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Central and Arctic Region

Canadian Science Advisory Secretariat
Science Advisory Report 2022/008

ASSESSMENT OF REDFISH IN THE NORTHWEST ATLANTIC FISHERIES ORGANIZATION (NAFO) SUBAREA 0, OCTOBER 2016

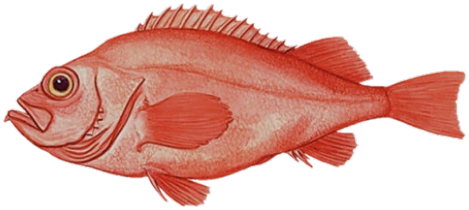

Image: Redfish (Sebastes spp.) from Google; Charlotte Knox, Illustrator: Heflinres Illustration Agency

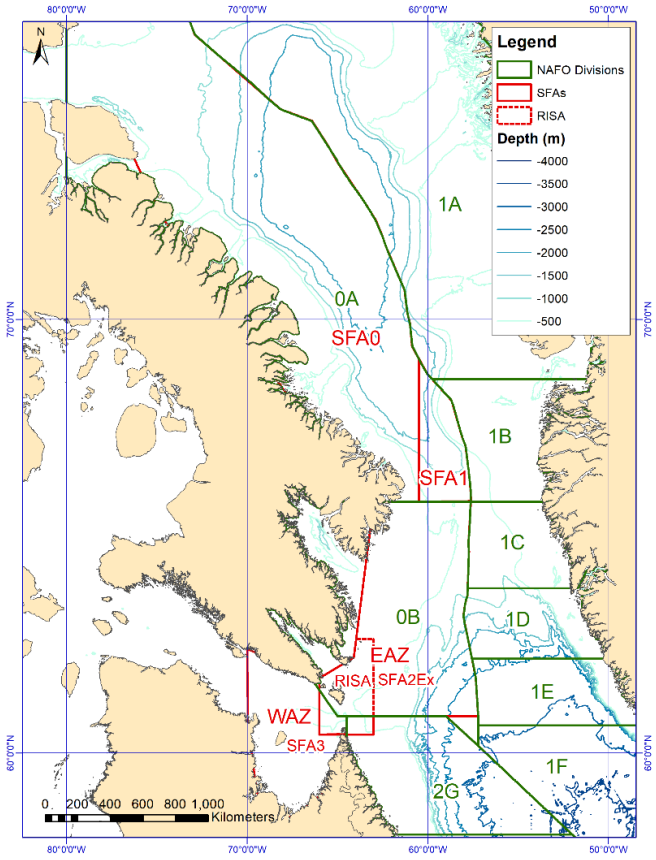

Figure 1. Northwest Atlantic Fisheries Organization (NAFO) Divisions and the Eastern Assessment Zone (EAZ; including former Shrimp Fishing Area [SFA] 2EX and Resolution Island Survey Area [RISA]) and the Western Assessment Zone (WAZ; formerly Shrimp Fishing Area 3).

Context:

*In the Northwest Atlantic, redfish range from Baffin Island in the north, to waters off New Jersey in the south and are managed in several discrete units. In Northwest Atlantic Fisheries Organization Subarea (SA) 0 (Divisions 0A and 0B) two redfish species have been identified, Deepwater Redfish (*Sebastes mentella*) and the less dominant Golden Redfish* (S. norvegicus*; previously known as* S. marinus*). Acadian Redfish (*S. fasciatus*), which are more common in southern waters, have not been identified in surveys conducted in SA 0 to date. There have been no Canadian fisheries for redfish in SA 0 and this stock has*

not been previously assessed. A fishery on the adjacent stock in SA 2 + 3K has been under moratorium since 1997 and this stock was last assessed in 2001 (DFO 2001, Power 2001). In April 2010, the Committee on the Status of Endangered Wildlife in Canada assessed the Deepwater Redfish/Acadian Redfish complex in Canada and designated the Northern Population (distributed from Baffin Bay south to the Grand Banks) as Threatened (COSEWIC 2010). A Recovery Potential Assessment was conducted in a 2011 Zonal Canadian Science Advisory Secretariat Advisory Process (DFO 2011a) and updated to include SA 0 in 2013 (DFO 2014). Limit reference points (LRPs) were also developed for the Northern Population based on data from SA 2 + 3K, using a Bayesian surplus production model (DFO 2012).

