Fisheries and Oceans Canada | Pêches et Océans Canada
Ecosystems and Oceans Science | Sciences des écosystèmes et des océans

Canadian Science Advisory Secretariat
Newfoundland and Labrador Region | Science Response 2021/043

2020 STOCK STATUS UPDATE FOR AMERICAN PLAICE IN NAFO SUBAREA 2 + DIV. 3K

Context

This document is the result of a 2020 scientific update on the status of American Plaice (*Hippoglossoides plattesoides*) in Northwest Atlantic Fisheries Organization (NAFO) Subarea 2 + Division 3K, as requested by Fisheries and Oceans Canada (DFO) Resource Management. In light of the COVID-19 situation, the full Regional Peer Review meeting scheduled for March 24-27, 2020 had to be cancelled. Alternatively, it was decided that the Centre for Science Advice (CSA), Newfoundland and Labrador (NL) Region, would coordinate an internal virtual DFO Stock Update.

This stock was last fully assessed in 2003 (DFO 2003) with a status update and limit reference point meeting held in 2012 (DFO 2012). Information available for the current update included fishery landings (1960-2019) and discards (2010-2019), and annual fall Research Vessel (RV) surveys (1978-2019). Data considered here from RV surveys provide information on spatial distribution and size composition, as well as indices of biomass, abundance, and recruitment.

This Science Response Report results from the Regional Science Response Process held on April 1-2, 2020 for the SA2+3K American Plaice Stock Assessment.

Background

American Plaice is a benthic marine flatfish with reported catches in temperatures ranging from -1.5 to 13°C. In Northwest Atlantic waters this species has been observed occupying depths ranging from 20 to 1,400 m. This species is slow growing, with sexual dimorphism evident with faster growth in females which reach larger sizes than the males for any given age.

The commercial fishery for this stock peaked in 1970 at 12,686 t (Figure 1). Catches decreased to the early 1990s, and a moratorium on directed fishing was declared in 1994. Annual landings cannot be provided for the recent period (2013-2017 and 2019) due to privacy restrictions imposed by DFO policy on fisheries with limited participation. Landings are generally low, averaging 31.9 t from 2010 to 2014 and 3.6 t from 2015 to 2019 (Table 1), with a recent peak at 100 t in 2013. Bycatch is primarily from the Greenland halibut otter trawl fishery. Over the same periods (2010-2014, 2015-2019), bycatch of American Plaice reported discarded dead at sea averaged 6.8 t and 9.2 t, respectively (Table 2).

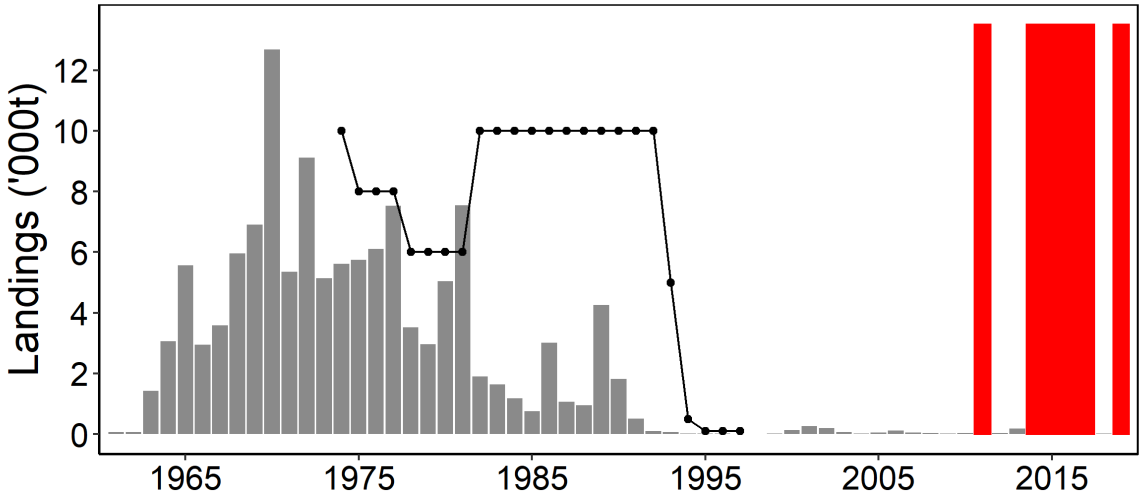

Figure 1: Fishery landings (grey bars) and total allowable catch (TAC; points and lines) for American Plaice in Subarea 2+Div. 3K. Red bars indicate years where annual landings data are not able to be released due to privacy restrictions. Recent landings are generally low, averaging 31.9 t from 2010 to 2014 and 3.6 t from 2015 to 2019.

Analysis and Response

Oceanographic and Ecosystem Conditions

The Newfoundland and Labrador climate experienced cold conditions between the mid-1980s and the mid-1990s, and from about 2014 to 2017. These conditions are associated with positive phases of the North Atlantic Oscillation (NAO) and changes in large-scale ocean circulation (e.g., increased Labrador Current transport along the NL shelf edge) (DFO 2019). In 2018 and 2019, the bottom temperature in Divs. 2J3K was back to the warmer than normal conditions experienced since the mid-1990s (warmest since 2011), while the overall NL climate has returned to close to normal conditions (Figure 2). Primary (chlorophyll) and secondary (zooplankton abundance and biomass) production indices have improved over the past 3-4 years (Figure 3). However, there have been significant changes in zooplankton community structure, with an increase in small zooplankton species, and decrease in large copepods.

