NORTHERN (2J3KL) COD STOCK UPDATE

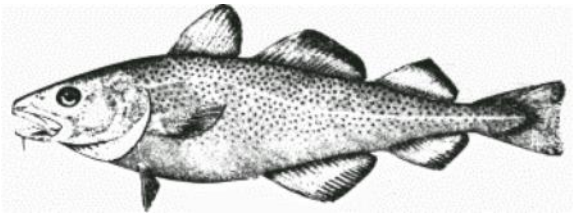

Image: Northern Cod

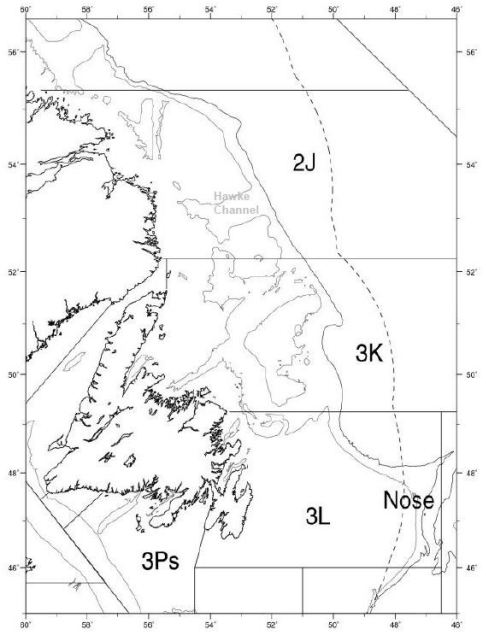

Figure 1. Stock area of Northern (2J3KL) cod. The dashed line indicates Canada's 200 nautical mile Exclusive Economic Zone (EEZ).

Context

A conservation limit reference point (LRP) was established for Northern (2J3KL) Cod in 2010 (DFO 2011). This reference point defines the boundary between the critical and cautious zones within the Precautionary Approach framework and defines the stock level below which serious harm is occurring. The most recent assessment (March, 2013) concluded that the stock was 85 % below the LRP; at this level the stock is considered to have suffered serious harm and the ability to produce good recruitment is seriously impaired. The current multi-year management plan, whereby harvesters are permitted an annual allowance of 2.3 t (= 5,000 lb) per fisher, is scheduled to remain in place until 31 March 2016. However, new information is available annually and the purpose of the current update is to examine data obtained during 2013 to monitor any changes in stock status. This update was prepared to advise on the latest status of the stock which has been subjected to ongoing stewardship and recreational fisheries in the inshore since 2006. Although there are no explicit timelines or targets for stock rebuilding upon which to base advice, a rebuilding plan for this stock is currently under development.

This Science Response Report (SRR) results from the Science Response Process of 26 March 2014 on the Northern (2J3KL) Cod Stock Update. The status of the Northern Cod stock was updated based on key information obtained during 2013. The meeting reviewed information from:

1. the DFO autumn research vessel (RV) survey (indices of abundance, biomass, spawning stock biomass (SSB), and trends in mortality rates);

2. the inshore sentinel catch rate index; and
3. fishery exploitation rates based on tagging.

Analysis and Response

Reported Landings

A stewardship fishery for cod and a recreational fishery for groundfish were permitted in the inshore during 2013. Commercial fishers were permitted an allowance of 2.3 t (5,000 lb) per harvester, an increase of 33 % over the preceding 4-year period. Recreational fishers were permitted a maximum catch of 15 fish per boat per day. Reported landings in 2013 were 4,299 t. The 2013 landings comprised 4,001 t in the stewardship fishery, 275 t in the sentinel surveys, and 23 t taken as by-catch. Catches outside the Canadian EEZ (200 mile limit) during 2013 are not yet available, but have generally been < 300 t during the past 5 years. Recent catch history is summarized in Appendix Table 1.

There are no requirements to report recreational landings. Therefore, total catch in 2013 is uncertain. However, analysis of tag returns suggests that removals of commercial size fish from recreational fisheries during 2013 were approximately 37 % of the removals from the stewardship fishery.

Stock Trends

Bottom-Trawl Surveys

The abundance and biomass indices from the autumn RV surveys have been low since the start of the moratorium in 1992 (Figs. 2 and 3). The abundance index increased during 2005-09 and the biomass index increased during 2005-08; these increasing trends did not persist during 2009-11 but have resumed during 2011-13. The abundance index for 2013 was strongly influenced by increased numbers of pre-recruits (ages 0-2). The average abundance and biomass indices during 2011-13 are 11 % and 14 %, respectively, of the average during the 1980s. Index values for the period 1991-2013 are summarized in Appendix Table 2.