Fisheries and Oceans Canada (DFO) Fisheries and Aquaculture Management requested the current assessments to review the LRPs and provide advice on the status of the stocks to inform management decisions. This Science Advisory Report is from the October 19–21, 2016 zonal peer review on Assessments of Redfish in Northwest Atlantic Fisheries Organization (NAFO) Subarea 0, and Subarea 2 and Division 3K. Additional publications from this meeting will be posted on the *DFO Science Advisory Schedule as they become available.*

SUMMARY

- This is the first assessment of redfish in Northwest Atlantic Fisheries Organization (NAFO) Subarea (SA) 0 (Divisions 0A and 0B).
- Biomass estimates for Deepwater Redfish (*Sebastes mentella*) from Fisheries and Oceans Canada (DFO) surveys in NAFO Division 0B (400 to 1500 m) during 2011 to 2015 have been in the range of 20,000 to 43,000 t. This is an increase from estimates of 6,800 t in 2000 and 13,600 t in 2001. The Eastern Assessment Zone survey index for redfish spp. (primarily *S. mentella*) from the Northern Shrimp Research Foundation survey has been relatively stable between 100,000 and 150,000 t, with a peak in 2010 of about 336,000 t.
- An index of recruitment is not available, peaks in abundance in the Division 0B survey can be followed from 17 to 25 cm between 2011 and 2015. The proportion of Deepwater Redfish greater than 20 cm also increased from < 40% in 2000 and 2001 to > 80% during 2013–2015.
- Redfish in SA 0 are not commercially harvested. Fishing mortality is limited to bycatch, mainly of juvenile fish caught in shrimp fisheries, and to a lesser extent in Greenland Halibut (*Reinhardtius hippoglossoides*) fisheries. Bycatch totals rarely exceeded 200 t during 1997 to 2012.
- The peer-review meeting was not able to validate or invalidate existing limit reference points (LRPs) for the Northern Population of Deepwater Redfish (SA 0+2+3KLNO) derived from production models in 2012, due to substantive concerns about input data and incomplete documentation of the rationale for model formulation.
- In the absence of an LRP, it is not possible to identify what zone of the Precautionary Approach Framework the SA 0 Deepwater Redfish stock is currently within.
- Despite a gap in the time series, the Division 0B survey indicates an increase in biomass from the first two surveys conducted in 2000 and 2001 to more recent surveys during 2011 to 2015. Also, the Eastern Assessment Zone survey has been relatively stable during 2005 to 2012, except for a very high value in 2010. These survey indices, suggest recent levels of bycatch in SA 0 are not limiting stock development.
- Any requests to conduct exploratory fisheries for redfish in NAFO SA 0 should be considered with caution and proceed only with robust programs in place for monitoring and scientific data collection. Stock indices need to be closely monitored throughout any

exploratory fishing. The minimum mesh size used should not be smaller than is allowed in other Canadian jurisdictions.

INTRODUCTION

Redfish inhabit cold waters (3 to 8 °C) along slopes of banks in both the Northwest and Northeast Atlantic. In Canada they range from Baffin Bay to the Grand Banks and the Gulf of St. Lawrence. Redfish found in Baffin Bay and Davis Strait, also referred to as the Northwest Atlantic Fisheries Organization (NAFO) Subarea (SA) 0, Divisions 0A and 0B (Figure 1), are dominated by Deepwater Redfish (*Sebastes mentella*). Golden Redfish (*S. marinus*, now known as *S. norvegicus*) are also present in SA 0 but have been found in < 0.1% of NAFO Division 0B survey catches (Figures 1 and 2). Golden Redfish are more common on the Flemish Cap, off the Grand Banks of Newfoundland. Acadian Redfish (*S. fasciatus*), while similar to Deepwater Redfish, have not been identified in research surveys in SA 0. Despite their physical similarities Acadian and Deepwater redfish have different habitat preferences, with Deepwater Redfish preferring deeper waters and Acadian Redfish being dominant on the more southern continental slopes (western part of the Scotian Shelf and Gulf of Maine).

Redfish are slow growing and long-lived (up to 75 years; Campana et al. 1990), with maximum sizes reaching 60 cm. Size-at-maturity varies from low estimates in the range of 22–24 cm (Sévigny et al. 2007) to 38–39 cm (Magnússon and Magnússon 1995). Redfish produce live young that disperse with currents over large distances (Valentin et al. 2015). Redfish are known as ‘pulse recruiters’, producing strong year-classes on the order of every 5–12 years. Larvae are found primarily in surface waters and young fish remain pelagic for 4–5 months. Generally, redfish inhabit deeper waters as they grow, with Deepwater Redfish occupying 350–500 m depths and Acadian Redfish typically occupying shallower depths, between 150 and 300 m. Redfish are known to make daily vertical migrations and therefore, are considered semi-pelagic. Within SA 0 redfish are most abundant in Division 0B, off the southern coast of Baffin Island and east of Resolution Island in the Davis Strait (Figure 2).