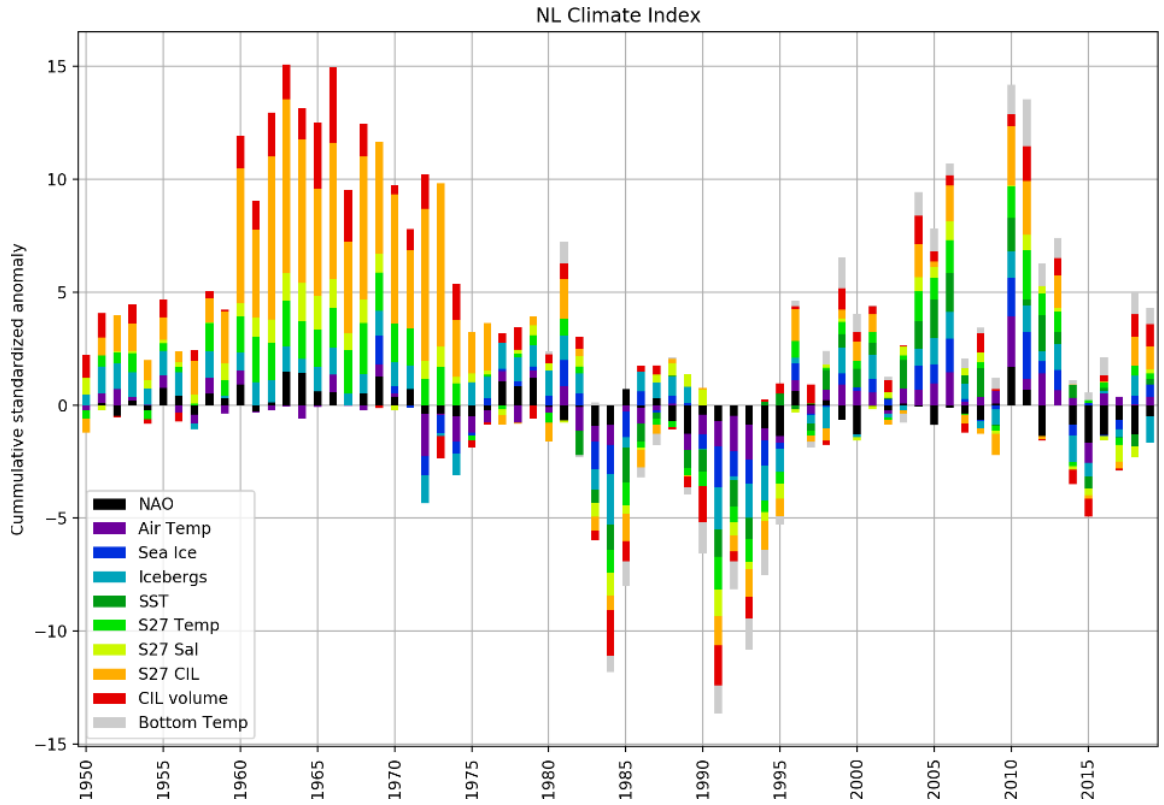

Figure 2: Newfoundland and Labrador climate index derived by summing the normalized anomalies of NAO index, air temperature, sea ice season duration and total volume on the Labrador and Newfoundland shelves (starting in 1969), the number of icebergs, sea surface temperature (SST) (starting in 1982), vertically-averaged temperature and salinity at Station 27, cold intermediate layer (CIL) mean temperature and core temperature at Station 27, the summer CIL volume of the areas of the hydrographic sections Seal Island, Bonavista and Flemish Cap, and the spring and fall bottom temperature in NAFO divisions 3LNOPs and 2J3KLNO, respectively (starting in 1980). See Cyr et al. 2020 for details.

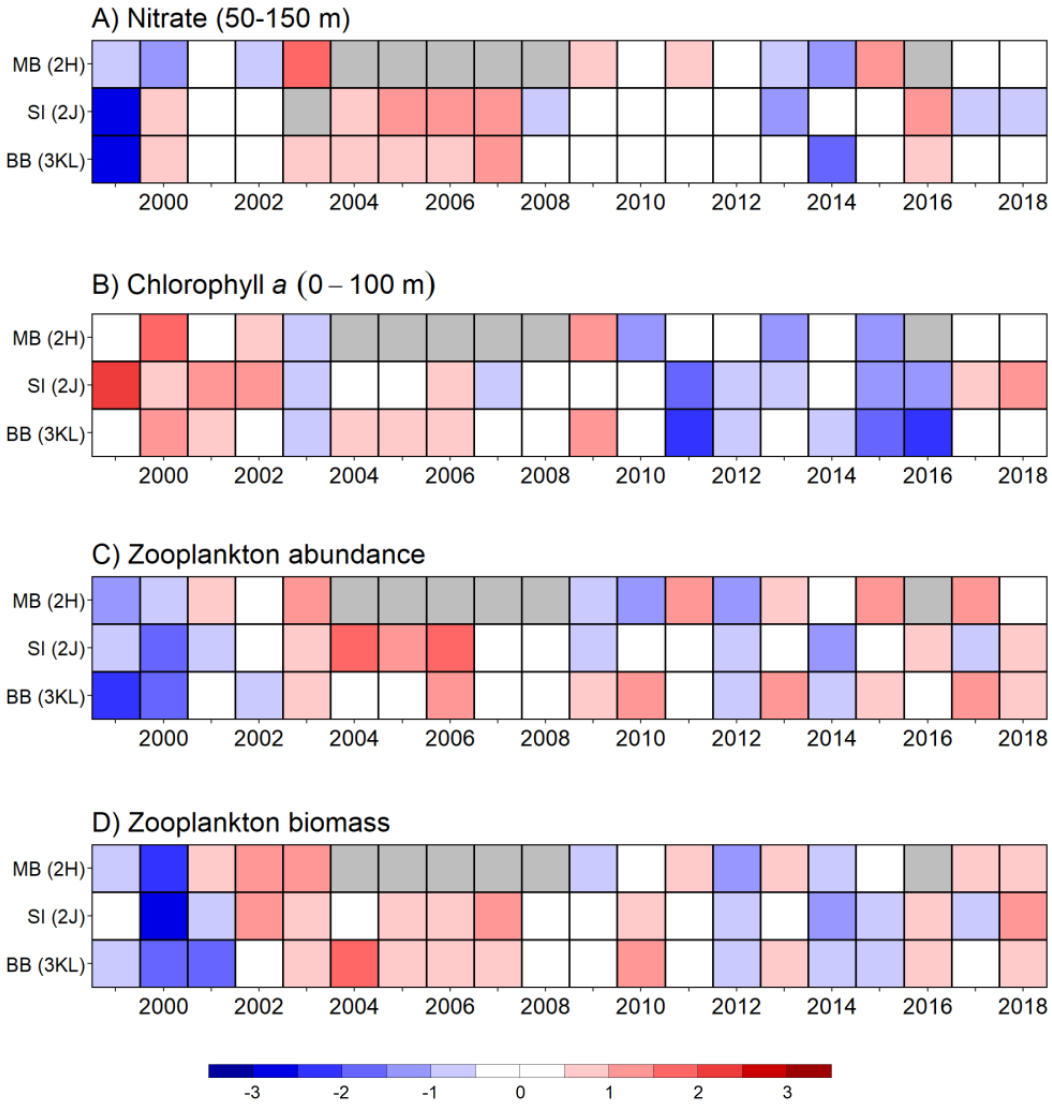

Figure 3: Annual anomaly scorecards for (A) integrated nitrate concentration, (B) integrated chlorophyll concentration, (C) zooplankton abundance, and (D) zooplankton biomass along three cross-shelf sections in NAFO divisions 2HJ3K. Colours indicate anomaly from the mean for the reference period (1999-2015) in standard deviation units. White cells indicate near normal levels. Grey cells indicate missing data. Red (blue) cells indicate higher (lower) than normal levels. Sections are listed from north (top) to south (bottom). MB: Makkovik Bank section, SI: Seal Island section, BB: Bonavista Bay section (see Cyr et al. 2020).

The ecosystem structure of the NL bioregion can be described in terms of four Ecosystem Production Units (EPUs): the Labrador Shelf (Divs. 2GH), the Newfoundland Shelf (Divs. 2J3K), the Grand Bank (Divs. 3LNO), and southern Newfoundland (SubDiv. 3Ps) (NAFO 2014, 2015, Pepin et al. 2014). Ecosystem conditions on the Newfoundland Shelf (Divs. 2J3K) are indicative of limited productivity of the fish community. Total Research Vessel (RV) survey biomass indices remain much lower than prior to the collapse in the early-1990s (Figure 4). While there have been some increases in the finfish component of the community since this collapse, total and finfish RV biomass indices declined again during the mid-2010s. These changes have been associated with changes in community structure. During the 1990s and early-2000s the

community was dominated by shellfish. Increases in groundfishes were accompanied by declines in shellfish, leading to a groundfish-dominated community since the late-2000s and early-2010s (Koen-Alonso and Cuff 2018) (Figure 4).

The analysis of stomach contents collected during RV fall surveys indicates that shrimp *Pandalus spp.* was a dominant prey for American Plaice in the late-2000s and early-2010s. As shrimp declined, capelin *Mallotus villosus* dominance in the stomachs increased until 2013, but declined afterward. American Plaice diet has been more diversified in 2016-2019, with no single prey being highly dominant. Important prey items have been Arctic Cod *Boreogadus saida*, amphipods, ophiuroids (brittle and basket stars), polychaetes and bivalves, in addition to shrimp and capelin (Figure 5). Stomach content weights of American Plaice show a decline in the mid-late 2010s, suggesting limitations in food availability in recent years (Figure 5).

