57 | 10 | 6 | 4 | | 16 |
| 11 | 1 | 1 | 87 | 25 | 11 | 3 | 2 | 15 | 82 |
| 12 | 11 | 4 | 148 | 168 | 12 | 14 | 17 | 66 | 293 |
| 13 | 40 | 21 | 62 | 179 | 13 | 140 | 124 | 11 | 86 |
| 14 | 147 | 91 | 69 | 80 | 14 | 376 | 219 | 4 | 79 |
| 15 | 283 | 178 | 128 | 80 | 15 | 295 | 163 | 2 | 70 |
| 16 | 28 | 153 | 51 | 71 | 16 | 46 | 49 | | 9 |
| 17 | 147 | 82 | 16 | 25 | 17 | 9 | 16 | | 1 |
| 18 | 62 | 34 | 3 | 2 | 18 | 2 | 2 | | |
| 19 | 17 | 8 | 2 | 1 | 19 | | 1 | | |
| 20 | 7 | 7 | 1 | 1 | 20 | | 1 | | |
| 21 | 1 | 3 | 1 | | 21 | | | | |
| 22 | 2 | 2 | | | 22 | | | | |
| 23 | 1 | 1 | | | 23 | | | | |
| 24 | | | | | 24 | | | | |
| 25+ | 2 | | | | 25+ | | | | |
| n | 762 | 600 | 596 | 700 | n | 900 | 600 | 100 | 699 |

| Length, cm | 1993 w | | | | Length, cm | 1993 e | | | |
|---------------|--------|------|------|------|---------------|--------|------|------|------|
| | 1 qrt | 2qrt | 3qrt | 4qrt | | 1 qrt | 2qrt | 3qrt | 4qrt |
| 7 | | | | | 7 | | 1 | | |
| 8 | 3 | | | 2 | 8 | | 3 | | |
| 9 | 11 | 1 | 3 | 6 | 9 | 6 | 12 | | 1 |
| 10 | 61 | 6 | 2 | 7 | 10 | 15 | 15 | 4 | 3 |
| 11 | 32 | 5 | 41 | 11 | 11 | 44 | 39 | 95 | 13 |
| 12 | 52 | 41 | 148 | 662 | 12 | 321 | 359 | 189 | 121 |
| 13 | 133 | 127 | 301 | 277 | 13 | 205 | 201 | 149 | 391 |
| 14 | 101 | 135 | 266 | 294 | 14 | 96 | 64 | 51 | 190 |
| 15 | 108 | 196 | 139 | 97 | 15 | 85 | 69 | 11 | 61 |
| 16 | 141 | 170 | 61 | 31 | 16 | 25 | 27 | | 18 |
| 17 | 45 | 70 | 22 | 6 | 17 | 3 | 8 | | 2 |
| 18 | 62 | 29 | 5 | 2 | 18 | | | | |
| 19 | 6 | 10 | 1 | 1 | 19 | | 1 | | |
| 20 | | 5 | | 1 | 20 | | 1 | | |
| 21 | 3 | 2 | | 2 | 21 | | | | |
| 22 | | 1 | 1 | 1 | 22 | | | | |
| 23 | | 2 | | | 23 | | | | |
| 24 | | | | | 24 | | | | |
| 25+ | | | | | 25+ | | | | |
| n | 758 | 800 | 990 | 1400 | n | 800 | 800 | 499 | 800 |

| Length, cm | 1994 w | | | | Length, cm | 1994 e | | | |
|---------------|--------|------|------|------|---------------|--------|------|------|------|
| | 1 qrt | 2qrt | 3qrt | 4qrt | | 1 qrt | 2qrt | 3qrt | 4qrt |
| 7 | | | | | 7 | | | | 1 |
| 8 | 1 | | | 6 | 8 | 1 | 1 | 4 | 2 |
| 9 | | 2 | | 6 | 9 | 2 | 1 | 3 | 7 |
| 10 | 4 | 2 | 3 | 2 | 10 | 9 | 14 | | 1 |
| 11 | 3 | 5 | 4 | | 11 | 2 | 22 | 1 | 5 |
| 12 | 4 | 1 | 11 | 20 | 12 | 53 | 67 | 16 | 23 |
| 13 | 40 | 58 | 84 | 161 | 13 | 160 | 328 | 108 | 234 |
| 14 | 103 | 156 | 201 | 298 | 14 | 63 | 209 | 133 | 441 |
| 15 | 57 | 144 | 122 | 144 | 15 | 7 | 48 | 27 | 77 |
| 16 | 55 | 119 | 40 | 45 | 16 | 3 | 7 | 8 | 7 |
| 17 | 17 | 61 | 15 | 10 | 17 | | 2 | | 2 |
| 18 | 11 | 25 | 3 | 4 | 18 | | 1 | | |
| 19 | 2 | 18 | | 3 | 19 | | | | |
| 20 | 2 | 5 | 1 | | 20 | | | | |
| 21 | 1 | 1 | 1 | 1 | 21 | | | | |
| 22 | | 1 | | 1 | 22 | | | | |
| 23 | | 1 | | | 23 | | | | |
| 24 | | 1 | | | 24 | | | | |
| 25+ | | | | | 25+ | | | | |
| n | 300 | 600 | 485 | 701 | n | 300 | 700 | 300 | 800 |



