Northwest Atlantic Fisheries Organization

Report of the Scientific Council Meeting

02 -15 June 2023
Halifax, Nova Scotia

NAFO
Halifax, Nova Scotia, Canada
2023

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Recommended Citation:
NAFO. 2023. Report of the Scientific Council, 02 -15 June 2023, Halifax, Canada. NAFO SCS Doc. 23/18.

Scientific Council June Meeting Participants
02 – 15 June 2023

From left to right:
Front row: Karen Dwyer, Diana González-Troncoso, Katherine Sosebee, Mark Simpson
Second row: Katie Schleit, Patricia Gonçalvez, Lisa Hendrickson, Kevin Hedges
Third row: Rasmus Nygaard, Tom Blasdale, Andrew Kenny, Rick Rideout
Fourth row: Laura Wheeland, Mar Sacau Cuadrado, Fernando González-Costas, Andrea Perreault
Fifth row: Paul Regular, Irene Garrido Fernandez, Adriana Nogueira
Sixth row: Miguel Caetano, Mackenzie Mazur, Mrtha Krohn
Seventh row: Adolfo Merino Buisac, Mariano Koen-Alonso, Dawn Maddock Parsons
Back row: Ricardo Alpoim, Brian Healey, Kenji Taki, Luis Ridao Cruz
Missing from Photo: Trajce Alcinov, David Bélanger, Fatemeh Hatefi, Danny Ings, Ellen Kenchington, Rajeev Kumar, Emilie Novaczek, Divya Varkey, Igor Yashayaev, Alex Kokkalis, Pablo Durán Muñoz, Liivika Näks, Doug Butterworth, Rebecca Rademeyer, Carsten Hvingel, Yulia Badina, Konstantin Fomin, Sergey Melnikov, Temur Tairov, Ihor Honcharuk, Valeriy Paramonov, Yulia Zabarna, Lisa Readdy, Paula Frantantoni, Gorka Merino, Brian Petrie, Anthony Thompson, Brynn Devine, Susanna Fuller, Gemma Rayner

Scientific Council Chairs 2023

From left to right:
Miguel Caetano, Chair of STACFEN; Mark Simpson, Chair of STACFIS; Karen Dwyer, Chair of Scientific Council; Diana González-Troncoso, Vice Chair of Scientific Council and Chair of STACREC; and Rick Rideout, Chair of STACPUB

REPORT OF SCIENTIFIC COUNCIL MEETING
02 -15 June 2023

Chair: Karen Dwyer Rapporteur: Tom Blasdale

I. PLENARY SESSIONS

The Scientific Council met at the Atrium building, Saint Mary's University, Halifax, NS, Canada, during 02 – 15 June 2023, to consider the various matters in its Agenda. Representatives attended from Canada, Denmark (in respect of Faroe Islands and Greenland), the European Union, Japan, Norway, the Russian Federation, Ukraine, the United Kingdom, and the United States of America. Observers from the Food and Agriculture Organization (FAO), and Oceans North were also present, as well as two external reviewers. The Executive Secretary, Scientific Council Coordinator, and other members of the Secretariat were in attendance.

The Executive Committee met prior to the opening session of the Council to discuss the provisional agenda and plan of work.

The Council was called to order at 10:00 on 02 June 2023. The provisional agenda was **adopted**. The Scientific Council Coordinator was appointed the rapporteur.

The opening session was adjourned at 13:00 on 02 June 2023. Several sessions were held throughout the course of the meeting to deal with specific items on the agenda. The Council considered and **adopted** all the standing committee reports on 15 June 2023.

The Council considered and **adopted** the Scientific Council Report of this meeting of 02 -15 June 2023. The Chair received approval to leave the report in draft form for about two weeks to allow for minor editing and proof-reading on the usual strict understanding there would be no substantive changes.

The meeting was adjourned at 13:30 on 15 June 2023.

The Reports of the Standing Committees as adopted by the Council are appended as follows: Appendix I - Report of the Standing Committee on Fisheries Environment (STACFEN), Appendix II - Report of Standing Committee on Publications (STACPUB), Appendix III - Report of Standing Committee on Research Coordination (STACREC), and Appendix IV - Report of Standing Committee on Fisheries Science (STACFIS).

The Agenda, List of Research (SCR) and Summary (SCS) Documents, and List of Representatives, Advisers and Experts, are given in Appendices V-VII.

The Council's considerations on the Standing Committee Reports, and other matters addressed by the Council, follow in Sections II-XV.

II. REVIEW OF SCIENTIFIC COUNCIL RECOMMENDATIONS IN 2022

Recommendations from 2022 are considered in the relevant section of this report.

III. FISHERIES ENVIRONMENT

The Council **adopted** the Report of the Standing Committee on Fisheries Environment (STACFEN), as presented by Chair, Miguel Caetano. The full report of STACFEN is in Appendix I.

The recommendations made by STACFEN for the work of the Scientific Council as **endorsed** by the Council, are as follows:

- STACFEN **recommends** *considering Secretariat support for an invited speaker to address emerging issues and concerns for the NAFO Convention Area during the 2024 STACFEN meeting. Contributions from invited speakers may generate new insights and discussions within the committee regarding integrating environmental information into the stock assessment process.*
- STACFEN **recommends** *the presentation of work linking the decadal variation of oceanographic-climate changes over the Convention Area.*
- STACFEN **recommends** that *further discussions occur between STACFEN and STACFIS members on environmental data integration into the various stock assessments.*

IV. PUBLICATIONS

The Council **adopted** the Report of the Standing Committee on Publication (STACPUB) as presented by the Chair, Rick Rideout. The full report of STACPUB is in Appendix II.

The recommendations made by STACPUB for the work of the Scientific Council as **endorsed** by the Council, are as follows:

- STACPUB **recommends** *the use of the Scientific Council Meetings SharePoint as a repository to make SC working papers from previous years available to SC members and participants of SC meetings.*
- STACPUB **recommends** *ceasing the printing of working papers and documents at SC meetings. Printing can be done by request.*

V. RESEARCH COORDINATION

The Council **adopted** the Report of the Standing Committee on Research Coordination (STACREC) as presented by the Chair, Diana Gonzalez-Troncoso. The full report of STACREC is in Appendix III.

The recommendations made by STACREC for the work of the Scientific Council as **endorsed** by the Council, are as follows:

- A peer review process to perform comparative fishing analyses between new and old research vessels used in the Canadian-NL surveys is being carried out by Canada later in 2023. STACREC **recommends** *waiting until the finalization of this peer review process before exploring spatial models, such as those used during WKUSER2, to potentially fill holes in survey coverage*.
- In June 2022, STACREC **recommended** *exploring the spatio-temporal models used during the Joint ICES/NAFO shrimp benchmark in January 2022 to model gaps in the surveys.* This recommendation is also deferred until after the Canadian peer review process.
- STACREC **recommends** *a comprehensive study to investigate redfish stock structure in NAFO Divisions 2 and 3, with consideration of species splitting and recent approaches to studying redfish stock structure in other RFMOs.*
- STACREC **recommends** *work continue on further incorporating changes in ocean climate and ecosystem conditions into stock assessments and the understanding of species dynamics. Specifically, analyses presented here should be expanded to further quantify temperature changes during the Canadian and EU surveys on the Grand Bank and presented at STACFEN 2024.*

With regard to the Faroes longline survey:

- STACREC **recommends** that *the Contracting Party consults with an external expert on longline surveys to further refine their survey design. If a revised research plan is received by SC prior to the September meeting, STACREC can provide additional comment as needed.*
- In light of concerns with respect to the design of the Faroes longline survey, STACREC **recommends** that *a scientist from DFO Maritimes region should be invited to present details of the design of the Canadian Atlantic halibut longline survey.*

VI. FISHERIES SCIENCE

The Council **adopted** the Report of the Standing Committee on Fisheries Science (STACFIS) as presented by the Chair Mark Simpson. The full report of STACFIS is in Appendix IV.

There were no general recommendations arising from STACFIS. The Council endorsed recommendations specific to each stock and they are highlighted under the relevant stock considerations in the STACFIS report (Appendix IV).

VII. MANAGEMENT ADVICE AND RESPONSES TO SPECIAL REQUESTS

1. The NAFO Commission

The Commission requests are given in Annex 1 of Appendix V.

The Scientific Council noted the Commission requests for advice on Northern shrimp (Northern shrimp in Div. 3M and Divs. 3LNO (Item 1)) will be undertaken during the Scientific Council meeting on 13 to 15 September 2023.

a) Request for Advice on TACs and Other Management Measures

The Fisheries Commission at its meeting of September 2010 reviewed the assessment schedule of the Scientific Council and with the concurrence of the Coastal States agreed to request advice for certain stocks on either a two-year or three-year rotational basis. In recent years, thorough assessments of certain stocks have been undertaken outside of the assessment cycle either at the request of the Commission or by the Scientific Council's own accord based on recent stock developments.

Cod in Division 3M Advice June 2023 for 2024

Recommendation for 2024

Catches up to 3/4 F_{lim} are projected to result in a very low probability (≤10%) of the stock going below B_{lim} and of fishing mortality exceeding F_{lim} in 2024. All fishing scenarios with fishing mortality less than 2/3 F_{lim} are projected to promote growth in SSB.

SC therefore advises that exploitation should not exceed 2/3 F_{lim} in 2024.

Management objectives

No explicit management plan or management objectives have been defined by the Commission. Convention General Principles are applied (NAFO GC Doc. 07-04).

Convention Principle	Status	Comment
Restore to or maintain at Bmsy	Intermediate	Bmsy undefined, B > Blim
Eliminate Overfishing (Stock)	OK	F < Flim
Eliminate Overfishing (Ecosystem)	OK	Total EPU catches < 2TCI
Apply Precautionary Approach	OK	Blim and Flim defined
Minimize harmful impacts on living marine resources and ecosystems	Intermediate	Directed fishery, VME closures in effect, effectiveness of bycatch regulations uncertain
Preserve marine biodiversity	Unknown	Cannot be evaluated

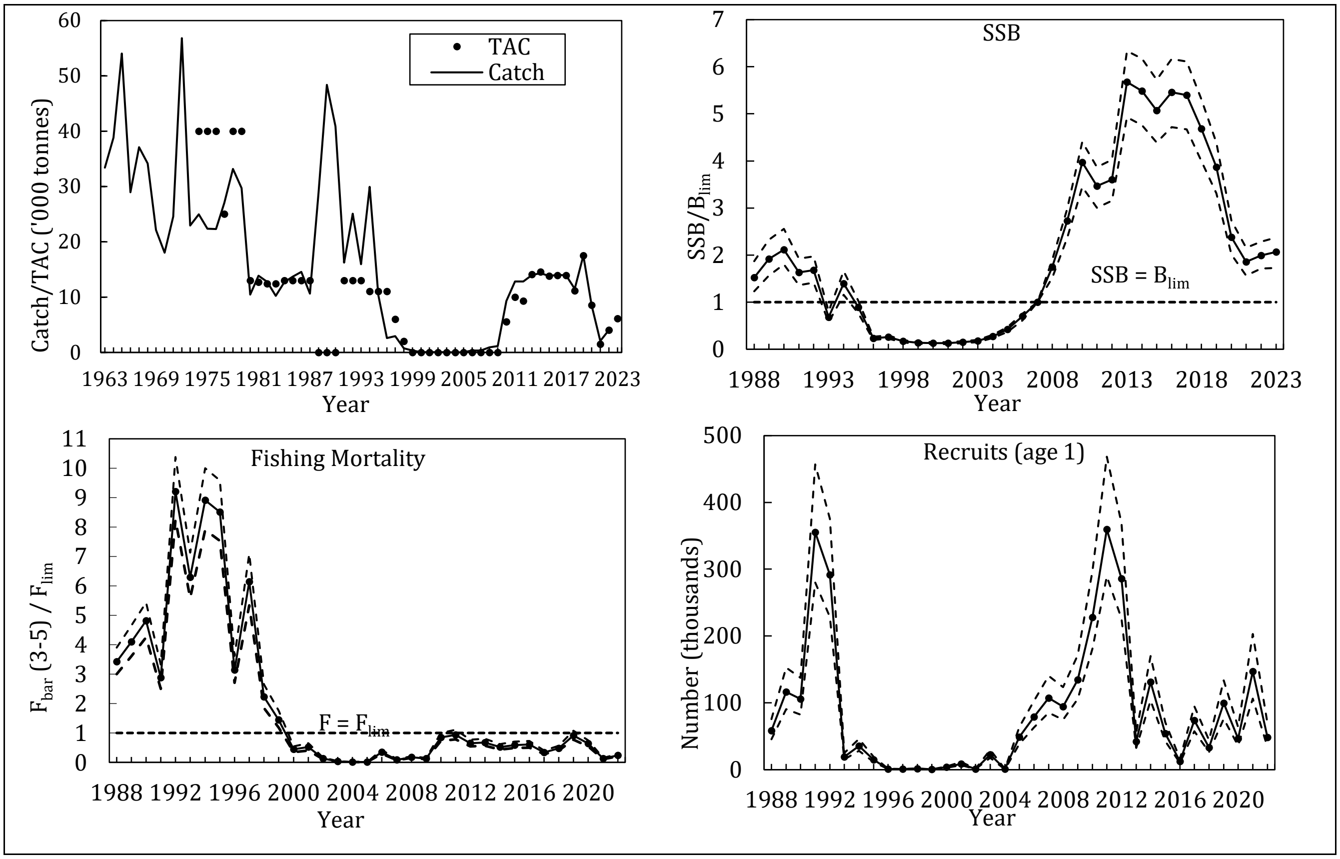
OK
Intermediate
Not accomplished
Unknown

Management unit

The cod stock in Flemish Cap (NAFO Div. 3M) is considered to be a distinct population.

Stock status

SSB declined rapidly since 2017 but has remained stable during the last 3 years and is estimated to be above B_{lim}. Since 2013, recruitment has varied at intermediate levels, much lower than those observed in 2011-2012. Fishing mortality has remained below F_{lim} since the fishery reopened in 2010. F has generally decreased since 2019 and in 2022 is below F_{lim} with a high probability.



Reference points

$B_{lim} = SSB_{2007}$: Median = 14 755 tons of spawning biomass (Scientific Council, 2023).

$F_{lim} = F_{30\%SPR}$: Median = 0.157 (Scientific Council, 2023).

Projections

Stochastic projections of the stock dynamics from 2023 to the start of 2025 were conducted. F_{bar} is the mean of the F at ages 3-5 and is used as the indicator of overall fishing mortality; F_{sq} is the status quo F, calculated as the mean of the last three years F_{bar} (2020-2022).

Table 1.

	B		SSB		Yield
	Median and 80% CI				
$F_{bar} = 0$					
2023	53812	(47944 - 61013)	27709	(24790 - 30794)	6100
2024	58438	(51161 - 68867)	30747	(27207 - 34601)	0
2025	65890	(56510 - 78568)	39660	(34924 - 44681)	
$F_{bar} = F_{sq}$ (median = 0.053)					
2023	53812	(47944 - 61013)	27709	(24790 - 30794)	6100
2024	58438	(51161 - 68867)	30747	(27207 - 34601)	6509
2025	59324	(50003 - 72050)	33696	(29110 - 38825)	
$F_{bar} = F_{2023}$ (median = 0.058)					
2023	53812	(47944 - 61013)	27709	(24790 - 30794)	6100
2024	58438	(51161 - 68867)	30747	(27207 - 34601)	7079
2025	58752	(49433 - 71480)	33199	(28505 - 38167)	
$F_{bar} = 1/2F_{lim}$ (median = 0.078)					
2023	53812	(47944 - 61013)	27709	(24790 - 30794)	6100
2024	58438	(51161 - 68867)	30747	(27207 - 34601)	9176
2025	56673	(47350 - 69385)	31352	(26697 - 36365)	
$F_{bar} = 2/3F_{lim}$ (median = 0.104)					
2023	53812	(47944 - 61013)	27709	(24790 - 30794)	6100
2024	58438	(51161 - 68867)	30747	(27207 - 34601)	11708
2025	54177	(44843 - 66893)	29127	(24423 - 34096)	
$F_{bar} = 3/4F_{lim}$ (median = 0.117)					
2023	53812	(47944 - 61013)	27709	(24790 - 30794)	6100
2024	58438	(51161 - 68867)	30747	(27207 - 34601)	12903
2025	53003	(43651 - 65719)	28064	(23409 - 33003)	
$F_{bar} = F_{lim}$ (median = 0.157)					
2023	53812	(47944 - 61013)	27709	(24790 - 30794)	6100
2024	58438	(51161 - 68867)	30747	(27207 - 34601)	16163
2025	49790	(40459 - 62527)	25247	(20608 - 30117)	

Table 2.

	Yield		P(SSB < SSBlim)			P(F > Flim)		
	2023	2024	2023	2024	2025	2023	2024	P(SSB_{25} > SSB_{23})
F=0	6100	0	<1%	<1%	<1%	<1%	<1%	100%
Fsq = 0.053	6100	6509	<1%	<1%	<1%	<1%	<1%	100%
F2023 = 0.058	6100	7079	<1%	<1%	<1%	<1%	<1%	100%
1/2Flim = 0.078	6100	9176	<1%	<1%	<1%	<1%	<1%	94%
2/3Flim = 0.104	6100	11708	<1%	<1%	<1%	<1%	<1%	72%
3/4Flim = 0.117	6100	12903	<1%	<1%	<1%	<1%	2%	52%
Flim = 0.157	6100	16163	<1%	<1%	<1%	<1%	50%	14%

The results indicate that the total biomass and SSB are likely to increase or remain stable by the start of 2025 in all scenarios except with $F=F_{lim}$. The probability of SSB being below B_{lim} is very low (≤1%) in all the scenarios. The probability of SSB in 2025 being above that in 2023 ranges between 14% and 100%, depending on the scenario (Tables 1 and 2).

Under all scenarios except $F= F_{lim}$, the probability of F_{bar} exceeding F_{lim} is less than or equal to 2% in 2024.

Assessment

A Bayesian SCAA model, introduced at the 2018 benchmark, was used as the basis for the assessment of this stock with data from 1988 to 2022.

The next full assessment for this stock will be in 2024.

Human impact

Mainly fishery related mortality. Other sources (e.g., pollution, shipping, oil-industry) are undocumented.

Biological and environmental interactions

Redfish, shrimp and smaller cod are important prey items for cod. There are strong trophic interactions between these species in the Flemish Cap.

The Flemish Cap (3M) Ecosystem Production Unit (EPU) has not experienced sustained reductions in overall productivity observed in other EPUs. With the exception of a short-lived increase in 2005-2009, total EPU biomass has remained fairly stable over time despite the changes in individual stocks.

Ecosystem sustainability of catches

The impact of bottom fishing activities on VMEs in the NRA was last assessed in 2021. The risk of Significant Adverse Impacts (SAIs) on sponge and large gorgonian VMEs was assessed to be low, while this risk for sea pen VMEs has been assessed as intermediate. The risks of SAIs on small gorgonian, black coral, bryozoan and sea squirt VMEs were assessed as high. A number of areas in the Flemish Cap (3M) EPU have been closed to bottom fishing to protect VMEs.

3M cod is included in the piscivores guild of the Flemish Cap (3M) Ecosystem Production Unit (EPU). Other NAFO managed stocks in this guild and EPU are 3M redfish and 2+3KLMNOPs Greenland halibut. The Catch/TCI is below the 2TCI ecosystem reference point (3M Piscivore $Catch_{2022}$/TCI=0.98) indicating a low risk of ecosystem overfishing.

Fishery

Cod is caught in directed trawl and longline fisheries and as bycatch in the directed redfish fishery by trawlers. The fishery is regulated by quota. New technical regulations were introduced in 2021, in particular a closure of the directed fishery in the first quarter as well as sorting grids to protect juveniles.

Recent catch estimates and TACs ('000 tonnes) are as follows:

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TAC	14.5	13.8	13.9	13.9	11.1	17.5	8.5	1.5	4.0	6.1
STATLANT 21	14.4	12.8	13.8	13.9	10.5	13.0	8.5	2.6	NA*	
STACFIS	14.3	13.8	14.0	13.9	11.5	17.5	8.5	2.1	4.0	

*STATLANT 21a data for 2022 were not yet available at the time of writing

Sources of information

SCS Doc. 23/05REV, 23/06, 23/08, 23/13 and SCR Doc. 23/03, 23/04 and 23/09.

Redfish (*Sebastes mentella* and *Sebastes fasciatus*) in Division 3M Advice June 2023 for 2024

Recommendation for 2024

Some instability in the assessment results compared to previous assessments was evident. SC was not able to resolve the reason for this retrospective pattern and this adds uncertainty to the projection results.

Given the uncertainty in the projections, this stock will be reassessed in 2024, and therefore SC is providing advice for only one year. The TAC corresponding to a fishing mortality of $F_{0.1}$ would be 21 888 t in 2024. However, SC advises that fishing mortality be kept at the current level, corresponding to a TAC of 17 503 t in 2024.

Management objectives

No explicit management plan or management objectives defined by Fisheries Commission. Convention General Principles are applied (NAFO GC Doc. 07-04).

Convention Principle	Status	Comment
Restore to or maintain at Bmsy	Intermediate	Bmsy and Blim undefined, B above the time series average
Eliminate Overfishing (Stock)	Intermediate	Flim undefined, F is low
Eliminate Overfishing (Ecosystem)	OK	Total EPU catches < 2TCI
Apply Precautionary Approach	Not accomplished	No reference points defined
Minimize harmful impacts on living marine resources and ecosystems	Intermediate	Directed fishery, VME closures in effect, Effectiveness of bycatch regulations uncertain
Preserve marine biodiversity	Unknown	Cannot be evaluated

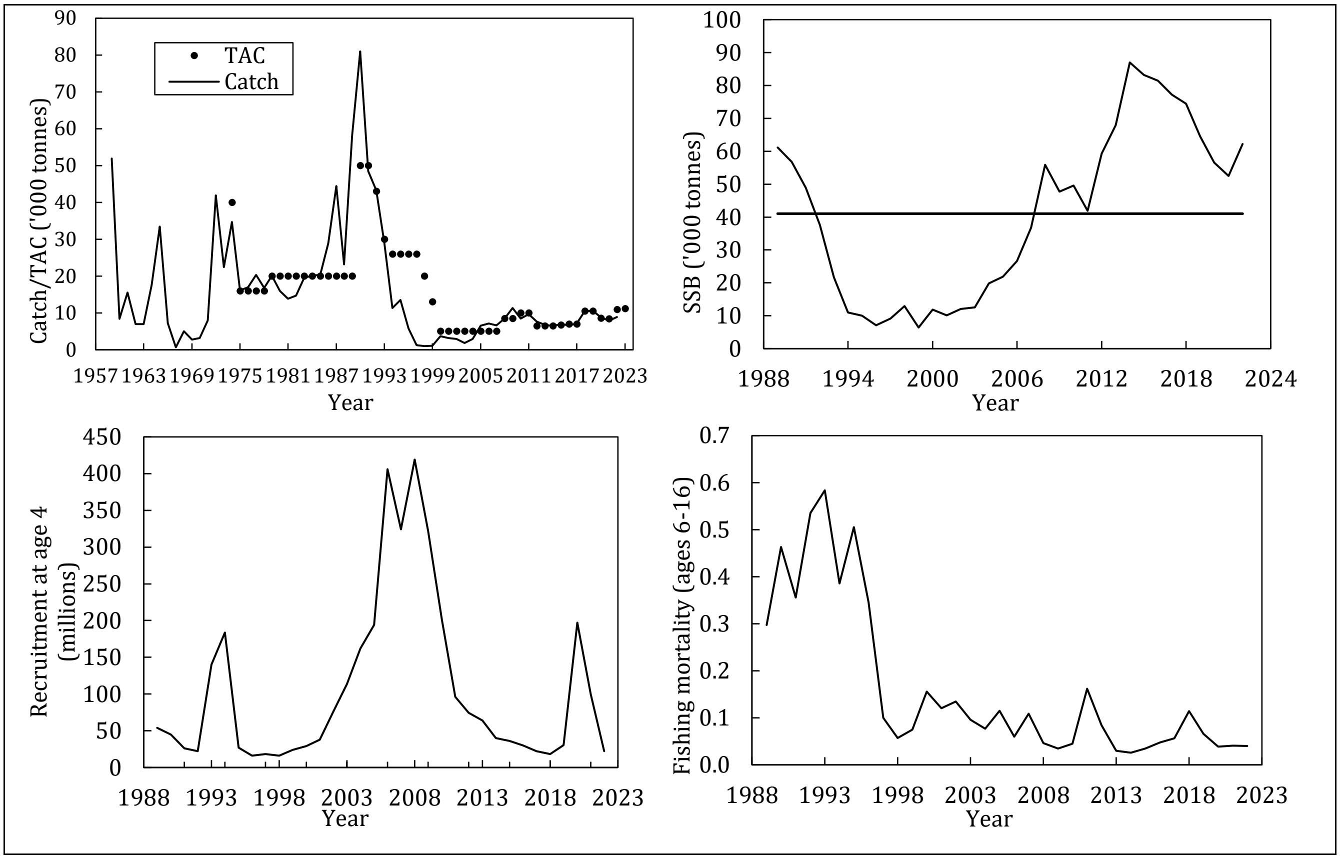
- OK
- Intermediate
- Not accomplished
- Unknown

Management unit

Catches of redfish in Div. 3M include three species of the genus *Sebastes; S. mentella, S. norvegicus* (=*S. marinus*) and *S. fasciatus*. For management purposes, they are treated as one stock. The assessment and advice are based on data for only two species (*S. mentella* & *S. fasciatus*), labeled as beaked redfish. The TAC advice is adjusted to reflect all three species on the Flemish Cap, based upon the relative species distribution in recent surveys.

Stock status

SSB has declined since 2014, but in 2022 is still well above the long term mean. After an extended period of declining recruitment, the recruitment estimates for 2020 and 2021 are at or above the mean while the 2022 value is low. Fishing mortality remains relatively low compared to the 1980s and 1990s.



Reference points

No reference points have been defined.

Assessment

Input data comes from the EU Flemish Cap bottom trawl survey and the fishery. A quantitative model (XSA) introduced in 2003 was used. Increased natural mortality was assumed from 2006 to 2010, but natural mortality was low (more typical of redfish) in other years. There is no evidence that natural mortality has increased recently from the level of 0.1 adopted in the 2017 assessment, and therefore, the 2023 XSA assessment was run with average M from 2015 onwards fixed at 0.1.

The next full assessment of this stock will be in 2024.

Projections

Short term (2024-2026) stochastic projections were carried out for female spawning stock biomass (SSB) and catch, under the most recent level of natural mortality and considering six options for fishing mortality and catch levels (F_0, $F_{0.1}$, F=M, $F_{statusquo}$, 1.25 TAC and 0.75 TAC). Projections assume that redfish catches (all species) in 2023 are equal to the redfish TAC ($F_{statusquo}$ is defined as the corresponding F). Recruitment entering in 2023 to 2025 is given by the geometric mean of the 2017-2019 recruitments (age 4 XSA).

The assessment has had a consistent tendency to underestimate stock size (both SSB and 4+biomass) for the last five years. Since the previous assessment in 2021 the fishable biomass series has therefore been revised upwards and in addition this component of the stock has increased since 2021. The potential yields estimated in the projections are therefore also more optimistic than seen in the 2021 assessment. STACFIS was not able to resolve the reason for this retrospective pattern, and this adds uncertainty to the projection results., SSB is projected to decline under all projection scenarios, with the exception of the F=0 scenario, and to be at around the average for the assessment time-series (since the late 1980s) by 2026.

***F*=0**

Year	SSB Median and 80% CI	Yield	TAC
2023deterministic	59314	10937	11171
2024	55090 (49792 - 63774)	0	0
2025	57333 (51786 - 66352)		
2026	58901 (52905 - 68977)		

***F0.1*=0.0635**

Year	SSB Median and 80% CI	Yield	TAC
2023deterministic	59314	10937	11171
2024	55090 (49792 - 63774)	20243	21888
2025	50045 (45230 - 57911)		
2026	45495 (40633 - 53368)		

***F*=*M*=0.1**

Year	SSB Median and 80% CI	Yield	TAC
2023deterministic	59314	10937	11171
2024	55090 (49792 - 63774)	30510	32988
2025	46450 (41969 - 53691)		
2026	39584 (35278 - 46516)		

***Fsq*= 0.0500**

Year	SSB Median and 80% CI	Yield	TAC
2023deterministic	59314	10937	11171
2024	55090 (49792 - 63774)	16188	17503
2025	51496 (46584 - 59550)		
2026	48009 (42944 - 56417)		

1.25 TAC (*F*= 0.039355)

Year	SSB Median and 80% CI	Yield	TAC
2021deterministic	59314	10937	11171
2024	55090 (49792 - 63774)	12915	13964
2025	52661 (47650 - 60824)		
2026	50096 (44840 - 58802)		

0.75 TAC (*F*=0.0231331)

Year	SSB Median and 80% CI	Yield	TAC
2023deterministic	59314	10937	11171
2024	55090 (49792 - 63774)	7749	8378
2025	54502 (49317 - 63022)		
2026	53524 (48040 - 62834)		

average beaked redfish proportion in the 2020-2022 3M redfish catch 0.925

	$F_{0.1}$	*F=M*	*Fsq*	1.25 TAC	0.75 TAC
P(SSB_{2024}>SSB_{2023})	<10%	<10%	<10%	<10%	<10%
P(SSB_{2025}>SSB_{2023})	<10%	<10%	>10%	>10%	>10%
P(SSB_{2026}>SSB_{2023})	<10%	<10%	<10%	<10%	>10%

Human impact

Mainly fishery related mortality. Other sources (e.g., pollution, shipping, oil-industry) are undocumented.

Biology and Environmental Interactions

Shrimp and cod are important prey and predator of redfish. There are strong trophic interactions between these species in the Flemish Cap.

The Flemish Cap (3M) Ecosystem Production Unit (EPU) has not experienced sustained reductions in overall productivity observed in other EPUs. With the exception of a short-lived increase in 2005-2009, total EPU biomass has remained fairly stable over time despite the changes in individual stocks.

Ecosystem sustainability of catches

The impact of bottom fishing activities on VMEs in the NRA was last assessed in 2021. The risk of Significant Adverse Impacts (SAIs) on sponge and large gorgonian VMEs was assessed to be low, while this risk for sea pen VMEs has been assessed as intermediate. The risks of SAIs on small gorgonian, black coral, bryozoan and sea squirt VMEs were assessed as high. A number of areas in the Flemish Cap (3M) EPU have been closed to bottom fishing to protect VMEs.

3M redfish is included in the piscivores guild of the Flemish Cap (3M) Ecosystem Production Unit (EPU). Other NAFO managed stocks in this guild and EPU are 3M cod and 2+3KLMNOPs Greenland halibut. The Catch/TCI is below the 2TCI ecosystem reference point (3M Piscivore $Catch_{2022}$/TCI=0.98) indicating a low risk of ecosystem overfishing.

Fishery

Redfish is caught in directed bottom trawl fisheries at intermediate depths (300-700m), but also as bycatch in fisheries directed for cod and Greenland halibut. The fishery in NAFO Div. 3M is regulated by minimum mesh size and quota.

Recent catch estimates and TACs (‘000 t) are as follows:

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TAC	6.5	6.7	7.0	7.0	10.5	10.5	8.6	8.4	10.9	11.2
STATLANT 21	6.4	6.9	6.6	7.1	10.5	10.5	8.6	8.6	NA*	
STACFIS Total catch [1]	7.4	6.9	6.6	7.1	10.5	10.6	8.8	8.3	10.0	
STACFIS Catch [2]	4.6	5.2	6.2	6.9	10.3	10.2	8.7	7.9	8.9	

[1] STACFIS total catch on 2011-2014 based on the average 2006-2010 bias.
[2] STACFIS beaked redfish catch estimate, based on beaked redfish proportions on observed catch.
* STATLANT 21a data for 2022 were not yet available at the time of writing

Sources of information: SCR Doc. 23/003, 040; 21/34, SCS Doc. 23/06, 13; 22/06,13; 21/05,06

American plaice in Division 3M Advice June 2023 for 2024 – 2026

Recommendation for 2024 - 2026

The stock has recovered to the levels of the mid 1990s, however, recruitment has been poor since 2018. SC considers that there is not sufficient supporting evidence that the stock would be able to sustain a fishery at this time and recommends that there be no directed fishing in 2024, 2025 and 2026. Bycatch should be kept at the lowest possible level.

Management objectives

No explicit management plan or management objectives defined by the Commission. Convention general principles are applied.

Convention Principle	Status	Comment
Restore to or maintain at Bmsy	🔴	Bmsy and Blim undefined, stock level low/depleted
Eliminate Overfishing (Stock)	🟡	Flim undefined, no directed fishing, F is low
Eliminate Overfishing (Ecosystem)	🟢	Total EPU catches < 2TCI
Apply Precautionary Approach	🔴	No reference points defined
Minimize harmful impacts on living marine resources and ecosystems	🟢	No directed fishing
Preserve marine biodiversity	⚪	Cannot be evaluated

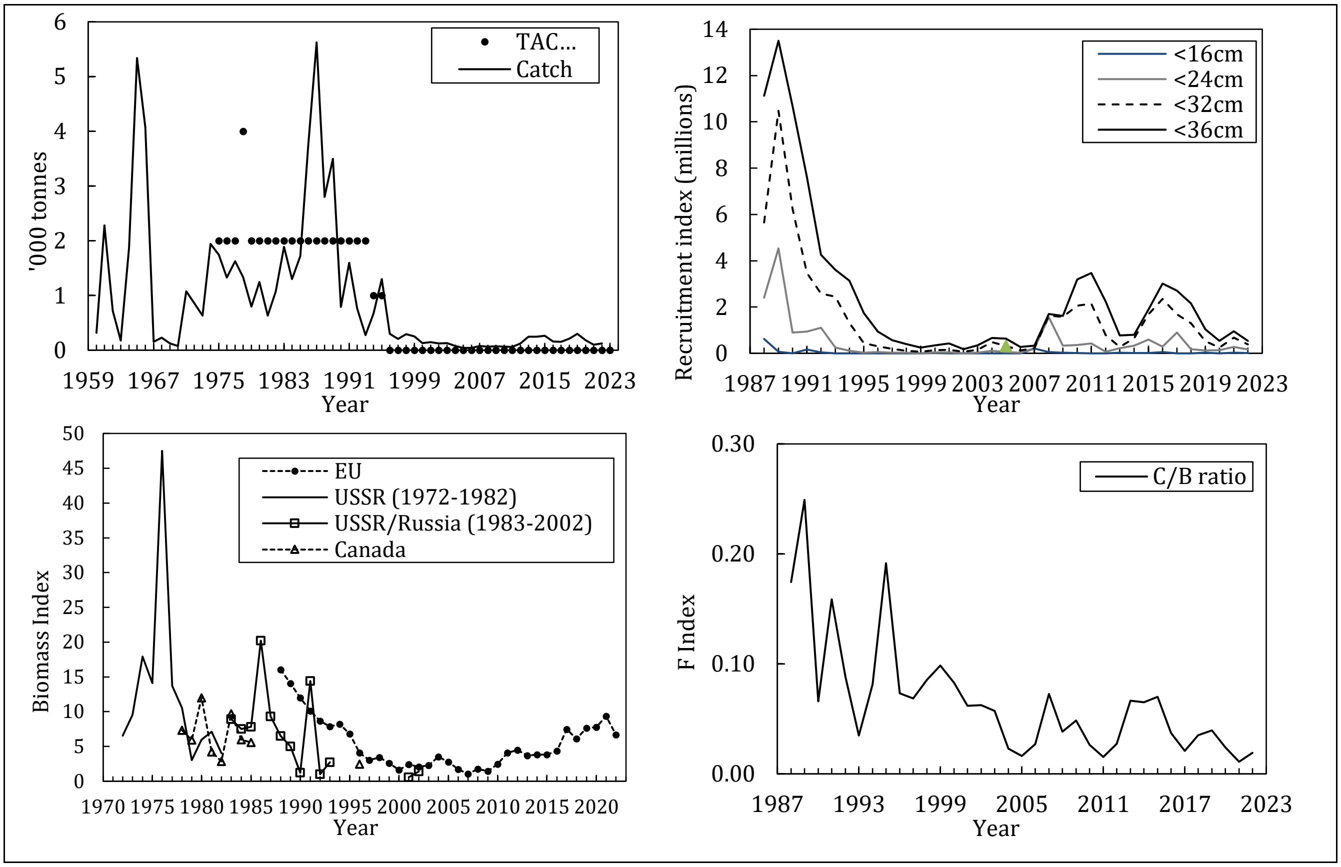
🟢 OK
🟡 Intermediate
🔴 Not accomplished
⚪ Unknown

Management unit

The American plaice stock in Flemish Cap (Div. 3M) is considered to be a distinct population.

Stock status

The stock has increased in recent years following two recruitment pulses in 2008-2012 and 2015-2018, and recovered to levels similar to the mid-1990s. However, recruitment has been poor since 2018 while relative F remains low.



Reference points

No reference points have been defined.

Projections

Quantitative assessment of risk at various catch options is not possible at this time.

Assessment

This assessment is based upon a qualitative evaluation of research vessel survey series and bycatch data from commercial fisheries.

The next full assessment is planned for 2026.

Human impact

Mainly fishery related mortality. Other sources (e.g. pollution, shipping, oil-industry) are undocumented.

Biological and environmental interactions

The stock occurs mainly at depths shallower than 600 m on the Flemish Cap. Main stomach contents are echinoderms, shrimp and hyperiids.

The Flemish Cap (3M) Ecosystem Production Unit (EPU) has not experienced sustained reductions in overall productivity observed in other EPUs. With the exception of a short-lived increase in 2005-2009, total EPU biomass has remained fairly stable over time despite the changes in individual stocks.

Ecosystem sustainability of catches

3M American plaice is included in the benthivore guild of the Flemish Cap (3M) Ecosystem Production Unit (EPU). The other NAFO managed stock in this guild and EPU is 3M shrimp. The Catch/TCI is below the 2TCI ecosystem reference point (3M Benthivore $Catch_{2022}$/TCI=0.01) indicating a low risk of ecosystem overfishing.

Fishery

American plaice is caught as bycatch in otter trawl fisheries, mainly the cod and redfish fisheries. From 1979 to 1993 a TAC of 2 000 tonnes was in effect for this stock. A reduction to 1 000 tonnes was agreed for 1994 and 1995 and a moratorium was agreed to thereafter.

Recent catch estimates and TACs ('000 tonnes) are as follows:

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TAC	ndf	ndf	ndf	ndf	ndf	ndf	ndf	ndf	ndf	ndf
STATLANT 21	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	NA*	
STACFIS	0.2	0.3	0.2	0.2	0.2	0.3	0.2	0.1	0.1	

ndf No directed fishing.

* STATLANT 21a data for 2022 were not yet available at the time of writing

Special comments

No special comments

Sources of information

SCR Doc. 23/003, 024; 20/39; SCS Doc. 23/13; 22/13; 21/05, 09

Yellowtail flounder in Divisions 3LNO Advice June 2023 for 2024-25

Recommendation for 2024 to 2025
Scientific Council advises that fishing mortality up to 75% F_{msy}, corresponding to catches of 15 560 t and 15 810 t in 2024 and 2025, respectively, have risk of no more than 30% of exceeding F_{lim}, and are projected to maintain the stock around B_{msy} with a low risk of being below B_{lim}.