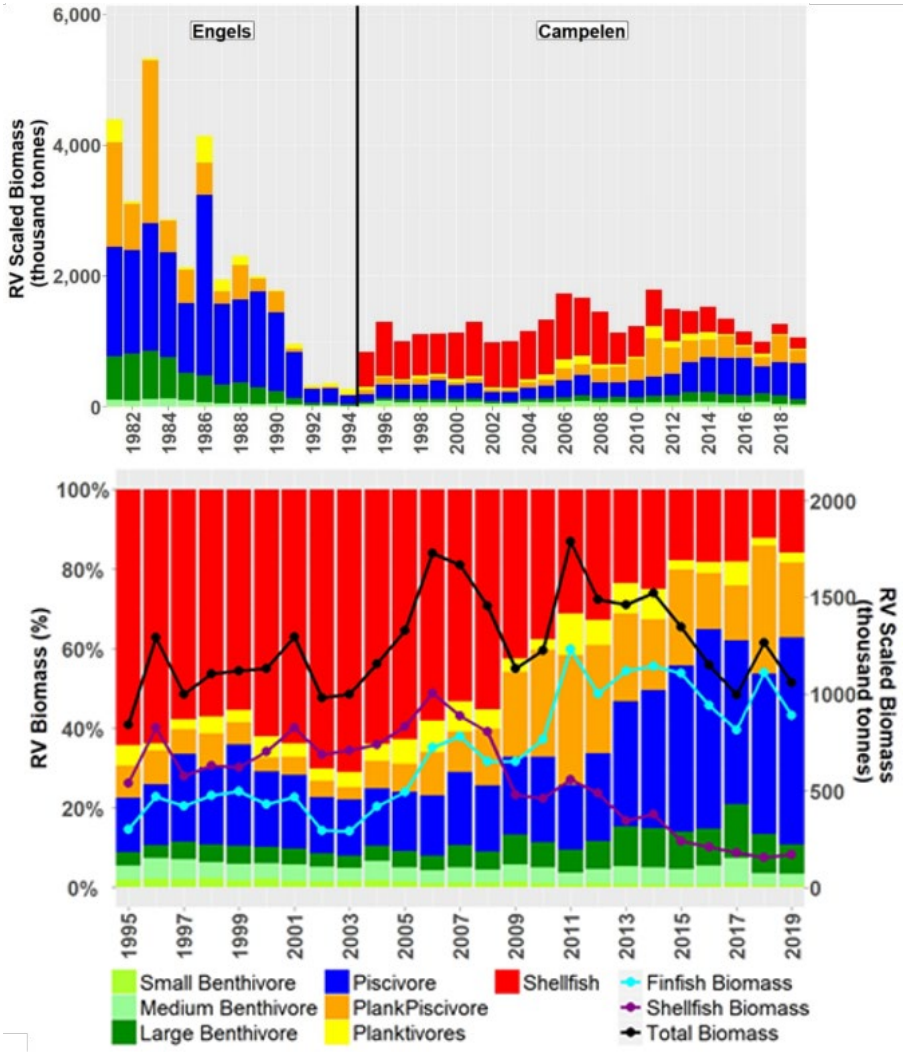

Figure 4: Summary of the structure and trends of the fish community in the Newfoundland Shelf EPU (Divs. 2J3K). Top: total RV survey biomass indices across fish functional groups. Indices for the Engels period have been scaled to be comparable to the Campelen series. Comparable shellfish data were not collected prior to 1995. Bottom: synoptic view of the changes in the structure of the fish community during 1995-2019. Bars indicate the composition of RV survey biomass by fish functional groups, while lines indicates the trajectories of RV survey biomass by large taxonomic aggregates (finfish, shellfish, and total).

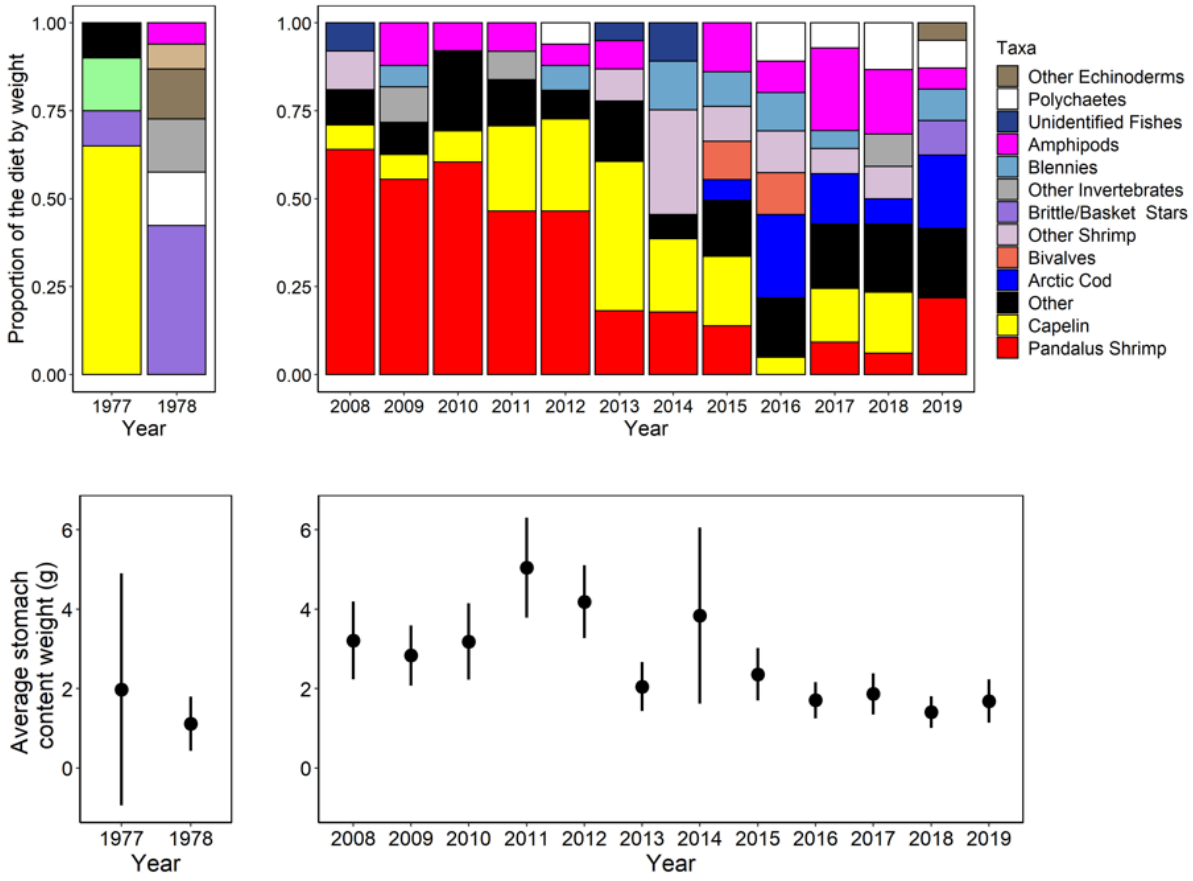

Figure 5: Food and feeding of American plaice in the Newfoundland Shelf EPU (Divs. 2J3K). Top: fall diet composition from stomach content analysis. Taxa with proportions <5% in any year have been grouped into "Other". Bottom: Average stomach content weights (±95% CI) from non-empty stomachs of fish within the 20-40cm size range.

