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Stock Annex: Cod (*Gadus morhua*) in Subdivisions 22–24 (Western Baltic Sea)

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Cod (*Gadus morhua*) in Subdivisions 22–24 (Western Baltic Sea)
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A. General

A.1. Stock definition

The distribution area of Western Baltic cod biological population is the ICES Subdivisions 22-23 and partly SD 24. Subdivision 23 was included in the Western Baltic stock in 1997 and it is the Sound between Denmark and Sweden bordering Kattegat.

Cod in the Baltic Sea have been managed as one stock until 2002. Since 2003, the management is based on two stock units, Western Baltic Cod (ICES SD 22 -24) and Eastern Baltic Cod (ICES SD 25 – 32). The individual cod was previously assigned to its stock of origin, Western or Eastern Baltic stock, only according to the area where they were caught and independently of its biological origin. There is ample evidence supporting the difference between the two populations, based on taggings (Berner, 1967, 1974; Bagge, 1969; Otterlind, 1985; Berner and Borrmann, 1985), phenotypic differences (Birjukov, 1969; Berner and Vaske, 1985; Müller, 2002) and genetics (Nielsen et al., 2003; Nielsen et al., 2005). However, the tagging programs also documented that eastern and western Baltic cod stocks co-occur in the Arkona Basin (SD 24) (Aro, 1989; Nielsen et al., 2013). Also, qualitative evidence of occurrence of juvenile cod in the Bornholm Sea, but spawned in the western Baltic Sea, is given by a study based on the microstructure analyses of otoliths (Oeberst and Böttcher 1998). Different studies suggest that migration towards their natal areas takes place when the development of sexual products starts (Müller, 2002; Bleil and Oeberst 2002).

In recent years, the abundance of adult cod in SD 24 has rapidly increased, and genetic analyses of 2011 data revealed that a large part of the cod found in SD 24 is genetically eastern Baltic cod (Eero et al. 2014). This was confirmed by otolith shape analyses (ICES 2015a) and new genetic analyses of both juveniles and adults from 2014 (Hemmer-Hansen et al. unpublished). The presence of eastern cod in SD 24 has resulted in large spatial differences in cod abundance and biological parameters in the western Baltic management unit, i.e. between SD 22 and SD24 (Eero et al. 2014). This poses a number of challenges for fisheries management, related to potential depletion of the true western Baltic cod population, and misinterpretation of exploitation status of the cod found in this area (Eero et al. 2014).

WKSIBCA (ICES 2014) decided that splitting the assessment input data according to the proportions of eastern and western Baltic cod found in SD 24 would be appropriate. This was based on the assumption that, given the evidence available, the present assignment of cod according the area of capture is obviously biased. The splitting approach was implemented at WKBALTCOD in 2015 and the assessment should be conducted for a biological population of the western Baltic cod (SD 22-23 plus a fraction of the cod found in SD 24), in contrast to previous assessments in former years which have been conducted for a geographical area (SD 22-24).

