**6.4.30** **Advice May 2013**

**ECOREGION** **North Sea**

**STOCK** **Sprat in Subarea IV (North Sea)**

**Advice for July 2013 - June 2014**

ICES advises on the basis of the MSY approach that catches of sprat from July 2013 to June 2014 should be no more than 144 000 t. All catches are assumed to be landed.

**Stock status**

| F (Fishing Mortality) | 2010 | 2011 | 2012 | |
|---|---|---|---|---|
| **MSY ($F_{MSY}$)** | ? | ? | ? | Undefined |
| **Precautionary approach ($F_{pa}$,$F_{lim}$)** | ? | ? | ? | Undefined |
| **Qualitative evaluation** | ✓ | ✓ | ✓ | Below provisional $F_{MSY}$ proxy |

| SSB (Spawning Stock Biomass) | 2011 | 2012 | 2013 | |
|---|---|---|---|---|
| **MSY ($B_{trigger}$)** | ? | ? | ? | Undefined |
| **Precautionary approach ($B_{pa}$,$B_{lim}$)** | ✓ | ✓ | ✓ | Full reproductive capacity |

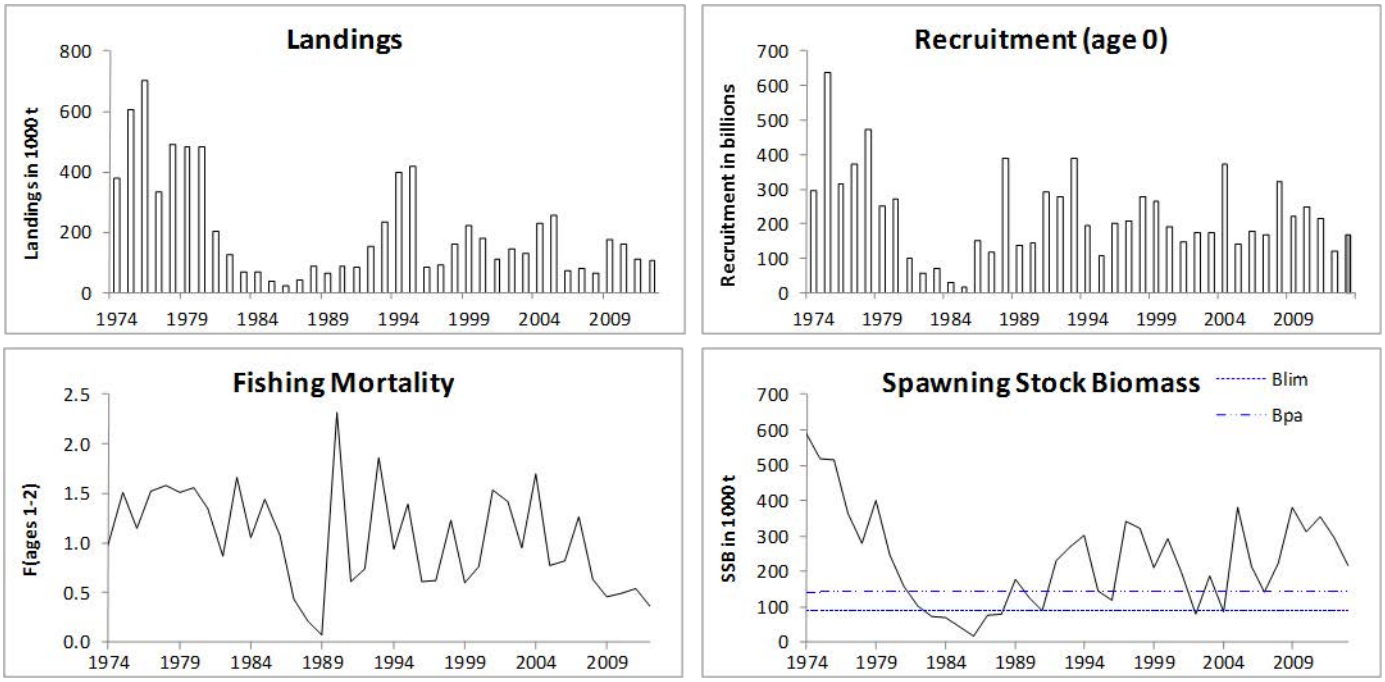


**Figure 6.4.30.1** Sprat in the North Sea. Summary of stock assessment (weights in thousand tonnes). Top right: SSB and F over the years. NB: Years on the x-axes refer to the model years (i.e. 2009 corresponds to the period from July 2009 to June 2010). The plot for F does not show the provisional $F_{MSY}$ proxy, because it varies over time.

