
Annex 2 – Stock Annex Cod Coastal

Quality Handbook**ANNEX:cod-coastal****Standard Procedure for Assessment****XSA/ICA Type**

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Norwegian Coastal cod
Working Group:	Arctic Fisheries Working Group
Date:	11-05-2010

Approach used by the 2010 WG

For several years the xsa-analyses based on this stock annex have shown a retrospective bias. At the same time the trends seen in the survey and the catches have been considered to be a sufficient basis for the advice. The 2010 wg was asked to evaluate a rebuilding plan for coastal cod. It was then a need for a more robust analytical assessment. In addition, a new time series on catch at age in the recreational fishery was presented and added to the canum for commercial catches.

An estimate for F 2009 was obtained from surveys and an estimate for F2008 were obtained directly from catches (details in Annex 10). These estimates were used for deciding on a best estimate of F2009 that were used as terminal F in a traditional vpa. Selection at age in 2009 and Fold for earlier years were taken from a trial xsa. In addition to this, the annual values for maturity were replaced by the average observed over the survey series (1995-2009).

The traditional vpa were then taken as the final assessment.

With the new catch data the xsa showed improved diagnostics, particularly for the younger ages, when assuming catchability dependent on stock numbers for ages 2 and 3.

Some of these changes were rather ad hoc. Some intercessional further work should examine this further, and a benchmark would be relevant in near future.

Chapters A-I is the stock Annex dated 24. April 2009.

A General

A.1. Stock definition

Cod in the Barents Sea, the Norwegian Sea and in the coastal areas living under variable environmental conditions form groups with some peculiarities in geographical distribution, migration pattern, growth, maturation rates, genetics features, etc. The degree of intermingle of different groups is uncertain (Borisov, Ponomarenko and Yaragina, 1999). However, taking into account some biological characteristics of cod in the coastal zone and the specifics of the coastal fishery, the Working Group consi-

dered it acceptable to assess the Norwegian coastal cod stock (in the frame of ICES) separately from North-East Arctic cod.

Both types of cod (the Norwegian Coastal cod and the North-East Arctic cod) can be met together on spawning grounds during spawning period as well as in catches all the year round both inshore and offshore in variable proportions.

The Norwegian Coastal cod (NCC) is distributed in the fjords and along the coast of Norway from the Kola peninsula in northeast and south to Møre at 62° N. Spawning areas are located in fjords as well as offshore along the coast. Spawning season extends from March to late June. The 0 and 1-group of NCC inhabit shallow water both in fjords and in coastal areas and are hardly found in deeper trawling areas until reaching about 25 cm. Afterwards they gradually move towards deeper water. NCC starts on average to mature at age 4-6 and migrates towards spawning grounds in early winter. The majority of the biomass (about 75 %) is located in the northern part of the area (North of 67° N).

Tagging experiments of cod inhabiting fjords indicate only short migrations (Jakobsen 1987, Nøstvik and Pedersen 1999, Skreslet, *et al.* 1999). From these experiments very few tagged cod migrated into the Barents Sea (<1%). Investigations based on genetics find large difference between NCC and North-East Arctic cod (NEAC) (Fevolden and Pogson 1995, Fevolden and Pogson 1997, Jørstad and Nævdal 1989, Møller 1969), while others do not find clear differences (Árnason and Pálsson 1996, Mork, *et al.* 1984, Artemjeva and Novikov, 1990). Investigations also indicate that NCC probably consists of several separate populations.

Ongoing microsatellite studies on the genetic structure of cod along the entire Norwegian coast have revealed considerable genetic differences. Two main clusters were indicated: one north of 64 deg north (Trondheimsfjord) and one to the south of this. Differences were also observed between regions within these clusters. The conclusion is that NCC is not a single stock.

A.2. Fishery

Coastal cod is mainly fished by small coastal vessels using traditional fishing gears like gillnet, longline, hand line and danish seine, but some is also fished by trawlers and larger longliners fishing at the coastal banks. The fishery is dominated by gillnet (50%), while longline/hand line account for about 20%, Danish seine 20% and Trawl 10% of the total catch. There was a shift around 1995 in the portion caught by the different gears. Before 1995 the portion taken by longline and hand line was higher, while the portion taken by danish seine was lower. Norwegian vessels take all the reported catch. However, trawlers from other countries probably take a small amount of NCC when fishing near the Norwegian coast fishing for North-East Arctic cod and North-East Arctic haddock.