There have been no Canadian fisheries directed towards redfish in SA 0, although small commercial catches were reported to the STATLANT 21A database by the USSR in 1977 (169 t) and 1990 (289 t), prior to the extension of the Canadian Exclusive Economic Zone. Redfish are reported as bycatch in Canadian northern shrimp (*Pandalus borealis* and *P. montaguii*) and to a lesser degree Greenland Halibut (*Reinhardtius hippglossoides*) bottom trawl fisheries. There is 100% at-sea observer coverage of the northern shrimp and Greenland Halibut trawl fisheries in SA 0, therefore, estimates of redfish bycatch are considered to be representative of overall removals. However, these fisheries do not differentiate redfish catches by species. The introduction of the Nordmore grate (28 mm spacing) to the shrimp trawl gear in 1993 reduced fish bycatch considerably. This will have benefited long-lived redfish species, with the proportion of redfish in the catch declining to approximately 2%, from highs of 32% (Siferd 2010).

In April 2010, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assessed the Northern Population of Deepwater Redfish (NAFO SA 0+2+3KLNO; Figure 1) as Threatened (COSEWIC 2010). In 2011, a Recovery Potential Assessment (RPA) was completed (DFO 2011a) and in 2012 reference points were developed (DFO 2012). In 2013 an addendum was published to extend the RPA to include SA 0 (DFO 2014). The RPA and the reference point development considered data from a portion of the Northern Population (autumn survey of Div. 2J3K and removals from SA 2 + Div. 3KLNO). These data were the most useful for modelling the population. However, genetic stock structuring in the Northern Population is uncertain. Since the COSEWIC assessment and RPA were undertaken, genetic sample coverage has expanded to include numerous sample locations throughout the Northern Population. However, the results were not available prior to this 2016 assessment and the link

between redfish in SA 0 and stock areas to the south, either during larval/juvenile stages or as adults remains unknown.

