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Update on trends in biomass and state of the stock of northern (2J+3KL) cod

J. Brattey, B. P. Healey, D. Parsons, E. Murphy, D. Power,
M. J. Morgan, and K. Dwyer

Science Branch,
Dept of Fisheries and Oceans,
P. O. Box 5667,
St. John's NL A1C 5X1
Canada

Introduction

This document item VII-1-c)-x) on the Agenda of the Scientific Council Meeting held in June 2012, i.e. the Fisheries Commission's Request for Scientific Advice on Management in 2013 and beyond of certain stocks in subareas 2, 3 and 4 and other matters):

"**For the cod stock in Divisions 2J+3KL, the Scientific Council is requested to comment on the trends in biomass and state of the stock in the most recent Science Advisory Report from the Canadian Science Advisory Secretariat (CSAS)**."

Background

The northern (Divs. 2J+3KL) cod stock is typically assessed annually during CSAS Regional Advisory Process (RAP) meetings held in St. John's, NL. Science Advisory Reports provide a synopsis of the meeting results and advice (DFO, 2010, 2011) and details of the assessment are outlined in Research Documents (Brattey et al. 2011). In addition to standard assessment meetings, a conservation limit reference point (LRP) was established for Northern cod following a CSAS framework meeting held in November 2010 (DFO, 2010). This reference point defines the boundary between the critical and cautious zones within the DFO Precautionary Approach framework (DFO, 2009) and defines the stock level below which serious harm is occurring.

The most recent CSAS report on the status of northern (2J+3KL) cod was prepared following a Regional Science Special Response Process (SSRP) conducted on 12 March 2012 in St. John's NL (DFO, 2012). Rather than a full assessment, the status of the Northern cod stock was updated based on key information obtained during 2011. This is similar to the Scientific Council monitoring of stocks between full assessments.

In recent assessments of the status of northern cod no VPA-type analysis that require catch information have been used as the basis for scientific advice, mainly due to the lack of reliable catch information. In particular, there have no direct estimates of recreational fishery landings from this stock and tagging information suggest that these could be substantial relative to stewardship fishery landings (DFO 2011, 2012). Recent assessments have largely been based on cohort modeling of DFO RV autumn survey data (DFO, 2010, 2011; Brattey, 2011). This model provided relative estimates of stock size and absolute estimates of total mortality rates (Z). A conservation limit reference point (LRP) recently established for Northern cod and this was defined as the average survey SSB for the 1980's period. The value can be obtained directly from survey data or from modeled estimates, and can be expressed either as survey SSB mean weight per tow (54 kg /tow in 2010), or as swept area estimate of SSB . After the 1980's, SSB for 2J+3KL has been low and recruitment consistently poor, indicating that the stock has been below a level where serious harm occurs.

The present document, which comments on trends in biomass and state of the stock, is based on information given in the latest CSAS Science Response Report entitled “Stock assessment update of northern (2J+3KL) cod” (DFO, 2012).

Reported Landings

A summary of reported landings (nearest thousand tons) is given in Table 1 in Appendix I. A moratorium in the offshore has been in place since 1992, but intermittent fisheries have taken place in the inshore, with reported landings ranging from 4,000 to 9,000 t during 1998-2002 and from 1,000 t to 4,000 t during 2006-2011.

A stewardship fishery for cod and a recreational fishery for groundfish were permitted in the inshore of 2J+3KL during 2011. Reported landings of cod in 2011 were 3,139 t. The 2011 landings comprised 2,872 t in the stewardship fishery, 214 t in the sentinel surveys, and 43 t taken as by-catch. There are no direct estimates of landings from the recreational fishery for 2011; therefore total catch in 2011 is uncertain. However, analysis of tag returns suggests that removals from recreational fisheries during 2011 were approximately 50% of removals from the stewardship fishery.

