1.5.6.1. Response to Norwegian Request on Populations in Poor Condition

The Royal Norwegian Ministry of Fisheries and Coastal Affairs asked ICES to undertake an evaluation of the International Union for Conservation of Nature (IUCN) criteria used for redlisting marine fish species (20-09-2007, see attached letter in Annex 1).

Redlisting is understood to mean a species (or stock) is at risk of extinction. This advice is relevant to Norway's domestic redlisting process.

ICES convened two workshops. The first Workshop (WKPOOR1 (ICES, 2009a)) addressed methods for evaluating extinction risk, and outlined approaches that could support advice on how to avoid potential extinction. The second Workshop (WKPOOR2 (ICES, 2009b)) applied the results of the first workshop to four stocks selected as being of interest to Norway and ICES.

ICES Response

ICES assesses the status of fish stocks and provides advice under the precautionary approach aimed at avoiding impairing their reproductive capacity. This advice is aimed at stocks that are believed to be in a state of impaired reproductive capacity, and thus at risk of a further critical reduction in population size and potentially extinction. The same data and methods may be used for assessing stock status for the two objectives. However, different approaches are used to assess the potential risk of extinction.

There are three general methods for evaluating extinction risk: (1) screening methods, such as the IUCN redlisting criteria; (2) simple population viability analysis based on time trends; and (3) age structured population viability analysis. The rate of false positives (prediction of extinction which does not occur) and false negatives (the occurrence of unpredicted extinction) is likely to be the highest for screening methods, lower for simple population viability analysis based on time trends, and lowest for age structure population viability analysis. None of the methods are considered reliable for accurately estimating the probability of extinction, but they may be useful to evaluate the relative probability of extinction between species or between management options.

ICES recommends that all available stock assessment information (particularly that related to stock-recruitment dynamics) be examined when exploring the potential of extinction. Applying this approach, ICES concludes that the following stocks are at risk of a further critical decline in stock size and potentially extinction:

1. Coastal cod in Subarea I and Division IIa
2. *Sebastes mentella* in Subareas I and II
3. *Sebastes marinus* along the coastal shelf from beyond 62 N to Spitsbergen

Cod in the North Sea (Subarea IV), the Skagerrak (the northern section of Division IIIa), and the eastern Channel (Division VIId) was also examined. Persistent low recruitment is a reason for concern about the future viability of the stock. However, a precautionary management plan has been adopted which, if successfully implemented, has a high probability of facilitating the recovery of this stock.

ICES fisheries management advice for each of the four stocks calls for reductions in fishing mortality and catches.

Background

Methodology: Estimating the probability of extinction risk is inherently difficult because:

1. Extinction of exploited marine species is extremely rare, such that there is virtually no empirical information upon which to model extinction or test models;

2. Extinction risk is heavily dependent on the nature of density dependent processes of population regulation (e.g., depensation) at very low population sizes, and very little is known about such processes.

3. The final step to extinction is usually (based mainly on observations for terrestrial and freshwater ecosystems) caused by a catastrophe, which by definition is a rare event and difficult to predict.

4. Time series of abundance data and other data on demographics are relatively short compared to long term concerns about extinction.

Another limitation is the lack of information on the historic spatial structure of stocks in terms of spawning grounds and sub-stock production units. Some of these sub-stock units may be eradicated by overfishing and other causes (e.g., habitat loss). The lost of these units may foretell a loss of robustness of the entire population and an increased risk of extinction. The temporal and spatially loss of sub-stock units may be useful for modeling the probability of extinction of the entire stock. In some cases, these sub-stock units may merit protection in their own right.

A number of approaches have been used in evaluating extinction risk including: (1) Screening methods, such as the IUCN redlisting criteria; (2) simple population viability analysis based on time trends; and (3) age structured population viability analysis have some utility in evaluating extinction risk.

Screening methods may be useful to prompt a more comprehensive analysis, but should not be used as the basis for a listing decision when more detailed data are available, as is typically the case for exploited marine species. Screening methods also only provide an evaluation of stock status at a point in time. They do not include a projection into the future which is more useful for estimating the probability of extinction. As well, criteria based on the rate or magnitude of population decline may overlook the fact that even well managed exploited fish populations can experience large declines. Furthermore, in some cases even a small additional decline may induce a population to pass a tipping point and lead to an increased chance of extinction.