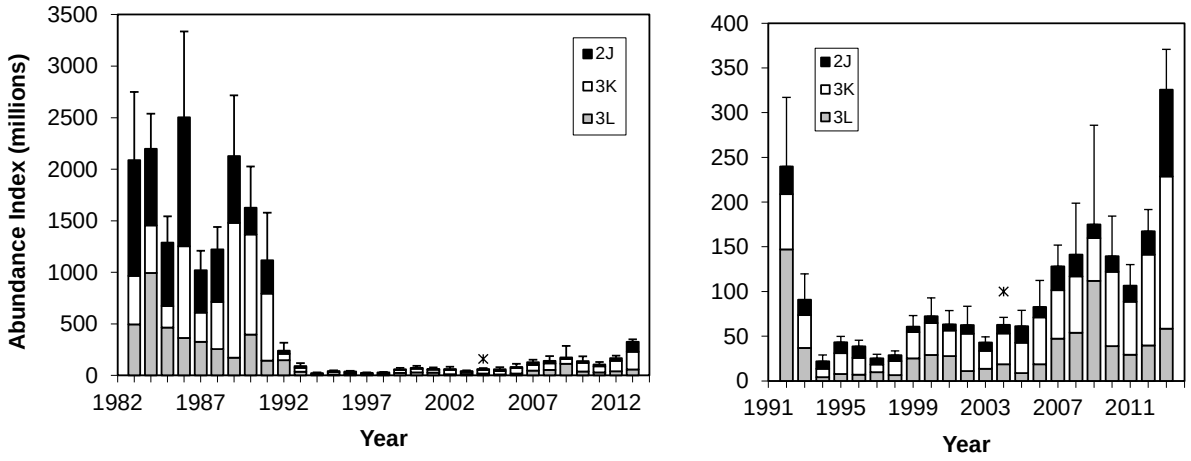

Figure 2. Offshore abundance index (+2 SE's) from autumn RV surveys in 2J3KL. The right panel is expanded to show trends from 1992 onwards. Asterisks indicate partial estimates from incomplete survey coverage of 3L in 2004.

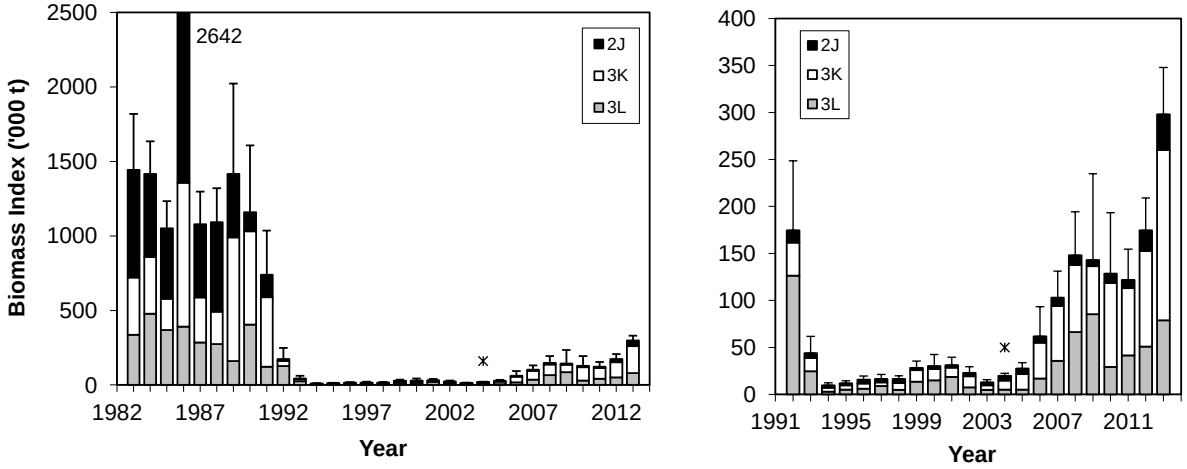

Figure 3. Offshore biomass index (+2 SE's) from autumn RV surveys in 2J3KL. The right panel is expanded to show trends from 1992 onwards. Asterisks indicate partial estimates from incomplete survey coverage of 3L in 2004.