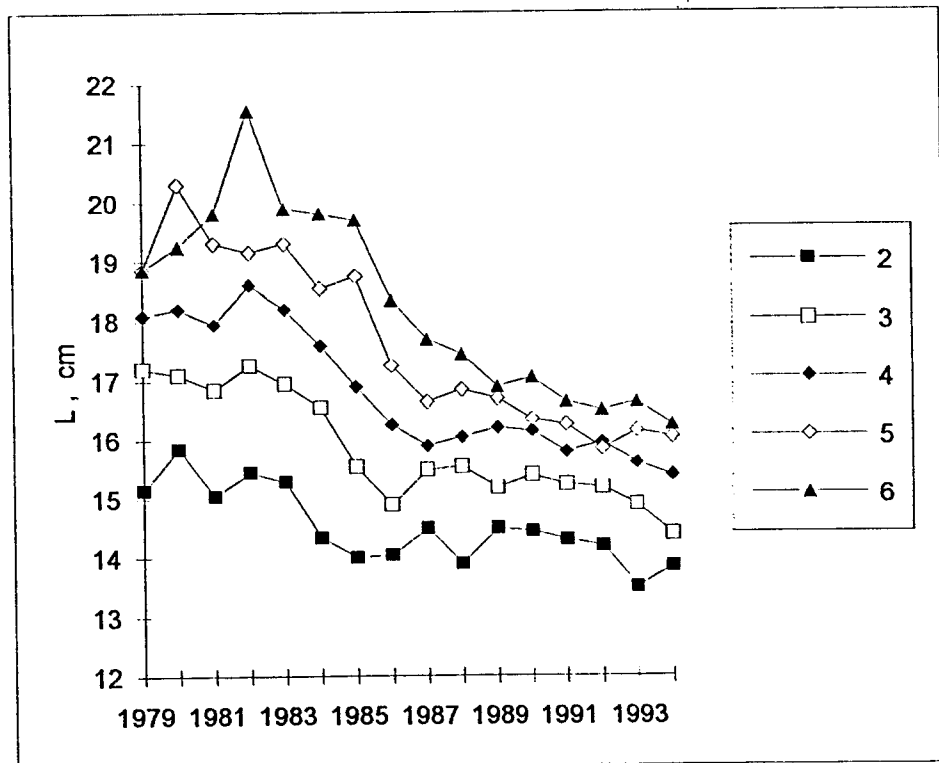


Figure 2 . Mean length at age of herring in the Gulf of Finland (1979-1994)