The TAC set for coastal cod is added to the Norwegian TAC for North-east Arctic cod, giving a total, combined TAC to distribute on fishing vessels. Cod catches are not identified to stock at landing, and therefore no landings are counted against a separate coastal cod quota. When the fishing year is finished the catches of coastal cod are estimated from otholit sampling. All regulations for North-east Arctic cod also applies to coastal cod. This includes minimum catch size, minimum mesh size, maximum by-catch of undersized fish, and closure of areas having high densities of juveniles. In addition, trawl fishing for cod is not allowed inside the 6-n.mile, and since the mid 90-ies the fjords in Finnmark and northern Troms (areas 03 and 04) has been closed for fishing with Danish seine, and since 2000 the large longliners have

been given restrictions, now only allowed to fish outside the 4 n.mile. Since 2004 additional restrictions on coastal fisheries have been introduced to reduce catches of coastal cod. In these new regulations "fjord-lines" are drawn along the coast to close the fjords for direct cod fishing with vessels larger than 15 meter. A box closed for all fishing gears except hand-line and fishing rod is defined in the Henningsvær-Svolvær area. This is an area where spawning concentrations of coastal cod is usually observed and where the catches of coastal cod has been high. Since the coastal cod is fished under a combined coastal cod/north-east arctic cod quota, these regulations are supposed to turn parts of the traditional coastal fishery over from catching coastal cod in the fjords to catch more cod outside the fjords where the proportion of North-east Arctic cod is higher. Further restrictions were introduced in 2007 by not allowing pelagic gill net fishing for cod and by reducing the allowed by-catch of cod when fishing for other species inside fjord lines from 25% to 5%, and outside fjord-lines from 25% to 20%. In 2009 a fjord area off Ålesund was closed in the spawning season for fishing with all gears except handline and fishing rod.

A.3. Ecosystem aspects

Not investigated

B. Data

B.1 Commercial catch

From 1996, cod caught inside the 12 n.mile zone have been separated into Norwegian coastal cod and North-east Arctic cod based on biological sampling (Berg, *et al.* 1998) The method is based on otolith-typing. This is the same method as is used in separating the two stocks in the surveys targeting NEAC. The catches of Norwegian coastal cod (NCC) have been calculated back to 1984 using available data on otolith typing. During this period the catches have been between 22,000 and 75,000 t.

The separation of the Norwegian catches into NEAC and NCC is based on:

- No catches outside the 12 n.mile zone have been allocated to the NCC catches.
- The catches inside 12 n.mile zone are separated into quarter, fishing gear and Norwegian statistical areas.
- From the otolith structure, catches inside the 12 n.mile zone have been allocated to NCC and NEAC. The Institute of Marine Research in Bergen has been taking samples of commercial catches along the coast for a long period.

Norwegian commercial catch in tonnes by quarter, area and gear are derived from the sales notes statistics of The Directorate of Fisheries. Data from 8 sub areas are aggregated on 6 main areas for the gears gillnet, long line, hand line, Danish seine and trawl. No discards are reported or accounted for, but there are reports of discards and incorrect landings with respect to fish species and amount of catch. The scientific sampling strategy from the commercial fishing is to have age-length samples from all major gears in each area and quarter. The sampling intensity is determined by knowledge on the distribution of the combined cod catches.

There are at present no defined criteria on how to allocate samples of catch numbers, mean length and mean weight at age to unsampled catches. The following general process has been applied: First look for samples from a neighbouring area if the fishery extends to this area in the same quarter. If there are no samples available in

neighbouring areas, search for samples from other gears with the most similar selectivity in the same area or in neighbouring areas. The last option is to search in neighbouring quarters, first from the same gear in the same area, and then from neighbouring areas and similar gears. Age-length keys from research surveys with shrimp trawl (Norwegian coastal survey) are also used to fill holes.

Weight at age is calculated from the commercial catch back to 1984. The mean values are weighted by catches in the respective areas.

Proportions mature at age from 1984 to 1994 are obtained from the commercial catch data. From 1995 onwards the proportions mature at age are obtained from the Norwegian coastal survey.

Norway is assumed to account for all NCC landings. The text table below shows which kind of data are collected:

Country	Kind of data				
	Caton (catch in weight)	Canum (catch at age in numbers)	Weca (weight at age in the catch)	Matprop (proportion mature by age)	Length composition in catch
Norway	X	X	X	X	X

B.2. Biological

Weight at age in the stock is obtained from the Norwegian coastal survey in from 1995 onwards. From 1984 to 1994 weight at age in stock is taken from weight at age in the catch because no survey data from this period are available. The mean values are weighted by biomass in the respective areas. In 2007 a weight at age series of un-weighted mean values from the survey was calculated and used in the SURBA analysis.