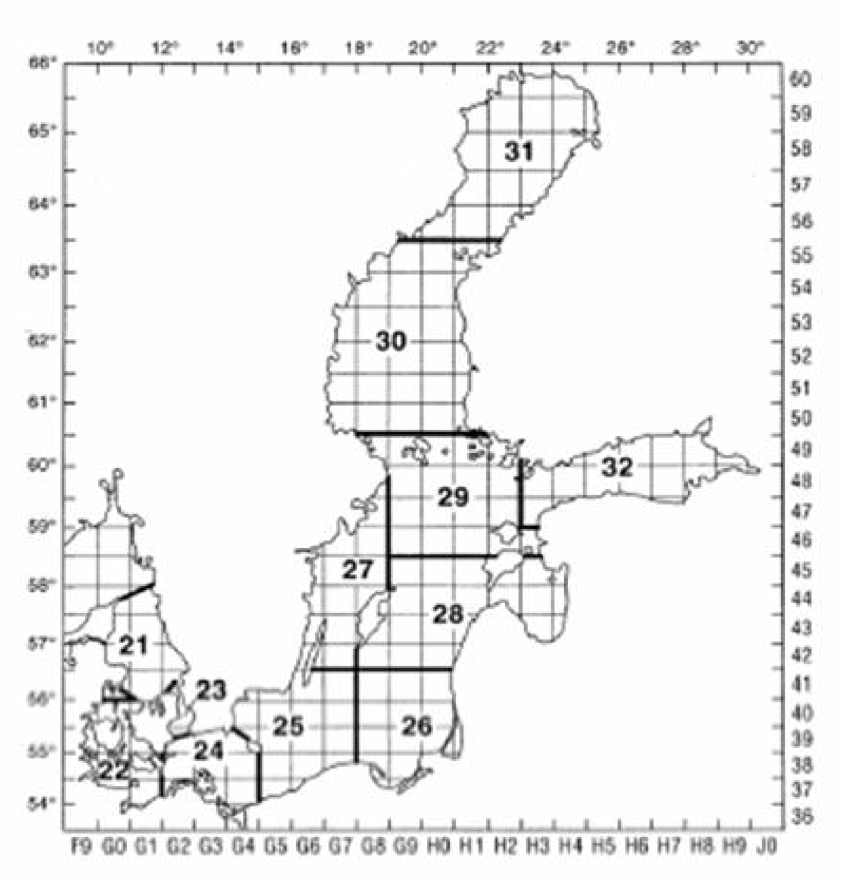

Fig. A1. Map of Subdivisions (SDs) in the Baltic Sea.

1.1.1 Spawning

The reproductive cycle starts at the end of October / beginning of November. The period until beginning of spawning takes about 4 months (Bleil and Oeberst, 1997). The minimum length of maturation in the Kiel Bight between 1992 and 1999 was 22 and 28 cm for males and females, respectively and varied slightly in the Mecklenburg Bight (male: 23 cm, female: 24 cm) and in the Arkona Sea (male: 21 cm, female: 23 cm) (Bleil and Oeberst, 2002). The spawning period is from end of February to beginning of June; main spawning season March to April (Poulsen, 1931; Strodmann, 1918; Kändler, 1944; Berner, 1960; Bagge et al, 1994). Male cod reach maturity stage “spent” earlier than females and stay longer in the spawning area. Larger cod start earlier and continue the spawning activities for a longer period than smaller cod (Bleil and Oeberst, 1997). The spawning area is considered to be the deepest parts of the Danish Belt Sea, deepest parts of the Kiel Bight, of the Fehmarn Belt and of the Mecklenburg Bight (deeper than 20 m) and, but with lower importance, the deepest parts of the Arkona Sea (deeper than 40 m) (Bleil and Oeberst, 2002). Salinity > 15 psu is required for the fertilization and more than 20 psu to ensure buoyancy of eggs (Westernhagen, 1970; Nissling and Westin, 1997).

A.2. Commercial fishery

Cod catches in the Western Baltic are taken mainly by trawlers, gillnetters and to a smaller degree Danish Seiners in Sub-divisions 22-24.

In 1932 a trawling ban was implemented in Sub-division 23 (The Sound), due to the heavy shipping activity. The ban was not implemented in a minor area "Kilen" adjacent to Kattegat (SD 21). Gillnetters land half of the commercial catch in this SD, however in "Kilen" mainly trawlers have taken the landings. Catches in SD 22-24 are predominantly Danish, German and Swedish, with smaller amounts occasionally reported by other Baltic coastal countries.

1.1.2 Fishery regulations

Besides the TAC regulation, fishing effort in the western Baltic is regulated by the number of fishing days, which according to the management plan, should be reduced by 10% each year, until F target is reached. The fisheries in SD 22-24 are seasonally closed from 1st -30th of April; however, vessels <12m are allowed to catch cod for 5 days at sea per month during the closure period.

A BACOMA codend with a 120-mm mesh was introduced by IBSFC in 2001 in parallel to an increase in diamond mesh size to 130 mm in traditional codends. In October 2003 the regulation was changed to a 110-mm BACOMA exit window or a T90 codend (in which the mesh in the codend and extension piece is turned by 90°). These were expected to enhance the compliance by the fishing industry and to be in better accordance with the minimum landing size, which was changed from 35 to 38 cm in the same year. There is no clear evidence of a difference in the selectivity between the two gears. Implementation of the BACOMA window in Estonia, Lithuania and Poland was made in May 2004. In 2010 the BACOMA 120 mm was re-introduced in the Western Baltic.

In 2009 Denmark and Sweden agreed on a cod fishing ban in the northern part of the Sound in February and March. The area and seasonal closures do not apply for recreational fisheries. The minimum landings size regulation applies both for commercial and recreational fisheries.

Recreational catch (from Germany) is taken into account in the assessment. In Germany, the recreational fishing is under the jurisdiction of the federal states. Although recreational fishing licenses (does not distinguish between freshwater or saltwater fishing) are obligatory for fishing in the Baltic Sea, only the state of Mecklenburg-Western Pomerania (MV) demands a coastal fishing permit for the Baltic Sea allowing the estimation of anglers. There are no seasonal or spatial closures regulating the marine recreational fishery for cod, however the legal minimum landing size for cod is 38 cm.