The spawning stock has been above $B_{pa}$ since 2005, with the exception of 2007, where SSB was approximately at $B_{pa}$. Fishing mortality shows an overall decreasing trend since 2004. Recruitment appears more stable than is often the case for short-lived species, with recruitment in 2012 estimated to be below average.

**Management plans**

No specific management objectives are known to ICES.

**Biology**

Sprat in the North Sea is short-lived with high natural mortality. The age zero year class is not highly available to the fishery and the catch is dominated by fish of ages 1 and 2.

**Environmental influence on the stock**

The zooplankton community structure that sustains sprat stocks appears to be changing. The implications of the environmental change for sprat are unknown, but no trends in recruitment have been observed in the last years.

**The fisheries**

Sprat in Subarea IV is mainly fished together with juvenile herring bycatches and the exploitation of sprat is limited by the herring bycatch restrictions imposed on the fisheries. Two regulations limit the sprat trawl fishery in addition to the sprat TAC, one being the bycatch ceiling for herring and the other the herring bycatch percentage limit in industrial fisheries. Given the relatively large North Sea autumn-spawning herring stock, the sprat fishery has been limited by the bycatch limits. The majority of sprat landings are taken in the Danish small-meshed trawl fishery, which has about 10% bycatch of herring. The Norwegian sprat fishery is carried out by purse-seiners and small-meshed trawlers. Norwegian regulations for the North Sea sprat fishery allow for a maximum 10% (by weight) bycatch of herring. The bycatch percentage in this fishery is unknown.

| | |
|---|---|
| **Catch distribution** | Total catch (2012): 85.6 kt, where 100% were landed. |

**Effects of the fisheries on the ecosystem**

Sprat is an important prey species in the North Sea ecosystem. The effects of the sprat fishery on other fish species, marine mammals, and seabirds are at present unknown. Concern has been expressed about the preservation of inshore sprat as a food resource for breeding seabirds.

**Quality considerations**

This is the first time since 2008 that ICES is able to present an analytical assessment for this stock, and it is a marked improvement over previous assessments. The current assessment was proposed during the benchmark in February 2013, introducing a new model (single-species SMS with quarterly time-steps) and the inclusion of the acoustic time-series (HERAS). The acoustic time-series is now long enough to be used in the assessment, and it is considered a reliable index of the abundance of the stock.

To better match the sprat life-cycle, the assessment year has been changed from January–December to July–June, and this improves the performance of the assessment model.

**Scientific Basis**

| | |
|---|---|
| **Assessment type** | Age-based analytical assessment using SMS. |
| **Stock data category** | Category 1 |
| **Input data** | Three survey indices (IBTS Q1&3, HERAS);<br>Commercial catches (international landings, ages and length frequencies from catch sampling);<br>Annual maturity data (from IBTS Q1);<br>Natural mortalities from multispecies model. |
| **Discards and bycatch** | Discards are not included in the assessment and considered to be negligible. |
| **Indicators** | None. |
| **Other information** | Benchmarked in 2013 (ICES, 2013a). |
| **Expert Group report** | HAWG |

**6.4.30** **Supporting information May 2013**

**ECOREGION** **North Sea**

**STOCK** **Sprat in Subarea IV (North Sea)**

**Reference points**

| | *Type* | *Value* | *Technical basis* |
|---|---|---|---|
| **MSY Approach** | MSY $B_{trigger}$ | Not defined. | |
| | $F_{MSY}$ | 1.3 | Provisional $F_{MSY}$ proxy based on M (where M is estimated based on a multispecies assessment and varies over time; 1.3 is the value in 2013). |
| **Precautionary Approach** | $B_{lim}$ | 90 000 t | $B_{lim}$ was set to ensure that years of very good recruitment mainly occurred when the stock was above $B_{lim}$ and years of very low recruitment only occurred when the stock was below $B_{lim}$ (ICES, 2013). |
| | $B_{pa}$ | 142 000 t | $B_{pa} = B_{lim} \times \exp^{(\sigma \times 1.645)}$, with σ = 0.28 estimated from assessment uncertainty in the terminal year (ICES, 2013). |
| | $F_{lim}$ | Not defined. | |
| | $F_{pa}$ | Not defined. | |

