ICES WKFLABA REPORT 2010

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Report of the ICES/HELCOM Workshop on Flatfish in the Baltic Sea (WKFLABA)

8 - 11 November 2010

Öregrund, Sweden

ICES
International Council for the Exploration of the Sea
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Executive summary

The ICES/HELCOM Workshop on Flatfish in the Baltic Sea WKFLABA took place in

Öregrund (Sweden), 8-11 November 2010 (Chaired by Jan Horbowy, Poland, Ann-Britt Florin and Didzis Ustups, Sweden). In total, 16 ICES and HELCOM experts from 8 countries attended the meeting. The objectives of the meeting were to review the flatfish population structure in the Baltic Sea and to suggest possible stock assessment units from biological point of view. Trial assessments were also conducted for those stocks with sufficient existing data.

The agenda of the meeting was divided into two periods, the first for literature reviews and the second for data analyses and stock assessments.

In total 17 populations of flatfish (11 flounder, 3 plaice and 3 dab) were identified in the Baltic Sea. Lack of available information for turbot and brill did not allow identifying stock structure for these species

The workshop agreed that only the improved ageing methodology (sliced and stained or broken and burned) shall be used for all flatfish species. Long time series with new age data were available only for some stocks. For the other stocks the new methodology has only been used during the last few years. This reduces the possibility to use classical cohort based stock assessments models (e.g., XSA, ICA) for these stocks.

Therefore, alternative models for evaluations of dynamics and state of flatfish stocks were discussed. The following groups of methods were considered:

- Production models
- Difference models
- The models using Random Walk (RW)
- Length based Cohort Analysis
- Simple methods allowing approximate evaluation of exploitation level (catch curve analysis, total mortality estimates using mean age or mean length in the stock)

Different alternative models were used for estimation of biomass and/or mortality of flounder (Southern Baltic, Bay of Gdansk, Eastern Gotland, Swedish east coast, Estonian coast of Gulf of Finland) and turbot (in ICES SD 28) populations. Due to time constraints the workshop was just able to initiate some analyses and the obtained results by no way may be considered as final assessments. A lot of intersessional work is needed to compile the data and test the data and the models. Then, depending on reliability of results and diagnostics of the models, the assessment method for given stock might be proposed.

1 Opening of the meeting

The meeting started at 8 November 2010. In total, 9 institutes and 1 organisation were represented from 8 countries (see Table 1.1). In total, 16 participants joined the meeting. The participant list is in Annex 1.

Table 1.1. Represented countries and institutes during WKFLABA 2010

Country	Institute/Organisation
Denmark	National Institute of Aquatic Resources Section for Fisheries Advice
Estonia	Estonian Marine Institute, University of Tartu
Finland	Finnish Game and Fisheries Research Institute
Germany	Johann Heinrich von Thünen-Institute, Federal Research Institute for Rural Areas, Forestry and Fisheries, Institute of Baltic Sea Fisheries
Latvia	Institute of Food Safety, Animal Health and Environment - "BIOR"
Lithuania	Fisheries research laboratory
Poland	Sea Fisheries Institute
Sweden	Research station Ar, Gotland University
Sweden	Swedish Board of Fisheries Institute of Coastal Research
-	Helsinki Commission

2 Adoption of the agenda

The adopted agenda is in Annex 2.

3 Review of population structure of flatfish and assessment units (ToR 1 and 2)

ToR 1) Review population structure of flatfish, including but not limited to flounder and turbot, in the Baltic Sea taking into account all current available knowledge.

ToR 2) Suggesting possible assessment units from a biological point of view

Table 3.1 gives a summary of discovered references regarding population structure of flatfishes in the Baltic Sea and table 3.2 summarizes the suggested assessment units from a biological perspective identified by the workshop. Below follows a description of population structure for the 5 most common species of flatfishes in the Baltic Sea: brill, dab, plaice, turbot and flounder followed by a general discussions of limitations of the conclusions that can be drawn from current available data.

3.1 Brill

Brill is distributed mainly in the western part of the Baltic Sea and Brill fishery is dominated by Denmark in SD 22 (95% of the catches in 1985-2009, ICES 2010). Yearly landings within the Baltic Sea have varied between 19 and 106 tonnes during the last ten years (ICES 2010). The eastern border of its occurrence is not clearly described. The range of its distribution extends to the SD 25 (Florin 2005) but in the southern part of SD 24-25 (Poland EEZ) only single specimens are caught occasionally (unpublished data, E. Gosz). In SDs 26-32 these species was recorded few times during the last century (Plikšs & Aleksejevs 1998).

We have found no data concerning genetic or tagging or any other study that could be used to infer population structure within the Baltic, hence no suggestions for possible assessment stocks based on biological information can be given.

3.2 Dab

Dab is distributed mainly in the western part of the Baltic Sea and fishery is dominated by Denmark and Germany in SD 22, amounting to more than 1000 tonnes yearly and representing 47% and 36% respectively of total catches in the Baltic Sea during the last three years (data from ICES 2010). A significant amount, 100 tonnes, is also landed yearly in SD 24 by the same dominating countries, and commercial dab landings are reported to a lesser extent by Sweden in SD 25, 27 and 28 (Florin 2005, ICES 2010). The eastern border of its occurrence is not clearly described. Single specimens are caught only occasionally in the Polish EEZ (unpublished data, E. Gosz) as well as in SD 26-32 (Plikšs & Aleksejevs 1998, Ojaveer *et al* 2003).

Temming (1989) mainly based on taggings and meristic investigations by Jensen (1938), separated dab in the Belt Sea area (SD 22 and western part of SD 24, south of Mön) from dab in the Bornholm area (SD 25). This is in agreement with the study of Nissling *et al*. (2002) who reports that salinities requirements for egg development and neutral egg buoyancy of this species suggest there are two stocks of dab, one in SD 23 and western part of SD 24, and the second in the eastern part of SD 24 and SD 25.

For dab there is a no data on genetics and no direct comparisons has been made between SD 23 and 22. Nevertheless, based on the data above (Temming 1989, Nissling *et al* 2002) we suggest that there are 3 stocks in the Baltic Sea (Fig 3.2.1.). One stock in Belt Sea SD 22 +2 4W, one stock in Öresund SD 23 and one joint stock in Arkona and Bornholm basin (SD 24E + 25). It is unclear where the split of SD 24 is located. It is possible that the Öresund stock should be merged with the Belt Sea stock but merging stocks that have independent dynamics is a much more severe error from a stock conserving point of view, than to erroneously divide a homogenous stock in two separate assessment units (c.f. Laikre *et al* 2005). Hence we suggest using 3 and not 2 stocks of Dab in the Baltic.

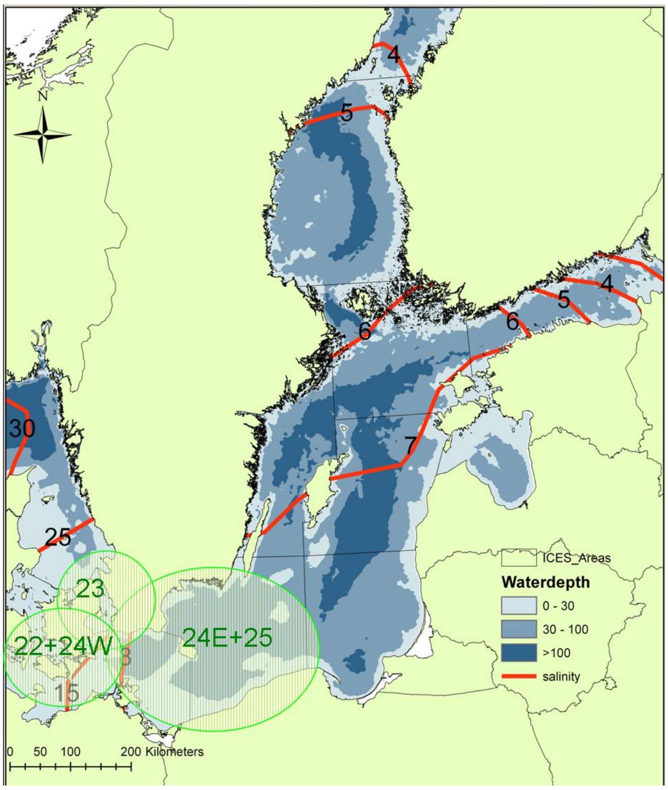


Figure 3.2.1. Approximate location of three identified stocks of dab in the Baltic Sea. Numbers within circles refers to ICES SD.

3.3 3.3 Plaice

Regular area of distribution of plaice in the Baltic Sea extends eastwards to the Gulf of Gdansk and northwards to the Gotland area but sporadically it is found further north (Plikšs & Aleksejevs 1998, Ojaveer *et al* 2003, Florin 2005). The distribution of this species is decreasing according to the level of salinity (from the west to the east in the southern Baltic Sea, Gosz *et al* 2008). The main fishing areas for plaice in the Baltic Sea are SD 22 (dominated by Denmark to 90%) and to an equal extent 24 + 25 (dominated by Denmark and Poland, ICES 2010). These areas stands for on average 95% of the total catch in the Baltic Sea during 2000-2009 which on average amounts to 2 000 tonnes yearly (ICES 2010).

Investigation of meristic characters showed no differences between eastern parts of SD 24 and 25 but these were in turn different from western parts of SD 24 and SD 22 (Poulsen 1932, 1938). In coherence with this tagging studies by Otterlind (1967) showed large extent of migration between SD 24 & 25 but limited outside this area. In addition Bagge & Steffensen (1989) report on tagging studies from SD 22 showing that migration does not occur to SD 24. Finally Nissling *et al* (2002) found no differences in neutral egg buoyancy between plaice from 24, 25 and 28. There is no genetic information for plaice in the Baltic Sea and unfortunately no investigations reported from SD 23 but in order to avoid merging stocks of independent dynamics we suggest that, analogous to dab, there are 3 stocks of plaice in the Baltic. One stock in Belt Sea SD 22 + 24W, one stock in Öresund SD 23 and one joint stock in Arkona, Bornholm, Gdansk and Eastern Gotland basin (SD 24 + 25 + 26 + 28) (Fig 3.3.1).

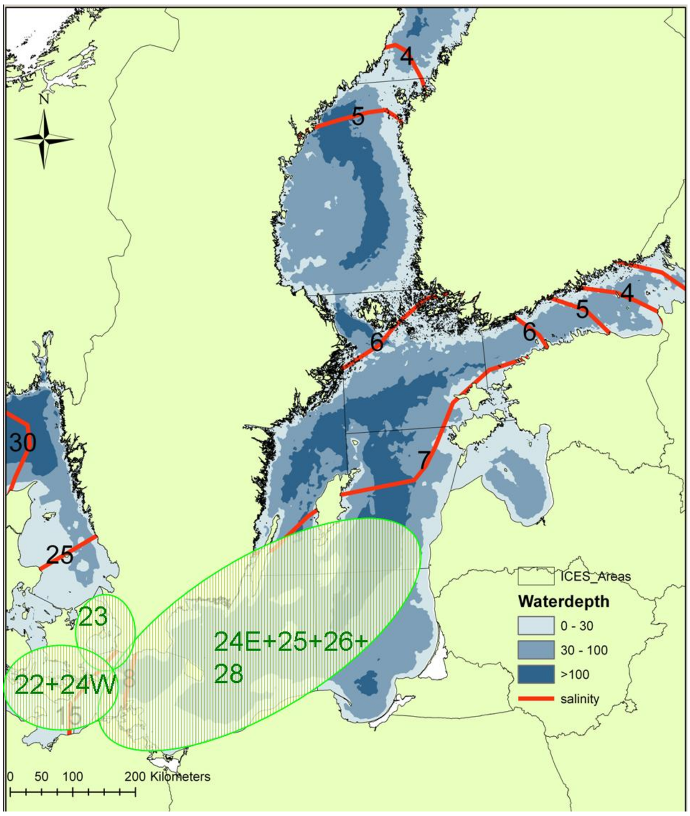


Figure.3.3.1. Approximate location of three identified stocks of plaice in the Baltic Sea. Numbers within circles refers to ICES SD.

3.4 Turbot

The turbot is a coastal species commonly occurring from Skagerrak up to the Sea of Åland (Florin 2005). Turbot spawns in shallow waters (10–40 m, 10–15 m in central Baltic) and the metamorphosing postlarvae migrate close to shore to shallow water (down to one meter depth) (Plikšs & Aleksejevs 1998, Ojaveer *et al* 2003, Florin 2005). Turbot fishery is dominated in the westerly parts of the Baltic Sea, SD 22-26 and mean annual landings amounts to less than 500 tonnes during the 2000´s (ICES 2010).

For turbot the genetic data show no structure within the Baltic Sea (Nielsen *et al* 2004, Florin&Höglund 2007), although the former discovered a difference between Baltic Sea and Kattegat with a hybrid zone in SD 22. However, phenotypic parameters (morphometry of spermatozoa) suggests there exist at least two local turbot population in the southern Baltic Sea, one in SDs 24-25 and the second in SD 26 (Gosz *et al.*, 2010). Spawning site fidelity of this species confirms there is high possibility of creating local (at least phenotypic based) stocks of turbot. Three different tagging studies from three different parts of the Baltic Sea all show that turbot have high spawning area fidelity and that 95% of the fishes move less then 30 km from tagging site although few individual specimens show a displacements of 100´s of kms (Table 3.1. Johansen 1916, Aneer & Westin 1990, Florin&Franzen 2010). The study from Bornholm area (Johansen 1916) is very small, however, and no information is available from the eastern part of the Baltic Sea, hence it is possible that turbot stocks in these areas behave in a different way.

To be able to elucidate the stock structure of turbot in the Baltic there is a need for tagging studies also from southern and eastern part. The investigations on spermatozoa size should be checked for environmental influence and preferably sampling would be done also in the northern part of the Baltic Sea. Studies on salinity requirements for reproduction as well as phentotypic data including growth rate from different parts of the Baltic could be of great value. In addition there is still a lack of knowledge on to how large extent there is exchange of larvas between different parts of the Baltic.

To conclude there is indications that turbot should be treated as several local stocks but there is not enough data to identify these different stocks hence the workshop refrained from suggesting potential assessment units for this species.

3.5 Flounder

The most distributed among all flatfish species in the Baltic Sea. Flounder occurs in all parts of the Baltic except for the eastern part of Gulf of Finland (SD 32) and the Bothnian Bay (SD 31) (Plikšs & Aleksejevs 1998, Ojaveer *et al* 2003, Florin 2005). Flounder fishery is dominating in the western and southern part of the Baltic Sea, on average 50%, 20% and 15% of the flounder landings are reported from SD 24 + 25, 26 and 22 respectively and yearly landings in the Baltic Sea amounts to 17 000 tonnes on average in the 2000´s (ICES 2010).

There are a lot of studies showing the existence of two different types of flounders in the Baltic Sea: one with pelagic and one with demersal eggs (Mielck & Künne 1932; Lönning & Solemdal 1972, Nissling *et al* 2002). The pelagic type spawns in deeper areas while the demersal spawns in shallow areas. The two types mix however in shallow areas during summer feeding time and both types probably aggregate in deeper areas during winter. A genetic study identified two different populations of flounder in the Baltic Sea (Florin & Höglund 2008), corresponding to the distribution of the pelagic and demersal type of flounder (Fig 3.5.1.). The same genetic differentiation between flounder with demersal (SD 28, 29) and pelagic (SD 22, 25) eggs was seen in Hemmer- Hansen *et al* (2007).

Measurements of salinity of neutral egg buoyancy (egg specific gravity) and salinity of spermatozoa activation (corresponding to fertilization) in different parts of the Baltic Sea (SD 23, 24, 25 and 28) suggest that flounder can be separated into three stocks. Flounder with demersal eggs constitute one distinct stock and those with pelagic eggs two stocks, one in SD 23 and one in SD 24-25 (Nissling *et al* 2002).

Studies of fecundity of flounder in SD 25, 27-29 revealed significant differences in fecundity between spawning strategies (demersal/pelagic eggs) but no intra-population differences (Nissling & Dahlman 2010).

Several tagging experiments have been conducted on flounder (see Table 3.1) and also reviewed in Bagge & Steffensen (1989) as well as Aro (1989). They show the possibility of several distinct stocks of flounder for both the demersal and pelagic type.

Based on data from tagging, genetics, fecundity and neutral egg buoyancy we suggest that for pelagic flounder there are 5 stocks in the Baltic, the first three are in line with the ones identified for dab and plaice, i.e SD 22, SD 23 and SD 24 + SD 25. Tagging data from Bagge (1966) suggest that the migration from both SD 22 and SD 23 are limited to SD 24 hence we do not merge SD24W with either of these. In addition there is a separate stock in Gdansk SD 26 and in the eastern Gotland basin (mainly SD28E but also stretching into SD 26 and 29). Approximate locations of the stocks are shown in figure 3.5.2. These 5 pelagic spawning flounder populations cover about 90% of landings (data from ICES 2010).

For demersal flounder, based on tagging experiments we follow Aro 1989 as well as Bagge & Steffensen 1989, and suggest 6 stocks: one stock along the Swedish coast in SD 27, two stocks in SD 28; one around the Gotland Island and one in Irbe Strait, including western part of Gulf of Riga and up to Hiiumaa island in Estonia, one stock in SD29/30 and finally two stocks in SD 32 (one along the Finnish coast and one along the Estonian coast) (Figure 3.5.3).

There is uncertainty if demersal flounder also occurs in SD 26 (it does according to genetic studies Florin&Höglund 2008) and in SD 25 (coastal spawners are described in this area by Otterlind 1967).

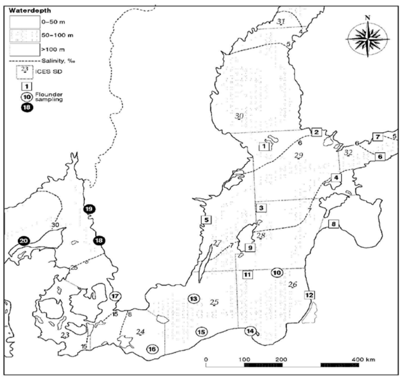


Figure 3.5.1. Genetic differentiation between flounder with pelagic (circle) and demersal (square) eggs (Florin & Höglund 2008).

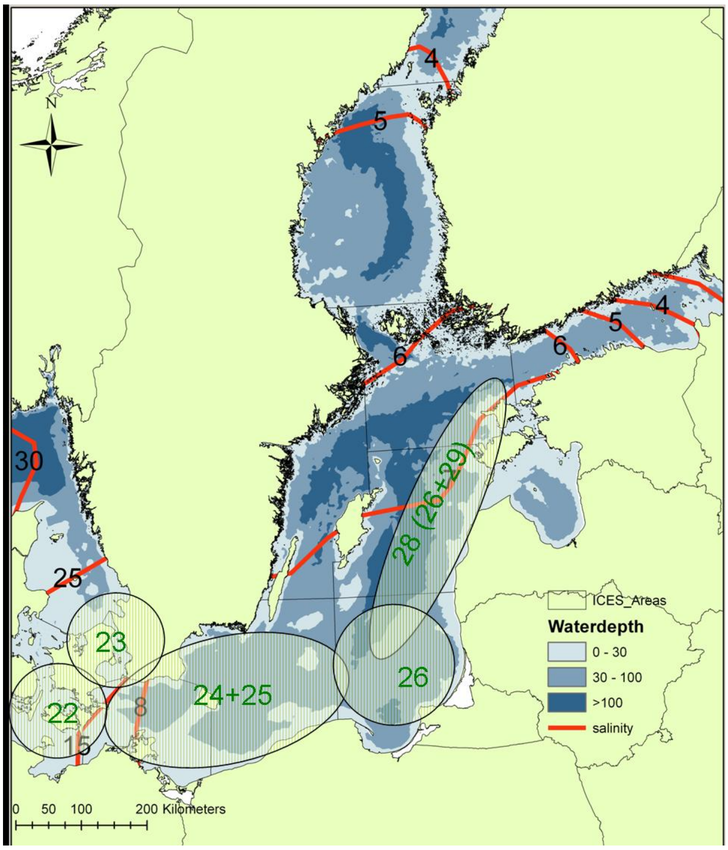


Figure 3.5.2. Approximate location of five identified stocks of pelagic flounder in the Baltic Sea. Numbers within circles refers to ICES SD.

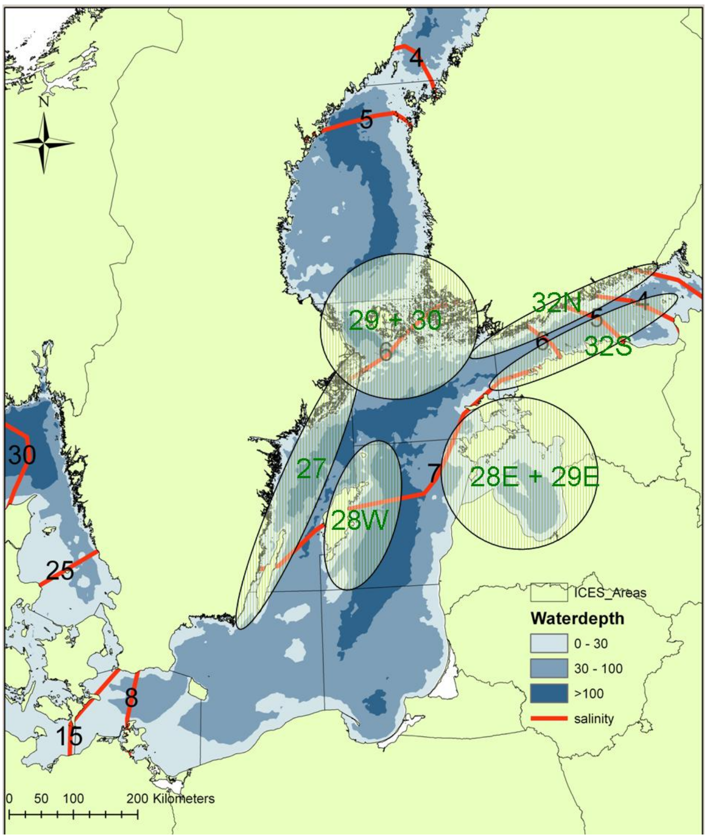


Figure 3.5.3. Approximate location of six identified stocks of demersal flounder in the Baltic Sea. Numbers within circles refers to ICES SD.

3.6 Limitations of suggested stock assessment units and identification of gaps of knowledge

Most studies reviewed have only covered limited parts of the distribution area, making direct comparisons between flatfish from different parts of the Baltic Sea impossible. General there is a lack of data from shallow coastal areas which are important for spawning turbot and demersal flounder. Another problem is that the distribution of stocks and boundaries between them changes with hydrological conditions which vary depending on amount of saltwater inflow in the Baltic. For plaice, for example, in good hydrological conditions spawning is possible in both the Gotland deep and Bay of Gdansk but during bad condition spawning is restricted to the Arcona and Bornholm Basin (Nissling *et al* 2002). The inflow of salt water also changes the distribution of pelagic flounder which during these years comes even into SD 32 which normally harbours only demersal flounder (Grauman 1981, Drevs 1999). Furthermore, after stronger inflows from the North Sea oxygen conditions in bottom layer change in opposite directions in Baltic Proper and Gulf of Finland (HELCOM, 1996). Another problem is that populations mix outside spawning time. Demersal and pelagic spawning flounder for example mix in deeper water during winter and in shallower feeding areas in late summer-early autumn. It is also important to note that many studies are done several decades ago when the oxygen situation were much better in the Baltic Sea (HELCOM, 1996) and hence the population structure where not the same as today.

The question was raised if the genetic or phenotypic based differentiation of flatfish stocks should be used for assessments purposes. Phenotypic characters are invoked by temporal sequence of environments in which the organism develops and functions therefore stock dynamic relay mostly on it and hence larger weight should be given to these when identifying stocks for assessment and management. In addition, tagging studies showing the real-time exchange of individuals between areas are more relevant when defining stocks that have independent stock dynamics than other markers, such as genetics or physiological adaptations, since the latter could be indifferent between areas that for other reasons do not exchange enough individuals to be treated as same stock from a fishery perspective.