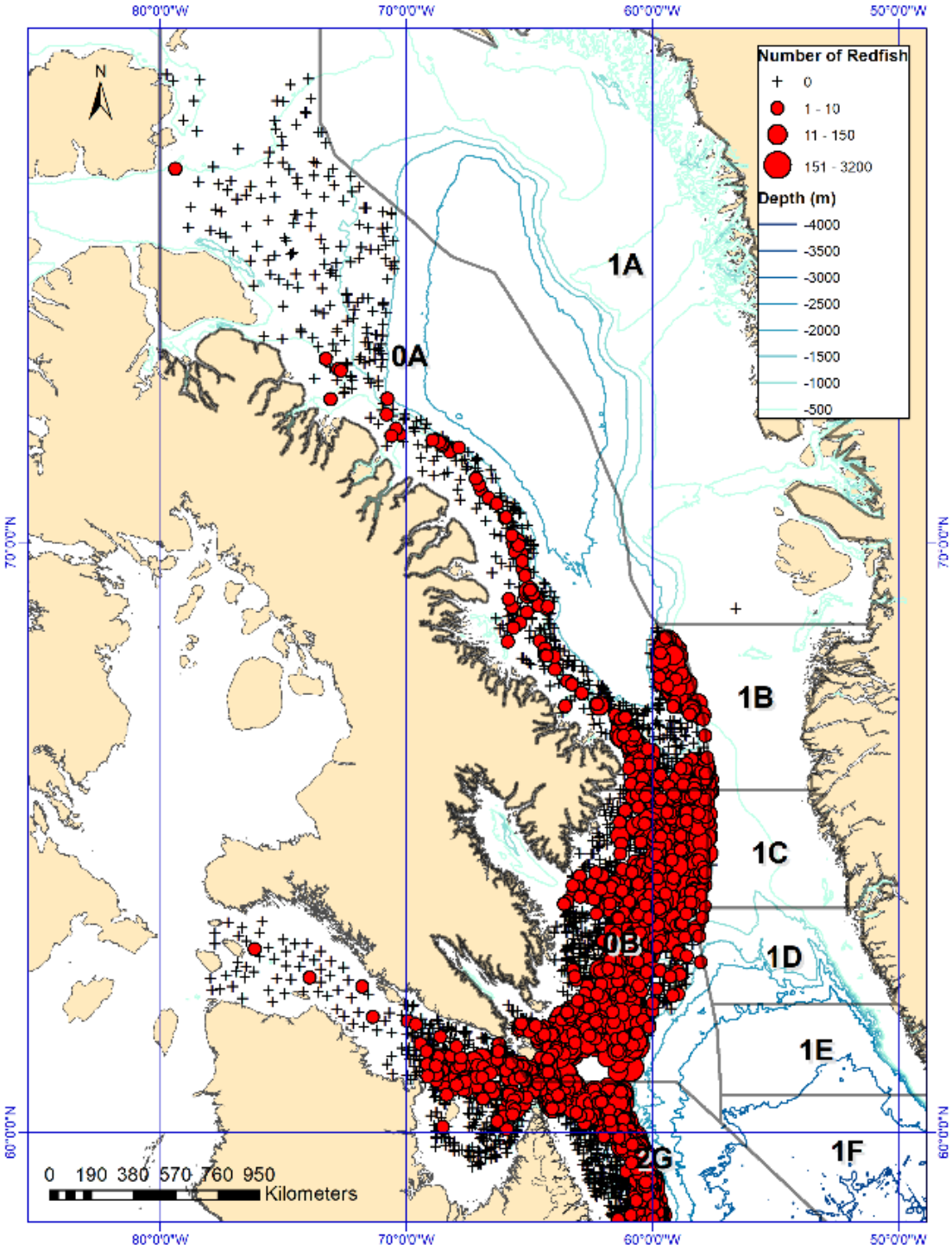

Figure 2. Distribution of redfish catch (red circles) from Fisheries and Oceans Canada and Northern Shrimp Research Foundation surveys conducted during 2005–2015 (black crosses indicate sets with no redfish).

Ecosystem

Physical Oceanographic Environment

The relatively shallow shelf extending southeast off the coast of Baffin Island is dominated by relatively cold (0 °C), low salinity water flowing south along the coast of Baffin Island, as well as currents flowing out of Hudson Strait. These currents mix with warmer (3–4 °C) saltier water moving west from Greenland at about 64 °N in the Labrador Sea near Resolution Island (Buch 2000). Information on sea ice extent indicated the south Baffin Shelf was ice covered from December to June in 2013 (Ribergaard 2014). Mean near-bottom temperatures for Division 0A (south of 72 °N), ranged from to -0.2 to 1.7 °C and declined with depth (Treble 2016). Bottom temperatures in Division 0B are warmer, 2.1 to 4.1 °C with the warmest temperatures at depths 800 to 1000 m (Treble 2016).

Invertebrate and fish community

Deepwater Redfish was identified as an indicator species, along with American Plaice (*Hippoglossoides platessoides*) and Roughhead Grenadier (*Macrorus berglax*) in a fish assemblage occupying the shallow, warm water of the south Baffin shelf (Jorgensen et al. 2005). Redfish were identified as prey for larger fish species such as Greenland Halibut off Labrador and the Grand Banks of Newfoundland (Dwyer et al. 2010), while in Division 0B redfish were found to comprise approximately 8% of Greenland Halibut diet (DFO unpublished data). Portions of the south Baffin and northern Labrador shelf habitat have been closed to protect *Geodia* sp. sponge and large gorgonian coral aggregations (Kenchington et al. 2016).

ASSESSMENT

Survey Methodologies

Fisheries and Oceans Canada (DFO) has conducted random depth-stratified bottom trawl surveys in portions of Div. 0A and 0B (Figure 2) in the fall (September–October) during 1999 to 2015, in collaboration with the Greenland Institute of Natural Resources and the research vessel (RV) Paamiut. An Alfredo III trawl with 140 mm mesh and a 30 mm mesh liner in the cod end was used for these deep water surveys (400 to 1500 m). All fish were sampled for individual length and weight and redfish were identified to species. See Treble (2016) for details on stratification and survey area. Not all areas and depths have been surveyed each year and few redfish were caught in Division 0A (Figure 2), therefore, the Division 0B survey is the primary index for Deepwater Redfish coming from the DFO surveys.

The Northern Shrimp Research Foundation (NSRF) has conducted surveys in the Eastern Assessment Zone (formerly Shrimp Fishing Areas (SFA) 2EX, and Resolution Island (RISA)) and in the Western Assessment Zone (formerly SFA 3) (DFO 2011b) (Figure 1) from 2005 to 2015 during summer (July–August) at depths of 100 to 800 m. Several different vessels have used a Campelen 1800 shrimp trawl to conduct this survey. There have been no experiments to standardize catch among these vessels. However, the same Captain has been used in an effort to limit changes in how the gear is fished. Also, in 2008 the Campelen trawl was modified; larger footgear was used and floatation was added to the belly seams, in an effort to minimize gear damage. Siferd and Legge (2014) used a flume tank to assess the impact of these changes on trawl performance and found that trawl geometry was not severely affected. Fish caught in the NSRF surveys are identified but only total count and weight data are recorded for each set and redfish have not been identified to species in most years. See Siferd (2014) for details on stratification and survey area. Few redfish have been caught in the Western Assessment Zone, therefore, the primary index for redfish species (primarily Deepwater Redfish) is from the NSRF survey in the EAZ.

Survey Indices

Biomass and Abundance

Deepwater Redfish biomass in the Division 0B survey was estimated at 6,800 t in 2000 and 13,600 t in 2001, then following a gap in the time series values have varied between 20,000 and 43,000 t (Figure 3). The abundance index has a slightly different pattern, with 2013 to 2015 estimates more comparable to those in 2000 and 2001 (Figure 3). The 2011 abundance value is influenced by 6 sets that contained more than 2000 fish (one set had almost 4000 fish). In other years there were only 1 or 2 sets with catches as high as 1000 fish. Also, note that in 2001 and 2014, strata at depths 400 to 800 m were poorly sampled, so estimates may not be as precise as in other years.