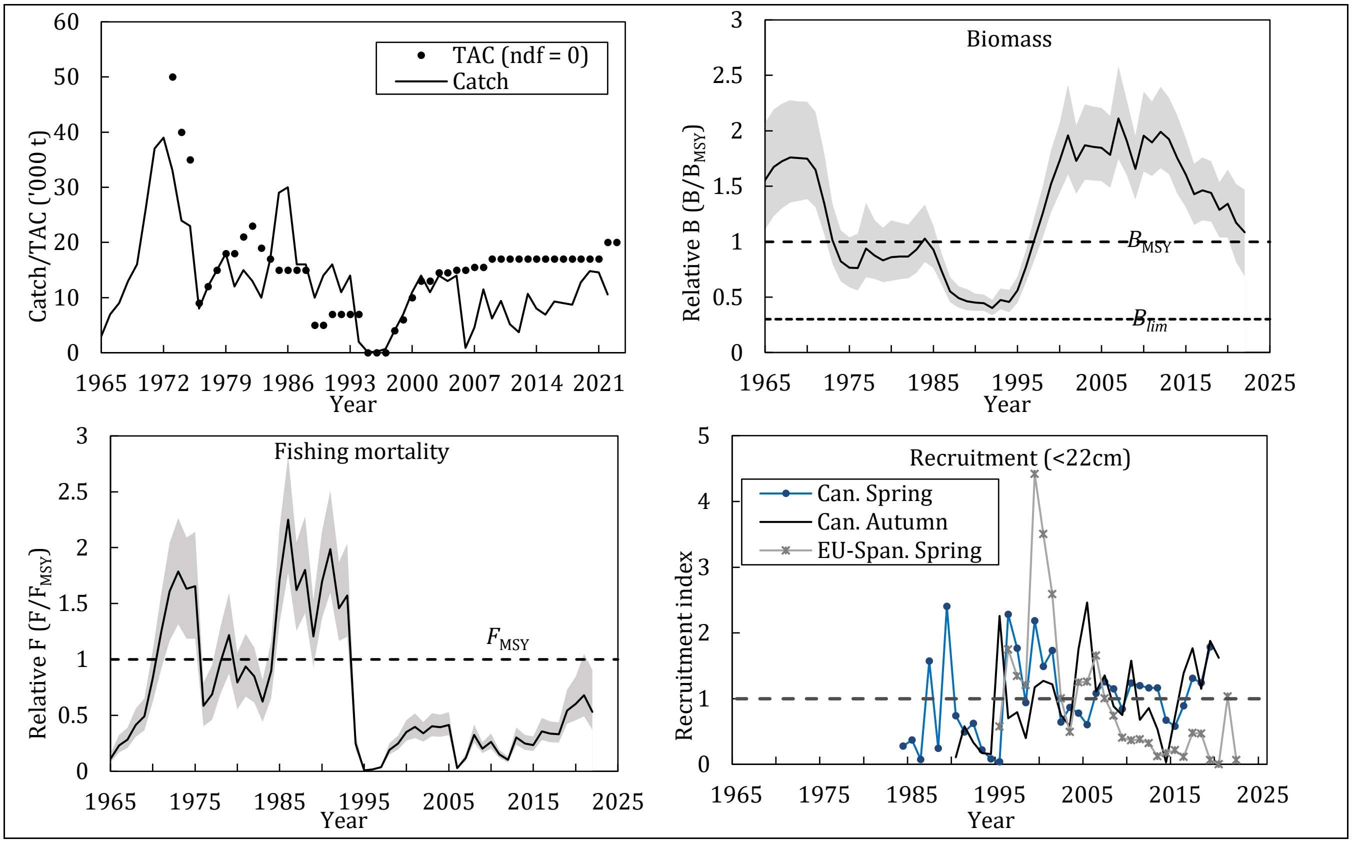
Management objectives
No explicit management plan or management objectives are defined by the Commission. Convention General Principles are applied.

Convention Principle	Status	Comment
Restore to or maintain at Bmsy	OK	B >= Bmsy
Eliminate Overfishing (Stock)	OK	F < Flim
Eliminate Overfishing (Ecosystem)	OK	Total EPU catches < 2TCI
Apply Precautionary Approach	OK	Blim and Flim defined
Minimize harmful impacts on living marine resources and ecosystems	Intermediate	Directed fishery, VME closures in effect, effectiveness of bycatch regulations uncertain
Preserve marine biodiversity	Unknown	Cannot be evaluated

OK
Intermediate
Not accomplished
Unknown

Management unit
The management unit is NAFO Divisions 3LNO. The stock is mainly concentrated on the southern Grand Bank and is recruited from the Southeast Shoal area nursery ground.

Stock status
The stock size has decreased since 2012, but remains above B_{msy} with a probability of 0.61. There is very low risk (<1%) of the stock being below B_{lim} and a very low risk of F being above F_{lim}=F_{msy} (7%). Recent recruitment is unknown.



Reference points

B_{lim} is 30% B_{msy} and F_{lim} is F_{msy} (STACFIS 2004 p 133).

Projections

Medium-term projections were carried forward to the year 2026 for $Catch_{2023}$=TAC=20 000 t. Constant fishing mortality was applied from 2023-2026 at several levels of F (F=0, $F_{status\ quo}$, 75% F_{msy}, 85% F_{msy}, and F_{msy}). At the end of the projection period, the risk of biomass being below B_{lim} is 6% or less in all cases.

For the $F_{status\ quo}$ projections, probability that F > F_{lim}=F_{msy} in 2025-2026 was from 0.11 to 0.12 and at 75% F_{msy}, that probability was between 0.27 and 0.28. Projected at the level of 85% F_{lim}, the probability that F > F_{lim} was 0.36 and for F_{msy} projections, this probability increased to 0.50. For biomass projections, in all scenarios for 2024-2026, the probability of biomass being below B_{lim} was 0.06 or less. The probability that biomass in 2026 is greater than B_{2023} is 0.60, 0.49, 0.44 and 0.38 for projections of $F_{status\ quo}$, 75% F_{msy}, 85% F_{msy}, and F_{msy} respectively.

Projections with $Catch_{2023}$= 20 000 t (TAC)		
Year	Yield ('000t) median	Projected relative Biomass(B/B_{msy}) median (80% CL)
F=0		
2024	0.00	1.13 (0.61, 1.62)
2025	0.00	1.32 (0.74, 1.84)
2026		1.49 (0.86, 2.02)
$F_{status\ quo}$ = 0.107		
2024	10.79	1.13 (0.61, 1.62)
2025	11.37	1.2 (0.63, 1.71)
2026		1.26 (0.65, 1.77)
75% F_{MSY} =0.151		
2024	15.56	1.13 (0.61, 1.62)
2025	15.81	1.15 (0.59, 1.65)
2026		1.16 (0.56, 1.67)
85% F_{MSY} =0.173		
2024	17.63	1.13 (0.61, 1.62)
2025	17.56	1.13 (0.57, 1.62)
2026		1.12 (0.52, 1.63)
F_{MSY} =0.202		
2024	20.74	1.13 (0.61, 1.62)
2025	20.03	1.09 (0.54, 1.58)
2026		1.06 (0.46, 1.56)

	Yield ('000t)		$P(F>F_{lim})$			$P(B<B_{lim})$			$P(B<B_{MSY})$			
$Catch_{2023}$=20 000t	2024	2025	2024	2025	2026	2024	2025	2026	2024	2025	2026	$P(B_{2026}<B_{2023})$
F=0	0	0	<1%	<1%	<1%	2%	1%	<1%	37%	23%	15%	16%
$F_{status\ quo}$ = 0.107	10.79	11.37	11%	11%	12%	2%	2%	3%	37%	32%	28%	40%
75% F_{MSY} = 0.151	15.56	15.81	26%	27%	28%	2%	3%	4%	37%	36%	35%	51%
85% F_{MSY} =0.173	17.63	17.56	35%	36%	36%	2%	3%	4%	37%	38%	39%	56%
F_{MSY} =0.202	20.74	20.03	50%	50%	50%	2%	4%	6%	37%	41%	44%	62%

Assessment
A Schaefer surplus production model in a Bayesian framework was used for the assessment of this stock. The results were comparable to the previous assessment. Input data comes from research surveys and the fishery. The last available survey that covered the complete stock area was in autumn 2020. New vessels are being used to conduct the Canadian surveys and information from 2022 onwards are being examined for comparability to the previous survey indices used in this assessment.

The next assessment is planned for 2025.

Human impact
Mainly fishery related mortality has been documented. Other sources (e.g. pollution, shipping, oil-industry) are undocumented.

Biology and Environmental interactions
The Grand Bank (3LNO) Ecosystem Production Unit (EPU) is currently experiencing low productivity conditions, with EPU biomass well below pre-collapse levels (pre-1990s). While some rebuilding was observed since the 1990s, biomass declined across multiple trophic levels and stocks after 2014, and has not yet returned to the early-mid 2010s level.

Ecosystem sustainability of catches

Fishing intensity on yellowtail flounder has impacts on Div. 3NO cod and Div. 3LNO American plaice through by-catch. General impacts of fishing gears on the ecosystem should also be considered. Areas within Divs. 3LNO have been closed to bottom fishing to protect sponge and coral species.

Yellowtail flounder is included in the benthivore guild of the Grand Bank (3LNO) Ecosystem Production Unit (EPU). Other NAFO managed stocks in this guild within the EPU include 3LNOPs thorny skate, 3NO witch flounder, 3LNO American plaice, and 3LNO shrimp. The Catch/TCI is below the 2TCI ecosystem reference point (3LNO Benthivore $Catch_{2022}$/TCI=0.80) indicating a low risk of ecosystem overfishing.

Fishery

Yellowtail flounder is caught in a directed trawl fishery and as by-catch in other trawl fisheries. The fishery is regulated by quota and minimum size restrictions. Catches in several years were low due to industry-related factors, but in recent years catches were higher, and in 2021 and 2022 were 86% and 53% of the TAC respectively. American plaice and cod are taken as by-catch in the yellowtail fishery. There is a 15% by-catch restriction on American plaice and a 4% limit on cod.

Recent catch estimates and TACs (‘000 tonnes) are as follows:

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TAC	17	17	17	17	17	17	17	17	20	20
STATLANT 21	8.0	6.7	8.3	9.2	8.6	12.3	14.0	16.1	NA*	
STACFIS	8.0	6.9	9.3	9.2	8.7	12.8	14.8	14.6	10.6	

* STATLANT 21a data for 2022 were not yet available at the time of writing

Special comments

Management of yellowtail flounder should take into consideration impacts on other stocks. By-catch in the yellowtail flounder fishery may be impeding recovery of Div. 3NO cod and American plaice in Div. 3LNO, which have both been below B_{lim} for many years. Measures to reduce by-catch of American plaice in the yellowtail flounder fishery, in particular, which currently has a 15% limit, could reduce the impact of fishing on the recovery of that stock.

Sources of information

SCR 22/018, 23/002, 23/016, 21/019; SCS 23/05, 23/06, 23/09, 23/13; NAFO/GC Doc 08/3 NAFO/FC 04/18

Recommendation for 2024 and beyond
Stock status is unknown. Catches of white hake in 3NO should not increase above recent levels (the average of the most recent five years is around 400 tonnes).

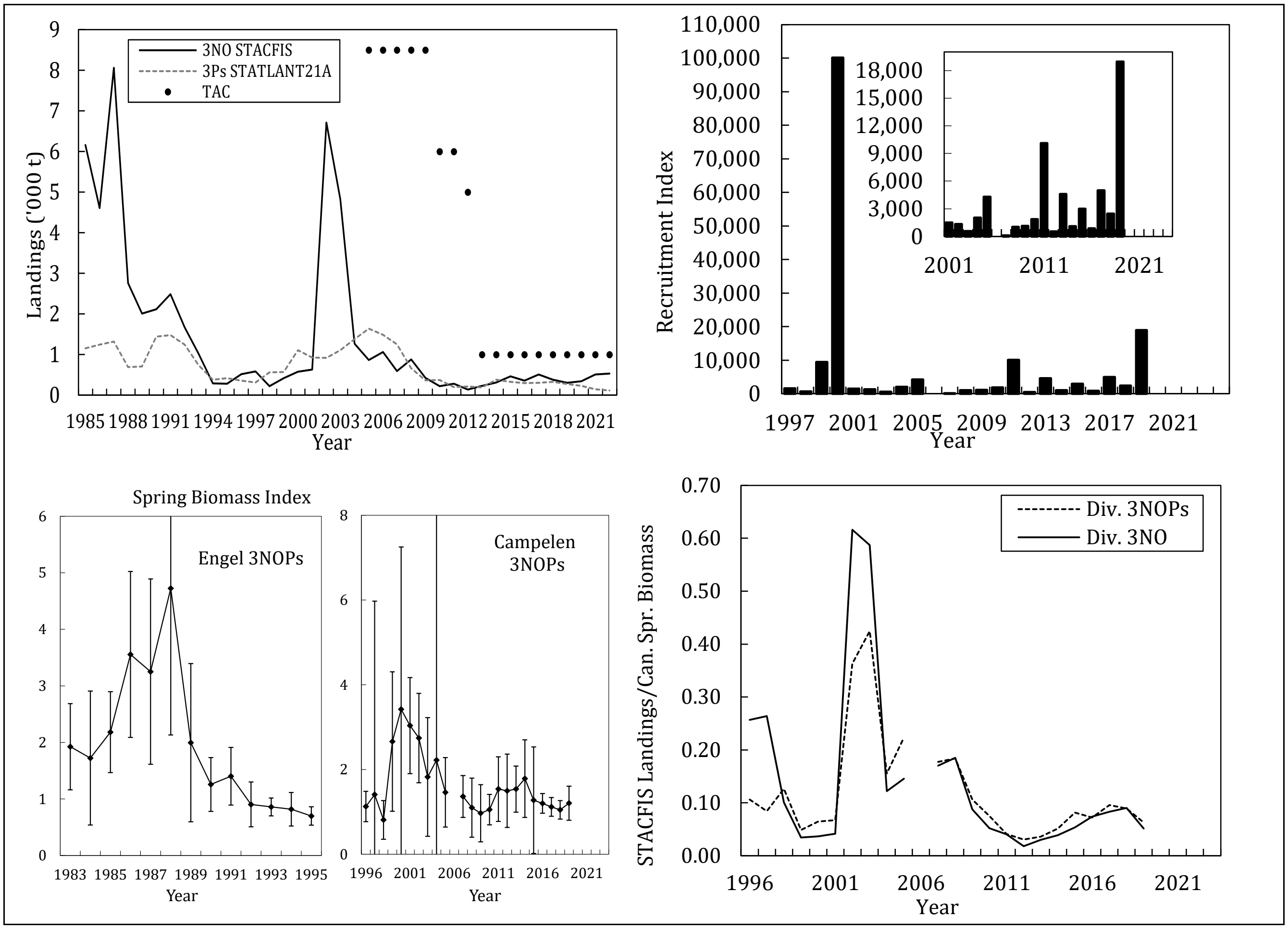
Management objectives
No explicit management plan or management objectives defined by the Commission. General Convention Principles are applied.

Convention Principle	Status	Comment
Restore to or maintain at Bmsy	Unknown	Bmsy and Blim undefined, stock status unknown
Eliminate Overfishing (Stock)	Unknown	F and Flim undefined, status unknown
Eliminate Overfishing (Ecosystem)	OK	Total EPU catches < 2TCI
Apply Precautionary Approach	Not accomplished	No reference points defined
Minimize harmful impacts on living marine resources and ecosystems	Intermediate	Directed fishery, VME closures in effect, Effectiveness of bycatch regulations uncertain
Preserve marine biodiversity	Unknown	Cannot be evaluated

OK
Intermediate
Not accomplished
Unknown

Management unit
The management unit is confined to NAFO Div. 3NO, which is a portion of the stock that is distributed in NAFO Div. 3NO and Subdivision 3Ps.

Stock status
Stock status is unknown. No information is available on recruitment and relative fishing mortality since 2019.



Reference Points

No reference points have been defined.

Assessment

The assessment is based upon a qualitative evaluation of stock biomass trends and recruitment indices. The last available survey that covered the complete stock area was in autumn 2020 and the last primary survey index was 2019. New vessels are being used to conduct the Canadian surveys and information from 2022 onwards is being examined for comparability to the previous survey indices used in this assessment.

The next full assessment of this stock was planned to be in 2025. However, until such time data is available to allow a full assessment, this stock will be monitored in the future by interim monitoring reports.

Human impact

Mainly fishery related mortality has been documented. Mortality from other human sources (e.g. pollution, shipping, oil-industry) are undocumented.

Biology and Environmental interactions

On the Grand Bank, white hake are near the northern limit of their range, concentrating along the southwest slope of the Grand Bank at temperatures above 5°C. The major spawning area is located on the shelf-edge on the Grand Bank. Weaker ocean currents on the continental slope during the spawning period are hypothesized to reduce potential losses of eggs and larvae due to entrainment in the Labrador Current and increase recruitment potential.

White hake feed mostly on crustaceans and fish. Larger individuals are reported to be cannibalistic and to feed upon eggs and juveniles. In nearshore areas, white hake are also thought to predate on smaller juvenile cod. Predators of white hake include Atlantic cod, other fish species, Atlantic puffins, Arctic terns, other seabirds and seals.

This stock straddles the 3Ps and 3LNO Ecosystem Production Units (EPU), which have been experiencing low productivity conditions in recent years, including biomass declines across multiple trophic levels and stocks in 3LNO since 2014.

Ecosystem sustainability of catches

White hake is included in the piscivore guild. Other NAFO managed stocks in this guild and relevant EPUs include 3O and 3LN redfish, 2+3KLMNOPs Greenland halibut, and 3NO cod. There is no TCI information for the Southern Newfoundland (3Ps) EPU. In the Grand Bank (3LNO) EPU the Catch/TCI is below the 2TCI ecosystem reference point (3LNO Piscivore $Catch_{2022}$/TCI=1.54) indicating an intermediate risk of ecosystem overfishing.

Fishery

White hake is caught in directed gillnet, trawl and long-line fisheries. In directed white hake fisheries, Atlantic cod, black dogfish, monkfish and other species are landed as bycatch. In turn, white hake are also caught as bycatch in gillnet, trawl and long-line fisheries directing for other species. The fishery in NAFO division 3NO, and subdivision 3Ps, are regulated by quotas.

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Div. 3NO:										
TAC	1	1	1	1	1	1	1	1[1]	1[1]	1[1]
STATLANT-21	0.3	0.4	0.4	0.5	0.4	0.3	0.3	0.5	NA*	
STACFIS	0.3	0.5	0.4	0.5	0.4	0.3	0.3	0.5	0.5	
Subdiv. 3Ps:										
TAC					0.5	0.5	0.5	0.5	0.5	0.5
STATLANT-21	0.4	0.3	0.4	0.3	0.3	0.3	0.2	0.1	0.1	

[1]May change in-season. See NAFO FC Doc. 19/01

* STATLANT 21a data for divisions 3NO in 2022 were not yet available at the time of writing

Sources of information

SCR Doc. 23/36; SCS Doc. 23/06, 23/09, 23/12, 23/13

b) Monitoring of Stocks for which Multi-year Advice was Provided in 2021 or 2022

Interim monitoring updates of these stocks were conducted and Scientific Council reiterates its previous advice as follows:

Recommendation for redfish in Divisions 3LN for 2022 for 2023: Available data indicate that biomass is at or below the long-term mean. The stock appears to be above the interim limit reference point (B_{lim}). In the absence of Canadian spring surveys in 2020 and 2021 proxy fishing mortality cannot be determined for those years. However, it is unlikely that levels of fishing mortality have changed substantially. Recruitment has been below the long-term average since the mid-2010s.

Scientific Council advises that catches should not exceed their current level of 11 500 t (the mean of the last 5 years).

Recommendation for witch flounder in Divisions 3NO for 2023-2024: In the projection period there is less than a 10% probability of being below B_{lim}; however the probability of exceeding F_{lim} is estimated to be above 30% in 2024 for F greater than 2/3 F_{msy}. Scientific Council therefore recommends that F should be no higher than 2/3 F_{msy}.

Recommendation for redfish in Division 3O for 2023-2025: The stock is below an interim survey-based proxy for B_{MSY} but above the limit reference point (B_{lim} =0.3$_{MSY}$-proxy) with a probability >99%. There is insufficient information on which to base predictions of annual yield potential. Catches have averaged about 9 000 t over the period used for the MSY proxy calculation (1991 -2021). Scientific Council is unable to advise on an appropriate TAC for 2023, 2024 and 2025.

Recommendation for thorny skate in Division 3LNO and subdiv. 3Ps for 2023-2024: The stock has been stable at recent catch levels in Div. 3LNO (approximately 3 710 t, 2017 - 2021) however, given the low resilience to fishing mortality and higher historic stock levels, Scientific Council advises no increase in catches.

Recommendation for cod in Divisions 3NO for 2022 – 2024: No directed fishing in 2022 to 2024 to allow for stock rebuilding. Bycatch of cod in fisheries targeting other species should be kept at the lowest possible level. Projections of the stock were not performed but given the poor strength of all year-classes subsequent to 2006, the stock will not reach B_{lim} in the next three years.

Recommendation for American plaice in Div. 3LNO for 2022-2024: Scientific Council recommends that, in accordance with the rebuilding plan, there should be no directed fishing on American plaice in Div. 3LNO in 2022, 2023 and 2024. Bycatch of American plaice should be kept to the lowest possible level and restricted to unavoidable bycatch in fisheries directing for other species.

Recommendation for capelin in Divisions 3NO for 2022-2024: No directed fishery.

Recommendation for roughhead grenadier in Subareas 2 and 3: There will be no new assessment until monitoring shows that conditions have changed.

Recommendation for alfonsino in Division 6G for 2019 and beyond: The substantial decline in CPUE and catches on the Kükenthal Peak in the past year indicates that the stock may be depleted. SC advises to close the fishery until biomass increases to exploitable levels.

c) Special Requests for Management Advice

i) Greenland halibut in SA2; application of HCR and determination of exceptional circumstances (request #2)

Commission Request #2 (Commission priority): *The Commission requests the Scientific Council to monitor the status of Greenland halibut in Subarea 2 + Div 3KLMNO annually to compute the TAC using the agreed HCR and determine whether Exceptional Circumstances are occurring. If Exceptional Circumstances are occurring, the Exceptional Circumstances protocol will provide guidance on what steps should be taken.*

Scientific Council responded:

Exceptional Circumstances are occurring due to recent gaps in Canadian survey time series. However, sensitivity analyses indicate that the application of the HCR will still be appropriate. The TAC for 2024 derived from the HCR is 15 153 t.

An HCR for Greenland halibut in Subarea 2+Div. 3KLMNO was adopted by the Commission in 2017. The HCR combines a "target based" and "slope based" rule, detailed below. The full set of control parameters for the adopted HCR are shown in **Table i.1** with a starting TAC of 16 500 t in 2018. All data inputs used to calculate the TAC for 2024 are shown in **Table i.2**. Inputs normally include five surveys; however, there were insufficient observations from the Canadian spring 3LNO survey to utilize that series in the HCR in 2022 and 2023.

	2018	2019	2020	2021	2022
Canada Fall 2J3K	✓	✓	✓	✓	✗
Canada Fall 3LNO	✓	✓	✓	✗	✗
EU 3M 0-1400m	✓	✓	✓	✓	✓
Canada Spring 3LNO	✓	✓	✗	✗	✗
EU-Spain 3NO	✓	✓	✗	✓	✓

*Target based (**t**)*
The target harvest control rule (HCR) is:

$$\text{TAC}_{y+1}^{target} = \text{TAC}_y \left(1 + \gamma(J_y - 1)\right) \qquad (1)$$

where TAC_y is the TAC recommended for year y, γ is the "response strength" tuning parameter, J_y is a composite measure of the immediate past level in the mean weight per tow from surveys (I_y^i) that are available to use for calculations for year y; four survey series are used, with i = 1, 2, 3, and 4 corresponding respectively to Canada Fall 2J3K, EU 3M 0-1400m, EU-Spain 3NO and Canada Fall 3LNO:

$$J_y = \sum_{i=1}^{4} \frac{1}{{\sigma^i}^2} \frac{J_{current,y}^i}{J_{target}^i} \Big/ \sum_{i=1}^{4} \frac{1}{{\sigma^i}^2} \qquad (2)$$

with $(\sigma^i)^2$ being the estimated variance for index i (estimated in the SCAA model fitting procedure),

$$J_{current,y}^i = \frac{1}{q} \sum_{y'=y-q}^{y-1} I_{y'}^i \qquad (3)$$

$$J_{target}^i = \alpha \frac{1}{5} \sum_{y'=2011}^{2015} I_{y'}^i \qquad \text{(where } \alpha \text{ is a control/tuning parameter for the MP)} \qquad (4)$$

and q indicating the period of years used to determine current status. Note the assumption that when a TAC is set in year y for year $y+1$, indices will not at that time yet be available for the current year y. Missing survey values are treated as missing in the calculation using the rule, as was done in the MSE. In such cases, q in equation (3) is reduced accordingly.

*Slope based (**s**)*

The slope harvest control rule (HCR) is:

$$\mathrm{TAC}_{y+1}^{slope} = \mathrm{TAC}_y\left[1 + \lambda_{up/down}\left(s_y - X\right)\right] \qquad (5)$$

where $\lambda_{up/down}$ and X are tuning parameters, s_y^i is a measure of the immediate past trend in the survey-based mean weight per tow indices, computed by linearly regressing $lnI_{y'}^i$, vs year y' for $y' = y-5$ to $y' = y-1$, for each of the four surveys considered, with:

$$s_y = \sum_{i=1}^{4} \frac{1}{(\sigma^i)^2} s_y^i \Big/ \sum_{i=1}^{4} \frac{1}{(\sigma^i)^2} \qquad (6)$$

with the standard error of the residuals of the observed compared to model-predicted logarithm of survey index i (σ^i) as estimated in the SCAA base case operating model. Missing survey values are treated as missing in the calculation using the rule, as was done in the MSE. In such cases, the slope in equation (6) is calculated from the available values within the last five years.

*Combination Target and Slope based (**s+t**)*

For the target and slope based combination:

i) $\boldsymbol{TAC_{y+1}^{target}}$ ***is computed from equation (1),***

ii) $\boldsymbol{TAC_{y+1}^{slope}}$ ***is computed from equation (5), and***

iii) $\boldsymbol{TAC_{y+1}} = \left(\boldsymbol{TAC_{y+1}^{target}} + \boldsymbol{TAC_{y+1}^{slope}}\right)/2$

Finally, constraints on the maximum allowable annual change in TAC are applied, viz.:

$$\text{if} \quad \mathrm{TAC}_{y+1} > \mathrm{TAC}_y\left(1+\Delta_{up}\right) \quad \text{then} \quad \mathrm{TAC}_{y+1} = \mathrm{TAC}_y\left(1+\Delta_{up}\right) \qquad (7)$$

and

$$\text{if} \quad \mathrm{TAC}_{y+1} < \mathrm{TAC}_y\left(1-\Delta_{\mathrm{down}}\right) \quad \text{then} \quad \mathrm{TAC}_{y+1} = \mathrm{TAC}_y\left(1-\Delta_{\mathrm{down}}\right) \qquad (8)$$

During the MSE process, this inter-annual constraint was set at 10%, for both TAC increases and decreases, and these constraints were adopted as part of the adopted HCR.

Following the HCR using the agreed survey data, the recommended TAC for 2024 is 15 153 t (**Table i.2**).

Table i.1. Control parameter values for the adopted HCR. The parameters α and X were adjusted to achieve a median biomass equal to B_{msy} for the exploitable component of the resource biomass in 2037 for the Base Case SCAA Operating Model.

TAC_{2018}	16 500 t
γ	0.15
q	3
α	0.972
λ_{up}	1
λ_{down}	2
X	-0.0056
δ_{up}	0.1
δ_{down}	0.1

Table i.2. Data used in the calculation of the TAC for 2024. The weights given to each survey in obtaining composite indices of abundance (target rule) and composite trends (slope rule) are proportional to the inverses of the squared values of the survey error standard deviations σ^i listed below.

	Canada Fall 2J3K	Canada Fall 3LNO	EU-Spain 3NO	EU 3M 0-1400m
2011	26.736	2.206	7.093	26.152
2012	23.504	1.712	7.373	19.198
2013	29.645	2.589	5.463	19.110
2014	33.336		6.239	23.921
2015	22.290	0.869	9.486	47.517
2016	18.541	1.314	8.796	28.298
2017	15.104	1.246	16.627	42.665
2018	17.054	1.887	7.875	29.803
2019	16.285	1.872	8.824	16.887
2020	15.840	2.714		13.230
2021	21.153		8.090	16.310
2022			10.284	13.492
s^i_{2023}	0.0619	0.1819	0.0447	-0.1620
$J^i_{current,2023}$	18.496	2.714	9.187	14.344
J^i_{target}	26.343	1.792	6.931	26.418
σ^i	0.220	0.260	0.380	0.210
$1/(\sigma^i)^2$	20.661	14.793	6.925	22.676
	TAC_{2023}	15 156 t	TAC^{target}_{2024}	14 923 t
	s_{2023}	0.009	TAC^{slope}_{2024}	15 382 t
	J_{2023}	0.898	TAC_{2024}	15 153 t

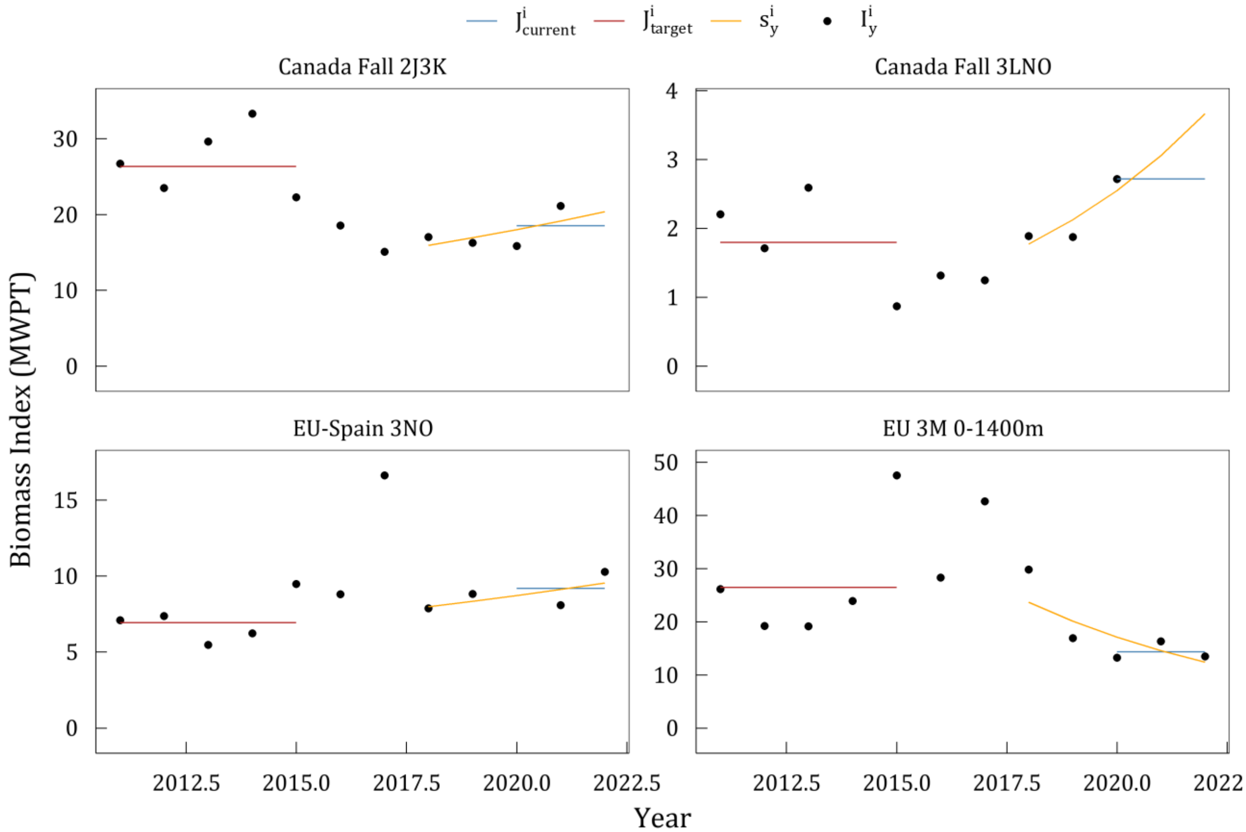


Figure i.1. Input for the Greenland halibut in Subarea 2 + Divisions 3KLMNO Harvest Control Rule along with visual representation of the target and slope based components of the rule. The red line represents the target (2011-2015 average; J^i_{target}), the blue line the current levels (2019 - 2022 average; $J^i_{current}$), and the orange line depicts recent log-linear trends (2017 - 2022 slope; s^i_y). Survey data come from Canadian fall surveys in Divs. 2J3K, Canadian fall surveys in Divs. 3LNO, EU Flemish Cap surveys (to 1400m depth) in Div. 3M and EU-Spain surveys in 3NO. Missing values within the last five years are not used in the calculation of the TAC using the HCR.

Exceptional Circumstances

In 2023, the SC evaluated each of the criteria indicated in the Exceptional Circumstances Protocol, as described below.

The following criteria constitute Exceptional Circumstances:

1. Missing survey data:

More than one value missing, in a five-year period, from a survey with relatively high weighting in the HCR (Canadian Fall 2J3K, Canadian Fall 3LNO, and EU 3M surveys);

More than two values missing, in a five-year period, from a survey with relatively low weighting in the HCR (Canadian Spring 3LNO and EU-Spain 3NO surveys);

There are Exceptional Circumstances occurring: over the last five years, there are two missing values from the highly weighted Canada Fall 3LNO series and three missing values from the relatively low weighted Canada Spring 3LNO series. There are insufficient data from the Canada Spring 3LNO to utilize it in the HCR, and only one value from the Canada Fall 3LNO series is contributing to the target based component of the HCR.

However, a series of sensitivity tests indicate that applying the HCR informed by the available survey data serves as a reasonable option for providing TAC advice for 2024 with minimal deviation from the agreed Management Procedure (HCR output from a series of sensitivity tests did not deviate by more than 9%; SCR Doc. 23/015). Accordingly, it was recommended that the agreed formula could still be applied to calculate the TAC, with the exclusion of Canada 3LNO Spring series.

2*. The composite survey index used in the HCR, in a given year, is above or below the 90 percent probability envelopes projected by the base case operating models from SSM and SCAA under the MS;*

The composite survey index (excluding the Canada Spring 3LNO survey) has remained within the 90% probability envelopes from the base case SCAA operating model (**Figure i.2**). Composite indices exceeded the 90% probability envelopes from the base case SSM between 2018 to 2020, which is not a conservation concern, and values since 2021 remain within the 90% probability envelopes (**Figure i.3**). Given the composite index remains within the 90% probability envelope from the SCAA and has been above or within the 90% probability envelope from the SSM projections, SC concludes that this does not constitute Exceptional Circumstances.

3. TACs established that are not generated from the MP.

The TAC established for 2023 was generated from the MP. This does not constitute Exceptional Circumstances.

The following elements will require application of expert judgment to determine whether Exceptional Circumstances are occurring:

1. the five survey indices relative to the 80, 90, and 95 percent probability envelopes projected by the base case operating models (SSM and SCAA) for each survey;

Survey indices from the past five years are primarily within the 80% probability envelopes from the base case SCAA operating model (17 out of 21 observations; **Figure i.2**). Likewise, survey indices were primarily within the 80% probability envelopes from the SSM projections (13 out of 21 observations; **Figure i.3**). The most recent index from the EU 3M survey does, however, fall below the 95% probability envelope. Though the trajectory of the EU 3M survey index is a possible concern, SC does not consider this Exceptional Circumstances. More data are required to determine whether declines are widespread and this knowledge gap is being taken into consideration as SC progresses with its review of the Operating Models for the MSE.

2. survey data at age four (age before recruitment to the fishery) compared to its series mean to monitor the status of recruitment;

This Exceptional Circumstance is not occurring as recent recruitment is near average (**Figure i.4**).

3. discrepancies between catches and the TAC calculated using the MP

The TAC for 2022 was 15 864 t. The catch in 2022 was 15 673 t (<2% difference). SC concludes that this does not constitute Exceptional Circumstances as catches are closely tracking the Management Procedure projections.

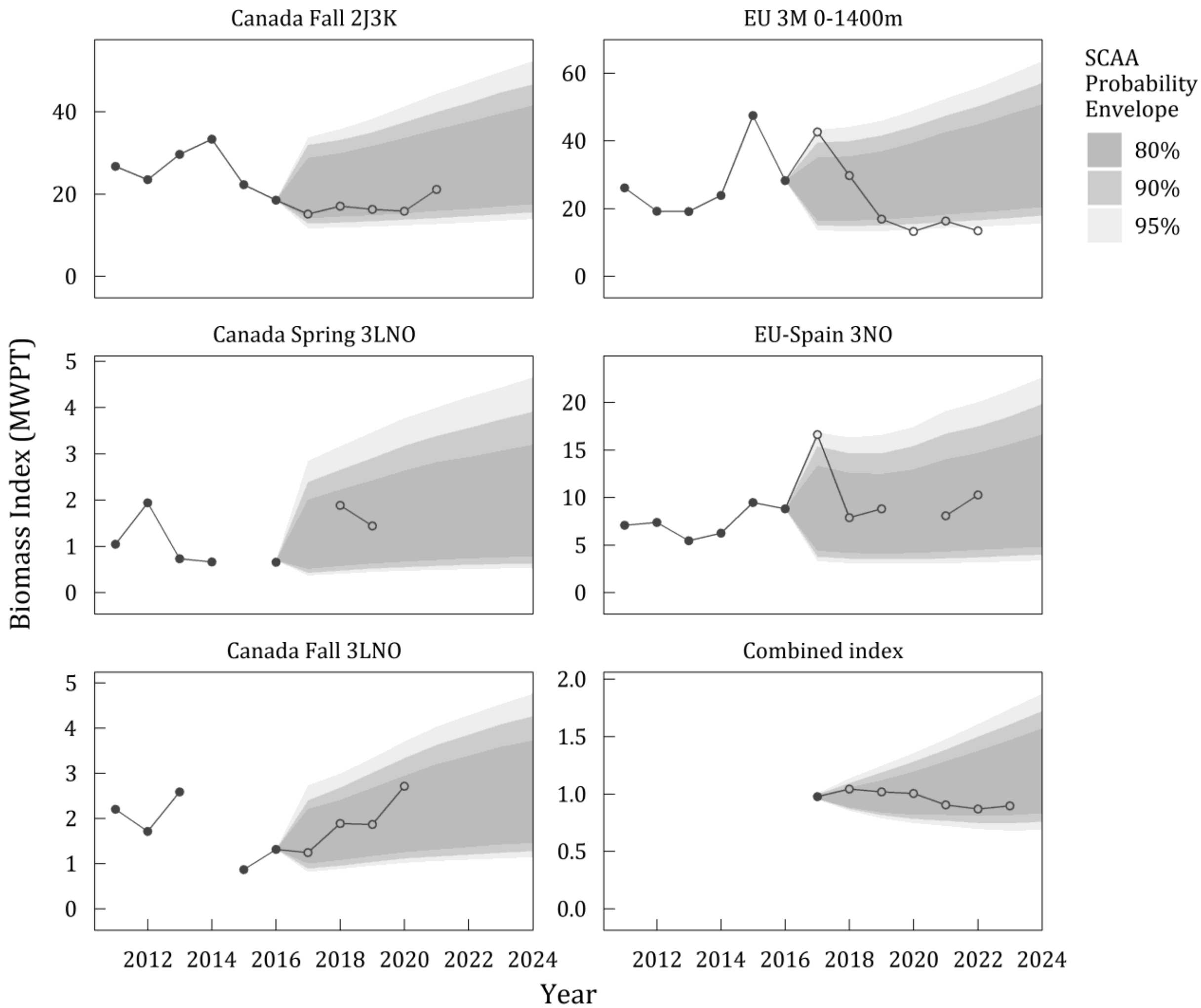


Figure i.2. Greenland halibut in Subarea 2 + Divisions 3KLMNO. Mean weight per tow from Canadian fall surveys in Divs. 2J3K, Canadian spring surveys in Divs. 3LNO, Canadian fall surveys in Divs. 3LNO, EU Flemish Cap surveys (to 1400m depth) in Div. 3M and EU-Spain surveys in 3NO. The figure also shows the combined index used in the target based component of the HCR. For the survey and combined indices, 80%, 90% and 95% probability envelopes from the SCAA base case simulation are shown. Index values observed from 2017 onward are shown using open circles.