Table 3.1. Studies giving information on population structure for flatfishes in the Baltic Sea

Species	Marker	Investigated area (ICES SD)	Main results	Reference
Turbot	Genetic (microsatellites)	21,23,24,25 ,26,28 & 29	Low genetic differentiation, FST=0.004, no isolation by distance pattern.	Florin & Höglund 2007
Turbot	Genetic (microsattelite s	Atlantic Ocean, North Sea, 20, 21, 22, 24, 29	Isolation by distance pattern with hybrid zone in SD 22 between Baltic Sea and Kattegat/Skagerrack/North sea samples; no differentiation between southern (24) and northern (29) Baltic.	Nielsen *et al* 2004
Turbot	Tagging	28	2380 adult turbots tagged near Gotland during spawning season between 2003-2005. 95% of recaptures within 30km but few fishes 100´s of km, recapture rate 6-18% within year.	Florin & Franzén 2010
Turbot	Tagging	27	401 adult turbot tagged in Askö near Stockholm between 1969 and 1973 during spawning season. 72 fish were recaptured. Recapture rates varied between 12 and 27% between years. 90% of the recaptured fish were caught < 20km, longest movement 96 km.	Aneer and Westin 1990
Turbot	Tagging	24	Tagging of 100 adult fish in spawning season near Island of Bornholm 1913, 46 recaptures 37-55% recapture rate within year, 95% of recaptures < 30 km, longest movement 26 sea miles.	Johansen 1916
Turbot	Morphometry	25, 26	Investigation on spermatozoan from male turbot caught during spawning in Pomeranian Bay (25) and Gulf of Gdansk (26) showed significant differences in size between areas.	Gosz *et al* 2010
Flounder	Genetics (microsattelite s+Heatshock protein)	SD 29, 28, 25, 22, North Sea + Atlantic + lake Pulmäki	Microsatellites revealed barrier between demersal spawners (28, 29) and pelagic spawners (25, 22) in the Baltic. HSC70 revealed adaptation (probably to low salinity) in all Baltic samples (22, 29, 25+ lake sample) compared to North sea and Atlantic samples	Hemmer Hansen *et al* 2007

Flounder	Genetic (microsattelites)	20-22, 24-30, 32	Two main clusters corresponding to demersal flounder in SD 27-29, 32 and shallow areas of SD 26 and pelagic flounder in the rest. The pelagic flounder could in turn be separated into Baltic (22, 24-26) and North sea (20, 21).	Florin & Höglund 2008
Flounder	Fecundity	25,27,28 & 29	Significant differences in fecundity between spawning strategies (demersal/pelagic eggs) but no intra-population differences	Nissling and Dahlman 2010
Flounder	Age, length, weight, cpue	28, 29, 32	Flounder with demersal eggs (bankflounder) in all investigated areas and with pelagic eggs (deepflounder) mainly in SD 28 but depending on hydrological conditions sometimes reaching into SD 29 and 32. Differences in growth rates, age distribution and dynamics of abundance suggest that Flounder in Estonian waters of the Gulf of Finland (32) is better to assess separately from flounder in SD 29.	Drevs, 1999; Drevs *et al*.1999; Ojaveer & Drevs, 2003; Drevs, 2006.
Flounder	Salinity requirement for egg development	23,24,25 & 28	Differences in psu requirements suggest 2 or 3 stocks with pelagic eggs (23 and 24+25) and one with demersal eggs.	Nissling *et al*. 2002
Flounder	Tagging	28, 29, 32	The recapture rate (in1942-1949) was 21%. The migrations were mainly less than 200 km (97%). Maximum migration 700 km.	Mikelsaar, 1957, 1958a, b, c;
Flounder	Tagging	29, 32	Migrations were mainly less than 200km. 1% of flounder, tagged in near the northern coast of island Hiiumaa were recaptured near Finnish coast.	Shchukina, 1970;
Flounder	Tagging	26	Recaptures up to 150 nm from tagging site, growth up to 13 cm in 2.5 year. Z=1.04, 64% per annum average M=0.32, 13% per annum average F= 0.72, 51% per annum average	Cieglewicz, 1963
Flounder	Tagging	SD 27	Only 13 recaptures of 1000 marked, 95% recaptured within 50km, most extreme 250km.	Florin pers comm
Flounder	Tagging	26,28,32	3 populations – one in western Gulf of Finland, one in eastern Gotland basin and one in Gulf of Gdansk, migration no more than 50-60 sea miles*	Vitins 1976
Flounder	Tagging	SD24, 25	Migration between areas but limited without areas suggesting one single stock in SD 24+25 separated from rest of Baltic stock. Recapture rate using scientific trawl between 21-30%	Otterlind 1967

Flounder	Tagging	SD29, 30, 32	SD29N and 30 constitutes a single stock, while SD 32 should be divided in a northern and southern coastal population with limited migration (2-8%) between them.	Aro & Sjöblom 1983
Flounder	Tagging	SD 28, 27	Majority of fishes tagged in coastal Gotland was recaptured not more than 30kms away with a recapture rate of 30%. Likewise majority of fishes tagged in deeper part of SD 28 was recaptured within 30km with a recapture rate of 20% Longest migration to Gdansk 300km. 99% of flounder tagged on Öland was recaptured less than 60 nm from tagging place but recapture rate was only 13%. No flounder were recaptured southwest of Rozewie-Öland limit. This suggests separate stocks in SD 27 and 28 which in turn are separate from SD 25.	Otterlind 1966
Flounder	Tagging	SD22, SD 23	SD 23, stocks seem local with limited migration to Kattegat and SD24. In SD 22 (Langelland, Fehmarn & S. Gedser) 3 stocks were identified with moderate migration to Belt sea and migration to SD 24 insignificant.	Bagge 1966, Bagge & Steffensen 1989
Plaice	Tagging	SD22	Tagging experiments in SD 22 show that migrations do not occur to SD 24, but some migrate into Kattegat. Bleghvad tagged 6000 plaice in Belt Sea, recapture rate 27-64%.	Blegvad 1934, Bagge & Steffensen 1989
Plaice	Tagging	SD24, 25	Extensive migration between areas suggesting one single stock in SD 24+25. Recapture rate between 31-36%	Otterlind 1967
Plaice	Meristic characters	SD22, SD24,25	Anal fin ray variation suggests one stock in SD 22 + SD 24W south of Mön, and another in SD24E+25.	Poulsen 1932, 1938
Plaice	Salinity requirements for egg development	24,25 & 28	No significant differences, suggesting one stock.	Nissling *et al*. 2002
Dab	Salinity requirements for egg development	23, 24 & 25	Differences in Psu requirements between SD 23 and SD 24 + 25.	Nissling *et al*. 2002
Dab	Tagging, meristics	22, 24, 25	No differences between SD 22 and SD 24 south of Mön, but these differed from SD 25.	Temming 1989

*1 sea mile= 1.852 km

Table 3.2. Summary of identified assessment units from biological viewpoint

Species	# stocks	Stockname	ICES SD
Dab	3	Belt Sea	22+24W
		Öresund	23
		Bornholm	24E+25
Plaice	3	Belt Sea	22+24W
		Öresund	23
		Southern Baltic	24E+25+26+28
Flounder	5 pelagic	Belt Sea	22
		Öresund	23
		Southern Baltic	24+25
		Bay of Gdansk	26
		Eastern Gotland	28 (26, 29)
	6 demersal	Swedish east coast	27
		Latvian coast + Gulf of Riga + Hiiumaa	28E+ 29SE
		Gotland Island	28 (27E)
		Åland	29,30
		Finnish coast of Gulf of Finland	32
		Estonian coast of Gulf of Finland	32

4 Evaluation of available age reading data (Tor3)

4.1 Flounder

Flounder population from ICES SD 26 was investigated to see the progress in flounder age reading between and within the countries. Comparison was based on ICES BITS Q1 surveys (data are available in ICES DATRAS database). We chose SD 26 due to high number of countries that are performing their surveys in SD 26 (in some years it was at most 6 countries – Latvia, Lithuania, Russia, Poland, Germany and Denmark). To cover only one population we used trawling stations only from depth strata 41-80m- we believe that in spring, before spawning, this area covers Gdansk population (see ToR 1). We chose the time period 2006 – 2009. In 2006 last flounder stock assessment in WGBFAS was performed and due to inconsistencies in age data it was stopped. After that in 2007 and 2008 two age reading workshop of flounder were organized to solve the problem in flounder age reading. One of the main conclusions was not to use whole otoliths for ageing but sliced and stained (or broken and burned as transition stage) should be used.

Flounder length distribution in 2006 varied by countries. The modal length groups were 22-27 cm, however in some countries it was remarkable smaller (Country 3 – 20-21 cm) or bigger (country 5 - 28-29 cm) [Figure 4.1.1]. For ageing all countries used whole otoliths in 2006. The biggest growth differences were in first age groups (Age group 2 – mean length by countries varied from 11.5 cm to 19.7 cm), this could be a signal that interpretation of first (or settling) ring is incorrect. For older age groups differences by countries were only 3-4 cm. In all countries in 2006 spring survey 4 years old fish dominated in population.

In 2009 flounder length distribution in spring was more homogenous by countries (figure 4.1.2). For ageing of flounder otoliths in 2009 two different methods were used by countries. Countries 1 and 4 used broken and burned otoliths while countries 2 and 3 still used whole otoliths. Comparing to 2006, differences in youngest age group by countries were significantly smaller in 2009 (only 3 cm -from 15 to 18 cm) what could be result of two age reading workshops where we took attention to determination of first annual rings. However age data for older age groups are remarkable dispersed. For 5 years old fish difference in mean length by countries is 8 cm (from 23.5 cm to 31 cm), while average age of 30 cm long flounder differ from 4,5 to 9 between countries. There is no correlation by age reading method. We could separate length at age by countries in two groups: with high growth (countries 3 and 4) and low growth rate (countries 1 and 2), and in both groups we have both age reading methods. As a result in differences in growth rate, age distribution by countries is different. In countries with higher growth rate 4 years old flounder dominated, while in countries 1 and 2 (with lower growth rate) – age group 6 was in highest number.

Growth rate by countries and years are shown in figures 4.1.3 and 4.1.4. In all years the highest growth rate was in country 4. Dispersion of age data between countries in last years is higher than that in 2006.

In country 1 (Figure 4.1.4) there is high variability of growth rate by years. The highest growth rate was in 2006 while later it decreased. In 2008 a new method (broken and burned) was used for ageing. Using a new method results showed remarkable lower growth rate than data from whole otoliths. In countries 2 and 3 in all years whole otoliths were used for ageing and data are quite constant by years. In country 4 in 2009 broken and burned otoliths were used for ageing. In contrast with country 1, there wasn’t difference in growth rate using two ageing methods.

Proportion of adult stock in population (PROPMAT)

The same data set (2006-2009) was used to analyze proportion of adult fish by age and length.

There was high variation of data by countries. For age group 2 in country 2 all fish already were adult, while in countries 3 and 4 – 100% of flounder were still juvenile (Figure 4.1.5). For age group 3 in country 2 all fish were adult, in countries 1 and 4 – mainly adult, but in country 3 all fish were still juvenile. Four age group 4 only in country 3 high number of juveniles (56 %) was observed while in other countries – only adults. We could divide countries in three groups. First (country 2) – all fish were adult starting from 2 years old fishes, second group (country 1 and 4) where in age group 4 almost all fish were adult, and third group (country 3) – where starting with age group 5, adult fish were dominant.

Comparing proportion of adult fishes by length group, we could find the similar differences by countries (Figure 4.1.6), that indicate that differences in PROPMAT is not only age biased but gonad staging problems take place.

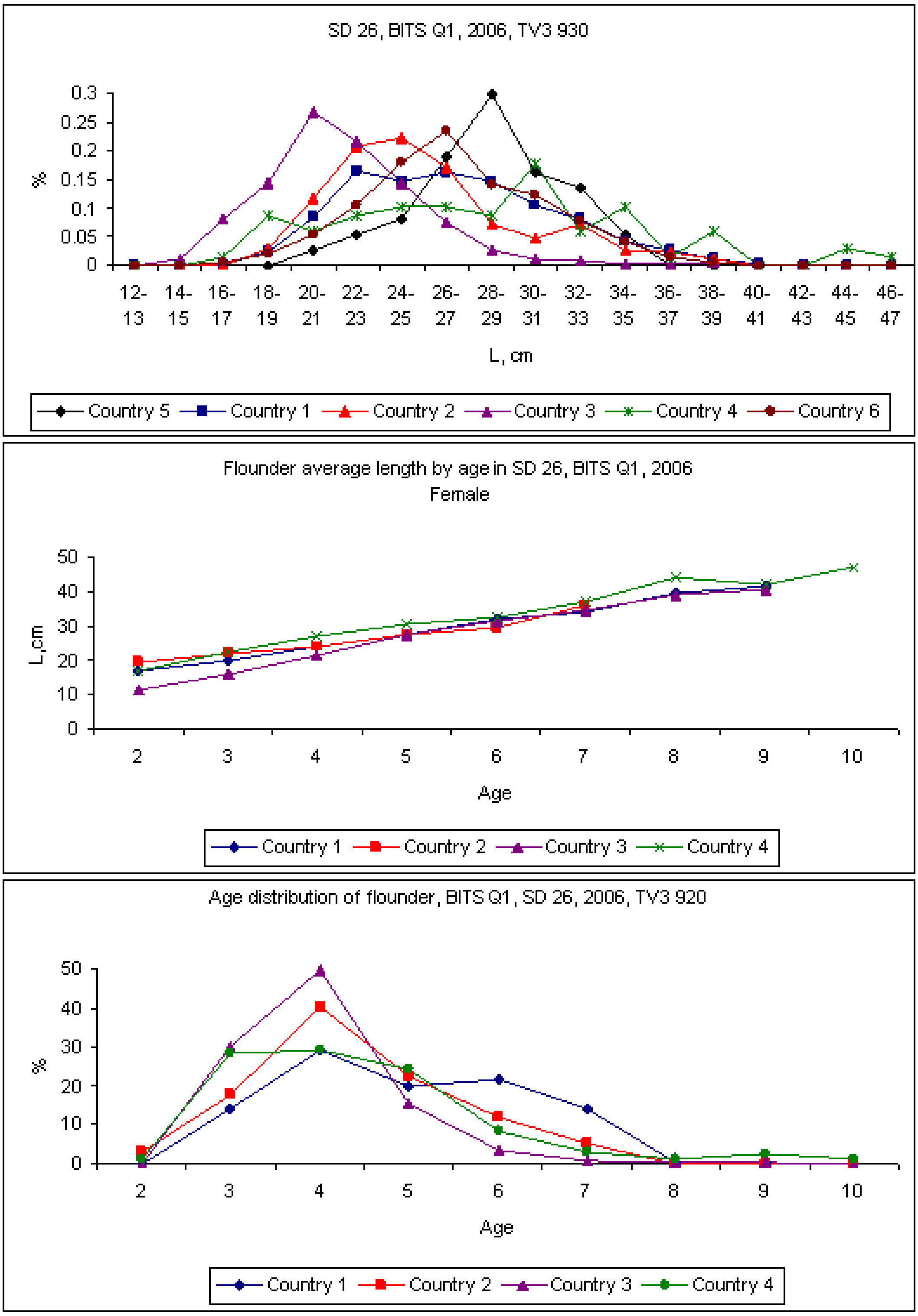


Figure 4.1.1. Flounder length and growth parameters from ICES BITS Q1 surveys by countries in 2006. Depth 41- 80 m. A) length distribution, B) average length by age, C) age distribution in surveys. Fishing gear – TV3 920 demersal trawl.

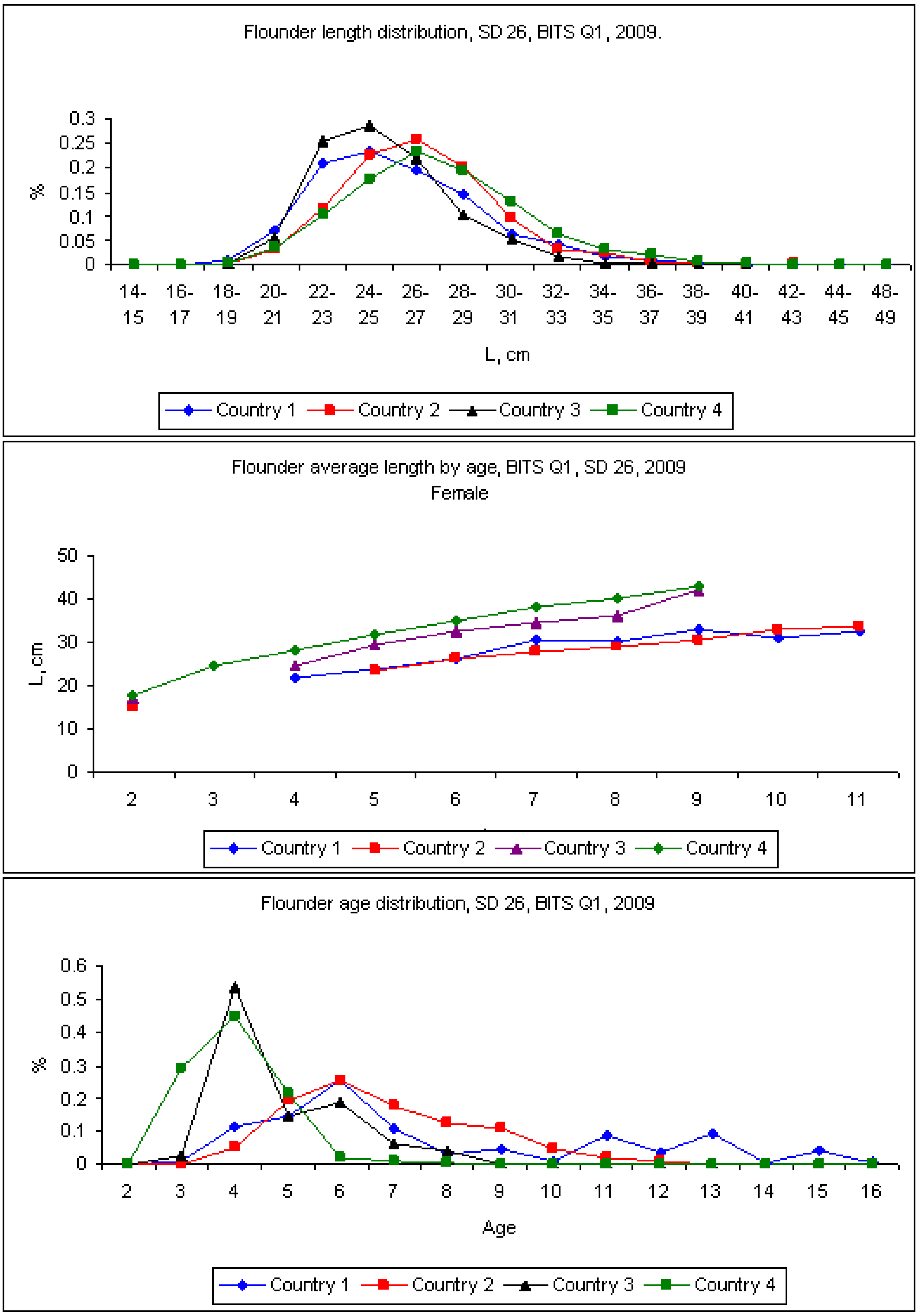


Figure 4.1.2. Flounder length and growth parameters from ICES BITS Q1 surveys by countries in 2009. Depth 41- 80 m. A) length distribution, B) average length by age, C) age distribution in surveys

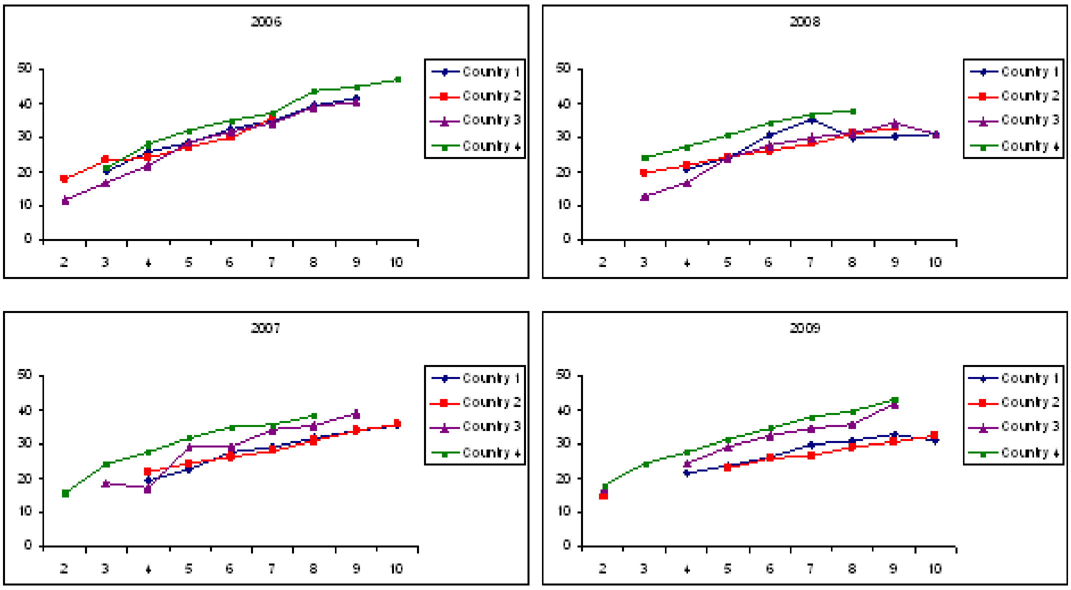


Figure 4.1.3. Flounder growth rate by years. ICES Subdivision **26, depth 41-80 m, only females**

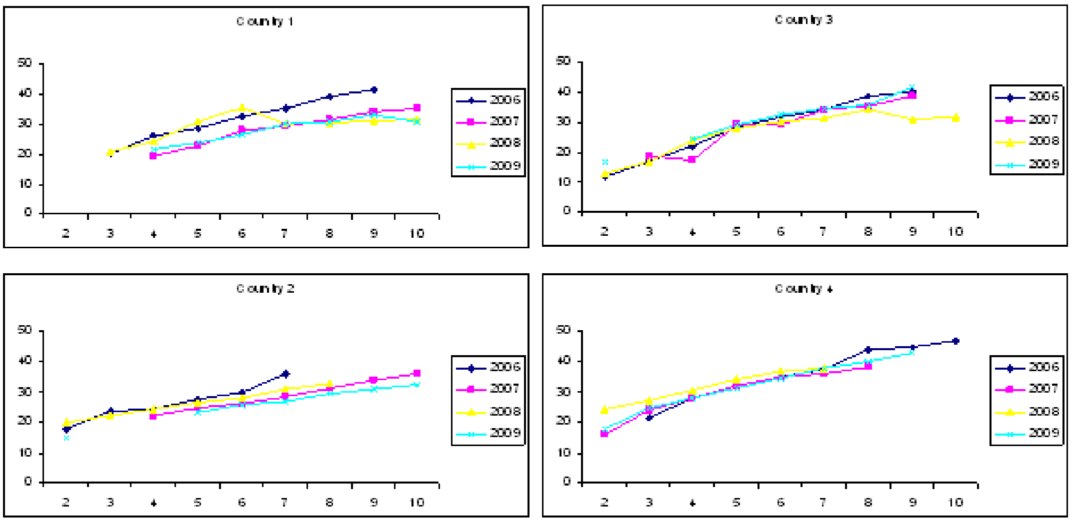


Figure 4.1.4. Flounder growth rate by countries. ICES Subdivision **26, depth 41-80 m, only females**

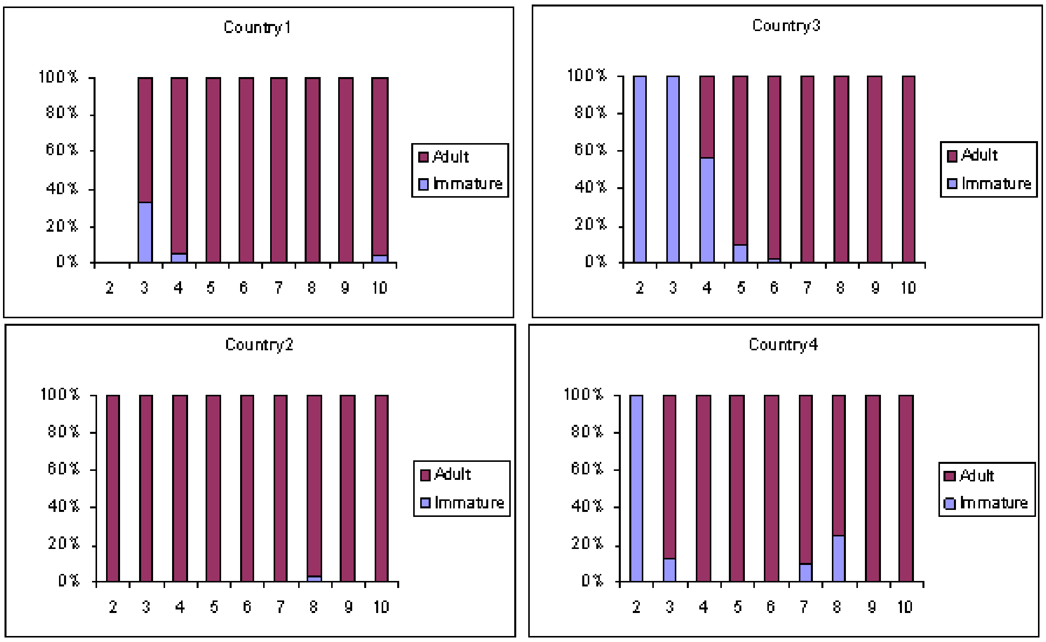


Figure 4.1.5. Proportion of adult flounder female by ages, 2006-2009, ICES SD 26, depth 41-80 m, DATRAS database.