The EAZ index for redfish species (primarily Deepwater Redfish) from the NSRF survey has been relatively stable between 100,000 t and 150,000 t, with a peak in 2010 of about 336,000 t (Figure 4).

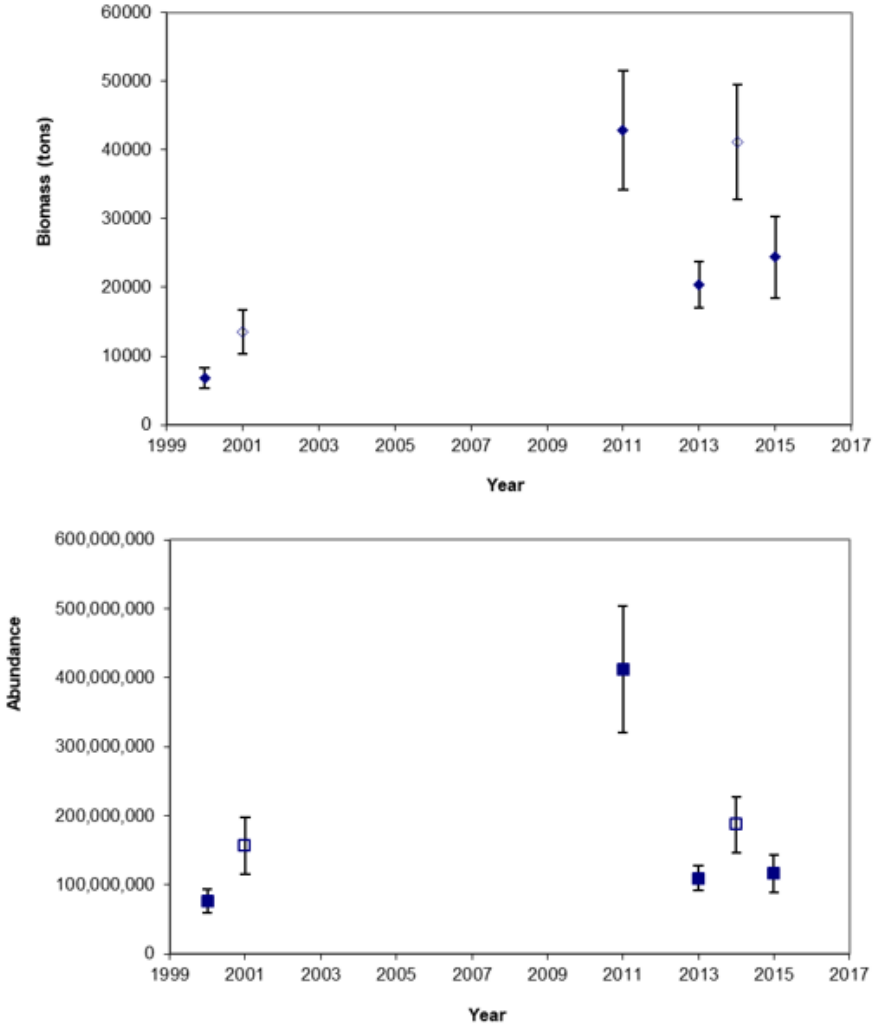

Figure 3. Biomass (t) and abundance indices (with standard error) for Deepwater Redfish from Fisheries and Oceans Canada surveys in Div. 0B. In 2001 and 2014, strata at depths 400 to 800 m were poorly sampled, so estimates may not be as precise as in other years.