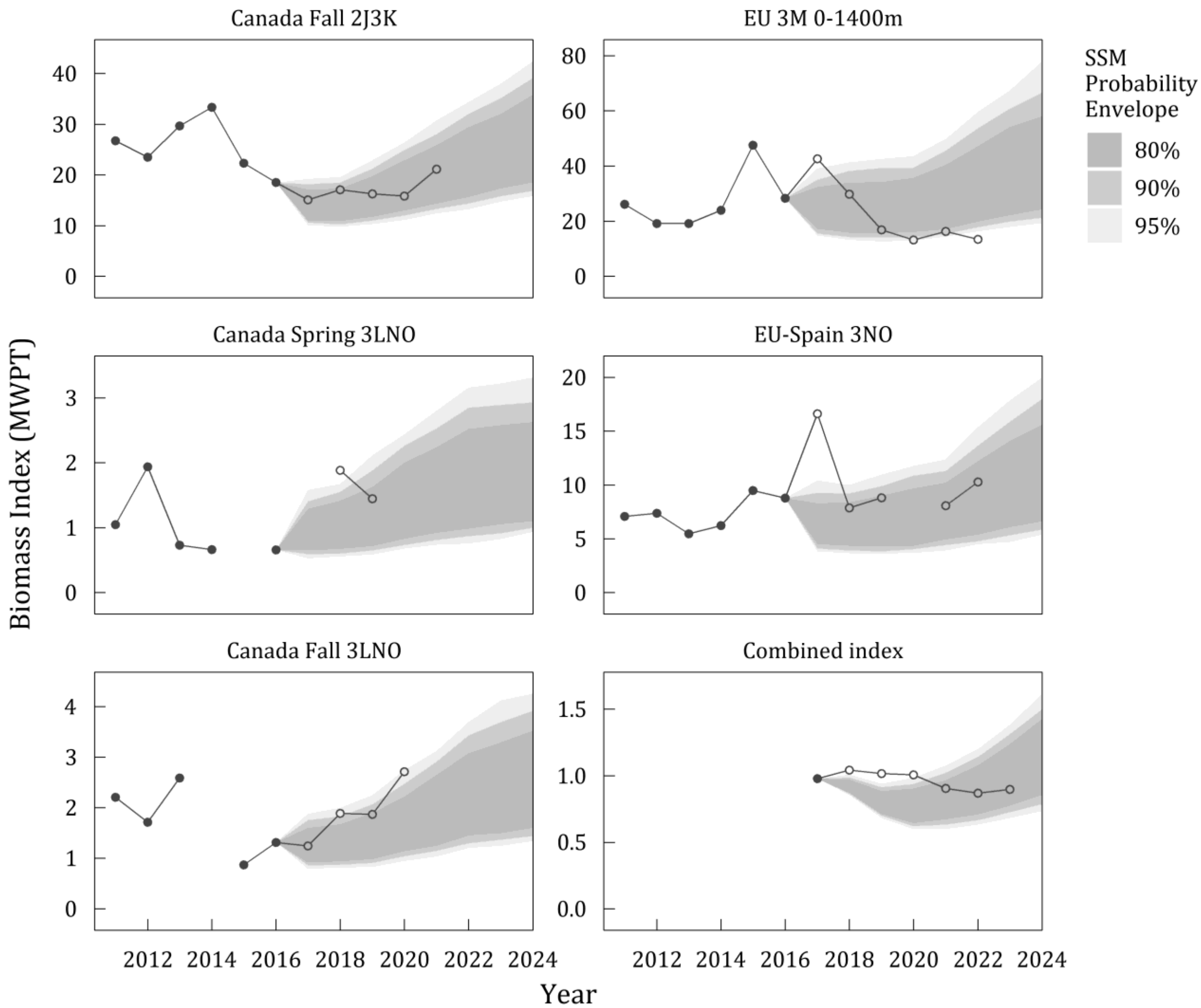


Figure i.3. Greenland halibut in Subarea 2 + Divisions 3KLMNO. Mean weight per tow from Canadian fall surveys in Divs. 2J3K, Canadian spring surveys in Divs. 3LNO, Canadian fall surveys in Divs. 3LNO, EU Flemish Cap surveys (to 1400m depth) in Div. 3M and EU-Spain surveys in 3NO. The figure also shows the combined index used in the target based component of the HCR. For the survey and combined indices, 80%, 90% and 95% probability envelopes from the SSM base case simulation are shown. Index values observed from 2017 onward are shown using open circles.

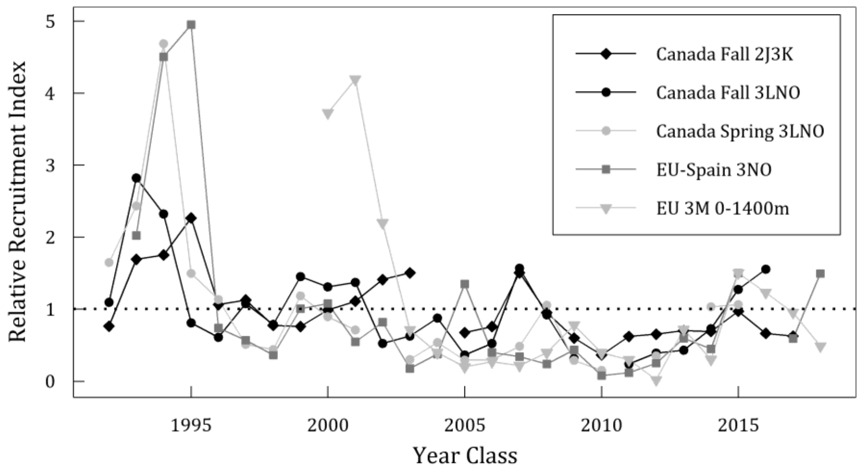


Figure i.4. Greenland halibut in Subarea 2 + Divisions 3KLMNO. Relative recruitment (age 4) indices from Canadian autumn surveys in Div. 2J3K, Canadian spring surveys in Div. 3LNO, Canadian fall surveys in Div. 3LNO, EU-Spain survey in 3NO and EU survey of Flemish Cap. Each series is scaled to its average, which then corresponds to the horizontal dotted line at 1.

ii) Evaluation of the impact of trawl surveys on VMEs (request #3)

Commission Request #3: *The Commission requests that Scientific Council continue its evaluation of the impact of scientific trawl surveys on VME in closed areas and the effect of excluding surveys from these areas on stock assessments.*

Scientific council responded:

While scientific bottom contacting trawl surveys do impact VMEs, SC concluded that the available evidence does not support a blanket exclusion of research surveys from all protected areas. Impacts from research surveys are not generally considered to cause long-term harm to VMEs due to their small footprint and long recurrence interval. The review of excluding closed areas from the surveys indicated that survey indices for some stocks would be impacted, making them unreliable for scientific advice. These surveys also play an important role in monitoring conservation objectives of the protected areas.

SC recommends that *the surveys can operate inside the closed areas in the NRA, but must make every effort to minimize impacts of the sampling and maximize the collection of data in the hauls made in those vulnerable areas.*

During the Scientific Council meeting in June 2022, several studies conducted by Canada and EU were presented, which analyzed the consequences of excluding the current scientific trawl surveys from closed areas. These studies indicated that survey indices for a number of stocks show measurable changes in estimates when sets from closed areas are omitted. They also indicated that recurrence times in scientific surveys may not result in significant adverse impacts in some cases (eg. sea pens). SC requested WG-ESA to further review these studies at its 2022 November meeting before making a final recommendation.

During the 2022 November meeting, WG-ESA conducted a review of these analyses. The analyzed surveys serve as the primary source of fisheries independent data for generating management advice. While it is recognized that scientific surveys are known to impact benthic species and habitats by causing immediate harm or mortality, these impacts differ by orders of magnitude with the fisheries bottom activities. This is because the survey effort is several times less than the fisheries effort.

A review of the analyses carried out for Canadian and EU surveys across multiple ecosystems did not support a blanket exclusion of research surveys from all protected areas. Survey recurrence times in relation to expected recovery times suggest that bottom-contacting science surveys would likely not pose a major long-term threat to benthic ecosystems. The review of excluding closed areas from the surveys indicated that survey indices would be impacted and/or biased, making them unreliable for scientific advice. Moreover, these surveys also play an important role in monitoring the conservation objectives of protected areas.

Regardless of the levels of impact, mitigation measures must still be considered to minimize harm while maintaining the integrity of the survey design. Some of these measures could include: moving sets outside the VME closed areas if possible, avoiding areas of particularly high density of VMEs within the closed areas, shortening the survey time within the closed areas and/or reducing the number of sets in the strata within the closed areas.

SC recommends that *the surveys can operate inside the closed areas in the NRA, but must make every effort to minimize impacts of the sampling and maximize the collection of data in the hauls made in those vulnerable areas.*

iii) 2+3KLMNO Greenland halibut and 3LN redfish MSE processes (request #4)

Commission request #4 *(Commission priority): The commission requests that scientific council continue to advance work on the 2+3KLMNO Greenland halibut and 3LN redfish MSE processes during 2022-2023, as per the approved 2023 workplan [COM-SC RBMS WP 22/07], in particular:*

a. Review and finalize the data series to be used for the two MSEs;

b. For the Greenland Halibut MSE: (1) propose, review and finalize Operating Models (OMs) to be used; and (2) Test Candidate Management Procedures (CMPs) to support the RBMS recommendation of an HCR to the Commission; and

c. For the 3LN Redfish MSE: (1) Proposal of an initial review of Operating Models; and (2) work to support the development of performance statistics and CMPs.

Scientific Council responded:

The commercial catch and survey data have been finalized for use in the upcoming 3LN redfish and 2+3KLMNO Greenland halibut MSE processes. However given the introduction of new research vessels for the Canadian surveys, complexities associated with obtaining and applying conversion factors may delay progress for both the Greenland halibut and 3LN redfish MSEs.

A series of Operating Models (OMs) have been proposed and reviewed for the Greenland halibut MSE. These OMs address uncertainties associated with factors such as recruitment variability, catch levels, selectivity patterns, natural mortality variation, and survey availability issues. SC approves the initial list of OMs; these will be implemented once the Canadian Autumn survey conversion factors are available. The primary Candidate Management Procedure (CMP) being considered is the current combined slope and target MP. Preliminary results indicate that its performance is comparable to that determined in the 2017 MSE process.

Initial OMs for 3LN redfish were reviewed and included state-space surplus production, age-based catch at length and survey-based models. SC endorses continued development into OMs, including a further exploration of the age-based catch at length model, and other model formulations. Work to support the development of performance statistics and CMPs are still in the early stages, since decisions need to be informed by the final OMs.

a) Review and finalize the data series to be used for the two MSEs.

The available catch and survey data to be used for the 3LN redfish and 2+3KLMNO Greenland halibut MPs were finalized at the intersessional January SC meeting (SCR 23/01, 23/07) and are summarized in Table iii.1. However, it was noted that it is considered unlikely that conversion factor estimates will be available for the Canadian Spring survey indices due to the early retirement of one of the vessels, which ends the Spring RV time series going forward. Sufficient comparative fishing data were obtained for the Canada Autumn survey; however, complexities associated with obtaining and applying conversion factors may delay progress on both the Greenland halibut and redfish MSE processes.

The impact of the missing Spring RV survey on the MSE process may be more substantial for 3LN redfish than for Greenland halibut, since the Spring RV survey is one of only two surveys that cover the stock area. The potential impacts of no longer having the Spring survey index need careful consideration. It may be necessary to revisit the work plans for both MSEs at the July WG-RBMS meeting.

b) For the Greenland Halibut MSE: (1) propose, review and finalize Operating Models (OMs) to be used; and (2) Test Candidate Management Procedures (CMPs) to support RBMS recommendation of an HCR to the Commission.

(1) A series of OMs have been proposed and reviewed for the Greenland halibut MSE. These OMs address uncertainties associated with factors such as recruitment variability, catch levels, selectivity patterns, natural mortality variation, and survey availability issues (see Table iii.2 for details). However, since the conversion factor from the Autumn survey is not expected to be available until mid-July at the earliest, OMs could not be finalised immediately. Scientific Council approved the suggested list of OMs; these will be implemented once the conversion factors are available.

(2) The primary CMP being considered is the current combined slope and target MP. Preliminary results indicate that its performance is comparable to that indicated by the 2017 MSE process. Minor adjustments have been made to the CMP to account for changes in the surveys. Specifically, the addition of the EU-Spain 3L survey, and removal of Canada Spring 3LNO survey and resultant reweighting of the CMP. Tuning of the CMP has been conducted to ensure the projected stock stabilizes around B_{msy} by the end of the projection period.

c) For the 3LN Redfish MSE: (1) Proposal of an initial review of Operating Models; and (2) work to support the development of performance statistics and CMPs.

(1) Initial OMs were reviewed and discussed and included state-space surplus production (SPM), age-based catch at length (ACL) and survey based (SURBA) models. Preliminary SPMs models fit the data and performed well under early sensitivity tests. Some issues were noted with the preliminary ACL model, including large process error estimates and unrealistic survey catchability estimates. The SURBA model presented was preliminary; however the practicality of considering a survey-only OM needs to be revisited in the context of the discontinuity in the Spring RV series. Council endorsed continued development of OMs, including further exploration of the ACL model, model formulations that incorporate environmental factors and considerations of a commercial fishery informed index.

(2) Work to support the development of performance statistics and CMPs are still in their early stages, since decisions need to be informed by the final OMs. However, a presentation, review, and discussion of Empirical and Model-Based MPs is expected at the July WG-RBMS meeting (COM-SC/23-02), time permitting due to changes related to discontinuity in the Spring RV series.

Table iii.1. Finalized data series for the 3LN redfish and 2+3KLMNO Greenland halibut MSE processes moving forward.

Redfish		Greenland halibut	
Name	Years	Name	Years
3LN EU-Spain	1995-2021	2J3K Canada Autumn	1996-2021
3LN Canada Autumn	1976-2021	3LNO Canada Autumn	1996-2020
3LN Canada Spring	1971-2021	3M EU-Spain 0-1400m	2004-2021
Commercial catch at length	1975-2022	3L EU-Spain	2003-2019
Commercial landings	1959-2022	3NO EU-Spain	1997-2021
Commercial weights at length	1990-2021	Commercial landings	1960-2021
EU-Spain survey weights at length	1997-2019	Commercial catch at age	1975-2021
		Commercial weights at age	1975-2021

Table iii.2. Operating model (OM) formulations for the 2+3KLMNO Greenland halibut MSE process

OM uncertainty considered	**Implementation**
Testing the impact of increased variability in recruitment	Higher recruitment variability
Evaluating the consequences of reduced recruitment levels over an extended period	8 years of recruitment halved
Assessing the implications of catch levels exceeding the total allowable catch (TAC) by 10%	Catch = 110% TAC
Investigating the effect of assuming no selectivity for older individuals in the population	Zero selectivity on plus-group
Allowing for a potential decrease in abundance while some surveys were absent	Decrease starting values of the population by 10% for all ages
Incorporating random errors in natural mortality estimates to account for uncertainties	Including future random error in M
Exploring a recruitment pattern where it drops linearly to the origin from the lowest value of biomass spawning potential observed in the assessment	Hockey-stick S/R relationship
Modelling an increase in M for ages 10 and above	Assumed senescence
Implementing an allometric shape for M based on weight-at-age	Implementing an allometric shape for M based on weight-at-age
Adjusting commercial selectivity patterns to decrease at a slower rate for higher age groups	Decrease doming in commercial selectivities
Simulating an increase in natural mortality during the initial projection period	M increase from 0.12 to 0.2 in the first 8 years of projections
Testing the performance using data exclusively from a subset of surveys	EU surveys only, excluding one EU survey and one Canadian survey

External Review

The MSE work carried out at this meeting was reviewed by two external reviewers; Mackenzie Mazur (DFO-Canada) and Gorka Merino (AZTI-Spain) who commented on the process and provided valuable feedback. Reviewers endorsed the work done by Scientific Council (see appendix IX).

Sources of information

SCR 23/01, 23/07, 23/14, 23/15, 23/26, 23/27, 23/35; COM-SC/23-02

iv) Inclusion of TCI summary information in stock summary sheets (request 5a):

Commission request 5a: *Include on a regular basis summary information on TCI in stock summary sheets (including indications of other NAFO managed stocks within the corresponding guild) and ecosystem summary sheets.*

Scientific Council responded:

SC has developed a template on how to include Total Catch Index (TCI) information in Stock Summary Sheets (SSSs). This template includes a reference to TCI in the summary table, and a new section describing sustainability of the catches for the guild and EPUs to which the SSS focal stock belongs. These modifications have been implemented in SSSs of the stocks assessed in 2023.

The design of the Ecosystem Summary Sheets (ESSs) already included a section for TCI information; this section has been updated to reflect the newly adopted framework and ecosystem reference point.

The Total Catch Index (TCI) is an indicator of the level of removals for a given functional guild (aggregate of species) that is consistent with the current productivity of the ecosystem (ecosystem sustainability). This indicator is derived from an Ecosystem Production Potential (EPP)-based framework.

The level of catches in relation to TCI for a given functional guild in an Ecosystem Production Unit (EPU) provides information on the risk of ecosystem overfishing in that EPU. NAFO has adopted 2TCI as an ecosystem reference point, where catches above 2TCI indicate a high risk of ecosystem overfishing. This information, together with stock assessment advice, is to be provided to the Commission (COM) for consideration within the process of setting Total Allowable Catches (TACs) for NAFO-managed stocks.

Stock Summary Sheets (SSSs) are updated by SC when a full assessment on the stock is conducted. This means that some SSSs are updated annually, while others are updated at a lower frequency. For this reason, in order to include updated TCI-related information on SSSs, updates need to be available on an annual basis. Therefore, SC has developed a new summary report on "Sustainability of Catches at the Ecosystem level". Details on this summary report are provided in SC Response to COM Request 5b.

The incorporation of the TCI information into the SSSs has been done by modifying the main summary table to include a line referencing the risk of ecosystem overfishing in relation to the 2TCI ecosystem reference point. This item will be color coded as red if Catch/TCI Ratio is larger than 2, and green if this ratio is less than 2. TCI information will also be included in the body of the SSS in the section "Ecosystem sustainability of catches", previously named "Effects of Fishing on the Ecosystem". This section will include a brief narrative describing catch levels in relation to TCI and indication of the NAFO managed stocks included in the guild of the focal stock of the ESS. An illustrative example for this section using the 2022 3M cod SSS is:

Ecosystem sustainability of catches

3M cod is included in the piscivores guild of the Flemish Cap (3M) Ecosystem Production Unit (EPU). Other NAFO managed stocks in this EPU within the piscivores guild are 3M redfish and 2+3KLMNOPs Greenland halibut. The Catch/TCI level for this guild in the Flemish Cap (3M) EPU is below the 2TCI ecosystem reference point (3M Piscivore Catch/TCI=0.82) indicating a low risk of ecosystem overfishing.

Complementing this section, a paragraph describing the overall productivity state of the EPU would also be added to the section "Biological and environmental interactions". An example for this text (in italics) using the 2022 3M Cod SSS is:

Biological and environmental interactions

Redfish, shrimp and smaller cod are important prey items for cod. Recent studies indicate strong trophic interactions between these species in the Flemish Cap.

A 2022 summary of the state of the fish community in the Flemish Cap (3M) EPU indicated that this ecosystem has not experienced sustained reductions in overall productivity observed in other EPUs. With the exception of a short-lived increase in 2005-2009, total EPU biomass has remained fairly stable over time despite the changes in individual stocks.

SC will also incorporate this information in the interim monitoring reports starting in June 2024.

SC also noted that stocks that are managed using a Harvest Control Rule (HCR) like Greenland halibut do not have SSSs. Developing SSSs for these stocks would provide a useful mechanism to concisely report on the stock, as well as a venue to include relevant TCI information. SC will look into developing these SSSs going forward.

In relation to the Ecosystem Summary Sheets (ESSs), the design of these summary sheets already included sections where TCI information was reported. These sections have been updated to reflect the EPP/TCI framework and 2TCI ecosystem reference point adopted by NAFO in 2022. The updated ESSs for the Grand Bank (3LNO) and Flemish Cap (3M) EPUs including TCI information aligned with the adopted EPP/TCI framework are presented in the SC Response to COM Request 5c.

v) TCI management considerations and communication of TCI information (request 5b):

Commission request #5b: *Work to support WG-EAFFM in exploring management considerations for occasions in which the 2TCI ecosystem reference point were to be exceeded and effective methods to communicate TCI-related information to the Commission, in particular for when 2TCI is, or expected to be exceeded.*

Scientific Council responded:

SC notes that while catches above the 2TCI ecosystem reference point are clearly associated with negative ecosystem outcomes, this high level of catch has been rare. This supports the treatment of these events as an analogous of Exceptional Circumstances in Management Strategy Evaluation. SC identified a series of science and management considerations that are relevant for defining courses of action in case the 2TCI level is exceeded (see text below).

To support the WG-EAFFM discussion on potential management actions in case 2TCI is exceeded, and to regularly communicate TCI-related information to COM, SC developed a report on the sustainability of catches at the ecosystem level to summarize the Catch/TCI information. The structure and content of this report is expected to evolve based on discussions and feedback from managers at WG-EAFFM and COM (see report below).

Management considerations for occasions in which the 2TCI ecosystem reference point were to be exceeded, similar to those when exceptional circumstances are triggered within MSE.

The analyses on catch levels in relation to TCI have indicated that catches exceeding 2TCI are clearly associated with negative ecosystem outcomes. From an ecosystem perspective, it is better to avoid exceeding 2TCI, than to react after this boundary has been crossed.

While the risk of exceeding 2TCI cannot be dismissed, these high catch levels have been rare in the last 25 years. However, unlike Exceptional Circumstances in Management Strategy Evaluation (MSE), which are often triggered by events outside management control (e.g. unexpected survey results, loss of surveys), exceeding 2TCI is more foreseeable (i.e. the catch component is within management control), and regular monitoring of catches in relation to TCI, together with general ecosystem monitoring, should provide early warnings.

The experience gained through the 2022 WG-EAFFM workshop on the implementation of Tier 1 of the Roadmap showed that, at least at the present time, management discussions and decisions towards preventing a high risk of ecosystem overfishing were better served by the provision of TCI information in a non-prescriptive way, and allowing the existing negotiation mechanisms within COM to incorporate the TCI-related information into the overall management discussions around setting TACs.

The framework adopted by NAFO identifies 2TCI as an ecosystem reference point, and catches above this reference point are associated with a high risk of ecosystem overfishing. The SC analyses underpinning this framework also identified catches between 1 and 2 TCI as posing an intermediate risk of ecosystem overfishing, and catches below TCI as having a low risk of ecosystem overfishing.

Science and management considerations relating to exceeding 2TCI could include:

Science considerations

1) Reasons for exceeding 2TCI. An increased likelihood of exceeding 2TCI could be related to:
   a) Stock assessment misspecification: stock assessments projecting single species yields that fail to properly consider ecosystem constraints, and/or
   b) Ecosystem productivity change/misspecification: ecosystem productivity has changed relative to its baseline level used in the TCI calculation.
2) Horizon for ecological negative impacts. How long catches exceeding 2TCI could be reasonably tolerated before negative ecosystem impacts would be expected?
3) Status and trends of the stocks involved. This would inform the stock level risks likely associated to the 2TCI exceedance.
4) Interactions among stocks. To inform trade-offs between options on how to reduce total catch levels.

Management considerations

1) Timing of management action in relation to advice. Should actions need to be taken immediately or can be staggered over time (e.g. considering all managed stocks within a guild)?
2) Impacts on fisheries from 2TCI exceedance. How long catches are expected to be over 2TCI (e.g. incoming TACs already agreed)? Consider trade-offs between current and future benefits.
3) Trade-offs among stocks. The TCI analysis provides no information about stocks within a guild, therefore, in the absence of additional analysis, a value judgement by managers on how to prioritize stocks for management actions would be required (e.g. conservation status, economic relevance, other?)
4) Process to evaluate/integrate information. An exceptional circumstances protocol is structured around basic steps (e.g. type of analyses to be performed, NAFO bodies involved, decision tree, integration within NAFO management cycle). What are the key steps of a 2TCI protocol from a manager's perspective?

While the intermediate and low risk of ecosystem overfishing levels have not been adopted by NAFO as part of its management framework, they still represent useful characterizations of risk from a science perspective. Regular examination of the Catch/TCI trends can provide sufficient early warnings of catches approaching 2TCI to allow those trends to be managed with minor TAC adjustments over a number of years, avoiding both the potential need for sudden/major readjustments of TACs and impacts on fisheries that would be expected to come with them.

While these observations and considerations by themselves do not constitute a structured protocol for addressing a 2TCI exceedance, they are expected to provide a useful starting point for a discussion between scientists and managers at WG-EAFFM on how best to structure such protocol, the elements it needs to contain, and the work and resources required for making it operational.

Effective methods to communicate TCI-related information to the Commission, in particular for when 2TCI is, or expected to be exceeded

In line with the science and management considerations detailed in the previous section, SC considered that an annual reporting on catches in relation to TCI would be an effective way to communicate to COM this information. SC produced such a report in 2023 to start delivering TCI information to COM, but the structure and content of the report is expected to evolve based on discussions and feedback from managers.

This report needs to be considered as a proof of concept towards developing effective tools to communicate TCI-related information to managers. It is intended to address both, the requirement to include TCI-related information in the regular reporting from SC to COM, and to serve as test case for the discussion with WG-EAFFM on effective ways of communicating this type of information.

The "Roadmap Tier 1: Sustainability of Catches at the Ecosystem Level" report provides an *at glance* perspective of the level of risk of ecosystem overfishing at the EPU scale.

Since most NAFO-managed stocks inhabit the Grand Bank (3LNO) and Flemish Cap (3M) EPUs, future versions of this report are intended to only provide detailed reporting for these EPUs. However, as this is the first time a report like this is put forward to COM, detailed reporting on the Newfoundland Shelf (2J3K) EPU has also been included for completeness.

The "Roadmap Tier 1: Summary Report on Sustainability of Catches at the Ecosystem Level" is included below:

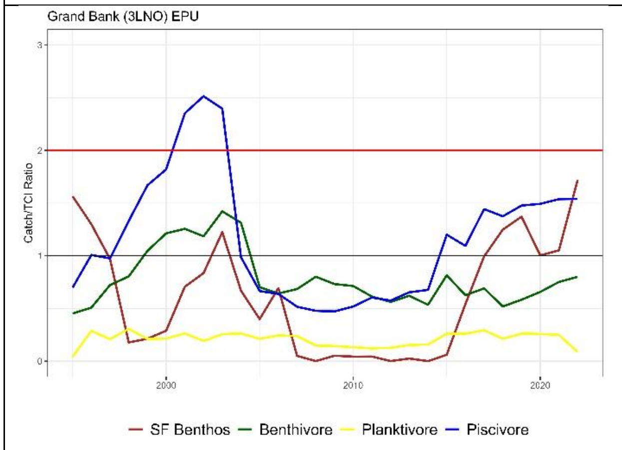
Roadmap Tier 1: Summary Report on Sustainability of Catches at the Ecosystem Level

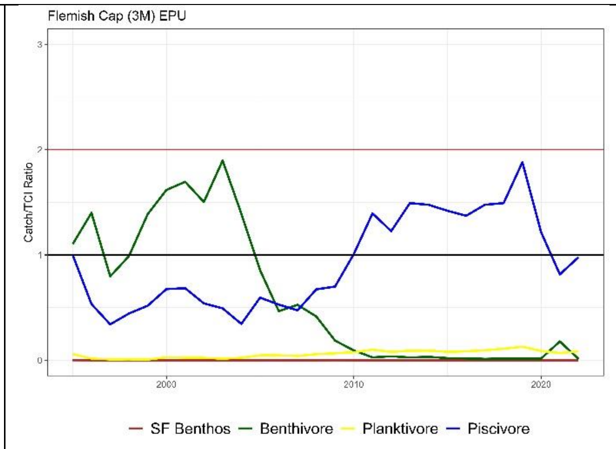
Since 2005 all Ecosystem Production Units (EPUs) evaluated (3M, 3LNO and 2J3K) have shown aggregate catch levels by functional guild which are consistent with the productivity of the EPUs and the risk level of ecosystem overfishing.

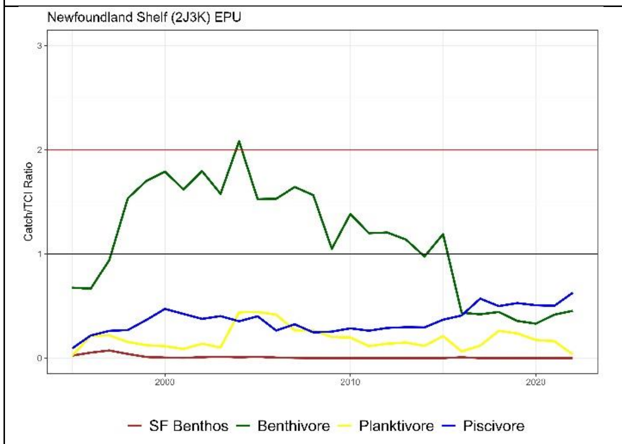
Approach:

Total Catch Index (TCI): This index is an indicator of the level of aggregated catch for a given functional guild (aggregate of species) that is consistent with the current productivity of the ecosystem (ecosystem sustainability). The comparison of aggregate catches with TCI is informative of the risk of ecosystem overfishing.

NAFO has adopted 2TCI as an ecosystem reference point to inform on ecosystem overfishing (EO).







Risk of ecosystem overfishing:

Catch > 2TCI: high risk of ecosystem overfishing

Catch between 1 and 2 TCI: intermediate risk of ecosystem overfishing

Catch < TCI: low risk of ecosystem overfishing

Summary:

Previous analyses demonstrated that, during 1960-1995, all the Ecosystem Production Units (EPUs) evaluated had experienced sustained catch levels consistent with ecosystem overfishing.

Since 2005 aggregated catches for all functional guilds have been below the 2TCI ecosystem reference point across all EPUs.

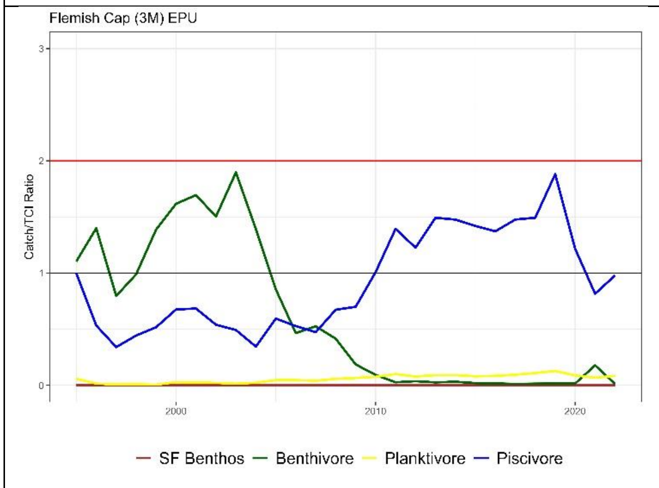
The catch levels for 2022 indicate a low risk of ecosystem overfishing on the Flemish Cap (3M) EPU and the Newfoundland Shelf (2J3K) EPU, and intermediate risk of ecosystem overfishing in the Grand Bank (3LNO) EPU.

All catch levels are consistent with preventing a high risk of ecosystem overfishing.

Details by EPU

NAFO-managed stocks predominantly inhabit the Flemish Cap (3M) and Grand Bank (3LNO) EPUs, and typically belong to the Piscivore, Benthivore and Planktivore functional guilds. Details on catch composition in relation to TCI for these focal EPUs is provided below to complement stock-assessment advice, and further assist NAFO management discussions on appropriate TAC levels that can consider the risk of ecosystem overfishing (EO).

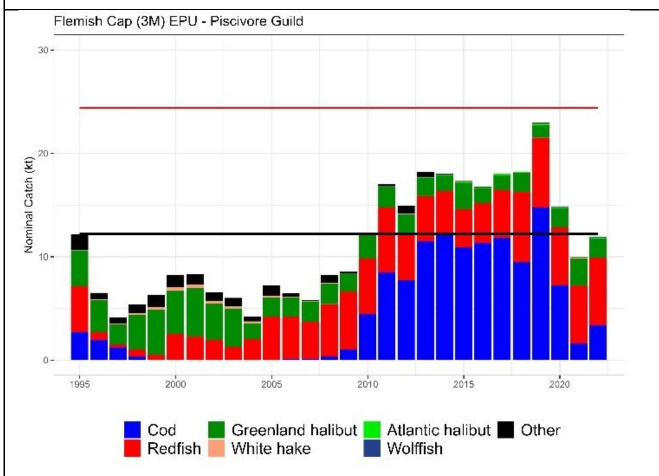
Flemish Cap (3M) Ecosystem Production Unit (EPU)



Overview

Catches for all functional guilds are below 2TCI, indicating that current fishing levels are consistent with preventing a high risk of ecosystem overfishing.

Catches for all functional guilds are currently below 1TCI, indicating a low risk of ecosystem overfishing.

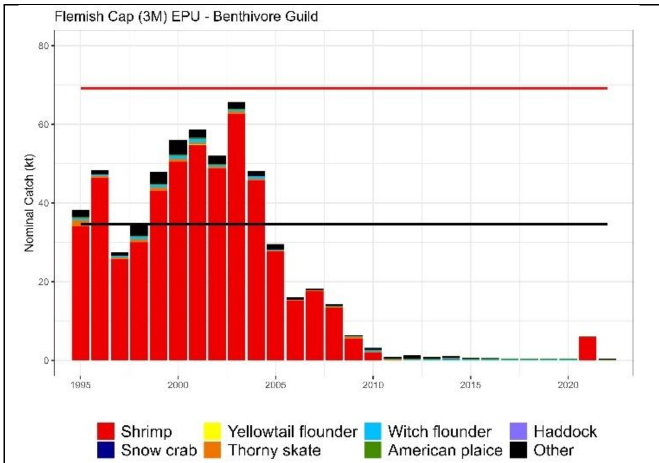
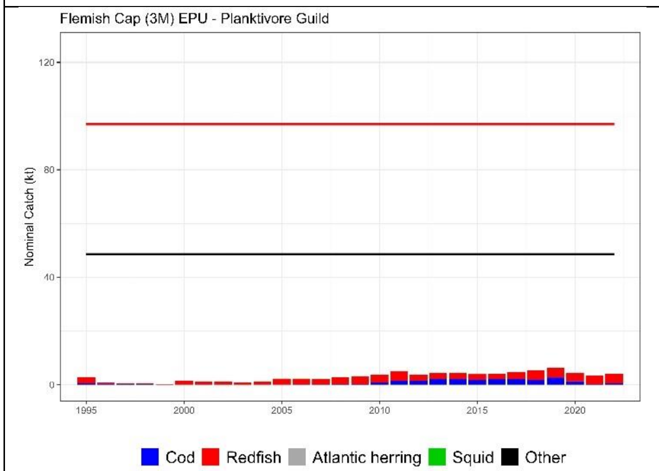
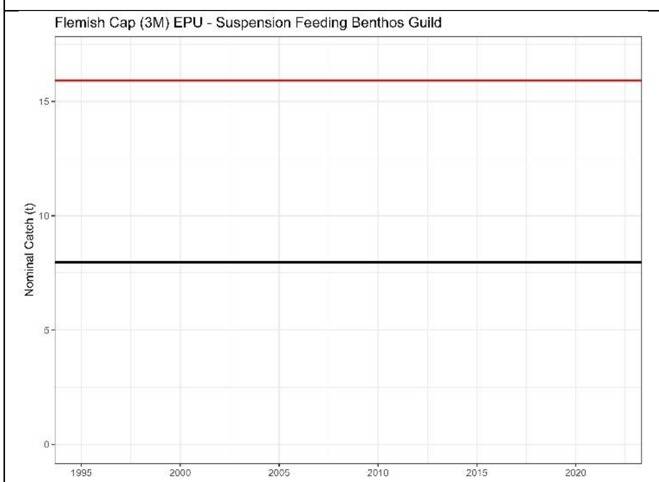


Piscivores Guild: low risk of EO

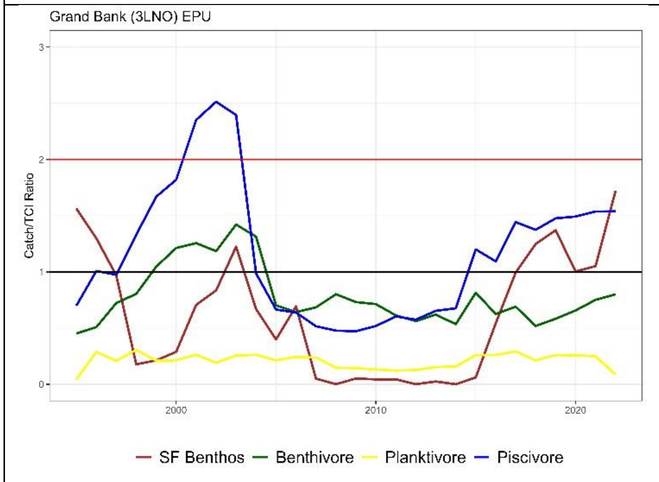
Current 2TCI=24kt

Catches are dominated by redfish, Greenland halibut and Atlantic cod.

Redfish (3M), Greenland halibut (2+3KLMNO) and Atlantic cod (3M) stocks are managed by NAFO.

	**Benthivores Guild: low risk of EO** Current 2TCI=69kt Catches are dominated by shrimp. Shrimp (3M) stock is managed by NAFO.
	**Planktivore Guild: low risk of EO** Current 2TCI=97kt There are no fisheries directed on planktivores in this EPU. A fraction of Atlantic cod and redfish catches is mapped to this functional guild to account for production during the early part of their life histories. Catches are dominated by younger ages of Atlantic cod and redfish.
	**Suspension Feeding Benthos Guild: low risk of EO** Current 2TCI=159kt There are no fisheries directing for Suspension Feeding Benthos in this EPU.

Grand Bank (3LNO) Ecosystem Production Unit (EPU)

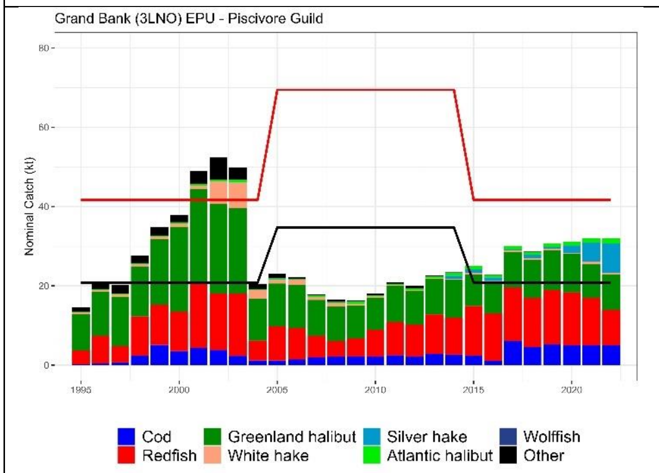


Overview

Catches for all functional guilds are below 2TCI, indicating that current fishing levels are consistent with preventing a high risk of ecosystem overfishing.

Catches for Piscivores and Suspension Feeding Benthos are between 1 and 2 TCI, indicating an intermediate risk of ecosystem overfishing.

Catches for Benthivores and Planktivores are below 1TCI, indicating a low risk of ecosystem overfishing.



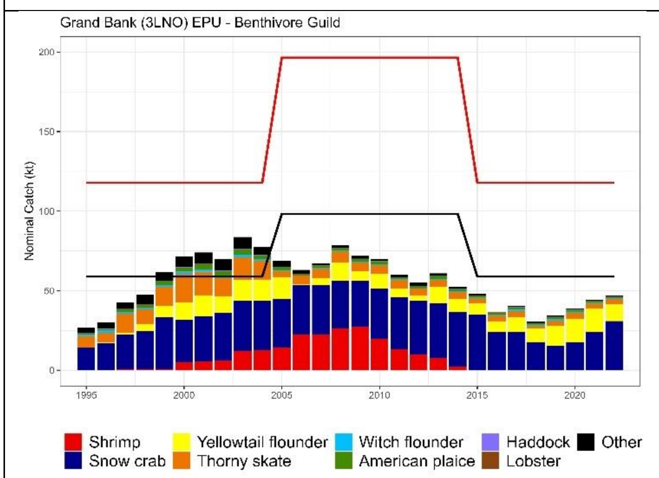
Piscivores Guild: intermediate risk of EO

Current 2TCI=42kt

Catches are dominated by redfish, Greenland halibut and Atlantic cod.

Redfish (3LN and 3O stocks), Greenland halibut (2+3KLMNO) and Atlantic cod (3NO -moratorium-) stocks are managed by NAFO, while the Atlantic cod (2J3KL -moratorium, Stewardship fishery only) stock is managed by Canada.

Catches of silver hake have noticeably increased since 2018, likely linked to ecosystem changes related to warming trends.

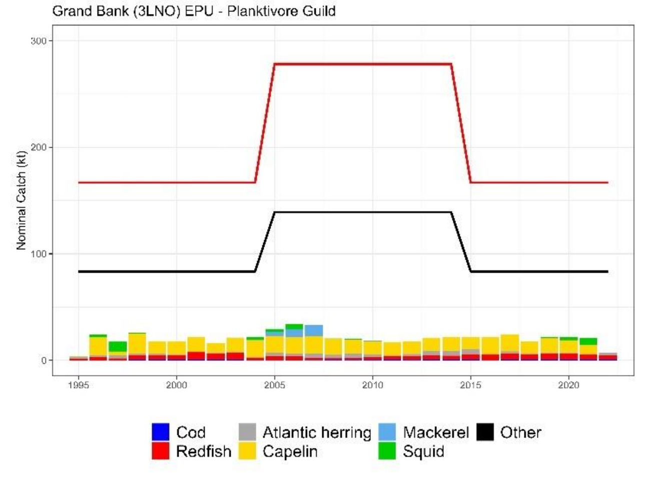


Benthivores Guild: low risk of EO

Current 2TCI=118kt

Catches are dominated by yellowtail flounder and snow crab.

Yellowtail flounder (3LNO) is managed by NAFO, while the snow crab (3L inshore, 3LNO offshore) is managed by Canada.



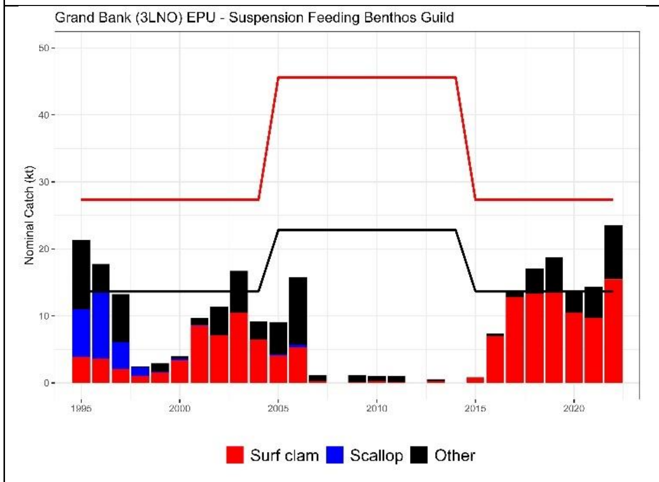
Planktivore Guild: low risk of EO

Current 2TCI=167kt

Catches are dominated by capelin (2J3KL).