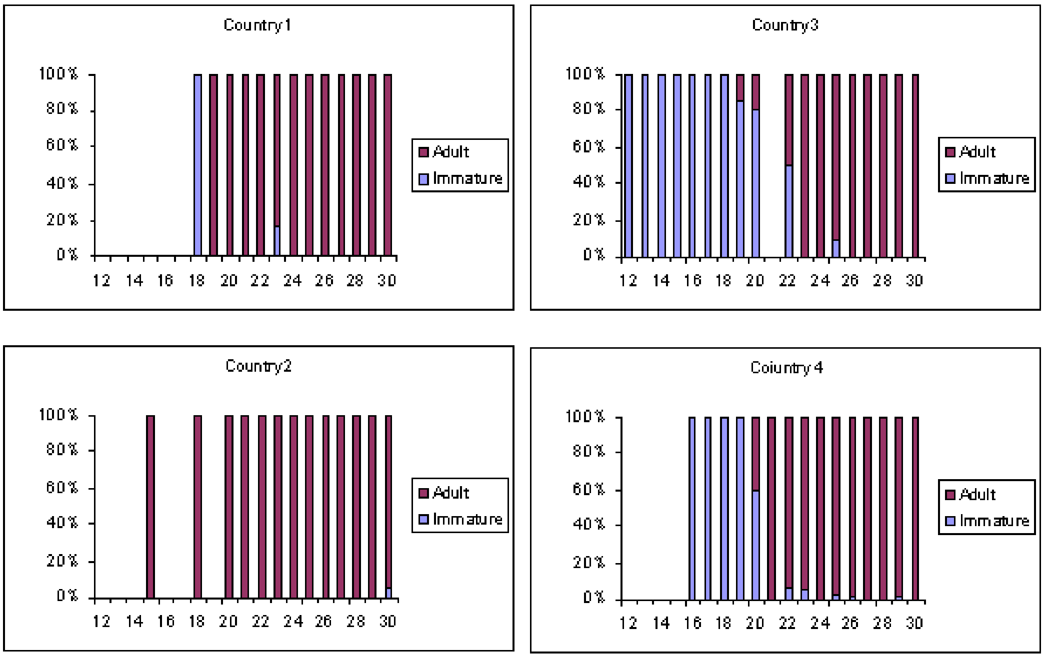


Figure 4.1.6. Proportion of adult flounder female by length, 2006-2009, ICES SD 26, depth 41-80 m, DATRAS database.

4.2 Turbot

For evaluation of turbot age results, data from three countries were available. Country 1 used sliced and stained method for ageing. Samples were collected from ICES SD 28, from 1998- 2007. Country 2 used whole otoliths for ageing. Samples were from ICES SD 26 and 28, from 1999-2009. Country 3 used also whole otoliths for ageing. Their samples were from ICES SD 26, from 1995-2009. To illustrate quality of age data correlation between catch at age and catch at age 1 year older next year was calculated (Table 4.2.1 and Figure 4.2.1). Sampling data were from commercial fishery and therefore due to gillnet selectivity first age groups were not fully representative. We could assume that from age group 5, turbot were fully representative in commercial fishery. Using sliced and staining method for ageing Country 1 had extremely high correlation coefficients (average in age groups 5-9 – 0.86). Correlation coefficients for countries 2 and 3 were remarkable lower (only for country 3 age groups 5 vs 6 reached a value of 0.32, for all other age groups the correlations were below 0.10). In figure 2.7 every generation was shown in different colour. In bottom picture, where sliced and stained method was used, we could follow strong generations through the years (for example generation 1997 – red colour, 1994 – dark blue) or weak generations (for example generation 1996-orange). In data from country 2 we could not follow any generation – in all years modal were 5-7 years old fish. The situation was similar in country 3 where 4-6 year old fishes dominated in catches instead of a specific generation.

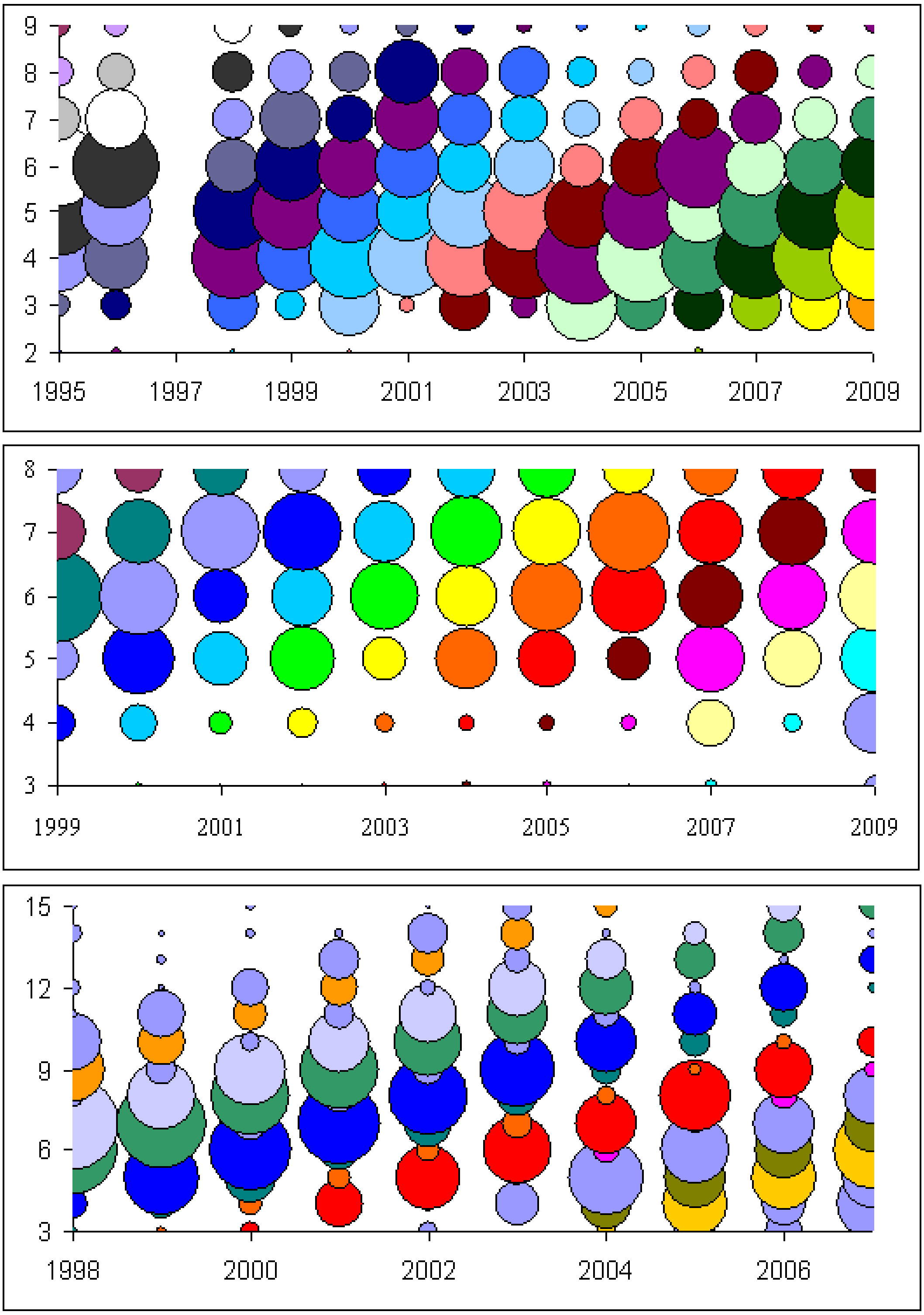


Figure 4.2.1.Age composition of turbot by countries (upper and middle - whole otoliths data from two countries, bottom – another country, otoliths sliced and stained). Every generation has different colour.

Table 4.2.1. Correlation coefficients between catch at age and catch at age 1 year older next year for turbot

Ages	Sliced	Whole	
	Country 1	Country 2	Country 3
3vs4	0.27	0.01	0.08
4vs5	0.12	0.02	0.02
5vs6	0.81	0.03	0.32
6vs7	0.89	0.00	0.01
7vs8	0.82	0.03	0.04
8vs9	0.94	0.43*	0.06
9vs10	0.74		
10vs11	0.85		
11vs12	0.73		
12vs13	0.61		
13vs14	0.68		
Mean 5-9	**0.86**	**0.02**	**0.11**

* Correlation showed opposite (increasing) trend

4.3 Polish flounder age data analysis

4.3.1 Age structure of flounder in Polish survey based on sectioned otoliths

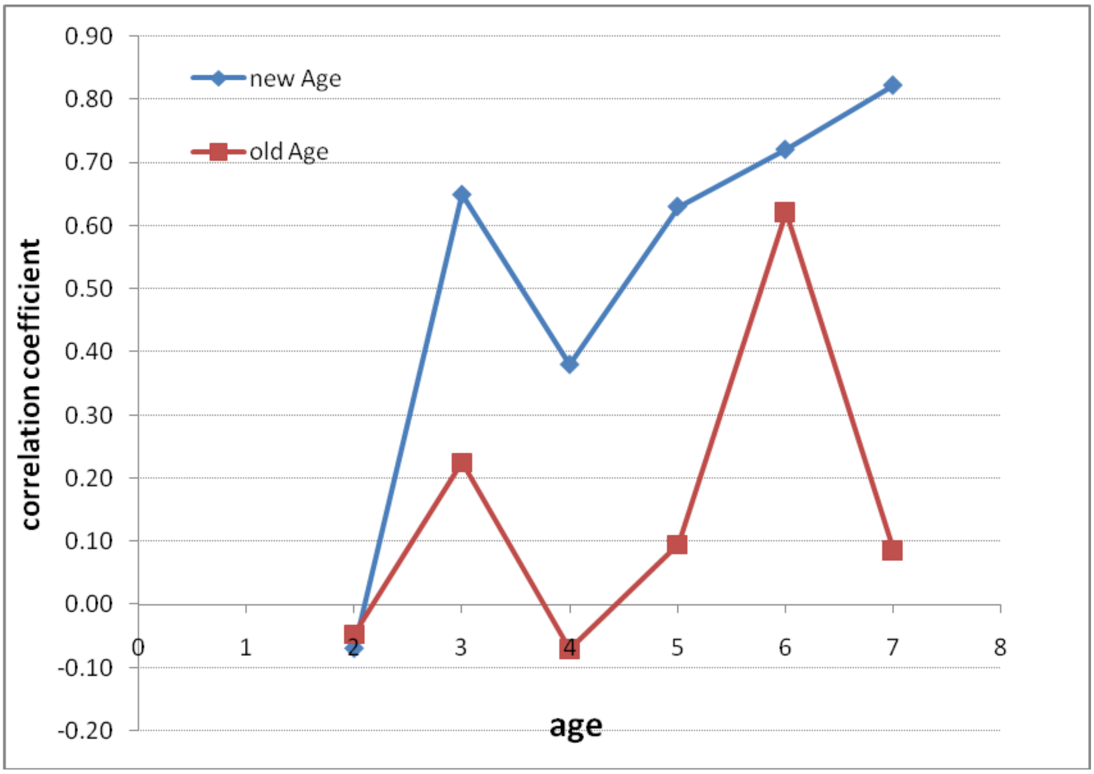
Sea Fisheries Institute (Poland) is conducting internal project on modeling influence of environment and fisheries on flounder resources. The project is financed by Polish Ministry of Science and Higher Education and the outcome should include conclusions on rational exploitation of flounder.

Selected tasks of the project are indicated below:

1) re-ageing of flounder from the last 10 years using sectioned otoliths (former aging was based on whole otoliths)
2) assessing the state of stocks with age-structured models and/or other analytical assessment methods

Within the first task about 4000 otoliths were sectioned and age was evaluated. Otoliths were selected from samples collected in 2000-2009 both from survey and commercial catches, and the intention was to re-read about 200 otoliths per year from survey and similar number of otoliths from commercial catches. In both cases samples from first quarter were taken. Next, the age composition of Polish catches in survey based on new age reading was estimated and its consistency was compared with consistency of age structure obtained with previous aging (based on whole otoliths). Consistency check of age structure was performed by regressing fraction which subsequent year-classes constitute in samples at given age in 2000-2008 against fraction which the same year-classes constitute in samples at age one year older in 2001-2009 and calculating correlation between both series. Results of such comparison for Subdivisions 25 and 26 are presented in Figure 4.3.1.1 a, b as correlation coefficients between both series at given ages. The age structure derived using sectioned otoliths is preliminary as the project is ongoing and more age readings are expected to be included in the analysis. For Subdivision 25 it can be seen clear improvement in aging consistency. Such improvement, however, is not the case for Subdivision 26 where at some ages it can be seen improvement in consistency but in some other there is lack of any consistency. The reason for poor consistency in Subdivision 26 could be smaller than in Subdivisions 25 size of samples which were taken so far for aging using sectioned otoliths.

a



b

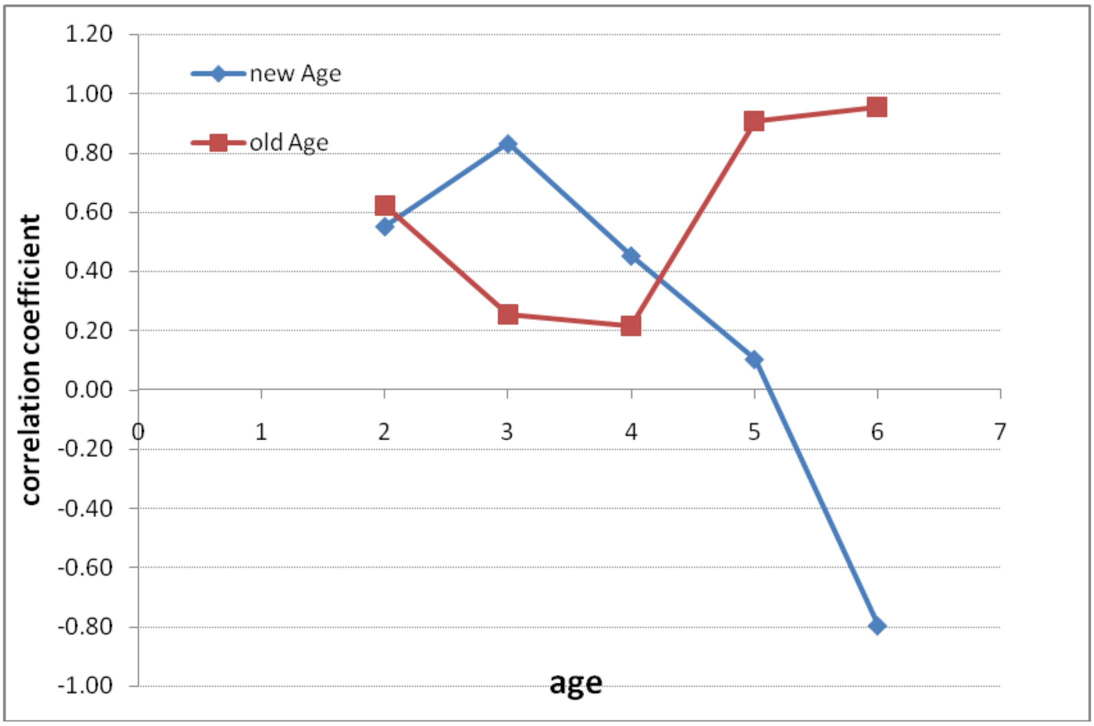


Figure 4.3.1.1 a,b. Check of consistency of estimated age structure for old aging and aging using sectioned otoliths expressed as correlation between fraction which given age constitutes in samples in 2000-2008 and fraction which age one year older constitutes in samples collected 2001-2009. Top panel refers to Subdivision **25 and bottom panel is to** Subdivision **26.**

4.3.2 Analysis of consistency of age structure in generated stock

Assumptions and simulations

Poor consistency of age structure may be occurring in a stable stock with very low dynamics in recruitment. To inspect aging consistency in such a situation the stock was generated using two classical equations of stock dynamics: the exponential decay of cohort numbers and the Baranov catch equation. The generated stock covered 11 years and consisted of 8 age groups. Fishing mortality was assumed to be separable into year and age effects. Stochasticity was introduced into the generated values by adding random lognormal error to the recruitment (Rec), year effect of fishing mortality (*F*), and estimated catches (C) through the following formula:

$$Y = \text{Expectation}(Y)^{*}\exp(Norm(0,SD)) \qquad (4.3.1)$$

where *Y* was recruitment or year effect of fishing mortality or catch at age in numbers and *Norm* was a normally distributed random variable with a zero mean and a given standard deviation, SD. It may be shown that for low SD (e.g. SD<0.5), coefficient of variation (CV) of a variable generated as Y (eq. 4.3.1) is in percent approximately equal to 100*SD, e.g.,. for SD=0.05 the CV of Y is 5% and reference to CV of the variable will be used in description of results of the simulations.

Natural mortality was set at 0.2.

In the generated stocks various options on dynamics of recruitment and fishing mortality were considered. Recruitment to the generated stock was:

a. fluctuating with log-normal random error along constant level,
b. increasing some fraction a year with added log-normal random error.

Similarly, fishing mortality was:

a. fluctuating with log-normal random error along constant level of 0.5,
b. increasing some fraction a year with added log-normal random error.

Standard deviation of random error in recruitment and fishing mortality was in the range 0.1 – 0.3, while fraction by which recruitment increased a year was 10%. Standard deviation of error in catch was in the range 0.05 – 0.3.

For different combinations of recruitment and fishing mortality options in the generated stock, the catch at age was estimated and its consistency was checked by calculating correlation between catch numbers at given age in simulated years and catch numbers at age one year older in next years. The simulations were repeated about 1000 times per given recruitment and fishing mortality option and histograms of correlation used for consistency check were determined.

Results

Distribution of correlation (consistency check) between catches in subsequent ages exemplified for recruitment fluctuating without trend with low CV of 10% and observation error in catch of 5% and 30% is presented in Figure 4.3.2.1. For high precision of catch information (CV of 5%) only a few percent of correlations (R) was below zero. However, in case of catch CV of 30% about 30% of R was below zero and 56% of R was below 0.25.

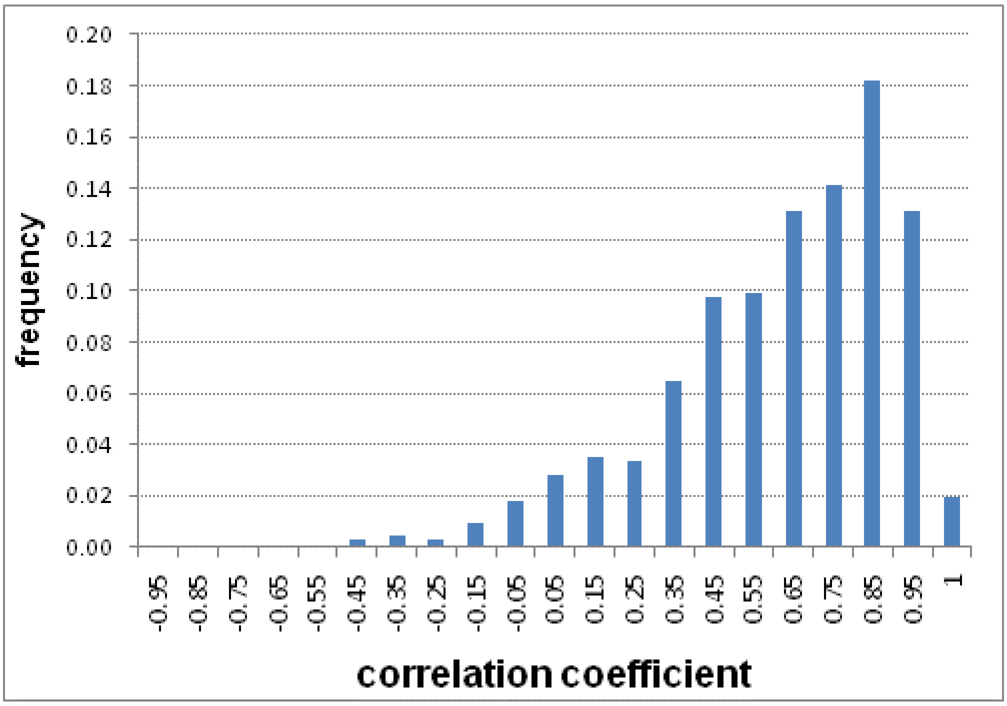
Figure 4.3.2.2 shows frequency of events R<0 or R<0.25 as dependent on observation error in catch at age numbers. The probability of poor consistency of catch data increases almost linearly with increasing error in the catch: relatively high consistency of catch data at CV of catch at level of 5-10% (SD=0.05-0.1) worsens quickly when catch error increases.

Trial assessment with XSA parameterized as in last flounder evaluation during WGBFAS meeting in 2006 (see section 7.1.1) shows that CV of fishing mortality and recruitment may be at level of 30%. Then, the distribution of R (Figure 4.3.2.3 a) indicates about 36%% of R<0.25 and 15% of R<0 for catch CV of 20%. The correlation decreases when error in catch increases (CV of 30%) - then R<0 in 20% of cases and R<0.25 in 45% of cases (Figure 4.3.2.3 b).

When trend is imposed on recruitment (10% increase per year) and random error with SD =0.2-0.3, then the frequency of events R<0 and R<0.25 is relatively low (8% and 20%, respectively) for medium error in the catches (20% CV). However, the frequency of low correlation increases to 14% (R<0) and 31% (R<0.25) when error in catch data shows CV of 30% (Figure 4.3.2.4).

The results of the simulations show that in case of stock fluctuating without trend and CV of recruitment and fishing mortality as estimated in last flounder assessment the probability of poor consistency of catch at age data may be relatively high.

a



b

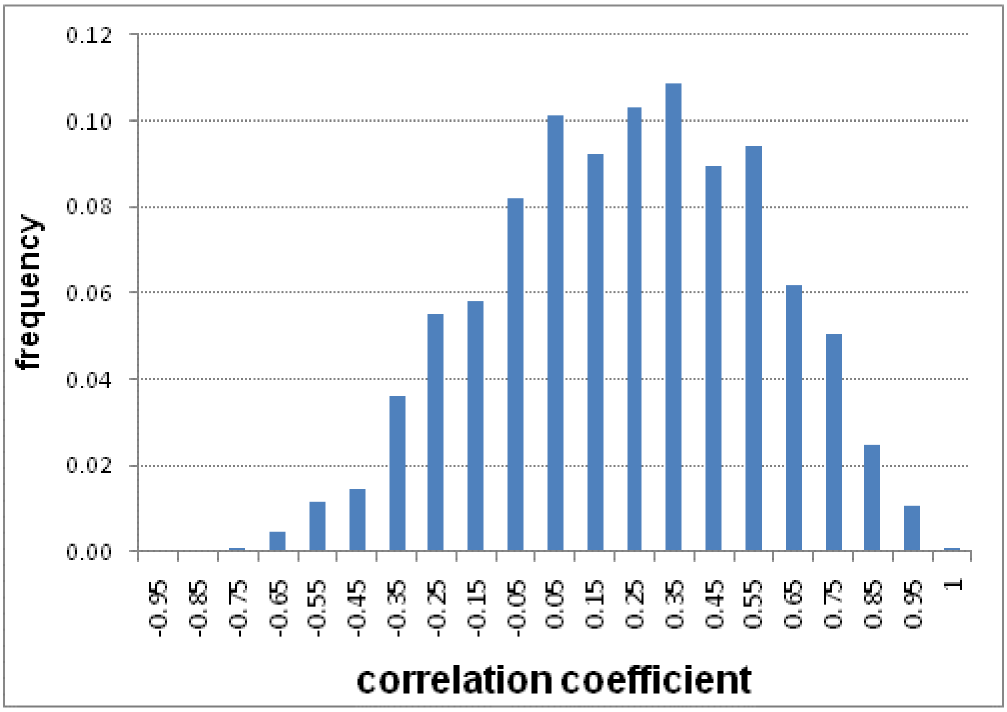


Figure 4.3.2.1. Histograms of distribution of correlation between catch at age and catch at age 1 year older. Recruitment and fishing mortality is fluctuating with low CV (10%) without trend, while catch is measured with low error (Fig. a, CV=5%) and high error (Fig. b, CV=30%).