Since 2015, a discard ban is in place, obliging the fisheries to land the entire catch of cod, with a "conservation reference size" of ≥35 cm (for commercial use) and a "Below minimum landing size" (BMS) of <35 cm.

1.1.3 Changes in fleet dynamics

Historically around half (but in some years up to 80%) of the total cod landings has been caught in the first quarter of the year, 2nd and 3rd quarter only accounting for 25% of the total landings. Furthermore, a very large part of the trips where cod is landed has more than 30% cod in the landings compared to the total catch weight. This indicates that cod in the Western Baltic is mainly fished in a directed cod fishery and to a lesser degree caught as by-catch in other fisheries. Small vessels are important in the Western Baltic area, e.g. more than 60% of the Danish fleet operating in the Western Baltic are below 15 meters. Subdivision 22 is mainly fished in 1st quarter indicating a direct spawning fishery, while SD 24 is also fished for cod in the rest of the year.

1.1.4 Effort

Effort limitations for the Baltic Sea cod fisheries were included in the 2006 TAC regulation (EC No. 52/2006). The intention was to reduce the allowed days at sea by 10% each year until the cod stocks were within safe biological limits. Effort was primarily limited by seasons closed for fishery. The main closed season was included in the regulation but member states (MS) were also given a number of days of closure to implement when suitable in the national fisheries. For Western Baltic cod, fisheries were prohibited between March 15th to May 14th with an additional 30 days of closure to be allocated individually by the Member States (MS). In 2007 three closed seasons January 1st to 7th, March 31st to May 1st and December 31st were included in the TAC regulation (EC No. 1941/2006) and MS were given an extra 77 days to allocate individually. In 2008 the management plan for the Baltic Sea cod (EC No. 1098/2007) was introduced and the effort limitation scheme changed. The closed season in the western Baltic was restrict-ed from April 1st to April 30th. Rules for how the number of allowed fishing days change from year to year are coupled to fishing mortality and the F targets in the man-agement plan.

1.1.5 National regulations

In 2009 a fishing ban from 1/2 -31/3 was implemented in the Northern part of SD 23 (The Sound) to protect the Kattegat cod, by reducing F. As a consequence the large cod catches in "Kilen" SD 23 have been reduced in the 1st quarter accompanied by a 50% decrease in total catches in SD 23 compared to the time period 2002-2008, before the closure.

On 1 January 2007 a new individual right-based regulation system was introduced in Denmark. Before this time quotas were split into 14-days rations, which were continuously adjusted to the amount of quota left, particularly around the end of the year. In 2007 this system was changed to a rather complex rights-based system (FKA - Vessel Quota Share), whereby fishermen are allocated a yearly share of the quota, and can subsequently trade it, exchange it or pool it with other fishermen. They are still subject to usual EU-regulations such as closed seasons and fishing days.

A.3. Ecosystem aspects

The oceanographic conditions in the Baltic are very much driven by meteorological forcing, influencing the inflow of sea water from the Kattegat into the Baltic Sea. Significant correlations have been demonstrated between the NAO and total fresh-water runoff, westerly winds, and salinity (Häninnen et al., 2000), ice conditions (Koslowski and Loewe, 1994) and local circulation and upwelling (Lehmann et al., 2002). Climate variability has been shown to affect the dynamics of many of the components of the Baltic ecosystem.

The species composition of the phytoplankton depends on local nutrients and salinity and changes gradually from the southwestern Baltic to the northeastern Baltic. Primary production exhibits large seasonal and inter annual variability. Normally, an intense spring bloom starts in March in the western Baltic. In the southern and western parts of the Baltic, diatoms dominate the spring bloom. Over the period from 1979 to 1999 downward trends were found for diatoms in spring and summer, whereas dinoflagellates generally increased in the Baltic proper, but decreased in the Kattegat.

Mass occurrences of blue-green algae are often made up of several species. Since 1992 the relative abundance of the most common species has shown a clear increasing trend in the Arkona Basin in the western Baltic.

The zooplankton community and species composition is influenced by the salinity gradient. Generally marine species (e.g. Pseudocalanus spp.) prevail in the western Baltic because of higher salinity than in the eastern areas. Changes in the species composition of the zooplankton have been linked directly to changes in salinity and temperature.

The composition of the benthos depends both on the sediment type and salinity, with suspension-feeding mussels being important on hard substrate while deposit feeders and burrowing forms dominate on soft bottoms. The species richness of the zoobenthos is generally poor and declines from the southwest towards the north in the Baltic Sea due to the decrease in salinity.