**Outlook for July 2013 to July 2014**

Basis: F(2012) = 0.381; Yield(2012) = 107; Recruitment(2012) = 121; Recruitment(2013) = 25 percentile of a log normal approximation of the recruitment (1992-2012) = 166 billion; SSB(2013) = 220. Note that all years (also in the table below) refer to the assessment years.

| **Rationale** | **Catch (July 2013 - June 2014)** | **Basis** | **F (July 2013 - June 2014)** | **SSB (2014)** | **% SSB change** [1] |
|---|---|---|---|---|---|
| MSY approach | 144 | Provisional $F_{MSY}$ proxy | 1.3 | 161 | −27% |
| Zero catch | 0 | F = 0 | 0 | 234 | 6% |
| Other options | 124 | F(2012) × 2.65 | 1 | 170 | −23% |
| | 134 | F(2012) × 3 | 1.143 | 165 | −25% |
| | 156 | F(2012) × 4 | 1.524 | 156 | −29% |
| | 165 | F(2012) × 4.5 | 1.715 | 152 | −31% |
| | 176 | F(2012) × 5.15 | 2 | 148 | −32% |

Weights in thousand tonnes.

[1] SSB 2014 relative to SSB 2013.

***MSY approach***

The ICES MSY approach for a short-lived species is typically an escapement strategy. Although some preliminary work towards the establishment of an MSY $B_{escapement}$ has been done, the associated uncertainties have not been sufficiently examined to be able to advise according to an escapement strategy at this stage. The value of MSY $B_{escapement}$ should take into account the uncertainties in the final assessment year as well as in the incoming recruitment.

To ensure precautionary exploitation and until an evaluation has been conducted, ICES considers that advice for this stock should be based on a $F_{MSY}$ proxy. For short-lived species, natural mortality is considered as a potential $F_{MSY}$ proxy (ICES, 2013b), although setting an $F_{MSY}$ reference point would also require evaluation. For this sprat stock fishing at F = M = 1.3 (where M has been derived from a multispecies assessment) corresponds to a catch of no more than 144 000 t from July 2013 to June 2014.

**Additional considerations**

The fishery for this short-lived species is dominated by 1- and 2-year-old fish. This requires information about incoming 1-year-old fish. In order to meet this requirement and to use a model that logically matches the natural life cycle of sprat, the annual period and the quarterly time-steps in the model were shifted relative to the calendar year. The annual time-steps in the assessment model go from 1 July to 30 June, and SSB and recruitment are estimated at July 1st. Hence, 2012 season 1 in the model refers to 2012 quarter 3, 2012 season 3 in the model refers to 2013 quarter 1, and so forth. Figure 6.4.30.5 illustrates how the annual cycle in the assessment model is shifted relative to the calendar year.

In line with the above, ICES is now providing catch advice for the period July to June in the following year. The TAC at present corresponds to the calendar year (January to December). It is expected that aligning the TAC period to the ICES advice period will facilitate management. In the context of the TAC still applying to the 2013 calendar year, with a potential in-year revision, the following information could facilitate using the advice ICES is currently providing: on average during 2009–2011, 85% of the catch in the period going from July of that year to June of the following year was taken during July–December. Applying this percentage to the catch advised for July 2013–June 2014 (144 000 t), it is expected that approximately 122 000 t would be taken during July–December 2013.

*Management considerations*

The ICES approach for MSY-based management of a short-lived species like sprat is usually an escapement strategy, i.e. to maintain SSB above MSY $B_{escapement}$ after the fishery has taken place. The value of MSY $B_{escapement}$ should take into account the uncertainties in the final assessment year as well as in the projections. After the appropriate reference points have been determined, the long-term consequences for the stock of using the MSY escapement strategy, or another type of MSY strategy, should be evaluated. This evaluation has not yet taken place; therefore, ICES is basing the advice this year on a provisional $F_{MSY}$ proxy. Sprat is an important forage fish, thus also multispecies considerations should be made.

The sprat and herring fisheries are linked; therefore, monitoring bycatch of juvenile herring should continue in the sprat fishery. Management measures that address the bycatch of juvenile herring should be revisited. Sprat catches in recent years have been well below the advised and agreed TAC. Management of this stock should consider management advice given for herring in Subarea IV.

The landing obligation for pelagic fisheries in EU waters is expected to be enacted in the beginning of 2015. This can be expected to have an impact on how the bycatch ceiling is utilized and a change in fishing patterns may occur.