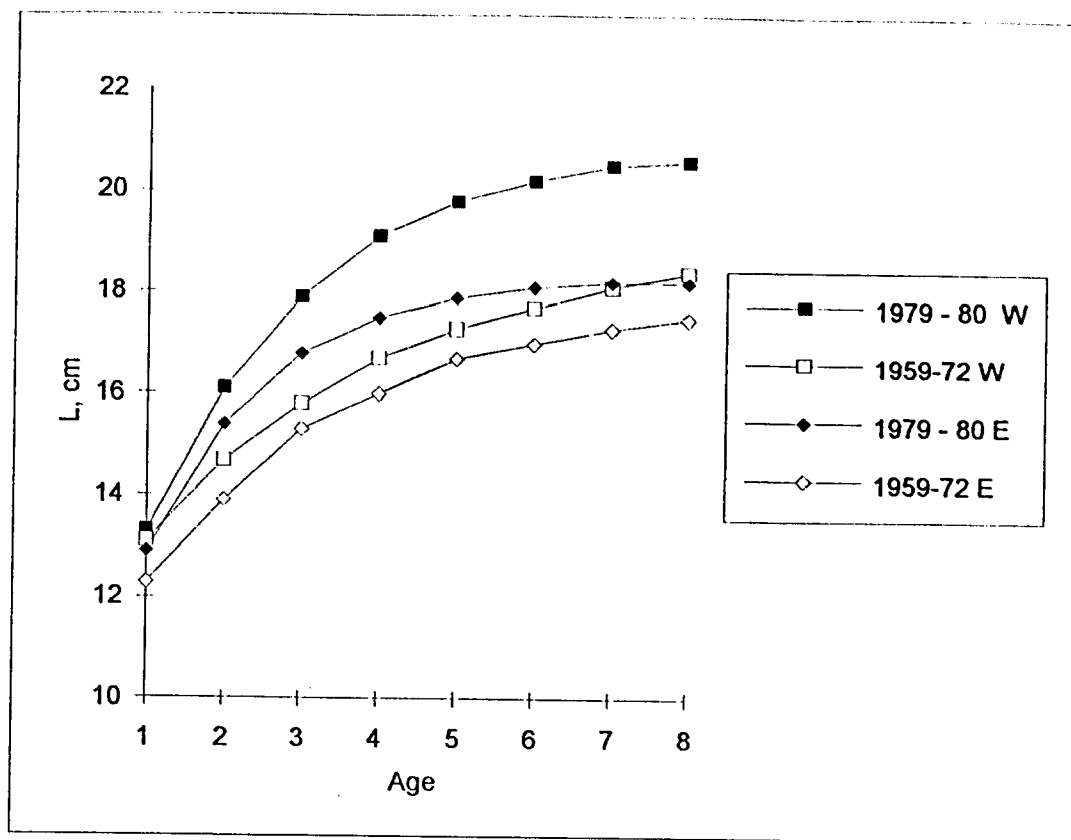


Figure 3. von Bertalanffy growth curves for herring in the Western (W) and eastern (E) Gulf of Finland in 1960s (after Ojaveer, 1976) and 1970s.