The distribution of the roughly 100 fish species inhabiting the western Baltic is largely governed by salinity. Marine species dominate in the western Baltic, while fresh-water species occur near river mouths and in lower salinity fjords and lagoons (Hempel and Nellen 1974). In the western Baltic, cod, herring, and sprat constitute the large majority of the fish community in both biomass and numbers. In the western Baltic cod is the main predator on herring and sprat, and there is also some cannibalism on small cod as in the eastern Baltic (Köster et al., 2003). Predation on cod eggs by sprat and herring has been described in the southern Baltic and especially for the Bornholm Basin. This interaction also occurs in the western Baltic in the most important spawning areas. However, cod egg predation by clupeids appears to be less important in the western spawning areas than in the eastern Baltic. This difference has been explained by a limited vertical overlap between predator and prey in these shallower areas (STORE 2003).

B. Data

B.1. Stock separation in SD 24

Time series of estimated proportions of eastern and western Baltic cod within SD 24 are available from 1996 onwards from otolith shape analyses, using genetically validated baselines (ICES 2015a). Data for population splitting is not available for all years in the time series; the extrapolations and assumptions made for years for which these data were missing are described in detail in ICES 2015a. Systematic differences in the pro-portion of mixing were found by sub-areas within SD 24, with a higher proportion of eastern cod closer to SD 25. The proportions of mixing in the easternmost rectangles in SD 24 and those in the middle of SD 24 were relatively similar (covering the Arkona basin). Thus, the proportions of eastern and western cod in SD 24 were estimated separately for 2 sub-areas, marked as Area 1 (Darss sill and entrance of SD 23) and Area 2 (Arkona basin) in Fig. 1.

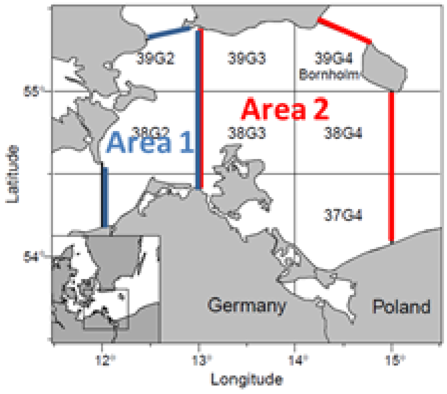

Figure 1. Map of SD 24 (mixing area of western and eastern cod) and sub areas (Area1 and Area 2) for which separate mixing proportions were estimated.

B.1. Catch

National commercial landings and estimates of catch composition in numbers and weights at age data by Subdivision are available from sampling programs back to 1970. Since the mid-1990s national landing information has been provided by quarter, Subdivision and gear (active gear and passive gear) and documented in the WG re-ports. Due to lack of information to distinguish between eastern and western cod popu-lation in SD 24 before mid-1990s, the assessment is currently only using data from 1994 onwards.

1.1.6 Commercial landings

CANUM, WECA and CATON for landings at a national level are compiled by the national institutes. Data are in this stage nationally aggregated to quarter, sub-division and gear type (active and passive gear) even though the sampling in each country often is stratified on several fisheries (metiers). Not all landings strata have matching biological information (age from otoliths and length measurements) and biological information must therefore be extrapolated from other strata, e.g. Sub-divisions or quarters. On the national level, data extrapolations of biological data for the strata where sampling is missing are only done in caseswhere biological information from other countries are not relevant. If biological information from other countries is relevant, only total landings in tonnes are given (i.e. no extrapolations are done nationally). The national data are submitted to the data coordinator and compiled. The remaining extrapolations of age distributions and mean weight at age are made by applying the compiled data based on the countries that have performed sampling in the strata. All data extrapolations are recorded for later documentation (since 2012 in InterCatch).

Total landings in SD 24 were adjusted to include only those representing the WB cod population. To do this, weighted average of the proportions of WB cod in SD 24 in the 2 sub-areas (Area 1 and Area 2 in Fig. 1) was applied. The weightings represented relative proportions of Danish and German (main part of fisheries in SD 24) commercial cod landings taken in Areas 1 and 2, respectively. Landings at age for the entire western cod population (i.e. including landings in SD 24) were obtained by upscaling the landings at age in SD 22 by the ratio of landings of WB cod (SD 22+24) taken in SD 24 Landings at age in SD 23 were subsequently added, to get the landings at age of WB population for SD 22-24.

1.1.7 Discard in commercial fisheries

The amounts of cod discarded by the fishers are estimated based on data collected by scientific observers onboard commercial fishing vessels from 1996 onwards. All relevant biological information concerning discards is recorded by observers. . Landing patterns have been compared from trips with and without observers onboard to see if there is an indication of changed behaviour when observers are on board.

The stratification is the same as for the landings and the discards are raised by the landings. In strata with landings but where no data on biological information exists on discard, data from other strata are used.

The following priorities were used when extrapolating the available biological information:

1) Same country, same quarter, adjacent Subdivision.