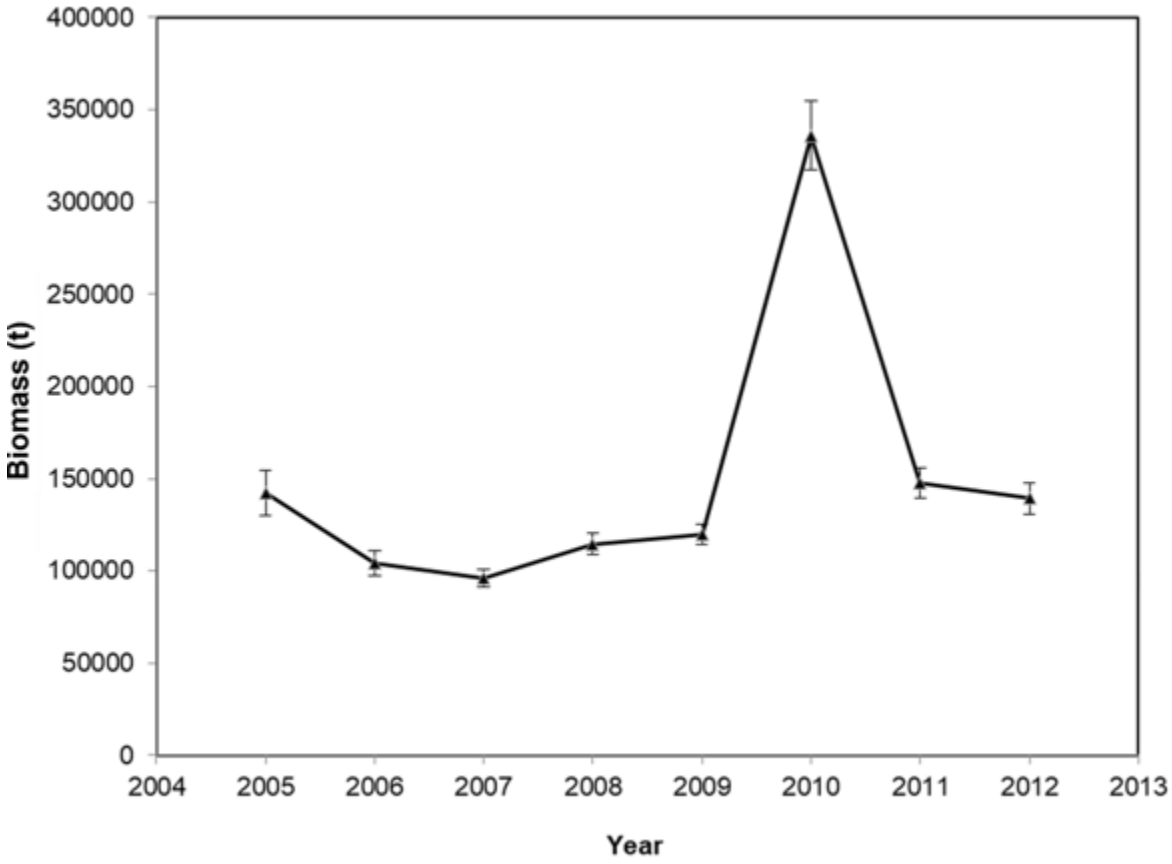

Figure 4. Biomass (t) index for redfish species from the Northern Shrimp Research Foundation surveys in the Eastern Assessment Zone (formerly Shrimp Fishing Areas 2EX and Resolution Island).

Mortality

There is no directed fishery for redfish in SA 0 so fishing mortality is very low, due exclusively to bycatch from the northern shrimp and Greenland Halibut fisheries. During 1997 to 2012 most of the bycatch came from the northern shrimp fisheries in SFA 1 (varying from < 1 t to 207 t) and SFA 2 (varying from 11 t to 149 t). Due to the Nordmore sorting grate (28 mm spacing) the redfish bycatch in the shrimp fishery is comprised primarily of juvenile redfish. Bycatch in the Greenland Halibut fishery for all of SA 0 varied from < 1 t to 18 t. Overall, bycatch averaged 128 t (17 t and 236 t), during 1997 to 2012. With only 3 years of Division 0B survey and bycatch data overlapping it was not possible to establish a proxy for fishing mortality, as has been done for the SA 2+3K stock. However, bycatch levels were relatively stable from 1997 to 2012, with a slight decline from 2010 to 2012, and were at levels two orders of magnitude lower than the survey biomass index (Figure 5).

Recruitment

Length Composition

Lengths in the Division 0B survey ranged from 2 to 48 cm. In 2001 there was a mode at 6–7 cm, then following the gap in the time series, peaks in abundance can be followed from 17 to 25 cm between 2011 and 2015 (Figure 6). The proportion of Deepwater Redfish greater than 20 cm also increased from < 40% in 2000 and 2001 to > 80% during 2013–2015.

Recruitment Index

A recruitment index, similar to that calculated for the SA 2+3K stock (i.e., abundance < 15 cm), has not yet been developed for the SA 0 stock.