Capelin (2J3KL) is managed by Canada.

A fraction of Atlantic cod and redfish catches is mapped to this functional guild to account for the planktivorous nature of these species during the early part of their life histories.



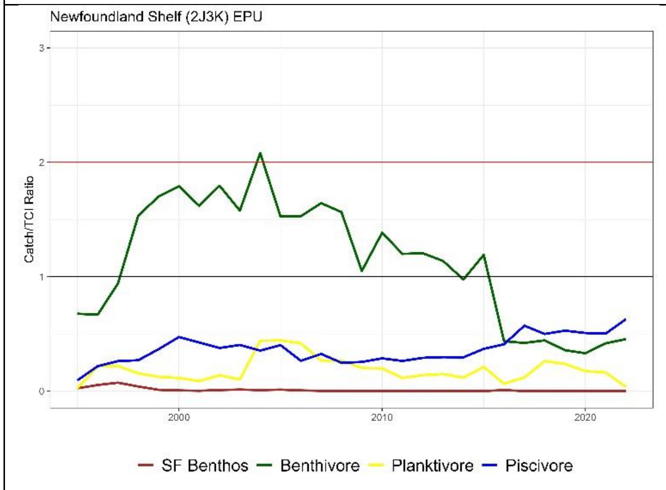
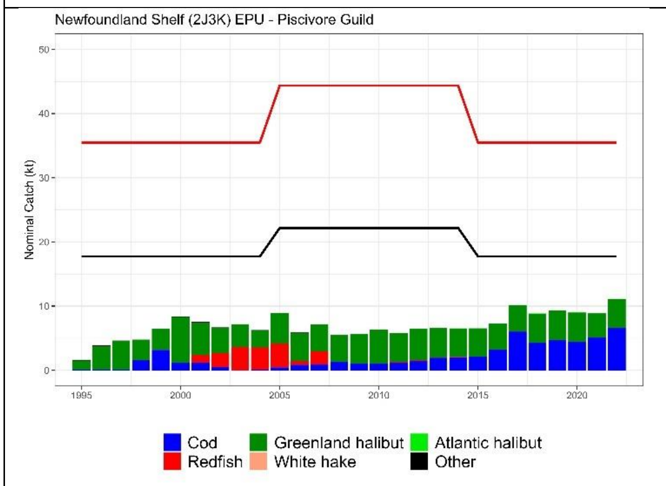
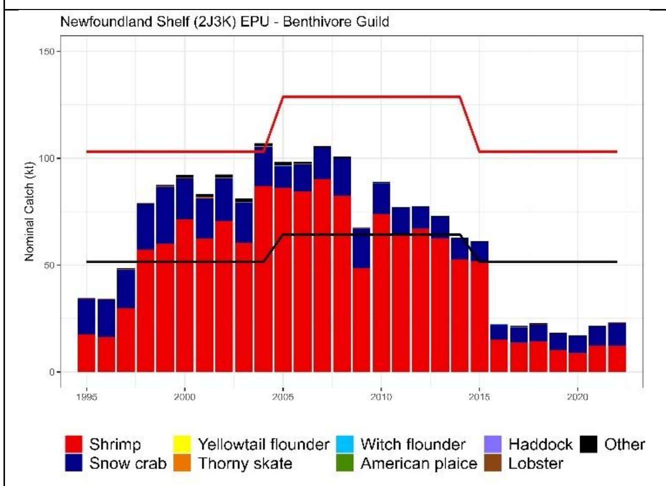
Suspension Feeding Benthos Guild: intermediate risk of EO

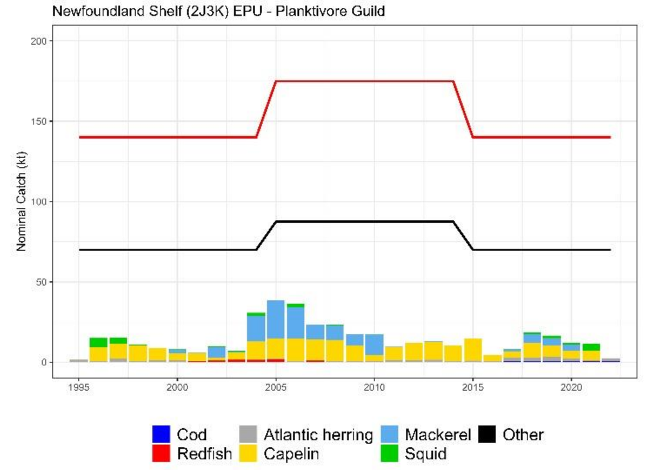
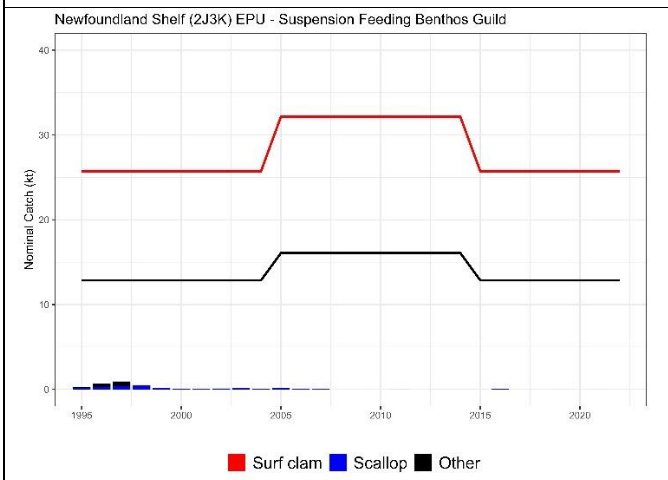
Current 2TCI=27kt

Catches are dominated by surf clam.

Surf clam is managed by Canada.

A complementary section for the Newfoundland Shelf (2J3K) EPU is presented below. This piece is not intended to be included in the regular reporting on TCI, but it was deemed relevant for the discussion on utility and effectiveness of the report.

<table>
<tr><th colspan="2">Newfoundland Shelf (2J3K) Ecosystem Production Unit (EPU)</th></tr>
<tr><td>
</td><td>Overview
Catches for all functional guilds are below 2TCI, indicating that current fishing levels are consistent with preventing a high risk of ecosystem overfishing.
Catches for all functional guilds are below 1TCI, indicating a low risk of ecosystem overfishing.</td></tr>
<tr><td>
</td><td>Piscivores Guild: low risk of EO
Current 2TCI=35kt
Catches are dominated by Greenland halibut and Atlantic cod.
Greenland halibut (2+3KLMNO) stock is managed by NAFO, while the Atlantic cod (2J3KL -moratorium, Stewardship fishery only) stock is managed by Canada.</td></tr>
<tr><td>
</td><td>Benthivores Guild: low risk of EO
Current 2TCI=103kt
Catches are dominated by shrimp and snow crab.
Shrimp (SFA 6 management area) and snow crab (2HJ and 3K assessment units) are managed by Canada.</td></tr>
</table>

 	**Planktivore Guild: low risk of EO** Current 2TCI=140kt Catches are dominated by capelin (2J3KL). Capelin (2J3KL) is managed by Canada. A fraction of Atlantic cod and redfish catches is mapped to this functional guild to account for production during the early part of their life histories.
 	**Suspension Feeding Benthos Guild: low risk of EO** Current 2TCI=26kt There are no fisheries directing for suspension Feeding Benthos in this EPU.

vi) Development of the 3LNO and 3M ecosystem summary sheets (ESS) (request #5c)

Commission request #5c: *Complete the development of the 3LNO ecosystem summary sheet (ESS), advance as much as possible the development of the 3M ESS, and continue working, if capacity allows, toward undertaking a joint Workshop with ICES (International Council for the Exploration of the Sea) on reporting on North Atlantic ecosystems.*

Scientific Council responded:

SC completed the development of Ecosystem Summary Sheets (ESSs) for the Grand Bank (3LNO) and Flemish Cap (3M) Ecosystem Production Units (EPUs).

SC has tentatively established a 5-year schedule for the update of ESSs, with the provision that updates could be triggered earlier than that if important ecosystem changes are detected.

No progress was made on the organization of a joint Workshop with the International Council for the Exploration of the Sea (ICES) on reporting on North Atlantic ecosystems. However, some of these elements are likely to be addressed in a proposed symposium on the Application of Ecosystem Approaches to Fisheries Management currently being organized by the Fisheries and Agriculture Organization (FAO) Areas Beyond National Jurisdiction (ABNJ) Deep Sea Project 2022-2027, SC, and possibly ICES, which is currently being planned for 2025.

As part of the implementation of the NAFO Roadmap, Ecosystem Summary Sheets (ESSs) provide a synoptic view on the state of NAFO ecosystems and their management regime, and constitute a tool for strategic assessment, advice and planning.

SC completed the update of the Grand Bank (3LNO) ESS, and fully developed the Flemish Cap (3M) ESS, but made no progress toward undertaking a joint Workshop with the International Council for the Exploration of the Sea (ICES) on reporting on North Atlantic ecosystems. However, some aspects of the work originally aimed for this workshop would likely be incorporated in a proposed symposium on the Application of Ecosystem Approaches to Fisheries Management currently being organized by the Fisheries and Agriculture Organization (FAO) Areas Beyond National Jurisdiction (ABNJ) Deep Sea Project 2022-2027, NAFO SC, and possibly ICES, which is currently being planned for 2025.

In completing the ESSs, SC noted that NAFO does not have a list of species of conservation concern (e.g. protected, endangered or threatened species) that can be used to focus monitoring of incidental mortality and/or other types of operational interactions. Developing such a list would be a necessary step to improve tracking, reporting and assessment of this type of impact of fisheries operations.

ESSs are tentatively scheduled to be updated every 5 years, with the provision that updates could be triggered earlier than that if important ecosystem changes are detected. Updating ESSs requires SC to fill Ecosystem Designated Expert (EDE) positions for the Grand Bank (3LNO) and Flemish Cap (3M) EPUs. At the present time only the EDE position for the Flemish Cap (3M) EPU has been filled on a provisional basis, while the EDE position for the Grand Bank (3LNO) EPU remains vacant.

The current structure of ESSs is the result of previous discussions between SC and WG-EAFFM. The structure distinguishes between ecological features and management measures, aligning the summary information with the general principles adopted by NAFO in Chapter III of its convention. The assessment focuses on average state (S – Status) and trend (T – Trend) over the last 5 years (Tables iv.1 and iv.2), but without losing the long-term perspective.

Table iv.1. Color scheme for the Ecological Features of the ecosystem summary sheet and the corresponding criteria for assignment to each category for the status and trends. Contributing elements time series should be standardized to zero mean and unit standard deviation relative to an appropriate reference period.

	Ecological Features	
	Status	**Trend**
Green	The state over the last 5 years is consistent with conditions observed/estimated during high productivity/high resilience periods. (mean > 0.5 SD)	The trend over the last 5 years indicates consistent improving of the state/condition. (trend > 1 SD/5 y or >20% increase in state)
Yellow	The state over the last 5 years is consistent with conditions observed/estimated during average productivity/average resilience periods.	The trend over the last 5 years does not indicate any consistent change of the state/condition.
Red	The state over the last 5 years is consistent with conditions observed/estimated during low productivity/low resilience periods. (mean < -0.5 SD)	The trend over the last 5 years indicates consistent deterioration of the state/condition. (trend < -1 SD/5 y or >-20% decline in state)
Grey	Unknown - insufficient data to assess or assessment pending.	Unknown - insufficient data to assess or assessment pending.

Table iv.2. Color scheme for the Management Measures of the ecosystem summary sheet and the corresponding criteria for assignment to each category for the status and trends.

	Management Measures	
	Status	**Trend**
Green	Good. Current management measures are delivering the desired results.	Good. Management measures over the last 5 years are improving conditions; moving towards/maintaining the desired results.
Yellow	Uncertain. Current management measures appear to have limited ability to deliver the desired results.	Uncertain. Management measures over the last 5 years are not improving conditions; no clear movement towards achieving the desired results.
Red	Poor. Current management measures appear insufficient to deliver the expected results or no management measure is in place.	Poor. Management measures over the last 5 years are not effective or no management measure is in place; conditions are moving away/deteriorating from the desired results.
Grey	Unknown - insufficient data to assess or assessment pending.	Unknown - insufficient data to assess or assessment pending.

Grand Bank (3LNO) Ecosystem Summary Sheet

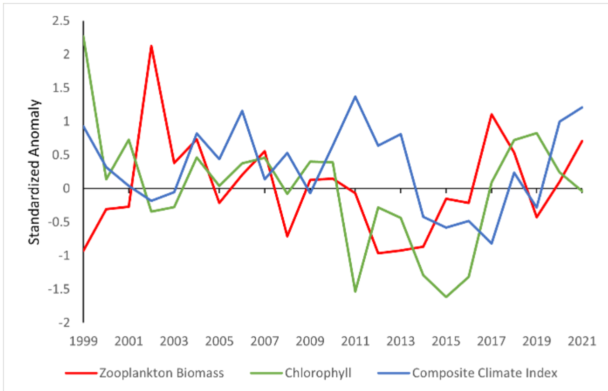
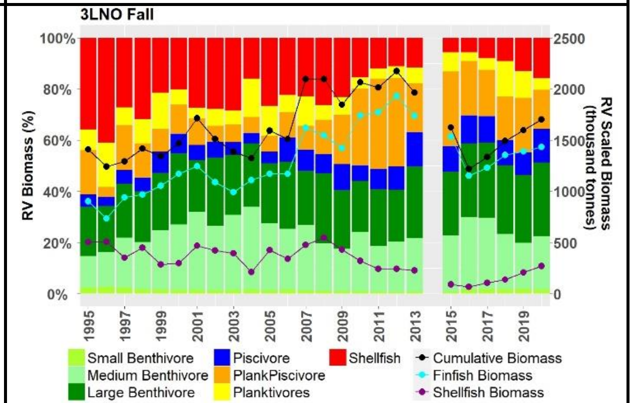
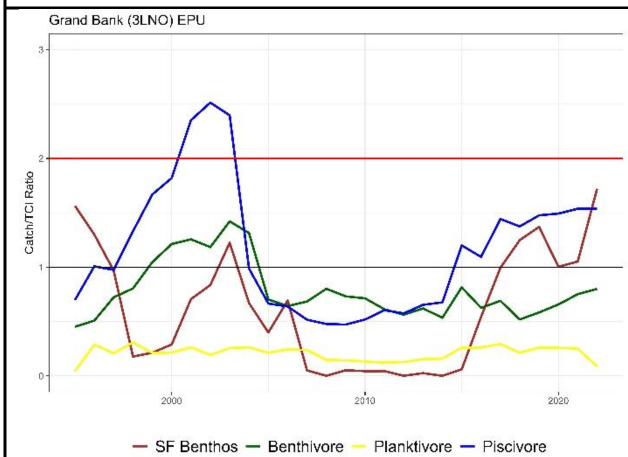
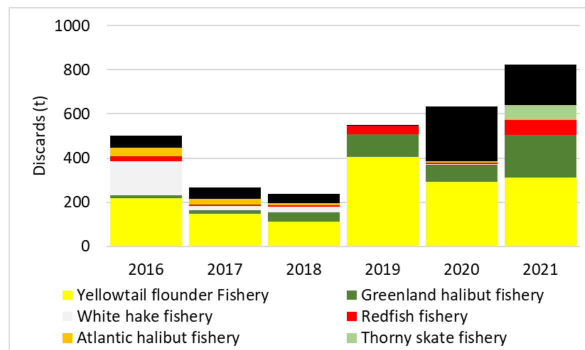
The Grand Bank (3LNO) EPU is currently experiencing low productivity conditions, with total EPU biomass well below pre-collapse levels (pre-1990s). Current reduced productivity appears associated with bottom-up processes. Ongoing warming trends together with increases in warm water species suggest that this ecosystem may be starting to undergo important structural changes. VME protection in this EPU has improved between 2019 and 2021, but only two VME types out of seven are well protected. Overall catch levels are consistent with current ecosystem productivity and the avoidance of high risk of ecosystem overfishing.

ECOLOGICAL FEATURES					
Convention Principle					**Comment**
A	Ecosystem status and trends (long-term sustainability)		Status (S)	Trend (T)	Summary of multiple trends/state
	1	Physical Environment			Ocean climate index above normal conditions in 2020-2021, with 2021 being the second highest value since 1999. Clear increasing trend over the last 5 years, from below normal conditions to above normal.
	2	Primary Productivity			Chlorophyll at normal level in 2021, recovered from a prolonged below normal state in 2013-2017. Indices are dominated by cyclic changes with no clear trend.
	3	Secondary Productivity			Zooplankton biomass above normal in 2021, recovered from below normal levels in 2011-2014. Indices are dominated by cyclic changes with no clear trend.
	4	Fish productivity			Total EPU biomass in 2020 from Canadian surveys increased from the lows in 2015-2016, but remains well below pre-collapse levels (pre-1990s). However, Spanish surveys indicate likely declines after 2020. Average weight of individuals by functional group in the survey has declined since the late 2000s and remains below normal for many functional groups.
	5	Community composition			Shellfish has increased in dominance in 2015-2020 after clear declines in previous years, but piscivores have yet to regain their pre-collapse dominance. There is an increase in warm water species like silver hake and Atlantic halibut.
B	Ecosystem productivity level and functioning		S	T	Summary of multiple trends/state
	1	Current Fisheries Production Potential			Total biomass density declined from ~40-50% to ~30% of the estimated pre-collapse (pre-1990s) level between 2014-2016. Some indications of improvement in 2019-2020, but lack of surveys prevents evaluating the progression of these changes.
	2	Status of key forage components			Reduced levels of capelin and shrimp, and near average levels of sand lance.
	3	Signals of food web disruption			Diet variable, declining trend in stomach content weights, with below normal levels since 2013.

E	State of biological diversity		S	T	Summary of multiple trends/state
	1	Status of VMEs			Area and biomass of VMEs are considered to be at similar levels since the start of their assessments. Differences in estimates in the 2016-2021 period are due to improvements in the evaluation methods and availability of data.
	2	Status of non-commercial species			Based on 22 non-commercial species selected from the multispecies surveys, 60% of the species are above 20% of their historical maximum, an increase from around 50% in 2016.
MANAGEMENT MEASURES					
Convention Principle					**Comment**
C/D	Apply Precautionary Principle		S	T	Summary of metrics on level of management action
	1	Aggregate catches and risk of ecosystem overfishing (2TCI ecosystem reference point)			All catches are below 2TCI. Piscivore and Suspension Feeding Benthos catches are above 1TCI. Piscivore catches have been increasing since 2015.
	2	Multispecies and/or environmental interactions			No explicit consideration of species interactions and/or environmental drivers.
	3	Production potential of single species			Only 66% of NAFO managed stocks (8 out of 12) are in condition of supporting fisheries. Some stocks have declining trends or status unknown due to lack of recent survey information and/or absence of reference points.
D/E	Minimize harmful impacts of fishing on ecosystems		S	T	Summary of metrics on level of management action
	1	Level of protection of VMEs			All VMEs with some level of protection, but only two out of seven with good level of protection. Protection has improved between 2019 and 2022. Fishing with bottom contacting gears does not intrude in closed areas.
	2	Level of protection of exploited species			Ecosystem reference point to inform on ecosystem overfishing (2TCI) has been adopted. LRPs or HCRs are available for 80% of managed stocks. No multispecies assessments are in place.
D/F	Assess significance of incidental mortality in fishing operations		S	T	Summary of metrics on level of management action
	1	Discard level across fisheries			Total discards for the NRA show a significant increase in 2018-2021. While the greatest tonnage occurs in the yellowtail flounder fishery, most fisheries show increasing trends in discards. In terms of percentage of total catch from a fishery, the reported discards relative to total catch in 2016-2021 was less than 5% for the main fisheries (redfish, yellowtail flounder, Greenland halibut, thorny skate). However, Atlantic halibut and white hake fisheries had high discard levels (15-50%) in 2016-2018.

			S	T	Comment
	2	Incidental catch of depleted and/or protected species, or other species of conservation interest			By-catch of American plaice in the yellowtail fishery is a concern for the rebuilding of this stock. Wollffish are species at risk in Canada. Incidental catch of wolffishes in 3LNO fisheries in 2016-2021 in the NRA was low (less than 1% of survey biomass), oscillating without trend around a value of 33 t per year. Incidental catch of Greenland sharks in the NRA during the same period oscillated without trend around a value of 60 t per year. Special protection measures for this species are in place.
OTHER CONSIDERATIONS (outside mandate of NAFO Convention)					
Human Activities other than fisheries			S	T	Comment
	1	Oil and gas activities			As of 2022, there are four offshore production fields on the Grand Bank and exploration activities along the Flemish Pass, eastern shelf break, and oceanic areas off the eastern shelf break. The total area for 3KLMNO of licenses[1] has increased 16.3-fold from 2014 to 2021. There have been 12 reported incidents between 2015 and 2022, with a major oil spill in 2018, and one in 2019 that extended into the NRA. A proposed development project in the Flemish Pass overlaps with fishing grounds. It is expected, based on current exploration leases and development projections, that oil and gas exploration activities will continue to increase in the NRA.
	2	Pollution			The most recent information (up to 2017) indicates that there is low occurrence and density of litter in 3L and fisheries are the primary source from both NAFO-managed and non-NAFO managed fisheries. Data for more recent years has been collected in the EU surveys but has yet to be analyzed. Standardized protocols for litter data collection have been implemented in the EU surveys.
Fisheries not managed by NAFO			S	T	Comment
		Non-NAFO fisheries (coastal states and other RFMOs)			Among the fisheries managed by Canada in this EPU, 70% are currently supporting fisheries, and 46% have Limit Reference Points. Lack of recent survey information represents a challenge for stock-assessments. Swordfish and tuna fisheries operate in this EPU under ICCAT jurisdiction.
		Level of protection of VMEs (coastal states and other RFMOs)			Only coral and sponge VMEs are considered for protection under Canadian regulations. Among the VMEs present and covered by these regulations most have some level of protection, and one is unprotected.

[1] License types: Exploration, Significant Discovery and Production

PHYSICAL ENVIRONMENT AND LOWER TROPHIC LEVELS	FISH COMMUNITY COMPOSITION AND BIOMASS
	
ECOSYSTEM AGGREGATED CATCHES	DISCARDS
	

Selected indicators to illustrate the 3LNO EPU status. Upper left-hand panel shows anomalies of the 3LNO subset of the NL Climate Index, chlorophyll-a, and zooplankton biomass index. Upper-right panel shows the relative composition of the fish community by functional groups from Canadian 3LNO fall survey. Lower left-hand panel shows the nominal total catch by functional guilds scaled relative to the corresponding Total Catch Index (TCI: black line; 2TCI: red line). The lower-right panel shows the tonnage of discards (total weight of all species) in each fishery from NAFO haul-by-haul catch reports and therefore include catches in the NRA only.

ECOLOGICAL FEATURES

Ecosystem Status and Trends

The last 5 years have been characterized by improved levels of nutrients and phytoplankton indices, as well as total zooplankton biomass with respect to earlier years. Small-sized copepods have significantly increased in abundance but the larger, lipid-rich taxa that are preferred prey of forage fish have been below normal in 2013-2020. After 2013-2014, total fish biomass declined and lost the gains built-up since the mid-1990s. After the lows around 2016-2017 the biomass of both finfish and shellfish showed signs of improvement by 2020. However, the declines observed in the Spanish survey after 2020 suggest that these improvements may have not continued. The piscivore functional group has not regained its pre-collapse dominance, with its proportion in biomass in the community remaining steady since 2015. Ongoing warming trends together with increases in warm water species like silver hake and Atlantic halibut suggest that this ecosystem may be starting to undergo structural changes.

Ecosystem productivity level and functioning

The Grand Bank continues experiencing low productivity conditions. After the regime shift in the late 1980s and early 1990s, this ecosystem never regained its pre-collapse biomass level. Improved conditions between the mid-2000s and early 2010s allowed a build-up of total biomass up to ~40-50% of the pre-collapse level. This productivity was associated to good environmental conditions for groundfish, and modest increases in forage species, principally capelin. Since 2013, reduced levels of capelin and shrimp, and near average levels of sandlance, have been observed; the biomass of these forage species are not showing a clear trend. A reduction in total biomass density to ~30% of pre-collapse levels occurred after 2013-2014. Some indications of improvement were observed in 2019-2020, but without a clear trend. More recent information is limited due to lack of Canadian surveys, with Spanish surveys indicating declines after 2020. Although variable, diet composition of key predators suggests reduced contributions of forage species, and average stomach content weights of cod and Greenland halibut have shown declines, suggesting poor foraging conditions.

State of biological diversity

Biological diversity is a multi-faceted concept. Out of its many dimensions, assessment of its state is being limited to Vulnerable Marine Ecosystems (VMEs) and the number of non-commercial fish species considered depleted until more comprehensive approaches can be developed. Although identification and delineation of VMEs is being done, it is difficult to assess their status given the absence of a defined baseline and the unquantified impacts from historical fishing activities. In this context, area and biomass of VMEs are considered to be at similar levels since the start of their assessments in 2016. Differences in estimates in the 2016-2021 period are due to improvements in the evaluation methods and data. Based on 22 non-commercial fish species selected from the multispecies surveys, 60% of the species are above 20% of their historical maximum. This has increased from around 50% in 2016.

MANAGEMENT MEASURES

Precautionary Principles

The NAFO Roadmap addresses sustainability of fishing at three nested levels of ecosystem organization: ecosystem, multispecies and stock levels. At the present time, only considerations at the ecosystem and stock levels are in place. All catches are below the 2TCI ecosystem reference point, indicating that catch levels are consistent with current ecosystem productivity and the prevention of ecosystem overfishing. However, piscivore and suspension feeding benthos catches are above TCI. Piscivore catches have been increasing since 2015. Only 65% of the NAFO managed stocks in the Grand Bank are in conditions of supporting fishing, and some stocks have declining trends or status unknown due to lack of recent survey information. Impacts of either species interactions or environmental drivers are not currently being considered in the provision of stock advice or management.

Minimize harmful impacts of fishing on ecosystems

Minimization of harmful impacts of fishing on benthic communities has been focused on the protection of VMEs. Many coral and sponge VMEs in the Grand Bank are currently protected with dedicated closures, but the 3O coral closure provides no effective protection for the identified VMEs in that area. Closures protect 95% of sponge VME, 38% of sea pen VME, and 87% of large gorgonian coral VME biomass in 3LNO, however only 23% of black coral VME biomass is currently protected by closures for other taxa. Only 2% or less of small gorgonian corals, sea squirts and erect bryozoans VME biomass are protected.

At the ecosystem level, Total Catch Indices (TCI) for functional guilds in this EPU have been developed and an ecosystem reference point (2TCI) has been adopted to inform on the risk of ecosystem overfishing. At the stock level, 80% of managed stocks have LRPs or HCRs, although some LRPs are based solely on survey indices. At this time, there are no multispecies assessments to inform on trade-offs among fisheries.

Assess significance of incidental mortality in fishing operations

Total aggregated discards have shown significant increases in 2018-2021, peaking at ~800 t in 2021. Total discards were highest in the yellowtail flounder fishery, but have been increasing in other fisheries too. As a fraction of total catches, the reported discards in 2016-2021 were less than 5% for the main fisheries (redfish, yellowtail flounder, Greenland halibut, thorny skate). However, Atlantic halibut and white hake fisheries had high discard levels (15-50%) in 2016-2018.

Generally, the incidental catch of wolffish in 3LNO fisheries in 2016-2021 was low (less than 1% of survey biomass), oscillating without trend around 33 t per year. Incidental catches of Greenland sharks oscillated around 60 t per year for the same period. Special protection measures for Greenland shark were adopted in 2022.

OTHER CONSIDERATIONS

Human activities other than fishing

As of 2022, there are four offshore production fields on the Grand Bank and intense exploration activities along the eastern shelf break, oceanic areas off the shelf break, and Flemish Pass. The total area for 3KLMNO of licenses[2] has increased 16.3-fold from 2014 to 2021. There have been 12 reported environmental incidents on the Grand Bank between 2015 and 2022, with a major oil spill in 2018, and one in 2019 that extended into the NRA. A proposed development project in the Flemish Pass overlaps with fishing grounds. It is expected, based on current exploration leases and development projections, that oil and gas exploration activities will continue to increase in the EPU, including the NRA.

The most recent information (up to 2017) indicates that there is low occurrence and density of litter in 3L and fisheries are the primary source from both NAFO-managed and non-NAFO managed fisheries. Data for more recent years has been collected in the EU surveys but has yet to be analyzed. Standardized protocols for litter data collection have been implemented in the EU surveys.

Fisheries not managed by NAFO

Among the fisheries managed by Canada in this EPU, 70% are currently supporting commercial fisheries, and 46% of those have LRPs. Lack of recent survey information represents a challenge for stock-assessments. Swordfish and tuna fisheries operate in this EPU under ICCAT jurisdiction.

Only coral and sponge VMEs are considered for protection under Canadian regulations (classified as Significant Benthic Areas - SiBAs). Among the VMEs present and covered by these regulations most have some level of protection (large and small gorgonians, and sea pens), and one is unprotected (sponges).

References

Cyr, F., P. S. Galbraith, C. Layton, D. Hebert, N. Chen, and G. Han. 2022. Environmental and Physical Oceanographic Conditions on the Eastern Canadian shelves (NAFO Sub-areas 2, 3 and 4) during 2021. NAFO SCR Doc. 22/020. 64p.

Bélanger, D. and F. Cyr. 2022. Environmental indices for NAFO subareas 0 to 4 in support of the Standing Committee on Fisheries Science (STACFIS). NAFO SCR Doc. 22/021. 17p.

Deering, R. L. Gullage, N. Ollerhead, and M. Koen-Alonso. 2022. Supporting analysis and information for the completion of the Grand Bank (3LNO) EPU Summary Sheet. SCR Doc. 22/XX. XXp.

[2] License types: Exploration, Significant Discovery and Production

Flemish Cap (3M) Ecosystem Summary Sheet

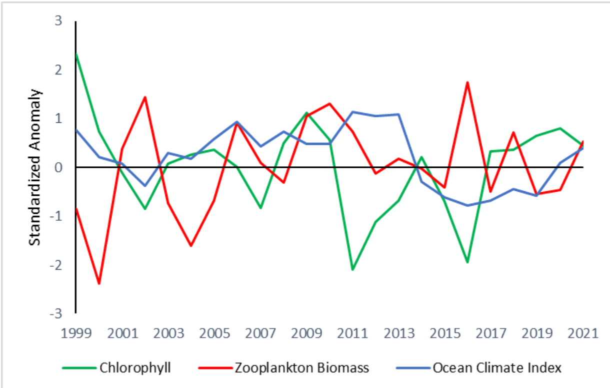
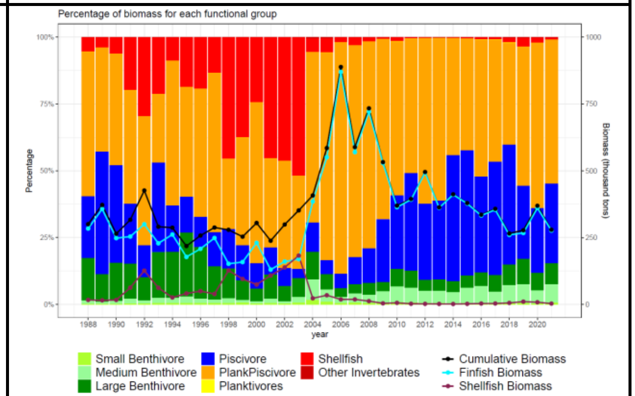
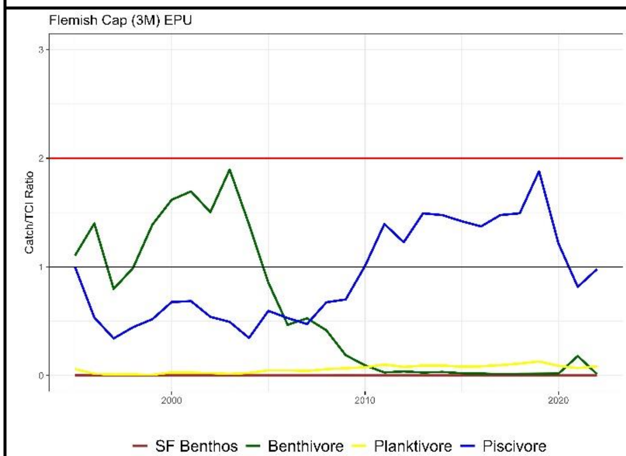
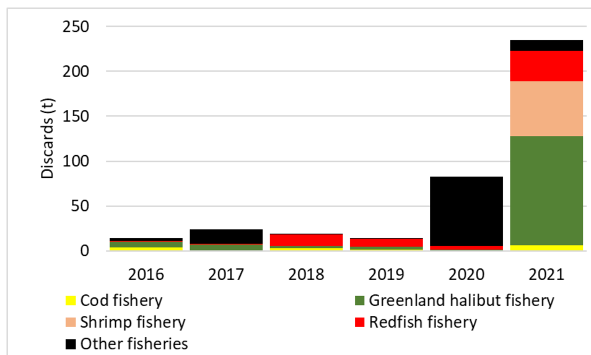
The Flemish Cap (3M) EPU is currently experiencing normal productivity conditions, with total biomass around the long-term level. VME protection in this EPU has improved between 2019 and 2021 with three out of five VME types well protected. Overall catch levels are consistent with current ecosystem productivity and the avoidance of high risk of ecosystem overfishing.

ECOLOGICAL FEATURES					
Convention Principle					**Comment**
A	Ecosystem status and trends (long-term sustainability)		Status (S)	Trend (T)	Summary of multiple trends/state
	1	Physical Environment			Ocean climate index at normal conditions in 2020-2021, after a 5 year period below normal (2015-2019). Clear increasing trend over the last 5 years, from below normal conditions to normal.
	2	Primary Productivity			Chlorophyll at normal level in 2021, after being above normal in 2019-2020. Indices show no clear trend.
	3	Secondary Productivity			Zooplankton biomass generally oscillating within the normal range in 2019-2021. Indices are dominated by cyclic changes with no clear trend.
	4	Fish productivity			Total biomass returned to average levels, after a peak in biomass in 2004-2010 driven by redfish recruitment. Shellfish remains low since the decline in shrimp. Average weight of individuals by functional group in the survey returned to normal range after increases between 2010 and 2017.
	5	Community composition			Community composition has remained relatively stable since 2010.
B	Ecosystem productivity level and functioning		S	T	Summary of multiple trends/state
	1	Current Fisheries Production Potential			Total biomass returned to average levels, after a peak in biomass in 2004-2010 driven by redfish recruitment.
	2	Status of key forage components			Reduced levels of shrimp and juvenile redfish. Trophic interactions between these species and cod are important mechanisms regulating the dynamics of all these species.
	3	Signals of food web disruption			Diet composition appears generally stable over the last decade (since the decline in shrimp). Stomach content weights have been above normal since 2014. However levels are now declining back to normal levels.
E	State of biological diversity		S	T	Summary of multiple trends/state
	1	Status of VMEs			Area and biomass of VMEs are considered to be at similar levels since the start of their assessments. Differences in estimates in the 2016-2021 period are due to improvements in the evaluation methods and availability of data.
	2	Status of non-commercial species			Based on 28 non-commercial species selected from the EU survey, 60% of the species have been above 20% of their historical maximum in 2012-2021. This indicator has

					decreased from around 80% in 2004-2009, but remains above the 40% level observed in 1992-2002.
MANAGEMENT MEASURES					
Convention Principle					**Comment**
C/D	Apply Precautionary Principle		S	T	Summary of metrics on level of management action
	1	Aggregate catches and risk of ecosystem overfishing (2TCI ecosystem reference point)			All catches have been below 2TCI since 1995. Piscivore catches are below 1 TCI in 2021, after been between 1 and 2 TCI during 2011-2020.
	2	Multispecies and/or environmental interactions			A multispecies model with cod, shrimp and redfish has been developed for this EPU. However, it has yet to be incorporated into scientific advice. No explicit consideration of species interactions and/or environmental drivers are currently being used.
	3	Production potential of single species			66% of NAFO managed stocks (four out of six) are in condition of supporting fisheries; some stocks have declining trends.
D/E	Minimize harmful impacts of fishing on ecosystems		S	T	Summary of metrics on level of management action
	1	Level of protection of VMEs			Three out of five VME types with good level of protection, with the exception being sea pens and small gorgonians. Protection has improved between 2019 and 2022. Fishing with bottom contacting gears does not intrude in closed areas.
	2	Level of protection of exploited species			Ecosystem reference point to inform on ecosystem overfishing (2TCI) has been adopted. LRPs or HCRs are available for 50% of managed stocks.
D/F	Assess significance of incidental mortality in fishing operations		S	T	Summary of metrics on level of management action
	1	Discard level across fisheries			Total discards in 3M showed a significant increase (>10-fold) between 2019 and 2021. While the greatest tonnage occurs in the Greenland halibut fishery, increases are observed in other fisheries. In terms of percentage of total catch from a fishery, the reported discards relative to total catch in the 2016-2021 was less or equal to 5% for the main fisheries (cod, redfish and Greenland halibut). Reporting of discards in minor fisheries is highly variable.
	2	Incidental catch of depleted and/or protected species, or other species of conservation interest			By catch of American plaice is a concern for the rebuilding of this stock. Incidental catch of Greenland sharks during 2016-2021 showed increases, going from values at or below 15 t in 2016-2019 to around 24 t in 2020-2021. Special protection measures for this species are in place.

OTHER CONSIDERATIONS (outside mandate of NAFO Convention)					
Human Activities other than fisheries			S	T	Comment
	1	Oil and gas activities			As of 2022, there is intense exploration activities along the Flemish Pass. The total area for 3KLMNO of licenses[3] has increased 16.3-fold from 2014 to 2021. There have been 12 reported incidents between 2015 and 2022 in the Grand Bank, with an oil spill extending into the NRA in 2019. There is anticipated development of the Bay du Nord oil field in the Flemish Pass. This project overlaps with VME areas, a VME closure, and fishing grounds. It is expected, based on current exploration leases and development projections, that oil and gas exploration activities will continue to increase in the NRA.
	2	Pollution			There is no information of the occurrence of litter in 3M. Data has been collected in the EU surveys but has yet to be analyzed. Standardized protocols for litter data collection have been implemented in the EU surveys.
Fisheries not managed by NAFO			S	T	Comment
		Non-NAFO fisheries (coastal states and other RFMOs)			Swordfish and tuna fisheries operate in this EPU under ICCAT jurisdiction.
		Level of protection of VMEs (coastal states and other RFMOs)			Not applicable.

[3] License types: Exploration, Significant Discovery and Production

PHYSICAL ENVIRONMENT AND LOWER TROPHIC LEVELS	FISH COMMUNITY COMPOSITION AND BIOMASS
	
ECOSYSTEM AGGREGATE CATCHES	DISCARDS
	

Selected indicators to illustrate the 3M EPU status. Upper left-hand panel shows anomalies of the 3M subset of the NL Climate Index, chlorophyll-a, and zooplankton biomass index. Upper-right panel shows the relative composition of the fish community by functional groups from EU 3M survey. Lower left-hand panel shows the nominal total catch by functional guilds scaled relative to the corresponding Total Catch Index (TCI: black line; 2TCI: red line). The lower-right panel shows the tonnage of discards (total weight of all species) in each fishery from NAFO haul-by-haul catch reports.

ECOLOGICAL FEATURES

Ecosystem Status and Trends

Ocean climate index is at normal conditions in 2020-2021, after a 5 year period below normal (2015-2019). Clear increasing trend over the last 5 years, from below normal to normal conditions. Chlorophyll-a was at normal level in 2021, after being above normal in 2019-2020, this index has been stable at or above normal since 2017. Zooplankton biomass generally oscillating within the normal range in 2019-2021; this index has been dominated by cyclic changes with no clear trend.

Total fish biomass from the EU survey has been stable through all the period analyzed, despite values above normal in 2004-2009. Fishes have increased their dominance in the community since 2004, with a low proportion of shellfish in the ecosystem. The piscivore functional group experienced low biomass in late 1990s and beginning of 2000s, but since 2009 the level is at or above the level of the beginning of the series.

Average weight of individuals by functional group in the survey returned to normal range after increases between 2010 and 2017.

Ecosystem productivity level and functioning

The Flemish Cap (3M) EPU is experiencing normal productivity conditions. Total biomass returned to average levels, after a peak in biomass in 2004-2010 driven by redfish recruitment. In terms of key forage species, reduced levels of shrimp and juvenile redfish have been observed in this EPU since 2009. Trophic interactions between these species and cod are important processes regulating the dynamics of these species. Diet composition appears generally stable over the last decade (since the decline in shrimp) and stomach content weights have been above normal since 2014, but have been returning to normal levels in recent years.