*Uncertainties in the assessment and forecast*

The assessment estimates high CVs for the commercial catches but lower CVs for surveys, indicating that the model is driven mainly by survey indices. There is some concern that the spatial distribution of the biological samples taken from the fishery do not always follow the catch distribution. This represents a problem if there are spatial differences in growth and age composition and may decrease the consistency between years of the cohort's signal in the catches. This may also partially explain why the CVs on the catches are higher than for the survey indices. To remedy the problem, the existing Danish and Norwegian biological samples were used to produce spatially explicit age compositions and weight-at-age whenever the sampling level allowed. Ideally, this should be coupled with total catches per quarter and statistical rectangle. Inclusion of a properly standardized effort index could potentially also represent part of a solution to the problem of high catch CVs.

The forecast is also sensitive to the choice of maturity ogive, for example whether a 3-year or a 10-year average is used in the forecast. A large proportion of the population contributes to SSB already at one year of age. This means that the estimated value of SSB after the fishery is highly dependent upon the recruitment value used in the forecast. A recruitment index providing indications of the size of the incoming age-0 year class would therefore be important for the forecast.

*Comparison with previous assessment and advice*

Last year, this stock was considered a data-limited stock and advice was given based only on the development in the survey indices. The stock has since been benchmarked, including a revision of IBTS survey indices, catch-at-age, weight-at-age, and natural mortality. A quarterly assessment model (SMS) is now applied, and advice is provided for the period from July 1st to June 30th in the subsequent year. The advice this year is based on the MSY approach.

**Sources**

Beaugrand, G. 2003. Long-term changes in copepod abundance and diversity in the north-east Atlantic in relation to fluctuations in the hydroclimatic environment. Fisheries Oceanography, 12: 270–283.

DeRiso, R. B. 1982. Relationship of fishing mortality to natural mortality and growth at the level of maximum sustainable yield. Canadian Journal of Fisheries and Aquatic Sciences, 39: 1054–1058.

ICES. 2006a. Report of the Study Group on Recruitment Variability in North Sea Planktivorous Fish (SGRECVAP). ICES CM 2006/LRC:03. 82 pp.

ICES. 2006b. Report of the Herring Assessment Working Group South of 620 N (HAWG), 14–23 March, ICES Headquarters. ICES CM 2006/ACFM:20. 647 pp.

ICES. 2008. Report of the Herring Assessment Working Group South of 62 N (HAWG), 11–19 March 2008, ICES Headquarters, Copenhagen. ICES CM 2008/ACOM:02. 601 pp.

ICES. 2012. Report of the Herring Assessment Working Group for the Area South of 62n (HAWG), 13– 22 March 2012, ICES Headquarters, Copenhagen, Denmark. ICES CM 2012/ACOM:06.

ICES. 2013a. Report of the Benchmark Workshop on Sprat (WKSPRAT), 11–15 February 2013, Copenhagen, Denmark. ICES CM 2013/ACOM:48.

ICES. 2013b. Report of the ICES Advisory Committee, 2013. ICES Advice, 2013. Book 1.

Mertz, G., and Myers, R. A. 1998. A simplified formulation for fish production. Canadian Journal of Fisheries and Aquatic Sciences. 55: 478–484.

Reid, P. C., Edwards, M., Beaugrand, G., Skogen, M., and Stevens, D. 2003. Periodic changes in the zooplankton of the North Sea during the twentieth century linked to oceanic inflow. Fisheries Oceanography, 12: 260–269.

Smith, A. D. M., Brown, C. J., Bulman, C. M., Fulton, E. A., Johnson, P., Kaplan, I. C., Lozano-Montes, H., Mackinson, S., Marzloff, M., Shannon, L. J., Shin, Y-J., and Tam, J. 2011. Impacts of Fishing Low-Trophic Level Species on Marine Ecosystems. Science, 333: 1147 (DOI: 10.1126/science.1209395).

Zhou, S., Yin, S., Thorson, J. T., Smith, A. D. M., and Fuller, M. 2012. Linking fishing mortality reference points to life history traits: an empirical study. Canadian Journal of Fisheries and Aquatic Sciences, 69: 1292–1301.

