

# EcoQO on spawning stock biomass of commercial fish species<sup>1</sup>

## Background

Spawning stock biomass of commercial fish species is one of the Ecological Quality Objectives (EcoQOs) in the EcoQO system of the North Sea. The background and technical basis for this EcoQO is described in an OSPAR background document (OSPAR 2005/242).

Commercial fish stocks are evaluated by ICES based on estimated size of their spawning stock biomass (B) and rate of fishing mortality (F). Limit and precautionary reference points (values) are set for B and F. The limit on spawning stock biomass ( $B_{lim}$ ) is where reproduction to the stock is impaired, and the limit on fishing mortality ( $F_{lim}$ ) is where there is high probability that fishing will cause the stock to decline, eventually to below  $B_{lim}$  where reproduction is impaired. The precautionary reference points are set with a safety or buffer zone, so that  $B_{pa}$  is higher than  $B_{lim}$  and  $F_{pa}$  is lower than  $F_{lim}$ . The purpose of the buffer zones is to have low probability that the limits are crossed due to uncertainties in the assessment. Thus, if the stock is estimated to be at  $B_{pa}$ , there is low probability that it in reality could be below  $B_{lim}$ .

A distinction is made between an underlying and an operational objective in the routine use in fisheries management. The underlying objective is to maintain or move the spawning stock biomass above  $B_{lim}$  with high probability, and to maintain or move fishing mortality below  $F_{lim}$  with high probability. The operational objective is to maintain or move the (usually annual) point estimate of spawning stock biomass above  $B_{pa}$  and to maintain or move the point estimate of F below  $F_{pa}$ .

ICES has advised that this EcoQO should be applied at the aggregate level for all commercial fish stocks and not for each single stock that is managed according to limit and precautionary reference points. It is therefore proposed that the results should be presented by stating the proportion of the stocks for which the operational objective is met, while spelling out the fish stocks for which it is not met.

## Overview of the results of recent Monitoring - Status of North Sea fish stocks 2006

The status of 26 stocks of 15 species of commercial fish in 2006 is presented in Table 2.1. This is based on the information from ICES (mainly 2007 assessments) downloaded from their web-page ([www.ices.dk](http://www.ices.dk)). The table gives 2006 information on the same 26 stocks that were included in the Background document with status for 2003 (OSPAR 2005).

The stocks in Table 2.1 are a mixed bag. Some are large North Sea stocks (North Sea cod, haddock, saithe, whiting, plaice, sole, and herring), others have more restricted distributions in the Kattegat-Skagerrak area or in the Eastern Channel (cod, whiting, plaice, sole, and herring), while others again are large migratory populations whose distributions include the North Sea part of the time (mackerel, horse mackerel, blue whiting).

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<sup>1</sup> This assessment is based on ICES advice in 2007, including data up to 2006. An updated assessment including data up to 2009 has been undertaken as part of the OSPAR assessment of the environment impact of fishing (publication no. 2009/465).

**Table 2.1:** Commercial fish stocks in the North Sea and their status in 2006 based on the ICES assessments ([www.ices.dk](http://www.ices.dk)) 1) Changed after 2003; B<sub>lim</sub> and B<sub>pa</sub> lower, F<sub>pa</sub> higher