Stock trends from autumn bottom-trawl surveys

(a) Biomass and Spawning Stock Biomass (SSB)

A time series of catch rate information from Canadian stratified random bottom-trawl surveys is available from 1983 onwards. The biomass index derived from the autumn research vessel (RV) surveys has been extremely low since the start of the moratorium in 1992 (Fig. 1). The biomass index increased during 2005-08 but the increasing trend has not persisted. The average biomass index during 2009-11 is 9% of the average during the 1980s.

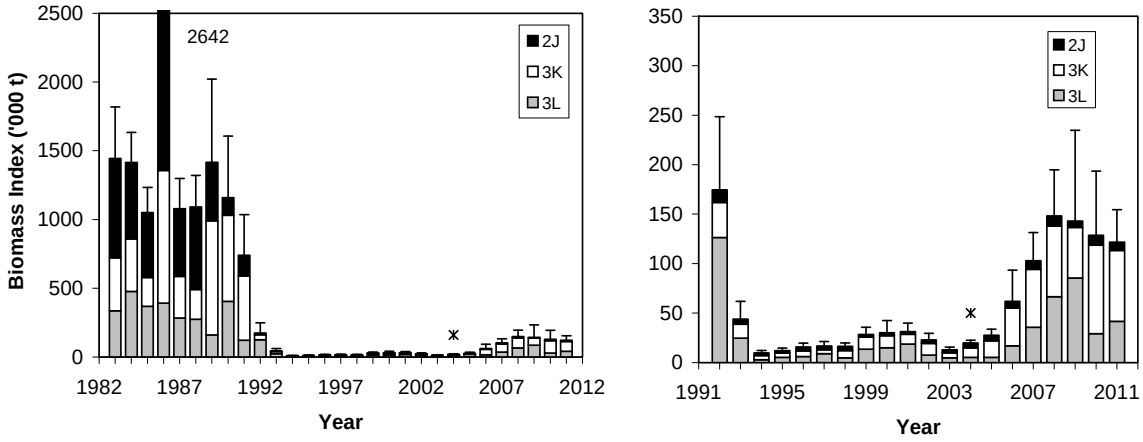

Figure 1: Offshore biomass index (+2 SE’s) from autumn RV surveys in 2J3KL. The right panel is expanded to show trends from 1992 onwards. Asterisks indicate partial estimates from incomplete survey coverage of 3L in 2004.

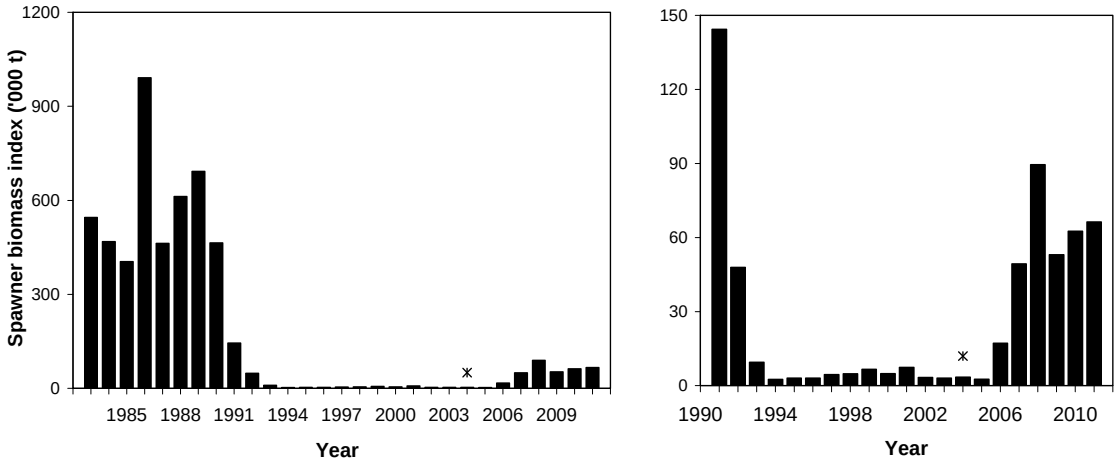

Figure 2: Offshore spawning stock biomass (SSB) index from autumn RV surveys in 2J3KL. The right panel is expanded to show trends from 1991 onwards. Asterisks indicate partial estimates from incomplete survey coverage of 3L in 2004.