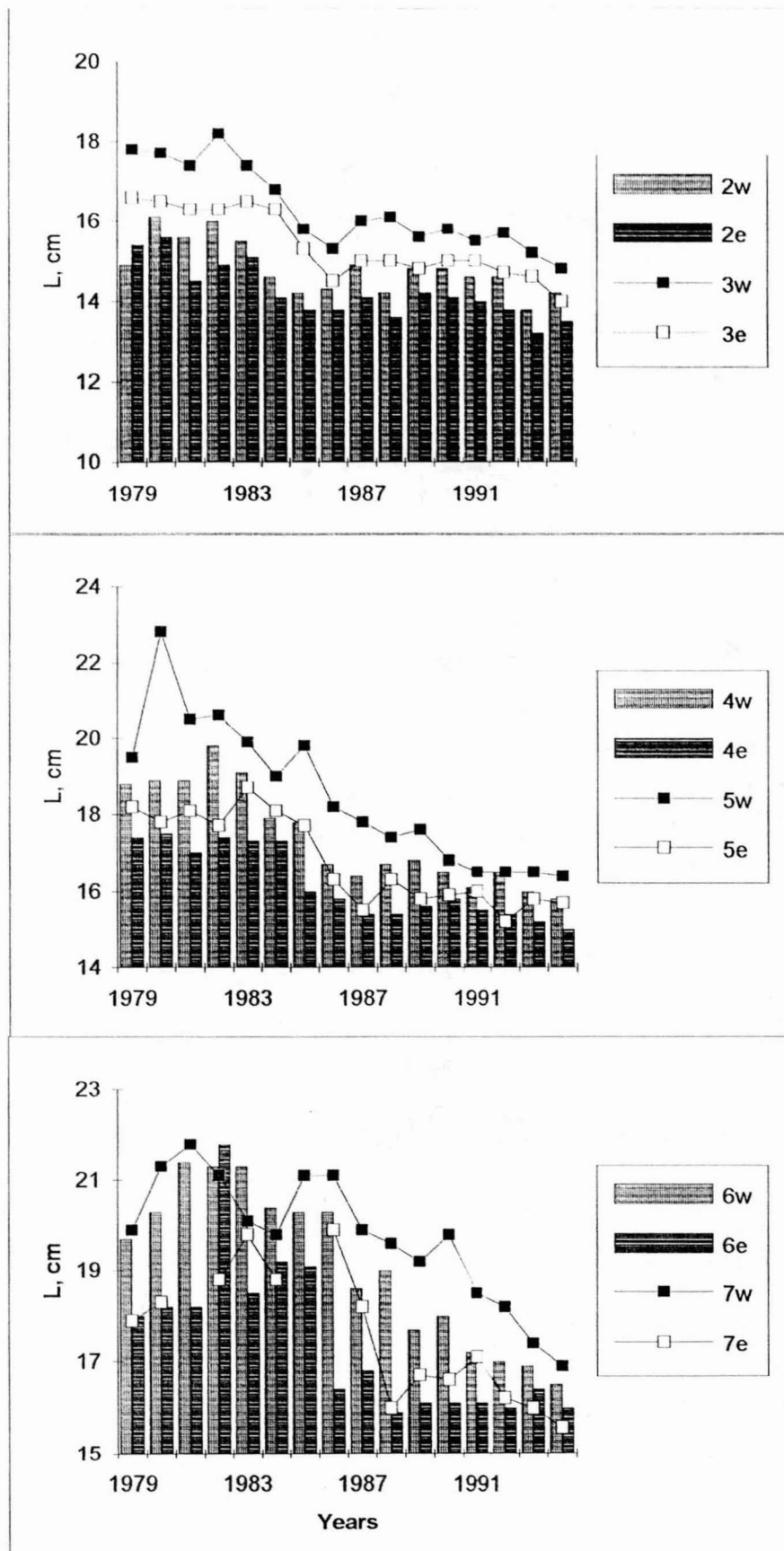


Figure 4 .Mean length at age of herring in the western and eastern Gulf of Finland in 1979 - 1994.