Species	Area	B <sub>lim</sub>	B <sub>pa</sub>	F <sub>pa</sub>	SSB 2006	Stock status
Cod	North Sea, Eastern Channel, Skagerrak	70 000	150 000	0.65	28 000	Outside safe biological limits
	Kattegat	6 400	10 500	0.6	low <B <sub>lim</sub>	Outside safe biological limits
Haddock	North Sea, Eastern Channel, Skagerrak	100 000	140 000	0.7	238 000	Within safe biological limits
Saithe	North Sea, Skagerrak, and west of Scotland	106 000	200 000	0.4	298 000	Within safe biological limits
Whiting	North Sea and Eastern Channel	225 000	315 000	0.65	na	Uncertain; declining trend since 1995, likely Outside safe biological limits
	Skagerrak, Kattegat	na	na	na	na	Unknown; likely decline of stock since 2002
Hake	Northern stock (Biscay-Celtic Sea-North Sea-Skagerrak)	100 000	140 000	0.25	142 000	Within safe biological limits
Plaice	North Sea 1)	160 000	230 000	0.60	197 000	Outside safe biological limits
	Skagerrak, Kattegat	na	24 000	0.73	na	Unknown
	Eastern Channel	5 600	8 000	0.45	na	Unknown
Sole	North Sea	25 000	35 000	0.4	28 000	Outside safe biological limits
	Skagerrak and Kattegat	770	1 060	0.3	3 900	Inside safe biological limits
	Eastern Channel	na	8 000	0.4	11 600	Inside safe biological limits
Herring	North Sea, Eastern Channel, Skagerrak	800 000	1 300 000	0.25	1 208 000	Outside safe biological limits
	Kattegat, Western Baltic	na	na	na	185 000	Unknown
Sprat	North Sea	na	na	na	na	Unknown, appears at a median level
	Skagerrak and Kattegat	na	na	na	na	Unknown
Mackerel	North Sea stock component					Severely depleted since the 1970s
	Combined (Western, Southern, North Sea)	na	2 300 000	0.17	2 200 000	Harvested outside safe biological limits
Horse mackerel	North Sea, Eastern Channel, Skagerrak	na	na	na	na	Unknown
	Western stock component	na	na	na	na	Unknown
Norway pout	North Sea and Skagerrak	90 000	150 000	na	80 000	Outside safe biological limits
Sandeel	North Sea	430 000	600 000	na	450 000	Outside safe biological limits
	Skagerrak, Kattegat	na	na	na	na	Unknown; possibly same stock complex as North Sea
Blue whiting	Portugal- Norway	1 500 000	2 250 000	0.32	5 500 000	Harvested outside safe biological limits
Anglerfish	North Sea, Skagerrak, Kattegat, west of Scotland	na	na	0.30	na	Unknown

Four of the stocks were assessed to have spawning stock biomass below  $B_{lim}$ , while another 4 stocks were assessed to be below  $B_{pa}$ . In addition, 2 stocks are fished outside  $F_{pa}$  ( $F > F_{pa}$ ). Five stocks were assessed to be inside (on the safe side) of the precautionary reference points ( $>B_{pa}$ ,  $<F_{pa}$ ). For 11 of the stocks, either reference points had not been set or quantitative assessment had not been possible due to inadequate data, and their status was therefore given as unknown or uncertain. In terms of the aggregated EcoQO, 5 of the 26 fish stocks were assessed to meet the EcoQO criteria on spawning stock biomass. The ones that failed to do so are:

*With spawning stock below  $B_{lim}$ :*

- Cod in the North Sea including Eastern Channel and Skagerrak
- Cod in Kattegat
- Mackerel, North Sea stock component
- Norway pout

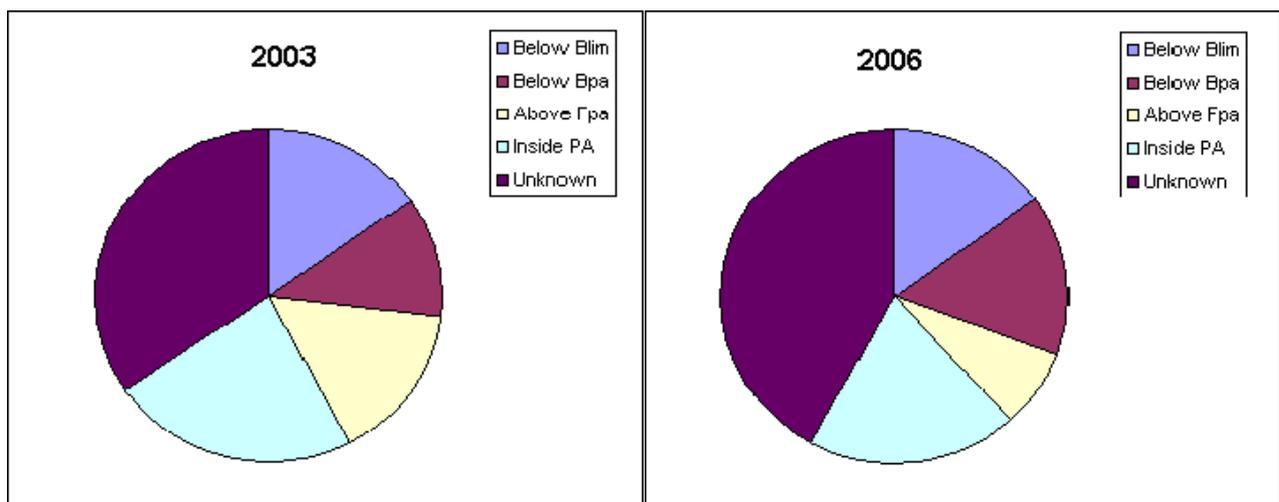
*With spawning stock below  $B_{pa}$*

- Plaice in the North Sea
- Sole in the North Sea
- Herring in the North Sea including Eastern Channel and Skagerrak
- Sandeel in the North Sea