Research Vessel Surveys

DFO has conducted depth-stratified randomized bottom trawl surveys in Div. 2G, 2H, 2J, and 3K since the late-1970s, although Divs. 2GH have not been surveyed every year. In 1995, the survey trawl was switched from an Engel 145 Hi-lift trawl with bobbin footgear to a Campelen 1800 shrimp trawl with rockhopper footgear (McCallum and Walsh 1996). The Campelen trawl is more effective than the Engel trawl in capturing small fish. Surveys in Div. 2J and 3K from 1978 to 1994 have been converted into Campelen-equivalent units for American Plaice (Morgan and Brodie 2000), but surveys in Divs. 2GH prior to 1995 have not been converted and therefore are not comparable to later surveys. Given the limited time series in Divs. 2GH, stock status is assessed based on indices from Divs. 2J3K.

There were substantial coverage deficiencies in the fall survey in 2018 and 2019, due to a combination of vessel issues and weather delays (Figure 6). Strata deeper than 750 m in Div. 2J were not sampled in 2019, and deeper than 750 m in Div. 3K were not sampled in 2018 or 2019. Some shallower strata were also missed in each year in Div. 2H (2018 and 2019) and Div. 3K (2019) resulting in a total of 11 missed strata in 2018 and 21 in 2019. Major sampling

reductions were implemented in 2019 in Div. 3K due to the significant time losses from weather delays, with only 77 of 156 planned sets completed.

Overall reduced survey effort contributed to increased uncertainty in the survey results from 2018 and 2019. However, given the broad and relatively homogeneous distribution of American Plaice in this area (Figure 7), this reduction of effort is not a major concern for interpretation of the status of this stock. A varying amount of the survey biomass has been located in strata deeper than 750 m (Table 3), averaging 0.1% over the last five years (2013-2017), but reaching 31% in 2009. The high proportion of biomass in the deep water in 2009 (and increased overall uncertainty in the biomass index from that year) was driven by a single large tow of large fish from southern Div. 3K and is not likely to be representative of typical distribution.

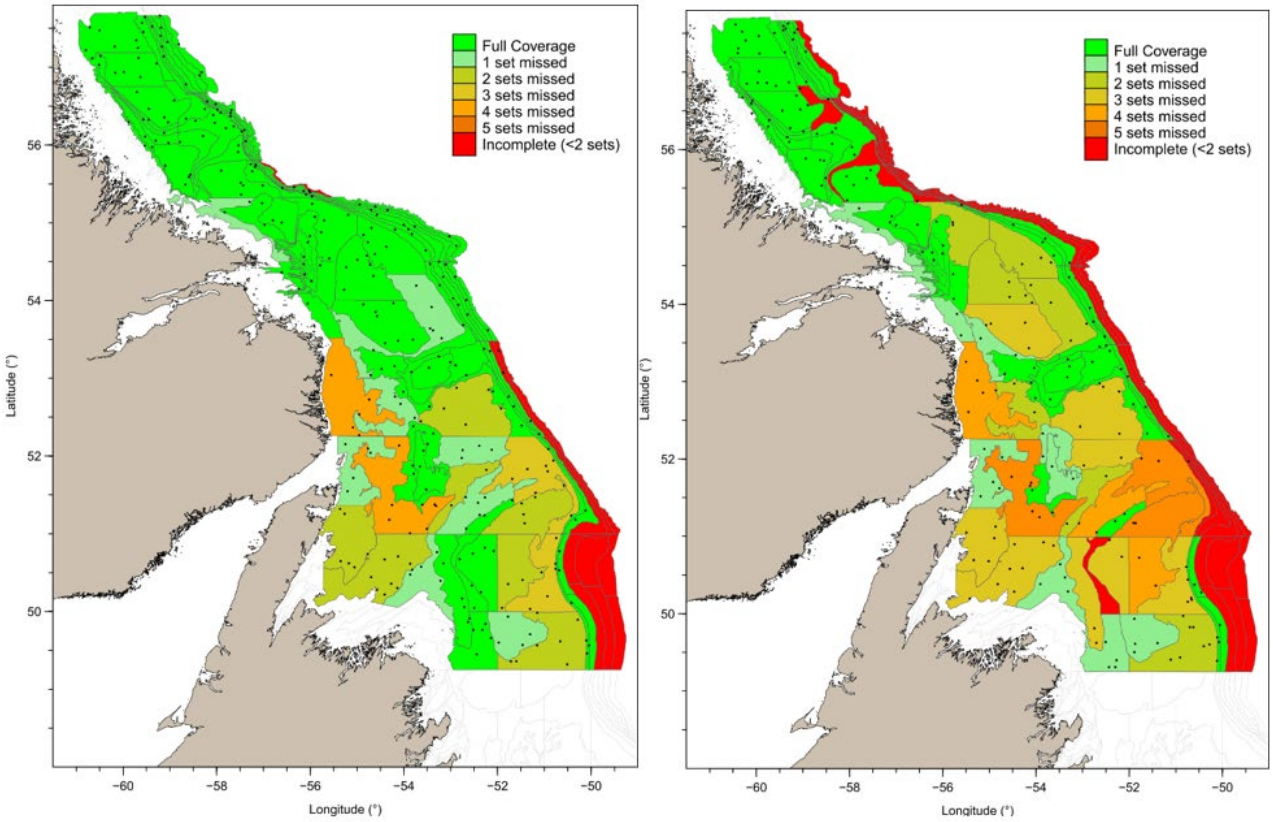

Figure 6: Survey coverage for the 2018 (left) and 2019 (right) fall DFO RV surveys in Divs. 2HJ3K.