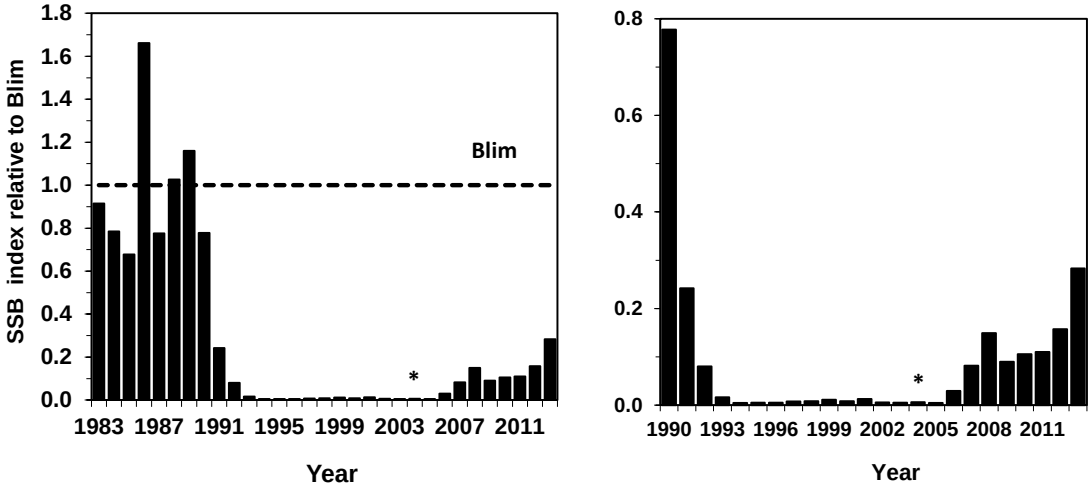

Figure 4. Spawning stock biomass index from autumn RV surveys in 2J3KL. The right panel is expanded to show trends from 1990 onwards. Asterisks indicate partial estimates from incomplete survey coverage of 3L in 2004.

The SSB index from the autumn RV survey declined rapidly in the late 1980s and early 1990s and remained very low for two decades after the 1992 moratorium. The SSB index has been variable since 2006 but shows an increasing trend (Fig. 4). The average SSB index during 2011-13 represents 18 % of the LRP (=B_{lim}, or biomass limit reference point) and the index value for 2013 is 28 % of the LRP. The stock has remained below the LRP (in the critical zone) since the early 1990s.

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

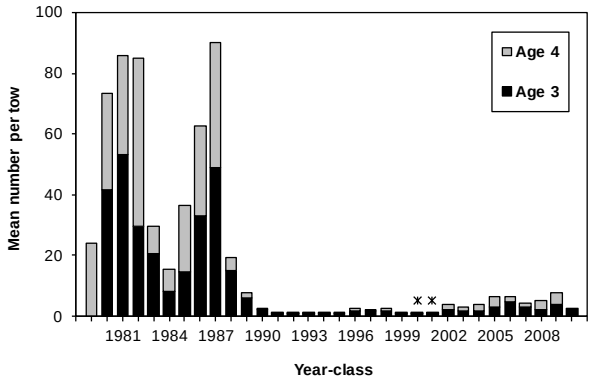

Figure 5. Abundance of the 1979-2010 year-classes at age 3 and/or age 4 in the offshore of 2J3KL from the autumn RV surveys. Asterisks indicate partial estimates for the 2001 year-class at age 3 and the 2000 year-class at age 4 due to incomplete survey coverage of 3L in 2004.

Year-class strength in the offshore in the 1990s and 2000s has been poor compared to the 1980s. The number of young fish (ages 3 and 4) in the autumn RV survey in the 1990s has consistently been much lower than during the 1980s, but improved slightly in year-classes produced from 2002 to 2009 (Fig. 5).

There are no indications of exceptional changes to SSB due to incoming recruitment (ages 3-4) in the next 1-2 years.