State of biological diversity

Biological diversity is a multi-faceted concept. Out of its many dimensions, assessment of its state is being limited to Vulnerable Marine Ecosystems (VMEs) and the number of non-commercial fish species considered depleted until more comprehensive approaches can be developed. Although identification and delineation of VMEs is being done, it is difficult to assess their status given the absence of a defined baseline and the unquantified impacts from historical fishing activities. In this context, area and biomass of VMEs are considered to be at similar levels since the start of their assessments in 2016. Differences in estimates in the 2016-2021 period are due to improvements in the evaluation methods and data. Based on 28 non-commercial species selected from the EU survey, 60% of the species have been above 20% of their historical maximum in 2012-2021. This indicator has decreased from around 80% in 2004-2009, but remains above the 40% level observed in 1992-2002.

MANAGEMENT MEASURES

Precautionary Principles

The NAFO Roadmap addresses sustainability of fishing at three nested levels of ecosystem organization: ecosystem, multispecies and stock levels. At the present time, only considerations at the ecosystem and stock levels are in place. A multispecies models for cod, redfish, and shrimp with potential application for management advice has been developed but not yet used. Catches for all functional guilds have been below the 2TCI ecosystem reference point since 1995, indicating that overall catches have been generally consistent with current ecosystem productivity and the prevention of ecosystem overfishing. Catches of piscivores have been between 1 and 2 TCI during 2011-2020 but declined below TCI in 2021. Among NAFO managed stocks, 66% (four out of six) are in condition of supporting fisheries, but some stocks are showing declining trends. Impacts of either species interactions or environmental drivers are not currently being considered in the provision of advice or management.

Minimize harmful impacts of fishing on ecosystems

Minimization of harmful impacts of fishing on benthic communities has been focused on the protection of VMEs. Many coral and sponge VMEs in the Flemish Cap are currently protected with dedicated closures. Closures protect 94% of sponge VME, 59% of sea pen VME, 95% of large gorgonian coral VME, and 76% of black coral VME biomass, but only 8% of small gorgonians VME biomass is currently protected in this EPU.

At the ecosystem level, Total Catch Indices (TCI) for functional guilds in this EPU have been developed and an ecosystem reference point (2TCI) has been adopted to inform on the risk of ecosystem overfishing. At the stock level, 50% of managed stocks have LRPs or HCRs, although some LRPs are based on survey indices. A multispecies model with cod, shrimp and redfish has been developed for this EPU. However, it has yet to be used in management. At this time, there are no multispecies assessments in place to inform on trade-offs among fisheries.

Assess significance of incidental mortality in fishing operations

Total discards showed a significant increase (>10-fold) between 2019 and 2021, going from ~13 t to ~235 t. While the greatest tonnage occurs in the Greenland halibut fishery, increases are observed in all fisheries. In terms of percentage of total catch from a fishery, the reported discards relative to total catch in the 2016-2021 was less or equal to 5% for the main fisheries (cod, redfish and Greenland halibut). Reporting of discards in minor fisheries (e.g. roundnose grenadier, witch flounder) are highly variable and with many reporting no discards.

Incidental catch of Greenland sharks during 2016-2021 also showed increases, going from values at or below 15 t in 2016-2019 to around 24 t in 2020-2021. Special protection measures for this species are in place.

OTHER CONSIDERATIONS

Human activities other than fishing

As of 2022, there is intense exploration activities along the Flemish Pass. The total area for 3KLMNO of licenses[4] has increased 16.3-fold from 2014 to 2021. There have been 12 reported incidents between 2015 and 2022 in the Grand Bank, with an oil spill extending into the NRA in 2019. There is anticipated future development of the Bay du Nord oil field in the Flemish Pass. This project overlaps with VME areas, a VME closure (Area 10, Northwest Flemish Cap), and fishing grounds. It is expected, based on current exploration leases and development projections, that oil and gas exploration activities will continue to increase in the NRA.

There is no information of the occurrence of litter in 3M. Data has been collected in the EU surveys but has yet to be analyzed. Standardized protocols for litter data collection have been implemented in the EU surveys.

Fisheries not managed by NAFO

Swordfish and tuna fisheries operate in this EPU under ICCAT jurisdiction.

References

Cyr, F., P. S. Galbraith, C. Layton, D. Hebert, N. Chen, and G. Han. 2022. Environmental and Physical Oceanographic Conditions on the Eastern Canadian shelves (NAFO Sub-areas 2, 3 and 4) during 2021. SCR Doc. 22/020. 64p.

Bélanger, D., and F. Cyr. 2022. Environmental indices for NAFO subareas 0 to 4 in support of the Standing Committee on Fisheries Science (STACFIS). SCR Doc. 22/021. 17p.

González-Troncoso, D., I. Garrido, C. González, L. Gullage, D. Belanger, F. Cyr and M. Koen-Alonso. 2022. Supporting analysis and information for the completion of the Flemish Cap (3M) EPU Summary Sheet. NAFO SCR Doc. 22/055.

[4] License types: Exploration, Significant Discovery and Production

vii) Re-assessment of previously recommended closures of 7a, 11a, 14a and 14b (request #6a)

***Commission Request #6a**: Complete the re-assessment of its previously recommended closures of 7a, 11a, 14a and 14b, incorporating catch and effort data for fisheries of shrimp from 2020 and 2021 into the fishing impact assessments. This work is needed for the 2023 WG-EAFFM meeting.*

Scientific Council Responded:

The updated assessment by SC concentrated on the consequences of closures 7a, 11a, 14a and 14b specifically on shrimp fishing activities in the Flemish Cap (NAFO Div. 3M) based on data from the 2020-2021 shrimp fishery that were not available when the original analysis of impacts from closures on fishing activities was conducted.

The overlap analysis indicated that closures 7a, 11a, 14a and 14b would have impacted at most 0.8% of the area fished for shrimp and 0.5% of average total catch as reported in 2020-2021, taking into account that these estimates are likely inflated as they are influenced by a single anomalous trawl track that crosses Area 7a.

SC therefore concludes that there is no discernible overlap between the re-assessed closures and the shrimp fishery, and that these 4 closures would have resulted in no discernible losses in catch for the shrimp fishery if they had been in place when the shrimp fishery was prosecuted.

SC **recommends** that *closures 7a, 11a, 14a and 14b remain closed until they are reassessed in 2026 along with the other VME fishery and seamount closures.*

As a request from the Commission (COM), the re-assessment of bottom fisheries in 2021 also included Scientific Council (SC) providing options for improving the protection of Vulnerable Marine Ecosystems (VMEs). These options were summarized in a SC proposal for a system of closures in the NAFO Regulatory Area (NRA) that included keeping existing closures, but with extensions to ten of them, creating three new closures, and modifying one previous closure that had been removed (Area 14). A review of this proposal by COM led to six of the proposed extensions and the modification to Area 14 being adopted. All the extended/modified closures were located in the Flemish Cap (NAFO Div. 3M) and came into effect in January 2022 (NAFO/COM Doc. 22-01, Figure vii.1).

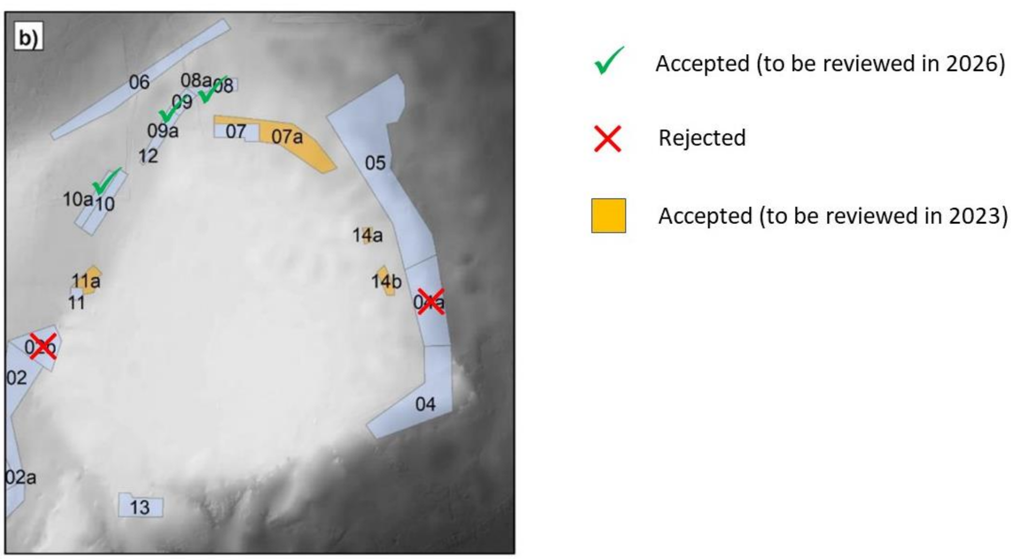


Figure vii.1 Map of VME fishery closures in the Flemish Cap (NAFO Div. 3M), showing those accepted, rejected and subject to additional review following the re-assessment of NAFO bottom fisheries in 2021.

While most closures were adopted for five years, closures 7a, 11a, 14a and 14b (Figure vii.1) were adopted for two years due to concerns that the data from the 2020-2021 3M shrimp fishery was not available at the time of the original analysis, and hence not being included in the SC evaluation of potential impact of the proposed closures on fishing activities. Therefore, the updated assessment by SC concentrated on the consequences of closures 7a, 11a, 14a and 14b specifically on fishing activities and catches for the shrimp fishery that operated in 2020-2021. Analyses were done using two datasets:

- The average annual effort (km.km^{-2} .year^{-1}) for all trawls from tracks derived from VMS pings filtered by speed to 0.5-5 knots from 2010 to 2021.
- The distribution of average catch per distance trawled (kg.km^{-1}) by fish species (including shrimp) based on tracks with associated catches derived from haul-by-haul catches combined with VMS pings based on start and end fishing times of hauls recorded in commercial vessel logbooks from 2020 to 2021.

The shrimp fisheries in 2020-2021 covered 2,575 km^2 and reported haul-by haul catches ranging between 5-14,601 kg. Catches per distance trawled ranged from 0.1-2,704 kg.km^{-1}. Of the closures under review, only Area Closure 7a has a partial overlap with shrimp fisheries. The analysis indicated that this overlap would have impacted 0.8% of the area fished for shrimp and 0.5% of average total catch as reported in 2020-2021 (Table vii.1). While this impact is already very low, these estimates may be artificially inflated. Most of the estimated impact is linked to fishing effort associated to what appears to be an anomalous trawl track, which makes a 90-degree change in direction to cross Area 7a in a northerly orientation perpendicular to other shrimp trawls (Figure vii.2). The part of the track crossing the closure may not represent true fishing effort and the associated catch should potentially be assigned into the part of the track that conforms to the direction taken by other shrimp trawls located outside of the closure. Maps of fishing effort and catch of shrimp for each area are shown in Figures vii.2–4. From this and the data presented in Table Vii.1 it is clear there is no discernible overlap between the re-assessed closures and the shrimp fishery. This implies that these 4 closures would result in no discernible losses in catch for the shrimp fishery.

Table vii.1. Proportion of all fishing effort for trawls between 2010 and 2021, and the effort and catches of the shrimp fishery between 2020 and 2021, occurring in the re-assessed VME fishery closures 7a, 11a, 14a and 14b.

	% of total in NRA				
	Closure 7a*	Closure 11a	Closure 14a	Closure 14b	Total
All trawls 2010-2021 (Speed-filtered VMS)					
Fished area (km^2)	0.50%	0.10%	0.03%	0.03%	0.66%
Effort (km/km^2/year)	0.04%	0.01%	0.00%	0.00%	0.05%
Shrimp trawls 2020-2021*(Logbook-filtered)					
Fished area (km^2)	0.80%	0%	0%	0%	0.80%
Catch (kg/km)	0.50%	0%	0%	0%	0.50%
All trawls 2020-2021 (Logbook-filtered)					
Fished area	0.14%	0.03%	0%	0%	0.17%
Total catch	0.08%	0.01%	0%	0%	0.09%

*The values for fished area and catch for shrimp include what appears to be an anomalous trawl track which crosses Area 7a in a northerly orientation perpendicular to other shrimp trawls (see Figure vii.2.b). Including this trawl may artificially inflate the estimates.

a) b)

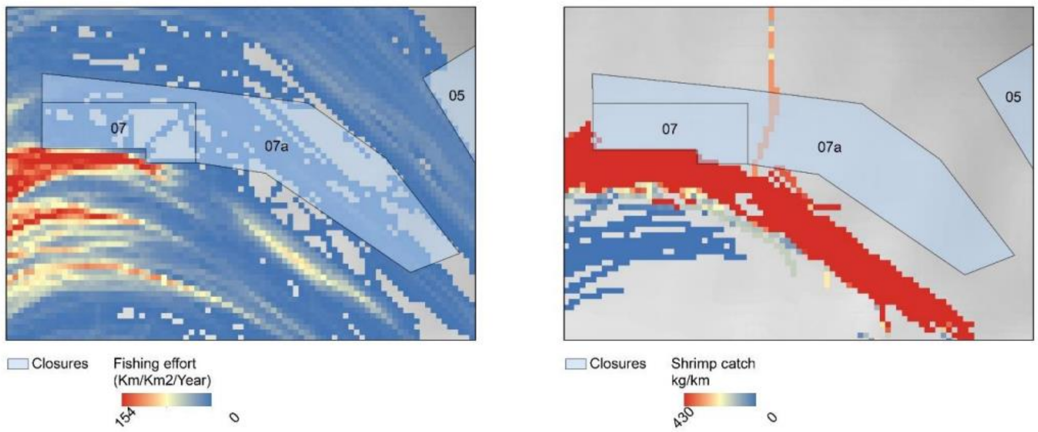


Figure vii.2. Overlap of Area Closures 7 and 7a with (a) average yearly effort (km.km^{-2} year^{-1}) from 2010-2021 by trawl fisheries; and (b) mean shrimp catch (kg.km^{-1}) from 2020-2021.

a) b)

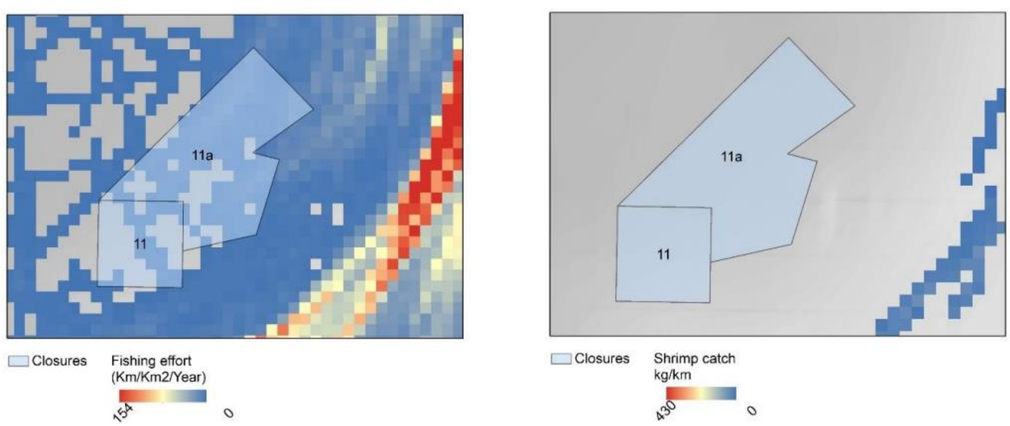


Figure vii.3. Overlap of Area Closures 11 and 11a with (a) average yearly effort (km km^{-2} year^{-1}) from 2010-2021 by trawl fisheries; and (b) mean shrimp catch (kg km^{-1}) from 2020-2021.

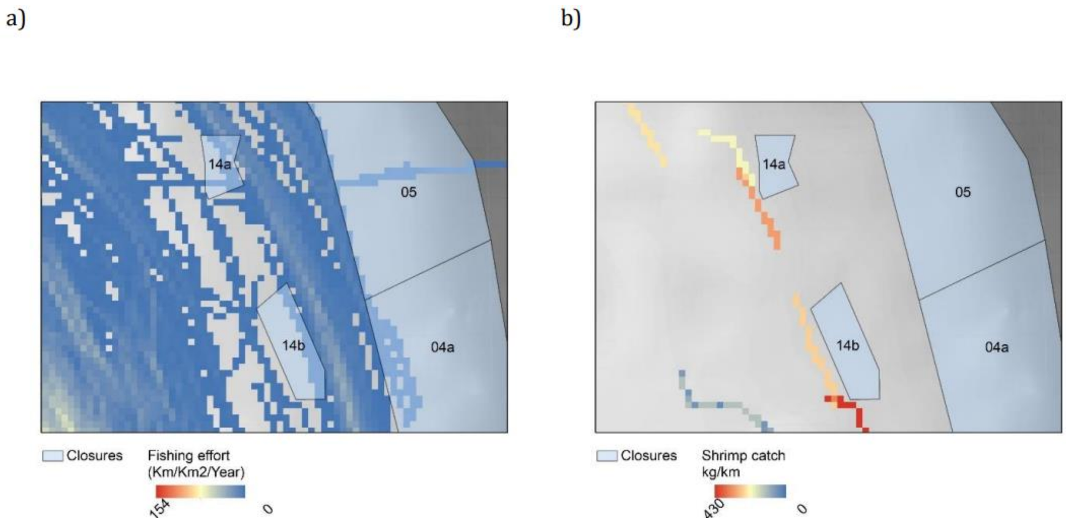


Figure vii.4. Overlap of Area Closures 14a and 14b with (a) average yearly effort (km km^{-2} year^{-1}) from 2010-2021 by trawl fisheries; and (b) mean shrimp catch (kg km^{-1}) from 2020-2021.

viii) Support the Secretariat in creating standardized data layers (request #6b)

Commission Request 6b: *Support the Secretariat in creating standardized data layers (using GIS), and products with supporting documentation (including metadata) for periodic reassessment purposes required to support the implementation of the NAFO Roadmap towards an Ecosystem Approach.*

Scientific Council responded:

SC established a data sub-group including the Secretariat to (i) develop a list of standard data products and procedures, including metadata, (ii) develop and maintain a NAFO geodatabase and (iii) prepare new fishing effort and integrated fishing effort/logbook data as required, to support the implementation of the NAFO EAF roadmap.

The identified standard data products and procedures developed by SC correspond to VME data, VMS data, fishing effort calculations, catch data and spatial analysis methods. In addition, SC continues to work with the secretariat to develop a centralized data repository using ArcGIS online to host the data and data-products for scientific advice.

Standardized GIS data layers

SC established a data sub-group including the Secretariat to (i) develop a list of standard data products and procedures, including metadata, (ii) develop and maintain a NAFO geodatabase and (iii) prepare new fishing effort and integrated fishing effort/logbook data as required, to support the implementation of the NAFO EAF roadmap.

SC has identified a number of standard 'core' data sets and products to be routinely updated and made available to NAFO users through an online geodatabase. These include trawl survey data annually updated for (i) full fish and invertebrate data, (ii) VME indicator species biomass, and (iii) functional group biomass. Trawl survey products include VME polygons and VME biomass to be updated when required to support periodic VME and fisheries re-assessment tasks, and annually updated products related to (a) VMS fishing effort beginning in 2010, (b) fishing effort integrated logbook/VMS data beginning in 2019, (c) the distribution of annual catches of commercially caught fish species beginning in 2010 using daily catch records and beginning in 2019 using haul by haul logbook data, and (d) haul by haul logbook data beginning in 2016. In addition, SC continues to work with the Secretariat to develop a centralized data repository using ArcGIS online to host the data and data-products for scientific advice.

SC also considered a timeline for the annual cycle of data collection from the scientific trawl surveys conducted by the EU (Spain, Portugal) and Canada (DFO NL) (Figure viii.1). In addition, the SC data sub-group will continue to explore the use of *R Markdown* as a means of standardizing reporting and assisting in data quality control (QC) and ensuring appropriate access to and usage of the data, and respecting privacy restrictions. There will also need to be discussion of how the data is to be maintained in the future.

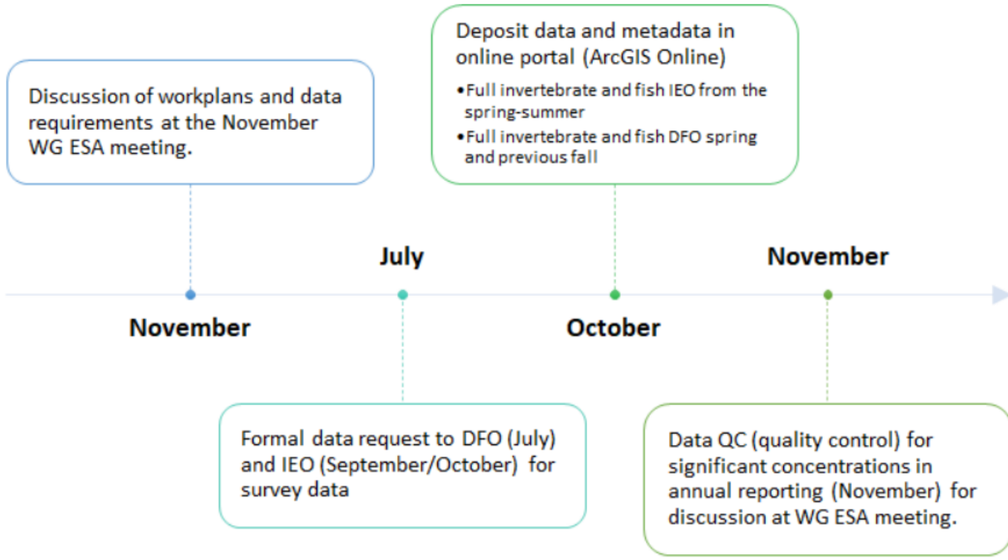


Figure viii.5. Data submission protocol. Action points and timelines for the annual cycle of data collection from the scientific surveys when it is to be used by WG-ESA.

Spatial analysis methods

The Data Sub-group agreed that all gridded data for rasters will be presented with a cell resolution of 1 km. When vector data for a polygon shape needs to be extracted from the raster data surface, the position of the grid cell centroid shall be used to determine whether or not a grid cell is included within or outside of the polygon as shown in Figure viii.2.

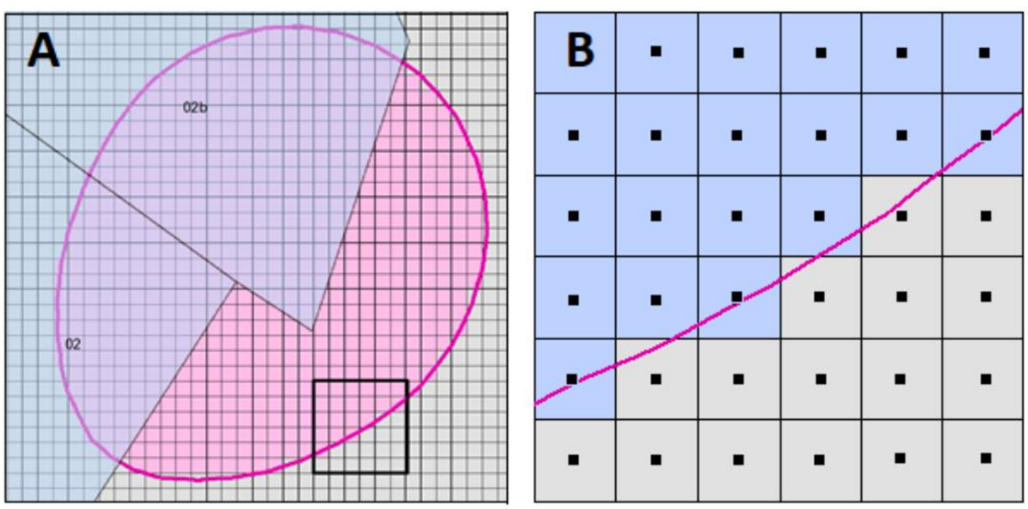


Figure viii.6. a) Illustration of the overlay of a polygon with a grid layer. Such overlays occur bet the VME polygons and the gridded biomass surfaces in recent work. b) Enlargement of the inset shown in a) in black outline showing how the decision to include the data in the grid cell in the estimate for the polygon is made. Grid cells with a centroid (black square) falling within the polygon perimeter are included in the data extraction for the polygon (blue cells) while those whose centroid lies outside of the polygon perimeter are excluded (grey cells).

The data sub-group is also exploring new methods to improve the accuracy of the VMS derived fishing effort layers, notably through the use of length of track, depth and fishing vessel directional changes, to supplement and improve the current speed filter approach. In particular, track directional change analysis may help to exclude erroneous track data such as that identified in the reassessment of Area 7a VME fishery closure.

ix) Operational objectives for the protection of VMEs and biodiversity in the NRA (request #6c).

***Commission Request #6c**. Continue working with WG-EAFFM towards developing operational objectives for the protection of VMEs and biodiversity in the NRA.*

Scientific Council responded:

SC agreed to use the internationally recognized definitions for ecosystem level (i) goals, (ii) objectives, (iii) targets and (iv) indicators, often used within assessment and management frameworks to evaluate performance (Table ix.1).

SC **recommends** that *the Commission considers approving the presented framework for ecosystem objectives and the continued development of objectives, targets and indicators.*

The implementation of the NAFO ecosystem roadmap necessitates developing long-term plans with clear priorities and objectives, in addition to having the means to monitor and assess progress towards those goals and objectives as part of a management process or framework. An example of such a management framework is presented in Figure ix.1 and the corresponding terms are defined in Table ix.1.

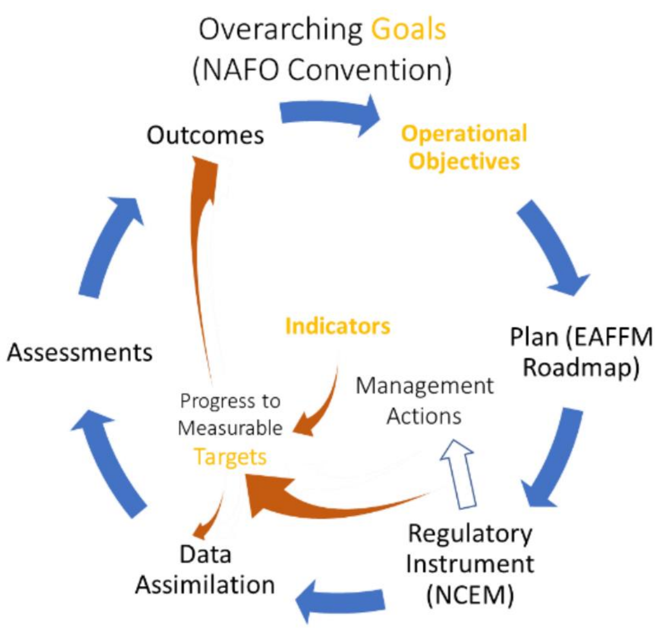


Figure ix.7. A simplified representation of a management process or framework setting goals and objectives that can proceed to implementation of policy and management actions, indicating the role of NAFO plans and regulations in developing a strategic approach and overseeing outcomes through measurable targets and the application of indicators (adapted from Tunnicliffe et al., 2020).

Table ix.2. Definition of terms typically used to track organizational performance with respect to management processes and frameworks (after Ehler, 2014).

Term	Definition
Goal	A statement of general direction or intent. Goals are high level statements of the desired outcomes to be achieved.
Objective	A specific statement of desired outcomes that represent the achievement of a goal.
Target	An interim point on the way to an outcome and eventually to a long-term management goal.
Indicator	A quantitative or qualitative statement or measured parameter that can be used to measure the effects of specific management actions over time.

The focus of discussions in SC was in relation to the work undertaken on the identification and mapping of VME (SCS 19/25) and the assessment of SAI (SCS 20/23).

The principle of setting environmental goals and objectives is demonstrated in several international fora, e.g. United Nations Fish Stocks Agreement (UNFSA), Convention on Biological Diversity (CBD), United Nations Conference on Sustainable Development (UNCSD). However, significant challenges remain on agreement of the specific indicators to assess performance relative to the targets and objectives set in these agreements – and this is also a challenge for the principles outlined in the NAFO Convention.

SC agreed to the framework definitions as outlined in Table ix.2, which are internationally recognized by the Intergovernmental Oceanographic Committee of United Nations Educational, Scientific and Cultural Organization (UNESCO) (Ehler, 2014), and the operational objective framework shown in Figure ix.1.

Specifically, in relation to ecosystem-based fishery management, Link (2010) proposes 5 goals that are clearly relevant to the work of NAFO, and which map well onto the primary elements (and Tiers) of the NAFO ecosystems roadmap and the principles of the NAFO Convention as shown in Table ix.2.

Table ix.3. The relationship between EBFM goals as identified by Link (2010) and the primary elements (and Tiers) of the NAFO ecosystem roadmap and the NAFO Convention principles.

EBFM Goals	NAFO Ecosystem Roadmap	NAFO Convention Principles
Prevent overfishing	Tiers 1 to 3	b, c, f
Protect critical, sensitive species and habitats	VME closures & by-catch measures	d, i
Conserve biodiversity	VME closures	d, e. i
Maintain trophic resilience	Tiers 1-2 & VME closures	d, e, i
Maximise societal benefits (subject to the previous goals).	Tier 3 & all elements	a, b

Establishing targets related to the current metrics used in NAFO to assess SAI and prevent ecosystem overfishing were considered by SC appropriate starting points for setting operational objectives, but it was also acknowledged that this does not represent everything that could be included and of relevance in ensuring positive biodiversity outcomes. Therefore, SC agreed that further discussion and analyses will be required to establish suitable quantitative targets (or reference values) to achieve a low risk of SAI. At this stage, SC considered that providing quantitative details of the current operational indicators in the framework (Table ix.3) was not appropriate, since the framework has yet to be formerly approved by the Commission.

Table ix.4. Proposed operational objectives for the protection of biodiversity and prevention of ecosystem overfishing in the NRA.

Overarching Goal[11]	*Goal*[12]	*Objective*[13]	*Target*[14]	*Indicator*[15]
Apply an ecosystem approach to fisheries management and safeguard the marine ecosystems in the NRA	Protect and conserve biodiversity and ecosystem integrity and functioning in the NRA	Protect and conserve biodiversity at levels that can maintain 'baseline' ecosystem-integrity, structure, and function.	Achieve low risk of SAI	Risk level of SAI
	Prevent ecosystem overfishing	Maintain ecosystem-level fishing pressure at sustainable levels	Achieve low risk of ecosystem overfishing	TCI
NAFO Convention Text		NAFO Convention Article II – Objective: Long-term conservation and sustainable use of fishery resources.	Article III – General Principles: (e) take due account of the need to preserve marine biological diversity, (b) adopt measures based on the best scientific advice available	

[11] Statement of intent – from the NAFO Convention text.
[12] Desired outcome.
[13] Specific desired outcome.
[14] A measurable point on the way to an outcome, for TCI these targets have been set and for VME we have the proportion of biomass protected.
[15] A measured parameter used to assess the effects of management actions against targets and objectives – e.g. TCI and VME biomass

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x) Review of the NAFO PA Framework (request #7)

Request #7 (Commission priority): *The Commission requests Scientific Council to continue progression on the review of the NAFO PA Framework in accordance to the PAF review work plan approved in 2020 and revised in 2022 (NAFO COM-SC Doc. 20-04), specifically:*

a. Develop a small set of revised PA frameworks based on the conclusions of the first PA Framework workshop to inform RBMS in proposing a draft revised framework in 2023; and

b. Apply in an illustrative way the revised PA frameworks to selected NAFO stocks, and consider how the SC advice may have differed under the revised PA Frameworks to inform RBMS in proposing a draft revised framework in 2023.

Scientific Council responded:

SC developed three alternative PA frameworks and carried out an exercise to illustrate alternative advice for cod Div. 3M, yellowtail flounder Divs. 3LNO and redfish Div. 3M stocks.

Some of the lessons that can be learned from the exercise are as follows:

- When distribution-based estimates of B_{buffer} and F_{target} render values too close to their corresponding limits, the effectiveness of these reference points within the PA is lost.
- The alternative qualitative advice depends on the length of the period used to evaluate the risk of biomass decrease.
- One of the advantages of alternative frameworks is that the specific objectives for each zone allow for clearer and easier provision of science advice.
- In the Safe Zone the alternative catch advice depends exclusively on how F_{target} is estimated in the alternative frameworks.
- Some flexibility would be desirable in the implementation of future frameworks for some species.
- Option 3, originally intended to be more precautionary than the alternatives, was the less precautionary result given the choices made for its implementation.

These results will be presented to WG-RBMS for further discussion in July.

a) Develop a small set of revised PA frameworks based on the conclusions of the first PA Framework workshop to inform RBMS in proposing a draft revised framework in 2023.

SC at its March 2023 meeting approved three alternative PA frameworks (SCS Doc. 23/11) with their corresponding management actions to inform WG-RBMS in proposing a draft revised framework in 2023. The three alternative frameworks decided by the SC were based on the PA Framework workshop conclusion (NAFO/COM-SC Doc. 22-07) to establish F_{target}, as well as the possible implementation of an intermediate biomass reference point or multiple biomass reference points between B_{lim} and B_{msy}. Two frameworks were approved with one operational biomass reference point between B_{lim} and B_{msy}, and a third framework with two operational biomass reference points between B_{lim} and B_{msy} was also approved.

SC also agreed on the stocks to which these frameworks will be applied (cod Div. 3M, redfish Div. 3M and yellowtail flounder Divs. 3LNO) and discussed the possible reference points or proxies values to use in the alternative frameworks. Agreement was not reached at that point on the reference points that should be used in the alternative frameworks for the redfish Div. 3M stock. At the June 2023 SC meeting, another proposal for possible proxies to be used in the alternative frameworks of this stock was presented based on SSB. SC has proposed proxies of reference points based on total biomass to be applied to test the alternative PA framework on redfish (SCR 23/25). Some difficulties were detected in the estimation of the possible reference point proxies to be used in the alternative frameworks in the case of redfish. These difficulties may illustrate future problems in the implementation of the frameworks to all NAFO stocks. As stated in the conclusions of the workshop, some flexibility would be desirable in the implementation of future frameworks for some species.

The three alternative frameworks were presented at the WG-RBMS meeting in April 2023 (NAFO/COM-SC Doc. 23-02). The WG-RBMS noted a preference to revise the terminology of the framework zones from Collapse, Danger, and Safe, to Critical, Cautious, and Healthy, respectively. There was also a suggestion to change the name of the Overfishing Zone, to the Risk of Overfishing Zone, noting that there is a specific definition of overfishing that may have legal implications. The SC agreed to change the names of the Collapse, Danger, and Safe zones to the names proposed in the WG-RBMS. Regarding the name of the Overfishing Zone, SC did not support the proposed name change to the Risk of Overfishing Zone. There was some discussion about potential alternative names but no suitable replacement was agreed upon.

SC considers that the Zones of the framework should be focussed on the status of the stock without attempting to describe named fishing zones. Fishing pressure should be a management action informed by the status of the stock.

Another suggestion is that qualitative management actions based on stock rebuilding should prescribe the time period over which that rebuilding is to be observed.

The SC also considered that future frameworks may include the possibility of fishing above F_{target} or F_{lim} for short periods when the biomass is well above B_{msy}.

The SC considers that some examples of the implementation and testing of future frameworks should consider stocks assessed by trends based on survey indices.

b) Apply in an illustrative way the revised PA frameworks to selected NAFO stocks, and consider how the SC advice may have differed under the revised PA Frameworks to inform RBMS in proposing a draft revised framework in 2023.

The alternative PA frameworks were applied to three NAFO example stocks (cod Div. 3M and yellowtail flounder Divs. 3LNO (SCR 23/23) and redfish in Div. 3M (SCR 23/25)) using information available from their most recent assessments. Catch advice under each alternative was compared to the most recent approved advice.

In the case of cod Div. 3M, two different sets of advice were presented for each of the alternative frameworks. One based on the risk from one-year projections and the other based on the risk from two-year projections. The stock trajectory for cod of last SC approved assessment placed the 2021 estimate F and SSB in the Danger Zone in the Option 1 and 2 and in the Recovery Zone in the Option 3 of the framework alternatives. The original F and catch advice and those produced by the alternative frameworks in these zones are presented in Table x.1.

The alternative qualitative advice depends on the length of the period used to evaluate the risk of biomass decrease. In general, the advice based on a) qualitative evaluation of risk over a two-year period and b) HCR, give catch levels similar to the original advice. On the other hand advice based on qualitative evaluation of risk over a one-year period gives lower catch levels than the original advice.

One of the advantages of alternative frameworks is that the clarity of the objectives in the zones allows for clearer and easier provision of science advice.

The stock trajectory for yellowtail flounder placed the 2020 estimate of relative F and relative Biomass in the Safe Zone of all three PA framework alternatives. In this Zone, the qualitative and HCR management actions are the same for the three alternative frameworks and indicate that advice should be framed to maintain F equal or below F_{target}. The original F and catch advice and those produced by the alternative frameworks in the safe Zone are presented in Table x.2.

The original advice from the last assessment was based on the risk of F greater than F_{lim} is equal to or less than 30%, and the risk that the biomass is less than B_{lim} is equal to or less than 10% at the end of the projection period. Alternative frameworks' management action are based on F levels equal to or less than F_{target}, so the alternative catch advice depends largely on how F_{target} is estimated in the alternative frameworks. If F is estimated from the distribution of F_{lim}, the estimated value of F_{target} is quite close to F_{lim} and gives a higher catch level than the original advice. Alternatively if F_{target} is defined as 75% F_{msy}, the alternative catch level is lower than the original advice which corresponded to 85% F_{msy}.

In the case of redfish Div. 3M, the last SC approved assessment placed the stock in the Safe Zone in all three alternative frameworks. The original advice was made based on F0.1 which in the alternative frameworks was decided to be the F_{lim} proxy and therefore a lower F level was chosen for the F_{target} (0.75 F_{lim}). The alternative frameworks' management measures in the Safe Zone are based on F levels equal to or less than F_{target}, so the alternative catch advice, as is also the case for yellowtail flounder, depends exclusively on how F_{target} is estimated in the alternative frameworks. In this case study, an F level equal to or less than 75% of the level advised in the original advice (F_{lim}=F0.1) was chosen

Some of the lessons that can be learned from the exercise are as follows:

- When distribution-based estimates of B_{buffer} and F_{target} render values too close to their corresponding limits, the effectiveness of these reference points within the PA is lost. This needs to be considered when reference points are chosen. This needs to be considered when reference points are chosen.

- The alternative qualitative advice depends on the length of the period used to evaluate the risk of biomass decrease.
- One of the advantages of alternative frameworks is that the clarity of the objectives in the zones allows for clearer and easier provision of science advice.
- In the Safe Zone the alternative catch advice depends exclusively on how F_{target} is estimated in the alternative frameworks.
- Some flexibility would be desirable in the implementation of future frameworks for some species.
- Option 3, originally intended to be more precautionary than the alternatives, was the less precautionary result given the choices made for its implementation.
- Because two of the case studies (3M redfish and 3LNO yellowtail flounder) were in the Safe zone, the advice did not change among the options and depended exclusively on the F target chosen. The differences in management between the three options are only seen in the Danger zone so only the 3M cod advice changes between options.

Table x.1. Cod Div. 3M fishing mortality and catch advice for 2023 approved by the SC in 2022 (2022 adv), and qualitative advice of Option 1 looking at risk in 2024 (Qualitative_2024) or 2025 (Qualitative_2025) and applying the HCR.

Option 1	2022_adv	Qualitative_2024	Qualitative_2025	HCR
F_adv	0.089	0.049	0.098	0.104
TAC_adv	5 791	3 314	6 319	7 666
Option 2	2022_adv	Qualitative_2024	Qualitative_2025	HCR
F_adv	0.089	0.049	0.098	0.074
TAC_adv	5 791	3 314	6 319	5 668
Option 3	2022_adv	Qualitative_2024	Qualitative_2025	HCR
F_adv	0.089	0.041	0.089	0.087
TAC_adv	5 791	2 807	5 764	6 540

Table x.2. Yellowtail flounder Divs. 3LNO fishing mortality and catch advice in tons for 2022-2024 period approved by the SC in 2022 (Original Adv.), and the F and catch advice in tons for the same period under the alternative frameworks.

	F (22-24)	TAC 2022	TAC 2023	TAC 2024
Original Adv.	85% F_{msy}	22 100	20 800	19 900
Options 1, 2 and 3	F_{target} _75% F_{msy}	19 500	18 800	18 300
Options 1, 2 and 3	F_{target} _95% F_{msy}	24 760	22 790	21 500

Table x.3. Redfish Div. 3M fishing mortality and catch advice in tons for 2022-2023 period approved by the SC in 2022 (Original Adv), and the F and catch advice in tons for the same period under the alternative frameworks.

HCR	F	TAC 2022	TAC 2023
Original advice	0.067	10.9	11.2
Option 1	0.050	8.3	8.8
Option 2	0.050	8.3	8.8
Option 3	0.050	8.3	8.8

xi) 3-5 year work plan (request #8)

Commission request #8: *The Commission requests Scientific Council to update the 3-5 year work plan, which reflects requests arising from the 2022 Annual Meeting, other multi-year stock assessments and other scientific inquiries already planned for the near future. The work plan should identify what resources are necessary to successfully address these issues, gaps in current resources to meet those needs and proposed prioritization by the Scientific Council of upcoming work based on those gaps.*

Scientific Council responded:

SC updated the 2023-2024 annual plan and identified resource gaps and priorities.