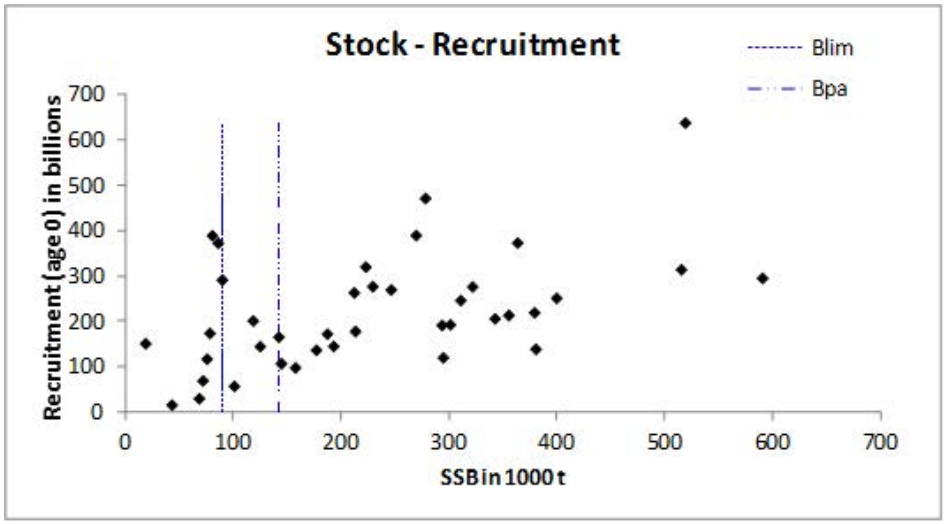


**Figure 6.4.30.2** Sprat in Subarea IV (North Sea). Stock–recruitment plot.

**Table 6.4.30.1** Sprat in Subarea IV (North Sea). ICES advice, management, catch, and landings.

| Year | ICES Advice | Predicted catch corresp. to advice | Agreed TAC[1] | Official catches | ICES landings |
|---|---|---|---|---|---|
| 1987 | Catch at lowest practical level | 0 | 57 | 78 | 32 |
| 1988 | TAC< recent catches, preferably zero | 0 | 57 | 93 | 87 |
| 1989 | No advice | - | 59 | 50 | 63 |
| 1990 | No advice | - | 59 | 51 | 73 |
| 1991 | No advice | - | 55 | 92 | 112 |
| 1992 | No advice | - | 55 | 72 | 124 |
| 1993 | No advice | - | 114 | 126 | 200 |
| 1994 | No advice for sprat; maintain bycatch regulations | - | 114 | 184 | 320 |
| 1995 | No advice | - | 175 | 190 | 357 |
| 1996 | No advice | - | 200 | 142 | 137 |
| 1997 | Enforce bycatch regulations | - | 150 | 123 | 103 |
| 1998 | Limited by restrictions on juvenile herring | - | 150 | 175 | 164 |
| 1999 | Limited by restrictions on juvenile herring | - | 225 | 182 | 188 |
| 2000 | Limited by restrictions on juvenile herring | - | 225 | 207 | 196 |
| 2001 | Catch prediction | 225 | 225 | 184 | 170 |
| 2002 | Catch prediction | 160 | 232 | 167 | 144 |
| 2003 | Catch prediction | 175 | 257 | 201 | 177 |
| 2004 | Catch prediction | 171 | 257 | 208 | 194 |
| 2005 | Catch prediction | 244 | 257 | 242 | 208 |
| 2006 | Catch predictions | < 250 | 175 | 136 | 114 |
| 2007 | Catch prediction | < 195 | 175 | 100 | 84 |
| 2008 | Catch prediction | < 170 | 170 | 77 | 61 |
| 2009 | No advice | - | 170 | 141 | 133 |
| 2010 | No advice | - | 170 | 157 | 144 |
| 2011 | Reduce catches | - | 170 | 145 | 134 |
| 2012 | Reduce catches | | 162 | 97 | 86 |
| 2012 (In year) | No increase in catches in 2012 | < 134 | | | |
| 2013 | MSY approach (catch for July 2013–June 2014) | < 144 [2] | 161.500 | | |

Weights in thousand tonnes.

[1] TACs are set for January–December where the advice since 2013 is given for July (of the TAC year) to June of the next year.

[2] Advice for July 1st 2013 to June 30th 2014.