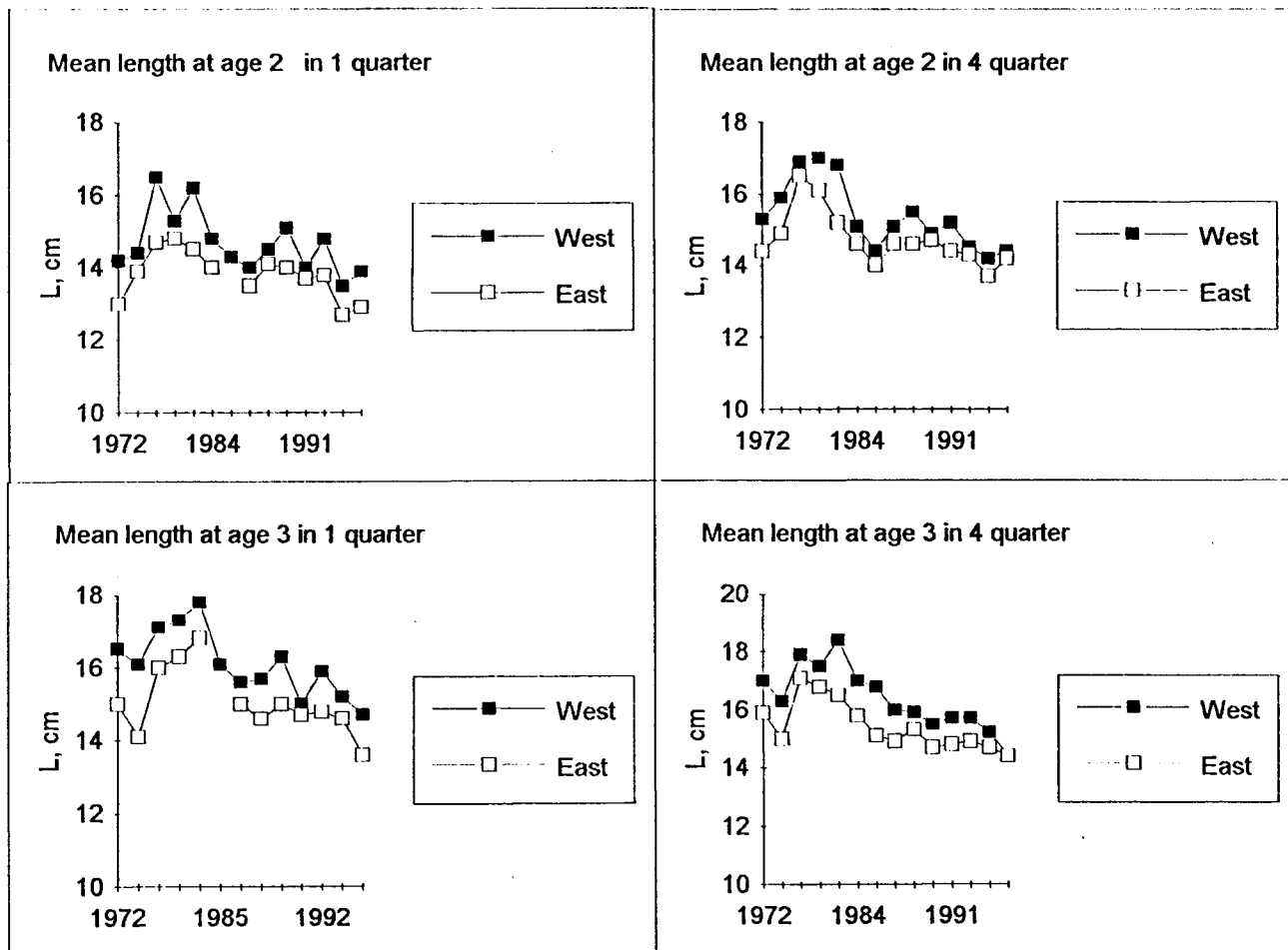


Figure 5 . Mean length of herring at age 2 and 3 in 1 and 4 quarter (1972-1994).

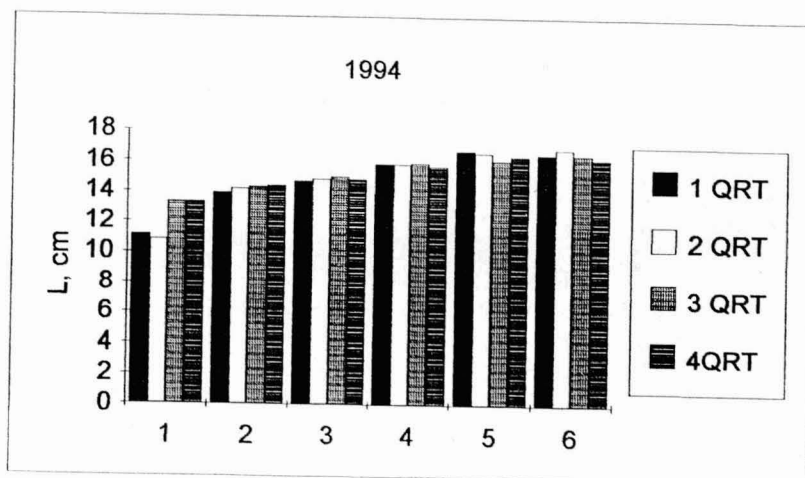
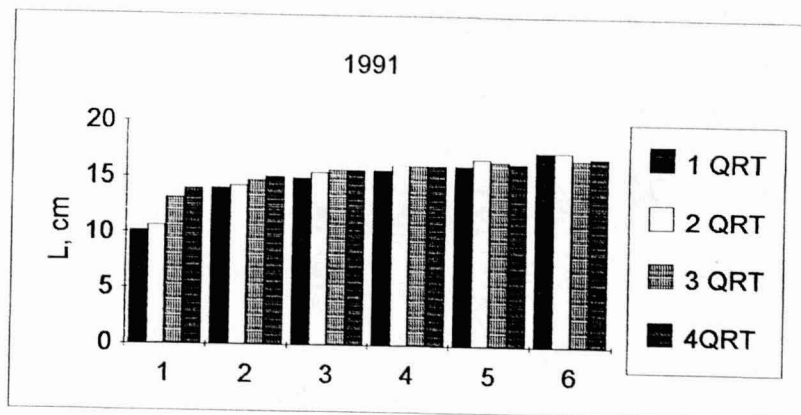
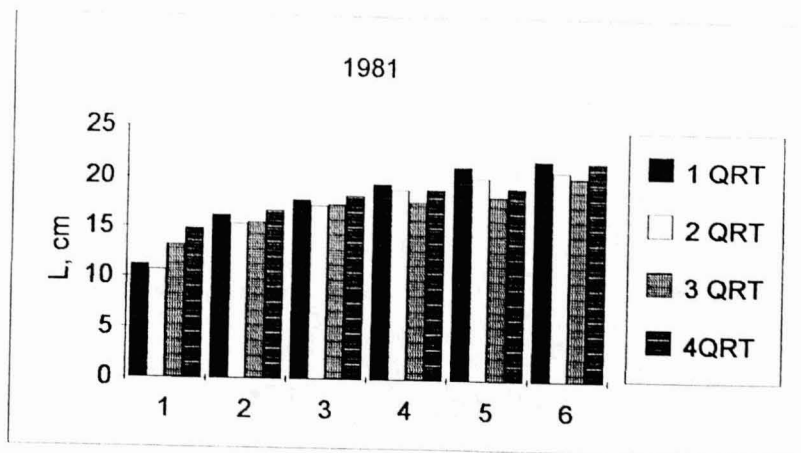