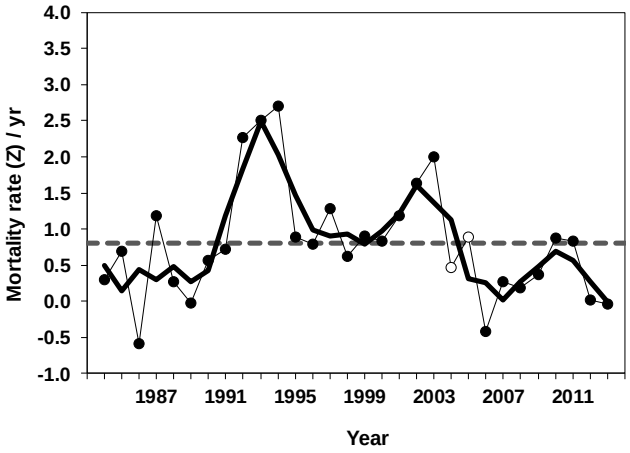

Figure 6: Total mortality rate (Z) of cod aged 4-6 calculated using data from the autumn RV surveys in the offshore of 2J3KL. For example, the value in 1996 is the mortality experienced by the 1991-1989 year-classes from ages 4-6 in 1995 to ages 5-7 in 1996. The dashed line is the time-series average (Z=0.81 which corresponds to 55 % mortality per year). The thick solid line is the 3-yr running mean. 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 year) from the early 1990s to the mid-2000s, with peaks during the early 1990s and early 2000s (Fig. 6). This high level of mortality during much of the post-moratorium period has been a major impediment to stock recovery. Total mortality shows a general decline after 2003, except during 2010 and 2011. The two most recent estimates of Z are close to zero or

marginally negative, suggesting year effects in recent survey catches. Total mortality rate averaged 0.27 during 2011-13 which corresponds to 24 % mortality per year.

In recent (2011-13) surveys, several cohorts have shown increasing numbers among older ages which is not biologically possible. This indicates that one or more of the 2011-13 surveys may be influenced by a year effect. Consequently, stock trends and total mortality estimates in the most recent three years are uncertain.

Sentinel Catch Rates - Inshore

For assessment and stock update purposes the inshore was divided into three areas:

1. a northern area (2J and northern 3K);
2. a central area (southern 3K and northern 3L); and
3. a southern area (southern 3L) that is partly dependent on migrant fish from 3Ps and possibly other offshore areas.

The dividing lines for these areas are Partridge Point at the western side of Notre Dame Bay and Grates Point at the eastern side of Trinity Bay (Fig. 7).

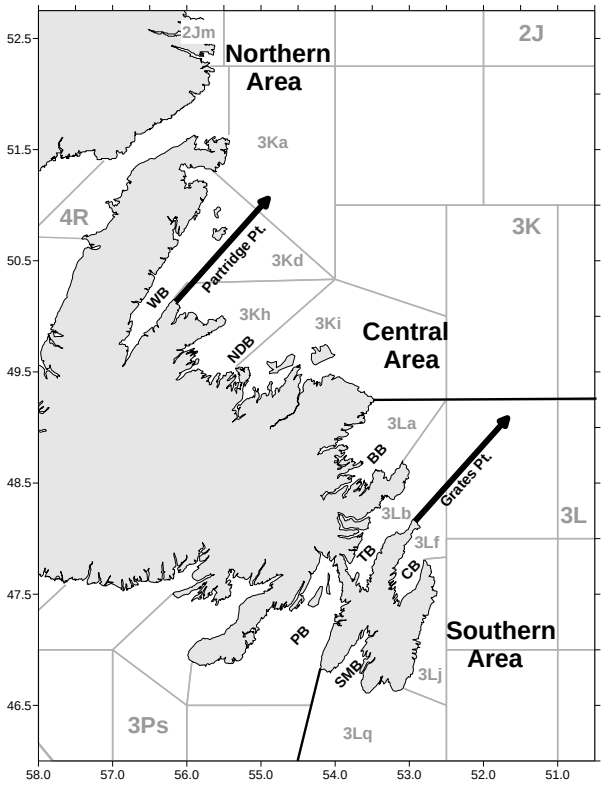

Figure 7. Eastern Newfoundland indicating the locations of the inshore northern, inshore central and inshore southern areas. Major bays are indicated: White Bay (WB), Notre Dame Bay (NDB), Bonavista Bay (BB), Trinity Bay (TB), Conception Bay (CB), and St. Mary's Bay (SMB); Placentia Bay (PB) is in Subdiv. 3Ps. Grey lines delimit boundaries of statistical unit areas (i.e., 3Ka, 3Kd, etc.).

Sentinel survey catch rates increased in the northern, central, and southern areas in 2013. Catch rates are well above the respective time series (1995-2013) average in the northern and central areas, but close to average in the southern area. Recent catch rates are much lower in the southern area compared with the northern and central areas (Fig. 8).