The plan includes annual requests from the Commission, including stock assessments and other scientific inquiries (e.g. from specific Contracting Parties for straddling stocks). The plan also includes work to address SC advice of its own accord.

SC reiterated that because there is no dedicated NAFO funding source for scientific research, the activities are subject to Contracting Party allocations that may not be stable/guaranteed. SC work continues to fall to a small number of scientists who are over-burdened with requests, and the workload issue remains unmanageable.

Currently there are two unfilled positions, STACFIS chair and a Designated Expert for the ecosystem summary sheets.

Carrying out analyses and providing advice in the context of multiple survey gaps has and will continue to add significant workload for assessments, MSEs and ecosystem analyses.

SC plans to organize its work commensurate to its capacity during the September meeting. This would also include assessing COM requests and prioritizing them based on its ability to get the work done.

SC updates and reviews the plan each June and September to include all requests with prioritization and rationale where appropriate as well as the resources required to respond to the requests.

While this plan will be reviewed and updated twice a year, SC emphasized the importance of stability in the work plan, i.e. that new requests should be clearly justified as they will have impact on delivering existing work plan items.

The work plan was first requested by the Commission in 2018 in response to Scientific Council concerns over increased workload. SC identified an increase in requests as well as an increased number of SC and WG meetings in recent years. These increased demands have made it exceedingly difficult to fully address all requests over the year. It was also noted that the requests in recent years are not only more numerous but more complex and with increased scope.

SC reiterates that the work plan would facilitate a more concrete discussion of trade-offs between effort dedicated to scientific activities, including addressing new versus the current/strategic requests. This rarely happens because the work falls to a small number of scientists who are overburdened with recurring requests, often pressured to deliver, and therefore are incapable of delivering on new, strategic requests. This is in addition to other daily work they do unconnected to NAFO.

SC plans to organize its work commensurate to its capacity during the September meeting. This would also include assessing COM requests and prioritizing them based on its ability to get the work done.

The 3-5 year workplan is not detailed - detailed plans are developed in working group specific work plans. The current approach is a 5-year plan that allows for a high-level view of activities planned for the next 5 years, with annual plans in which resource gaps and priorities will be addressed.

The plan includes requests from the Commission from the annual meeting, including stock assessments and other scientific inquiries (e.g. requests from coastal states). The plan also includes requests SC has made of its own accord. SC reiterated that where there is no dedicated NAFO funding source for scientific research, the activities are subject to Contracting Party allocations that may not be stable/guaranteed. The position of STACFIS chair will need to be filled and will be addressed in September 2023. Additionally, SC has created two additional ecosystem level designated expert positions as a first step towards supporting Roadmap work. One of the positions remains vacant (the other is temporarily filled) and SC requests help in filling this/ese position/s specifically and augmenting ecosystem expertise more generally.

Carrying out analyses and providing advice in the context of multiple survey gaps added significant workload for assessments, MSEs and ecosystem analyses at the June 2023 SC meeting. This issue is expected to continue in the medium term.

xii) Presentation of any new results from stock assessments and the scientific advice of pelagic Sebastes mentella (ICES Divisions V, XII and XIV; NAFO 1) (request #9)

Deferred until September due to lack of time.

xiii) Include any new Canadian stock assessments for cod 2J3KL (Canada), witch flounder 2J3KL (Canada) as an annex to the SC's annual report (request #10)

No new information was available.

xiv) Ongoing analysis of the Flemish Cap cod fishery (request #11)

Commission request #11: *The Commission requests Scientific Council, jointly with the Secretariat, to conduct ongoing analysis of the Flemish Cap cod fishery data by 2023 in order to:*

> *a. monitor the consequences of the management decisions (including the analysis of the redistribution of the fishing effort along the year and its potential effects on ecosystems, the variation of the cod catch composition in lengths/ages, and the bycatch levels of other fish species, benthos in general, and VME taxa in particular); and*
>
> *b. carry out any additional monitoring that would be required, including Div. 3M cod caught as bycatch in other fisheries during the closed period.*

Scientific Council responded:

After the implementation of the technical measures, changes have been observed in the size and age composition of the catches. The decrease in small sizes and young ages in trawler catches could be related to the sorting grids. The rest of the observed changes are more difficult to interpret and associate with any of the technical measures.

In addition to the technical measures implemented since 2021, substantial reductions in TAC of Div. 3M cod were made. This may affect the results of this analysis. In order to assess the effects of the technical measures, a longer observation period is needed. An updated analysis will be provided in 2025, consistent with the two-year advice interval previously defined.

In 2020 the Commission adopted technical measures, in force since January 2021, to try to protect the productivity of Division 3M cod stock. These measures included the closure of the directed fishery of the 3M cod during the first quarter of the year, as well as the mandatory use of sorting grids in the trawl fishery directed to this stock. In 2020 and 2021 the Commission requested SC to monitor the consequences of the implementation of these technical measures. In response to these requests, the SC agreed on the aspects to be studied before and after implementation to monitor the consequences of these measures.

Haul by haul data provided by the NAFO Secretariat have been used to study the situation in the cod directed fisheries and in the fisheries catching cod as bycatch before (2016-2020) and after (2021-2022) the measures were in place (SCR Doc. 23/011). Trawl hauls recorded as having negative effort or effort of more than 24 hours are removed from this analysis.

Prior to 2021, most of the cod catches from the directed fisheries were taken in the first quarter and in the east and southwest of the bank for the longliners and in the southwest for the trawlers. Since 2021 catches are mainly taken in the second quarter and they are concentrated in the central part of Flemish Cap bank for the longliners and in the southwest of Flemish Cap for the trawlers. Longline catches in 2022 include catches taken in the 2022 Faroes longline survey/fishery, and this may introduce some bias to the results from that year. Almost 100% of the cod catches made with longline gear, both before and after the technical measures were implemented, occurred in hauls targeting cod. In the case of cod catches from trawl hauls targeting cod, the percentage dropped from over 96% in the 2016-2020 period to 85-88% in the 2021-2022 period. In both longline and trawl directed fisheries, the percentage of catches and effort inside the VME polygons in 2021-2022 showed clear reductions from the levels in 2016-2020.

The bycatch of cod in the longline fisheries is negligible in the whole period 2016-2022. Cod bycatch in trawl fisheries increased significantly after the technical measures were implemented, mainly in 2022. No major change has been observed in the spatial-temporal pattern of sets catching cod as bycatch before and after the implementation of the technical measures. The impact on VMEs of longline sets catching cod as bycatch is minimal in both periods. Regarding the trawl hauls catching cod as bycatch, it should be noted the increase in effort carried out within the VME polygons of sponges and large gorgonians in the southwestern part of the Flemish Cap in 2022. Most of this bycatch is from the redfish fishery.

After the implementation of the technical measures, the proportion of intermediate lengths (42-54 cm) and ages (4-5 years) in the longline catches increased, while the proportion of larger individuals (>99 cm) decreased. In the trawl fishery, the proportion of smaller sizes (<45 cm) and the younger ages (1-3) decreased after the implementation of the technical measures.

While there are clear differences before and after the implementation of the technical measures, the general reduction in 3M cod TACs in 2021-2022 may confound the effect of the technical measures. In order to better understand the consequences of the implementation of technical measures, a longer period of data after implementation needs to be analyzed in future studies.

xv) Potential impact of activities other than fishing in the Convention Area (request #12).

Commission Request#12. *The Commission requests Secretariat and the Scientific Council with other international organizations, such as the FAO and ICES to inform the Scientific Council's work related to the* *potential impact of activities other than fishing in the Convention Area. This would be conditional on CPs providing appropriate additional expertise to Scientific Council.*

Scientific Council responded:

SC reiterates its prior advice that there are a number of activities occurring in the NRA (especially oil and gas) which have spatial overlap with NAFO bottom fisheries, NAFO closures and VMEs, and have the potential to impact fisheries resources and the ecosystem. These activities have increased in recent years.

Information on "activities other than fishing" (e.g. trends, spatial location, overlapping with fisheries, VMEs and closed areas, and potential impacts) will continue to be included in the Ecosystem Summary Sheets.

Geographical location of oil and gas activities in the NRA is publicly available from several sources. Conversely, information on the assessment of potential impacts of such activities, as well as mitigation measures, is scarce or difficult to obtain.

SC also notes that current expertise within WG-ESA in particular, and SC in general, is insufficient to allow SC to assess the long-term impacts of these activities on fisheries resources, VMEs and the wider marine ecosystem.

SC requests access to the data and analysis from monitoring programs of oil and gas activities from Contracting Parties.

SC also reiterates that CPs provide expertise in evaluation of marine environmental impacts of activities other than fishing (e.g. oil and gas).

SC acknowledges the value of the recently approved NEREIDA project by providing updates on the available information on the activities other than fishing (namely oil and gas and also marine litter).

Update on oil and gas activities

The issue of the potential impacts of activities other than fishing, is a matter of continuing concern in NAFO (NAFO, 2018, 2019, 2020, 2021). In 2022 (NAFO, 2022a), SC reiterated its prior advice that "*there are a number of activities occurring in the NRA (especially oil and gas) which appear to have significant spatial overlap with NAFO bottom fisheries, NAFO closures and VMEs, and have the potential to impact fisheries resources and the ecosystem. These activities have increased in recent years*". As documented in the scientific literature, routine oil and gas activities can have detrimental environmental effects during each of the main phases of exploration, production, and decommissioning (Cordes *et al*., 2016).

Environmental effects include impacts from routine operational activities such as drilling waste and produced water discharges (Neff *et al*., 2011; Neff *et al*., 2014), accidental discharges and spills (e.g. Cordes *et al*., 2016), long-term impacts on deep sea corals (e.g., Girard and Fisher, 2018) and impacts on deep-sea sponges and their associated habitats (Vad *et al*., 2016). The spatial information presented to the SC was obtained through a review of publicly available data sources[5], including a report (Equinor, 2020) on a development project located in the Flemish Cap ("*Bay du Nord Development Project*").

Spatial location of oil and gas activities and potential conflicts

An updated map of the geographical location of oil and gas activities in NAFO Divs. 3LNM was presented to SC (Figure xv.1) including new spatial data (licenses and wells) that was available during 2022 year. In comparison with the information assessed previously reported by the WG-ESA (Durán Muñoz and Sacau, 2021; NAFO, 2021), there are two new exploration wells in Division 3L, one of them located inside NAFO fishing grounds. In the map, the yellow star indicates the location of the proposed production installation within the "Bay du Nord Development Project" in the Flemish Pass (outlined in blue). SC noted that some of the exploration and proposed production activities related to this project, appear to have significant spatial overlap with NAFO bottom fisheries (Divisions 3L and 3M), VMEs (Division 3M) and NAFO closure No 10 (Division 3M):

[5] Available data was collected mainly from the Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) and the Impact Assessment Agency of Canada (IAAC).

- <u>Overlap and potential conflicts between oil and gas activities and NAFO fisheries</u> (e.g. reduction of fishing opportunities, ecosystem impacts, etc.), particularly in Division 3M, in the northern part of the project area where there is overlap between a "Significant Discovery Licence" (and their associated wells) and NAFO fishing grounds (see Figure xv.1), in an area where the Greenland halibut bottom trawl fishery takes place[6] (NAFO, 2020).
- <u>Overlap and potential conflicts between oil and gas activities, VMEs and VME Area closure No 10</u> (e.g. impacts on VMEs). It is worth noting that the overlap with VMEs and closed areas in Division 3M has increased substantially in recent years (Figure xv.2) due to both the increase in the number of licenses (i.e. Significant Discovery Licenses) and the expansion of Area closure No 10, implemented by NAFO (NAFO, 2022b). Moreover, there has also been an increase in the number of exploration wells within the project area, and some of them are located inside fishing grounds, VMEs or a VME closed area (Figure xv.2). This may have implications in relation to the potential OECM submission for bottom fishing closed area 10.

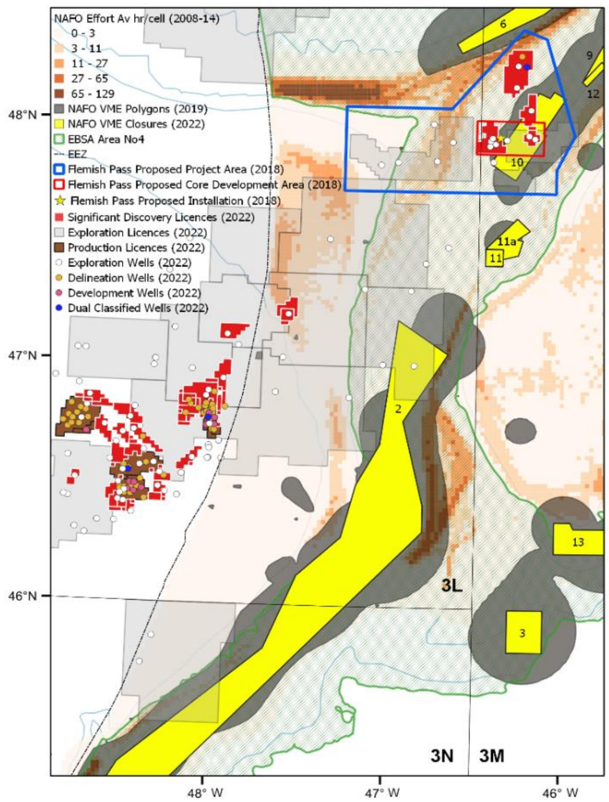

Figure xv.1. Updated map showing the geographical location of oil and gas activities in NAFO Divs. 3LMN. The map shows the potential conflict areas between different users of the marine space (e.g. oil and gas vs. fisheries) and between users and the marine environment (oil and gas vs. VMEs). The yellow star indicates the location of the proposed production installation within the "*Bay du Nord Development Project*" in the Flemish Pass (outlined in blue). The available spatial information on oil and gas activities (licences and wells) – at the reporting date, November 2022 – is noted in brackets (2022). Sources: NAFO, CNLOPB and CBD.

[6] Detailed maps of the footprint of the Greenland halibut trawl fishery (GHL-OTB-3LMNO) are available in the 2020 WGESA report

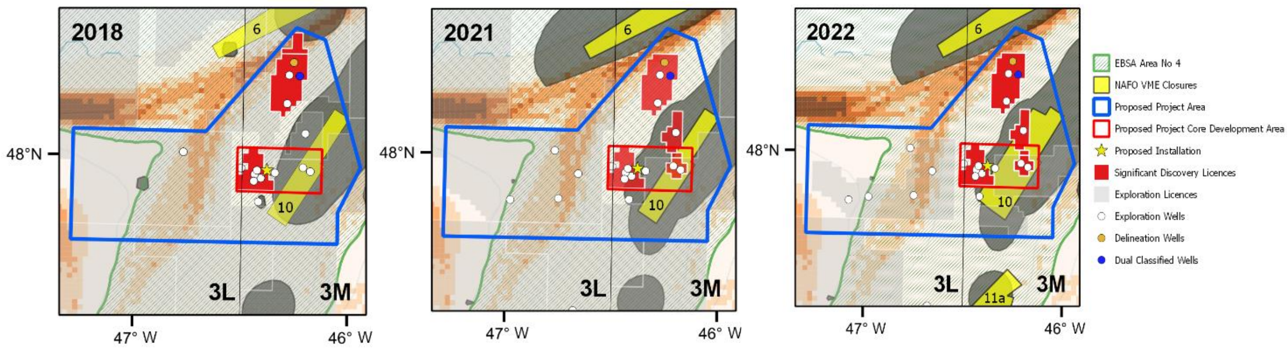

Figure xv.2. "*Bay du Nord Development Project*". Evolution over time of the degree of overlap between oil and gas activities, VMEs and VME Area closure No 10 (2018 -2022). There has been an increase in overlap due to both the increase in the number of Significant Discovery Licenses and the expansion of Area closure No 10. In addition, the number of exploration wells within the project area has also increased.

Another issue of concern presented to the SC is the overlap between oil and gas activities and NAFO groundfish surveys (e.g. restriction of sampling area and depth) and its potential effects on survey indices (e.g. abundance and biomass) and VMEs monitoring. Figure xv.3 shows the survey strata (Doubleday, 1981; Bishop, 1994) potentially affected by the oil and gas project in Division 3L (strata 731, 732, 733, 734, 745, 746 and 747; depths from 367 to 1280m) and Division 3M (strata 528, 529, 530, and 532; depths from 732 to 1463m). The location of survey hauls (EU and EU-Spain surveys) during the period 1988-2021 was also presented to SC.

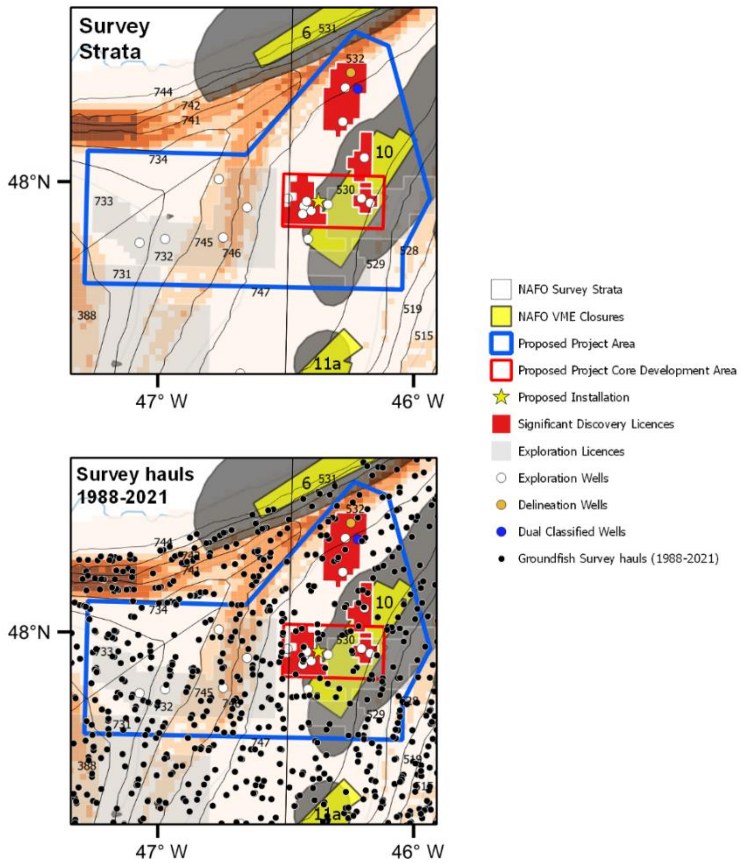

Figure xv.3. "*Bay du Nord Development Project*". The map shows the potential conflicts between oil and gas activities and groundfish surveys conducted in Divisions 3L and 3M, based on survey stratification and data from EU and EU Spain surveys (start position of survey hauls, period 1988-2021).

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2. Coastal States

a) Request by Denmark (on behalf of Greenland) for advice on management in 2024 of certain stocks in Subareas 0 and 1 (Annex 2)

Requests for management advice from Denmark (on behalf of Greenland) are presented in Annex 2 of Appendix V. Advice on stocks for which interim monitoring was requested is given in section 3c. below. Advice on *Pandalus borealis* is deferred to the September Scientific Council/NIPAG meeting.

The Scientific Council responded:

Demersal redfish and deep-sea redfish (*Sebastes* spp.) in Subarea 1

Advice June 2023 for 2024 and beyond

Recommendation for 2024 and beyond

Scientific Council advises that there should be no directed fishery until a significant improvement in stock status is detected.

Management objectives

No explicit management plan or management objectives have been defined by the Government of Greenland.

Management unit

These two species are managed together as a single unit. Survey data reveal an almost continuous distribution of both species from East Greenland to West Greenland; both areas had geographically distinct fisheries historically. However, the degree of connectivity between the two areas is unknown.

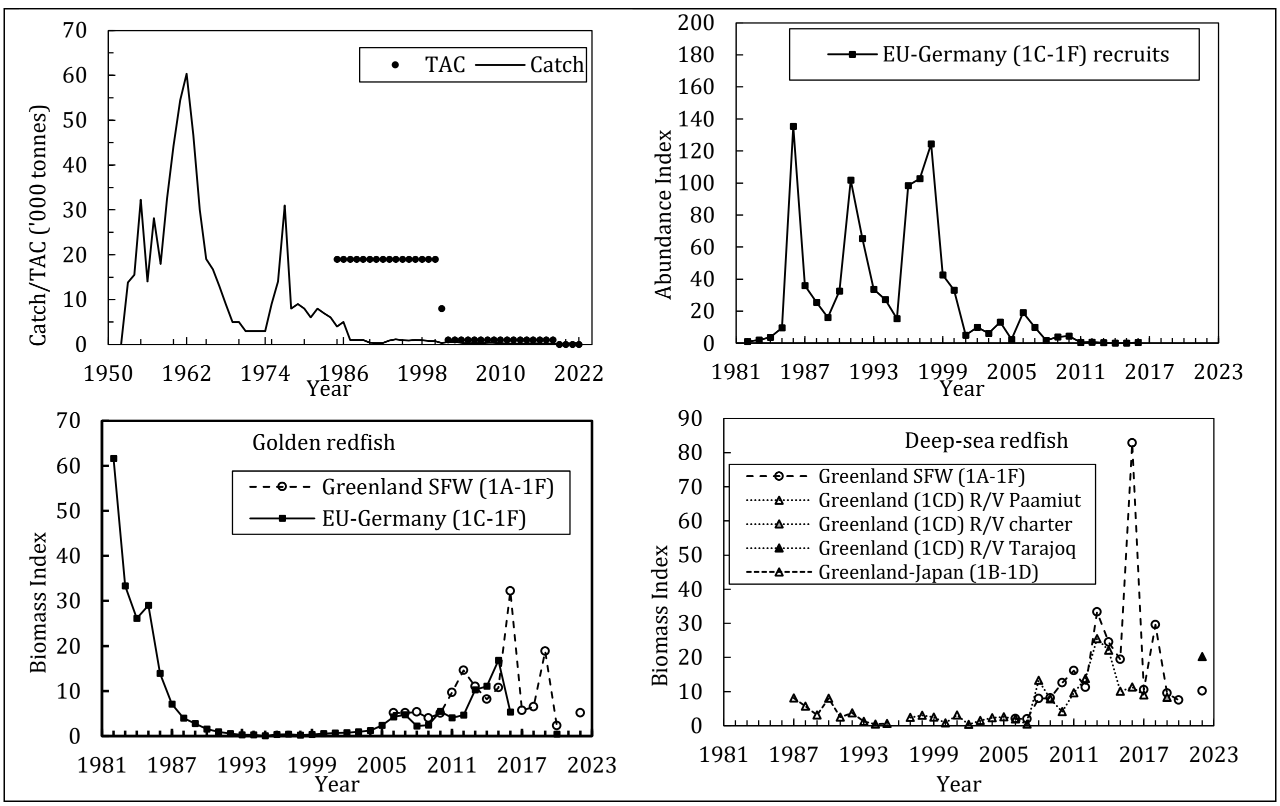
Stock status

Golden redfish

Survey indices indicate that the biomass remains far below historical levels. Recruitment is unknown. Fishing mortality is unknown, however recent catch levels of commercially sized redfish are low.

Deep-sea redfish

Biomass is slowly decreasing. Recruitment is unknown. Fishing mortality is unknown, however recent catch levels of commercially sized redfish are low.



Reference points

Could not be established.

Assessment

No analytical assessment was performed. The assessment was based upon a qualitative evaluation of survey indices, length composition in surveys, and historic fishery. The assessment is considered data-limited and with relatively high uncertainty, as surveys do not fully cover the distribution of the stock.

This stock will be monitored by interim monitoring report until such time as monitoring suggests a change in stock status.

Human impact

Mainly fishery related mortality. Other mortality sources (e.g. pollution, shipping, oil-industry) are undocumented.

Environmental impact

Unknown

Biological and environmental interactions

There is no integrated summary information available on the structure, status and trends of the marine ecosystem for the area inhabited by this stock.

Ecosystem sustainability of catches

Redfish is included in the piscivore guild. There are currently no Ecosystem Production Units defined nor TCI information for the distribution area of this stock.

Fishery

There is currently no significant directed fishery in West Greenland. Recent landings of redfish are bycatches taken in other fisheries: mainly longline, gillnet or jigging in the inshore and coastal areas, and trawl in the offshore areas.

The proportions of golden and deep-sea redfish in the historic catches are unknown. The catches of redfish peaked in the 1960s at 60 000 tonnes, but gradually decreased during the 1970s and 1980s. A significant unreported bycatch of redfish was likely taken during the 1980s and 1990s in the fishery targeting shrimp. With the implementation of sorting grids in the shrimp fishery in 2002, catches and bycatch of redfish are considered to be very low.

Recent catch estimates ('000 tonnes) are as follows:

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TAC	1	1	1	1	1	0	0	0	0	0
STATLANT 21	0.25	0.19	0.16	0.23	0.19	0.10	0.21	0.36	0.26	
STACFIS	0.17	0.26	0.17	0.24	0.19	0.14	0.20	0.26	0.29	

Sources of Information
SCR Doc. 20/052 23/012 013, 020; SCS Doc. 23/14.

Wolffish in Subarea 1 Advice June 2023 for 2024-2026

Recommendation for 2024 – 2026

Atlantic wolffish: The Scientific Council advises that there should be no directed fishery and bycatch should be kept to the lowest possible level.

Spotted wolffish: The Scientific Council advises that the TAC should not exceed mean catches from the period 2012 to 2015 when indices were increasing for both stocks. This corresponds to a catch of 775 tonnes.

Management objectives

No explicit management plan or management objectives have been defined by the Government of Greenland.

Management unit

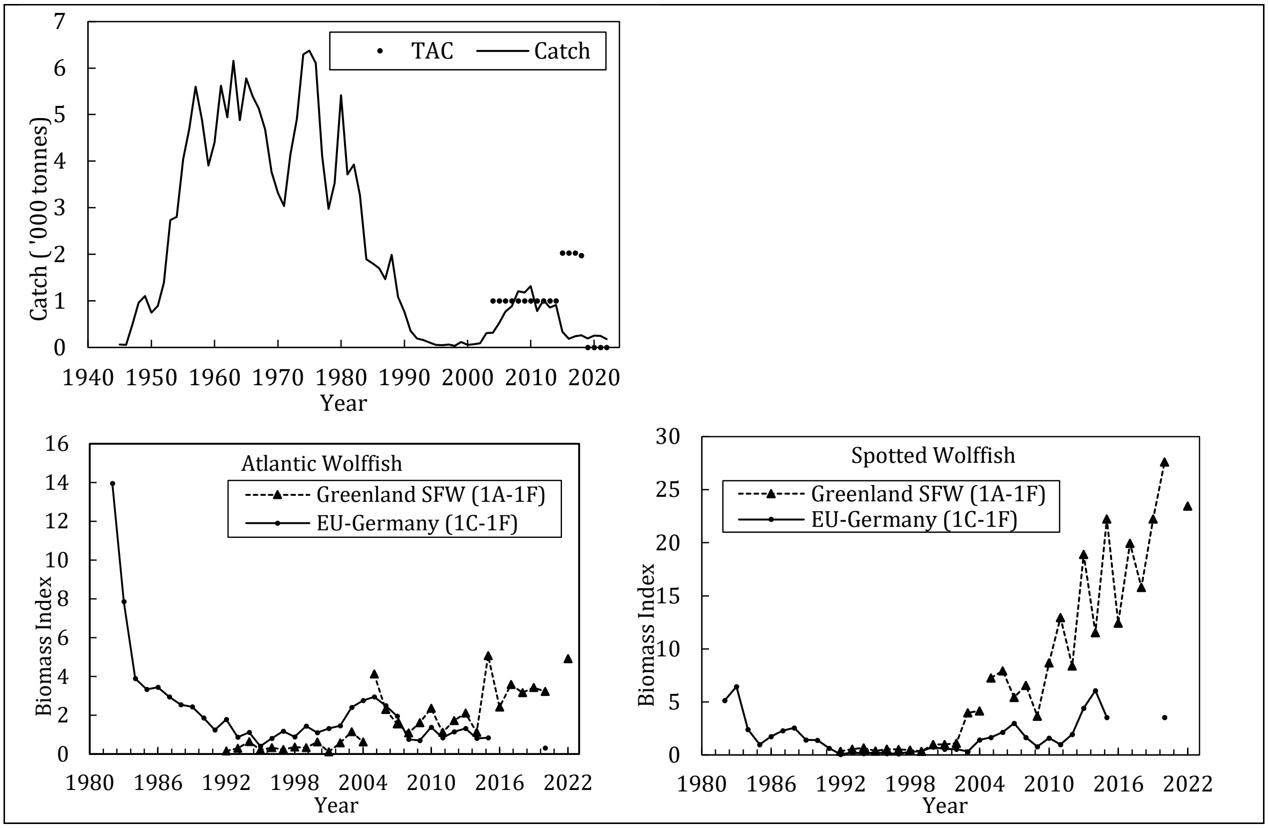
Atlantic wolffish is known to be more connected to the offshore banks in South and West Greenland and is considered a single unit.

Spotted wolffish is found in all areas both inshore and offshore, but is known to be the dominant species of wolffish in the coastal regions and the fjords in South, West and North Greenland. It is presumed to be a single stock.

Stock status

Atlantic wolffish: The biomass remains below the higher level of the 1980s. Recruitment and fishing mortality are unknown.

Spotted wolffish: Biomass in recent years is close to the higher levels observed in the early 1980s. Recruitment and fishing mortality are unknown.



Reference points

No reference points have been defined.

Assessment

No analytical assessment was performed. The assessment is based upon a qualitative evaluation of survey indices, length composition in surveys, and fishery data. The assessment is considered data limited and with relatively high uncertainty, as surveys do not fully cover the distribution of the stock.

The next assessment will be in 2026.

Human impact

Mainly fishery related mortality. Other mortality sources (e.g. pollution, shipping, oil-industry) are undocumented.

Biological and environmental interactions

There is no integrated summary information available on the structure, status and trends of the marine ecosystem for the area inhabited by this stock.

Ecosystem sustainability of catches

Wolffish is included in the piscivore guild. There are currently no Ecosystem Production Units defined nor TCI information for the distribution area of this stock.

Fishery

Wolffish are primarily taken as a bycatch in other fisheries. The commercial fishery for wolffish in West Greenland occurred from the 1950s to 1979 with catches of around 5 000 t per year. After 1980, the cod fishery gradually stopped in West Greenland and catches of wolffish also decreased during this period. In 2022, 165 t of wolffish was landed to factories mostly taken as bycatch in inshore small boat fisheries and 10 t was reported from offshore vessels.

Recent catch estimates ('000 tonnes) are as follows:

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Atlantic wolffish TAC		1.0	1.0	1.0	1.0	0	0	0	0	0
Spotted wolffish TAC		1.0	1.0	1.0	1.0	0	0	0	0	0
Wolffish TAC	1.0	2.0	2.0	2.03	2.0	0	0	0	0	0
STATLANT 21	0.9	0.4	0.2	0.2	0.3	0.2	0.2	0.2	0.2	
STACFIS	0.9	0.4	0.2	0.2	0.3	0.2	0.2	0.2	0.2	

Special comments

The ICES HCR for data limited stocks, which was previously used to provide advice for spotted wolffish, is no longer considered appropriate for this stock.

The two species are not usually separated in the landings. Given the different status of the Atlantic and spotted wolffish stocks, SC **recommends** *speciation of the landings for these two species*.

Sources of Information

SCR Doc. 20/056, 23/020 and; SCS Doc. 23/14.

b) Request by Canada and Denmark (Greenland) for Advice on Management in 2024 (Annex 2, Annex 3)

Requests for management advice from Canada and Denmark (on behalf of Greenland) are presented in Annex 2 and 3 of Appendix V. Advice on stocks for which interim monitoring was requested is given in section 3c. below. Advice on *Pandalus borealis* is deferred to the September Scientific Council/NIPAG meeting.

Greenland halibut in Subarea 0+1 (offshore)

Request by Canada and Denmark (Greenland): *Advice on Greenland Halibut, Offshore in Subareas 0 and 1 was provided in 2022 for the 2023 and 2024 fishing seasons. The Scientific Council is asked to evaluate whether the data collected in 2022 is sufficient to reconsider the harvest recommendation for 2024. If so, the Scientific Council is requested to provide updated advice on appropriate TAC levels for 2024, taking the new data into account.*

Scientific Council responded:

The main surveys for Greenland halibut 0+1 Offshore in 2022 were carried out using a new vessel and gear. These data are not calibrated to the previous survey series and therefore, insufficient to update advice on appropriate TAC levels for 2024.

The advice from 2022 is as follows:

The main index for this stock has not been updated since 2017, consequently stock status is increasingly uncertain. However, SC notes that the stock varied without trend between 2013-17 while the fishery was increasing. Average catches during this period were 29 640 t; therefore, SC recommends catches not to exceed this value in 2023 and 2024.

Data collected during 2022 have been evaluated by the SC. A survey series started in 2022 with a new vessel R/V Tarajoq, also using a new trawl gear (Bacalao 476). The deep surveys in Subarea 0 (expanded survey area in 2022 to include Division 0B and 0A-South) and Divisions 1CD were conducted; unfortunately, no comparative experiments between the different vessels and gears could be performed, as the former vessel R/V Paamiut was retired following the 2017 surveys.

Survey abundance and biomass indices were calculated but cannot be put into context with preceding data to examine trends. A model-based calibration (Huynh and Carruthers 2023) of survey data will be further explored for application with the current survey series, including validating using data from historic comparative towing experiments in other DFO regions. This work is expected to inform the scheduled 2024 assessment of this stock.

The new Bacalao trawl is expected to have different catchability from the previous Alfredo trawl used with the R/V Paamiut. The survey length frequency distribution has a similar range to preceding years, but relative catchability at length between the new and old gear is unknown. Higher numbers of small fish were observed in the catch, likely because of the change to using a Bacalao trawl, which has a smaller mesh size than the previous Alfredo trawl. A Stochastic Surplus Production Model In Continuous Time (SPICT; SRC Doc 23/031) that uses as input catches the combined deep-survey 0A-1CD index (1999-2017, and the 2019 index with uncertainty), and the shallow 1AF survey index of the biomass of fish > 35 cm was presented. SC noted concerns regarding the biomass scaling, especially at the start of the time series, raised questions about some parameter estimates (e.g. r), and suggested that priors be investigated further. The model was not accepted but model development is continuing.

NAFO SC determined that there is not sufficient new information from the 2022 surveys in Subareas 0 and 1 to reconsider the harvest recommendation for 2024. The SPICT model and model-based calibration work showed promise and will be developed further for the 2024 assessment.

Reference:

Huynh, Q.C., and Carruthers, T. 2023. Development of Spatial Operating Models to Test Survey Design and Calibrate a New Survey Index for Northwest Atlantic Fisheries Organization Subarea 0+1 (offshore) Greenland Halibut (*Reinhardtius hippoglossoides*). DFO Can. Sci. Advis. Sec. Res. Doc. 2023/038. iv + 35 p.

c) Monitoring of Stocks for which Multi-year Advice was provided in 2021 or 2022

Interim monitoring updates of these stocks were conducted and Scientific Council reiterates its previous advice as follows:

Recommendation for Greenland halibut in Division 1A inshore – Disko Bay for 2023-2024: Scientific Council advises that the TAC in 2023 and 2024 should not exceed 5 215 t.

Recommendation for Greenland halibut in Division 1A inshore - Uummannaq for 2023-2024: Scientific Council recommends that TAC in 2023 and 2024 should not exceed 5 153 t.

Recommendation for Greenland halibut in Division 1A inshore - Upernavik for 2023-2024: Scientific Council recommends that catch should not exceed 6 070 t.

Recommendation for Greenland halibut in Subarea 0+1 (offshore) for 2023 and 2024: The main index for this stock has not been updated since 2017, consequently stock status is increasingly uncertain. However, SC notes that the stock varied without trend between 2013-2017 while the fishery was increasing. Average catches during this period were 29 640 t, therefore, SC recommends catches not to exceed this value in 2023 and 2024.

VIII. REVIEW OF FUTURE MEETINGS ARRANGEMENTS

1. Scientific Council and STACFIS Shrimp Assessment Meeting, 13 – 15 September 2023

The Scientific Council and STACFIS Shrimp Assessment meeting will be held in Vigo, Spain, 13-15 September 2023.

2. Scientific Council, 18 to 22 September 2023

The Scientific Council September 2023 meeting will be held in Vigo, Spain, 18-22 September 2023.

3. WG-ESA, 14- 23 November 2023

The Working Group on Ecosystem Science and Assessment will meet at the NAFO Secretariat, Halifax, Nova Scotia, Canada, 14- 23 November 2023.

4. Scientific Council, June 2024

The Scientific Council June meeting will be held in Halifax, Nova Scotia, 31 May -13 June 2024.

5. Scientific Council (in conjunction with NIPAG), 2024

Dates and location to be determined.

6. Scientific Council, September 2024

Scientific Council noted that the Annual Meeting will be held in September in Halifax, Nova Scotia, unless an invitation to host the meeting is extended by a Contracting Party.

7. NAFO/ICES Joint Groups

a) NIPAG, 2024

Dates and location to be determined.

b) ICES – NAFO Working Group on Deep-water Ecosystem

Dates and location to be determined.

c) WG-HARP

Dates and location to be determined.

8. Commission- Scientific Council Joint Working Groups

a) WG-EAFFM

The joint Commission- Scientific Council Working Group on the Ecosystem approach to Fisheries Management (WG-EAFFM) will be held in Edinburgh, United Kingdom, 21-22 July 2022

b) WG-RBMS

The joint Commission- Scientific Council Working Group on Risk Based Management Systems (WG-RBMS) will be held in Edinburgh, United Kingdom, 17-20 July 2022.

c) CESAG

The next meeting of the Catch Estimation Strategy Advisory Group (CESAG) will be in Spring 2024.

IX. ARRANGEMENTS FOR SPECIAL SESSIONSOPICS OF FUTURE SPECIAL SESSIONS

No topics for future special sessions of SC were discussed.

X.MEETING REPORTS

1. Working Group on Ecosystem Science and Assessment (WG-ESA), 15-24 November 2022- SCS Doc. 22/25

The report of the meeting of the Working Group on Ecosystem Science and Assessment (WG-ESA), held at the NAFO Secretariat, Halifax, Nova Scotia, during 15-24 November 2022, was presented by its co-Chairs Mar Sacau Cuadrado (EU) and Andrew Kenny (UK).

2. Report from ICES-NAFO Working Group on Deepwater Ecosystems (WG-DEC), 16-20 May 2022

To be presented in September.

3. Meetings attended by the Secretariat

To be presented in September.

XI.REVIEW OF SCIENTIFIC COUNCIL WORKING PROCEDURES/PROTOCOL

1. General Plan of Work for September 2023 Annual Meeting

No new issues were raised that will affect the regular work plan for the September meeting.

XII.OTHER MATTERS

1. Designated Experts

The list of Designated Experts can be found below:

From the Science Branch, Northwest Atlantic Fisheries Centre, Department of Fisheries and Oceans, St. John's, Newfoundland & Labrador, Canada

Cod in Div. 3NO	Rick Rideout	rick.rideout@dfo-mpo.gc.ca
Redfish Div. 3O	Laura Wheeland	laura.wheeland@dfo-mpo.gc.ca
Redfish Div. 3LN	Andrea Perreault	andrea.perreault@dfo-mpo.gc.ca
American Plaice in Div. 3LNO	Katherine Skanes	katherine.skanes@dfo-mpo.gc.ca
Witch flounder in Div. 3NO	Dawn Maddock Parsons	dawn.parsons@dfo-mpo.gc.ca
Yellowtail flounder in Div. 3LNO	Dawn Maddock Parsons	dawn.parsons@dfo-mpo.gc.ca
Greenland halibut in SA 2+3KLMNO	Paul Regular	paul.regular@dfo-mpo.gc.ca
Northern shrimp in Div. 3LNO	Nicolas Le Corre	Nicolas.LeCore@dfo-mpo.gc.ca

From the Instituto Español de Oceanografia, Vigo (Pontevedra), Spain

Roughhead grenadier in SA 2+3	Fernando Gonzalez-Costas	fernando.gonzalez@ieo.csic.es
Splendid alfonsino in Subarea 6	Fernando Gonzalez-Costas	fernando.gonzalez@ieo.csic.es
Cod in Div. 3M	Irene Garrido Fernández	irene.garrido@ieo.csic.es
Northern Shrimp in Div. 3M	Jose Miguel Casas Sanchez	mikel.casas@ieo.csic.es

From the Instituto Nacional de Recursos Biológicos (INRB/IPMA), Lisbon, Portugal

American plaice in Div. 3M	Ricardo Alpoim	ralpoim@ipma.pt
Golden redfish in Div. 3M	Ricardo Alpoim	ralpoim@ipma.pt
Redfish in Div. 3M	Ricardo Alpoim (provisional)	ralpoim@ipma.pt

From the Greenland Institute of Natural Resources, Nuuk, Greenland

Demersal Redfish in SA1	Rasmus Nygaard	rany@natur.gl
Wolfish in SA1	Rasmus Nygaard	rany@natur.gl
Greenland halibut in Div. 1 inshore	Rasmus Nygaard	rany@natur.gl
Northern shrimp in SA 0+1	AnnDorte Burmeister	anndorte@natur.gl
Northern shrimp in Denmark Strait	Tanja B. Buch	TaBb@natur.gl
Greenland halibut in SA 0+1	Adriana Nogueira	adna@natur.gl

From Knipovich Polar Research Institute of Marine Fisheries and Oceanography (PINRO), Russian Federation

Capelin in Div. 3NO	Konstantin Fomin	fomin@pinro.ru

From National Marine Fisheries Service, NEFSC, Woods Hole, Massachusetts, United States of America

Northern Shortfin Squid in SA 3 & 4	Lisa Hendrickson	lisa.hendrickson@noaa.gov
Thorny skate in Div. 3LNO	Katherine Sosebee	katherine.sosebee@noaa.gov
White hake in Div. 3NO	Katherine Sosebee	katherine.sosebee@noaa.gov

2. Election of Chairs

Alfonso Pérez (EU) was appointed as co-Chair of WG-ESA, replacing Andrew Kenny (UK).