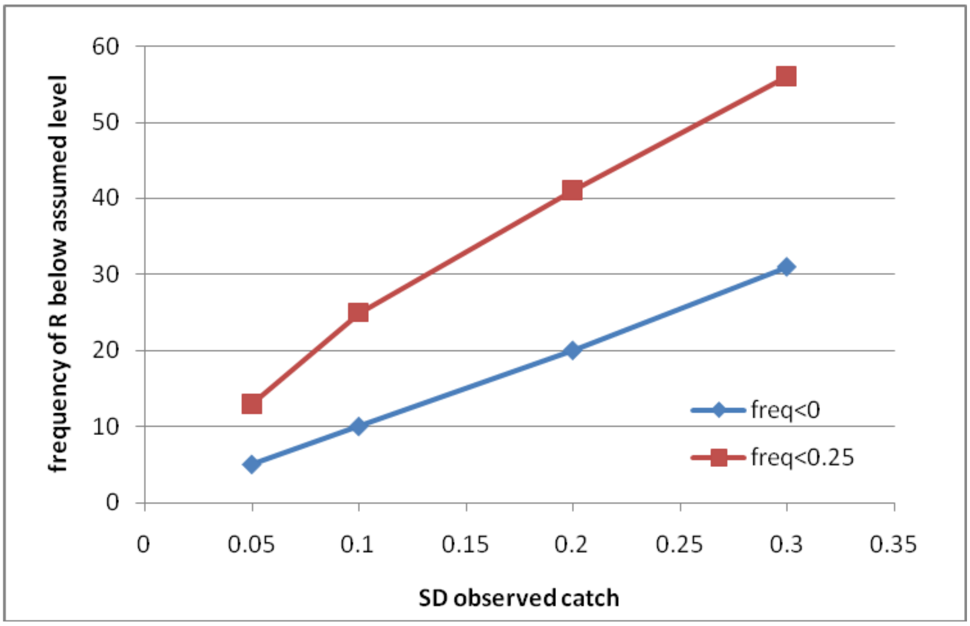
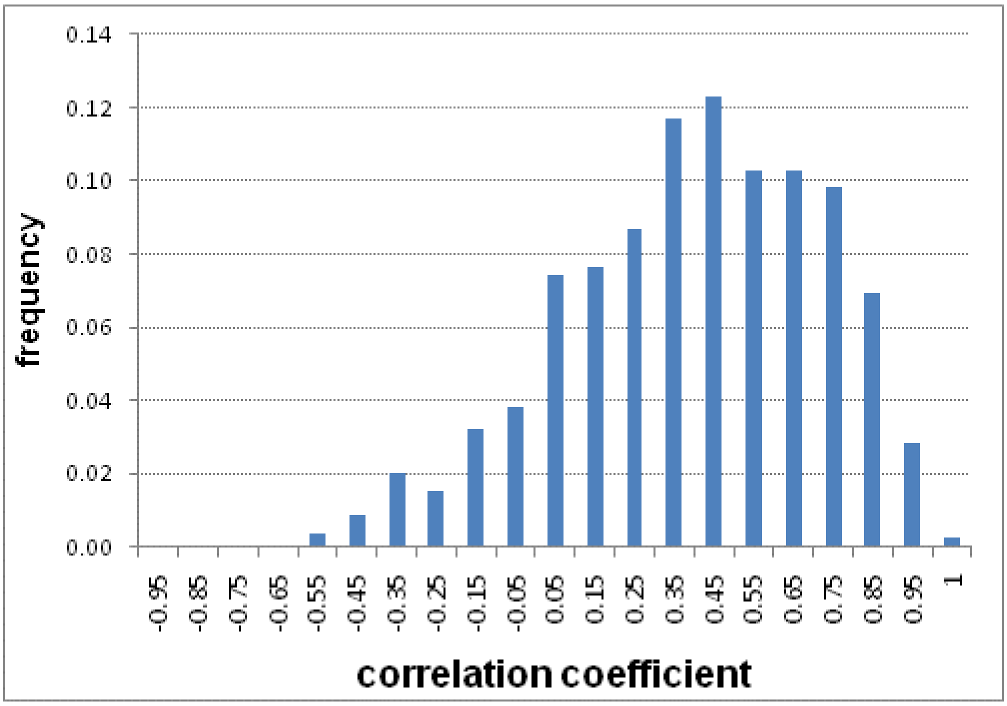


Figure 4.3.2.2. Frequency of events R<0 or R<0.25 as dependent on observation error in catch at age numbers (R is correlation between catch at age and catch at age 1 year older next year).

a



b

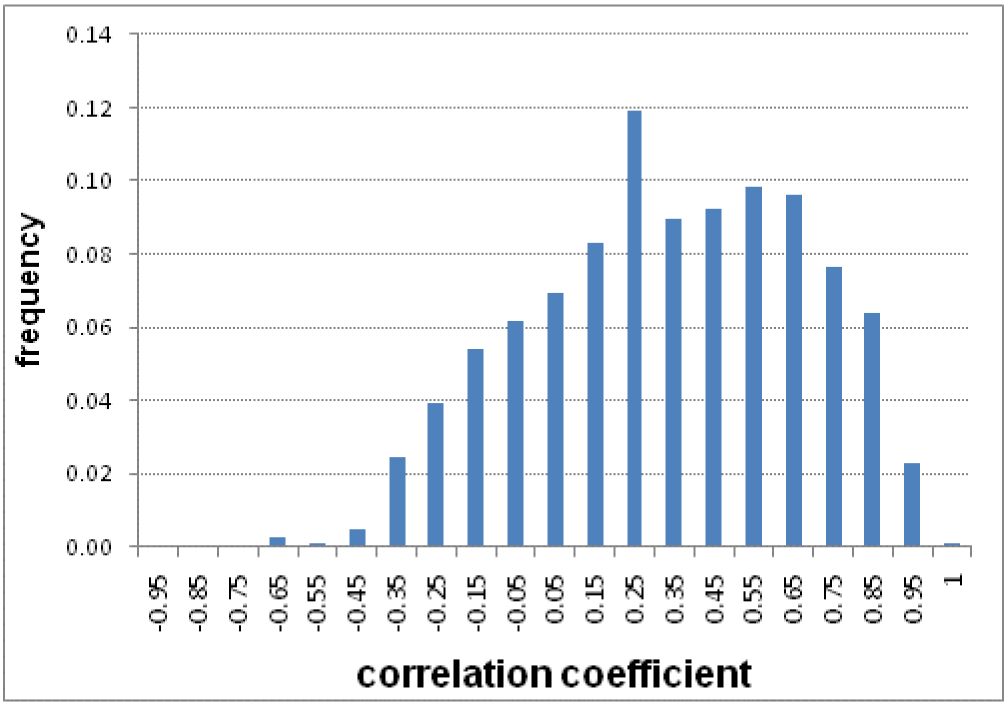
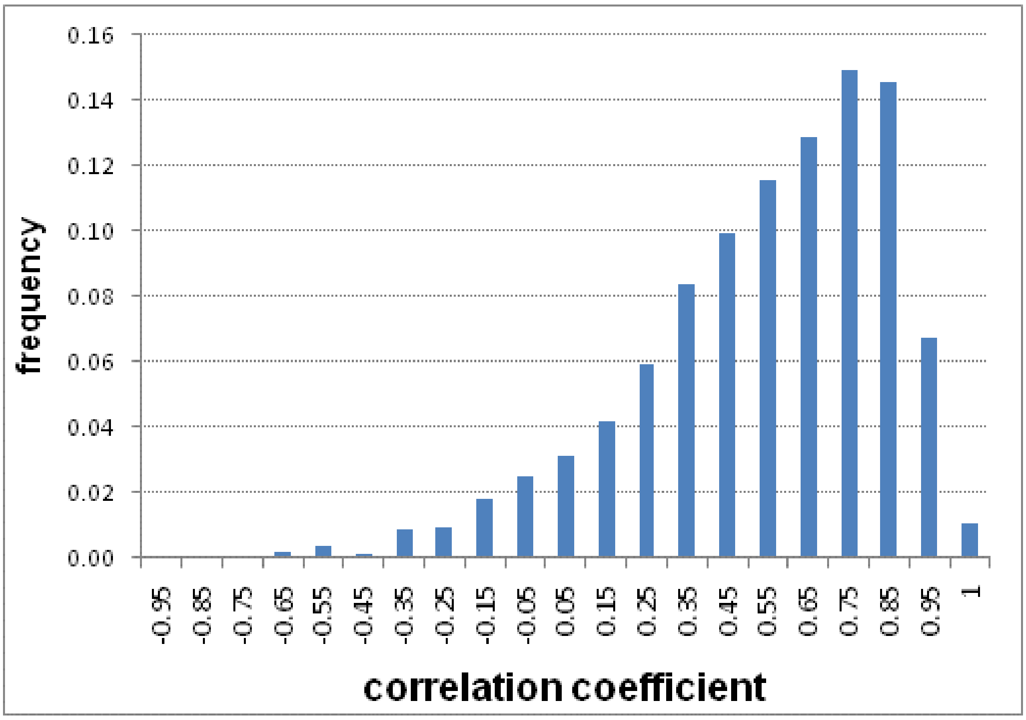


Figure 4.3.2.3. Histograms of distribution of correlation between catch at age and catch at age 1 year older. Recruitment and fishing mortality is fluctuating with CV as observed in flounder assessment (30%) without trend, while catch is measured with medium error (Fig. a, CV=20%) and high error (Fig. b, CV=30%).

a



b

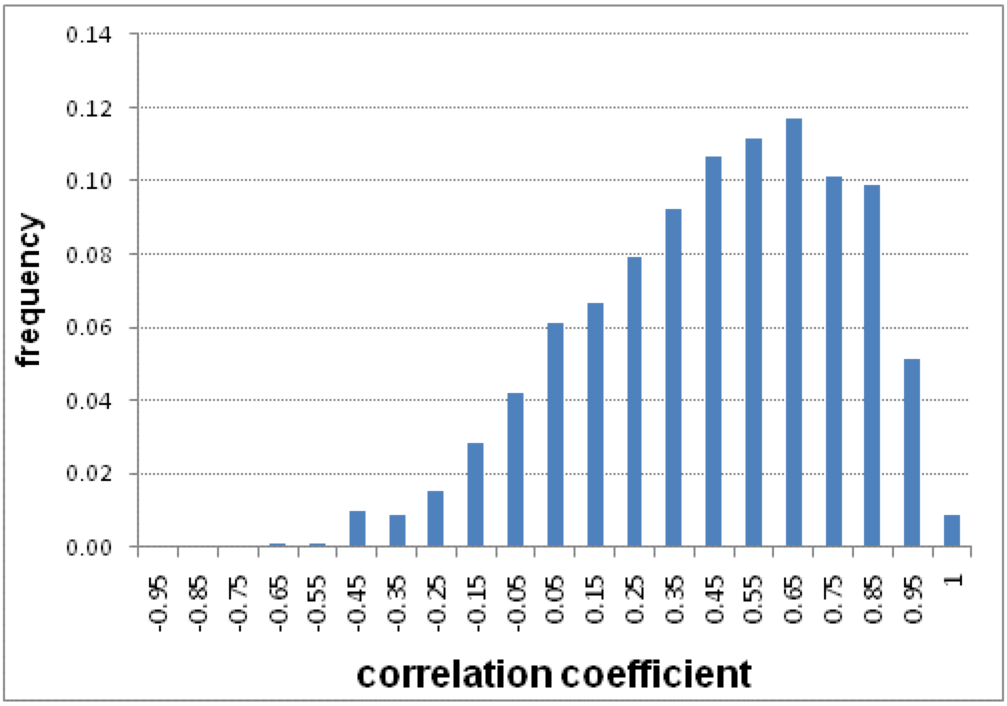


Figure 4.3.2.4. Histograms of distribution of correlation between catch at age and catch at age 1 year older. Recruitment is increasing 10% a year with CV as observed in flounder assessment (30%). Fishing mortality is fluctuating without trend (CV=30%), while catch is measured with medium error (Fig. a, CV=20%) and high error (Fig. b, CV=30%).

5 Available data for stock assessment by populations

Data availability for each stock was collected during the workshop (Table 5.1). The general decision of workshop was to include only age data with improved ageing methodology (sliced and stained or broken and burned). As a result only for few stocks there are long age data time series that are available for stock assessments. Catch volume (landing) information for flounder usually is available by subdivision; however in some subdivisions there are more than one flounder populations (subdivisions 28, 29, 32 see ToR 1).

Table 5.1. Available biological and fishery data for Baltic Sea flatfish by species and populations

Country	catch volume	discard volume	discard length distribution	discard age distribution	length distribution - commercial catches	length distribution - survey	catch at age in numbers	weight at age in the catch	weight at age in the stock	maturity by length and age	survey indices - biomass measure	survey indices - number at age	fishing effort	commercial catch per unit of effort
FLOUNDER - Deep see spawners														
Flounder 22 (Belt Sea)														
Flounder 23 (Öresund)														
SWE	1993-2009, SD				>1999		2008	2004, 2005, 2007, 2008	2004, 2005, 2007, 2008	2004, 2005, 2007, 2008				
Flounder 24-25 (Southern Baltic)														
DEN	1987-2009, Q		2003-2010 , Q	NA	1987-2010, Q	1987-2010, Q							1987-2009, Q	1987-2009 ,Q
LIT	1998-2010, M												1998-2010, M	1998-2010 ,M
POL	2005-2010	2005-2010	2005-2010	2005-2010	2000-2010	1994-2010	2006-2010	2006-2010	1994-2010	1994-2010	1994-2011	1994-2012	1990-2010	1990-2010
GER	1995, Q,SD	2007, Q,SD	2007, Q,SD,	2010, Q,SD	>1995, Q, SD	>1992, Q,SD; SD24 >2001)	2010, Q,SD	2010, Q,SD	2010, Q,SD	2010, Q	1992, Q,SD	2010, Q,SD	1995, Q,SD	1995, Q,SD
SWE	1980-2009, SD							2004-2010 SD, Q	2004-2010 SD, Q	2004-2010 SD, Q				
LAT	2005-2010, Q													
Flounder 26 (Bay of Gdansk)														
DEN	1987 - 2007, Q		2009, Q		1987-2010, Q	1987-2010, Q							1987-2009 Q	1987-2009

LIT	1998-2010, M	2005-2010, Q	2005-2010, Q		2005-2010, Q	2003-2010, M					2004-2010		1998-2010 M	1998-2010 M
POL	2005-2010	2005-2010	2005-2010	2005-2010	2000-2010	1994-2010	2006-2010	2006-2010	1994-2010	1994-2010				
RUS	1995-2009				2000-2009	1995-2009		2009		2009 A, 1995 L		1995-2009	1995-2009	1995-2009
LAT	1995-2010		2005-2010	2009-2010	2005-2010	2005-2010	>2009	>2009	>2009	>2009 A, 2005 L				
Flounder 28 (26, 29) [Eastern Gotland]														
EST	>1990, SD		>2000, Q,SD		>2000, Q, SD	>1997 SD							>1995, SD	SD 28, >1995
LAT	>1991, Q		2005-2010	2009-2010	2000-2010	>1991	>2009	>2009	>2009	>2009	>1991	>2009	1995-2004	
FLOUNDER- Bankspawners														
Flounder SD 32 S (Finnish coast of Gulf of Finland)														
EST	>1974;		>1985, Q		>1985, Q,SD	>1997 SD								>1995
Flounder SD 32 N (Estonian coast of Gulf of Finland)														
FIN	1980-2009, M				1980-2007								1980-2009	1980-2009
Flounder SD 29-30 (Åland)														
EST	>1976;		>1996, Q		>1995, Q,SD	>1993	2000-2008		2000-2008	2000-2008	2000-2008	2000-2008	>1995	>1995
FIN	1980-2009, M				1980-2007								1980-2009	1980-2009
Flounder 28E+ 29SE (Latvian coast + Gulf of Riga + Hiiumaa)														
LAT			2005-2010	2009-2010	2005-2010			2009-2010		2009-2010 A, 2005-2010 L	1987-2010 juv		1995-2005	
EST														
Flounder SD27E+28 (Gotland Island)														
SWE	1980-2009		2004-2010 Q, SD	2004-2010 Q, SD				2004-2010 Q, SD	2004-2010 Q, SD	2004-2010 Q, SD				
Turbot – Baltic sea														
SD 22-28														
DEN	1987-2009, Q		2009-2010 SD		1987-2009, Q	?							1987-2009 Q	1987-2009 Q
SD 24-26														
POL	2005-2010					2005-2010			1994-2010	1994-2010				

SD 26-28														
LAT	1995-2010		1995-2010		1995-2010	1995-2010				>1995	>1995 spawn.ind, >1998 juv		1996-2004	1996-2004
SD 28,29,32														
EST	>2008				Few	>1994 GNS 2000, > 2005 BITS				>1999	2000, > 2005 BITS; >1999 GNS		>2008	>2008
SD 26														
LIT	1998-2010, M				1998-???					1998-???			1998-2010 M	1998-2010 M
SD 26														
RUS	1995-2009				1995-2009			2009		2009 A, 1995 L				1995-2009
SD27-28														
SWE	1970-2010, SD				1998-2007		2008	1998-2009		1998-2009				
SD 24-25														
GER	>1995, Q,SD	>2007, Q,SD	>2007, Q,SD,	2010, Q,SD	>1995, Q SD	>1992, Q,SD	2010, Q,SD	2010, Q,SD	2010, Q,SD	>1995 L, 2010 A,	>1992, Q,SD	2010, Q,SD	>1995, Q,SD,	>1995, Q,SD
Plaice 24,25,26,28 (Southern Baltic)														
DEN	1987-2009 Q		2003-2009, Q		1987-2009Q								1987-2009	1987-2009
POL	2005-2010					2005-2010			1994-2010	1994-2010	no	no	no	no
GER	>1995, Q,SD	>2007, Q,SD	>2007, Q,SD,	2010, Q,SD	>1995, Q, SD	> 1992 Q, SD	2010, Q,SD	2010, Q,SD	2010, Q,SD	>1995, L,SD, Q >2010, A,SD, Q	>1992, Q,SD	2010, Q,SD	>1995, Q,SD	>1995, Q,SD
Plaice 22 +24W (Belt Sea)														
DEN	1987-2009, Q		2003-2009, Q		1987-2009, Q								1987-2009 Q	
GER	>1995, Q,SD	>2007, Q,SD	>2007, Q,SD,	2010, Q,SD	>1995, Q, SD	>1992, Q, SD	2010, Q,SD	2010, Q,SD	2010, Q,SD	>1995, L,SD, Q >2010, A,SD, Q	>1992, Q,SD	2010, Q,SD	>1995, Q,SD	>1995, Q,SD

Plaice 23 (Öresund)														
DEN	1987-2009, Q		2003-2009, Q		1987-2009, Q								1987-2009 Q	
Dab 24E-25 (Bornholm)														
DEN	1987-2009, Q		2003-2010, Q		1987-2009, Q								1987-2009 Q	1987-2009 Q
GER	>1995, Q,SD	>2007, Q,SD	>2007, Q,SD,	2010, Q,SD	>1995, Q SD	> 1992 Q,SD	2010, Q,SD	2010, Q,SD	2010, Q,SD	>1995, L,SD, Q >2010, A,SD, Q	>1992, Q,SD	2010, Q,SD	>1995, Q,SD	>1995, Q,SD
Dab 22 +24W (Belt Sea)														
DEN	1987-2009, Q		2003-2010, Q		1987-2009 Q								1987-2009 Q	1987-2009 Q
GER	>1995, Q,SD	<2007, Q,SD	2007, Q,SD,	2010, Q,SD	>1995 Q,SD	> 1992 Q,SD	2010 Q,SD	2010, Q,SD	2010, Q,SD	at length >1995, L,SD, Q >2010, A,SD, Q	>1992, Q,SD	2010, Q,SD	>1995, Q,SD	>1995, Q,SD
Dab 23 (Öresund)														
DEN	1987-2009, Q		2003-2010, Q		1987-2009 Q								1987-2009 Q	1987-2009
Brill Baltic Sea														
GER	>1995, Q,SD	>2007, Q,SD	>2007, Q,SD	2010, Q,SD	>1995 Q,SD	> 1992 Q,SD	2010, Q,SD	2010, Q,SD	2010, Q,SD	>1995, L,SD, Q >2010, A,SD, Q	>1992, Q,SD	2010, Q,SD	>1995, Q,SD	>1995, Q,SD

Q – Data available by quarters

M – Data available by months

SD – Data available by ICES Subdivision

L – Length measurements

A – Age data

6 Review of assessment methods which could be potentially used for stock assessment with the currently available data

The assessment methods which could be used for evaluations of dynamics and state of flatfish stocks were discussed. The following groups of methods were considered:

- Age-structured models (e.g., XSA, ICA, CAGEAN, ADAPT)
- Production models (e.g., Schaefer (1954), Fox (1970), Pella and Tomlinson (1969))
- Difference models (e.g., Deriso (1980), Horbowy (1992))
- The models using Random Walk (RW)
- Length based Cohort Analysis
- Simple methods allowing approximate evaluation of exploitation level (catch curve analysis, total mortality estimates using mean age or mean length in the stock)

Next, the stocks for which the available data allowed the application of the considered assessment models were identified.

1. The age-structured models base on standard VPA/Cohort Analysis equations, i.e. equation of exponential decay of cohort numbers and Baranov catch equation. For some of them (ICA, CAGEAN) it is assumed that fishing mortality (F) may be separated into year effect (f) and age effect (s) through the formula

$$F_{age,year} = f_{year} * s_{age} .$$

These methods are most data demanding, and to get reasonable fit of the model, it is usually required at least ten years series of

- catch at age data,
- survey at age estimates of stock size and/or survey biomass index,
- weight at age (in stock and in the catch),
- maturity at age.

The software to run these models is available, e.g. ICES provides XSA, ICA, and ADAPT models implementation. In addition, most of these models (except XSA) may be easily implemented in spreadsheet.

There are yet no flatfish stocks with long enough time-series using the recommended ageing methods (ICES 2007, 2008) to allow age-structured models. Including series based on whole otoliths the flatfish stocks for which data were available for the application of the age-structured models were identified as pelagic spawning flounder in the Southern Baltic (Subdivisions 24-25, Southern Baltic population), and in the Bay of Gdansk(Subdivision 26, Bay of Gdansk population).

2. Production models are less demanding methods in terms of data compared to age-structured models as the time series of age composition of catches is not needed to run these models. They usually are not good for stocks with large variance in recruitment, as recruitment is not explicitly modeled. The basic data needed is catch volume and fishing effort. Optionally the survey indices of stock biomass may be used for fitting the models; survey data may increase the reliability of the model fit. The package ASPIC available from ICES may be used to fit Schaefer model. The program provides estimates of Schaefer model parameters as well as estimates of stock size and fishing mortality. The bootstrap evaluation of variance of estimates is also provided in the package.

The flatfish stocks for which available data allow the application of the production models were identified as flounder in Subdivisions 24-25 (Southern Baltic population), and flounder in Subdivision 28 (Eastern Gotland population).

3. Difference models similarly as production models do not require time series of age composition of catches and surveys. An advantage of these models is that the recruitment to the stock is included as an explicit term in the difference model. Recruitment can be presented through stock-recruitment relationship or be included to the model directly as survey indices with a scaling coefficient. To apply difference models similar data as for production models are needed (catch volume, fishing effort, optionally index of stock size). In addition, the growth parameters and stock-recruitment relationship (or recruitment time series) is required. Growth parameters are estimated using an age data but it could be data from one year if growth of stock is relatively stable. In approach of Horbowy (1992) mean weight in the stock may be needed, but again age structure is not necessary to derive these time series.

The flatfish stocks for which available data allow the application of the difference models were identified as flounder in Subdivisions 24-25 (Southern Baltic population), and flounder in Subdivision 28 (Eastern Gotland population).

4. The models using random walk present new tendency in stock assessment and they get more popularity in recent years. Random walk (RW) is mathematical description of the trajectory that consists of taking successive random steps. The idea is that within some standard models (e.g. VPA type of models, production or difference models) processes such as fishing mortality and /or recruitment may be presented as a random walk. Consequently, when the models are fitted smaller number of parameters is estimated than in standard approach as in first step only variance of RW describing fishing mortality and /or recruitment is estimated. The realizations of F and/or recruitment are estimated in the next step, once other parameters have been fitted.

The flatfish stocks for which data allow the application of these methods were identified as the same for which age-structured models, production or difference models were identified as applicable.

5. In length based Cohort Analysis fish is allocated to age group on the basis of its size. Thus, the reliable growth model relating size and age of fish is essential for applying length based methods. The data usually required for these models are: catch volume, length distribution (both in survey and commercial catches), survey CPUE, growth rate (e.g. from one year if growth is stable), weight at length (in the stock and in the catch), maturity at length.

The flatfish stocks for which data allow the application of the length based Cohort Analysis were identified as the same for which age-structured models were identified as applicable.

6. Very simple methods allowing for approximate evaluation of exploitation intensity

Some approximate evaluation of the stock status (exploitation) may be sometimes obtained when analytical assessment is lacking but some limited age or length data are available. Then, catch curve or formulae using mean age or length could be attempted. These methods may be used to estimate total mortality (Z) of the stock but basic assumption for their application is that the considered stock is in equilibrium (recruitment and fishing mortality should be constant in a few years), at least approximately. Then (assuming natural mortality), fishing mortality may be estimated and compared with fishing mortality reference points, e.g. these from yield-per recruit analysis: $F_{0.1}$, F_{max}. On this basis conclusions on exploitation status may be drawn and an advice in terms of e.g. required change in fishing mortality (fishing effort) to improve stock status may be provided. Again, these methods provide only rough estimates of total (fishing) mortality and they rely strongly on assumption of equilibrium in the stock. Great caution is needed to interpret their results.

In the **catch curve analysis** the ln (catch at age numbers) are regressed against age (only ages fully recruited to the fishery are included) and absolute value of the slope of the regression is taken as proxy for total mortality. Thus, the regression is fitted through right, decreasing limb of the catch curve.

