Stock Annex: Sprat (*Sprattus sprattus*) in Division 3.a (Skagerrak and Kattegat)

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Sprat
Working Group:	Herring Assessment Working Group for the Area South of 62ºN (HAWG)
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A. General

A.1. Stock definition

Sprat distributed in ICES area 3.a is managed as one stock unit. Analyses of genetic population structure of European sprat (*Sprattus sprattus*) indicate a genetic differentiation in samples of sprat from Kattegat compared to adjacent areas (North Sea and the Baltic) (Limborg *et al* 2009, 2012). This genetic differentiation mirrors the gradient in mean surface salinity. This work is based on neutral markers, which are relatively insensitive. The genetic differentiation of sprat in Skagerrak and in the Swedish and Norwegian fjords on the coasts of Skagerrak, have not been thoroughly studied, even though Glover *et al.* (2011) indicates that sprat from the Oslo fjord differ from North Sea sprat. Further research on this issue is required.

A.2. Fishery

Sprat in 3.a are exploited by fleets from Denmark, Norway and Sweden. The Danish sprat fishery consists of trawlers using a < 16 mm mesh size and the landings are used for fishmeal and oil production. Some of the sprat landings from Denmark and Sweden are bycatches in the herring fishery using 16 mm mesh-size cod ends. The sprat fishery in Sweden can be dated back to the 1910s, and it was initially carried on exclusively in inshore waters. An important change took place in 1929 when the purse seine was used for the first time for taking sprat off the Swedish west coast (Southern Bohuslän). But when trawling began in earliest 1933, open sea fishing increased in importance especially with the introduction of the floating trawl.

Today sprat in 3.a for human consumption is caught with fine-mesh purse seines and ring nets mainly during autumn and winter in the Skagerrak. Fisheries take place throughout the year using ring nets, mid-water trawls and bottom trawls.

The Norwegian sprat fishery in Division 3.a is a traditional inshore purse seine fishery (vessels < 28 m) for human consumption. The Norwegian sprat fishery is seasonal, taking place from 1 August and onwards, and sprat is protected from 1 January to 31 July.

The majority of the landings are generally made by the Danish fleet. In 1997 a mixed-clupeoid fishery management regime was changed to a new agreement between the EU and Norway that resulted in a TAC for sprat as well as a bycatch ceiling for herring.

Catches are taken in all quarters, though usually with lower catches in the second quarter. Denmark has a total ban on the sprat fishery in Division 3.a from May to September. Norway has a general ban on the coastal sprat fishery from 1 January to 31 July.

There was a considerable increase in landings from about 10,000 t in 1993 to a peak of 96,000 t in 1994. However, the data prior to 1996 are considered less reliable due to the implementation of the new improved Danish monitoring scheme in 1996. From 1996 the landings have varied between 9,000 t (2008) and 40,000t (2005).

A.3. Ecosystem aspects

In the North Sea, sprat is an important part of the diet of numerous species, including demersal fish, zooplankton seabirds and other predators (marine mammals and elasmobranchs). The major natural sources of sprat removals in the North Sea include whiting, mackerel, horse mackerel and seabirds.

It is considered that there are fewer predator populations in 3.a than in the North Sea. For an analytical assessment it is not possible to include annual estimates of sprat consumption by predators as done for the North Sea stock, but it is possible to estimate average predation consumption.

A major source of uncertainty with 3.a sprats is the extent to which these fish derive from migrations of fish from the North Sea stock into 3.a. This question should be a priority for future investigations.

B. Data

B.1. Commercial catch

Commercial catch data are submitted to ICES from the nations exploiting sprat in Division 3.a. The sampling intensity for biological samples, i.e., age and weight-at-age is mainly performed following the EU regulation 1639/2001 as Denmark and Sweden, landing most of the catches, follows this regulation. This provision requires 1 sample per 2000 tonnes landed.

The majority of commercial catch and sampling data are submitted in the Exchange sheet. Data are also uploaded to Intercatch, which is maintained by ICES. Intercatch is still in development and is not completely satisfactory in terms of flexibility and outputs. Thus HAWG still request the Excel sheet, e.g. for getting the catch distribution by square.

The stock co-ordinator allocates samples of catch numbers, mean length and mean weight-at-age to unsampled catches using appropriate samples by gear (fleet), area and quarter. If an exact match is not available then a neighbouring area with 3.a in the same quarter is used. If this also proves insufficient, data from the same half year is used.

B.2. Biological

Mean-weight-at-age for all ages is in the range seen the last years. Mean weights-at-age for 1996-2003 are presented in ICES (2005).

No estimation of natural mortality is made for this stock.

B.3. Surveys

Three surveys cover this stock. The International Bottom Trawl Surveys (IBTS) cover the stock in Div. 3.a in the first and third quarter of the year. Additionally, the herring acoustic survey (HERAS) covers the same area during June-July.

The appropriateness and suitability of these surveys for use in the assessment of the 3.a sprat stock, was examined by the WKSPRAT in 2013.