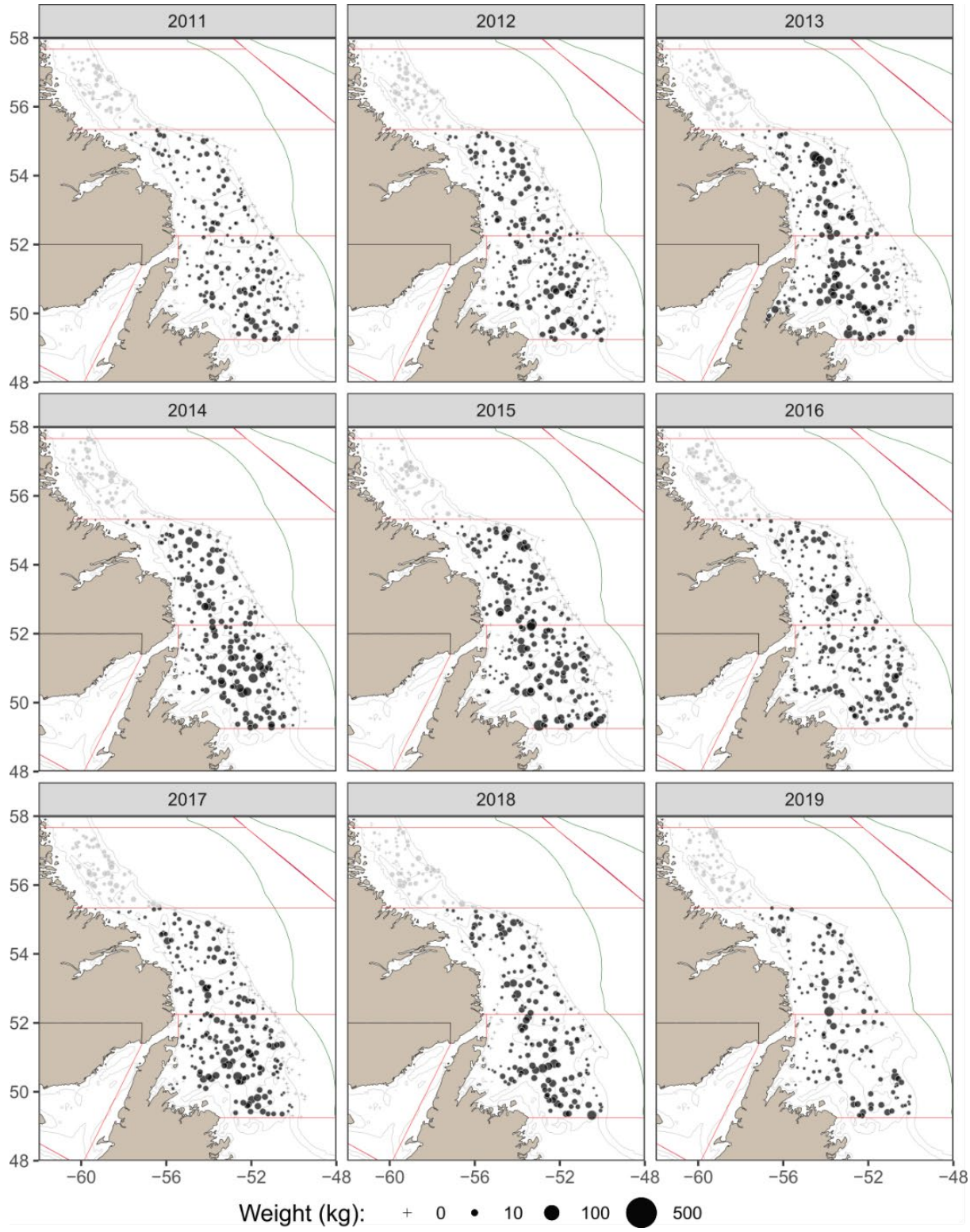

Figure 7: Distribution of American Plaice catch weights (kg per tow), by set, in Divs. 2H (grey), 2J and 3K (black) from 2011-2019. Only sets in 2J3K are used for biomass and abundance indices for this stock.

Survey indices of abundance (Figure 8) and biomass (Figure 12) declined in the late 1980s and through the 1990s, reaching a time series low in 2002. Both biomass and abundance increased slightly to about 2013, but have subsequently declined. Indices remain well below the levels of the 1980s. Details on the calculation of these indices can be found in Smith and Somerton (1981).

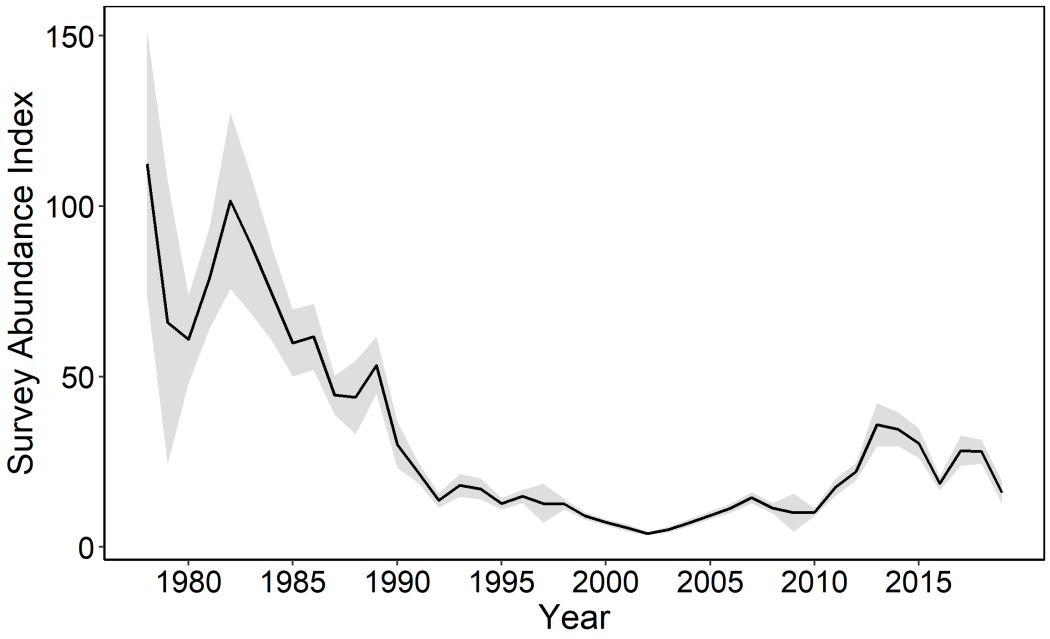

Figure 8: Survey abundance indices for American Plaice in Divs. 2J3K. Grey areas indicate 95% Confidence intervals.

Recruitment Index

Recruitment in this stock is defined as the abundance of age 3-5 American Plaice (Morgan et al. 2013). In the absence of recent aging data, a proxy for recruitment at age in this stock was estimated based on mean length at age information during the Campelen series (1995-2012). Given differences in growth, separate length ranges were used for males and females. The recruitment index was defined as the abundance of male American Plaice 16 to 25 cm total length, and females 16 to 29 cm (Figure 9).

The recruitment index (Figure 10) for this stock was highest at the start of the time series (1978), remaining above the long-term average to 1989. Recruitment declined through the late 1990s to a time series low in the early 2000s, remaining low to 2010. From 2011 to 2018, the recruitment index was generally at or above average (with the exception of 2016). However, in 2019 the recruitment index decreased to 74% of the long-term mean. The recent period of increased recruitment is also evident in survey length frequencies (Figure 11), where a presumptive strong year class can be observed entering in 2013.

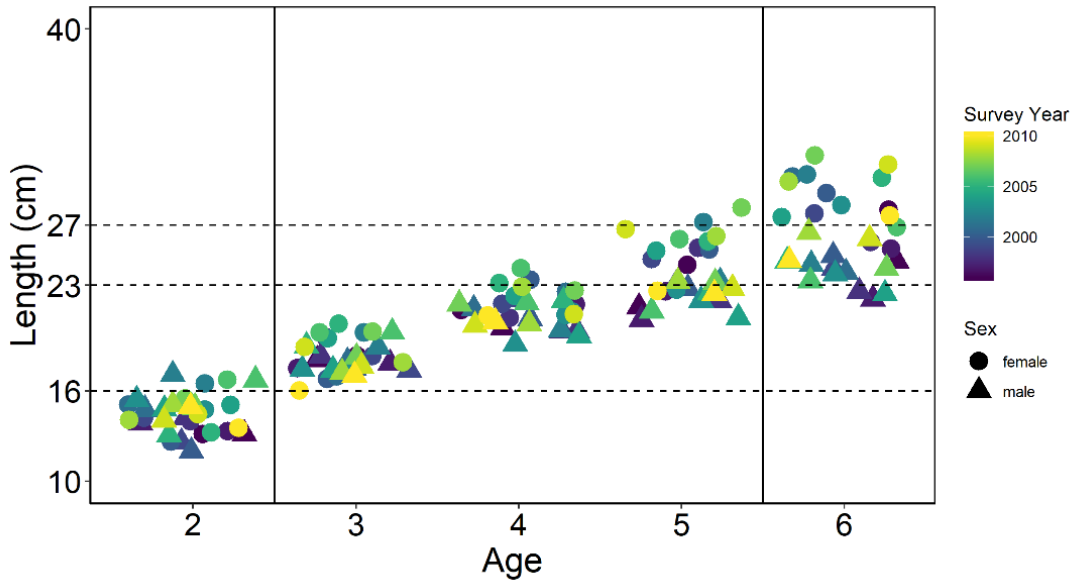

Figure 9: Mean length at age 2 to 6 for female (circles) and male (triangles) American Plaice from 1995-2012. The range of mean lengths at these ages were used to define a length based proxy for a recruitment index representing ages 3 to 5, defined here as 16 to 23 cm for males and 16 to 27cm for females.