The spawning stock biomass (SSB) index from the autumn RV survey has been low for several years since the 1992 moratorium, but increased slightly during 2005-08 (Fig. 2). The three most recent values of the SSB index show no major changes and during 2009-11 represent 10% of the average SSB observed in the 1980s.

The index values for abundance, biomass and SSB from 1991 onwards are given in Table 2 in Appendix I.

(b) Recruitment

Information on recruitment was derived from mean catch rate at age during the autumn RV surveys.

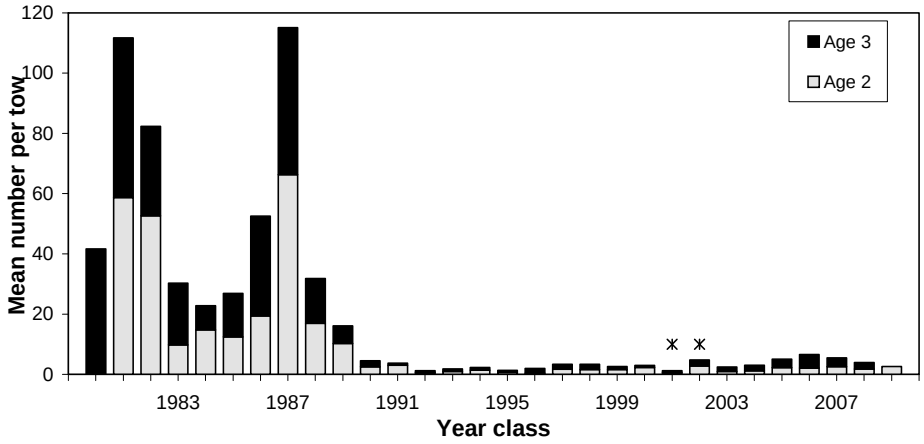

Figure 3: Abundance of the 1980-2009 year-classes at age 2 and age 3 in the offshore of 2J3KL from the autumn RV surveys. Asterisks indicate partial estimates for the 2002 year-class at age 2 and the 2001 year-class at age 3 due to incomplete survey coverage of 3L in 2004.

Year-class strength in the offshore in the 1990s and 2000s has been poor compared to the 1980s. The number of young fish (ages 2 and 3) in the autumn RV survey in the 1990s and 2000s has consistently been much lower than during the 1980s (Fig. 3).

(c) Total Mortality Rate (Z)

Information on total mortality rate was derived from mean catch rate at age during the autumn RV surveys (see legend to Fig. 4).

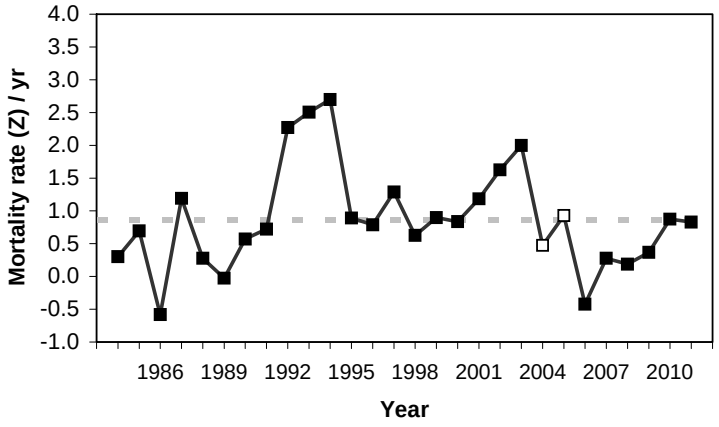

Figure 4: Total mortality rate (Z) of cod aged 4-6 calculated using data from the autumn RV surveys in the offshore of 2J3KL. For example, the value in 1996 is the mortality experienced by the 1991-1989 year-classes from ages 4-6 in 1995 to ages 5-7 in 1996. The dashed line is the time-series average (Z=0.87 which corresponds to 58% mortality per year). Open symbols indicate estimates based on an incomplete survey of 3L in 2004.