B.3.1. International Bottom Trawl Survey (IBTS)

The International Bottom Trawl Surveys started as an international coordinated survey in the mid-1960s directed towards juvenile herring. The gear used was standardised in 1977 to use the GOV trawl, but it took time to be phased in. By 1983 all participating nations were using this gear, and the index can be considered consistent from this point onwards. A third-quarter North Sea IBTS survey using the same methodology was started in 1991 and can be considered consistent from its initiation.

B.3.2. Herring Acoustic Survey (HERAS)

The Herring Acoustic Survey is a summer acoustic survey that has been performed as an ICES coordinated survey since the 1980s. Sprat has been reported as a separate target species in this survey from 1996 onwards. The coverage of this survey in Division 3.a has remained relatively unchanged (*e.g.* ICES PGIPS 2009).

Acoustic estimates of sprat have been available from the ICES co-ordinated Herring Acoustic surveys since 1996. In Division 3.a, sprat has mainly been observed in the Kattegat. Estimates of sprat abundance by age are only available from 2006 onwards.

B.4. Commercial CPUE

Not used for this stock.

B.5. Other relevant data

C. Assessment: data and method

No assessment of the sprat stock in Division 3.a has been presented since the mid-1980ies. Various methods have been explored without success (ICES CM 2007/ACFM:11).

D. Short-Term Projection

The stock is assessed by examining trends in IBTSQ3 age 1, IBTSQ1 age 1 and 2 and HERAS age 1. Other ages did not show internal and external consistency. Together, these two ages represent 77% of the landed biomass when used for in-year advice.

WKSPRAT proposed using the IBTS Q1 age 1 as an indicator of the incoming year class and IBTSQ1 age 2, IBTSQ3 age 1 the previous year and HERAS age 1 the previous year as indicators of age 2. These should provide in year advice for 3.a based on the ICES data limited stock approach (Category 3/4 DLS: ICES CM 2012/ACOM 68). Together, this provides an index of the sprat which will be age 1 and 2 in the beginning of July. These two age groups make up 77% of the catch biomass on average.

Method

WKSPRAT identified the useful survey indices for 3.a sprat as

- IBTS Q1 Age 1
- IBTS Q1 Age 2
- IBTS Q3 Age 1
- HERAS Age 1

As there were several indices of approximately equal quality, it was necessary to combine these into a single index. This was performed separately for the two cohorts (the cohorts with 1 and 2 winter rings in quarter 1). The cohort with one winter ring in the last available IBTS Q1 had only one survey index available whereas the cohort with 2 winter rings in the last available IBTS Q1 had three survey indices. To combine these three, all survey indices were expressed in relative deviation from the mean:

$$I = \frac{S_y - \sum_{i=1}^{N} S_i/N}{\sum_{i=1}^{N} S_i/N}$$

Where I is the index of a given age in a given survey, S is the survey catch per unit effort (or total number in the case of acoustic estimates), i are the different survey years and N is the number of years in which the survey is available. Indices of 2 winter ring sprat in quarter 1 were produced as:

$$\bar{I} = \frac{\sum_{j=1}^{M} I_j}{M}$$

Where subscript j denotes the survey (IBTS Q1 age 2 in the given year, IBTS Q3 age 1 in the previous year and HERAS age 1 in the previous year) and M is the number of surveys available (1 to 3 depending on year). A combined index for the two cohorts making up the majority of the catch was the produced as a weighted average of the cohort specific indices. Weights used were the average proportion of the weight of the catch which consisted of the particular age group over the past 3 years. With this method, the weights assigned to the two indices were 0.49 for the 1 winter ring index and 0.52 for the 2 winter ring index. The resulting anomaly index was multiplied by a precautionary buffer of 20% into a catch multiplier CM for the 2014 of:

$$CM_y = \frac{\left(1 + \bar{I}_y\right)}{\left(1 + (\bar{I}_{y-1} + \bar{I}_{y-2} + \bar{I}_{y-3} + \bar{I}_{y-4})/4\right)} * (1 - 0.2)$$

Where y indicates year.

If the index $\bar{I}$ exceeds 0.2 or falls below -0.2, it is replaced by an uncertainty cap of 0.2 and -0.2, respectively, so the minimum and maximum value of CM are 0.64 and 0.96. After 2014, the uncertainty cap has already been applied and the CM for 2015-2016 will be

$$CM = (1 + \bar{I})$$

The catch multiplier is used to estimate next year's TAC as

$$TAC_y = CM\left(C_{y-1} + C_{y-2} + C_{y-3}\right)/3$$

Results

The anomalies in the survey indices are seen in Fig. 9.7.1 and the total index in Fig. 9.7.2. Further, the proportion of all commercial catches (in biomass) consisting of fish with more than 2 winter rings is given in Fig. 9.7.3. Applying the rule stated under methods, the catch multiplier is estimated at 0.64. As the average catch over the last three years is 10 605 t, the TAC using this method will be 6 787 t which is well below the historical minimum of 8 700 t.

An Excel-sheet for doing these calculations can be found under Team Web Site > HAWG 2013 > Report 2013 > Draft Report > Sec 09 Sprat in Division IIIa > Tables.

E. Medium-Term Projections

Not performed

F. Long-Term Projections

Not performed

G. Biological Reference Points

No precautionary reference points are defined for this stock.

H. Other Issues

I. References

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