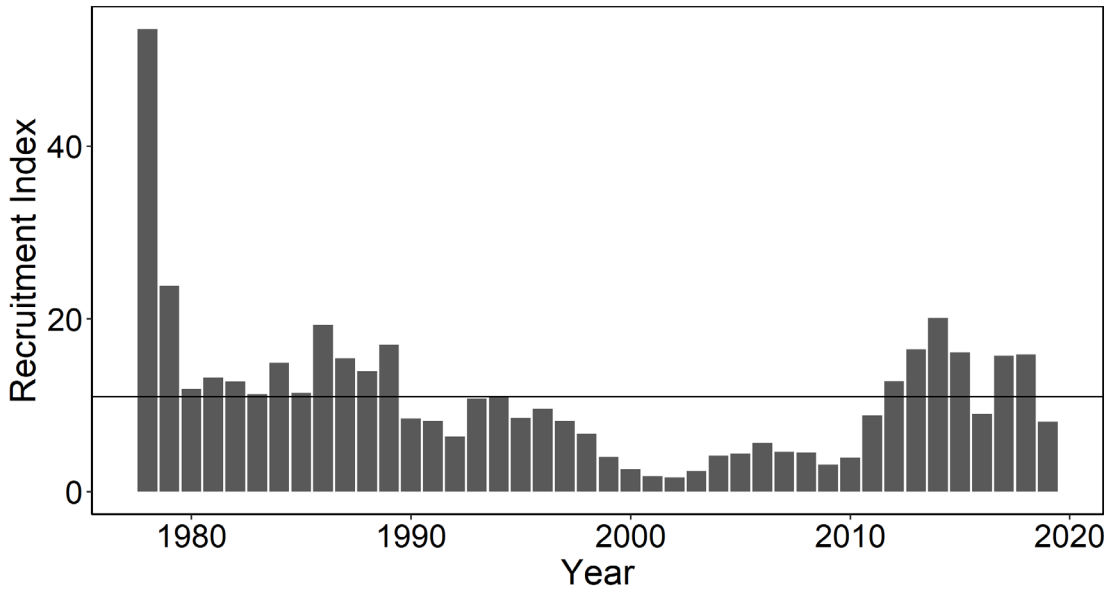

Figure 10: Survey recruitment index calculated from the abundance of male American Plaice from 16 to 23 cm total length and female American Plaice from 16 to 27 cm total length. The horizontal line indicates the time series average.

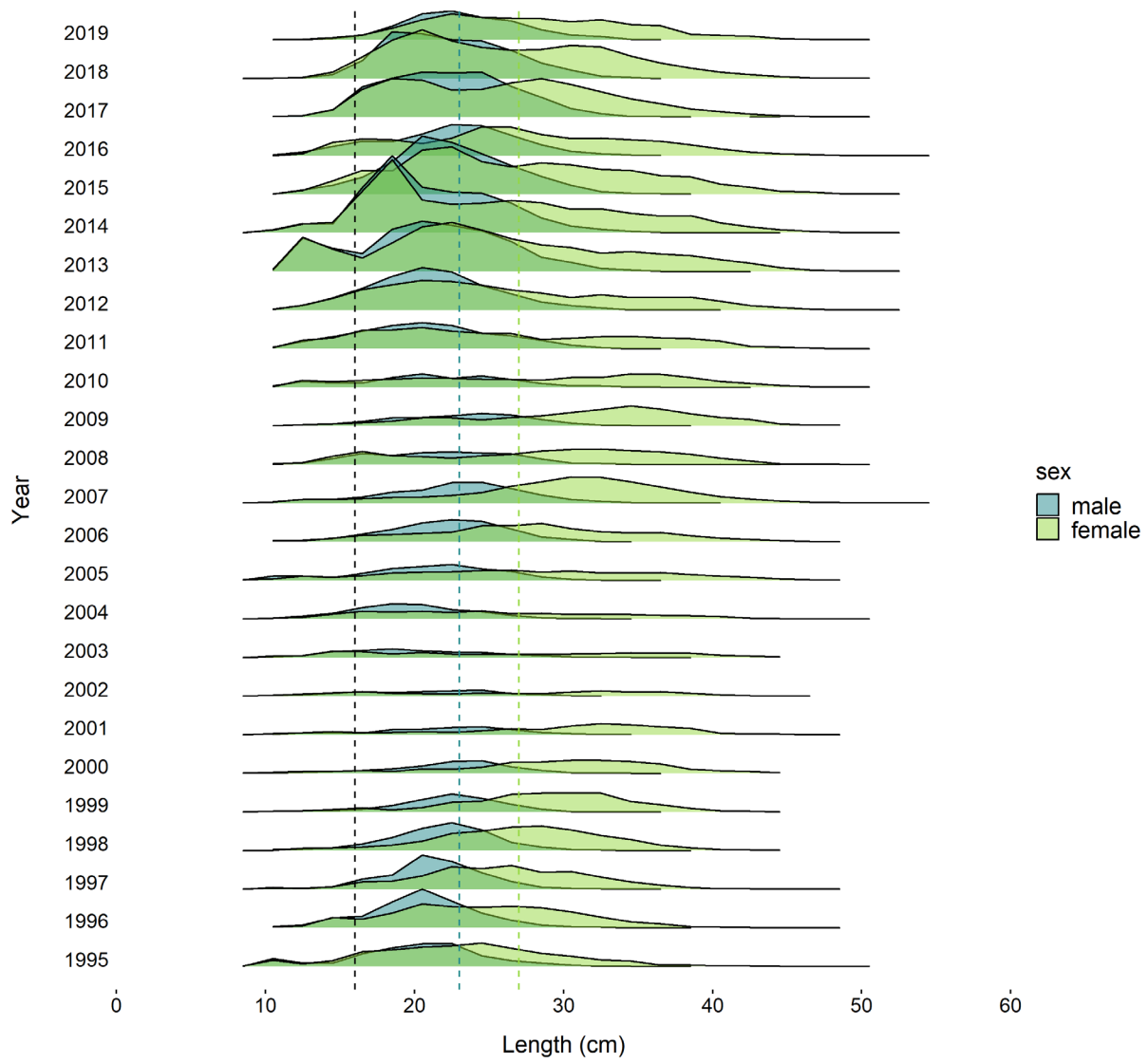

Figure 11: Survey length frequencies for American Plaice in Subarea 2+Div. 3K by sex. Vertical dashed lines indicate length ranges used for the recruitment index.

Spawning Stock Biomass (SSB)

An index of spawning stock biomass (SSB) is available to 2009 (Morgan et al. 2013), and is calculated by multiplying estimated maturity at age by abundance at age and weight at age in the survey. The SSB index declined rapidly after 1982 and reached its lowest level in 2003, followed by a small increase after 2006 (Figure 12), however the average of 2007 to 2009 was only 15% of the average over the 1978 to 1982 period. Ageing data is not available since 2012, precluding the calculation of comparable cohort-based estimates of maturity. The time series of SSB was therefore not updated. SSB averaged 40.9% (range: 14 to 64%) of the total survey biomass across the available time series (1978-2009).