The estimation of total mortality may be also based on **mean age (avT) or mean length (avL)** in the catches or in the stock. The formulae presented below may be used:

$$Z = \frac{1}{avT - T_c}$$

$$Z = \frac{K(L_\infty - avL)}{avL - L_c}$$

where

T_c= age of first capture,

L_c= length at first capture,

K, L_∞ = von Bertalanffy growth parameters.

The flatfish stocks (or stock components) for which data allow the application of the "simple methods" were identified as flounder in Subdivision 25 (Southern Baltic population), flounder in Subdivision 27 (Swedish east coast population), flounder in Subdivision 32 (Estonian coast of Gulf of Finland population), and turbot in Subdivision 28.

7 Trial assessments of stock status

7.1 Flounder in Subdivisions 24–25 (Southern Baltic population)

This stock of pelagic spawning flounder in southern Baltic Sea (Tab 3.2) has been assessed by WGBFAS until 2006, when the WG discovered serious inconsistencies in age –reading. The Workshop made an attempt to assess the stock using age-structured model because:

- assessment data for years 2006-2009 were available (aging based on method used so far)
- the intension was to compare the assessment with age-structured models (even if age data were problematic, as age reading was still based on old method) with assessment using production or difference model.

Thus, three assessment models were used for flounder evaluation:

1. XSA

a) standard parameterization as in 2005 (shrinkage SE of 0.5),

b) as above but with low shrinkage.

2. Difference model with standard approach.

3. Difference model with random walk on fishing mortality.

7.1.1 The XSA assessment

Input data

Generally, up to the data year 2004 (assessment year 2005) the assessment data were used as compiled by WGBFAS (ICES, 2006). The data for catch in tons (CATON), catch in numbers (CANUM) and mean weight in catch (WECA) for the years 2005 – 2009 were provided by the Baltic states to the WGBFAS and were compiled to the stock level just before the Workshop meeting. Data from recent years were compiled within Intercatch software. The catches in number represent landings only. The CANUM for not sampled countries and strata were estimated using in SD25 the Polish and in SD24 the German catches in number by quarter.

The survey indices of stock size from the Polish and German BITS surveys as numbers at age were taken from the DATRAS database and compiled according to the procedures applied by WGBFAS (see WGBFAS Reports 2005-2009, Tables 4.2.1.1-4.2.1.3 for explanation).

The check of consistency of catch at age data is presented in Figure 7.1.1. The consistency is very poor, similarly as observed in 2005 assessment. The correlation between catch numbers at given age and catch numbers of the same cohorts one year later is in range 0.4-0.5 for ages 4/5 and 5/6 and much lower at other ages.

The internal consistency of survey at age estimates was checked on graphs and is presented in Figure 7.1.2 a-c. The German fleet in 4th quarter is very inconsistent. Somewhat better consistency is seen for Polish fleet in 1st q, Subdivision 25 and German fleet in 1st quarter in Subdivision. 24.

Catch-at-age analysis

Tuning fleets

As in previous assessments three tuning data sets were available from Baltic International Trawl Survey:

- German survey in 1st & 4th quarters in Subdivision 24,
- Polish survey in 1st quarter in Subdivision 25.

The data were constrained to years 2001-2010, as in 2001 new gear (TV3) and new survey design were introduced into Baltic bottom trawl surveys.

XSA runs

The input data for catch at age analysis are presented in Tables 7.1.1a-d. Ages 3-7 and plus group at age 8 and older were used in assessment. The settings for the parameterisation of XSA were the following:

- tricubic time weighting,
- catchability dependent on year class strength at age 3 (in 2005 assessment (ICES, 2005) all independent on year-class strength),
- catchability independent of age for ages 5 and older (in 2005 assessment independent of age for ages 4 and older),
- the SE of the F shrinkage mean equal 0.5 (1st option) and 1.9 (2nd option).

Tables 7.1.2-7.1.3 contain the diagnostic of the runs.

Option 1, shrinkage SE=0.5

The log catchability (log q) residuals in German and Polish 1st quarter surveys are high and SE of log q varies from 0.7 to 1.2 with average level of about 1. The log q residuals for German fleet in quarter 4 are smaller, ranging between 0.5 – 0.6. The correlations between survey estimates of stock size and XSA values are good only for ages 3-5 for Polish survey in 1st quarter (R^2 = 0.5 – 0.8). In most other cases there is almost no correlation between survey and XSA estimates of stock numbers. Residuals distributions show increasing trends for Polish and German survey from 1st quarter (Figure 7.1.2).

The effect of F shrinkage on survivors estimates is quite high at ages 5-7 (about 30-50% of the weights of the estimates comes from shrinkage). The effect of population shrinkage on survivors estimates at age 3 is also high (50% of the weight of survivor estimates comes from shrinkage). Polish tuning fleet has highest influence on survivors estimates at younger ages while German survey from 4th quarter has bigger effect on the oldest ages. German fleet from 1st quarter usually produces much higher survivors numbers than other fleets.

Retrospective analysis (Figure 7.1.4) shows very scattered estimates, with tendency to overestimate SSB and underestimate F.

The assessment shows in recent 15 years quite stable stock with spawning biomass ranging between 25,000 – 30,000 tons and F which varies within 0.4 – 0.6. Detailed tables with fishing mortalities, stock numbers and assessment summary are not presented as the assessment is considered as trial only. Biomass estimates are presented in Figure 7.1.9.

Option 2, shrinkage SE=1.9

The SEs of log catchability for both German fleets are very variable (SEs = 0.3-1.3) with average equal to about 0.7 for both German fleets, and somewhat higher (but less variable) log q SE of 0.9 for Polish fleet. Residuals distributions show positive and negative blocks of values for Polish and German survey from 1st quarter (Figure 5.1.5). The correlation between survey estimates of stock size and XSA values are moderate for Polish and German surveys in 1 quarter (R^2 =0.4 –0.9). German survey in 4th quarter shows low correlation with XSA estimates of stock numbers.

The effect of F shrinkage on survivors estimates is low. However, the effect of population shrinkage on survivors estimates at age 3 is high (almost 50% of the weight of survivor estimates comes from shrinkage). Most impact on survivors estimates have Polish fleet and German survey from 4th quarter.

Retrospective analysis (Figure 7.1.6) shows very scattered estimates, with tendency to overestimate SSB and underestimate F.

The assessment with that parameterisation shows in recent 15 years increase in spawning stock biomass from about 20,000 to 40,000 tons and F which after increase to ca. 0.8 declined to 0.3 in most recent years. Detailed tables with fishing mortalities, stock numbers and assessment summary are not presented as the assessment is considered as trial only. Biomass estimates are presented in Figure 7.1.9.

Comments on the XSA assessment

The performed two options for XSA assessment are only first attempts to parameterise the XSA and none of them may be regarded as an accepted assessment at this stage of the work. Much more analyses would be needed to determine XSA parameterisation which could be considered as best for available data. The Workshop time was too short for such tasks, and the success of such work relies very much on preparatory work on data and assessment which have to be conducted intersessionaly.

Discards are not included in that assessment. However, they are high in some fisheries and areas and should be estimated for series of years and taken into account. That was discusses in more details by Gårdmark *et al.* (2006)

7.1.2 The assessment of flounder using difference model

The model and input data

The difference model (Horbowy, 1992) was used in the form

$$B(t+1) = \exp[Hw(t)^{-1/3} - qf(t) - M - k]B(t) + R(t+1),$$

$$R(t+1) = aRindex(t+1),$$

where B = biomass, t = time, q = catchability, M = natural mortality, H and k = individual growth parameters (anabolism and catabolism coefficients, respectively), w = average weight in the stock, R = recruitment, *Rindex* = recruitment index from the survey, and a = scaling coefficient. The parameters estimated within difference model were $B0$, q, and a.

For the difference model, M was assumed the same as in the XSA. The growth parameters H and k were assumed to be estimated outside the model using Polish length at age data and length-weight relationship for 2001-2009 in Subdivision 25.

These age data were obtained by reading age from sectioned otoliths. The estimate of H was 4.91 and k was 0.45. Other input data were the recruitment index and average weight in the stock.

The model was fitted to catches in 1994-2009 by minimizing the sum of the squared residuals between the "observed" and modelled catches in weight (*C*):

$$SS(param) = \sum_t (\ln C_t^{obs} - \ln C_t)^2 ,$$

where param is a vector of unknown parameters.

The recruitment at age 3 was taken from BITS survey. As a proxy for the fishing effort the ratio of catch to survey index of stock biomass was taken. As the survey gear and design changed in 2001, the survey data (recruitment and biomass index) collected before 2001 were rescaled to be comparable with data collected using present survey methodology. The rescaling parameter (*alfa*) was fitted within the model using relations:

$$R_{before2001} = aRindex_{before2001} alfa$$

and

$$Bsurvey_{before2001} = Bsurvey * alfa$$

where *before2001* indicates data collected in survey up to 2000 and *Bsurvey* is biomass estimate from the survey.

In addition, the difference model with fishing mortality treated as random walk was attempted. The model was fitted to observed catches and fishing effort by maximising joint log likelihood of the observations. The difference model with random walk was done only as a trial assessment.

Difference model results

The estimate of alfa is 1.13 suggesting that inclusion of new gear and survey design in 2001 had small effect on catchability of flounder. The residuals distribution for both standard difference model and the model employing random walk on fishing mortality are presented in Figure 7.1.7. Residuals for both models are similarly distributed but their size decreases with time. Fishing mortality estimated with random walk approach was smoother than the F from standard model (Figure 7.1.8), which could be expected. The estimates of stock size obtained with both models is presented in Figure 7.1.9 Biomass estimated with standard approach is about 10% higher than biomass in the model employing random walk. For comparison in Figure 7.1.9 the estimates of stock size using XSA are also presented. They are lower than the difference model estimates but XSA with low shrinkage shows similar trend to both difference model estimates. The standard deviation of random walk in F was estimated at 0.03.

Time did not allow for an extensive analysis of difference model fits. The retrospective analysis should be performed and the variance of model parameters and estimates should be calculated. Thus, the presented approach should be treated as being under development and estimates of stock size and fishing mortality cannot be regarded as an accepted assessment.

7.1.3 Catch curve analysis for flounder in Swedish catches, Subdivision 25

Pelagic spawning flounder in the southern Baltic Sea has also been sampled from Swedish commercial trawls in SD 25 and age data obtained using slicing and staining technique were available for 4th quarter in 2006. A catch-curve analysis for both sexes of the ages 3-10 years gives an estimate of mortality of 0.43 (Figure 7.1.10). In agreement with this, values of mean age in catch of 4.46 and age at first capture of 2 results in estimated total mortality of 0.41. That would indicate low fishing mortality of about 0.2 assuming natural mortality at 0.2. These estimates are similar to those obtained from XSA and difference model for stock in Subdivision 24-25.

Table 7.1.1a. Flounder in SD 24-25. Catch in Numbers (Thousands).

CANUM: Catch in numbers (Total International Catch) (Thousands)

Year	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1978	1210	5030	3834	2356	874	552
1979	2503	6059	3797	4057	1869	962
1980	940	5100	4997	1944	861	817
1981	1431	4472	3874	2138	1075	1073
1982	3450	5493	3156	2943	1436	1316
1983	3528	10712	4416	2096	976	726
1984	3348	5519	4847	2556	1170	1007
1985	5388	5286	3777	1605	1192	862
1986	4432	7830	4864	1975	1628	1635
1987	2712	5440	3218	1999	1018	1007
1988	5188	5240	4452	2038	870	872
1989	5123	9923	3135	1589	723	738
1990	5640	6081	2719	1188	529	533
1991	4865	7984	3185	1489	728	434
1992	1851	5031	3485	1605	665	727
1993	1946	6276	7138	3106	685	380
1994	4329	5949	4570	2746	748	450
1995	8053	16108	8892	4869	1244	603
1996	6757	8354	5553	3180	1959	1620
1997	6584	8192	4251	2073	1237	1415
1998	10609	8959	3306	1911	1201	487
1999	8033	5384	2729	1743	940	1192
2000	10024	8132	3779	1452	460	270
2001	10693	11822	6761	2960	804	462
2002	19464	15718	5344	2157	1327	603
2003	4610	5359	5553	4359	2136	1434
2004	10829	8664	7410	3556	1175	294
2005	10144	15105	10263	4521	1105	448
2006	4474	11032	7324	2644	862	130
2007	3486	17271	9048	2159	1397	1758
2008	3423	7588	10449	5513	1140	313
2009	7953	12566	6418	3839	561	138

Table 7.1.1b. Flounder in SD 24-25. Mean weight in the Catch and in the Stock (Kilograms).

WECA (=WEST): Mean weight in Catch (Kilograms)

Year	**Age 3**	**Age 4**	**Age 5**	**Age 6**	**Age 7**	**Age 8+**
1978	0.209	0.242	0.298	0.393	0.519	0.598
1979	0.203	0.260	0.313	0.362	0.445	0.509
1980	0.207	0.253	0.320	0.394	0.498	0.521
1981	0.195	0.246	0.313	0.413	0.458	0.537
1982	0.232	0.265	0.328	0.396	0.492	0.628
1983	0.233	0.268	0.325	0.390	0.497	0.640
1984	0.227	0.253	0.314	0.394	0.493	0.642
1985	0.216	0.253	0.310	0.381	0.461	0.593
1986	0.216	0.253	0.310	0.381	0.461	0.593
1987	0.243	0.302	0.374	0.427	0.541	0.764
1988	0.233	0.273	0.318	0.329	0.520	0.671
1989	0.238	0.286	0.348	0.410	0.464	0.672
1990	0.196	0.262	0.315	0.390	0.474	0.623
1991	0.212	0.261	0.328	0.394	0.466	0.631
1992	0.217	0.239	0.310	0.399	0.465	0.630
1993	0.193	0.225	0.291	0.306	0.437	0.517
1994	0.225	0.278	0.338	0.360	0.479	0.641
1995	0.253	0.275	0.328	0.390	0.534	0.693
1996	0.254	0.317	0.412	0.489	0.673	0.821
1997	0.252	0.291	0.349	0.434	0.530	0.553
1998	0.242	0.290	0.372	0.441	0.574	0.708
1999	0.241	0.301	0.396	0.464	0.594	0.820
2000	0.257	0.296	0.340	0.397	0.542	0.802
2001	0.243	0.280	0.364	0.461	0.575	0.831
2002	0.223	0.232	0.346	0.443	0.599	0.650
2003	0.261	0.280	0.329	0.418	0.534	0.640
2004	0.261	0.307	0.349	0.440	0.610	0.757
2005	0.236	0.264	0.311	0.358	0.442	0.573
2006	0.263	0.287	0.354	0.486	0.474	0.832
2007	0.219	0.238	0.301	0.417	0.489	0.671
2008	0.253	0.242	0.305	0.370	0.450	0.572
2009	0.247	0.289	0.383	0.458	0.498	0.679

Table 7.1.1c. Flounder in SD 24-25. Proportion Mature at Spawning Time.

MATPROP: Proportion of Mature at Spawning Time

Year	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
1978-1996	0.9	1.0	1.0	1.0	1.0	1.0
1997	1.0	1.0	1.0	1.0	1.0	1.0
1998	0.9	1.0	1.0	1.0	1.0	1.0
1999	0.9	1.0	1.0	1.0	0.9	1.0
2000-2001	0.9	1.0	1.0	1.0	1.0	1.0
2002	1.0	1.0	1.0	1.0	1.0	1.0
2003	0.7	1.0	1.0	1.0	1.0	1.0
2004-2005	0.9	1.0	1.0	1.0	1.0	1.0
2006	0.9	1.0	1.0	0.9	1.0	1.0
2007-2008	0.9	1.0	1.0	1.0	1.0	1.0
2009	0.9	1.0	1.0	0.9	1.0	1.0
2010	0.9	1.0	1.0	0.9	1.0	1.0

Table 7.1.1d. Flounder in SD 24-25. Tuning fleets.

FLT: Tuning fleets

Year	Fish. Effort	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
2001	0.5	25.2	10.1	3.2	1.4	0.5	0.6
2002	0.5	47.5	19.9	3.8	1.8	1.2	1.2
2003	0.5	8.2	7.7	1.8	0.5	0.2	0.2
2004	0.5	28.1	8.8	3.3	1.3	0.4	0.2
2005	0.5	10.1	4.9	2.4	0.6	0.3	0.2
2006	0.5	24.8	43.9	9.6	1.7	0.6	0.3
2007	0.5	13.9	11.0	8.9	1.4	0.3	0.2
2008	0.5	48.8	15.9	5.0	1.2	0.4	0.0
2009	0.5	65.1	19.6	5.2	3.0	0.6	0.7

FLT02: P25Q1

Year	Fish. Effort	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
2001	1	46.7	81.0	51.1	13.5	5.3	1.2
2002	1	38.1	81.6	67.6	11.2	14.4	4.4
2003	1	17.3	33.8	17.8	5.8	3.1	2.6
2004	1	28.7	237.7	135.8	41.2	6.9	3.6
2005	1	178.3	298.7	251.9	100.8	9.2	10.8
2006	1	219.5	263.3	131.0	53.9	15.8	6.5
2007	1	4.7	555.6	590.5	200.8	52.7	0.6
2008	1	8.5	56.2	112.6	121.1	72.2	23.7
2009	1	23.5	138.2	57.5	38.0	7.8	3.1

FLT03: G24Q1

Year	Fish. Effort	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8+
2001	1	15.8	7.1	1.2	0.4	0.3	0.3
2002	1	67.8	9.6	2.1	0.7	0.5	1.2
2003	1	31.9	12.7	1.7	0.6	0.4	0.4
2004	1	22.4	3.3	0.6	0.1	0.1	0.2
2005	1	16.6	19.6	3.7	1.0	0.3	0.1
2006	1	22.8	23.7	7.8	1.4	0.2	0.0
2007	1	24.8	43.9	9.6	1.7	0.6	0.3
2008	1	35.0	17.8	11.2	4.9	2.5	1.1
2009	1	6.4	13.8	8.9	4.9	2.8	1.8

Table 7.1.2 Flounder in SD 24-25. Diagnostics of XSA for shrinkage E=0.5.

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Lowestoft VPA Version 3.1

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Extended Survivors Analysis

Flounder in Subdivisions 24 and 25 WGBFAS 2006

CPUE data from file d:\FleDat10\FLT0109.txt


Catch data for 32 years. 1978 to 2009. Ages  3 to   8.
                             First    Last    First    Last
  Fleet                      year     year     age      age     Alpha     Beta
   FLT01: G24Q4  n/0.5h        2001     2009       3        7     0.87     0.96
   FLT02: P25Q1                2001     2009       3        7      0.1     0.15
   FLT03: G24Q1                2001     2009       3        7      0.1     0.15
Time series weights :
              Tapered time weighting applied
              Power =    3 over  20 years
Catchability analysis :
              Catchability dependent on stock size for ages <    4

                            Regression type = C
                       Minimum of   5 points used for regression
                            Survivor  estimates  shrunk  to  the  population  mean
              for ages <  4

              Catchability independent of age for ages >=    5
Terminal population estimation :
              Survivor estimates shrunk towards the mean F
              of the final   5 years or the   3 oldest ages.

              S.E. of the mean to which the estimates  are shrunk =    .500

              Minimum standard error for population
        estimates derived from each fleet =    .300

              Prior weighting not applied
Tuning converged after  22 iterations


 Regression weights
                 0.82  0.877  0.921  0.954  0.976   0.99  0.997      1      1
Fishing mortalities
```

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009
3	0.249	0.503	0.118	0.248	0.224	0.086	0.111	0.08	0.184
4	0.536	0.708	0.248	0.34	0.653	0.405	0.547	0.375	0.467
5	0.627	0.497	0.588	0.647	0.884	0.789	0.693	0.773	0.635
6	0.603	0.416	1.026	0.984	1.132	0.592	0.567	1.365	0.741
7	0.636	0.604	0.976	0.89	1.01	0.673	0.738	0.677	0.45

XSA population numbers (Thousands)

YEAR / AGE	3	4	5	6	7
2001	53600	31500	16000	7220	1890
2002	54400	34200	15100	7010	3240
2003	45600	26900	13800	7510	3790
2004	54500	33200	17200	6280	2200
2005	55900	34800	19300	7370	1920
2006	60300	36600	14800	6540	1950
2007	36600	45300	20000	5510	2960
2008	49200	26800	21500	8180	2560
2009	52400	37200	15100	8110	1710

Estimated population abundance at 1st Jan 2010

0	35700	19100	6550	3170

Taper weighted geometric mean of the VPA populations:

47300	30500	15000	6440	2410

Standard error of the weighted Log(VPA populations) :

0.1969	0.2405	0.2857	0.2567	0.3053

Log catchability residuals.

Fleet : FLT01: G24Q4 n/0.5h

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009
3	-0.01	0.44	-0.52	0.03	-0.56	-0.22	-0.02	0.35	0.49
4	-0.13	0.63	-0.5	-0.5	-0.84	1.07	-0.39	0.34	0.31
5	-0.29	-0.17	-0.75	-0.31	-0.52	1.04	0.58	0	0.27
6	-0.34	-0.23	-1.02	0.08	-0.72	-0.05	-0.1	0.08	0.44
7	0.01	0.31	-1.3	-0.14	-0.18	0.19	-0.86	-0.48	0.12

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	4	5	6	7
Mean Log q	-6.5519	-6.7843	-6.7843	-6.7843
S.E(Log q)	0.6332	0.5689	0.4907	0.5996

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Inter-cept	RSquare	No Pts	Reg s.e	Mean Log q
3	0.54	0.456	8.55	0.13	9	0.42	-6.59

Ages with q independent of year class strength and constant w.r.t. time

Age	Slope	t-value	Inter-cept	RSquare	No Pts	Reg s.e	Mean Q
4	0.89	0.081	6.97	0.08	9	0.61	-6.55
5	0.87	0.105	7.17	0.09	9	0.53	-6.78
6	1.07	-0.05	6.85	0.07	9	0.51	-6.98
7	-3.89	-2.235	10.59	0.03	9	1.66	-7.05

Fleet : FLT02: P25Q1

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009
3	0	-0.04	0.03	-0.08	0.14	0.09	0.07	-0.15	-0.07
4	-0.48	-0.53	-1.23	0.52	0.74	0.53	1.08	-0.71	-0.12
5	-0.67	-0.34	-1.57	0.25	0.78	0.37	1.57	-0.15	-0.49
6	-1.2	-1.38	-2.03	0.1	0.85	0.28	1.76	0.96	-0.27
7	-0.79	-0.33	-1.98	-0.65	-0.21	0.28	1.07	1.52	-0.33

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	4	5	6	7
Mean Log q	-5.391	-4.9804	-4.9804	-4.9804
S.E(Log q)	0.7808	0.9104	1.2388	1.0502

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Inter-cept	RSquare	No Pts	Reg s.e	Mean Log q
3	0.14	3.476	10.36	0.71	9	0.1	-7.34

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Inter-cept	RSquare	No Pts	Reg s.e	Mean Q
4	0.21	3.681	9.39	0.77	9	0.1	-5.39
5	0.21	2.183	8.74	0.54	9	0.16	-4.98
6	-0.38	-1.045	10.33	0.08	9	0.47	-5.03
7	2.09	-0.358	2.2	0.02	9	2.32	-5.1

Fleet : FLT03: G24Q1

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009
3	0.61	-2.24	-0.54	-0.07	0.48	-0.17	0.16	-0.78	2.37
4	-0.58	-0.35	0.12	-1.43	0.34	0.45	0.87	0.47	-0.1
5	-1.06	-0.45	-0.57	-1.82	-0.09	0.91	0.81	0.9	1.01
6	-1.36	-0.8	-0.94	-2.56	-0.4	-0.01	0.35	1.11	1.04
7	-0.31	-0.34	-0.67	-1.53	-0.28	-0.74	-0.05	1.52	2

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	4	5	6	7
Mean Log q	-7.7204	-8.3371	-8.3371	-8.3371
S.E(Log q)	0.6969	1.0213	1.2498	1.1367

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Inter-cept	RSquare	No Pts	Reg s.e	Mean Log q
3	-1.9	-0.9	16.86	0.01	9	1.32	-7.67

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Inter-cept	RSquare	No Pts	Reg s.e	Mean Q
4	0.49	0.644	9.09	0.2	9	0.36	-7.72
5	0.4	0.597	9.17	0.13	9	0.43	-8.34
6	0.24	0.954	8.82	0.19	9	0.28	-8.69
7	41.56	-0.626	31.96	0	9	49.27	-8.36

Terminal year survivor and F summaries :

Age 3 Catchability dependent on age and year class strength

Year class = 2006

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: G24Q4 n/0.5h	58371	0.479	0	0	1	0.105	0.116
FLT02: P25Q1	33291	0.3	0	0	1	0.268	0.196
FLT03: G24Q1	379994	1.681	0	0	1	0.009	0.019
P shrinkage mean	30490	0.24				0.502	0.212
F shrinkage mean	44377	0.5				0.116	0.15

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
35675	0.16	0.17	5	1.016	0.184

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2005

Fleet	Estimated	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: G24Q4 n/0.5h	26669	0.376	0.019	0.05	2	0.247	0.355
FLT02: P25Q1	16518	0.282	0.009	0.03	2	0.433	0.524
FLT03: G24Q1	15168	0.656	0.273	0.42	2	0.085	0.559
F shrinkage mean	19070	0.5				0.236	0.468

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
19097	0.2	0.09	7	0.442	0.467

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2004

Fleet	Estimated	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: G24Q4 n/0.5h	7747	0.328	0.109	0.33	3	0.277	0.559
FLT02: P25Q1	6001	0.274	0.201	0.73	3	0.341	0.677
FLT03: G24Q1	12191	0.569	0.212	0.37	3	0.093	0.39
F shrinkage mean	5056	0.5				0.289	0.765

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
6549	0.2	0.12	10	0.571	0.635

Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 5

Year class = 2003

Fleet	Estimated	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: G24Q4 n/0.5h	3728	0.319	0.181	0.57	4	0.326	0.658
FLT02: P25Q1	3527	0.301	0.197	0.65	4	0.199	0.686
FLT03: G24Q1	7486	0.605	0.179	0.3	4	0.075	0.381
F shrinkage mean	2233	0.5				0.4	0.938

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
3166	0.24	0.14	13	0.585	0.741

Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) 5

Year class = 2002

Fleet	Estimated	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: G24Q4 n/0.5h	1029	0.392	0.149	0.38	5	0.314	0.401
FLT02: P25Q1	1022	0.491	0.272	0.55	5	0.144	0.403
FLT03: G24Q1	4074	0.767	0.316	0.41	5	0.083	0.117
F shrinkage mean	591	0.5				0.46	0.62

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
894	0.28	0.18	16	0.662	0.45

Table 5.1.3 Flounder in SD 24-25. Diagnostics of XSA for shrinkage E=1.9.