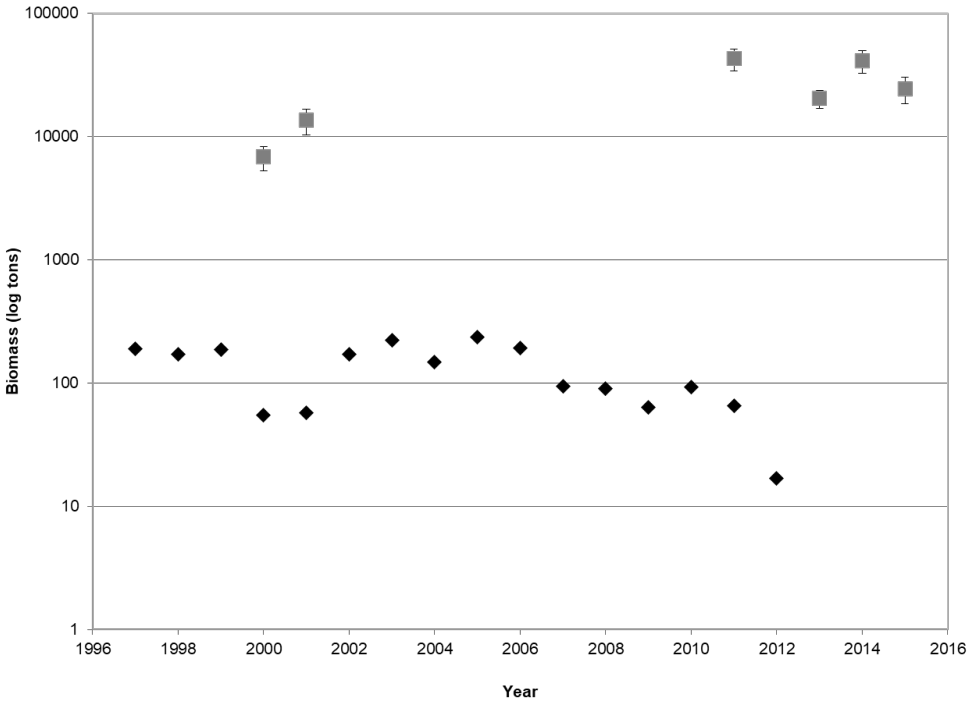

Figure 5. Redfish bycatch (t) from the northern shrimp and Greenland Halibut fisheries in Subarea 0 (black circles) and Deepsea Redfish biomass from the Division 0B survey (gray squares) (note the log scale on the y-axis).

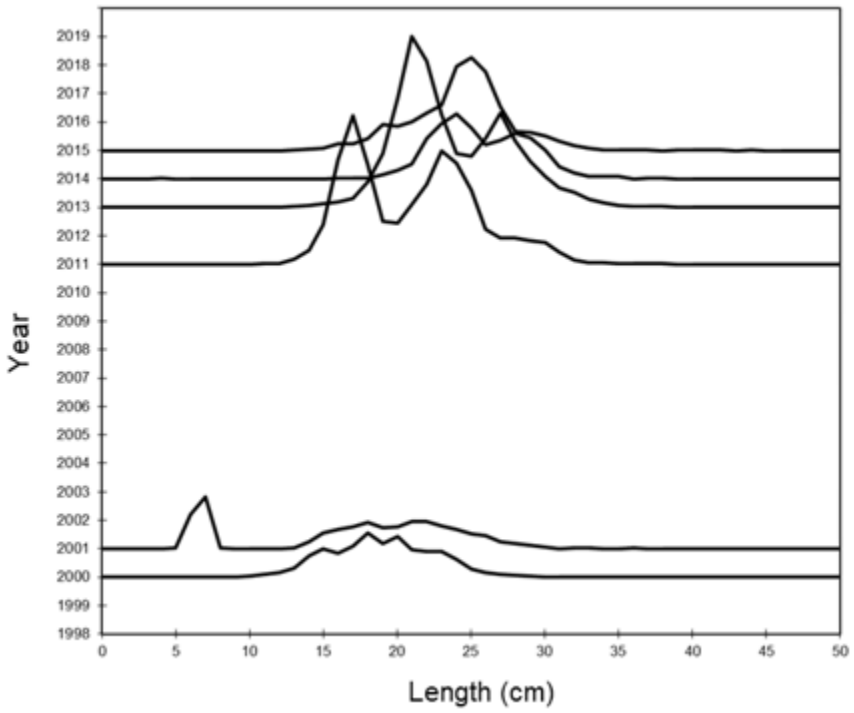

Figure 6. Length frequency by year for Deepwater Redfish from Fisheries and Oceans Canada Division 0B survey.

Reference Points

During the assessment plenary session, it was agreed that there were substantive concerns with the input data and incomplete documentation of the rationale for the production model formulation used to develop limit reference points (LRPs) for the Northern Population of Deepwater Redfish (SA 0+2+3KLNO). The meeting participants were not able to validate or invalidate LRPs derived in 2012 (DFO 2012) and as a result, the previously calculated reference points were not accepted, see DFO (2020) for more detail. The available data are also not sufficient to develop a stock level LRP for SA 0 redfish. In the absence of a LRP, it was not possible to identify which zone of the Precautionary Approach Framework the SA 0 stock is currently within.

Sources of Uncertainty

Redfish in SA 0 are primarily comprised of Deepwater Redfish, with lesser amounts of Golden Redfish. Acadian Redfish are similar in appearance to Deepwater Redfish but have not been identified in SA 0. Effort is made to separate these redfish species on DFO research surveys but not in the bycatch of commercial fisheries. The species have different depth and temperature preferences, therefore, changes in environmental conditions are likely to affect the three species differently. When interpreting survey indices and fisheries catch and bycatch data the complexities in redfish species distribution need to be considered.