A fixed natural mortality of 0.2 is used both in the assessment and the forecast. Some fjord studies (Pedersen and Pope, 2003a and b, Mortensen 2007, Pedersen *et al.*, 2007). indicate that the main predators on young cod is larger cod, cormorants and saithe. There are no estimates of annual predation mortality for the stock complex.

Both the proportion of natural mortality before spawning (Mprop) and the proportion of fishing mortality before spawning (Fprop) are to 0.

B.3. Survey

Since 1995 a Norwegian trawl-acoustic survey (Norwegian coastal survey) specially designed for coastal cod has been conducted annually in September (prior to 2003) and in October-November (28 days). The survey covers the fjords and coastal areas from the Varangerfjord close to the Russian border and southwards to 62° N. The aim of conducting a acoustic survey targeting Norwegian coastal cod has been to support the stock assessment with fishery-independent data of the abundance of both the commercial size cod as well as the youngest pre-recruit coastal cod. The survey therefore covers the main areas where the commercial fishery takes place, normally dominated by 4 - 7 year old fish.

The 0- and 1 year-old coastal cod, mainly inhabiting shallow water (0-50 meter) near the coast and in the fjords, are also represented in the survey, although highly variable from year to year. However, the 0-group cod caught in the survey is impossible to classify to NCC or NEAC by the otoliths since the first winter zone is used in this

separation. A total number of more than 200 trawl hauls are conducted during the survey (100 bottom trawl, 100 pelagic trawl).

The survey abundance indexes at age are total numbers (in thousands) computed from the acoustics.

Ages 2-8 are used in the XSA-tuning. Ages 2 – 9 are used in a SURBA analysis.

B.4. Commercial CPUE

No commercial CPUE are available for this stock.

B.5. Other relevant data

A number of bottom trawl tows are made during the coastal survey, and since 2003 the survey has aimed for towing at the same fixed positions each year. This might be used to calculate a bottom trawl index.

C. Historical stock development

Acoustic survey

The total acoustic biomass varies between 144,000t (1995) and 30,300t (2005), showing a decline from 1995 until 2003, and flat level since 2003. The indices show considerable year to year variations. The acoustic spawning biomass vary between 75,000t (1995) and 12,700t (2005), showing the same type of trend as the total biomass. The recruitment of 2 year old fish vary from 20 million individuals in 1995 to 2 million in 2005, also showing the same, but stronger trend as the total stock.

SURBA analysis

The SURBA analysis (SURBA 2.10) is run with the same data as input to the XSA (see below). However, the age span is 2 – 9 year in the SURBA analysis. The settings are set similar to the XSA settings. The weight at age for the stock is calculated as un-weighted mean values to avoid some of the large fluctuations in the weight at age from the survey calculations.

The history of the stock is reflected in the same way in this analysis as in the survey, showing a drop to a level in the later years about 25% of the level in 1995. The recruitment is down to a 10% level.

VPA analysis

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options chosen:

Tapered time weighting applied, power = 3 over 20 years

Catchability independent of stock size for all ages

Catchability independent of age for ages ≥ 8

Survivor estimates shrunk towards the mean F of the final 2 years or the 4 oldest ages

S.E. of the mean to which the estimate are shrunk = 1.0

Minimum standard error for population estimates derived from each fleet = 0.300

Prior weighting not applied

Input data types and characteristics:

Type	Name	Year range	Age range	Variable from year to year Yes/No
Caton	Catch in tonnes	1984 – last data year	2 – 10+	Yes
Canum	Catch at age in numbers	1984 – last data year	2 – 10+	Yes
Weca	Weight at age in the commercial catch	1984 – last data year	2 – 10+	Yes
West	Weight at age of the spawning stock at spawning time.	1984 – last data year	2 – 10+	Yes/No - assumed to be the same as weight at age in the catch from 1984-1994
Mprop	Proportion of natural mortality before spawning	1984 – last data year	2 – 10+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1984 – last data year	2 – 10+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1984 – last data year	2 – 10+	Yes
Natmor	Natural mortality	1984 – last data year	2 – 10+	No – set to 0.2 for all ages in all years
Tuning fleet	Norwegian coastal survey	1995 – last data year	2 – 8	

The results show a variation of the total biomass between 310,000t (1984) and 87,000t (2008) with the value in 1995 being 260,000t. The spawning stock is estimated to 170,000t in 1995, falling to 50,000t in 2008. The fishing mortality is estimated to 0.38 on average. The pattern of stock decline is fairly similar to that of the survey.