2) Same quarter, same Subdivision, another country.

3) Another country, same quarter, adjacent Subdivision

The assessment for biological western Baltic cod population includes discards esti-mates from SD 22-23. For the fraction of SD 24 landings that are included in the as-sessment, discards are assumed to be a similar proportion of total commercial catch as in SD 22. The commercial catch at age for SD 22 (landings plus discards) was upscaled by the ratio of landings of WB cod (SD 22+24) taken in SD 24 and the catch is SD 23 are added, to obtain total commercial catch at age for the western cod population.

1.1.9 Recreational catch

Due to the large impact of the marine recreational fishery, it was decided (WKBALT ; ICES, 2013) to use recreational fisheries data in the assessment of the western Baltic cod. The longest available time series of recreational fisheries including biological data is from Germany. Therefore, only German recreational data is currently included in the assessment, whereas Danish and Swedish data are recommended to be included as well in the future.

The German marine recreational data collection program follows a multiannual multistage survey design (for further information see Strehlow et al., 2012). An off-site survey (mail-diary) is used to estimate effort. On-site, a stratified random sample of access points and days is used to estimate catch rates (cpue). Length distributions of recreational catches are collected by onboard measurements of charter vessel trips. Other data sources were self-reported length samples from fishing events. Commercial/BITS length-weight relationships and age-length keys and were used for conversion of recre-ational catch numbers to biomass and length at age.

The German marine recreational fisheries data are grouped into sea-based (boat angling, charter boat angling, trolling) and land-based (shore angling, wading) fishing modes. Data are collected on quarterly basis and grouped half yearly to reduce variance. Further stratification is by coastal states, Subdivision, harvest and release in numbers.

German marine recreational fisheries data are available from 2005 onwards. Recreational length distributions (SD 22 & 24) are available from 2009 onwards. Releases are also sampled since 2009 in a consistent way. Using these data the average catch from 2005-2011 was used to extrapolate the years 1994 to 2004. To account for the historic development of marine recreational fishing in the former GDR after unification, recreational catches in Mecklenburg Western Pomerania were set at 20% in 1991 with a linear increase until 1995. To convert recreational catches in numbers to CANUM, the recreational length distribution from 2010 is used for the years 1994 to 2008. From 2009 onwards length distribution data from recreational catch is available. The ALK used for conversion are based on BITS data for the years 1994 to 2002 and on commercial sampling data from 2002 onwards.

The amounts of recreational releases (discards) are estimated following two compilations methods:

- Land-based releases are estimated assuming 100% mortality.
- Sea-based releases are estimated applying 15.8% mortality based on a catch and release containment study from 2012 (Weltersbach & Strehlow 2013).

All recreational cod catches taken in SD 22 and 24 by Germany were considered western Baltic cod and included in the assessment. Spatial analysis revealed that recreational catches (charter boat) in SD 24 around the Island of Ruegen were taken close to shore in area 38G3.

B.2. Biological information

1.1.8 Weight information:

- Catch weights are derived from a combination of landings, discards (SD 22-23) and recreational catch (weighted by numbers).
- Weights-at-age in the stock for ages 1-3 are based on Q1 survey data (DATRAS) from SD 22-23. Weights at ages 4-11 in the stock were set equal to the annual weights in catches.

Mean weights at age in recreational catch are derived from commercial WLK. From 2009 onwards mean weights are estimated based on the respective recreational length distribution from each year. The WLK used for conversion are based on German BITS data for the years 1991 to 2002 and on German commercial sampling data from 2003 onwards.

The calculation of mean weight at age from survey based on individual fish sampling data raised with total length frequencies is currently not available from DATRAS. The calculation is currently done by the Danish national lab following the procedure described below:

i) pool the data for a stock area, i.e. SD 22-23

ii) calculate number of fish sampled (for weight) at length (l), by age-class (a), by sex (s) ($S_{l,a,s}$);

iii) calculate the sum of fish sampled at length, by sex ($T_{l,s}$); and the sum of all fish sampled at length (T_l)

iii) calculate total number of fish caught by length (length frequency) (N_l)

iv) calculate mean weight of sampled fish at length, by age, by sex ($W_{l,a,s}$)

Raise the weight of sampled fish with total length frequency as follows:

v) $$X1_{l,a,s} = \frac{S_{l,a,s}}{T_{l,s}} * N_l * \frac{T_{l,s}}{T_l}$$

vi) calculate the sum of $X1_{l,a,s}$ values over length classes within each age-group ($X1_{a,s}$)

vii) $$X2_{l,a,s} = W_{l,a,s} * X1_{l,a,s}$$

viii) Calculate the sum of $X2_{l,a,s}$ values over length within age-group ($X2_{a,s}$)

ix) Calculate mean weight at age (WAA), by sex

$WAA_{a,s}= X2_{a,s}/ X1_{a,s}$

x) use the sex ratio of fish in samples to combine $WAA_{a,s}$ estimates to an estimate of WAA_a (combined weight for female and males)

1.1.9 Maturity information:

Spawning probability is used instead of proportion mature, to account fact that all fish that are mature may not contribute to spawning. Only data from SD 22-23 for Q1 were included in spawning probability calculation. Due to very few sampled fish at age 5 and older, spawning probability for these age-groups was set to 1.