Stock Status

The limit reference point (LRP) for this stock is defined at 70,000 t of survey spawning stock biomass, based on the stock recruit relationship (DFO 2012). A lack of aging data precluded the calculation of a cohort-based SSB consistent with this LRP. However, total survey biomass remains below the LRP (Figure 12), with a high (>0.99) probability. As SSB is less than total survey biomass, SSB must also remain below the LRP. The stock is in the Critical Zone.

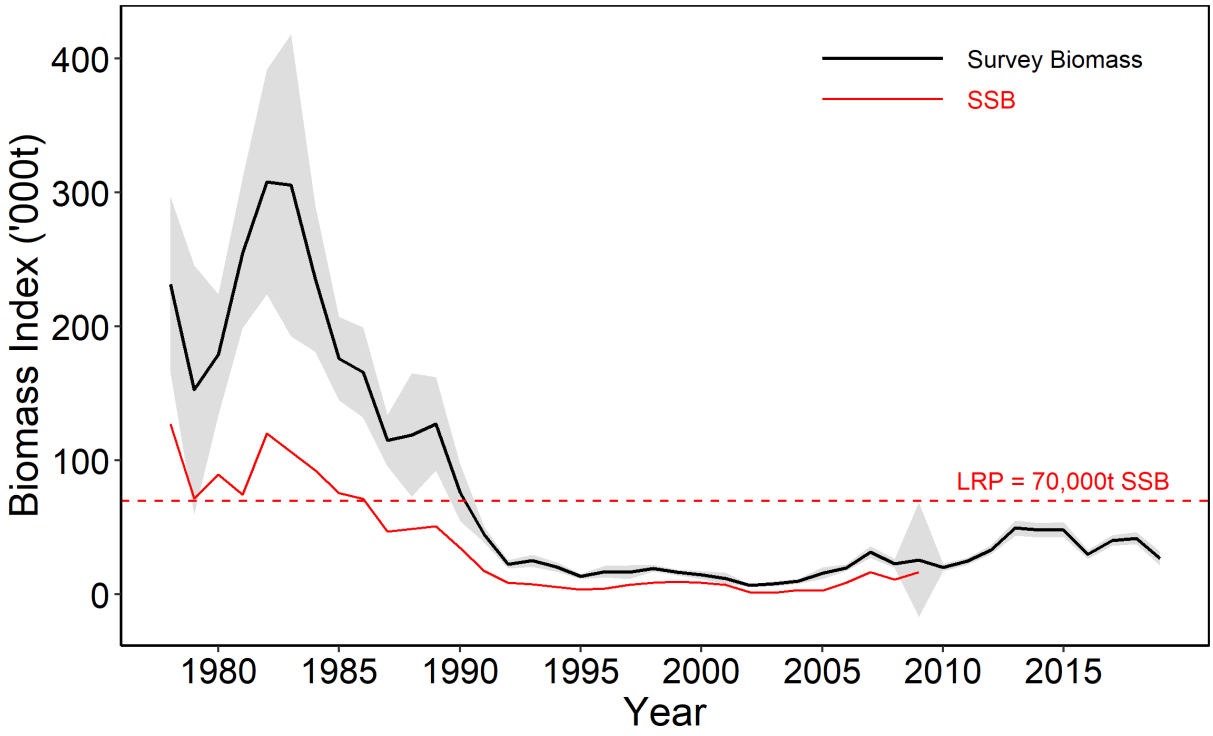

Figure 12: Total survey biomass indices (black line with grey 95% CI) and spawning stock biomass (1978 to 2009, from DFO 2012; red line) for American Plaice in Divs. 2J3K relative to the Limit Reference Point (LRP = 70,000 t SSB Index; dashed red line). The timeseries of SSB could not be updated to 2019 due to a lack of ageing data.

Sources of Uncertainty

Reduced RV survey coverage in 2018 and 2019 increases uncertainty in biomass and abundance indices. Decreased set density reduces precision of survey estimates.

The missed strata in 2018 and 2019 accounted for an average of 5.4% and 7.9% of the total survey biomass, respectively, during the Campelen series (since 1995). In years with incomplete coverage the survey index may underestimate stock size. The magnitude of this underestimation cannot be determined, but is not considered to impact interpretation of stock status relative to the limit reference point (LRP.)

A lack of aging data precluded the calculation of a cohort-based spawning stock biomass (SSB) for recent years consistent with the defined LRP for this stock (DFO 2012). However, total survey biomass remains below the LRP with a >99% probability and stock status relative to the LRP can still be determined.

Direct and indirect effects of ecosystem level changes on American Plaice in Subarea 2+Div 3K are not fully understood, but recent conditions suggest limited prey availability and reduced ecosystem productivity.

Conclusions

Ecosystem conditions on the Newfoundland Shelf (NAFO Divs. 2J3K), the main area of distribution of this stock, are indicative of limited productivity of the fish community.

A recent period of above average recruitment (generally since 2012) has not resulted in subsequent increases in biomass.

Total survey biomass of American Plaice remains below the LRP, with a high (>0.99) probability. The stock is currently in the Critical Zone.

Consistency with the DFO decision-making framework incorporating the Precautionary Approach requires that removals from all sources must be kept at the lowest possible level until the stock clears the critical zone.

Contributors

Name	Affiliation
Bob Rogers	DFO – Science (NL Region)
Darrell Mullowney	DFO – Science (NL Region)
Greg Robertson	DFO – Science (NL Region)
Karen Dwyer	DFO – Science (NL Region)
Laura Wheeland	DFO – Science (NL Region)
Mariano Koen-Alonso	DFO – Science (NL Region)
Paul Regular	DFO – Science (NL Region)
Rick Rideout	DFO – Science (NL Region)
Ellen Careen	DFO – Resource Management (NL Region)
Eugene Lee	DFO – Centre or Science Advice (NL Region)

Approved by

A. Mansour
Regional Director Science
Newfoundland and Labrador Region
Fisheries and Oceans Canada
July 21, 2021

Sources of Information

This Science Response Report results from the Regional Science Response Process held on April 1-2, 2020 for the SA2+3K American Plaice Stock Assessment.

Cyr, F., Colbourne, E., Galbraith, P.S., Gibb, O., Snook, S., Bishop, C., Chen, N., Han, G., and D. Senciall. 2020. Physical Oceanographic Conditions on the Newfoundland and Labrador Shelf during 2018. DFO Can. Sci. Advis. Sec. Res. Doc. 2020/018. iv + 53 p.

DFO. 2003. American Plaice in Subarea 2 and Division 3K. DFO Can. Sci. Advis. Sec. Stock Status Rep. 2003/044

DFO. 2012. Reference points for American Plaice (*Hippoglossoides platessoides*) in NAFO Subarea 2 + Division 3K and Subdivison 3Ps. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/025.

DFO. 2019. Oceanographic Conditions in the Atlantic Zone in 2018. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2019/034.

Koen-Alonso, M., and A. Cuff. 2018. Status and trends of the fish community in the Newfoundland Shelf (NAFO Div. 2J3K), Grand Bank (NAFO Div. 3LNO) and Southern Newfoundland Shelf (NAFO Div. 3Ps) Ecosystem Production Units. NAFO SCR Doc. 18/070.

McCallum, B.R., and S.J. Walsh. 1996. Groundfish Survey trawls used at the Northwest Atlantic Fisheries Centre, 1971-present. NAFO SCR Doc. 96/50, Ser No. N2726, 18p

Morgan, M.J., and W.B. Brodie. 2000. An assessment of American plaice stock in NAFO Subarea 2 and Division 3K. DFO Can. Sci. Advis. Sec. Res. Doc. 2000/130.