**Table 6.4.30.2** Sprat in Subarea IV (North Sea). ICES landings by area (in tonnes). Sprat in Subarea IV (North Sea). ICES landings by area (in tonnes). See ICES (2006b) for earlier landings data. Catch in fjords of western Norway are excluded. These figures do not in all cases correspond to the official statistics and cannot be used for management purposes. The Division IVb catches for 2000–2007 divided by Divisions IVbW and IVE can be found in ICES (2008).

| Year | Quarter | Area | | | | Total |
|---|---|---|---|---|---|---|
| | | IVaW | IVaE | IVb | IVc | |
| 2007 | 1 | | | 582 | 247 | 829 |
| | 2 | | | 241 | 3 | 244 |
| | 3 | | | 16 603 | | 16 603 |
| | 4 | 769 | | 41 850 | 23 531 | 66 150 |
| | Total | 769 | | 59 276 | 23 781 | 83 826 |
| 2008 | 1 | | | 2 872 | 43 | 2 915 |
| | 2 | | | 52 | * | 52 |
| | 3 | | | 21 787 | | 21 787 |
| | 4 | | | 27 994 | 8 334 | 36 329 |
| | Total | | | 52 706 | 8 377 | 61 083 |
| 2009 | 1 | | | 36 | 1 268 | 1 304 |
| | 2 | | | 2 526 | 1 | 2 527 |
| | 3 | | 22 | 41 513 | | 41 535 |
| | 4 | | | 78 373 | 9 336 | 87 709 |
| | Total | | 22 | 122 448 | 10 604 | 133 075 |
| 2010 | 1 | | | 10 976 | 17 072 | 28 048 |
| | 2 | | | 3 235 | 3 | 3 238 |
| | 3 | | | 14 220 | | 14 220 |
| | 4 | | | 62 006 | 35 973 | 97 979 |
| | Total | | | 90 437 | 53 048 | 143 485 |
| 2011 | 1 | | | 3 747 | 21 039 | 24 786 |
| | 2 | | | 2 067 | 3 | 2 070 |
| | 3 | | | 22 309 | 451 | 22 761 |
| | 4 | 8 | | 70 256 | 13 759 | 84 023 |
| | Total | 8 | | 98 380 | 35 252 | 133 640 |
| 2012 | 1 | | | 81 | 1 649 | 1 730 |
| | 2 | | | 2 924 | 0 | 2 924 |
| | 3 | | | 26 779 | 307 | 27 086 |
| | 4 | | | 47 765 | 6 060 | 53 825 |
| | Total | 0 | 0 | 77 549 | 8 016 | 85 565 |

* < 0.5 tonnes

**Table 6.4.30.3** Sprat in Subarea IV (North Sea). Summary of the assessment.

| Year | Recruitment | SSB | Landings | Mean F |
|---|---|---|---|---|
| | Age 0 | | | Ages 1–2 |
| | millions | tonnes | tonnes | |
| 1974 | 295931 | 590355 | 379883 | 0.977 |
| 1975 | 637949 | 518830 | 607849 | 1.513 |
| 1976 | 314845 | 515133 | 701782 | 1.151 |
| 1977 | 373635 | 363312 | 335306 | 1.522 |
| 1978 | 471681 | 277897 | 489316 | 1.577 |
| 1979 | 251840 | 399520 | 484624 | 1.511 |
| 1980 | 270293 | 246161 | 483279 | 1.557 |
| 1981 | 98879 | 157392 | 201840 | 1.344 |
| 1982 | 58064 | 100752 | 127212 | 0.866 |
| 1983 | 69990 | 71625 | 67486 | 1.658 |
| 1984 | 31021 | 68242 | 68416 | 1.059 |
| 1985 | 16872 | 42942 | 39458 | 1.446 |
| 1986 | 152040 | 18513 | 20659 | 1.075 |
| 1987 | 117848 | 75470 | 42156 | 0.432 |
| 1988 | 389712 | 80360 | 86481 | 0.208 |
| 1989 | 13762 | 176813 | 63698 | 0.072 |
| 1990 | 145641 | 124670 | 89571 | 2.319 |
| 1991 | 292181 | 89576 | 84649 | 0.616 |
| 1992 | 277499 | 229060 | 153649 | 0.735 |
| 1993 | 390060 | 269314 | 234265 | 1.863 |
| 1994 | 193592 | 301043 | 398697 | 0.938 |
| 1995 | 107915 | 144308 | 416538 | 1.393 |
| 1996 | 201867 | 118159 | 83634 | 0.607 |
| 1997 | 206679 | 342415 | 90316 | 0.626 |
| 1998 | 276951 | 321635 | 161433 | 1.225 |
| 1999 | 264031 | 211862 | 220736 | 0.598 |
| 2000 | 192360 | 293278 | 179540 | 0.758 |
| 2001 | 145915 | 192745 | 110442 | 1.535 |
| 2002 | 174733 | 78083 | 144265 | 1.413 |
| 2003 | 173091 | 187017 | 131255 | 0.952 |
| 2004 | 373211 | 85722 | 229197 | 1.699 |
| 2005 | 139759 | 380236 | 257645 | 0.771 |
| 2006 | 178795 | 213021 | 70750 | 0.825 |
| 2007 | 166239 | 141970 | 78730 | 1.270 |
| 2008 | 320758 | 222621 | 65598 | 0.634 |
| 2009 | 219981 | 379008 | 175282 | 0.459 |
| 2010 | 246921 | 310601 | 161814 | 0.496 |
| 2011 | 214250 | 355114 | 111200 | 0.536 |
| 2012 | 120725 | 294419 | 107070 | 0.365 |
| 2013 | 166000 | 217169* | | |
| Average** | 221934 | 230159 | 203993 | 1.041 |