To avoid large fluctuation in maturity index between the years, running mean over 3 years is applied.

The calculation of the maturity index is currently done by the Danish national lab, based on individual fish samples, raised with total length frequencies as described below:

i) Maturity categories: Spawner (stages 2,3,4,6,62,63,64,"III","IV","V","VI") and non-spawner (stages 1,5,65,66,"I","II","VII","VIII","IX","X");

ii) calculate the number of sampled fish in given maturity categories (e.g. mature (mat) and immature (immat)) at length, by age and (Smat,l,a,s).

iii) calculate total number of fish caught by length (length frequency) (Nl)

iv) calculate the sum of fish sampled at length, by sex (Tl,s); and the sum of all fish sampled at length (Tl)

Raise the sampled maturities with total length frequency in the following steps:

v) $$X_{mat,l,a,s} = \frac{S_{mat,l,a,s}}{T_{l,s}} * \frac{T_{l,s}}{T_l} * N_l$$

$$X_{immat,l,a,s} = \frac{S_{immat,l,a,s}}{T_{l,s}} * \frac{T_{l,s}}{T_l} * N_l$$

vi) calculate the sum of X mat,l,a,s and X immat,l,a,s values over length classes within age groups and maturity classes, by sex (X mat,a,s; X immat,a,s)

vii) calculate proportion mature by age, by sex

$$M_{a,s} = \frac{X_{mat,a,s}}{X_{immat,a,s} + X_{mat,a,s}}$$

viii) use the sex ratio of fish in samples to combine $M_{a,s}$ estimates to an estimate of M_a (combined weight for female and males).

B.3. Surveys

BITS 1st and 4th quarter surveys are available for the Western Baltic cod stock. The surveys are conducted with two vessels, the Danish “Havfisken” and the German “Solea”.

The surveys are coordinated by the ICES working group “Baltic International Fish Survey” (WGBIFS) and have been coordinated and designed in a similar way since 2001.

The data from the two vessels are combined into one cpue time series per quarter.

Danish ‘Havfisken’ surveys in SD 22-23 in 1st and 4th quarter.

The Danish survey is conducted twice a year in The Sound (SD 23) and Western Baltic (SD 22) and to a smaller degree in SD 24, in March and November by “Havfisken” from DTU Aqua. The Danish survey is part of the BITS, and designed to provide annual abundance indices for cod, plaice and sole. The trawl is a standard TV3-520 with rubber discs of 10-cm diameter on the ground rope and with a trawl speed of 3 knots. The time series starts in 1995 for the first quarter and in 1994 for the fourth quarter. The spa-tial coverage has changed over time; in the period 1994-2000 the survey covered SD 23 and 22 down to Mecklenburg Bay, in 2001 the survey covered SD 23 and 22 to the Kiel Bay and since 2004 the survey has covered SD 23 and from Little Belt and Great Belt to the Northern part of SD 22 (Figure B3.1).

German “Solea” survey in SD22-24, 1st and 4th quarter.

The Bottom trawl Surveys have been carried out by the German RV Solea since 1992. The surveys covered the southern part of SD 22 (Kiel Bight and Mecklenburger Bight) and the Arkona Sea.

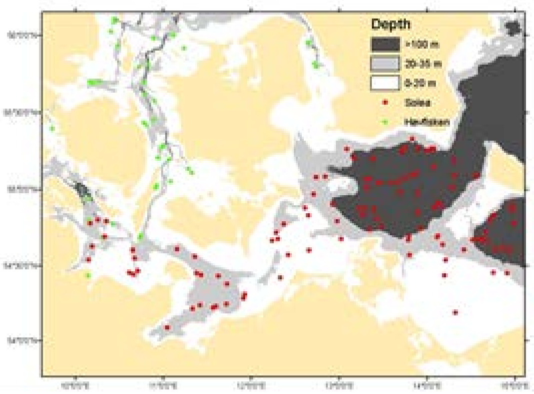

Figure B3.1. Example of area distribution of the two surveys Solea and Havfisken in both quar-ters.