*Harvested outside  $F_{pa}$ :*

- Mackerel, combined stocks
- Blue whiting

The aggregated status of stocks in 2006 is shown in Figure 2.1 where it is compared to that in 2003. The same number of stocks (4) was below  $B_{lim}$  in each of the two years, with North Sea cod, cod in Kattegat, and North Sea mackerel being in this group both years. Norway pout fell from being within safe limits in 2003, to below  $B_{lim}$  in 2006. In contrast, North Sea plaice improved its situation from being below  $B_{lim}$  in 2003 to above  $B_{lim}$  (but below  $B_{pa}$ ) in 2006.



**Figure 2.1.** Proportions of North Sea fish stocks outside and inside safe biological limits. Three categories are used for stocks outside safe limits: stocks below  $B_{lim}$ , stocks below  $B_{pa}$  but above  $B_{lim}$ , and stocks harvested above  $F_{pa}$  but with spawning stock above  $B_{pa}$ . Based on the information on 26 stocks in Table 2.1 for 2006. The information for 2003 is from OSPAR (2005).

Four stocks were assessed to be below  $B_{pa}$  in 2006, compared to 3 in 2003. The four stocks in 2006 were the North Sea stocks of plaice (up from  $<B_{lim}$ ), sole (as in 2003), herring (down from inside safe limits), and sandeel (change from uncertain). Two stocks were harvested outside  $F_{pa}$  in 2006 compared to 4 in 2003. The two were the combined stock of mackerel and blue whiting, which were in the same category also in 2003.

Five stocks were assessed to be within safe limits ( $>B_{pa}$ ,  $<F_{pa}$ ) in 2006, compared to 6 in 2003. These were haddock, saithe, sole in Skagerrak-Kattegat and in the English Channel, and hake. The first four of these were within safe limits also in 2003, along with North Sea herring and Norway pout.

Eleven stocks were classified as having unknown or uncertain status in 2006, compared to 9 in 2003. For seven of these stocks, no reference points have been determined. These are whiting, herring, sprat, and sandeel in Skagerrak and Kattegat, sprat and horse mackerel in the North Sea, and the western stock of horse mackerel. Quantitative assessments were not possible for whiting in the North Sea (also in 2003), plaice in Skagerrak-Kattegat and in the English Channel, and anglerfish. In 2003 there was no assessment result for sandeel in the North Sea.

Figure 2.2 shows a time series of status of 14 of the North Sea fish stocks from 1970 (starting later for some of the stocks) to 2006. This is an update of Figure 9 in the Background document (OSPAR 2005/242). Since assessment results may change back in time based on the most recent information, there are also some smaller changes in stock status for years prior to 2004.

North Sea cod and cod in Kattegat have fallen into the red zone (stock below  $B_{lim}$  and fishing mortality above  $F_{lim}$ ) since 1999 or 2000. Norway pout has come into the red zone since 2004. Other stocks have shown the opposite trend. Thus haddock and saithe have come out of red or orange into the safe green zone from 2001 or 2002. Also sole in the Eastern Channel and hake have come into the green zone in recent years.

**Figure 2.2.** (Next page). Time series of stock status for main North Sea fish stocks for the period from 1970 to recent. The stock status is shown by colour codes as identified in the key.  $<pa$  in yellow cells indicates spawning stock biomass below  $B_{pa}$ .  $<pa$  in orange cells indicates fishing mortality below  $F_{pa}$



## Has the EcoQO been met?

This question was also addressed in the Background document (OSPAR 2005/242) where the difficulty of interpreting the objective was discussed.

The short answer to the question is that the objectives are not met. Five out of 26 stocks within safe limits, or 5 out of 15 stocks for which reference points are set and assessment could be carried out, is lower than the objective. It is far below the objective if this is understood to mean that the operational objective of being within safe limits relative to the precautionary reference points (stock above  $B_{pa}$  and fishing mortality below  $F_{pa}$ ) should be met for all stocks. However, this may imply double precaution since the operational objective is related to the underlying objective, which is to have low probability that the stock in reality should fall below  $B_{lim}$ .