3. Budget items

Scientific Council considered the draft budget for 2024 provided by the Secretariat and noted the following:

i. The postponed IFS Flatfish symposium is expected to be held in 2024, so the allocation of funding to sponsor this event should be carried over from 2023.
ii. SC endorsed a proposal to fund Mariano Koen-Alonso to attend the World Fisheries Congress in 2024.
iii. The ICES/FAO/NAFO deep seas symposium is expected to take place in early 2025, so funds will be required to be spent in 2024 and 2025.
iv. SC requested the Secretariat to provide a firm budget for the ArcGIS online account set up in response to Commission Request 6b.

4. Other business

a) Implications of Missing Survey Data

SC notes that recent survey gaps, along with incomplete vessel calibrations for some of the Canadian surveys, are impacting our ability to provide advice and advance requests. This issue is also negatively impacting efficiency at SC and leading to increased workload. These problems will continue over the near to medium term, in part linked to the multi-year assessment schedule, and to the SC capacity required to produce additional work.

Results of ongoing analyses will be presented to SC in September and an update provided to the Commission at that time. Regardless of results, significant data limitations have been identified and impacts to SC's ability to provide advice are expected.

Survey Data Availability

In recent years, there have been considerable interruptions to the usual availability of scientific survey data available to SC to conduct its research and to address Commission Requests. While the Covid-19 pandemic introduced a short-term gap in many data streams from both commercial fisheries (e.g. catch sampling) and fisheries-independent surveys, these were temporary issues with impacts that could largely be overcome. More substantially, there have been significant interruptions in the availability of Canadian scientific survey data over 2020-2023. This survey dataset is crucial to the work of SC, as it underpins the assessment of many stocks and the resultant harvest advice, as well broader issues such as providing historical VME biodiversity, and biomass trends for Ecosystem Summary Sheets. Further, the EU-Spain survey conducted in Div. 3L (NRA) has not been undertaken since 2019, and in Div. 3NO (NRA) was incomplete in 2020. A summary of recent survey data availability used by SC to assess stocks managed by the Commission shows unprecedented gaps in completion (Table 1). A lack of data is most acute for the Grand Bank (Divs. 3LNO), with multiple missing data points in recent years.

Canada (SCR 23/40) reported continuing to work through a period of transitioning to new research vessels while older vessels are to be retired. A fundamental requirement for this process is to conduct calibration studies between the new and old ships so that historic time-series can be continued. Although this work is continuing, there have been vessel challenges which have impacted the completion of the calibration work, and has also prevented annual surveys from being completed.

Table 1. Availability of fisheries-independent survey data for addressing stock assessment requests and ecosystem questions, 2013-2022. Note the 2022 CAN surveys were done with the new vessel and are not yet converted.

Survey	Year										
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
CAN Divs. 3LNO, Spring	C	NC	C	C	NC	C	C	NC	NC	P	C
CAN subDiv. 3Ps, Spring	C	C	C	C	C	C	C	NC	C	C	NC
CAN Divs. 2J3KL, Fall	C	C	C	C	C	C	P	C	C	NC	
CAN Divs. 3NO, Fall	C	NC	C	C	C	C	C	C	NC	NC	
EU Div. 3M, Summer	C	C	C	C	C	C	C	C	C	C	
EU (ESP) Div. 3NO, Summer	C	C	C	C	C	C	C	NC	C	C	
EU (ESP) Div. 3L, Summer	C	C	C	C	C	C	C	NC	NC	NC	

Key: C=Completed, NC=Not Completed, P=Partial

Impacts of Missing Survey Data

Impacts of the lack of survey data have been well documented in previous SC reports. However, the compounding effect of missing multiple successive years is unprecedented, and is further complicated by incomplete calibration studies. For some stocks and issues, there are unanswerable questions about recent changes to stock size, distribution and potential species interactions. For the stocks on the Grand Bank in particular, SC is challenged, and in some cases unable, to continue to provide advice using established approaches. To attempt to bring some consistency in dealing with these survey gaps, the Chair of SC, on behalf of a small working group, presented a "decision tree" which might aid with determining how to deal with these gaps based on a number of factors (eg frequency of assessment cycle, whether or not the stock has a model, the health of the stock etc.). In all cases, it was decided that where there is several years of missing data, assessments will be more uncertain, and more caution necessary in the management of the fishery.

Calibration studies and analyses are ongoing. However, calibration work was not fully completed and significant gaps in the availability of conversion factors are expected. This will have impacts on SC's ability to provide advice and may include an inability to update stock size for survey-based assessments, including status relative to existing limit reference points, update analytical assessment models, and conduct ecosystem-level studies. There are also considerable impacts on ongoing Management Strategy Evaluation studies, both with respect to simulating population dynamics, but also for the types of possible Harvest Control Rules that can be considered (especially in the absence of calibrated data series).

Beyond the difficulties created by this period of missing survey data, this issue is also negatively impacting efficiency at SC. There is added workload to investigate alternate approaches to produce scientific results and possible routes to advice, and increased plenary review to evaluate these. In the absence of data and any mitigating approaches, there will be increased uncertainty in stock status and trends, in ecosystem structure, trends, and productivity state, and the scientific advice SC provides on these topics. These problems will continue over the near to medium term, in part linked to the multi-year assessment schedule, and to the SC capacity required to produce additional work.

Results of ongoing analyses will be presented to SC in September and an update provided to the Commission at that time. Regardless of results, significant data limitations have been identified and impact on SC's ability to provide advice is expected.

b) NAFO Other Effective area-based Conservation Measures (OECMs)

SC was informed of the work being led by WG-EAFFM on the evaluation of the NAFO area-based fishery management measures (ABFMs), e.g. VME bottom fishing closures and seamount closures, as potential Other Effective Area-based Conservation Measures (OECMs) as defined in the Convention of Biological Diversity (CBD) Decision 14/8, adopted in 2018 (CBD, 2018). The intent of this work is to examine the possibility of submitting some of the NAFO ABFMs to CBD as NAFO contributions to the global inventory of OCEMs, and through this action, to support the "30 by 30" objective of the CBD Global Biodiversity Framework.

SC confirmed that the evidence compiled on VME sponge closures (Areas 1, 2, 3, 4, 5, and 6) and seamount closures (Corner Rise) meets the criteria for potential OECM recognition. Furthermore, SC raised additional questions about VME bottom fishing closure Area 10 (which is also established to protect sponges), as there are other human activities taking place in the Flemish Pass area (i.e., oil and gas), and how to move forward where there are multi-sectoral activities taking place in the area.

SC also concluded that the VME bottom fishing closures established to protect corals in the NRA are likely to meet the OECM criteria, but a completed pro-forma -the formal mechanism for the submission- for their full evaluation is still pending. Furthermore, it was considered that all existing seamount closures are highly likely to meet the OECM criteria, based on current evidence, given they are VME elements comprising known VME habitats.

References

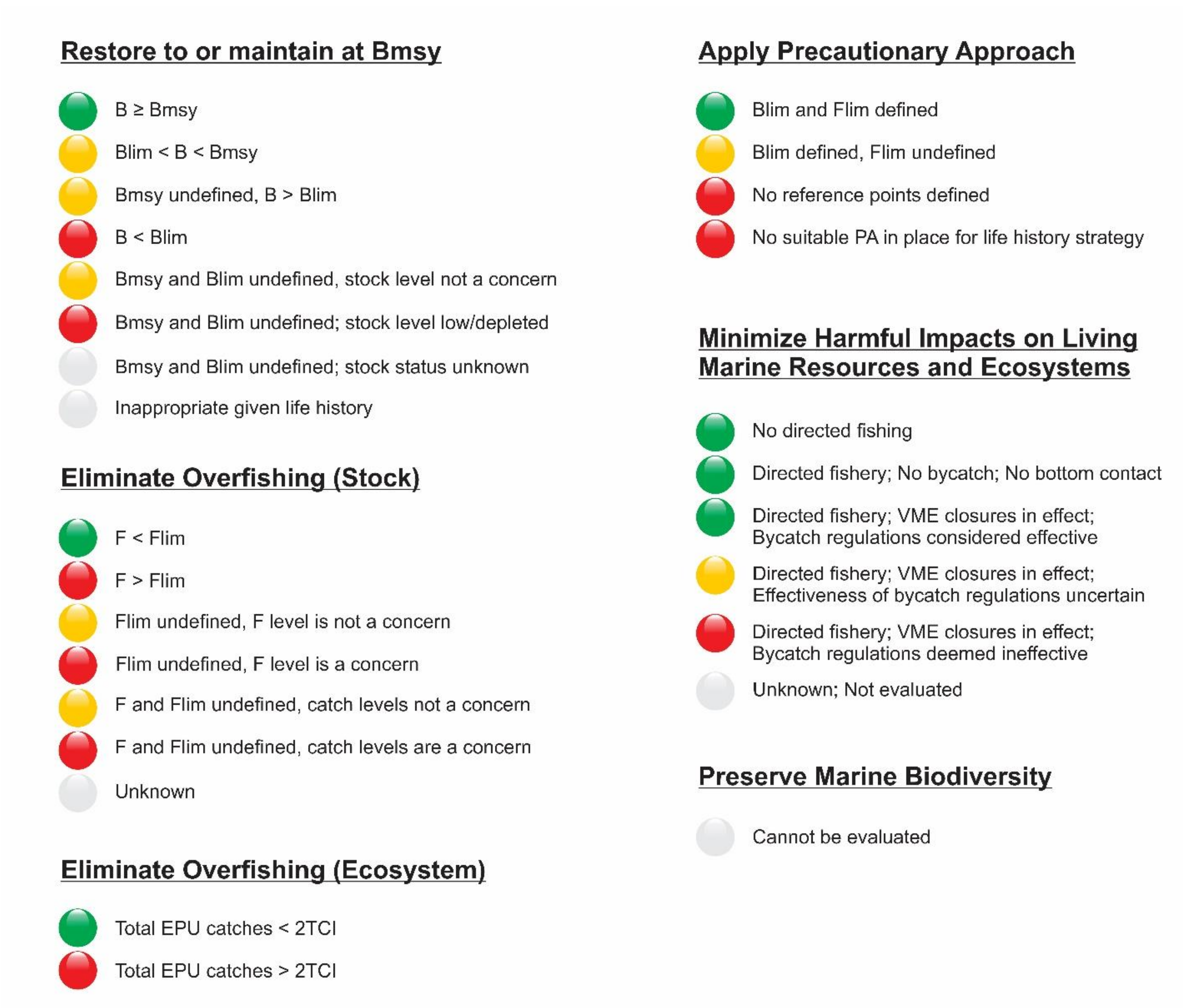
CBD. 2018. Decision 14/8 Protected areas and Other Effective Area-based Conservation Measures. 14th Meeting of the Conference of the Parties to the Convention on Biological Diversity, 17-29 November, Sharm El-Sheikh, Egypt. CBD/COP/DEC/14/8: 19 pp. https://www.cbd.int/doc/decisions/cop-14/cop-14-dec-08-en.pdf.

c) Presentation of NAFO merit Award to Andrew Kenny (UK)

Andrew Kenny had no idea what he was getting into when he signed on as co-Chair of the SC Working Group on Ecosystem Approaches to Fisheries Management (WGEAFM, yes one F) back in 2008. At the time NAFO SC was starting to consider what the implementation of the new NAFO convention might imply for SC work while NAFO as a whole was facing the challenge of protecting VMEs. Addressing these challenges demanded new science, new ways of thinking about what sustainably managing fisheries in the high seas encompassed, and leadership to navigate unknown and sometimes turbulent waters to make these things happen. Andy proved himself a great skipper, and maybe a little glutton for punishment too. He co-chaired WGEAFM/WG ESA from 2008 to 2023 The growth of the implementation of an ecosystem approach in NAFO led to the creation of COM-SC working groups that provided a shared space for managers and scientists to find common grounds on how the new science advice could be implemented. As part of this path, Andy also served as SC co-Chair of the COM-SC Working Group on the Ecosystem Approach Framework to Fisheries Management (WGEAFFM, yes two Fs) from the beginning of the group in 2014 until 2022. During his tenure as co-Chair of these working groups Andy led the development of a novel approach to evaluate the impact of fishing on VMEs that has become a global reference on the field, and put NAFO at the forefront of the management and conservation of VMEs among RFMOs. His leadership was essential for the development of the NAFO Roadmap, and he played a critical role in taking many of its elements from the science realm and into application for management and conservation, including the groundbreaking adoption by NAFO of an ecosystem reference point to inform on the risk of ecosystem overfishing. Over the last 15 years, Andy has been a gentle, optimistic, but nonetheless unstoppable driving force in making the ecosystem approach operational both at SC and NAFO at large, and his contributions have certainly changed how NAFO approaches the broader question of what sustainable fisheries management really means. At this time of Andy stepping down from his co-Chair duties at WGESA and WGEAFFM, SC wants to thank and recognize him for all these years of outstanding work and leadership that have definitely made a difference.

d) Updating of SC Traffic Light Approach

Based on a review demonstrating inconsistencies in the approach used to assign traffic light colours over the past decade, SC accepted a set of standard rules for applying traffic light colours going forward. These rules are built into a html application that was used for the first time to create traffic light tables in 2023. The use of these standard rules will in some instances result in traffic lights changing colour relative to previous reports. Further details are provided in SCR 23/006, but the selections available by default in the app and the assigned traffic light colours are summarized below:



e) FAO DSF Project – EAFM Symposium

Andy Kenny, on behalf of Tony Thompson, presented the outline of a proposal to hold a symposium under the auspices of the FAO Deep-sea Fisheries Project on the "Application of the Ecosystem Approach to Fisheries Management – holistic developments". EAFM was introduced at the Reykjavik Conference in 2001, however application to whole ecosystems remains challenging. There are many examples of the inclusion of species or habitat specific approaches, e.g. VMEs, seabirds, certain sharks, marine mammals, and fish stocks etc. However, NAFO is one of the few RFMOs to apply a more holistic multispecies approach, through their recently adopted ecosystem production potential (EPP) and 2×TCI (total catch index) assessments. Through this, we will gain a better understanding of ecosystem health and avoid ecosystem overfishing. The symposium will highlight recent advances among the RFMOs and provide recommendations for future uptake and directions for the practical implementation of EAFM.

The FAO are planning to hold a symposium in early 2025 and are seeking the support of NAFO to be a co-sponsoring partner and lead advisor to the symposium. ICES have also been approached as a co-sponsor of the symposium.

It was agreed that SC in principle should supported this initiative and become an organising and sponsoring partner, subject to a more detailed and agreed financial (direct costs) and in-kind (staff time) contribution requested for the event. In addition, it was also suggested that the NAFO journal could provide an opportunity to publish the proceedings of the symposium.

XIII. ADOPTION OF COMMITTEE REPORTS

The Council, during the course of this meeting, reviewed the Standing Committee recommendations. Having considered each recommendation and also the text of the reports, the Council **adopted** the reports of STACFEN, STACREC, STACPUB and STACFIS. It was noted that some text insertions and modifications as discussed at this Council plenary will be incorporated later by the Council Chair and the Secretariat.

XIV. SCIENTIFIC COUNCIL RECOMMENDATIONS TO THE COMMISSION

The Council Chair undertook to address the recommendations from this meeting and to submit relevant ones to the Commission.

XV. ADOPTION OF SCIENTIFIC COUNCIL REPORT

At its concluding session on 15 June 2023, the Council considered the draft report of this meeting, and adopted the report with the understanding that the Chair and the Secretariat will incorporate later the text insertions related to plenary sessions and other modifications as discussed at plenary.

XVI. ADJOURNMENT

The Chair thanked the participants for their hard work and cooperation, noting particularly the efforts of the Designated Experts and the Standing Committee Chairs. The Chair thanked the Secretariat for their valuable support and Saint Mary's University for the excellent facilities. There being no other business the meeting was adjourned at 13:30 on 15 June 2023.

APPENDIX I. REPORT OF THE STANDING COMMITTEE ON FISHERIES ENVIRONMENT (STACFEN)

Chair: Miguel Caetano Rapporteur: Miguel Caetano

The Committee met at the Atrium Building, Saint Mary's University, 903 Robie St., Halifax, NS, Canada and by videoconference on the 01 of June 2023 to consider environment-related topics and report on various matters referred to it by the Scientific Council. Representatives attended from Canada, Denmark (in respect of the Faroe Islands and Greenland), European Union (Portugal, Spain and Estonia), Japan, the Russian Federation, Norway, Ukraine, United Kingdom and the United States of America. The Executive Secretary, Scientific Council Coordinator and other members of the Secretariat were in attendance.

1. Opening

The Chair opened the meeting by welcoming participants to this June 2023 Meeting of STACFEN.

The Committee noted the following documents would be reviewed: SCR Doc. 23/005, 23/017, 23/018, 23/019, 23/038.

2. Appointment of Rapporteur

Miguel Caetano (STACFEN chair) also acted as a rapporteur.

3. Adoption of the Agenda

The provisional agenda was adopted with no further modifications.

4. Review of Recommendations from 2022

STACFEN **recommended** *consideration of Secretariat support for an invited speaker to address emerging issues and concerns for the NAFO Convention Area during the 2023 STACFEN Meeting. Contributions from invited speakers may generate new insights and discussions within the committee regarding the integration of environmental information into the stock assessment process.*

STATUS: STACFEN invited Brian Petrie, a physical oceanography scientist from DFO – Canada with a long career on ocean monitoring and observation, for a plenary talk. The presentation entitled "Temporal Evolution of the fish community and critical traits of cod on Flemish Cap" had a positive impact on SC promoting a wide discussion.

STACFEN **recommended** *the elaboration of a work linking the widespread oceanographic-climate changes over the Convention Area.*

STATUS: The work was produced, but due to unavailability of expert, could not be presented to the SC and was deferred to next June.

STACFEN **recommended** *discussions with STACFIS members on environmental data integration into the various stock assessments.*

STATUS: The unavailability of physical and ocean climate index for 2022 led to a reduced input of environmental data to STACFIS assessments for this year.

5. ICES-NAFO workshop 4th Decadal Variability of the North Atlantic and its Marine Ecosystems

STACFEN was represented in the meeting by Frederic Cyr and David Belanger. Frederic Cyr and Paula Fratantoni from STACFEN were members of the symposium's scientific committee, bridging ICES and NAFO scientists to challenges associated with changes in the climate-ocean system in the North Atlantic.

a) An overview of the climatic-oceanographic changes in the NAFO regulatory area during the last decade.

A composite Climate Index was suggested to give a global perspective of the changes in the ocean. A twenty-year perspective of the variability of the mesozooplankton community in the Newfoundland waters was also presented. This trophic element from the food chain is a key link in marine food webs, transferring energy from primary producers to higher trophic levels.

b) Seven decades of climate variability on the Newfoundland and Labrador shelf by Cyr et al., 2022

Systematic hydrographic observations on the Newfoundland and Labrador (NL) shelf have been carried out by Canada and other countries since the late 1940's. These observations were further augmented in 1998 (both with a better spatial and seasonal coverage, but also with the addition of biogeochemical sampling) after the creation of the Atlantic Zone Monitoring Program by Fisheries and Oceans Canada. Seven decades of these observations have been collated into the NL Climate Index (NLCI) that aims to describe the environmental conditions on the NL shelf and in the Northwest Atlantic as a whole. It consists of the average of 10 normalized anomalies. This index now runs from 1951 to 2021 and will be updated annually. Such indices have been proven to be a useful tool for the production of advice for fisheries management and ecosystem status on the NL shelf. Results suggest, for example, that the NL shelf climate undergoes large decadal variations. Winter conditions in the Northwest Atlantic largely set the stage for the ocean conditions on the NL shelf during the rest of the year. It is shown that decadal changes of the sea level pressure above the North Atlantic influences the subpolar gyre, and thus the interactions between the Labrador and the North Atlantic currents, two major contributors to the NL shelf climate variability. This variability has in turn important consequences for the biogeochemistry and the overall productivity of the NL shelf ecosystem.

c) Seasonal and semi-decadal variations in mesozooplankton community composition in coastal Newfoundland waters by Belanger, 2022

Zooplankton are key organisms in marine food webs. They effectively transfer energy from primary producers to the upper trophic levels through predation from selective planktivorous and other heterotrophs that primarily target specific species or taxa. Here twenty years (2000-2019) of data collected on average twice monthly by the AZMP at a coastal monitoring station served to describe mesozooplankton intra- and inter-annual signals in Newfoundland coastal waters. Multivariate and univariate methods were applied to abundance data for eleven copepod and four non-copepod taxa to quantify seasonal (spring, summer, and fall) and semi-decadal variations in zooplankton community composition. Zooplankton assemblage was dominated by small cyclopoid Oithona (~50%) and calanoid Pseudocalanus (~20%) copepods year round. Summer assemblages were characterized by a 4.5 times increase in the abundance of *Calanus finmarchicus* compared to spring, while fall assemblages are characterized by 2-4 times increase in Oithona, Centropages, and *Temora longicornis* copepods and pteropods, along with a 50-90% decrease in large *Calanus glacialis* and *C. hyperboreus* copepods and cladocerans relative to summer. Zooplankton assemblages also varied on a semi-decadal to decadal scale. The abundance of *C. finmarchicus* increased ~1.5 times between the early and the late 2000s while that of Pseudocalanus and Oithona copepods increased ~1.7 times between the mid-2000s and late 2010s, particularly in the fall. The abundance of Appendicularians more than tripled during the 2010s compared to the 2000s. More work is needed to understand how the changes in zooplankton community structure affects energy flow to upper trophic levels.

6. Inventory of environmental data in the NAFO convention area - Report 2021 SCR 23/019

The Marine Environmental Data Section (MEDS) of the Oceans Science Branch of Fisheries and Oceans Canada act as the Regional Environmental Data Center for NAFO. As part of this role, MEDS provides an annual inventory of environmental data collected in the NAFO Convention Area to the NAFO subcommittee for the environment (STACFEN), including inventories and maps of physical oceanographic observations such as ocean profiles, near-surface thermosalinographs, drifting buoys, currents, waves, tides and water level measurements for the previous calendar year (2022).

In order for MEDS to carry out its responsibility of reporting to the Scientific Council, the Designated National Representatives selected by STACFEN are requested to provide MEDS with all marine environmental data collected in the Northwest Atlantic for the preceding years. The data of highest priority are those from the standard sections and stations, as described in NAFO SCR DOC., No. 1, Serial N 1432, 9p.

Data that have been formatted and archived at MEDS are available to all members on request and are available from DFO institutes. Requests can be made by telephone (001) 613 990 6065, by e-mail to info@dfo-mpo.gc.ca, by completing an on-line order form on the MEDS web site at http://www.meds-sdmm.dfo-mpo.gc.ca/isdm-gdsi/request-commande/form-eng.asp or by writing to Oceans Science Branch, Fisheries and Oceans Canada, 12th Floor, 200 Kent St., Ottawa, Ont. Canada K1A 0E6. The following table summarizes data received by MEDS for the NAFO Convention Area (NCA) in 2021.

Data observed in NAFO Convention Area in 2022

Data Type	Platform Type	Counts/Duration
Oceanographic profiles	Autonomous drifting (Argo)	6131* profiles from 194 platforms
	Moorings (Viking)	653* profiles from 5 platforms**
	Gliders	10747* profiles from 5 platforms
	Ship	10532 profiles (8350 CTD; 1314 CTD RT*; 360 bottle; 190 XBT; and 318 XBT RT* profiles)
Surface/near-surface observations	Ship (thermosalinograph)	(none reported)
	Drifting buoys	382090* obs. from 194 buoys
	Moored buoys	493534* obs. from 18 buoys**
	Fixed platforms	81841* obs. from 4 platforms
	Water level gauges	35 sites, avg. ~1 year each

*Data formatted for real-time transmission.
**All Canadian wave buoys indicated in this report measure waves, and the moorings measuring CTD oceanographic profiles are also equipped with surface buoys measuring waves.

Data observed prior to 2022 in NAFO Convention Area and acquired between January 2022 and May 2023

Data Type	Platform Type	Counts/Duration
Oceanographic profiles	Ship	18156 profiles (12978 CTD + 4444 bottle + 734 XBT profiles) from 238 cruises

7. Plenary presentation: "Temporal Evolution of the fish community and critical traits of cod on Flemish Cap"

The NAFO response to a precipitous decline of the Flemish Cap cod (*Gadus morhua*) stock during the 1990s was the imposition of an 11-year moratorium on directed fishing for cod; recovery followed, leading to a reopening of the fishery. Over the three decades that encompassed the pre-collapse, collapse and recovery stages, the cod stock status was characterized by four metrics: spawning stock biomass (SSB), maturity- and weight-at age, and recruitment. These metrics were separated into two distinct states defined by high (low) SSB, low (high) weight-at-age 4, low (high) proportion-mature-at-age 4, and high (low) recruitment. The temporal evolution of these traits was consistent with a density dependent conceptual model suggesting phenotypic plasticity operated during the rebuilding of the stock. The temporal progression of the total biomass of 8 components – shrimp, redfish, Greenland halibut, wolfish, roughhead grenadier, other grenadiers, skates and eelpouts – of the broader fish community was inversely related to total cod biomass, underlying its key ecosystem position as a top predator. The recent decline of the cod SSB by ~12,000 t per year (2017-2021) to ~24,000 t, just above the Limit Reference Point of 15,271 t, is a cause for concern.

8. Highlights of Environmental Conditions in NAFO sub-Areas 2, 3 and 4 for 2022 (SCR Doc. 23/017)

The highlights for the environmental conditions in the NAFO sub-areas 2, 3 and 4 during 2022 can be summarized as:

- The initiation of the spring phytoplankton bloom was, on average, earlier than normal in the Gulf of St. Lawrence and on the Scotian Shelf, later than normal on the Grand Bank and the Flemish Cap, and near normal elsewhere;
- Bloom duration was either near normal or slightly shorter than normal across the region in 2022;
- The magnitude of the spring phytoplankton bloom was, on average, below normal on the Grand Bank, above normal on the southern Newfoundland and the Scotian Shelf, and near normal elsewhere;
- Mean nitrate inventories increased to above-normal in 2022 for the first time since 2015;
- Mean chlorophyll inventories remained near normal for a 2nd consecutive year in 2022 after two consecutive years of above-normal levels;
- Total copepod abundance decreased to near normal after two consecutive years of above-normal levels. Copepod abundance in 2022 was at its lowest level in 20 years and was particularly low on the Flemish Cap and in southern Newfoundland;
- The abundances of *Calanus finmarchicus* and *Pseudocalanus* spp. copepods were near normal but at their lowest levels since 2015 and 2012, respectively; and
- Mean total zooplankton biomass for the region decreased from above normal to near normal in 2022 and was at its second lowest level since 2015.

9. Review of the physical, biological and chemical environment in the NAFO Convention Area during 2021

a) Sub-areas 0-1. 2022 Oceanographic Conditions in the Labrador Sea in the Context of Seasonal, Interannual and Multidecadal Changes (SCR Doc. 23/038).

In the Labrador Sea, the coldest and freshest North Atlantic basin south of the Greenland-Iceland-Scotland Ridge, wintertime surface heat losses result in the formation of dense waters that play an important role in ventilating the deep ocean and driving the global ocean overturning circulation. In the winter of 2022, the central Labrador Sea experienced a near-normal cumulative surface heat loss, although it was much higher than in 2021. The 2022 winter (Dec.–Mar.) North Atlantic Oscillation (NAO) index was below-normal and the lowest since 2013. As a result, the winter surface cooling in the central Labrador Sea was the highest since 2015. However, the winter mixing was only as deep as 1600 m in 2022, meaning moderately-deep winter convection, following shallow convection of the previous year. Sea ice area from Davis Straight to Southern Labrador Sea increased from an 11-to-12-year low observed in 2021 to a 4-to-8-year high in 2022, depending on the region.

With respect to temperature anomalies averaged annually over the central Labrador Sea, in the period of 2002-2022, sufficiently covered with profiling Argo float observations, the upper 100 m layer was the coldest in 2015 and 2018. After 2018, this layer attained above-normal annual temperatures in 2019–2022, with an 11-year high occurring in 2021.

The intermediate, 200-2000 m, layer of the Labrador Sea started to cool immediately after hitting a record warm point of the 1972–2020 period in 2011. This cooling trend was mainly driven by strengthening and progressively deepening winter convection in 2012 and during 2014-2018. Such multiyear persistence of deepening winter convection, continuing through the winter of 2018 when it exceeded 2000 m in depth, resulted in the most voluminous, densest, and deepest formation of Labrador Sea Water since 1994. The situation changed in 2019, with the depth of winter convection eventually reducing to 800 m in 2021. Correspondingly, the intermediate layer has been warming since 2019, while its seawater density decreasing sustaining a negative density trend spanning the period of 2018-2021. Between 2018 and 2021, the annual mean intermediate layer density reduced by about 0.02 kg/m^3. There was a sustained freshening observed in the upper and intermediate layers since 2017.

Vertical distributions of dissolved oxygen and chlorofluorocarbons (CFCs) – CFCs, industrially Freon, are the anthropogenic gases that are commonly used as tracers of convectively-formed water masses spreading in the ocean – in the central Labrador Sea, based on quality controlled instrumental-drift-corrected measurements assembled since 1990, follow very closely the multiyear events of recurrently persistent renewal of dense deep Labrador Sea Water in the Atlantic Ocean.

Presently, any omission or cancelation in the annual ship surveys does not have any sensible impact on both representativeness and uncertainty of the Labrador Sea state assessment variables presented in this report as both seasonal and longer-term variability signals are sufficiently and accurately resolved with the help of profiling Argo float observations.

b) NAFO sub-area 1. Report on hydrographic conditions off West Greenland June-July 2022 (SCR Doc. 23/005).

Hydrographic conditions were monitored at all 10 hydrographic standard sections in June-July 2022 across the continental shelf off West Greenland. Three offshore stations have been chosen to document changes in hydrographic conditions off southern part of West Greenland. The coastal water showed temperatures above the long-term mean south of the Sisimiut section. After few years with a relative fresh Subpolar Mode Water mass, salinity returned to above its long-term mean.

c) Sub-areas 2, 3 and 4. Biogeochemical oceanographic conditions in the Northwest Atlantic during 2022 (SCR Doc. 23/017).

This report reviews the spatiotemporal variability in biogeochemical indices derived from satellite observations (spring phytoplankton bloom initiation, duration and magnitude) and *in situ* measurement of oceanographic variables (nitrate and chlorophyll-*a* concentration, and zooplankton abundance and biomass) across NAFO Subareas 2, 3 and 4 with an emphasis on the year 2022. The initiation of the spring phytoplankton bloom was earlier than normal in the Gulf of St. Lawrence and on the Scotian Shelf, later than normal on the Grand Bank and the Flemish Cap, and near normal elsewhere. Nitrate inventories increased from near normal to above normal and were at their highest level since 2015, while chlorophyll-*a* inventories remained near normal for a 2nd consecutive year. The decrease in total copepod abundance from above normal to near normal was mainly driven by a decrease in the abundance of small copepod taxa, including *Pseudocalanus spp*., which was at its lowest level since 2012. A similar total zooplankton biomass decrease from above normal to near normal was driven by a decline in the abundance of the large, energy-rich *Calanus finmarchicus* copepods, which was at its lowest level since 2015.

d) Sub-areas 5 and 6. Hydrographic Conditions on the Northeast United States Continental Shelf in 2022 (SCR Doc. 23/018).

An overview is presented of the atmospheric and oceanographic conditions on the Northeast U.S. Continental Shelf during 2022. The analysis utilizes hydrographic observations collected by the operational oceanography programs of the Northeast Fisheries Science Center (NEFSC), which represents the most comprehensive consistently sampled ongoing environmental record within the region. Record warm temperatures were recorded across the entire Northeast U.S. Shelf during 2022. Notable cold anomalies observed in the northern Middle Atlantic Bight during Fall are linked to a Warm Core Ring filament and distortion of the shelf-slope front. Deep (slope) waters entering the Gulf of Maine continue to be warmer and saltier than average, marking more than one full decade that southern source waters have dominated the slope water composition in the region. The Cold Intermediate Layer in the western Gulf of Maine was warmer than normal, while the underlying water mass in Wilkinson Basin was much warmer and slightly saltier than normal.

10. Recommendations Based on Environmental Conditions

STACFEN **recommends** *considering Secretariat support for an invited speaker to address emerging issues and concerns for the NAFO Convention Area during the 2024 STACFEN meeting. Contributions from invited speakers may generate new insights and discussions within the committee regarding integrating environmental information into the stock assessment process.*

STACFEN **recommends** *the presentation of work linking the decadal variation of oceanographic-climate changes over the Convention Area.*

STACFEN **recommends** that *further discussions occur between STACFEN and STACFIS members on environmental data integration into the various stock assessments.*

11. National Representatives

The National Representatives for hydrographic data submissions was updated by the Secretariat: E. Valdes (Cuba), Tracje Alcinov (Canada), **Vacant** (Denmark), **Vacant** (France), **Vacant** (Germany), **Vacant** (Japan), H.

Sagen (Norway), **<u>Vacant</u>** (Portugal), E. Tel (Spain), L. J. Rickards (United Kingdom), and P, Fratantoni (USA), **<u>Vacant</u>** (Russian Federation).

12. Other Matters

No other subject was discussed.

13. Adjournment

The Chair thanked STACFEN members for their excellent contributions and the Secretariat for their support and contributions.

The meeting was adjourned on 15 June 2023.

APPENDIX II. REPORT OF THE STANDING COMMITTEE ON PUBLICATIONS (STACPUB)

Chair: Rick Rideout Contributor: Alexis Pacey

The Committee met at Saint Mary's University, 903 Robie St. Halifax, NS, on 8 June, 2023 at 3:00 p.m., to consider publications and communications related topics and report on various matters referred to it by the Scientific Council. Representatives attended from Canada, Denmark (in respect of Faroe Islands and Greenland), European Union (Portugal, Spain, Estonia), Japan, Norway, Russian Federation, Ukraine, United Kingdom, and the United States of America. The Scientific Council Coordinator was in attendance as were other members of the Secretariat staff.

1. Opening

The Chair opened the meeting by welcoming the participants.

2. Appointment of Rapporteur

Alexis Pacey (NAFO Secretariat) was appointed rapporteur.

3. Adoption of Agenda

The agenda was presented at the beginning of the meeting.

4. Review of Publications:

a) Journal of Northwest Atlantic Fishery Science (JNAFS)

Volume 53, Regular issue, was published online only December 2022, containing five articles. Currently, Volume 54 has one published article, two articles in review with associate editors.

b) The NAFO Scientific Council Reports

The NAFO Scientific Council Reports 2022 (Redbook) volume 44 (365 pages) was published in March 2023 online. 10 print copies were made.

c) NAFO Scientific Council Studies

There were no submissions for 2022.

d) NAFO Commission-Scientific Council Reports

These reports are found in the Meeting Proceedings of the Commission from September 2021-August 2022 (312 pages) and was published in September 2022. Three copies were printed.

e) ASFA

All SCR and SCS documents for 2022 have been submitted to ASFA (Aquatic Science & Fisheries Abstracts) as of February 2023, including JNAFS, SC Reports (Redbook) 2021, 2022 and Meeting Proceedings of the Commission 01 September 2021-August 2022.

All records since 2021 were input using OpenASFA, which was released in April 2021 and they are available at: https://www.fao.org/fishery/en/openasfa. ProQuest, ASFA's publishing partner, ingest all indexed records from OpenASFA once per month. https://www.proquest.com/search (Login and password available through your library/institute). If you do not have access to the ASFA database through your institute, please see the publications manager for the username and password to access the ASFA/ProQuest database.

In order to determine the value of continued ASFA submissions, it was noted that a survey will be circulated by email to SC members to evaluate if current members are using the service or not. Previous STACPUB discussions had indicated that younger members of SC were not even familiar with ASFA and that Google Scholar was a more common literature search tool. However, it was pointed out that ASFA is typically part of a larger database, Earth, Atmospheric and Aquatic Science Collection, and that submission to such databases could be an important consideration with respect to raising the profile of NAFO publications, such as JNAFS.

5. Review of Recommendations in 2022

The recommendations made by STACPUB for the work of the Scientific Council as endorsed by the Council, are as follows:

STACPUB **recommends** that *the Secretariat explore ways to make SC working papers permanently available to SC via a password-protected site.*

STATUS: Presented at the 2023 SC June meeting. Careful consideration was given to two potential ways to make working papers available online to SC members: via the Meetings SharePoint site, or via the NAFO members' page. The members page option would allow anyone with login credentials for the members site to access the archived working papers. That would potentially include non-science members that do not take part in SC meetings. The SharePoint option would allow only participants of SC meetings to access the working papers. While this would also include non-SC members attending SC meetings (e.g. observers) to access archived working papers, it was still considered a preferable option. In addition, STACPUB noted that SC meetings generally involve use of the SharePoint already and therefore accessing the archived working papers via this method would not require an additional login, whereas the members page would. STACPUB asks the Secretariat to create a tab on the Scientific Council Meetings SharePoint site where SC working papers would be uploaded in folders by year.

STACPUB **recommends** *the use of the Scientific Council Meetings SharePoint as a repository to make SC working papers from previous years available to SC members and participants of SC meetings.*

6. Other Matters

a) Future printing of SCR documents

A request was made by the Secretariat to consider whether the practice of printing three copies of all SC documents and working papers for availability to meeting participants was still necessary. It was noted that most, if not all meeting participants are accessing electronic copies of the papers via the SharePoint during meetings and not using the printed copies. The Secretariat noted that in most cases all three copies of papers are ending up in the recycling bin at the end of meetings. It was unanimously agreed that the default practice of providing printed copies of documents could cease. The Secretariat noted that printing of working papers and documents would still be available by request.

STACPUB **recommends** *ceasing the printing of working papers and documents at SC meetings. Printing can be done by request.*

b) Publication Guidelines for SCR

Secretariat will continue to monitor SCR submissions to ensure that only papers presented at SC or SC working group meetings are published. No issues in 2022.

c) Raise the profile of the Journal of Northwest Atlantic Fishery Science (JNAFS)

A discussion took place about potential ways to raise the profile of JNAFS. It was emphasized up front that taking on such a challenge would require a long-term strategy and that there is no quick solution. STACPUB noted two major issues that should be addressed as first steps. The first issue is that JNAFS is not currently tracked by Web of Science and is therefore not given an Impact Factor by that web service. This was pointed out as a factor that would prevent many scientists from submitting manuscripts to JNAFS. Scientists are often evaluated in terms of career promotion, etc. by the prominence of the journals in which they publish, and impact factor is the main indicator of journal prominence. It was acknowledged that for some scientists, submitting to JNAFS would be no more impactful for their careers than publishing a research document. Getting JNAFS into Web of Science should be a priority. The other major issue that STACPUB considers important to address is the dated appearance of the JNAFS website. Participants considered the online experience as an important consideration when selecting a journal for paper submission and it was pointed out that the most successful journals in recent years are those that have focussed heavily on improving their online appearance and services.

Other ways of actively promoting JNAFS that were discussed included investing in marketing and creating an awareness campaign using various methods, e.g. creating pamphlets to distribute at conferences, increasing the email campaign, posters, etc. This would include targeting universities and institutes and gathering an expanded mailing list for a target audience. It was noted that approximately 10 SC members raised their hands when asked if they had previously published their research in JNAFS.

STACPUB also discussed some of the positive aspects of JNAFS that could be emphasized in any promotion campaign, including the fact that it is open-access on both ends (no fees), the niche or unique regional content, and the longevity of the publication.