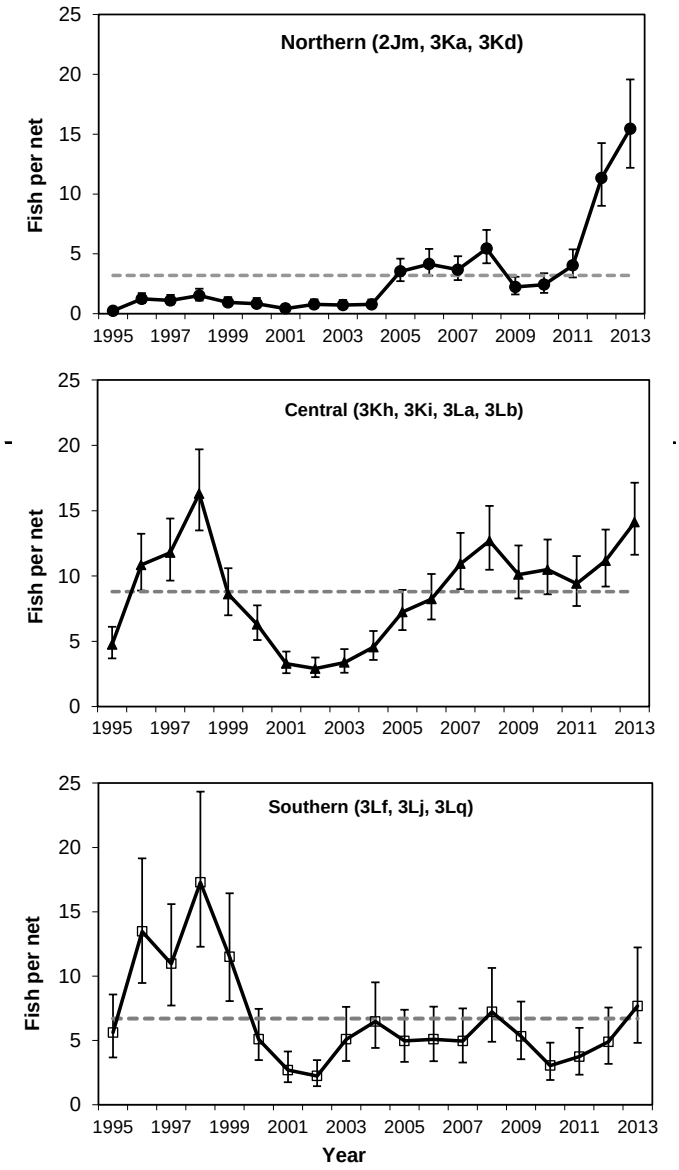

Figure 8. Trends in gillnet (5½ inch mesh) catch rate indices from sentinel surveys for each of the three inshore areas depicted in Figure 7. Series means are plotted as dashed lines.

Information from the Sentinel survey and autumn DFO RV survey in 2013 is generally consistent. Both indicate some improvement in stock status, particularly in 2J and 3K.

Tagging

Information from recaptures of cod tagged in various inshore regions of 3KL during 1997-2013 was used to estimate average annual exploitation (harvest) rates. No cod were tagged in the offshore during 2009-13, but most tagging was conducted during July-October when migrant offshore cod would be inshore.

Exploitation rates were consistently low for cod tagged in central and southern areas, ranging between 2 % and 5 % during 2012 and 2013. These estimates incorporate assumed values for the annual rate of natural mortality (0.2 in 3L and 0.4 in 3K) and are based on tagged cod in the 50-85 cm length range at release; these cod would be well selected by commercial gears.

The reporting rate of tags from commercial fishers during 1997-2013 has ranged from 69 % to 85 % and shows no clear trend; the 2013 reporting rate was 69 %. A constant but lower reporting rate of tags was estimated for recreational fishers during 2006-13 (49-54 %). Lower reporting rates add uncertainty to the estimates of exploitation rates and the analyses of movement patterns and stock structure.

Recreational fishers returned 37 % of the total number of tags received from the stewardship fishery, after numbers were adjusted by respective tag reporting rates. This percentage is the lowest observed in the past 6 years (2008-13, range 37 % to 91 %), but indicates that recreational landings in 2013 were a substantial portion of total removals.