```
Lowestoft VPA Version 3.1
10/11/2010  17:42
Extended Survivors Analysis
Flounder in Subdivisions 24 and 25 WGBFAS 2006
CPUE data from file d:\FleDat10\FLT0109.txt

Catch data for 32 years. 1978 to 2009. Ages  3 to   8.
```

Fleet	First year	Last year	First age	Last age	Alpha	Beta
FLT01: G24Q4 n/0.5h	2001	2009	3	7	0.87	0.96
FLT02: P25Q1	2001	2009	3	7	0.1	0.15
FLT03: G24Q1	2001	2009	3	7	0.1	0.15

```
Time series weights :
             Tapered time weighting applied
             Power =    3 over  20 years
Catchability analysis :
             Catchability dependent on stock size for ages <    4

                          Regression type = C
                      Minimum of   5 points used for regression
                          Survivor  estimates  shrunk  to  the  population  mean
             for ages <  4

             Catchability independent of age for ages >=    5
Terminal population estimation :
             Survivor estimates shrunk towards the mean F
             of the final   5 years or the   3 oldest ages.

             S.E. of the mean to which the estimates  are shrunk =    1.900

             Minimum standard error for population
       estimates derived from each fleet =    .300

             Prior weighting not applied

Tuning converged after  30 iterations

Total absolute residual between iterations
29 and  30 =     .01341
```

Final year F values

Age	3	4	5	6	7
Iteration 29	0.1845	0.4841	0.4374	0.3991	0.0691
Iteration 30	0.1841	0.4847	0.4345	0.3927	0.066

Regression weights

0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009
3	0.252	0.514	0.116	0.186	0.165	0.074	0.091	0.082	0.184
4	0.568	0.722	0.256	0.332	0.427	0.272	0.45	0.294	0.485
5	0.714	0.548	0.61	0.681	0.841	0.379	0.376	0.544	0.434
6	0.68	0.521	1.299	1.071	1.298	0.537	0.181	0.414	0.393
7	0.762	0.762	1.749	2.105	1.301	0.967	0.613	0.137	0.066

XSA population numbers (Thousands)

YEAR / AGE	3	4	5	6	7
2001	53100	30200	14600	6630	1670
2002	53500	33800	14000	5870	2750
2003	46500	26200	13400	6620	2860
2004	70700	33900	16600	5980	1480
2005	73700	48100	19900	6870	1680
2006	69300	51200	25700	7040	1540
2007	44100	52700	31900	14400	3370
2008	47900	33000	27500	18000	9830
2009	52300	36200	20100	13100	9710

Estimated population abundance at 1st Jan 2010

0	35700	18200	10800	7360

Taper weighted geometric mean of the VPA populations:

50200	32700	16700	7440	2820

Standard error of the weighted Log(VPA populations) :

0.2561	0.3259	0.4199	0.4844	0.6682

Log catchability residuals.

Fleet : FLT01: G24Q4 n/0.5h

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009
3	-0.3	-3.45	4.32	-0.76	2.95	0.08	2.55	-2.01	-3.47
4	0.1	0.81	-0.31	-0.37	-1.21	0.77	-0.48	0.22	0.51
5	0.16	0.22	-0.43	0.03	-0.32	0.39	0.09	-0.18	0.07
6	0.09	0.32	-0.37	0.48	-0.23	0.09	-1.14	-1.3	-0.09
7	0.52	0.89	-0.04	1.64	0.49	0.97	-0.83	-2.05	-1.7

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	4	5	6	7
Mean Log q	-6.7112	-7.0557	-7.0557	-7.0557
S.E(Log q)	0.6684	0.265	0.6816	1.2851

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Inter-cept	RSquare	No Pts	Reg s.e	Mean Log q
3	-3.6	-0.824	26.16	0	9	3.01	-6.7

Ages with q independent of year class strength and constant w.r.t. time

Age	Slope	t-value	Inter-cept	RSquare	No Pts	Reg s.e	Mean Q
4	1.88	-0.453	3.34	0.04	9	1.33	-6.71
5	0.86	0.508	7.45	0.67	9	0.24	-7.06
6	-5.11	-3.913	18.07	0.06	9	1.87	-7.31
7	-1.72	-6.773	9.55	0.49	9	0.84	-7.1

Fleet : FLT02: P25Q1

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009
3	0.13	0.09	0.07	-0.25	0.04	0.14	-0.11	-0.09	0.01
4	-0.32	-0.4	-1.09	0.61	0.5	0.3	1.04	-0.81	0.02
5	-0.39	-0.08	-1.37	0.46	0.92	-0.05	1.24	-0.25	-0.62
6	-0.93	-1.02	-1.7	0.34	1.12	0.38	0.93	0.23	-0.61
7	-0.47	0.03	-1.43	0.08	0.14	0.72	1.1	0.28	-1.94

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	4	5	6	7
Mean Log q	-5.5062	-5.1569	-5.1569	-5.1569
S.E(Log q)	0.7036	0.8029	0.9662	1.0072

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Inter-cept	RSquare	No Pts	Reg s.e	Mean Log q
3	0.18	3.214	10.3	0.7	9	0.14	-7.44

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
4	0.3	3.48	9	0.79	9	0.14	-5.51
5	0.42	1.622	7.89	0.55	9	0.31	-5.16
6	0.61	0.775	6.74	0.38	9	0.6	-5.26
7	1.97	-1.035	2.71	0.15	9	1.94	-5.31

Fleet : FLT03: G24Q1

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009
3	0.63	-1.89	-0.39	-0.23	0.24	-0.22	0.09	-0.57	2.19
4	-0.42	-0.22	0.26	-1.34	0.11	0.22	0.83	0.37	0.05
5	-0.78	-0.2	-0.36	-1.6	0.05	0.49	0.48	0.8	0.87
6	-1.09	-0.43	-0.61	-2.33	-0.13	0.08	-0.48	0.38	0.7
7	0.01	0.02	-0.12	-0.8	0.07	-0.29	-0.02	0.28	0.4

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	4	5	6	7
Mean Log q	-7.8356	-8.5136	-8.5136	-8.5136
S.E(Log q)	0.6133	0.8119	1.0002	0.3542

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
3	-1.69	-1.246	16.26	0.03	9	1.16	-7.77

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Inter-cept	RSquare	No Pts	Reg s.e	Mean Q
4	0.5	1.116	9.18	0.44	9	0.3	-7.84
5	0.37	2.27	9.38	0.66	9	0.24	-8.51
6	0.46	1.816	9	0.63	9	0.36	-8.92
7	0.75	2.791	8.42	0.95	9	0.19	-8.56

Terminal year survivor and F summaries :

Age 3 Catchability dependent on age and year class strength

Year class = 2006

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: G24Q4 n/0.5h	1105	3.471	0	0	1	0.004	2.017
FLT02: P25Q1	36133	0.3	0	0	1	0.477	0.182
FLT03: G24Q1	316568	1.476	0	0	1	0.02	0.022
P shrinkage mean	32657	0.33				0.486	0.199
F shrinkage mean	56428	1.9				0.014	0.12

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
35686	0.22	0.19	5	0.888	0.184

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2005

Fleet	Estimated	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: G24Q4 n/0.5h	27419	0.691	0.498	0.72	2	0.119	0.347
FLT02: P25Q1	17015	0.278	0.039	0.14	2	0.687	0.512
FLT03: G24Q1	16972	0.577	0.247	0.43	2	0.169	0.513
F shrinkage mean	26500	1.9				0.026	0.357

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
18208	0.23	0.11	7	0.455	0.485

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2004

Fleet	Estimated	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: G24Q4 n/0.5h	11771	0.277	0.126	0.46	3	0.47	0.401
FLT02: P25Q1	8144	0.267	0.191	0.72	3	0.381	0.538
FLT03: G24Q1	18056	0.483	0.2	0.41	3	0.133	0.279
F shrinkage mean	7577	1.9				0.016	0.569

Weighted prediction:

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
10751	0.18	0.12	10	0.655	0.434

Age 6 Catchability constant w.r.t. time and age (fixed at the value for age) 5

Year class = 2003

Fleet	Estimated	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Esti-mated F
FLT01: G24Q4 n/0.5h	5999	0.267	0.055	0.21	4	0.493	0.457
FLT02: P25Q1	7727	0.278	0.25	0.9	4	0.335	0.371
FLT03: G24Q1	14460	0.476	0.159	0.33	4	0.15	0.215
F shrinkage mean	3381	1.9				0.022	0.707

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
7358	0.18	0.12	13	0.68	0.393

Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) 5

Year class = 2002

Fleet	Estimated	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
FLT01: G24Q4 n/0.5h	6085	0.262	0.368	1.4	5	0.327	0.08
FLT02: P25Q1	6868	0.278	0.427	1.53	5	0.257	0.071
FLT03: G24Q1	10899	0.306	0.03	0.1	5	0.404	0.046
F shrinkage mean	917	1.9				0.013	0.44

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
7753	0.17	0.18	16	1.08	0.066

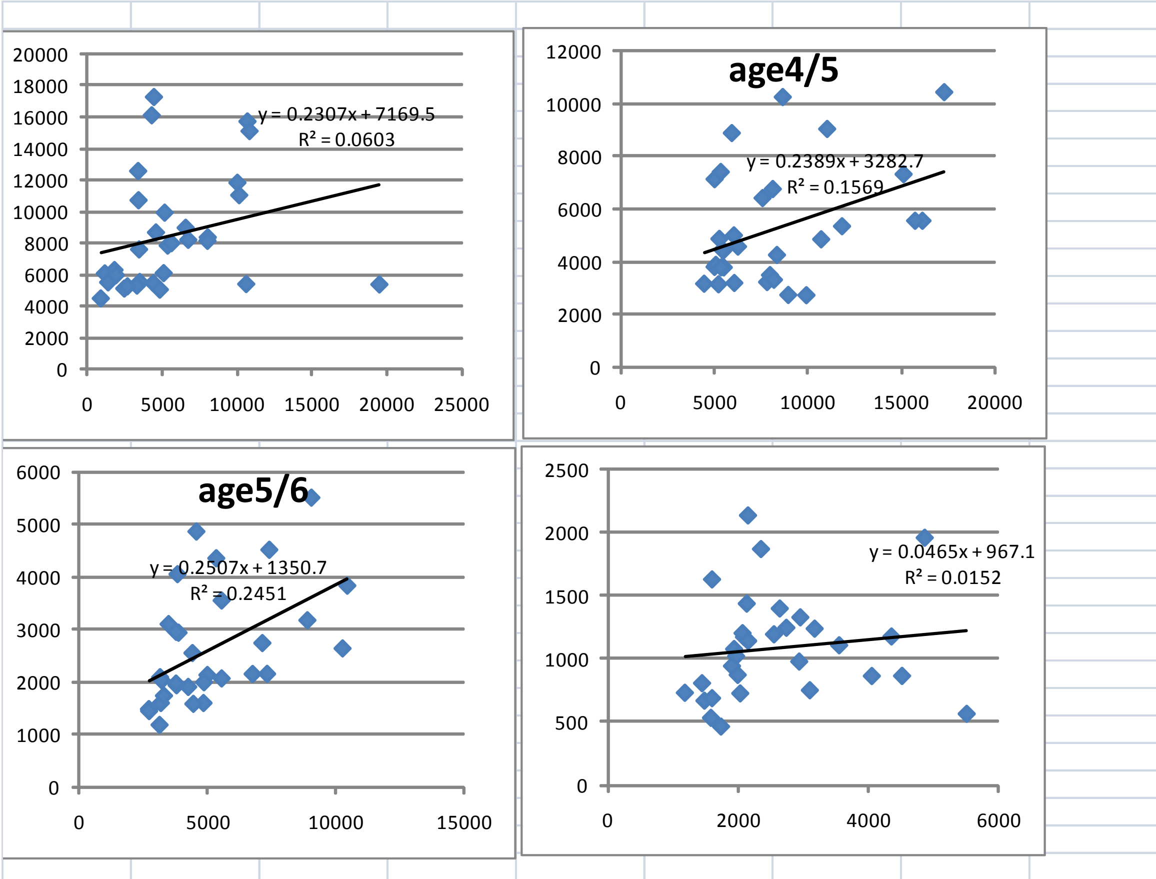

Figure 7.1.1. Flounder in SD 24-25. Check for consistency of catch at age data.

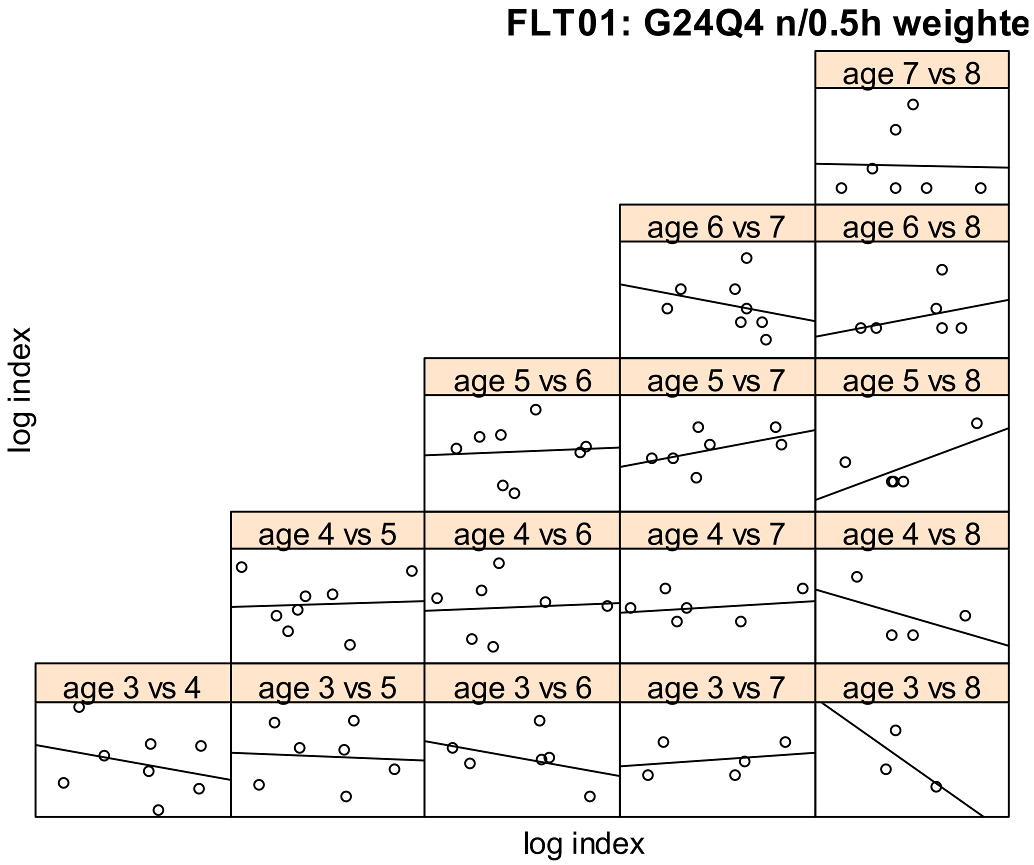

Figure 7.1.2a. Flounder in SD 24-25. Check for consistency in Baltic International Trawl Survey for German fleet in 4th quarter.

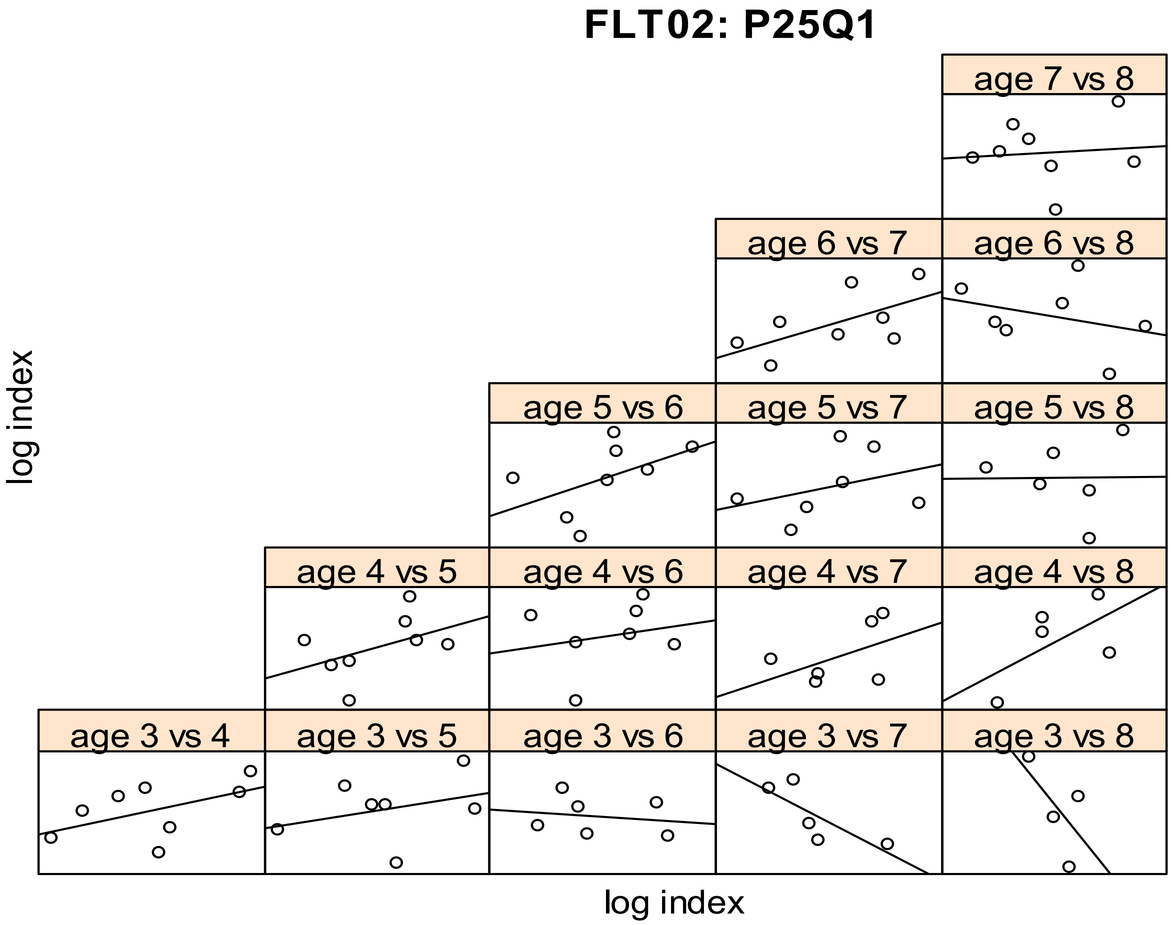

Figure 7.1.2b. Flounder in SD 24-25. Check for consistency in Baltic International Trawl Survey for Polish fleet in 1st quarter.

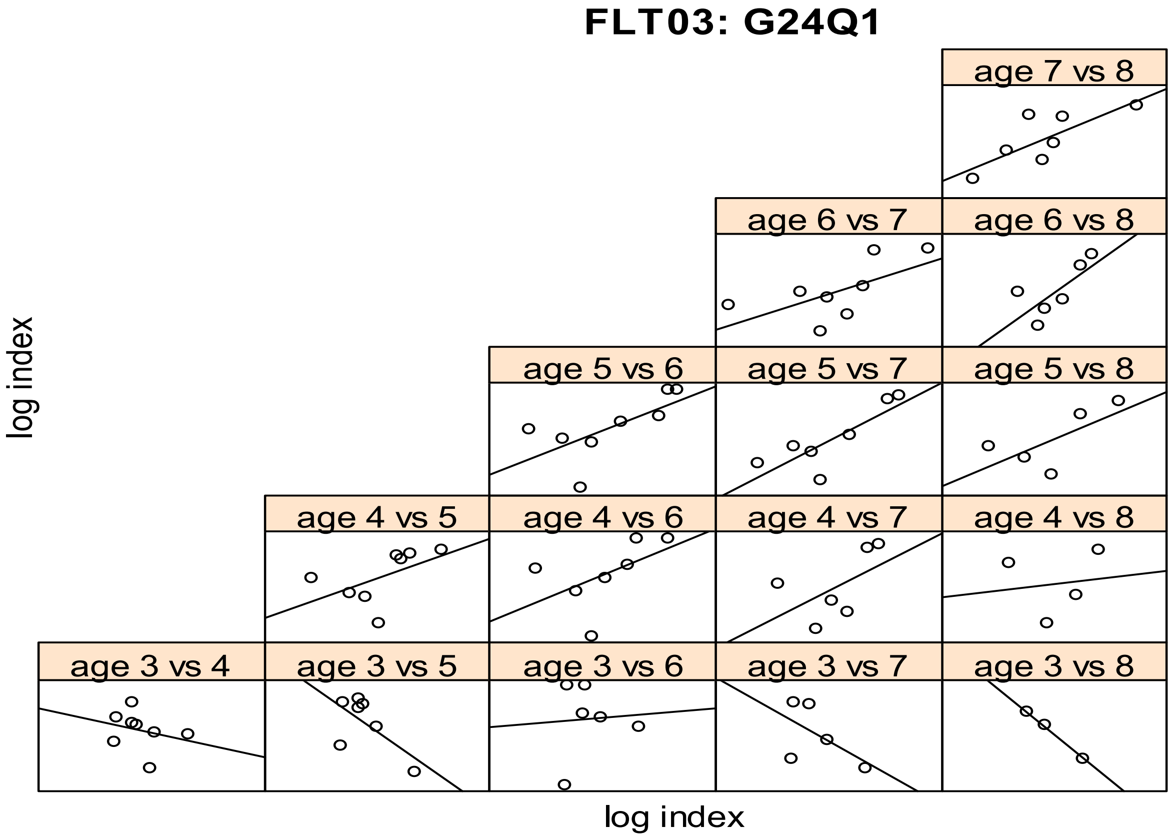

Figure 7.1.2c. Flounder in SD 24-25. Check for consistency in Baltic International Trawl Survey for German fleet in 1st quarter.

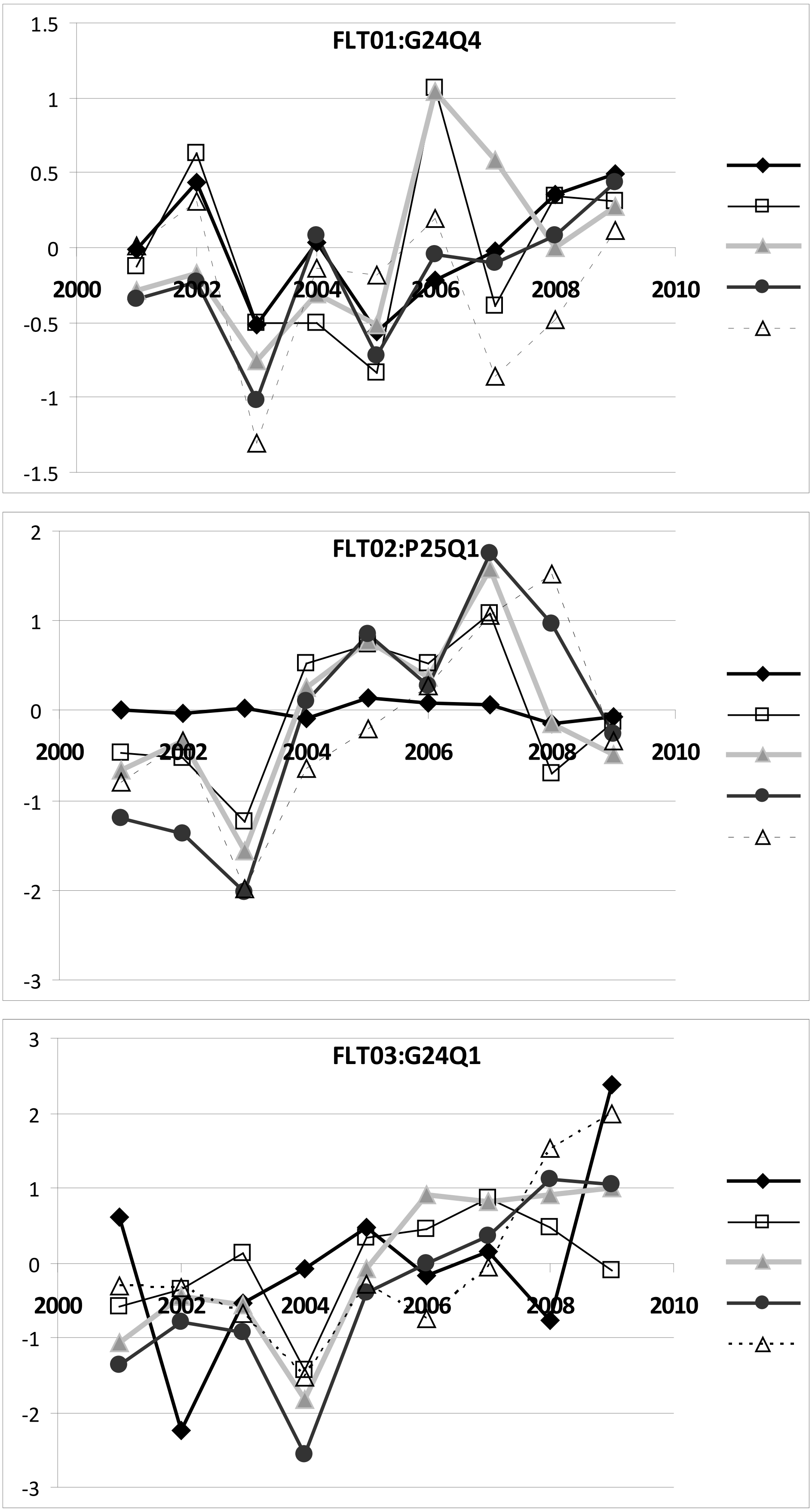

Figure 7.1.3. Flounder in SD 24-25. Log catchability residuals by fleets (shrinkage SE=0.5).

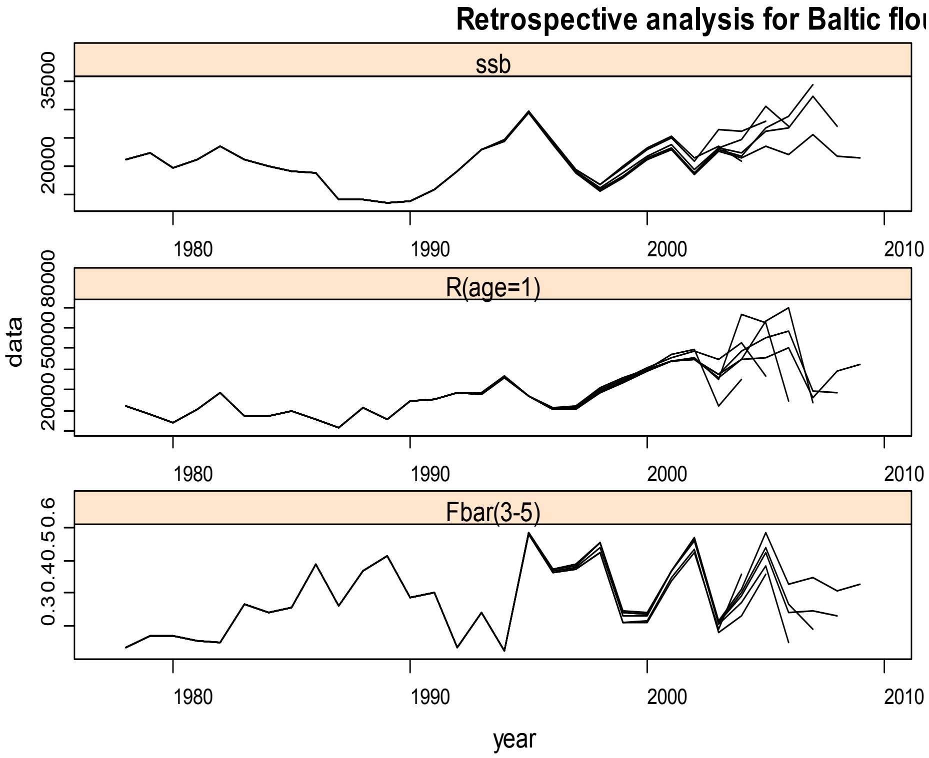

Figure 7.1.4. Flounder in SD 24-25. Retrospective analysis for shrinkage SE=0.5.

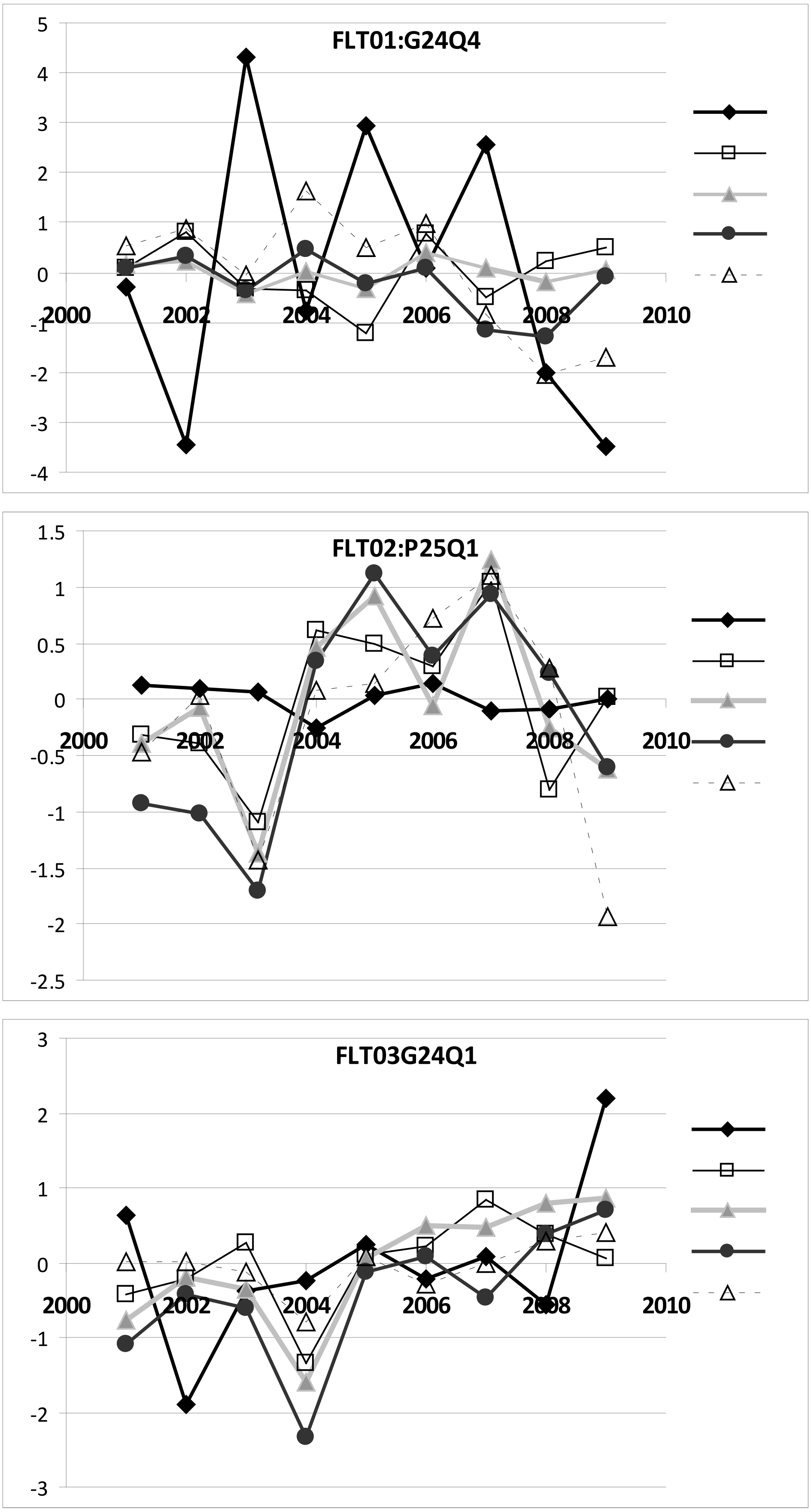

Figure 7.1.5. Flounder in SD 24-25. Log catchability residuals by fleets (shrinkage SE=1.9).

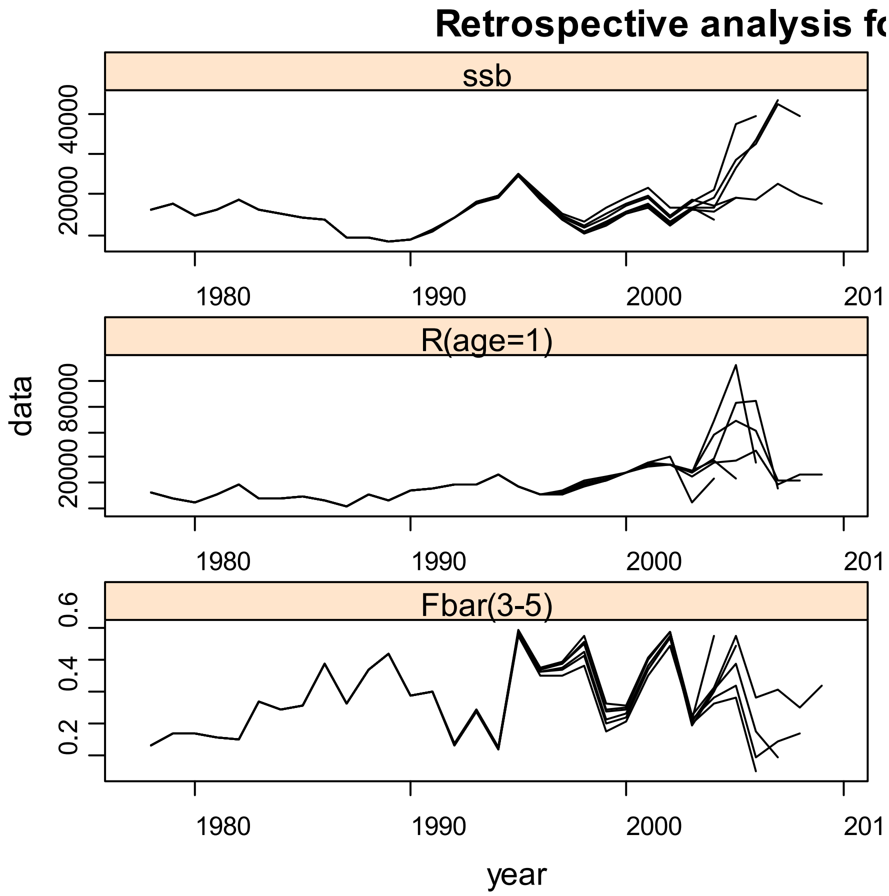

Figure 7.1.6. Flounder in SD 24-25. Retrospective analysis for shrinkage SE=1.9.

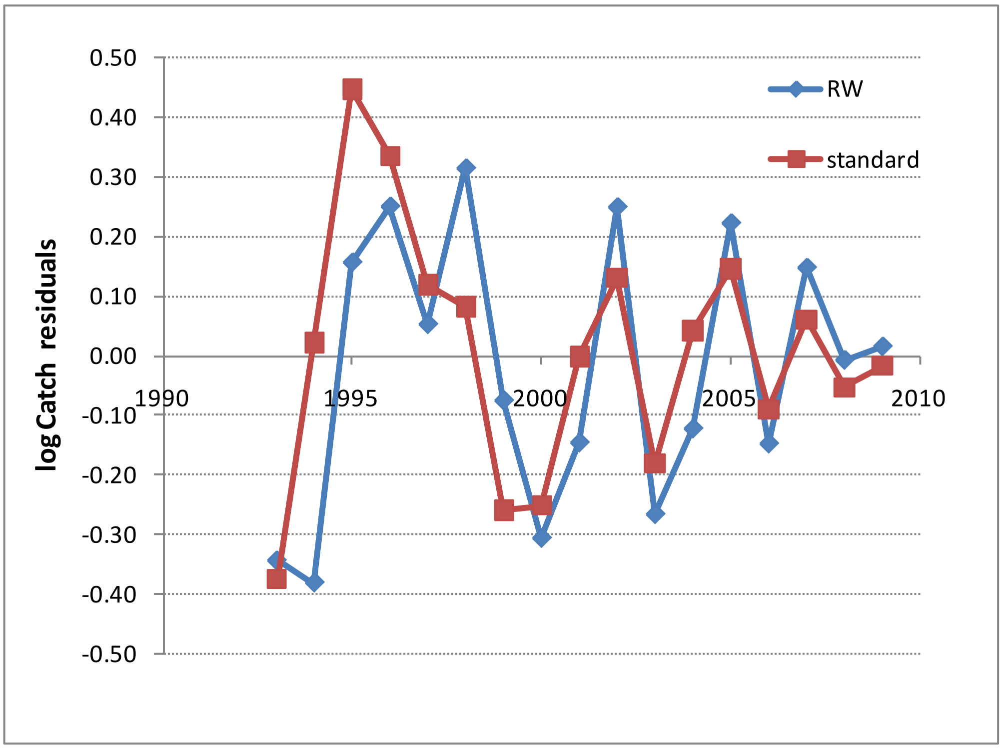

Figure 7.1.7. The logCatch residuals for flounder in Subdivisions 24-25 in difference model with standard approach (standard) and random walk on fishing mortality (RW).

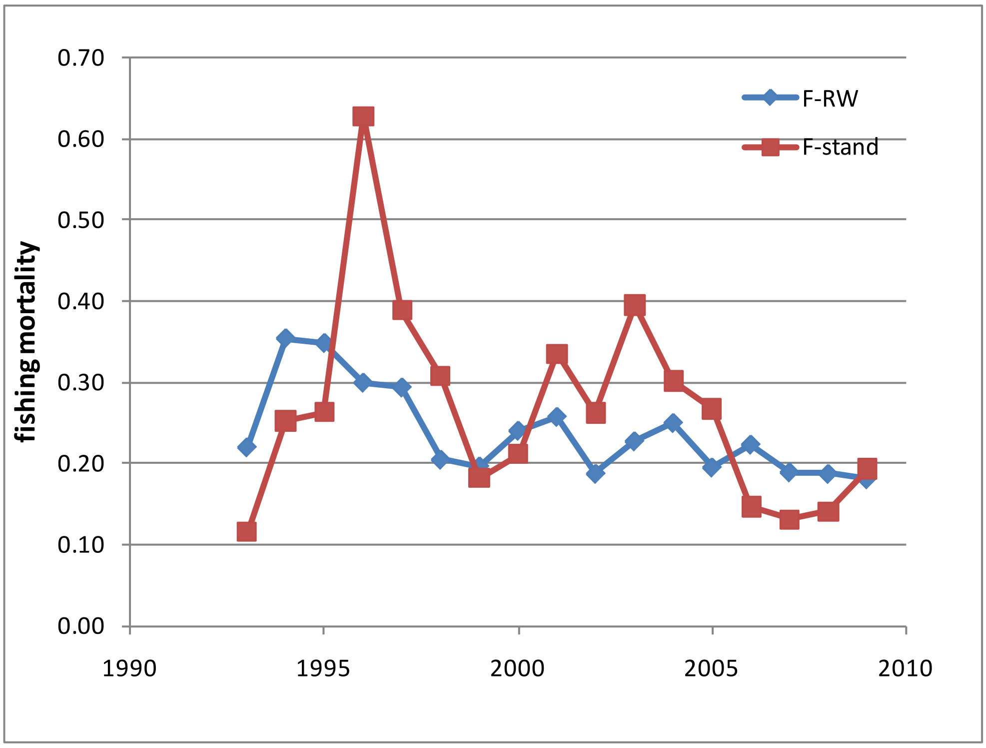

Figure 7.1.8. Fishing mortality of flounder in Subdivisions 24-25 as estimated by difference model with standard approach (F-stand) and random walk on F (F-RW).

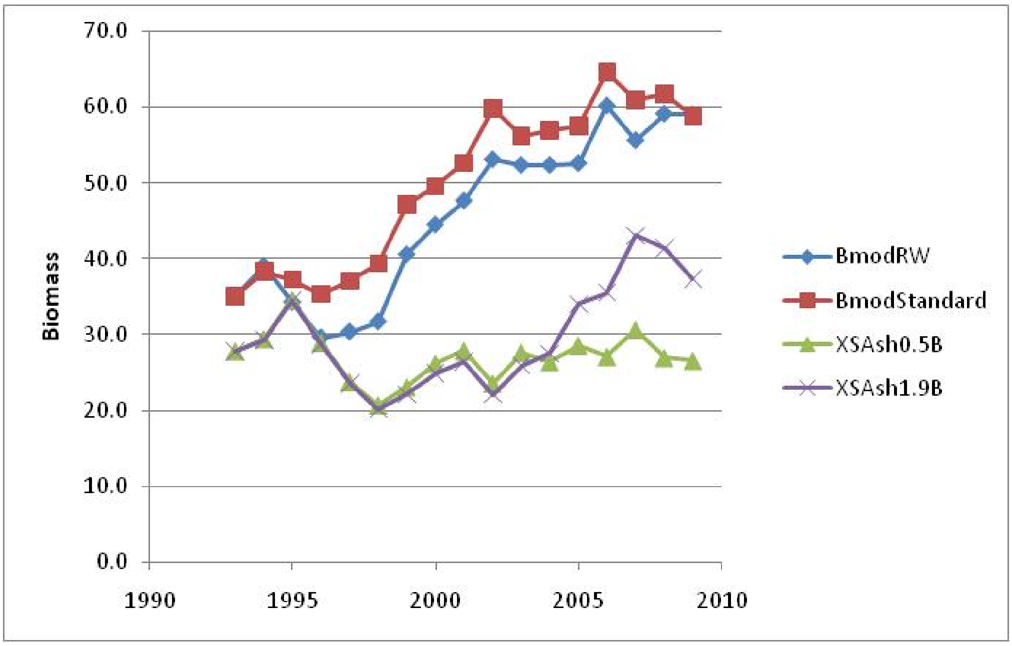

Figure 7.1.9. Flounder in SD 24-25. Biomass estimated by difference model by difference model with standard approach (F-stand) and random walk on F (F-RW) and XSA.

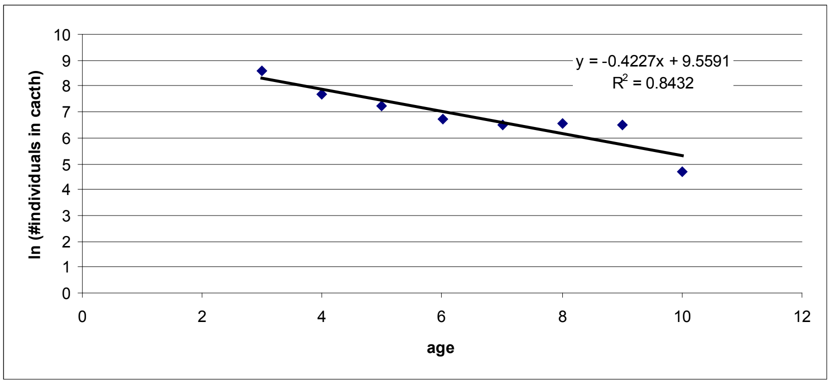

Figure 7.1.10. Catch curve for flounder in trawl sample in SD 25, 4th quarter.

7.2 Flounder in Subdivision 27 (Swedish east coast population)