Figure 6 .Mean length in age groups 1-6 of herring in the western Gulf of Finland.

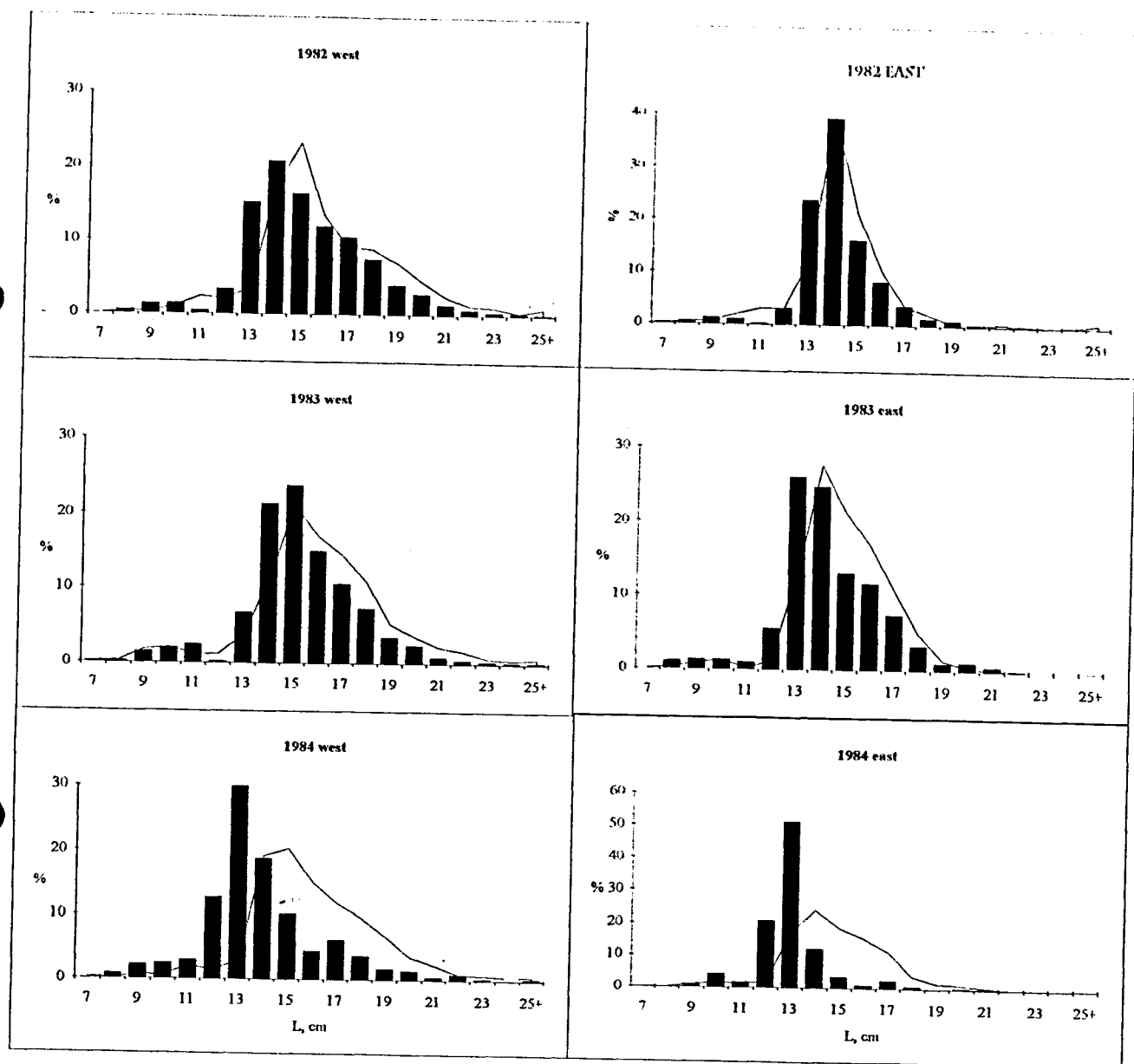


Figure 7 . Seasonal dynamics of length distribution of herring in 1982-1984. Area: January-June; Bars: July - December.

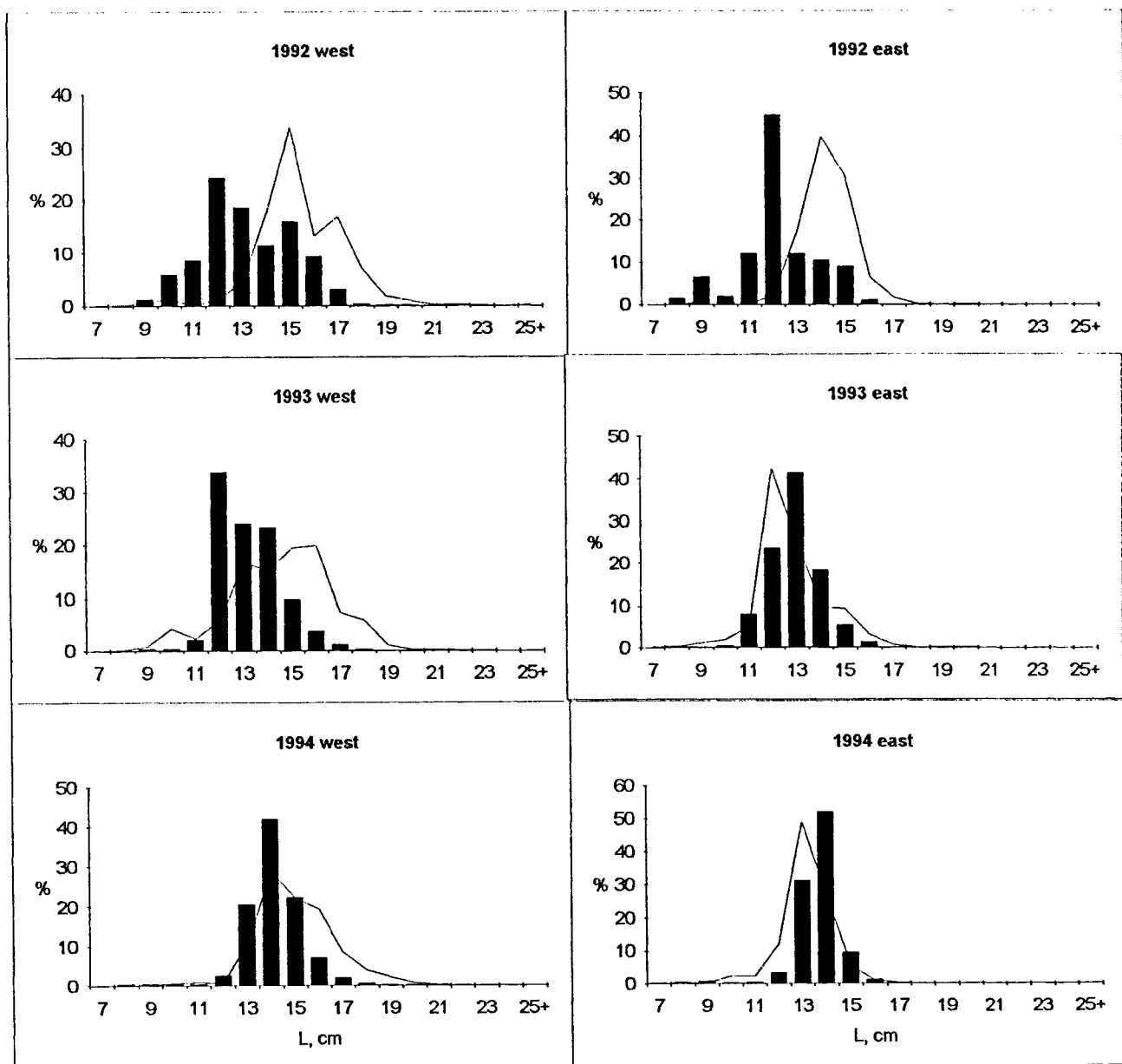


Figure 8 . Seasonal dynamics of length distribution of herring in 1982-1984. Area: January-June; Bars: July - December.