The total mortality rate (*Z*, ages 4-6) was low in the 1980s, but was at a high level (*Z*>0.6, i.e., >45% per yr) from the early 1990s to the mid-2000s, with peaks during the early 1990s and early 2000s (Fig. 4). This high level of mortality during much of the post-moratorium period has been a major impediment to stock recovery. Total mortality declined substantially during 2003-06, resulting in an expansion of the age composition, and this was an important factor in the increase in total biomass and SSB during 2005-08 (Figs. 1 and 2). However, Z has increased in the recent period and in 2009-11 averaged 0.69, which corresponds to 50% mortality per year. If this level of total mortality continues, prospects for further stock growth are poor.

(d) Tagging

Information from recaptures of cod tagged in various regions of Divs. 3KL was used to estimate average annual exploitation (harvest) rates. The number of cod tagged per year during 2008-2011 has ranged from 2,000 to 5,400. Cod tagged offshore in 3K during winter 2008 were recaptured widely throughout the inshore of 3KL during the summer and autumn of 2008-2011, indicating that offshore cod underwent their traditional seasonal inshore migration similar to the pre-moratorium period.

Reporting rates of tags were estimated using a high-reward tagging study. The reporting rate of tags from commercial fishers during 1997-2011 has ranged from 70% to 86% and shows no trend; the 2011 reporting rate was 73%. A constant but lower reporting rate was estimated for recreational fishers during 2006-2011 (51-53%).

Exploitation rates were consistently low for cod tagged in the offshore and for those tagged inshore in central and southern areas, ranging between 2 and 10% during 2009-11. These estimates included different assumed values for the annual rate of natural mortality (0.2 and 0.4) and different size ranges of tagged cod (50-85 cm and >60 cm) to account for the influence of size-selective fishing gears.

Conclusions

Spawning stock biomass (SSB) of northern cod has been well below the LRP since the early 1990s. Although a slight improvement in status was observed during 2005-2008, the increasing trend has not persisted and in 2010 the stock was 90% below the LRP (DFO, 2011). Modeling of SSB from DFO RV survey data was not conducted for the 2012 update of stock status. However, the SSB index value from the 2011 survey is only marginally above the 2010 value (Fig. 2) and the stock has shown no significant improvement, remaining well below the LRP.

Tagging results indicate that current levels of removals have resulted in low exploitation rates; however, total mortality rates increased to approximately 50% per year in 2009-11. At current levels of recruitment and survival prospects for further stock growth are poor and the stock will not reach the LRP in the short term.

A draft of proposed text for the Scientific Council report to address the Fisheries Commission request is given in Appendix II.

References

Brattey, J., Cadigan, N.G., Dwyer, K., Healey, B.P., Morgan, M.J., Murphy, E.F., Maddock Parsons, D., and Power, D. 2011. Assessment of the cod (*Gadus morhua*) stock in NAFO Divisions 2J+3KL in 2010. DFO Can. Sci. Advis. Sec. Res. Doc. 2010/103. viii + 108 p..

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Appendix I

Table 1: Reported landings by management year in NAFO Divs. 2J3KL (nearest thousand metric tons). Detailed catch history is reported in Brattey et al. 2011.

Year	62-76 Avg.	77-91 Avg.	98	99	00/ 01	01/ 02	02/ 03	03-06 Avg.	06/07 & 07/08[1,2]	08/ 09[1]	09/ 10[1,2]	10/ 11[1,2]	11/ 12[1,2]
TAC	N/A	N/A	4	9	7	6	6	0	-	-	-	-	-
Can. Fixed	88	90	5	9	5	7	4	1	3	4	3	3	3
Can. Mobile	**9**	84	-	-	-	-	-	-	-	-	-	-	-
Others	405	38	-	-	-	-	-	-	-	-	-	-	-
Totals	502	212	5	9	5	7	4	1	3	4	3	3	3

[1] There was no TAC in the last six years, but fishers were permitted an allowance per license holder of 3,000 lb in 2006/07, 2,500 lb in 2007/08, 3,250 lb in 2008/09, and 3,750 lb in 2009/10, 2010/11, 2011/12.
[2] Does not include Canadian recreational fisheries as no direct estimates were available.