Population Viability Analysis (PVA) is a method that projects a population forward in time using uncertainty to make statements about the probability of population abundance falling below some predetermined level in a given number of years. PVA is useful to indicate the relative risk of extinction (e.g., between stocks) rather than to estimate the absolute probability. The PVA is a forecast of what would be likely to happen to a stock if current conditions remain unchanged throughout the projection period. This assumption of stationarity implies that the conditions that generated the observed values will continue into the future.

Another approach is the Age Structured Population Viability Analysis. In the standard application of this approach the simple PVA is augmented to account for life stage/age structure allowing density dependence and other forms of non-stationarity to occur in the projections. This approach allows comparison of the relative probability of extinction for alternative management options.

Standard fishery models can also be used to examine the risk of extinction. Stock and recruitment estimates can be compared to the replacement line under the current mortality rate. When total mortality is too high, the replacement line will be to the left of recruitment values associated with low stock size, causing the stock to decline. If depensation is present in the stock-recruitment relationship (or if the stock-recruitment relationship changes over time causing a smaller slope at the origin), too high a mortality rate will cause the stock to eventually go extinct. There is no time period involved in this approach, but continued recruitment below the replacement line implies a high probability of extinction.

Coastal cod in Subarea I and Division IIa: Trend analysis of twelve time series all show a declining trend in stock abundance. The stock-recruitment plot depicts the time trend (Figure 1.5.6.1.1). A low stock is largely the result of low recruitment and, to date, no large year classes have been produced at low stock sizes. Above 100 000 t, both high and low recruitments have occurred, while below 100 000 t only low recruitments have been observed. A blunt hockey stick fit (i.e., the red line in the graph) indicates a stock size break point at 129 000 t with a recruitment plateau at 32 million recruits and F_{crash}=0.31. A fishing mortality above F_{crash} will eventually drive a stock to extinction based on the estimated S-R function. In the sloping part of the red line, the majority of points are below the line indicating depensation.

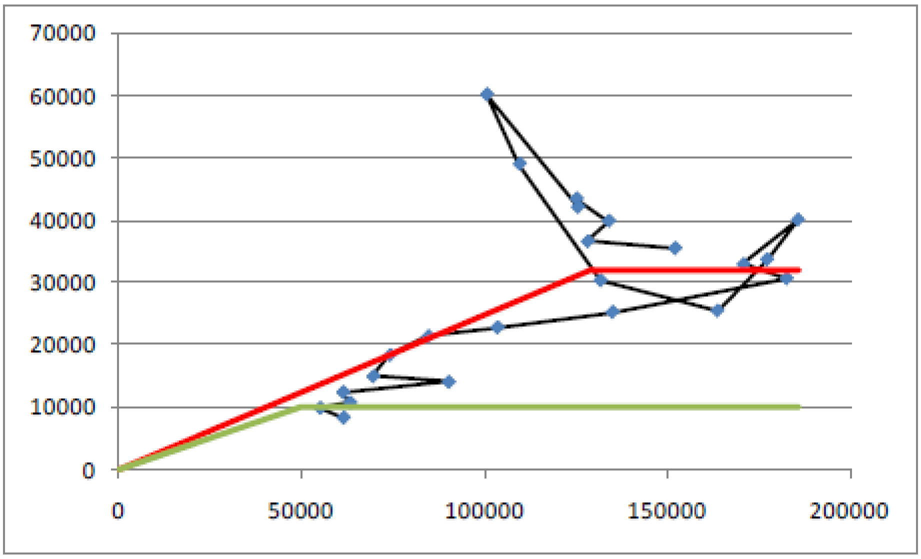

Figure 1.5.6.1.1 Stock-recruit data (year classes 1984–2006) and fitted break point line (red). The green line reflects the assumed low recruitment regime.

If the stock is in a regime where only low recruitment is possible, a break point around the recent stock-recruit points (R= 10 million, SSB=50 000 t) could be reasonable. As such, if the stock is further reduced, additional declines in recruitment (from the present level) would be expected. The associated F_{crash} is 0.26. Yield per recruit analysis indicate that F0.1 = 0.19 and F_{max} = 0.43. The latter is well above F_{crash}, and even the F0.1 value is dangerously close to it.

For this stock, ICES fisheries management advice has, since 2004, been that there should be a zero catch due to recruitment failure (ICES, 2009c – Section 3.4.2).