The true stock size is not known but is estimated with uncertainty. However, we can use the estimated stock size falling below  $B_{lim}$  as an indication to what degree the underlying objective is being met. Four stocks represent about 15% of the total of 26 stocks, or about 25% of the 15 stocks for which stock status is available. If low probability for falling below  $B_{lim}$  is taken to be 5%, this would mean that 1 in 20, or about 5% of the stocks, could be estimated to be below  $B_{lim}$  by chance.

Figure 2.3 shows a graphical representation of the status of the 14 stocks, grouped into 4 categories: stock size below  $B_{lim}$ , stock below  $B_{pa}$ , stock fished outside precautionary limit ( $F > F_{pa}$ ), and stock within safe limits (stock  $> B_{pa}$ , fishing mortality  $< F_{pa}$ ). The proportion of stocks below  $B_{lim}$  has increased from <10 % in the 1980s to around 20% in the 1990s and 2000s. This reflects a history where North Sea herring was the only species with stock below  $B_{lim}$  in the 1980s, through a situation where haddock, saithe, herring and hake were below  $B_{lim}$  in the early 90s, followed by a recovery of these stocks but a deterioration for cod and Norway pout falling below  $B_{lim}$  in the 2000s.

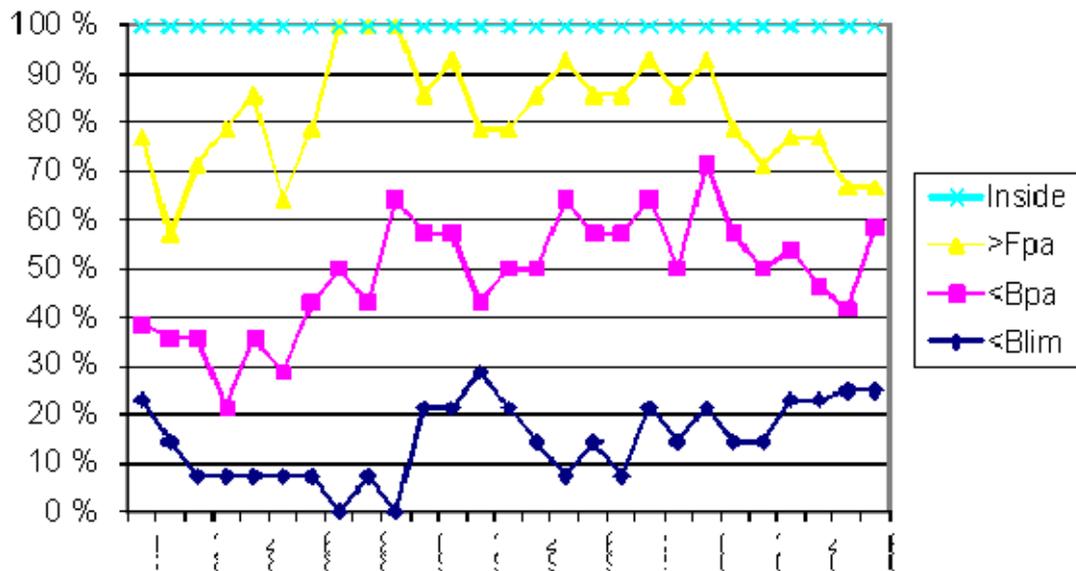
The proportion of stocks falling below  $B_{pa}$  (including those below  $B_{lim}$ ) increased from 30-40% in the 1980s to about 50-60% in the 1990s. The proportion has declined somewhat to around 50% in the 2000s (Figure 2.3).

The proportion of stocks that were harvested at a rate above the precautionary limit ( $F > F_{pa}$ ) but where the stock level still remained above  $B_{pa}$ , decreased from 40-50% in the 1980s, to around 30% in the 1990s and to around 20% in the 2000s.

The proportion of stocks that were within safe limits (spawning stock  $> B_{pa}$  and fishing mortality  $< F_{pa}$ ) were around 20-40% in the 1980s, decreased to 10-20% in the 1990, and increased again to around 30% in the 2000s. This reflected a shift from plaice, Norway pout, hake and blue whiting being within safe limit in the early 1980s, to haddock, saithe and sole being within safe limits in the recent years.