Table 2. Cod abundance (000's), biomass (t) and spawning stock biomass (SSB, t) indices from DFO autumn RV surveys (1991 onwards). Values for years prior to 1991 are reported in Brattey et al. 2011.

	Abundance (000's)				Biomass (t)				SSB (t)
Year	**2J**	**3K**	**3L**	**Total**	**2J**	**3K**	**3L**	**Total**	**Total**
1991	323,637	649,349	144,684	1,117,670	150,136	467,502	121,759	739,397	144,399
1992	30,960	61,622	147,158	239,740	12,795	35,344	126,323	174,462	47,909
1993	16,989	36,907	36,813	90,709	5,129	14,227	24,596	43,952	9,561
1994	8,145	9,361	4,291	21,797	2,693	4,241	2,874	9,808	2,578
1995	12,305	23,200	7,735	43,240	2,312	4,578	5,115	12,005	3,050
1996	13,081	18,550	7,067	38,698	4,261	5,457	6,140	15,858	3,057
1997	6,936	8,428	9,859	25,223	3,609	3,978	8,991	16,578	4,502
1998	6,636	15,612	6,454	28,702	4,483	7,280	4,804	16,567	4,865
1999	6,074	29,308	25,281	60,663	2,527	12,230	13,611	28,368	6,643
2000	7,516	35,774	29,010	72,300	3,082	11,994	15,070	30,146	4,885
2001	7,033	28,535	27,724	63,292	2,646	9,890	18,706	31,242	7,378
2002	9,534	41,853	10,984	62,371	3,680	11,889	7,460	23,029	3,388
2003	9,315	19,908	13,638	42,861	3,065	4,912	4,849	12,826	3,065
2004	9,503	34,468	18,605	62,576	4,921	9,609	5,266	19,796	3,472
2005	18,519	33,834	8,780	61,133	5,719	16,696	5,118	27,533	2,625
2006	11,739	52,285	18,711	82,735	6,818	38,009	16,982	61,809	17,150
2007	26,656	54,122	47,249	128,027	8,755	58,427	35,722	102,904	49,354
2008	45,583	62,848	53,957	162,388	10,429	71,329	66,401	148,159	89,553
2009	15,250	47,949	111,782	174,981	6,473	51,106	85,410	142,989	52,996
2010	17,278	83,060	39,012	139,350	9,905	89,388	29,255	128,548	62,573
2011	17,937	59,233	29,282	106,452	8,542	71,541	41,615	121,698	66,312

Appendix II

An update of the status of the northern (2J+3KL) cod stock was presented based on the most recent information in the Canadian Science Advisory Secretariat Science Report. This stock update was based mainly on data from a time series (1983-2011) of catch rate information from Canadian stratified random research vessel (RV) bottom-trawl surveys conducted during autumn, and from tagging results. The spawning stock biomass index from the RV survey has been low for several years since the 1992 moratorium, but increased slightly during 2005-08 due to a reduction in mortality rates. The increasing trend has not persisted and the three most recent values of this index (2009-2011) show no major changes. In 2010, the stock was 90% below the LRP based on survey index values and modeled estimates. The SSB index value from the 2011 survey indicates that the stock has shown no significant improvement and remains well below the LRP.

Tagging results indicate that current levels of removals have resulted in low exploitation rates; however, total mortality rates increased to approximately 50% per year in 2009-11. At current levels of recruitment and survival, prospects for further stock growth are poor and the stock will not reach the LRP in the short term.