North Sea cod (Subarea IV, the Skagerrak [the northern section of Division IIIa], and the eastern Channel [Division VIId]): The estimated recruitment time series for North Sea cod as provided in the most recent assessment was used in the time trend analysis. This series spans 1963–2008 and shows an increase in recruitment (as well as stock biomass) during the 1960s to 1980s, following a decline (Figure 1.5.6.1.2). However, this change in recruitment is not as evident when the annual relative changes ($\lambda t = \ln(Nt+1/Nt)$) are plotted over time (Figure 1.5.6.1.3). The mean of the population growth rates (λt) is -1.6% with a standard deviation of 0.945. If a shorter time series (1980–2008) is considered, the mean growth rate is -11% with a standard deviation of 1.039. Stochastic trend projects based on either of the time series are so uncertain (due to relatively large standard deviations) that they are not useful for assessing the probability of extinction.

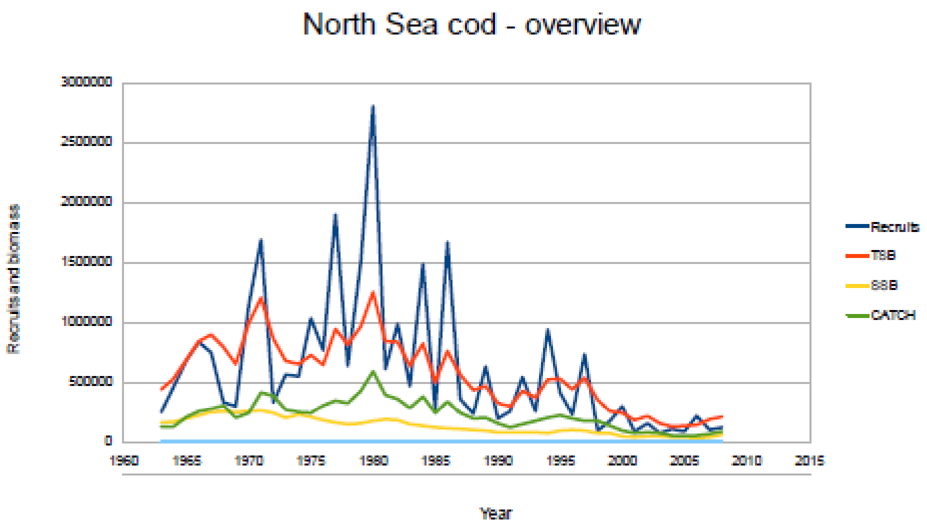

Figure 1.5.6.1.2 Time series of recruits, total stock biomass, spawning stock biomass, and catch for North Sea cod.