<u>Calculation of survey indices</u>

Survey indices are calculated using a model-based approach, following the methodology described in Berg and Kristensen (2012). The indices are calculated for SD 22-23 and including the westernmost part of SD 24 (until 13 degrees line). The indices start from 2001 when the survey gear and design were standardized. In earlier years, different gears were used with too little overlap to be able to account for gear differences in the model. The Figures below (Figure B.3.2. and B.3.3.) show the average spatial distribution of cod in the years used in survey indices. The model includes the effects of latitude/longitude, ship, time of the day and haul duration. The model is fitted separately for Q1 and Q4

$$g(\_i) = Year(i) + f_1(lon_i;\ lat_i) + U(i)_{ship} + f_3(time_i) + \log(HaulDur_i)$$

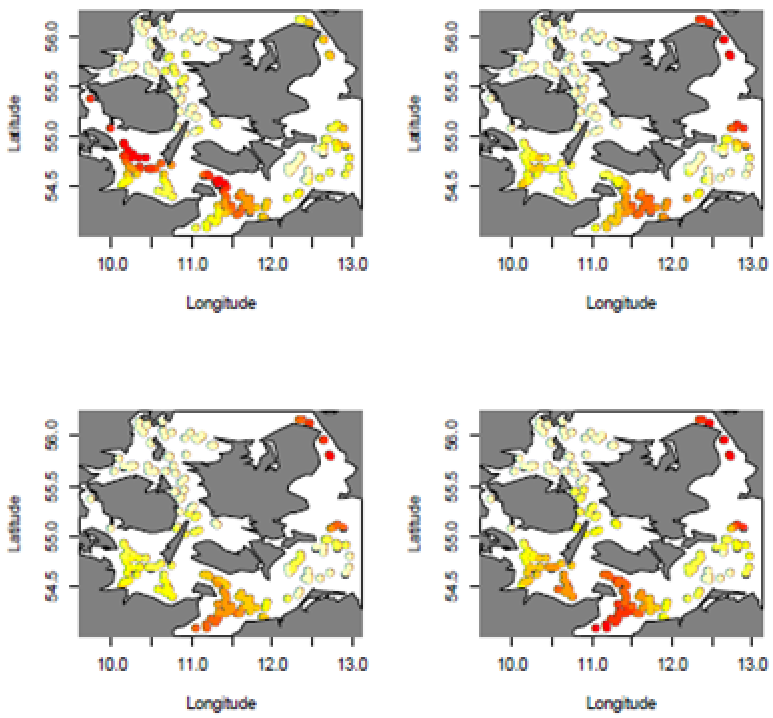

Figure B. 3.2. Distribution map for ages 1 (top left), 2 (top right), 3 (bottom left), and 4 (bottom right) in Q1 (2001-2014).

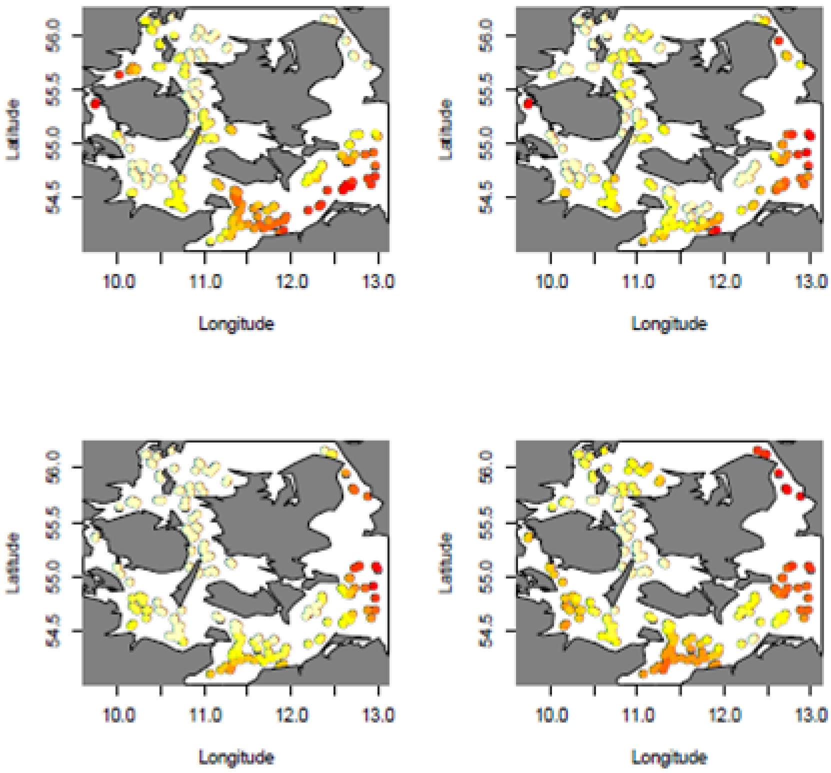

Figure B 3.3. Distribution map for ages 1 (top left), 2 (top right), 3 (bottom left), and 4 (bottom right) in Q4 (2001-2014).