Sebastes spp. are known as episodically recruiting species where large year-classes may occur only once a decade, or less frequently, even in healthy populations.

Redfish survey catchability can vary significantly due to biological (formation of dense aggregations) or environmental (water temperature effects or depth range) factors, leading to high inter-annual variation.

CONCLUSIONS AND ADVICE

Biomass indices suggest the SA 0 Deepwater Redfish stock has been relatively stable during 2000 to 2015. The stock is comprised primarily of fish between 15 and 30 cm in length. There is no directed fishery and bycatch totals rarely exceeded 200 t during 1997 to 2012.

The meeting participants were not able to validate or invalidate existing LRPs for the Northern Population of Deepwater Redfish (SA 0+2+3KLNO) derived from production models in 2012, due to substantive concerns about input data and incomplete documentation of the rationale for model formulation, therefore, without an accepted LRP it is not possible to identify what zone of the Precautionary Approach Framework the SA 0 Deepwater Redfish stock is currently within.

Given that current bycatch is two orders of magnitude lower than current biomass estimates and survey indices have been relatively stable, a carefully monitored exploratory fishery for redfish in NAFO SA 0 could be considered. However, the life history of the species, knowledge gaps regarding stock productivity and connectivity, and the relatively small size of fish in SA 0, suggests that any increase in fishing mortality should be carefully considered and monitored closely.

KNOWLEDGE GAPS AND RESEARCH NEEDS

The Atlantic redfish population(s) genetic structure needs to be further investigated to better understand connectivity between SA 0 and adjacent stocks.

Lack of age information precludes certain types of analyses such as growth rates, length or weight-at-age, and cohort-based population modelling.

Stock indices for SA 0 appear to be based on immature fish (< 25 cm). However, an assessment of maturity status and stock productivity has not been done for Deepwater Redfish in SA 0.

The survey time series currently available for the assessment are short, relative to the lifespan of redfish. Also, the Division 0B survey does not include depths above 400 m and uses an Alfredo trawl that is more suited to groundfish, while the NSRF survey uses a Campelen shrimp trawl that should have better catchability for redfish, but does not collect data from individual fish. One solution would be to approach the NSRF survey organizers about the possibility of collecting additional data on redfish catches beyond total counts and weights.

LIST OF MEETING PARTICIPANTS

Name	Affiliation
Darrell Mullowney (Chair)	DFO – Science, Newfoundland and Labrador Region
Jim Meade (CSA Office)	DFO – Science, Newfoundland and Labrador Region
Emilie Novaczek (Rapporteur)	Memorial University of Newfoundland
John Brattey	DFO – Science, Newfoundland an Labrador Region
Corina Busby	DFO – Science, National Capital Region
Eugene Colbourne	DFO – Science, Newfoundland an Labrador Region

Name	Affiliation
Karen Dwyer	DFO – Science, Newfoundland an Labrador Region
Geoff Evans	DFO – Science, Newfoundland an Labrador Region
Brian Healey	DFO – Science, Newfoundland and Labrador Region
Kevin Hedges	DFO – Science, Central and Arctic Region
Danny Ings	DFO – Science, Newfoundland an Labrador Region
Dawn Maddock Parsons	DFO – Science, Newfoundland an Labrador Region
Joanne Morgan	DFO – Science, Newfoundland an Labrador Region
Don Power	DFO – Science, Newfoundland an Labrador Region
Paul Regular	DFO – Science, Newfoundland an Labrador Region
Rick Rideout	DFO – Science, Newfoundland an Labrador Region
Peter Shelton	DFO – Science, Newfoundland an Labrador Region
Margaret Treble	DFO – Science, Central and Arctic Region
Margaret Warren	DFO – Science, Newfoundland an Labrador Region
Nadine Wells	DFO – Science, Newfoundland an Labrador Region
Dave Coffin	DFO – Fisheries and Aquaculture Management, Newfoundland and Labrador Region
Bob Vere	Canadian Centre for Fisheries Innovation (CCFI)
Monty Way	Fish Food & Allied Workers Union (FFAW) – Corner Brook
Erin Carruthers	FFAW
Roland Hedderson	FFAW
Wayne Masters	Fish Harvester, Red Harbour
Jeff Roberts	Fish Harvester, Hermitage
Brian J. Careen	Fish Harvester, St. Bride's
Kris Vascotto	Groundfish Enterprise Allocation Council (GEAC)
Dennis Slade	Icewater Seafoods
Joel Vigneau	IFREMER Science
Shelley Dwyer	NL Department of Forestry, Fisheries and Aquaculture

SOURCES OF INFORMATION

This Science Advisory Report is based on the October 19–21, 2016 zonal peer review on Assessments of Redfish in Northwest Atlantic Fisheries Organization (NAFO) Subarea 0, and Subarea 2 and Division 3K. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

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