*Using mean weights from 2012.

**Period 1974 –2012.

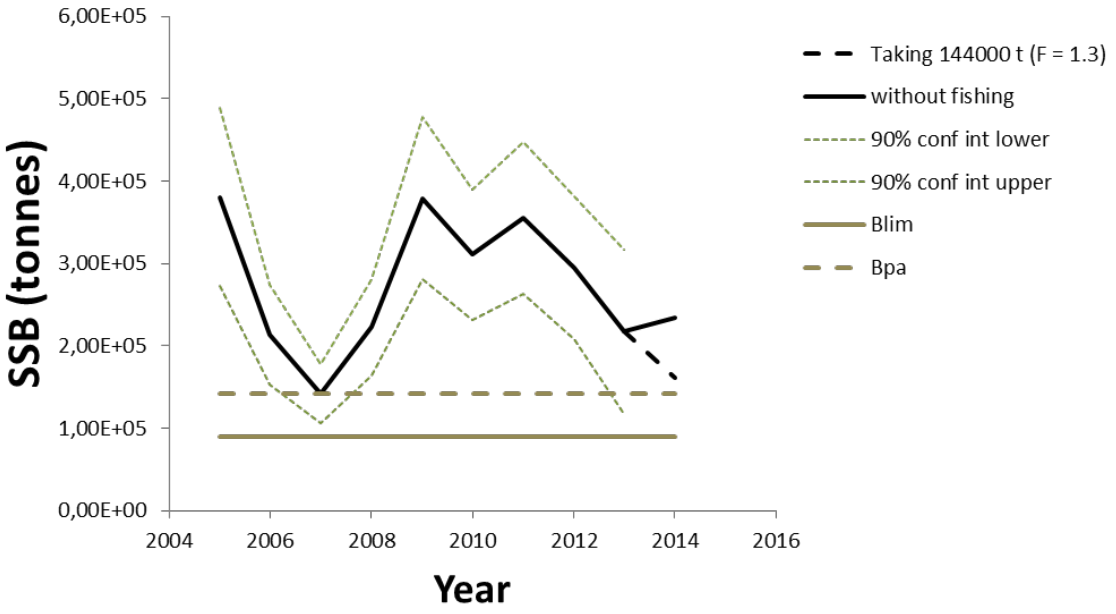


**Figure 6.4.30.3** Sprat in Subarea IV (North Sea). Historical SSB estimates (and associated uncertainty) and projected SSB values in 2014 under no fishing, and with catches of 144 kt. The uncertainty associated with the prediction of SSB in 2014 cannot be evaluated without performing stochastic projections, but is considered to be larger than the uncertainty about SSB in 2013. The reason for this is that the main ages contributing to SSB in 2014 are the 2012 and 2013 year classes, which are the most uncertain, as they are the ones for which the least information is available.