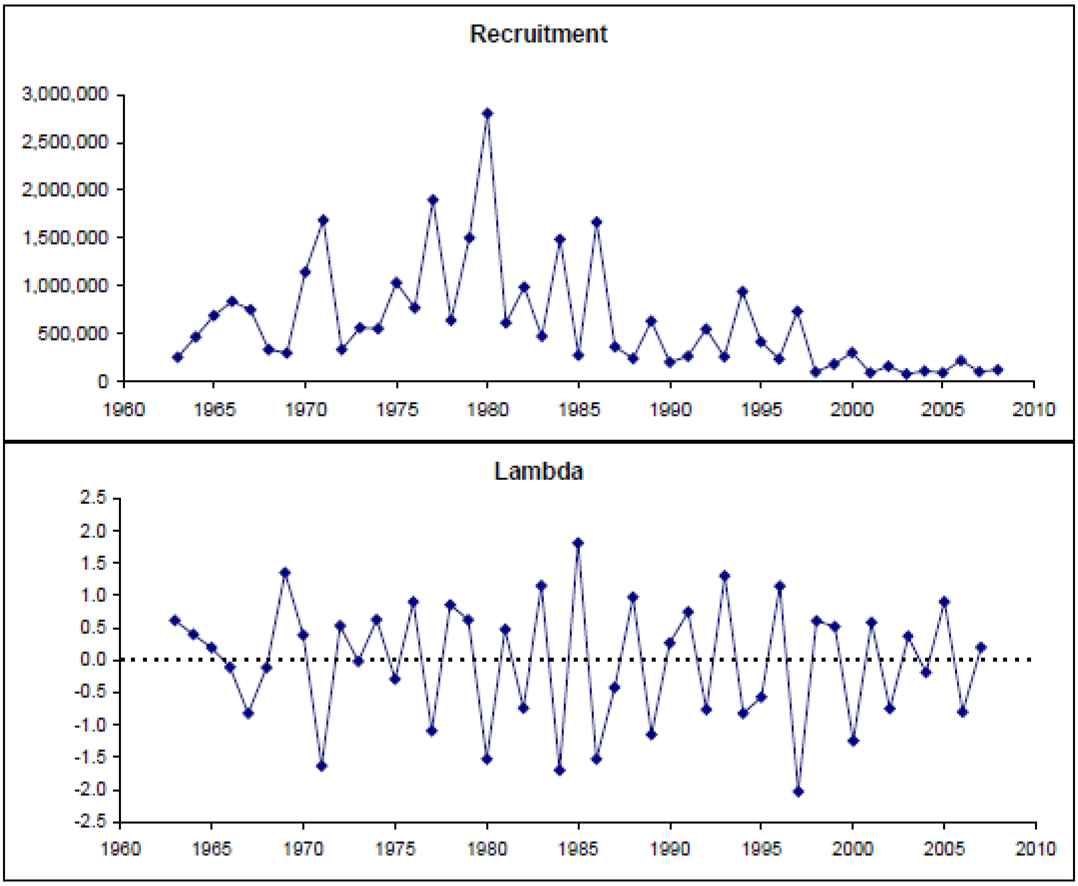

Figure 1.5.6.1.3. North Sea cod time series of recruitment (thousands of fish, top panel) and lambda (=ln(Nt+1/Nt, bottom panel).

The stock-recruitment plot for the North Sea cod is given in Figure 1.5.6.1.4. A hockey stick fit gives a stock size break point at 159 000 t with a recruitment plateau at 626 million fish (red line in Figure 1.5.6.1.4) and F_{crash}=0.91. This high sustainable F assumes that the recruitment pattern observed in the older part of the time series would reoccur if SSB is rebuilt. The historic data give some indication of depensatory recruitment (more points being below the sloping part of the break point line than above). If there is depensation, then fishing at F_{crash} is not sustainable.

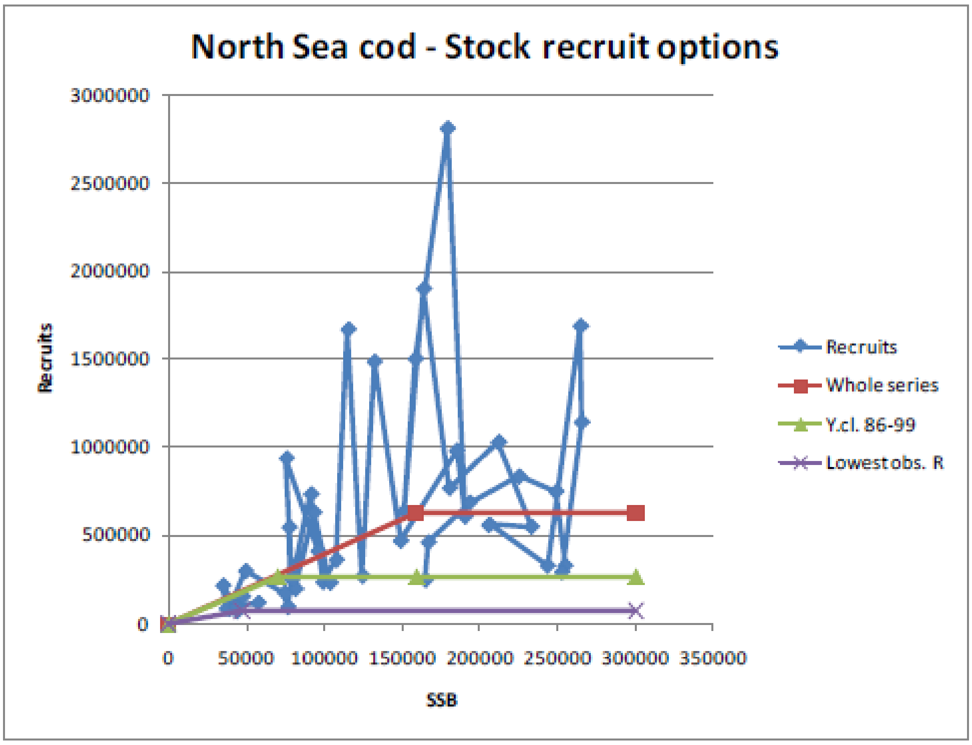

Figure 1.5.6.1.4 Stock-recruit data (year classes 1963–2007) connected with lines. Recent data are in the lower left corner. The red line is the break point line fitted to the full series. The green line is the break point line with an R plateau equal to the geometric mean of the year classes 1986–1999. The lower dark blue line corresponds to a break point defined at the lowest observed recruitment.