Flounder was regularly sampled from commercial gill net fishery on the Swedish east coast, SD 27, in the years 2004-2007. This represents the stock of demersal spawning flounder on Swedish east cost (Tab. 3.2). Age and length distribution of the catch was recorded from a sub-sample of fishermen while the total catch was recorded for all commercial fisheries in the area. Age was determined using the slice & staining technique. Catch curve analysis, restricted to the ages 8-16 to get a good linear fit, gives an estimate of total mortality for both sexes combined of 0.28 (Figure 7.2.1). Catch at first age compared to mean age in catches for females and males separately (Table 7.2.1) gives lower estimates of mortality for both females (Z of 0.13-0.19) and males (Z of 0.09-0.15).

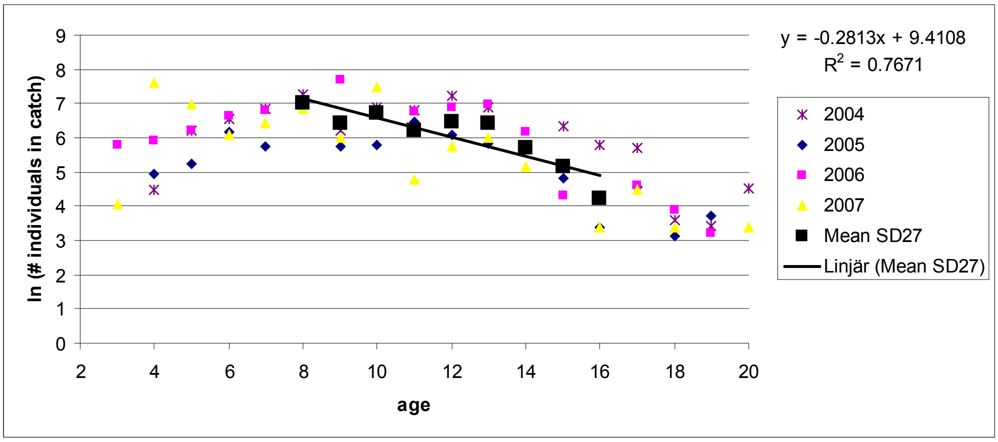

Figure 7.2.1. Catch curve analyses of flounder 2004-2007 in SD 27.

Table 7.2.1. Flounder in SD 27

year	mean age		age at first capture		mortality	
	F	M	F	M	Zf	Zm
2004	10.07	14.90	4	4	0.16	0.09
2005	9.79	10.65	4	4	0.17	0.15
2006	9.53	9.54	2	3	0.13	0.15
2007	7.33	9.46	2	3	0.19	0.15

7.3 Flounder in Subdivisions 28 (Eastern Gotland population)

Difference model

Experimental stock assessment of flounder from SD 28 (Eastern Gotland population) was performed using difference model (Horbowy, 1992). For calculation of growth parameters (based on von Bertalanffy equation) data from whole otoliths covering 2000-2004 and data from broken and burned otoliths collected in 2009 were available. To compare impact of age reading methods (and possibly growth differences) on results of difference models, growth parameters for both age reading methods and periods were calculated separately.

Flounder landings from SD 28 (Latvia and Estonia) in 1995-2004 were used from WGBFAS report (Figure 7.3.1). In SD 28 direct flounder fishery is not very active. To calculate fishing effort, only Latvian demersal trawlers with catches of more than 50% of flounder were selected (Figure 7.3.2). Due to low quality of data in 1996-1998 long-term average was used.

Flounder recruitment indices were taken form juvenile coastal survey in Irbe Strait, and index of young of the year was calculated. Mean weight of flounder was calculated from Latvian BITS surveys in first quarter.

Results

Growth parameters for flounder in SD 28 using whole and broken and burned otoliths are presented in Table 7.3.1. The model fit to the catches was relatively good and similar for growth parameters obtained from whole and broken and burned otoliths (Figure 7.3.3 and 7.3.4). The biomass estimates were almost independent of the method of estimating growth parameters: both approaches provided very similar biomass. The results suggest biomass fluctuating along stable level of 1200 tons. In future effort data for recent years of flounder fishery should be compiled and next exploratory assessment could cover time period 1994 – 2010.

Table 7.3.1. Growth parameters of flounder from SD 28 by two different age reading methods.

Growth parameters	Burned (2009)	Whole (2000-2005)
H	0.52	0.58
k	0.072	0.060

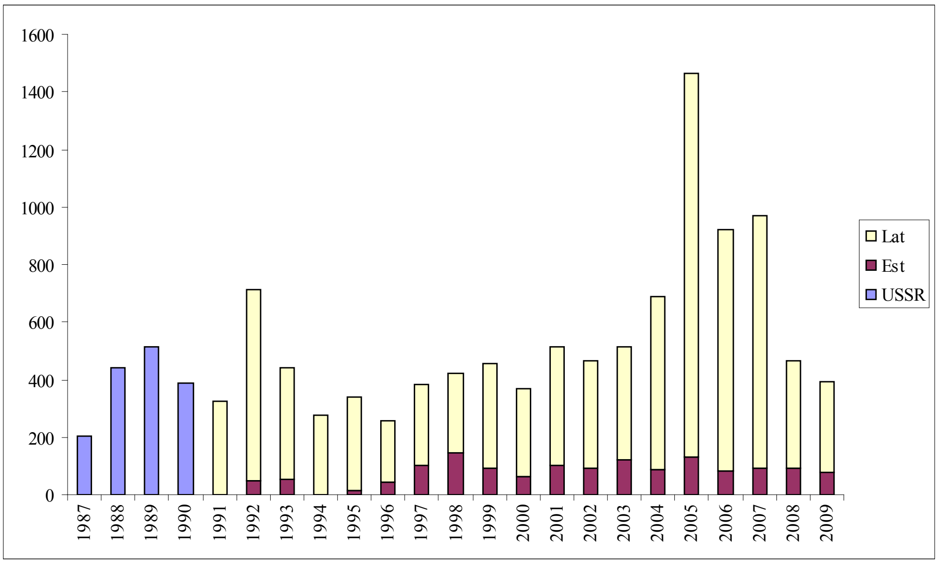

Figure 7.3.1. Landings of flounder in SD 28 by countries.

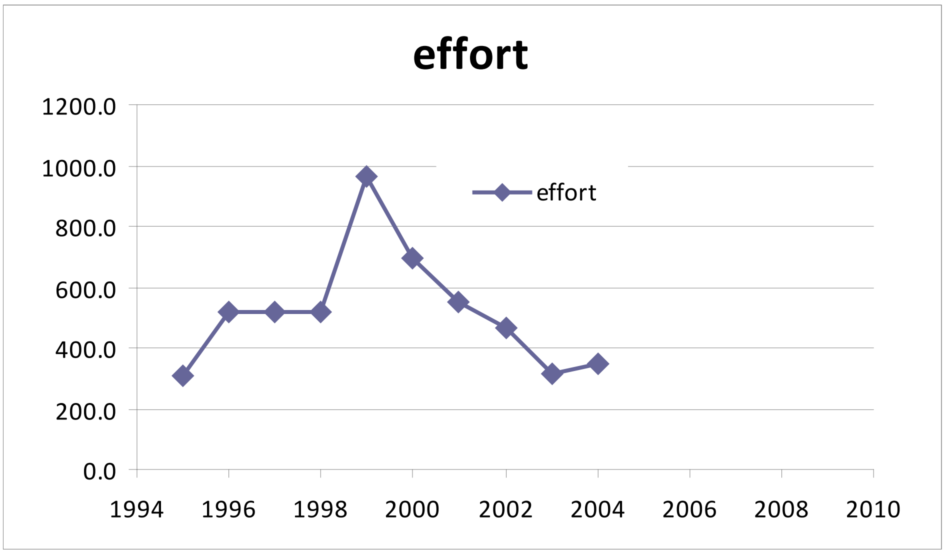

Figure 7.3.2. Flounder fishery effort data in 1994-2004. Only Latvian fishermen data.

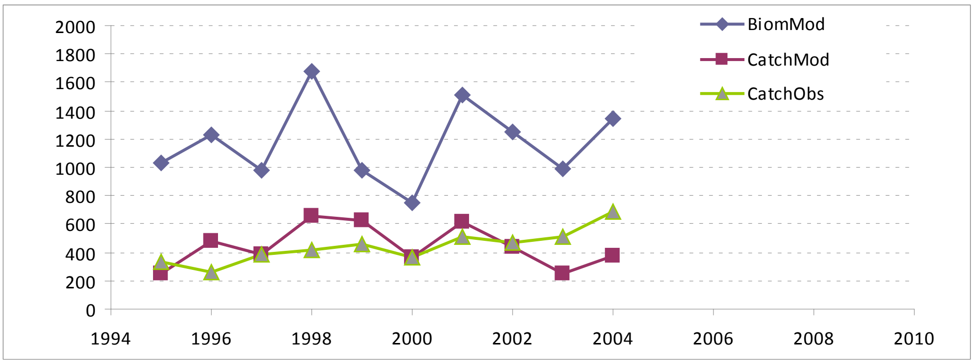

Figure 7.3.3. Difference model results for flounder SD 28, using broken and burned otoliths.

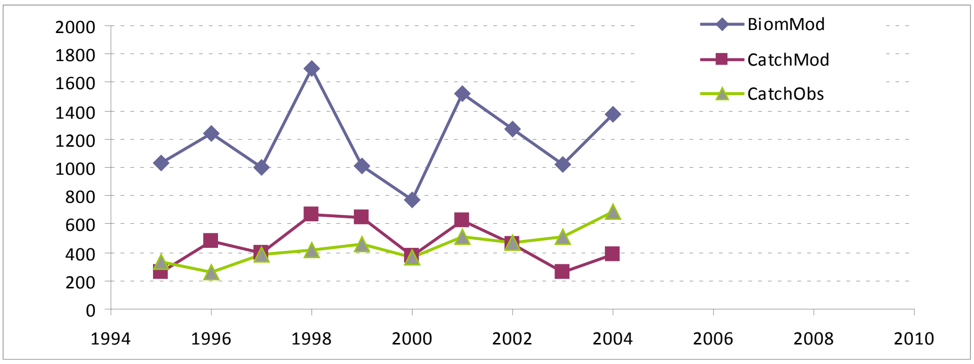

Figure 7.3.4. Difference model results for flounder SD 28, using whole otoliths.

7.4 Flounder in Gulf of Finland, Estonian coast of Gulf of Finland population

The catch in numbers in Estonian fishery in 2002 – 2009 was available. The data for tuning were lacking and only simple cohort analysis using assumed values for terminal fishing mortality could be presented. This data is supposed to represent the stock of demersal spawning flounder in the Estonian coast of Gulf of Finland (Tab.3.2). Only data from whole otoliths were available.

The slope of catch curve was estimated at 0.6 indicating roughly level of total mortality if stock is approximately in equilibrium (Figure 7.4.1). The estimate of Z basing on length data and growth parameters results in Z of about 0.65.

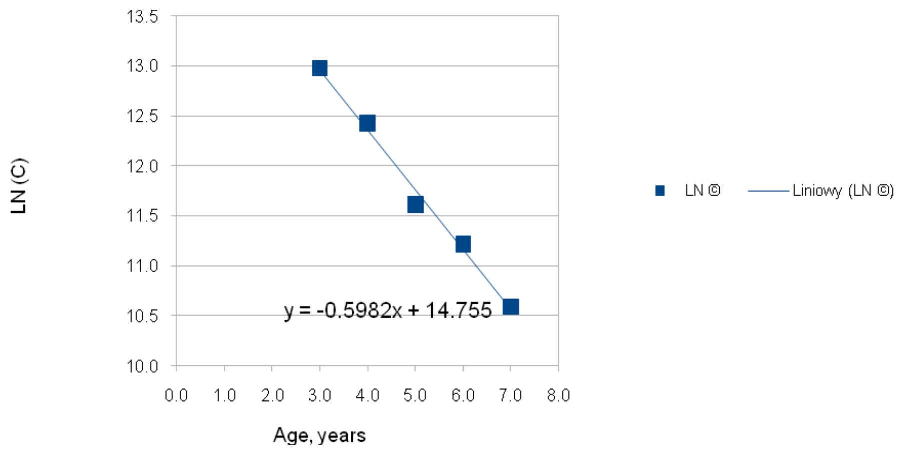

Figure 7.4.1. The catch curve for flounder in Gulf of Finland (Estonian data).

7.5 Turbot in Subdivision 28

Turbot was regularly sampled from commercial gill net fishery east of Gotland, SD 28, in the summer of 1998-2007. Age and length distribution of the catch was recorded from a subsample of fishermen while the total catch was recorded for all commercial fisheries in the area. All ages were determined using the slice & staining technique apart from a subsample of the catch 1999 that was first determined using whole otoliths and later reread with the slicing technique. Since 75% of landings consisted of females a cohort analysis was based only on females. Data was restricted to ages of 5 years and older since younger fish were not fully recruited to the fishery. The catch curve following single cohorts of turbot was applied first. For each cohort the catch of females of different ages (number of individuals ln transformed) was regressed over ages (Figure 7.5.1). Under some equilibrium conditions, the slope of the regression is an approximation of the total mortality. The average mortality for cohorts was 0.86 (SD = 0.28).

Cohort analysis requires longer time series of age determined data. An alternative estimation of mortality that can be based on just one year of data is catch-curve analysis, which is analogous to the cohort analysis but instead of cohorts the catch of single years are used.

Using the same turbot data as above a catch curve analysis was performed (Figure 7.5.2). This time the data had to be restricted between 6 and 10 years old females in order to get a good fit of a straight line. Mean mortality in this analysis was 0.60.

Correct ages are important when making these types of analyses. Therefore a comparison was made of the catch at ages from the 1999 sample based on data from otoliths that had been read both whole and sliced (Figure 7.5.3). This revealed that based on whole otoliths Z is estimated at 1.3 while based on sliced otoliths Z equals 0.53.

Also a third assessment method was tried on the same data, namely catch at first age compared to mean age in catch for the years 1999-2007 (Table 7.5.1). For 1999 the results from both sliced (1999) and whole (1999W) otoliths are shown. Results show that mortality in females is more than twice as high as for males (this is not surprising considering that 75% of landings consist of females). Furthermore the data shows that using whole otoliths overestimates the mortality, just as in the catch-curve analysis, and the discrepancy between mortality estimated from whole and sliced otoliths are largest in males (the latter is not surprising since earlier workshops (ICES 2007, 2008) have shown that ages of males are underestimated using whole otoliths compared to sliced or burned otoliths).

Table 7.5.1. Turbots from SD 28.

Year of catch	Mean age		Age at first capture		Mortality	
	females	males	females	males	**Zf**	**Zm**
1999	7.741	8.198	3	3	0.211	0.192
1999W	7.066	5.49	4	3	0.326	0.402
2000	7.716	9.589	3	3	0.212	0.152
2001	7.495	10.06	4	4	0.286	0.165
2002	7.401	10.48	3	3	0.227	0.134
2003	7.844	11.29	4	4	0.26	0.137
2004	6.536	11.38	3	3	0.283	0.119
2005	5.979	9.791	3	3	0.336	0.147
2006	6.886	9.801	2	3	0.205	0.147
2007	5.777	9.636	4	3	0.563	0.151

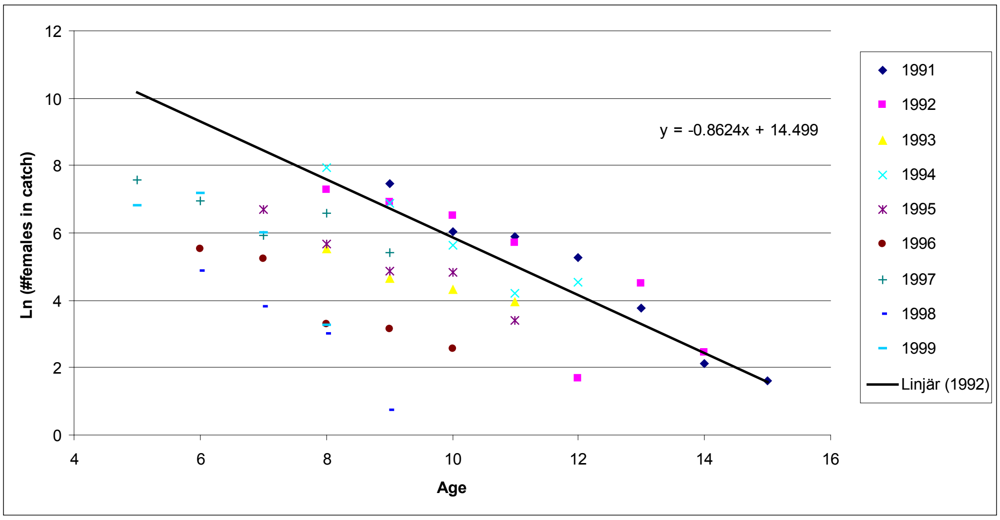

Figure 7.5.1. Analysis of cohorts 1991-1999 of turbot in SD 28. The regression line and equation is shown for cohort 1992 as an example.

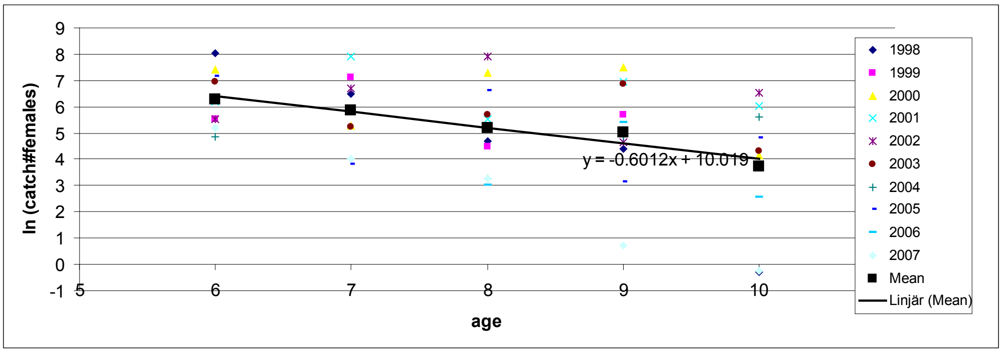

Figure 7.5.2. Catch-curve analysis 1998-2007 for turbots in SD 28.

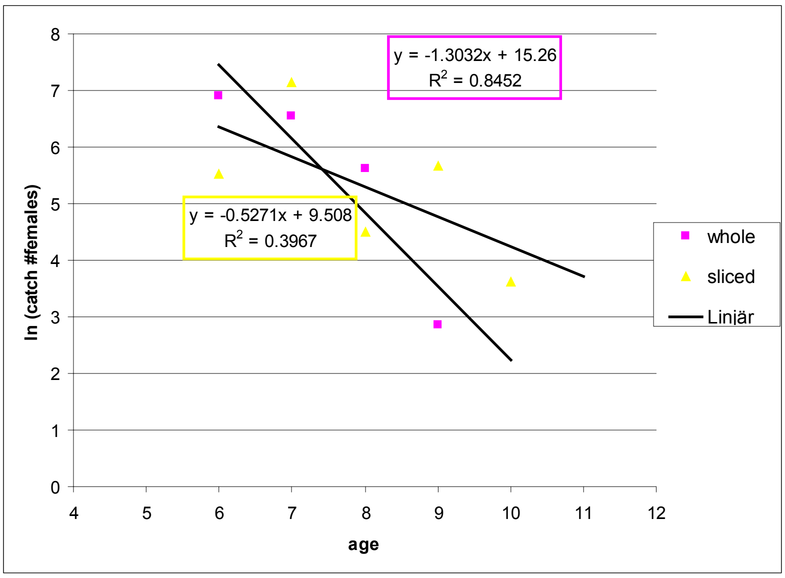

Figure. 7.5.3. Comparisons of catch-curve analysis of turbots from SD 28 based on readings from whole or sliced otoliths.

8 Management actions (ToR4)

Different management actions in flatfish fishery are performed by countries.

8.1 Flounder

Estonia

Fishing mortality has not been too high. However, minimum legal total length for fishing was reduced by Ministry to 18 cm in SD 29 and 32. 25 % of female flounders and 13 % male flounders at length 18 cm have not spawned yet in the Gulf of Finland. Therefore T.Drevs proposed to raise the minimum legal size to 21 cm.

In SD 28 minimum legal size is 21 cm.

The ban in SD 32 is 15.02-31.05 and in SD 28 and 29 15.02-15.05. The Minister of the Environment may temporarily change the ban start or end dates.

Lithuania

In gillnet fishery minimum mesh size is 70 mm. Minimum landing size – 21 cm. No ban for fishery in coastal area.

Russia

The minimum interior mesh size of fishing gears for flounder fisheries is given in Table 8.1.1

Table 8.1.1. Minimal meshsize in Russian flounder fishery

GEAR	FLOUNDER
Bottom trawl	105 mm with open windows BAKOMA 120 mm or 130 mm
Gillnet	120 mm

The minimum catch size: 21 cm for flounder. Terms of bans during spawning: The ban is from 01 .03 to 15. 05. By-catch of flounder is allowed to 30% of full weight catch of cod under the specialized fishery.

Germany

Minimum landing size for flounder is 25 mm while minimum mesh opening is 120 mm (Table 8.1.2). Flounder fisheries restrictions are applied only to female. Flounder fishery ban in spawning season was cancelled since 2006.

Table 8.1.2. Flounder fishery restriction in Germany