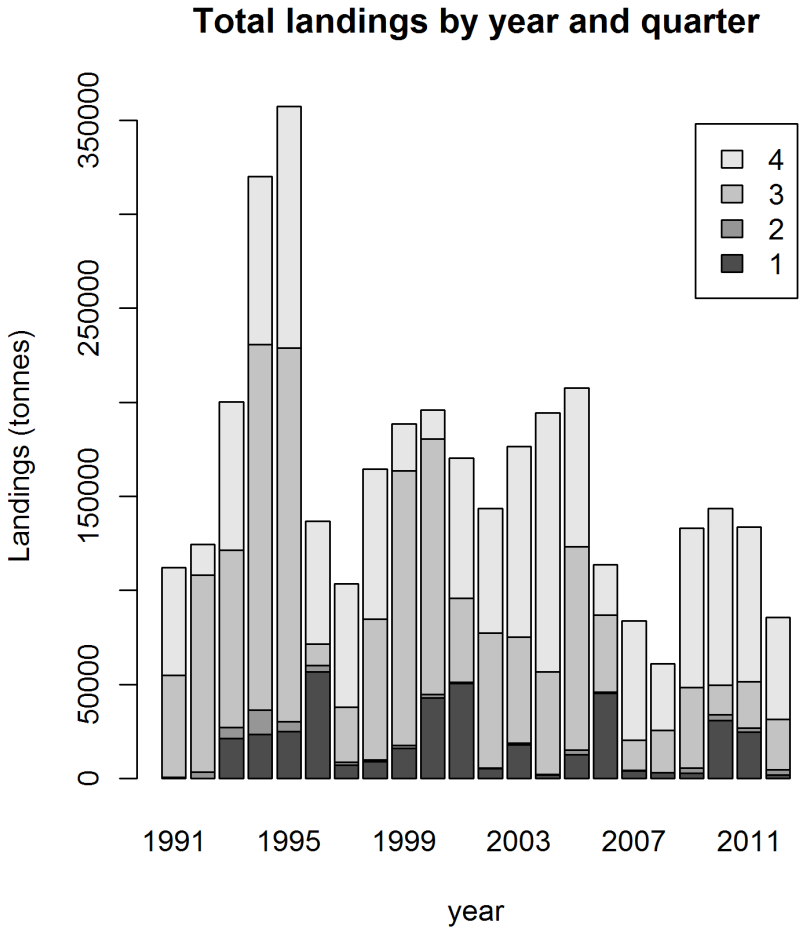


**Figure 6.4.30.4** Sprat in Subarea IV (North Sea). ICES landings per quarter (in tonnes).

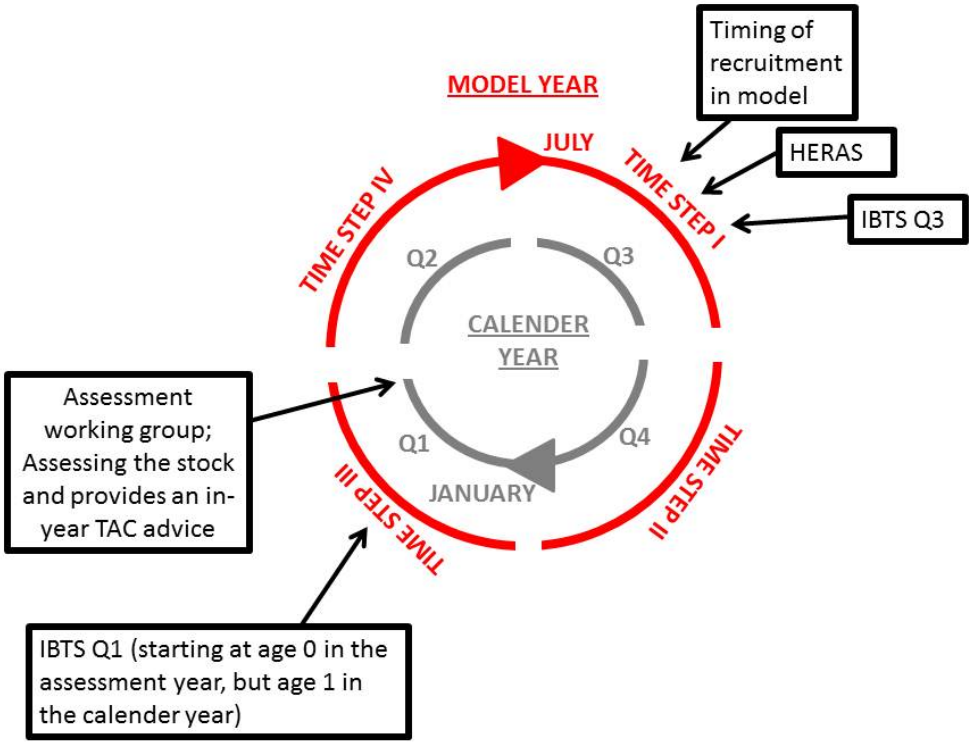


**Figure 6.4.30.5** An illustration of how the annual cycle in the assessment model is shifted relative to the calendar year.