B.5. Other relevant data

VMS data are available for the Danish fleet since 2005. The VMS signal is transmitted once per hour for vessels above 12 meters and is combined with the Danish logbooks, thereby providing the gear used.

German VMS data are available for vessels >15m since the beginning of the recording and for vessels >12 m since 2012 . This almost exclusively covers tracks of trawlers.

C. Model settings

Model used: SAM. The State-Space Assessment Model (Nielsen and Berg 2014). This model was run using the web interface that can be viewed at www.stockassessment.org.

Configuration of the model is specified below:

Min Age (should not be modified unless data is modified accordingly)

0

Max Age (should not be modified unless data is modified accordingly)

7

Max Age considered a plus group (0=No, 1=Yes)

1

```
# The following matrix describes the coupling of fishing mortality STATES
# Rows represent fleets.
# Columns represent ages.
0	1	2	3	4	5	5	5
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
 # Use correlated random walks for the fishing mortalities
# ( 0 = independent, 1 = correlation estimated, 2-AR correlation)
2
# Coupling of catchability PARAMETERS
0	0	0	0	0	0	0	0
1	2	3	4	4	0	0	0
0	5	6	7	7	0	0	0
 # Coupling of power law model EXPONENTS (if used)
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
 # Coupling of fishing mortality RW VARIANCES
0	1	1	1	1	1	1	1
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
 # Coupling of log N RW VARIANCES
1	2	2	2	2	2	2	2
# Coupling of OBSERVATION VARIANCES
0	1	2	2	2	2	2	2
3	4	5	6	6	0	0	0
0	7	8	9	9	0	0	0
 # Stock recruitment model code (0=RW, 1=Ricker, 2=BH, ... more in time)
0
# Years in which catch data are to be scaled by an estimated parameter
0
# first the number of years
# Then the actual years
# Them the model config lines years cols ages
# Define Fbar range
3	5
```

Input data types and characteristics:

Type	Name	Year range	Available Age range	Used Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1994-last data year	1+	1+	Yes
Canum	Catch at age in numbers (landings, dicards, recreational catch)	1994-last data year	1-10+	1-7	Yes
Weca	Weight at age in catch	1994-last data year	1-10+	1-7	Yes
West	Weight at age in the stock.	1994-last data year	1-10+	0-7	Yes
Mprop	Proportion of natural mortality before spawning	1994-last data year	1-10+	1-7	No - set to 0 for all ages and all years
Fprop	Proportion of fishing mortality before spawning	1994-last data year	1-10+	1-7	No - set to 0 for all ages and all years
Matprop	Spawning probability	1994-last data year	1-7	1-7	Yes
Natmor	Natural mortality	1994-last data year	0-10+	0-7	No

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	BITS 1st quarter	2001-present	AG 1-4
Tuning fleet 2	BITS 4th quarter	2001- present	AG 0-4

D. Short-Term Projection

Short term forecast is based on the SAM short-term forecast module output. Selected scenarios will be simulated forward in time starting from estimates from the last data year. The forward simulations carry alongthe estimated uncertainties and correlations to the projections of calculated quantities (TAC, SSB, Fbar).

The standard settings for short-term projection should be based on the following general rules:

Model to be used: SAM age structured prediction module

Initial stock size: Final year estimates from SAM.

Recruitment estimates: For final year class and onwards - sampled from the recent 10 years.

Natural mortality is 0.2 for all ages except age 0 with 0.8 and age 1 with 0.242.

Other necessary future values of natural mortality, stock weights, catch weights and proportions mature, and selection at age will be calculated as averages of data values in the most recent three years.

E. Medium-Term Projections

Not considered appropriate for this stock.

F. Long-Term Projections

Not considered appropriate for this stock.

G. Biological Reference Points

WKBALTCOD (ICES, 2015a) recommended Blim at 27.4 kt. This is based on the Hockey-stick break point in stock recruitment relationship, using revised SSB an R data from WKBALTCOD 2015. Following the ICES standard the Bpa is then Blim * 1.4 = 38.4 kt.

Fmsy was suggested to be 0.26 (range low-high without advice rule; 0.15-0.45) based on stock – recruitment simulations for the whole year range (1994-2014) and weight at age, maturity and natural mortality from an average of the years 2004-2013 (WKBALTCOD, ICES, 2015a, 2015b).

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