D. Short-term projection

No quantitative projection but trends in stock biomass, mortality and recruitment obtained from surba (and xsa) are used to indicate stock development. t

E. Medium-term projections

Not done.

F. Long-term projections

Not done.

G. Biological reference points

Not available.

H. Other issues

I. References

- Árnason, E. and Pálsson, S. 1996. Mitochondrial cytochrome b DNA sequence variation of Atlantic cod *Gadus morhua*, from Norway. *Molecular Ecology* 5: 715-724.
- Artemjeva, K.F. and G.G. Novikov. 1990. Peculiarities of population structure of the Northeast Atlantic cod. In: *Ecology, reproduction and conservation of biological resources in seas of the Northern Europe*. Murmansk, p.162-164 (in Russian)
- Berg, E., Eriksen, I. A. and Eliassen, J.-E. 1998. Catch-statistics for Norwegian Coastal cod 1984-1997, -data and methods. *Fiskeriforskning*,10/1998.
- Borisov, V. M., Ponomarenko, V. P. and Yaragina, N. A. (1999). A Critical Review of the Population Status in Coastal cod (*Gadus morhua*) from Barents Sea Region of Norway. *Journal of Ichthyology* 39: 18-28.
- Fevolden, S. E. and Pogson, G. H. 1995. Difference in nuclear DNA RFLPs between the Norwegian coastal and the Northeast Arctic population of Atlantic cod. pp. 403-415. In: Skjoldal, H. R., Hopkins, C., Erikstad, K. E. and Leinaas, H. P. (ed.) *Ecology of Fjords and Coastal Waters*, Elsevier Science B. V.
- Fevolden, S. E. and Pogson, G. H. 1997. Genetic divergence at the synaptophysin (Syp I) locus among Norwegian coastal and north-east Arctic populations of Atlantic cod. *Journal of Fish Biology* 51: 895-908.
- Jakobsen, T. 1987. Coastal Cod in Northern Norway. *Fisheries Research* 5: 223-234.
- Jørstad, K. E. and Nævdal, G. 1989. Genetic variation and population structure of cod, *Gadus morhua* L., in some fjords in northern Norway. *Journal of Fish Biology* 35: 245-252.
- Mork, J., Giskeødegård, R. and Sundnes, G. 1984. Population genetics studies in cod (*Gadus morhua* L.) by means of the haemoglobin polymorphism; observations in a Norwegian coastal population. *Fiskeridirektoratets Skrifter Serie Havundersøkelser* 17, No. 12: 449-471.
- Mortensen, E. 2007. Er det variasjon i diett og lengde ved alder hos torsk (*Gadus morhua* L.) nord for 64°N? [in Norwegian]. Master Thesis, University of Tromsø, June 2007.
- Møller, D. 1969. The relationship between Arctic and coastal cod in their immature stages illustrated by frequencies of genetic characters. *Fiskeridirektoratets Skrifter Serie Havundersøkelser* 15: 220-233.
- Nøstvik, F. and Pedersen, T. 1999. Movement pattern and growth of wild cod (*Gadus morhua* L.) and hatchery-reared cod released as 1-group. pp. 315-333. In: Howell, E., Moksness, E. and Svåsand, T. (ed.) *Stock Enhancement and Sea Ranching*, Fishing News Books, Oxford.
- Pedersen, T. and Pope, J.G. 2003a. Sampling and a mortality model of a Norwegian cod (*Gadus morhua* L.) fjord population. *Fish. Res.* 63, 1-20.
- Pedersen, T. and Pope, J.G. 2003b. How may feeding data be integrated into a model for a Norwegian fjord population of cod (*Gadus morhua* L.). *Sci. Mar.* 67 (Suppl. 1), 155-169.
- Pedersen, T., Nilsen, M., Berg, E., and Reigstad M. 2007. Trophic modell of a lightly exploited cod-dominated ecosystem. In; Nilsen, M: "Trophic interactions and the importance of macrobenthic invertebrate production in two Arctic fjord systems". A dissertation for PhD, University of Tromsø, Autumn 2007.
- Skreslet, S., Albrigtsen, I., Andersen, A. P., Kolbeinshavn, A., Pedersen, T. and Unstad, K. 1999. Migration, growth and survival in stocked and wild cod (*Gadus morhua* L.) in the Vestfjord region, North Norway. pp. 306-314. In: Howell, E., Moksness, E. and Svåsand, T. (ed.) *Stock Enhancement and Sea Ranching*, Fishing News Books, Oxford.