Given the indication of depensation and uncertainty about the reoccurrence of high values of recruitment if the stock is rebuilt, additional analyses of the stock-recruitment data were conducted (i.e., the series from 1986–1999 only, lowest observed recruitment values only). These analyses indicate lower values of F_{crash} (0.63 and 0.62 respectively).

Poor recruitment and the possibility of depensation are concerns, and the condition of the stock warrants careful monitoring. However, ICES has advised that the multiannual Management Plan for North Sea cod is precautionary and it should result in stock rebuilding if the Plan is fully implemented (i.e., all stock removals are counted against the TAC determined according to the Plan). The ICES recommended catch for 2010 is expected to generate a fishing mortality of 0.51 (ICES, 2009c – Section 6.4.2). F=0.51 is lower than the lowest estimate of F_{crash}. However, a larger margin of safety might be considered in the future.

***Sebastes mentella* in Subarea I and II:** The fishery on this stock developed around 1970, and reached a peak at 269 000 t in 1979 before rapidly declining (although a second catch peak occurred in 1982). A fishery on new grounds developed in the late 1980s (with a peak catch of to 49 000 t in 1991) before declining to a relatively stable level of 10 000–15 000 t. Since 2003, a new fishery has again developed, this time as a pelagic fishery in international waters, with catches close to 30 000 t in 2004.

The pattern of fishery development, decline, and re-development may reflect the episodic nature of recruitment with infrequent strong year classes (among mostly poor recruitment) resulting in a build up of the fishery followed by a decline. The 1989 cohort is the last strong year class. Since then, recruitment seems to have been poor, which suggests that the stock and the fishery are likely to decline as this year class disappears.

Three survey time series were available for this stock: the Norwegian bottom trawl survey in the Svalbard and Barents regions, and the Ecosystem survey. The survey time series are relatively short (1992–2008 for the Norwegian bottom trawl surveys and 1996–2008 for the Ecosystem survey). The surveys give widely different perspectives on the population growth rate and future population levels (Table 1.5.6.1.1). The Norwegian bottom trawl in the Barents area produces a positive population growth rate due to a large cohort observed in 2008. The Norwegian bottom trawl survey in the Svalbard area has the strongest negative growth rate because this cohort was not detected. The Ecosystem survey initiated after the period of high abundance during 1992–1995 indicates slightly negative trend. Stochastic projections of these trends using the estimated standard deviations generated wide confidence intervals for future stock abundance.

The Svalbard survey series indicates that the stock has a high probability of declining to a very low level by 2050 (95% probability of being one third or less than the lowest level ever observed).

	S. mentella		
Year	Barents	Svalbard	Ecosystem
1992	892	1,462	
1993	1,136	1,050	
1994	1,413	1,161	
1995	1,507	900	
1996	1,009	605	1,366,761
1997	808	194	587,223
1998	502	317	577,670
1999	357	640	755,562
2000	385	379	690,837
2001	236	344	507,131
2002	306	379	573,565
2003	301	365	625,687
2004	172	113	314,030
2005	229	152	279,072
2006	180	287	602,255
2007	144	158	876,986
2008	1,073	102	1,024,894
Population Growth Rate			
mean	1%	-17%	-2%
stdev	0.606	0.556	0.442
Projected Population Abundance in 2011			
5%ile	195	13	266,456
95%ile	6,136	307	3,338,319
Projected Population Abundance in 2050			
5%ile	3	0	3,465
95%ile	1.2E+06	36	3.8E+07

Table 1.5.6.1.1 Norwegian bottom trawl survey indices (on age) for *S. mentella* in the Svalbard area (Division IIb) in summer/fall 1992–2006 (numbers in millions), along with the estimated mean and standard deviation of the population growth rate for each series and the 5%ile and 95%ile of the projected populations in 2011 and 2050.