Morgan, M.J., Dwyer, K.S., and P.A. Shelton. 2013. Reference points and assessment update for American Plaice (*Hippoglossoides platessoides*) in NAFO SA2 + Div. 3K and Subdiv. 3Ps. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/152. iii + 64 p.

NAFO. 2014. Report of the 7th Meeting of the NAFO Scientific Council Working Group on Ecosystem Science and Assessment (WGESA). 18-27 November 2014, Dartmouth, Canada. NAFO SCS Doc. 14/023.

NAFO. 2015. Report of the 8th Meeting of the NAFO Scientific Council (SC) Working Group on Ecosystem Science and Assessment (WGESA) [Formerly SC WGEAFM]. Dartmouth, NS, 17-26 November, 2015. NAFO SCS Doc. 15/19.

Pepin, P., Higdon, J., Koen-Alonso, M., Fogarty, M., and N. Ollerhead. 2014. Application of ecoregion analysis to the identification of Ecosystem Production Units (EPUs) in the NAFO Convention Area. NAFO SCR Doc. 14/069.

Smith, S.J., and G.D. Somerton. 1981. STRAP: A user-oriented computer analysis system for groundfish research trawl survey data. Can. Tech. Rep. Fish. Aquat. Sci. 1030: iv + 66 p.

Appendix I –Tables

Table 1: Commercial Fishery Landings for Subarea 2+3K American Plaice. A moratorium on directed fishing was established in 1994, with a bycatch quota in place from 1994-1997. (ndf = no directed fishing). "Release Restricted" indicates that landings for that year cannot be released publicly due to DFO privacy restrictions requiring a minimum of 5 fishers, 5 vessels, and 5 buyers be involved in a fishery for data to be published (commonly referred to as "The Rule of 5").

Year	Landings (t)	TAC	Year	Landings (t)	TAC
1960	16	NA	1990	1,825	10,000
1961	67	NA	1991	510	10,000
1962	64	NA	1992	104	10,000
1963	1,421	NA	1993	77	5,000
1964	3,068	NA	1994	16	500, ndf
1965	5,558	NA	1995	28	100, ndf
1966	2,949	NA	1996	16	100, ndf
1967	3,591	NA	1997	9	100, ndf
1968	5,951	NA	1998	3	ndf
1969	6,902	NA	1999	7	ndf
1970	12,686	NA	2000	67	ndf
1971	5,348	NA	2001	132	ndf
1972	9,121	NA	2002	100	ndf
1973	5,140	NA	2003	34	ndf
1974	5,620	10,000	2004	13	ndf
1975	5,747	8,000	2005	30	ndf
1976	6,107	8,000	2006	62	ndf
1977	7,525	8,000	2007	23	ndf
1978	3,522	6,000	2008	16	ndf
1979	2,965	6,000	2009	7	ndf
1980	5,040	6,000	2010	22	ndf
1981	7,545	6,000	2011	release restricted	ndf
1982	1,900	10,000	2012	20	ndf
1983	1,633	10,000	2013	90	ndf
1984	1,175	10,000	2014	release restricted	ndf
1985	753	10,000	2015	release restricted	ndf
1986	3,018	10,000	2016	release restricted	ndf
1987	1,063	10,000	2017	release restricted	ndf
1988	953	10,000	2018	11	ndf
1989	4,248	10,000	2019	release restricted	ndf

Table 2: American Plaice in Subarea 2+3K reported as discarded dead at sea in commercial fisheries

Year	Discard Dead (tonnes)
1998	8.3
1999	3.5
2000	4.5
2001	6.2
2002	1.5
2003	0.9
2004	2.7
2005	7.3
2006	9.9
2007	10.9
2008	4.0
2009	3.5
2010	5.9
2011	6.7
2012	5.1
2013	9.6
2014	6.6
2015	22.1
2016	10.9
2017	4.9
2018	4.3
2019	3.8

Table 3: Biomass index by strata depth for Divs. 2J3K during the Campelen Series (1995-2019). n.f indicated no strata in that depth range were completed.

Survey Year	Max Strata Depth (m)								Total Biomass Index	% biomass index >750 m
	200	300	400	500	750	1000	1250	1500		
1995	208	3,702	4,460	2,725	1,297	991	34	0	13,417	7.6%
1996	507	5,303	6,628	2,434	966	1,258	26	0	17,121	7.5%
1997	572	5,977	6,895	2,045	727	398	18	0	16,632	2.5%
1998	921	6,174	7,671	3,821	677	202	21	0	19,488	1.1%
1999	567	4,827	6,693	3,383	989	101	6	0	16,565	0.6%
2000	408	2,851	6,865	2,547	707	1,166	14	6	14,564	8.1%
2001	208	2,928	5,572	1,664	1,244	466	40	0	12,123	4.2%
2002	170	1,569	2,463	1,549	917	84	53	10	6,814	2.2%
2003	263	1,658	2,062	1,438	551	1,985	27	21	8,006	25.4%
2004	443	3,045	3,694	1,373	582	669	0	0	9,807	6.8%
2005	375	3,168	5,635	2,411	961	3,219	81	0	15,850	20.8%
2006	279	5,127	10,836	2,361	1,094	218	0	0	19,916	1.1%
2007	849	6,010	16,662	4,517	2,145	1,393	10	0	31,586	4.4%
2008	160	7,671	10,903	3,249	1,033	39	0	0	23,053	0.2%
2009	257	4,671	7,282	3,312	2,380	7,967	0	0	25,870	30.8%
2010	769	6,674	7,801	1,970	1,564	1,486	0	0	20,264	7.3%
2011	1,794	12,077	8,861	1,498	690	0	0	0	24,919	0.0%
2012	3,254	19,286	8,779	1,721	317	8	0	0	33,365	0.0%
2013	2,199	28,279	15,155	3,197	759	33	0	0	49,622	0.1%
2014	3,810	25,873	13,755	4,118	430	0	0	0	47,986	0.0%
2015	3,840	22,252	17,299	4,374	591	0	0	0	48,356	0.0%
2016	1,633	9,281	10,133	5,218	3,546	130	0	0	29,942	0.4%
2017	2,509	19,788	11,776	5,965	347	0	0	0	40,385	0.0%
2018[1]	1,128	18,033	15,444	6,167	1,281	0	0	0	42,054	0.0%
2019	1,710	7,433	11,248	5,385	1,201	n.f.	n.f	n.f	26,977	NA

[1]Biomass from 2J only. No strata >750 m were completed in Div. 3K in 2018

This Report is Available from the:

Center for Science Advice
Newfoundland and Labrador Region
Fisheries and Oceans Canada
P.O. Box 5667
St. John's, NL A1C 5X1

Telephone: 709-772-8892
E-Mail: DFONLCentreforScienceAdvice@dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas-sccs/

ISSN 1919-3769
ISBN 978-0-660-41081-4 Cat. No. Fs70-7/2021-043E-PDF

Correct Citation for this Publication:

DFO. 2021. 2020 Stock Status Update for American Plaice in NAFO Subarea 2 + Div. 3K. DFO Can. Sci. Advis. Sec. Sci. Res. 2021/043.

Aussi disponible en français :

MPO. 2021. Mise à jour sur l'état du stock de plie canadienne en 2020 dans la sous-zone 2 et la division 3K de l'OPANO. Secr. can. des avis sci. du MPO. Rép. des Sci. 2021/043.