The precautionary approach with **pa** reference points was introduced in the ICES advice and fisheries management from the mid 1990s. One question is whether this helped to improve the situation for the fish stocks. To a moderate degree, this seems to have been the case. As seen from Figure 2.3, the number of stocks within safe limits increased, and the proportion of stocks harvested outside  $F_{pa}$ , and the proportion with spawning stock below  $B_{pa}$ , decreased from the late 1990s to the 2000s. At the same time there was an increase in the stocks below  $B_{lim}$  reflecting mainly the negative development of the two cod stocks (North Sea and Kattegat).

## Status of North Sea fish stocks



**Figure 2.3:** Proportions (cumulative) of fish stocks assessed to have spawning stock biomass  $<B_{lim}$ , spawning stock biomass  $<B_{pa}$  (but  $>B_{lim}$ ), fishing mortality higher than  $F_{pa}$ , and stocks being within safe limits (biomass  $>B_{pa}$ , fishing mortality  $<F_{pa}$ ). Based on time series from 1980 to present for 14 stocks shown in Figure 2.2.

### Use of the EcoQO

The EcoQO for commercial stocks of fish species in the North Sea is largely of the limit-type of objectives, being based on a lower limit for spawning stock biomass, below which recruitment (production of offspring) will be impaired.

The use of this EcoQO is the responsibility of the competent fisheries management authorities, which are the EU and Norway. OSPAR has no competence to adopt programmes and measures on questions related to the management of fisheries.

The fish stocks are routinely monitored by the North Sea countries and their status assessed by ICES. Poor quality of catch statistics may limit the quality and sometimes prevent quantitative assessments.

Management objectives have been set for several of the stocks. For some of the major North Sea stocks this is done as part of management agreements between the EU and Norway. This is the case for North Sea cod, haddock, herring, plaice and saithe. For these stocks, the objective is to maintain the stock above  $B_{lim}$  while aiming at a fishing mortality at or below  $F_{pa}$ . For North Sea herring the management plan is a harvest control rule (HCR), while for North Sea cod the plan includes a recovery plan aiming to rebuild the stock to above  $B_{pa}$ . The European Commission has enacted Council Regulations with recovery plans for cod in Kattegat and for hake (northern stock). Management objectives have also been set for the large stocks of mackerel (combined stocks) and blue whiting as parts of agreements between the coastal states (Faroe Islands, Iceland, Norway and EU). The objectives are to maintain the stock above  $B_{pa}$  (mackerel) or  $B_{lim}$  (blue whiting), while keeping  $F$  at or below  $F_{pa}$ .

There are no explicit management objectives set for about half of the stocks listed in Table 2.1. These include smaller stocks such as plaice, sole, whiting and sandeel in Skagerrak and Kattegat, plaice and sole in the Eastern Channel, and sprat in Skagerrak. Management objectives are also lacking for some larger stocks including North Sea stocks of sole, whiting, sandeel and sprat, and also Norway pout, horse mackerel, and anglerfish.

## Relation to Ecosystem Approach and the EC Marine Strategy Directive

The set of EcoQOs for the North Sea was developed with the aim of being an integral part of the Ecosystem Approach (EA) to the management of the North Sea, contributing to the objectives part of the EA. As such it is particularly important, as it can contribute to the further integration of fisheries and environmental protection, conservation and management measures, as called for in the Statement of Conclusions from the Intermediate Ministerial Meeting on the Integration of Fisheries and Environmental Issues in Bergen in March 1997.

The MSFD does not include fisheries, as it is a directive for measures to be drawn up by EU Member States, and the competence for fisheries management has been given to the European Commission. The EcoQO on commercial fish stocks can therefore have an important supplementary role to the MSFD by covering a key aspect of fisheries in relation to the overall objective of achieving good environmental status.

## References

- OSPAR (2005). North Sea Pilot Project on Ecological Quality Objectives. Background document on the Ecological Quality Objective for spawning stock biomass of commercial species in the North Sea. OSPAR Commission 2005, Publication No. 2005/242.
- ICES (2007). Report of the ICES Advisory Committee on Fishery Management, Advisory Committee on the Marine Environment and Advisory Committee on Ecosystems, 2007. ICES Advice Books 5, 6 and 9.

*↪ Go to full QSR assessment report on the evaluation of the OSPAR system of Ecological Quality Objectives for the North Sea (publication number 406/2009 (update 2010))*