There is no accepted analytical assessment for this stock. While the survey data give an indication of the relative size and frequency of strong year classes, they do not indicate the absolute size of year classes. Assuming that the 1992–2002 catches (average of slightly above 10 000 t) resulted from a period with stable exploitation, the implied average recruitment during the period would be about 100 000 recruits. Unless there has been an increase in recruitment (which does not seem to be the case), the increase in catches since 2004 is probably unsustainable.

ICES advice for this stock is that there should be no directed trawl fishery in 2010, and that area closures should be maintained and bycatch limits should be as low as possible until a significant increase in spawning stock biomass (and a subsequent increase in the number of juveniles) has been verified (ICES, 2009c – Section 3.4.5).

***Sebastes marinus* along the European coastal shelf from beyond 62oN to Spitsbergen:** Recruitment in this stock has been poor since the early 1990s (Figure 1.5.6.1.5). The decline in recruitment preceded the decline in spawning stock size, suggesting that poor recruitment is being affected by an exogenous factor (something other than the fishery). Nevertheless, poor recruitment is a concern and threatens the future viability of the stock.

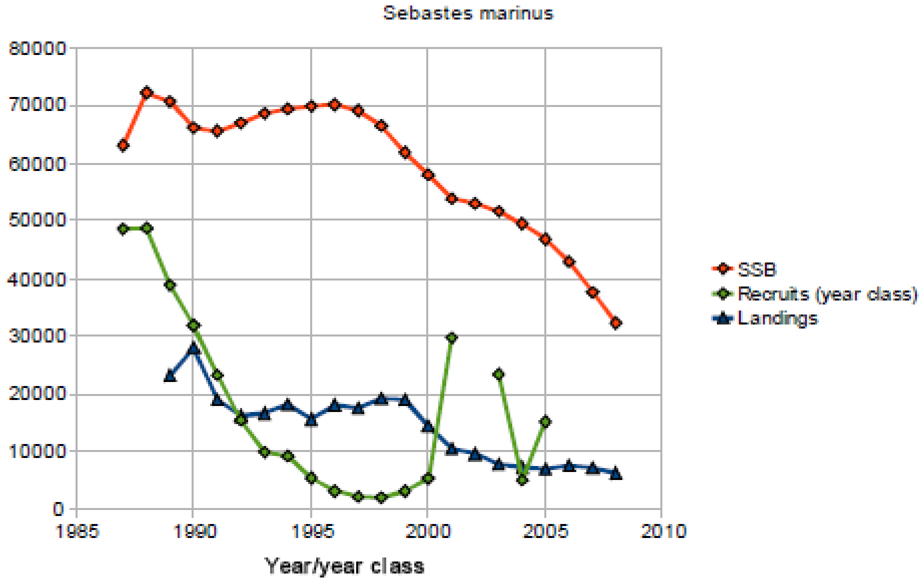

Figure 1.5.6.1.5 SSB, recruitment and landings.

The fishery was previously unregulated, but due to the poor recruitment and subsequent decline in SSB, the directed trawl fishery in Norwegian waters ceased in 2003. Since then, further restrictions to protect *S. marinus* have been introduced in other fisheries, and annual catches have stabilized at about 7000 t, compared to 15 000–30 000 t or more in previous years.

Two surveys of the stock are available (Table 1.5.6.1.2), and both indicate a negative trend. Stochastic projections indicate at least a 5% probability of extinction by 2050.

	S. marinus	
Year	Barents	Svalbard
1992	67,042	51,530
1993	40,568	39,215
1994	59,766	20,155
1995	69,930	23,400
1996	55,030	6,500
1997	60,980	16,950
1998	48,487	15,696
1999	27,879	19,748
2000	20,230	6,250
2001	20,380	12,940
2002	17,814	2,518
2003	15,230	2,229
2004	13,520	2,430
2005	8,944	1,177
2006	15,030	1,148
2007	7,652	7,702
2008	6,306	11,292
Population Growth Rate		
mean	-15%	-9%
stdev	0.326	0.889
Projected Population Abundance in 2011		
5%ile	1,639	711
95%ile	10,301	109,255
Projected Population Abundance in 2050		
5%ile	0	0
95%ile	399	2.9E+06

Table 1.5.6.1.2 Survey time series for redfish (*S. marinus*) along the European coastal shelf from beyond 62°N to Spitsbergen together with the estimated mean and standard deviation of the population growth rate for each series and the 5%ile and 95%ile of the projected populations in 2011 and 2050.