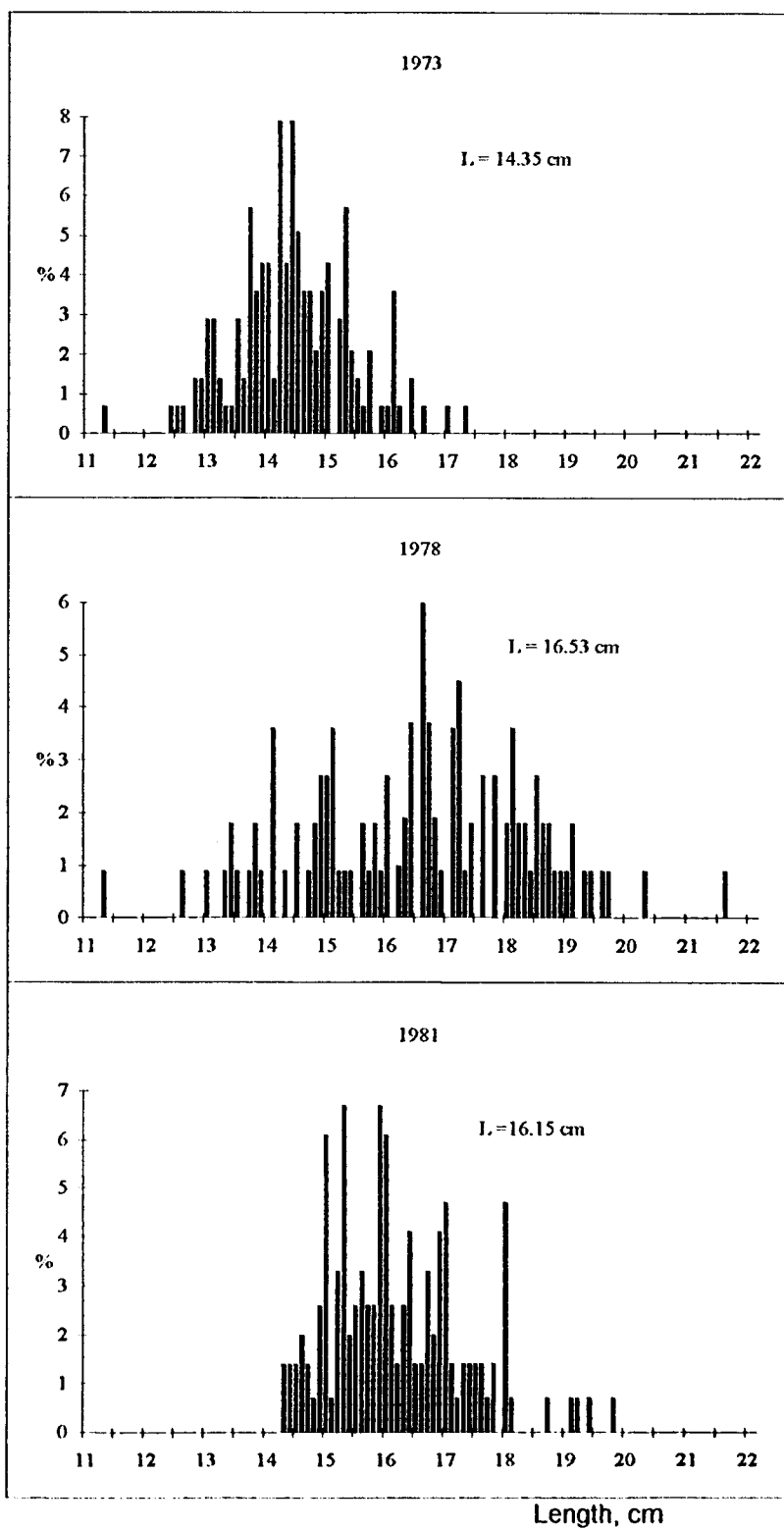


Figure 9 . Length distribution of herring at age 2 (1 quarter, western part of the Gulf of Finland). L = mean length.