Conclusions

- Reported landings in 2013 were 4,299 t. This comprised 4,001 t in the stewardship fishery, 275 t in the sentinel surveys, and 23 t taken as by-catch, but excludes recreational fishery removals. Catches outside the Canadian EEZ (200 mile limit) during 2013 are not yet available, but have generally been < 300 t during the past 5 years.
- There are no requirements to report recreational landings. Therefore, total catch in 2013 is uncertain. However, analysis of tag returns suggests that removals of commercial size fish from recreational fisheries during 2013 were approximately 37 % of the removals from the stewardship fishery.
- A conservation limit reference point has previously been established for Northern cod and is defined as the average spawning stock biomass during the 1980s.
- Based upon the autumn DFO surveys the three year average SSB increased from 12 % of the LRP in 2010-12 to 18 % in 2011-13. The stock has remained below the LRP (in the critical zone) since the early 1990s.
- Total mortality rate from DFO surveys averaged 0.27 during 2011-13 which corresponds to 24 % mortality per year. During 2010-12 total mortality averaged 0.46 which corresponds to 37 % mortality per year.
- In recent (2011-13) surveys, several cohorts have shown increasing numbers among older ages which is not biologically possible. This indicates that one or more of the 2011-13 surveys may be influenced by a year effect. Consequently, stock trends and total mortality estimates in the most recent three years are uncertain.
- Tagging results indicate that current levels of removals have resulted in low exploitation rates (< 6 %).
- Sentinel survey catch rates increased in the northern, central, and southern areas in 2013. Catch rates are well above the respective time series (1995-2013) average in the northern and central areas, but close to average in the southern area. Recent catch rates are much lower in the southern area compared with the northern and central areas.
- Information from the Sentinel survey and autumn DFO RV survey in 2013 is generally consistent. Both indicate some improvement in stock status, particularly in 2J and 3K.
- There are no indications of exceptional changes to SSB due to incoming recruitment (ages 3-4) in the next 1-2 years.
- In keeping with the DFO decision-making framework incorporating the precautionary approach, removals should remain low to promote stock growth.

Contributors

Name	Affiliation
Brattey, John	DFO Science NL
Brodie, Bill (Chair)	DFO Science NL
Healey, Brian	DFO Science NL
Jarvis, Harvey	FFAW
Maddock Parsons, Dawn	DFO Science NL
Meade, James	DFO Science NL (CSAS)
Parrill, Erika	DFO Science NL (CSAS)
Power, Don	DFO Science NL
Rowe, Sherrylynn	CFER, Marine Institute, MUN

Approved by

B. R. McCallum, Regional Director Science
Newfoundland and Labrador Region
Fisheries and Oceans Canada
April 15, 2014

Sources of information

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Appendices

Table 1. Reported landings by management year in NAFO Divs. 2J3KL (nearest thousand metric tons). Detailed catch history is reported in Brattey et al. 2010.

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] to 12/13	13/14[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	4
Can. Mobile	9	84	-	-	-	-	-	-	-	-	-	-
Others	405	38	-	-	-	-	-	-	-	-	-	-
Totals	502	212	5	9	5	7	4	1	3	4	3	4

[1] There was no TAC in the last eight 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, 3,750 lb in 2009/10 to 2012/13, and 5,000 lb in 2013/14.

[2] Does not include Canadian recreational fisheries landings.

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. 2010.

Year	2J Abundance	3K Abundance	3L Abundance	Total Abundance	2J Biomass	3K Biomass	3L Biomass	Total Biomass	Total SSB (t)
1991	323,637	649,349	144,684	1,117,670	150,136	467,502	121,759	739,397	144,400
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	3,475
2005	18,519	33,834	8,780	61,133	5,719	16,696	5,118	27,533	2,662
2006	11,739	52,285	18,711	82,735	6,818	38,009	16,982	61,809	17,517
2007	26,656	54,122	47,249	128,027	8,755	58,427	35,722	102,904	48,818
2008	24,492	62,848	53,957	141,297	10,281	71,329	66,401	148,011	89,065
2009	15,250	47,949	111,782	174,981	6,473	51,106	85,410	142,989	53,578
2010	17,278	83,060	39,012	139,350	9,905	89,388	29,255	128,548	63,051
2011	17,937	59,233	29,204	106,374	8,542	71,541	41,615	121,698	65,546
2012	26,108	101,579	39,584	167,903	21,900	101,579	50,985	185,169	93,920
2013	97,130	170,174	58,344	325,648	37,986	181,106	78,927	298,019	169,032

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Fax: (709) 772-6100
E-Mail: DFONLCentreforScienceAdvice@dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas-sccs

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