Simulations were performed using the assumption that the poor recruitment observed during the 1999–2002 period (an average of 26.8 million recruits) would apply in the future, with recruitment independent of the spawning biomass. Twenty simulated trajectories (Figure 1.5.6.1.6) having a constant annual catch of 7000 t annually (about the recent level) indicate that a fishery of this magnitude is probably not sustainable.

ICES fisheries management advice is that there should be no directed fishery in 2010 on this stock (ICES, 2009c – Section 3.4.6).

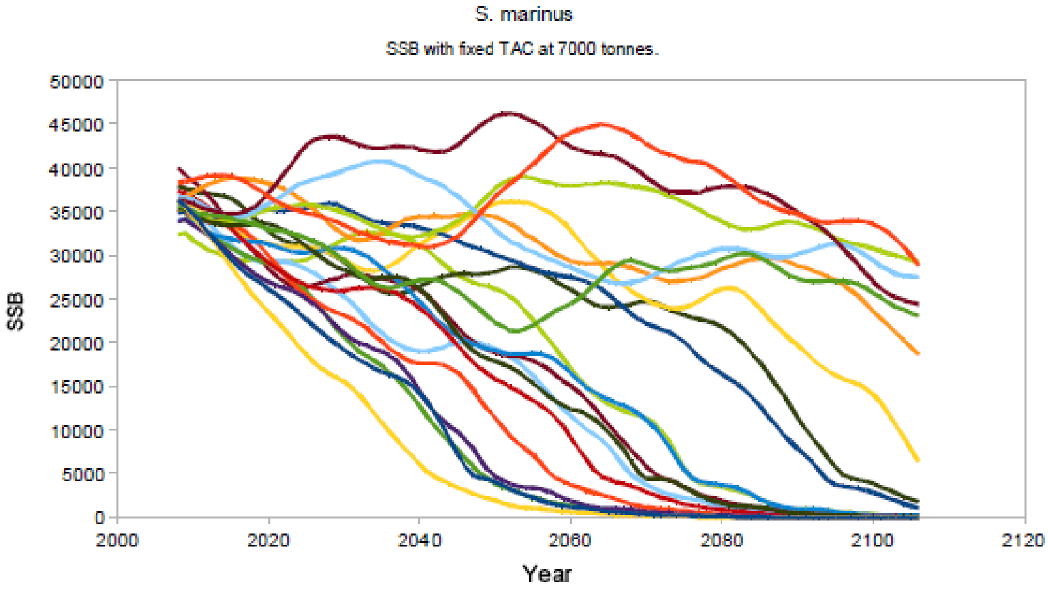

Figure 1.5.6.1.6 Individual projections of SSB for a constant catch of 7000 t.

Source of Information

ICES. 2009a. Report of the Workshop on analytical methods for evaluation of extinction risk of stocks in poor condition (WKPOOR1), ICES Headquarters 18–20 May 2009 (ICES CM 2009/ACOM:29)

ICES. 2009b. Report of the Workshop for the Exploration of the Dynamics of Fish Stocks in Poor Conditions (WKPOOR2), Bergen, Norway 24–27 August 2009 (ICES CM 2009/ACOM:49)

ICES. 2009c. ICES 2009. Report of the ICES Advisory Committee, 2009, ICES Advice, 2009. Books 1–11.

Annex 1

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Evaluation of the IUCN criteria used for redlisting of marine fish species

The Royal Norwegian Ministry of Fisheries and Coastal Affairs asks hereby The International Council for the Exploration of the Sea (ICES) to undertake an evaluation of the IUCN criteria used for redlisting of marine fish species.

The following tasks should be considered:

1. Review of the IUCN criteria and evaluate the suitability and usefulness of using these on marine fish species. Comparison with the ICES system of reference points.
2. Evaluate whether the risk analytical methods currently used by IUCN are suitable for marine fish species, and, if necessary, suggest other and more appropriate methods and procedures
3. Discuss and suggest procedures and methods within ICES to gather and provide useful biological information about non-commercial species that may improve the redlist evaluation of these species.

We look forward to your response with regards to this request.

Yours sincerely,

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Director General

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Deputy Director General

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