SPECIES	MINIMUM MESH OPENING		MINIMUM LANDING SIZE		PROTECTED SEASON		
	value	Valid until	value	Valid until	from	from	Valid until
Flounder female	120	now	25	now	Feb 1	Apr 30	2006

Latvia

Since Latvia is a member of The European Union there is no commercial fishing limit for flounder. Before 2004 annual flounder catch limit was determined, usually 700 t (where 500 t belongs to open sea fishery (2 nautical miles from coast) while 200t for coastal fishery)

From 15th February till 15th May flounder fishing is forbidden, 10 % of by-catch is allowed

Sweden

Swedish regulations for flatfishes in the Baltic Sea includes banned fishing during spawning time for flounder: 15 feb-15 may in SD 26-28, 29S. Minimum landing size for flounder 23 cm in SD 22-25, 21 cm in SD 26-28, and 18 cm in SD 29S. Minimum landing size is not applied for handheld gears (used by recreational fishers).

In addition one marine protected area (Gotska sandön north of Gotland Island) was established in 2006 with turbot and flounder as the target species.

Poland

All management actions are those implemented by EU

Denmark

No information

Finland

No information

8.2 Turbot

Lithuania

In gillnet fishery minimum mesh size is 110 mm. Minimum landing size – 30 cm. Ban for fishery June 1- July 31 (international regulation). However, each year fishermen requires extending of fishery at least till June 10. Institute accepts or rejects request dependently on environmental conditions and fishery success.

Russia

The minimum interior mesh size of fishing gears for turbot fisheries is given in Table 8.2.1

Table 8.2.1. Minimal meshsize in Russian turbot fishery

Gear	Turbot
Bottom trawl	-
Gillnet	175 mm

The minimum catch size: 30 cm for turbot.

Terms of bans during spawning: The ban is from 01.06 to 31.07. Fishery by any gears was banned in the coastal strip by width of 2.5 nautical miles from shores during that period. Setting up of gillnets by length more than 12 km is banned for vessels by length less than 12 m. There is also banned to set up gillnets by length more than 24 km for vessels by length more than 12m.

Germany

The minimum mesh opening in turbot fishery is 120 mm (Table 8.2.2), minimum landing size is 30 cm, turbot protection season is from 1 June till 31 July.

Table 8.1.2. Turbot fishery restriction in Germany

SPECIES	MINIMUM MESH OPENING		MINIMUM LANDING SIZE		PROTECTED SEASON		
	value	Valid until	value	Valid until	from	from	Valid until
Turbot	120	now	30	now	Jun 1	Jul 31	now

Latvia

Directed fishery for turbot started in beginning of 1990-ies. Due to high market value and limited stock size, strong over-fishing was observed. Total fishing quota was reduced from 100t to 30 t. In coastal zone fishing was regulated by numbers of turbot nets. Due to small stock size fishing in open sea was closed in 2001, but since 2005 in coastal zone, too. Only 10% of bycatch was allowed. Since 2010 fishing in coastal zone is open with limited amount of nets.

Minimal landing size is 30 cm; minimum mesh size in turbot fishery is 120 mm

Sweden

Swedish regulations for flatfishes in the Baltic Sea includes banned fishing during spawning time for turbot: 1 Jun- 31 Jul in SD 25, 26 and 28 south of lat 56.50N. Minimum mesh opening for turbot is 110 mm. Minimum landing size for turbot. Minimum landing size is not applied for handheld gears (used by recreational fishers).

In addition one marine protected area (Gotska sandön north of Gotland Island) was established in 2006 with turbot and flounder as the target species.

Poland

All management actions are those implemented by EU

Denmark

No information

Finland

No information

Estonia

No information

8.3 Other flatfish

Germany

Minimum mesh opening size for brill, dab and plaice is 120 mm (Table 8.3.1). Minimum landing size for dab and plaice is 25 cm while for brill is 30 cm. There is no protection season for brill, dab and plaice. Till 2006 protection season (from 1 June till 31 July for brill and from 1 February till 30 April for plaice) was for brill and plaice

Table 8.3.1. Fishery restriction in Germany for brill, dab and plaice

SPECIES	MINIMUM MESH OPENING		MINIMUM LANDING SIZE		PROTECTED SEASON		
	value	Valid until	value	Valid until	from	from	Valid until
Brill	120	now	30	now	Jun 1	Jul 31	2006
Dab	120	now	25	now			
Plaice	120	now	25	now	Feb 1	Apr 30	2006

Sweden

Swedish regulations for flatfishes in the Baltic Sea includes minimum mesh opening for brill, plaice, dab, sole and lemon sole in Baltic Sea - 110 mm. Minimum landing size for brill are 30 cm, for plaice 25cm in the Baltic Sea. Minimum landing size is not applied for handheld gears (used by recreational fishers).

Poland

All management actions are those implemented by EU

Latvia

No information

Denmark

No information

Finland

No information

Estonia

No information

8.4 Changes in flatfish fishery regulations in 2011.

New regulations in 2011 will take place for flatfish fishery in the Baltic Sea.

Common regulation in the Baltic Sea was changed and since 1 Januray 2011 new

REGULATION (EU) amending Council Regulation (EC) No 2187/2005 as regards the prohibition of highgrading and restrictions on fishing for flounder and turbot in the Baltic Sea, the Belts and the Sound.

Restrictions on fishing for flounder and turbot

1) The retention on board of the following species of fish, which are caught within the geographical areas and during the periods mentioned below, shall be prohibited:

SPECIES	GEOGRAPHICAL AREA	PERIOD
Flounder	Subdivisions 26, 27, 28 and 29 south of 59°30′N	15 February to 15 May
	Subdivision 32	15 February to 31 May
Turbot	Subdivisions 25, 26 and 28 south of 56°50′N	1 June to 31 July

2) By way of derogation from paragraph 1, when fishing with trawls, Danish seines or similar gears with a mesh size equal to or greater than 105 mm or with gillnets, entangling nets or trammel nets with a mesh size equal to or greater than 100 mm, by-catches of flounder and turbot may be retained on board and landed within a limit of 10% by live weight of the total catch retained on board and landed during the periods of prohibition referred to in paragraph 1.".

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Annex 1: List of participants

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Annex 2: Agenda

Agenda of ICES/HELCOM Workshop on Flatfish in the Baltic Sea WKFLABA

Öregrund (Sweden), 8-11 November 2010

Monday 8 Nov.

PM

Introduction

Population structure

- Plaice, Dab and Brill
- Turbot
- Flounder

Tuesday 9 Nov

AM

Population structure (summary)

Data availability

- Presentations
- Discussion

PM

Data availability

- Data availability checking by species, by country

Flatfish management actions

- Presentations
- Discussion

Wednesday 10 Nov.

AM

Data availability (summary)

Flatfish stock assessments

- Presentation of methods
- Preliminary results
- Discussion of approaches to be applied

PM

Flatfish stock assessment

- Performing assessments – work in subgroups

Thursday 11 Nov

AM

Flatfish stock assessment

Presentation of results

Discussion

PM

Conclusion

Recommendations

Annex 3: WKFLABA terms of reference for the next meeting

The ICES/HELCOM Workshop on Flatfish in the Baltic Sea

[WKFLABA] (Chaired by Jan Horbowy, Poland, Ann-Britt Florin and Didzis Ustups, Sweden) will meet in Gdynia, Poland in the end 2011 – beginning 2012:

a) Update on knowledge of flatfish population structure in Baltic Sea

b) Evaluation of age reading data aged with improved methodology

c) Investigation of the effects of age reading method on the assessment of flatfish stocks

d) Flatfish maturity data

e) Trial stock assessment of flatfish populations in the Baltic Sea

WKFLABA will report by ….. to the attention of the XXXXX Committee.

Supporting Information

Priority:	
Scientific justification and relation to action plan:	
Resource requirements:	
Participants:	The Group is normally attended by some 15-20 members and guests.
Secretariat facilities:	None.
Financial:	No financial implications.
Linkages to advisory committees:	
Linkages to other committees or groups:	There is a very close working relationship with the Baltic Fisheries Assessment Working Group.
Linkages to other organizations:	The work of this group is relatad with HELCOM activities.

Annex 4: Recommendations

Recommendation	For follow up by:
1. Workshop recommend for ageing of flatfish using sliced and stained otoliths. For institutions lacking the appropriate equipment, broken and burned method was recommended.	Research institutes
2. It is recommended to collect more biological and genetic information to fill the gaps in knowledge about population structure (especially for flounder and turbot in coastal regions, as well as brill in Baltic Sea)	Research institutes
3. The interactions between coastal and deepsea spawning flounder merits further investigations since these stocks mix during fishing season	Research institutes
4. Suggested biological populations should be used in future assessment if possible. The information on population structure should also be forwarded to the WGBFAS.	WGBFAS
3. It is not recommended to perform classical age based stock assessment for flatfish stock in Baltic Sea in WGBFAS 2011	WGBFAS
4. It is recommended to apply turbot fishing ban during spawning for whole South Baltic Sea (including ICES SD 24)	