Rick Rideout, Chair of STACPUB, offered to organize a small sub-group to discuss how to raise the profile of JNAFS. He asked for STACPUB members interested in being involved in these efforts to contact him. He will also be reaching out to individuals who may have expertise and experience in journal publishing, including some of the younger members of SC who may have valuable opinions about modern publishing practices. The sub-group will work intersessionally to come up with a strategy intended to raise the profile of JNAFS.

d) Potential new logo update

The logo redesign project is currently with STACFAD. There were five responses from CPs on feedback about the potential new logo. A focus group will reconvene sometime in June to discuss the responses. There will be three options to discuss: retain the current logo, or the favorite option of the new logo that bears a resemblance to the General Fisheries Commission for the Mediterranean (GFCM) logo and may need to be removed as a feasible option, or refresh the current logo to reflect a contemporary and modern image. It was encouraged that anybody from SC could be part of the focus group meeting. One member volunteered.

e) Meeting reports and deadlines

It was noted that the delivery of timely reports from meetings has become exceedingly difficult. Discussions initially focussed on how to find ways to shorten report completion times but quickly switched to workload as the root cause of delayed reports. Some time was spent discussing the potential to have an abbreviated version of meeting advice that could be shared with managers immediately following the meeting. However, it was ultimately agreed that the goal should always be to have a full draft report completed by the end of each meeting. Unfortunately, attempts to respond to the excessive number of requests to SC in recent years have resulted in long meeting hours, the need for additional meetings, and often the need for post-meeting time in order to complete reports. The reality is that once SC members leave meetings, their other work obligations can make it difficult to complete reports in a timely fashion. This can be exacerbated by the fact that delays in report writing (and the need to work on other non-NAFO related priorities) often results in difficulties remembering some meeting details. It was noted that the issue with respect to report completion had been discussed in previous years and SC had suggested that the majority of reports should be completed during meeting time, even if that occurs at the expense of not completing the full agenda.

STACPUB was in support of this position and discussions took place about the need to prioritize work items and the potential need to identify items that might not get completed during SC meetings. Eventually the STACPUB chair interjected to say that the discussion had probably crossed over into the realm of Scientific Council and the discussion on this matter was concluded.

7. Adjournment

The Chair thanked the participants for their valuable contributions, the rapporteur for taking the minutes and the Secretariat for their support.

APPENDIX III. REPORT OF THE STANDING COMMITTEE ON RESEARCH COORDINATION (STACREC)

Chair: Diana González-Troncoso Rapporteur: Tom Blasdale

1. Opening

The Committee met at the Atrium Building, Saint Mary's University, on various occasions throughout the meeting to discuss matters pertaining to statistics and research referred to it by the Scientific Council. Representatives attended from Canada, Denmark (Faroes & Greenland), European Union (Estonia, Portugal and Spain), Japan, Norway, Russian Federation, Ukraine, United Kingdom and United States of America. The Scientific Council Coordinator and other members of the Secretariat were in attendance.

The June Scientific Council meeting was preceded by a virtual meeting on May 4th, during which information on biological surveys carried out in 2022 in the NAFO Regulatory Area were presented. Future surveys for 2023 were also discussed.

2. Appointment of Rapporteur

The Scientific Council Coordinator, Tom Blasdale, was appointed as rapporteur for this meeting.

3. Review of previous recommendations from 2022 and new recommendations from 2023

a) Recommendations about surveys coverage

In 2015, STACREC **recommended** that *an analysis of sampling rates be conducted to evaluate the impact on the precision of survey estimates*. As a separate aspect, in September 2017 STACREC discussed *possibilities for combining multiple surveys in different areas and at different times of the year to produce aggregate indices*. In 2018, SC agreed at the September meeting that this constitutes a relevant topic for a special session, but in the future due to other commitments. In September 2019 it was agreed that a speaker on this general topic would be invited to the June 2020 SC meeting, and the STACREC chair take the lead in arranging this invitation. However, due to the pandemic, it was not possible to have an invited speaker in June. However, a Canadian scientist attended the ICES WKUSER (Workshop on Unavoidable Survey Effort Reduction) in January 2020 and presented information on survey coverage issues. Feedback from this meeting was presented to STACREC in May 2021. A follow-up WKUSER was held in September 2022. Another Canadian scientist attended the meeting and presented the results during this meeting (see section 7.c.). The conclusion was that by implementing the recommendations from the workshop, scientists and survey managers can make informed decisions and maintain the integrity of survey time series data.

A peer review process to perform comparative fishing analyses between new and old research vessels used in the Canadian-NL surveys is being carried out by Canada later in 2023. STACREC **recommends** *waiting until the finalization of this peer review process before exploring spatial models, such as those used during WKUSER2, to potentially fill holes in survey coverage.*

The lack of Canadian surveys and how to use these methods was raised. A peer review process to perform comparative fishing analysis analyses between new and old research vessels used in the of Canadian-NL surveys is being carried out by Canada later in 2023., so STACREC recommends to waiting until the finalization of this peer review process, to take place later in 2023, before exploring spatial trying the models, such as those used during the WKUSER2, to potentially fill holes in survey coverage.

In June 2022, STACREC **recommended** *exploring in the future the spatio-temporal models used during the Joint ICES/NAFO shrimp benchmark in January 2022 to handle gaps in the surveys.* This recommendation is deferred also until after the Canadian peer review.

Although having a Workshop could be useful, it would be very difficult due to the commitments that Scientific Council has for the next years.

Linked with this, in June 2019 and June 2020 STACREC **recommended** the *actions for future years whenever survey coverage issues arise.* These actions can be found in the 2020 STACREC report.

b) Recommendations about redfish

i. Most of the surveys conducted (except for the EU-3M survey in recent years) record redfish without separating by species and STACREC **recommended** in 2018 that *all surveys should aim to examine redfish composition at the species level, while recognizing that this may not always be achievable due to trade-offs between different activities and aims of surveys.*

This was again discussed at the 2019 meeting, where it was noted that no progress had occurred in species separation since the 2018 recommendation. There are difficulties to achieve this task that were noted in 2018 (such as the lack of an agreed methodology for species identification that all surveys would use in a consistent manner and lack of time and resources in some surveys to take on additional tasks). It was **agreed** that, as a first step, an attempt could be made at separating golden (*S. norvegicus*) from beaked (*S. mentella* and *S. fasciatus*) redfish for fish above a certain length, as this seems a relatively easy task.

Canada is carrying out a series of studies for separating redfish, and preliminary results are aimed to be presented during June 2024. There is not ongoing work in the rest of the surveys.

ii. A preliminary compilation of information on the stock structure of redfish in Division 3O in relation to adjoining redfish stocks (Units 2, 3Ps and 3LN) was presented in the June 2019 SC meeting. It was concluded that the initial basis for delineating stock structure was weak. STACREC **recommends** *a comprehensive study to investigate redfish stock structure in NAFO Divisions 2 and 3, with consideration of species splitting and recent approaches to studying redfish stock structure in other RFMOs.*

Canada is carrying out genetic studies across Divisions 2 and 3. Preliminary results are aimed to be presented during June 2024.

c) Recommendations about reviewers

Reviewers attended NAFO June meetings in 2019 and 2020 to review some stocks assessed by NAFO. In 2022, reviewers of Tier 1 of the Ecosystem Roadmap attended the meeting. In 2023, MSE reviewers have attended the meeting. For next year, the most supported idea is to have an expert on data limited stocks. It is clear to STACREC that having a reviewer is a key point for improving our work. The STACREC chair will take the lead in arranging this invitation.

d) Recommendations about future new surveys

In June 2022, STACREC **recommended** that *the Commission amend Article 4 in the NAFO Conservation and Enforcement Measures (NCEM) to include some considerations made during the meeting.* Almost all these considerations were addressed by the Commission and added to the 2023 NCEM except the approval of the Research Plan by the Scientific Council in advance of the survey. Some discussions took place during the meeting and it was **agreed** that it is not a matter of the Scientific Council to authorize a survey in advance, but to say if the Research Plan is detailed enough to be considered a scientific survey by the Scientific Council and, so, to be used in the assessments to produce advice.

e) Recommendations about the Faroes longline survey

Linked to iv), in May 2023 FAMRI (Faroe Marine Research Institute) submitted a Research Plan for the longline Faroe survey to be reviewed by the Scientific Council. This matter is covered in section 7.f.

STACREC reviewed the Research Plan and considers that it does not fulfill the requirements to be considered a scientific survey and therefore the indices derived from it are not appropriate to be included in the assessment model.

STACREC **recommends** that *the Contracting Party consults with an external expert on longline surveys to further refine their survey design. If a revised research plan is received by SC prior to the September meeting STACREC can provide additional comments as needed*.

In light of concerns with respect to the design of the Faroes longline survey, STACREC **recommends** that *a scientist from DFO Maritimes region should be invited to present details of the design of the Canadian Atlantic halibut longline survey.*

f) Bottom temperature studies

An exploration of bottom temperatures during the Canadian surveys was presented. The summary can be seen in section 7.e. STACREC **recommends** *work continue on further incorporating changes in ocean climate and ecosystem conditions into stock assessments and the understanding of species dynamics. Specifically, analyses presented here should be expanded to further quantify temperature changes during the Canadian and EU surveys on the Grand Bank and presented at STACFEN 2024.*

4. Fishery Statistics

a) Progress report on Secretariat activities in 2021/2022

i) STATLANT 21A and 21B:

In accordance with Rule 4.4 of the Rules of Procedure of the Scientific Council, as amended by Scientific Council in June 2006, the deadline dates for this year's submission of STATLANT 21A data and 21B data for the preceding year are 1 May and 31 August, respectively. The Secretariat produced a compilation of the countries that have submitted to STATLANT and made this available to the meeting.

Due to legal issue regarding the confidentiality of data provided to the European Commission by Member States, the EU was not able to provide full STATLANT 21A data in time for the June 2023 SC meeting. NAFO Secretariat is working with the European Commission and Member States to resolve these issues.

Table 1. Dates of receipt of STATLANT 21A reports for 2020-2022 and 21B reports for 2020-2022 received prior to 03 June 2023.

Country/component	STATLANT 21A (deadline, 1 May)			STATLANT 21B (deadline, 31 August)		
	2020	2021	2022	2019	2020	2021
CAN-CA	14 Jul 22	14 Jul 22				
CAN-SF	30 Apr 21	6 Jun 22	24 Apr 2023	2 Jul 20		
CAN-G	5 May 21	27 May 22	26 Apr 2023			6 Sep 22
CAN-NL	30 Apr 21	26 May 22	28 Apr 2023	31 Aug 20	31 Aug 21	
CAN-Q						
CUB						
E/BUL						
E/EST	30 Apr 21	28 Apr 22	21 Apr 2023	29 Jun 20	23 Aug 21	26 Aug 22
E/DNK	27 May 21	30 Mar 22	9 Jun 2023	21 Aug 20	21 Jul 21	15 Aug 22
E/FRA						
E/DEU	30 Apr 21	7 Apr 22	9 Jun 2023	29 Jun 20	30 Aug 21	25 Aug 22
E/LVA	26 Apr 21	21 Apr 22	5 Apr 2023			
E/LTU		31 May 22	9 Jun 2023		3 Jul 21	
EU/POL		24 Jun 22				
E/PRT	26 Apr 21	19 Apr 22		31 Aug 20	28 Aug 21	30 Sep 22
E/ESP	31 May 21	14 Jun 22	9 Jun 2023	24 Jun 20	7 Jun 21	15 Jun 22
GBR						
FRO	12 Jan 21	6 Apr 22	5 Jun 2023	15 Dec 20	12 Jan 21	6 Apr 22
GRL	3 May 21	6 May 22	1 May 2023	25 Aug 20	30 Aug 21	25 Aug 22
ISL						

JPN	28 Apr 21	27 Apr 22	28 Apr 2023	28 Aug 20	24 Aug 21	30 Aug 22
KOR						
NOR	10 May 21	22 Apr 22	9 Jun 2023	4 Sep 20	1 Sep 21	2 Sep 22
RUS	30 Apr 21	27 Apr 22	28 Apr 2023		30 Aug 21	25 Aug 22
USA	4 Mar 22	25 May 22	31 May 2023			
FRA-SP	21 Jun 21	26 Apr 22	27 Apr 2023			25 Aug 22
UKR						

5. Research Activities

a) Biological Sampling

i) Report on activities in 2022/2023

STACREC reviewed the list of Biological Sampling Data for 2022 prepared by the Secretariat and noted that any updates will be inserted during the summer. The SCS Document will be finalized for the September 2023 Meeting.

ii) Report by National Representatives on commercial sampling conducted

Canada-Newfoundland (SCS Doc. 23/12):

Information was obtained from the various fisheries taking place in all areas from Subareas 0, 2, 3 and portions of Subarea 4. Information was included on fisheries for the following stocks/species: American plaice (SA 2 + Division 3K, Div. 3LNO, Subdiv. 3Ps), Atlantic cod (Div. 2GH, Div. 2J3KL, Div. 3NO, Subdiv. 3Ps), Atlantic salmon (SA 2, SA 3, SA4), capelin (SA 2 + Div. 3KL, Div. 3NO), Greenland halibut (SA 2 + Div. 3KLMNO), haddock (Div. 3LNO, Subdiv. 3Ps), Iceland scallop (Div. 2HJ, Div. 3LNO, Subdiv. 3Ps, Div. 4R), American lobster (Div. 3K, Div. 3L, Div. 3Pn, Div. 3Ps, Div. 4R), pollock (Div. 3LNO, Subdiv. 3Ps), Northern shrimp (SA 2 + Div. 3K, Div. 3LNO), redfish (SA 2 + Div. 3K, Div. 3LN, Div. 3O, Div. 3P4VW), sea scallop (Div. 3KLNO, Subdiv. 3Ps, Div. 4R), snow crab (Div. 2HJ, Div. 3KLNO, Subdiv. 3Ps, Div. 4R), squid (SA 2+3), thorny skate (Div. 3LNO, Subdiv 3Ps) and white hake (Div. 3NO, Subdiv. 3Ps). Additionally, a summary of recent stock assessments and research projects for several of marine species are included in this report.

Denmark/Faroe Islands (SCS 23/08):

A total of four Faroese commercial vessels conducted fishery operations in the NAFO Regulatory Area in 2022, mainly in subarea 3M. The fishery is conducted exclusively by longliners since 2017. Biological samples of cod are collected since 2014 (length and weight measurements). In 2019 samples of Greenland halibut were provided to SC. The Faroese quota of cod in 3M is 22.35% of the total. Other commercial important fish species caught in 2022 are Greenland and Atlantic halibut and white hake.

Denmark/Greenland (SCS 23/14):

Data on catch rates from STATLANT were obtained from trawl, gillnet and longline fisheries in NAFO Div 1A-F for Atlantic halibut, Atlantic cod, capelin, Greenland cod, Greenland halibut, roundnose grenadier, redfish, Greenland shark, Northern rays, Northern wolffish and wolffish. Length frequencies, from Greenland, were available for Greenland halibut trawl offshore fishery in 1AB and 1CD, longline fishery in 1A, 1D and 1F inshore, gillnet fishery in 1A inshore and pound net inshore in 1A; for cod from the trawl inshore fishery in 1A and 1D, the gillnet fishery 1D inshore, with fishing rods in 1D inshore, and from pound nets in 1D inshore; for roundnose grenadier with the offshore trawl in 1A. A total of 158 length samples were taken, and 839 564 individuals, including Greenland halibut, cod, and roundnose grenadier were measured, in NAFO Div. 1A-F. A total of 504 otoliths in Div. 1A, 1C, 1D from cod, and Greenland halibut were collected.

EU-Germany (NAFO SCS Doc 23/16):

Data on catch rates were obtained from trawl catches for Greenland halibut in Div. 1C and 1D.

EU-Estonia (NAFO SCS Doc. 23/04REV):

Catch data were obtained from two fishing vessels in Subarea 3LMNO. A total of three trips were made and spent a total of 285 days in the area. The main target species were redfish, yellowtail flounder and Greenland halibut. To a lesser extent, silver hake, American plaice, cod. In addition to collecting catch, discard and effort data, NAFO observers sampled the length of 8,987 specimens and recorded 10,547 other biological parameters.

EU-Portugal (NAFO SCS Doc. 23/13):

Data on catch rates were obtained from trawl catches for: redfish (Div. 3LMNO); Greenland halibut (Div. 3LM), silver hake (3NO), white hake (3O) and cod (Div. 3M).

Data on length composition of the catch were obtained for: redfish (S. mentella) (3LMNO); Greenland halibut (3LM); cod (3MN); silver hake (3NO); white hake (3NO); American plaice (3M); witch flounder (3M) and thorny skate (3O).

EU-Spain (NAFO SCS Doc. 23/06):

A total of 8 Spanish trawlers operated in Div. 3LMNO NAFO Regulatory Area (NRA) during 2022, amounting to 1,117 days (16,592 hours) of fishing effort. Table 3 presents the Spanish effort (fishing hours) since 2003 in NRA Subarea 3. Total catches (Table 1) for all species combined in Div. 3LMNO were 15,101 tons.

In addition to NAFO observers (NAFO Observers Program), eight IEO scientific observers were onboard Spanish vessels during 2022, comprising a total of 344 observed fishing days, around 31% coverage of the total Spanish effort. Besides recording catches, discards and effort, these observers carried out biological sampling of the main species taken in the catch. For Greenland halibut, roughhead grenadier, American plaice and cod this includes recording weight at length, sex-ratio, maturity stages, performing stomach contents analyses and collecting material for reproductive studies. Otoliths of these four species were also taken for age determination. In 2022, 482 length samples were taken, with 62,875 individuals of different species examined to obtain the length distributions.

During 2022 there was no fishing activity of the Spanish fleet in NAFO Division 6G.

Japan (NAFO SCS Doc. 23/02):

Since 2016, one Japanese otter trawler operated in Div. 3L and 3M. The total catch including discards was 1 284 tons. Target species (main fishing Divisions) (catch) were Greenland halibut (1 205 tons) in 3LM. Number of size measurements in 2022 for Greenland halibut. There were small catches of redfish (7 tons) in 3L and no catches of yellowtail flounder in 2022.

Russia (NAFO SCS Doc. 23/09):

Catch rates were available from Greenland halibut (Divs. 1ACD, 3LM, with bycatch statistics), Atlantic cod (Divs. 3LMNO), Redfish (Divs. 3LN, 3M, 3O, with bycatch statistics), Yellowtail flounder (Div. 3N), Skates (Div. 3LNO), American plaice (Divs. 3MNO), Witch flounder (Divs. 3NO), Roughhead grenadier (Divs. 3LM), Roundnose grenadier (Div. 3L), White hake (Divs. 3NO), Atlantic halibut (3LMNO). Length frequencies were obtained from Greenland halibut (Divs. 1A, 1CD, 3LM), Roughhead grenadier (Div. 3L), Roundnose grenadier (Div. 3M), Blue wolffish (Divs. 3L), Spotted wolffish (Div. 3N), Blue antimora (*Antimora rostrata*) in Div. 3L, Black dogfish (*Centroscyllium fabricii*) in Div. 3L, Threebeard rockling (*Gaidropsarus ensis*) in Div. 3L), Nezumia (*Nezumia bairdii*) in Divs. 3LM, Greater eelpout (*Lycodes esmarkii*) in Div. 3L. Age-length distribution for Greenland halibut in Divs. 3LMN, as well as statistics on marine mammal occurrences and VME indicator species catches, are also available.

USA (SCS Doc. 23/15):

The report described catches and survey indices of 36 stocks of groundfish, invertebrates and elasmobranchs. Research on the environment, plankton, finfishes, marine mammals, and apex predators were described. Descriptions of cooperative research included a longline survey in the Gulf of Maine and Shark tagging. Other studies included age and growth, food habits, and tagging studies. A description of the Population Dynamics Branch assessment review process was given.

b) Biological Surveys

i) *Review of survey activities in 2022 and early 2023 (by National Representatives and Designated Experts)*

On May 4th 2023, a STACREC meeting reviewed the survey activities and data by contracting parties prior to the Scientific Council meeting in June.

Canada – Newfoundland and Labrador (SCR Doc. 23/042):

The 2022 Canadian spring survey used a new research vessel for which catchability conversion factors are not yet available. This survey was completed in Subdiv. 3Ps, but Div. 3NO was completed at a greatly reduced allocation, and Div. 3L was incomplete. Given reduced coverage, indices from 3LNO in spring 2022 are not considered broadly applicable but may be a representative index in a few cases. The Canadian 2022 fall survey was not undertaken, with effort instead directed to a targeted comparative fishing program to calibrate the new research vessels.

Results of the peer review of the comparative fishing are expected prior to the June SC meeting in 2024.

Canada – Subarea 0 (SCR 23/029)

During 1999-2017 surveys were completed in Div. 0A-south (to 72N) using the RV Paamiut with and Alfredo III trawl. In 2018 the RV Paamiut was retired and a replacement vessel was not available. In 2019 the FV Helga Maria with the Alfredo III trawl and trawl doors from the RV Paamiut was used as interim vessel, but the data analyses detected significant differences in catchability below 700 m, therefore the survey was not used to assess stock status. A survey in Subarea 0 was completed in November 2022 using the RV Tarajoq with a Bacalao trawl; this vessel and trawl will be used for the survey in future years. Survey stratification was expanded in 2022 relative to previous years, adding a 200-400 m depth stratum and expanding the survey to include all of Division 0B. The survey now fishes the following depth strata in each of Divs. 0A (south of 72N) and 0B: 200-400, 401-600, 601-800, 801-1000, 1001-1200, 1201-1400, 1401-1500 m. The survey was planned with 30 days at-sea to complete 79 stations in Division 0A and 110 stations in 0B. The 2022 survey encountered sea ice in Div. 0A and was not able to complete stations north of 68N; the survey completed 31 stations in Div. 0A and 107 stations in 0B. Survey biomass and abundance indices were calculated but cannot be directly compared to previous indices calculated from data collected using the RV Paamiut with an Alfredo III trawl.

Denmark/Greenland (SCR 20/15, 23/005, 012, 013, 020, 021, 022, 032, 037):

An hydrographic cruise was carried out across the continental shelf off West Greenland to sample 10 standard sections onboard TARAJOQ during the period 30 May to 30 June and onboard the Royal Danish Navy vessel HDMS EJNAR MIKKELSEN during the period 14 July to 23 July (NAFO 1B-F). Data from three offshore stations were taken to document changes in hydrographic conditions off Southwest Greenland (NAFO Div. 1D-F). Results were presented as Scientific Council Research Document.

The Greenland Shrimp and Fish trawl survey in West Greenland in NAFO Div. 1A-F (50 - 600 m) was initiated in 1988. From 1988 to 1900, several vessels conducted the survey. From 1991 to 2017, the surveys have been conducted on board RV Paamiut. In 2018 and 2019-2020, two different charter vessels were used, Sjudarberg and Helga Maria, respectively, and in 2022, the survey was completed with the new R/V Tarajoq. The three vessels used all the standard gear from the research vessel Paamiut (Cosmos trawl gear with a mesh size 20 mesh liner in the cod-end, doors, all equipment such as bridles etc., and Marport sensors on doors and headlines), in an effort to make the 2018 and 2019-2020 and 2022 surveys as identical as possible with the previous years surveys. The effect of the survey vessel change has been examined by looking at gear performance variables and survey length frequencies. The performance of all variables examined remained relatively stable with the three different vessels suggesting that the indices can be comparable. The survey was carried out between June 25 – July 17. The survey follows a buffered stratified random sampling. A total of 331 valid hauls were conducted. Survey results including biomass and abundance indices for Greenland halibut, cod, deep-sea redfish, golden redfish, American plaice, Atlantic wolfish, spotted wolfish, and thorny skate were presented as Scientific Council Research Documents.

The Greenland deep-sea survey in NAFO Div. 1CD (400-1500 m) was initiated in 1997, following a buffered stratified random sampling. From 1997 to 2017, surveys have been conducted on board RV Paamiut. No surveys were conducted in 2018, 2020 and 2021. In 2019, a charter vessel was used, CV Helga Maria, which used all the standard gear from the research vessel Paamiut (cosmos trawl, doors, all equipment such as bridles etc., and Marport sensors on doors and headlines). The performance of the gear and the length frequencies from the two different vessels has been examined. Results suggested that the performance of the trawl gear has been different at depths > 700 m, that could have affected the abundance and biomass. In 2022, a new time series survey started with the new R/V Tarajoq, using a new gear Bacalao 476. the survey was conducted from Oct 13th to Oct 26th . The gear used a Bacalao 476 trawl with a mesh size of 136 mm and a 30-mm mesh-liner in the cod-end. A total of 65 valid hauls were conducted. Survey results including mean catch, mean number, biomass and abundance indices, and length frequencies for Greenland halibut, roundnose grenadier, roughhead grenadier, and deep-sea redfish were presented as Scientific Council Research Documents.

The Greenland halibut gillnet surveys in 1A inshore were initiated in 2001, in Disko Bay. The survey normally covers four transects and each gillnet set is compiled of five different nets with different mesh size (46, 55, 60, 70 and 90 mm half mesh). From 2013 to 2015, the surveys in Uummannaq and Upernavik gradually changed from longline surveys to gillnet surveys. Surveys are conducted with the R/V Sanna. In 2022, 46, 43 and 42 gillnet stations were set in Disko Bay, Uummannaq and Upernavik, respectively. Results are presented as three Scientific Research Documents.

The Greenland halibut bottom trawl survey in 1D inshore (Nuuk, Ameralik and Qarajat fjords) was initiated in 2015. The survey has been conducted with the R/V Sanna equipped with a 1440 mesh Bacalao trawl. The survey is bottom-stratified with fixed stations (stations were selected where bottom conditions allow bottom trawling). A total of 17 valid stations were conducted, in 2022. Survey results, including biomass and abundance indices for Greenland halibut, shrimp, deep-sea redfish and Golden redfish, were presented as Scientific Council Research Document.

EU-Spain and EU-Portugal (SCR 23/004 and 005):

Since 1995, Spain carries out annually a Spring-Summer survey in the NAFO Regulatory Area of Div. 3NO. In 2003, it was decided to extend the Spanish 3NO survey toward Div. 3L (Flemish Pass). In 2021, the 3L survey could not be carried out due to the exceptional pandemic situation caused by COVID 19 and in 2022 it could not be carried out due to technical problems with the research vessel.

The Spanish bottom trawl survey in NAFO Regulatory Area Div. 3NO was conducted from 5th of June to the 4th of July 2022 on board the R/V Vizconde de Eza. The gear was a Campelen otter trawl with 20 mm mesh size in the cod-end. Following the method used last year, a total of 113 valid hauls were taken within a depth range of 40-1410 m according to a stratified random design and 114 hydrographic profiles. Furthermore, a stratified sampling by length class and sex was used to sample otoliths of Atlantic cod, American plaice and Greenland halibut for growth studies. Also, gonads of Atlantic cod and American plaice were sampled from histological maturity and fecundity studies. The results of this survey, including biomass indices with their errors and length distributions, as well as the calculated biomass based on conversion of length frequencies for Greenland halibut, American plaice, Atlantic cod, yellowtail flounder, redfish, witch flounder, roughhead grenadier, thorny skate and white hake are presented as Scientific Council Research Documents. In addition, age distributions are presented for Greenland halibut and Atlantic cod.

The EU Spain and Portugal bottom trawl survey in Flemish Cap (Div. 3M) was carried out on board R/V Vizconde de Eza using the usual survey gear (Lofoten) from July 4th to August 25th 2022. The area surveyed was Flemish Cap Bank to depths up to 800 fathoms (1460 m) following the same procedure as in previous years. The number of hauls was 182 and one of them was null. Survey results including abundance indices of the main commercial species and age distributions for cod, redfish, American plaice, roughhead grenadier and Greenland halibut are presented as a Scientific Council Research documents. Flemish Cap survey results for Northern shrimp (Pandalus borealis) were presented in SCR 22/052. Samples for histological assessment of sexual maturity of cod, redfish, Greenland halibut and roughhead grenadier were taken. Oceanography studies continued to take place.

VME data from the 2022 EU; EU-Spain and Portugal Division 3M (Flemish Cap) bottom trawl groundfish surveys and EU-Spain NAFO Regulatory Area Divisions 3NO (Grand Banks of Newfoundland):

Data on deep-water corals and sponges were presented from the 2022 EU-Spain and Portugal bottom trawl groundfish survey. The data was made available to the NAFO WGESA to improve mapping of Vulnerable Marine

Ecosystem (VME) species in the NAFO Regulatory Area (Divs. 3MNO). Distribution maps of presence and catches above threshold for RV data of sponges (100 kg/tow), large gorgonians (0.6 kg/tow), small gorgonians (0.2 kg/tow), sea pens (1.3 kg/tow), Boltenia sea squirts (0.35 kg/tow), bryozoans (0.2 kg/tow) and black corals (0.4 kg/tow) were presented.

Due to logistical issues during 2022, R/V Vizconde de Eza only carried out two surveys, one in Division 3M (Flemish Cap) sampling between 128 -1470 m, with a total of 183 tows (182 valid; 1 no valid) and other in Divisions 3NO (Grand Banks of Newfoundland) sampling between 40 - 1460 m depth with a total of 114 tows (113 valid; 1 no valid). In total there were 297 bottom trawl tows, two of them considered invalid due to technical problems during the fishing operation. 110 hauls out of 295 valid tows have shown zero catches (i.e. no presence) of VME indicator species groups. This represents the 37.3% of the total valid hauls.

Sponges were recorded, with non-significant concentrations (< 100 kg/tow), in 81 of the 295 valid tows (27.5% of the valid tows analyzed), with depths ranging between 128 - 1460 m. One of the valid tows was found to have a significant concentration of sponges (≥ 100 kg/tow).

Large gorgonians were recorded, with non-significant concentrations (< 0.6 kg/tow), in 9 of the 295 valid tows (3% of valid tows analyzed), with depths ranging between 607- 1405 m. One of the valid tows had a significant concentration of large gorgonians (≥ 0.6 kg/tow).

Small gorgonians were recorded, with non-significant concentrations (< 0.2 kg/tow), in 39 of the 295 valid tows (13.2% of valid tows analyzed), with depths ranging between 482- 1470 m. One of the valid tows had a significant concentration of small gorgonians (≥ 0.2 kg/tow).

Sea pens were recorded, with non-significant concentrations (<1.3 kg/tow), in 101 tows (34.2% of valid tows analyzed), with depths ranging between 221 - 1470 m. One significant concentration (≥ 1.3 kg/tow) was recorded.

Black corals were recorded, with non-significant concentrations (< 0.4 kg/tow), in 18 tows (6.1% of valid tows analyzed), with depths ranging between 281 - 1336 m. One significant concentration (≥ 0.4 kg/tow) was recorded.

Sea squirts (Boltenia ovifera) was recorded, with non-significant concentrations (< 0.35 kg/tow), in 1 tow (0.3% of valid tows analyzed), at a depth of 562 m. Three significant concentrations (≥ 0.35 kg/tow) were recorded.

Bryozoans were recorded, with non-significant concentrations (< 0.2 kg/tow), in 25 tows (8.5% of valid tows analyzed), with depths ranging between 49 - 1377 m. Two significant concentrations (≥ 0.2 kg/tow) were recorded.

NEREIDA

A new NEREIDA Grant Proposal “Research in support of the reassessment of NAFO bottom fisheries in 2022 (NAFO)” was approved with a financing of 149.000 euros. The project has a duration of 18 months, starting on 1st January 2023. The proposed action has three specific activities: i) To analyze the methodology to study the bottom-fishing footprint in the NAFO Regulatory Area (NRA); ii) To monitor the spatial and temporal distribution of marine litter and iii) To update available information on spatial distribution of existing and planned activities other than fishing in NRA, particularly oil and gas.

New information on oil and gas activities: An updated map of the geographical location of oil and gas activities in NAFO Divs. 3LNM was presented to the 2022 WGESA. New spatial data (licences and wells) was available this year from publicly available data sources. In comparison with the information assessed previously reported by the WGESA, there are two new “exploration wells” in Division 3L, one of them located inside NAFO fishing grounds. There has been an increase in the overlap between oil and gas activities, VMEs and VME Area closure No. 10 due to both the increase in the number of “significant discovery licenses” and the expansion of Area closure No 10. In addition, the overlap between oil and gas activities and NAFO groundfish surveys, in Div 3LM was also presented, based on survey stratification and the start position of survey hauls (EU and EU Spain: 1988-2021). This is a matter of concern in terms of possible future restrictions on the area and depth of sampling.

USA (SCR Doc. 23/015):

The US conducted a spring survey in 2022 covering NAFO Subarea 5 and 6 aboard the FSV Henry B. Bigelow. There were 365 out of the normal 350-380 successfully completed. The fall survey successfully completed 311 stations in NAFO Subareas 5 and 6. Results are presented for a single survey for 30 stocks. The fall indices for both cod stocks are low and the stocks are exhibiting truncated age structure. Two of the three stocks of yellowtail flounder are near or at the lowest values observed. High survey estimates were found for northern silver hake and butterfish in 2022.

ii) Summary of the decisions and conclusions stock by stock regarding whether the survey can be used as a stock index for 2022.

The 2022 Canadian spring survey used a new research vessel for which catchability conversion factors are not yet available. So, no survey indices are available for the stock assessments of the Grand Banks. The Canadian 2022 fall survey was not undertaken.

No 3L EU-Spain survey was conducted in 2022.

c) Tagging activities

Two tagging activities by Canada were presented.

i) Tagging: Ocean Tracking Network Greenland halibut in NAFO Subareas 0 and 1

Results of Ocean Tracking Network Greenland halibut tracking studies in NAFO Subareas 0 and 1 between 2010 and 2022 were presented. Fish were tracked using acoustic tags that were surgically implanted in the visceral cavity. Tags allow the identification of individual fish when they swim within ~800 m of a moored tag receiver; tag batteries last approximately 7 years. Tag receivers have been deployed as gates moored in Cumberland Sound, around Broughton Island, at Scott Inlet (from inside the fiord to the shelf break), in Pond Inlet, along the shelf break in Baffin Bay, at the Disko Fan Conversation Area, along the Divs. 0A-0B border and along the Divs. 0B-2G border. The mooring placements have allowed examination of movement patterns within inshore habitats, between inshore and offshore habitats, and among fishery management areas. Data are informing stock structure and connectivity, with implications for management of developing inshore fisheries in Canada.

ii) Tagging and telemetry of Greenland Halibut (NAFO DA 2+Div. 3KLMNO, SA0) and witch Flounder (NAFO Div. 2J3KL).

An update on an ongoing telemetry research project being undertaken by Fisheries and Oceans Canada was provided to STACREC. This program (2021-2025) is examining the movement ecology of Greenland halibut and witch flounder, and aim to quantify seasonal and inter-annual movements of these species in the context of habitat use, migration, and stock and survey boundaries. This program also aims to advise on mitigation strategies to reduce Greenland shark bycatch in the Greenland halibut fishery based on spatial and temporal overlap in movement patterns. Initial results shown indicate high post-tagging survival of witch flounder, and narrow temperature range of Greenland halibut across a wide depth use. Updates on project progress and analyses will continue to be shared with SC, with further results anticipated at the 2024 SC meeting.

6. Review of SCR and SCS Documents

There were no documents to be revised.

7. Other Matters

a) Report on data availability for stock assessments (by Designated Experts).

During the 2019 STACREC meeting, it was suggested that there should be a better organized process for requesting and submitting data for stock assessment and other processes, such as National Research Reports. There was no time to discuss this again during the 2021 meeting. Some discussions were raised during 2022 June and September STACREC meetings. In all the cases, it was highlighted that special care has to be taken with regards to confidentiality and duplication of the data. The types of available data and how to proceed with each are detailed in the June 2022 STACREC report. During this meeting, no progress could be made. This matter will be revisited during the September meeting:

1. Data that are in the SCR and SCS and are public.
2. Data submitted to the Designated Experts by the National Representatives.
3. Assessment data and code.
4. Data that belongs to the Contracting Parties and are sent to NAFO.

b) Annual submissions of information to NAFO: National Research Reports, Inventories of biological surveys, List of biological sampling data, List of tag releases, RV surveys on a stock by stock basis.

Discussions on the above information took place in STACREC in 2019-2022. As no progress was made, this will be revisited during the September meeting:

1. National Research Reports
2. List of biological sampling data
3. RV surveys on a stock by stock basis
4. Inventories of biological surveys

The document *SC Request for Info* pdf (NAFO 23/040) was converted by the Secretariat into a fillable pdf.

c) Summary of the ICES Workshop on Unavoidable Survey Effort Reduction 2 (WKUSER2)

The ICES Workshop on Unavoidable Survey Effort Reduction 2 (WKUSER2) was held on September 17th 2022 in Galway, Ireland. The workshop focused on addressing the challenges posed by unavoidable changes in survey effort while minimizing information loss and ensuring continuity in survey time series. The workshop brought together experts to review existing research, current practices, and recommend future directions in four key areas: survey design for flexibility, combining surveys and dealing with data gaps, modelling and simulations, and tools and technology development.

In the first area, survey design for flexibility, it was acknowledged that fish distribution can change unpredictably, available resources may be reduced, and sampling frames can be affected. Not taking appropriate actions in response to these changes can compromise the final data products. To overcome this challenge, the workshop emphasized the need to adapt survey designs, such as through calibration, to account for these changes and maintain data quality.

The second area, combining surveys and dealing with data gaps, explored strategies for handling overlapping or non-overlapping survey data. When overlap exists, the workshop suggested potential approaches like paired sampling or modeling techniques to combine the data effectively. However, when overlap is lacking, the workshop recommended investigating new or modified sampling designs to create overlap and ensure continuity in the data series.

The third area, modelling and simulations, focused on best practices in model development, validation, and diagnostics. The workshop identified two pathways for simulations: resample-based and model-based. Simulations were seen as valuable tools for evaluating the risks associated with survey effort reductions and can help inform decision-making processes.

The fourth area, tools and technology development, emphasized the evaluation of existing tools for assessing changes in sampling design. Standardization and accessibility of these tools were considered crucial, along with the need for transparency, documentation, and code accessibility. This ensures that scientists and survey managers can effectively evaluate the impact of survey effort changes on data and advice quality.

Overall, roadmaps were developed for each topic area to provide guidance to scientists and survey managers when evaluating and mitigating the impact of survey effort changes on data and advice quality. By implementing the recommendations from the workshop, scientists and survey managers can make informed decisions and maintain the integrity of survey time series data.

For more information, the full workshop report can be accessed at https://doi.org/10.17895/ices.pub.22086845.v1.

d) Presentation of the NORSUSTAIN project

Research institutes from six different Nordic countries (Canada, Greenland, Iceland, Norway, Faroes Islands and Denmark) are collaborating within the project NORSUSTAIN (Sustainable blue growth by science and improved management) to study the spatial population structure of Greenland halibut (*Reinhardtius hippoglossoides*). The project is founded by the Nordic Council and aims to clarify stock structure by use of multiple methods such as genetics, tagging, trace elements in otoliths, drift modelling and the use of fishery and survey data. The outcome will be valuable for Nordic coastal communities by means of improved biological knowledge that can be operational for direct implementation in biological advice and thereby ensure a sustainable and robust management of the resource.

Analysis of historic tagging experiments (1952-2019) show evidence for three biological populations of Greenland halibut in the North Atlantic: one in the Gulf of St. Lawrence; one comprising the Newfoundland, and Labrador shelf and Grand Banks, Davis Strait and Baffin Bay (including deep-water inshore areas) in the west; and one comprising the Barents Sea, Norwegian Sea, and waters around Faroe Islands, Iceland, and off Southeast Greenland in the east. There is some evidence of mixing around Southeast Greenland and West Iceland (Vihtakari et al. 2021).

Multivariate Autoregressive State-Space Models were used, with survey data from 3 of the 4 offshore stocks from the North Atlantic (Barent sea stock, East Greenland-Iceland-Faroes stock and the Davis Strait-Baffin Bay stock), to test whether there is data support for the current stock delineation or whether alternate population structures should be considered. The best-fit model would treat Greenland halibut in the East Greenland-Iceland-Faroes stock as two independent populations (east and west), with potential connections between eastern Iceland and the Barent Sea Stock (Ubeda et al. 2023).

References

Úbeda, J., Nogueira, A., Tolimieri, N., Vihtakari, M., Elvarsson, B., Treble, M. , and Boje, J. 2023. Using multivariate autoregressive state-space models to examine stock structure of Greenland halibut in the North Atlantic. Fisheries Management and Ecology. Doi: 10.1111/fme.12639

Vihtakari M., Elvarsson B., Treble M., Nogueira A., Hedges K., Hussey N.E., Wheeland L., Roy D., Ofstad L.H., Hallfredsson E.H., Barkley A., Estévez-Barcia D., Nygaard R., Healey B., Steingrund P., Johansen T., Albert O.T., and Boje J. 2022. Migration patterns of Greenland halibut in the North Atlantic revealed by a compiled mark-recapture dataset. ICES Journal of Marine Science, 2022; fsac127, https://doi.org/10.1093/icesjms/fsac127

e) Bottom temperatures on the Grand Banks during the CAN-Spring and CAN-Fall surveys.

An exploration of bottom temperatures during the Canadian surveys was presented. The Canadian spring survey in 2022 was incomplete and is not yet converted, but temperature data are available for use. These were added to the existing Campelen survey series (spring & fall since 1996). Increases in temperature are apparent – consistent with broader climate indices reported by STACFEN – but within the Grand Bank survey these are dominated by changes in Div. 3O. The highest rate of change is observed in strata 184-366m deep in Div. 3O.

Concern was raised about the potential impact of changes in temperatures on the abundance, distribution, and composition of fish observed during the survey, and on stock and ecosystem dynamics.

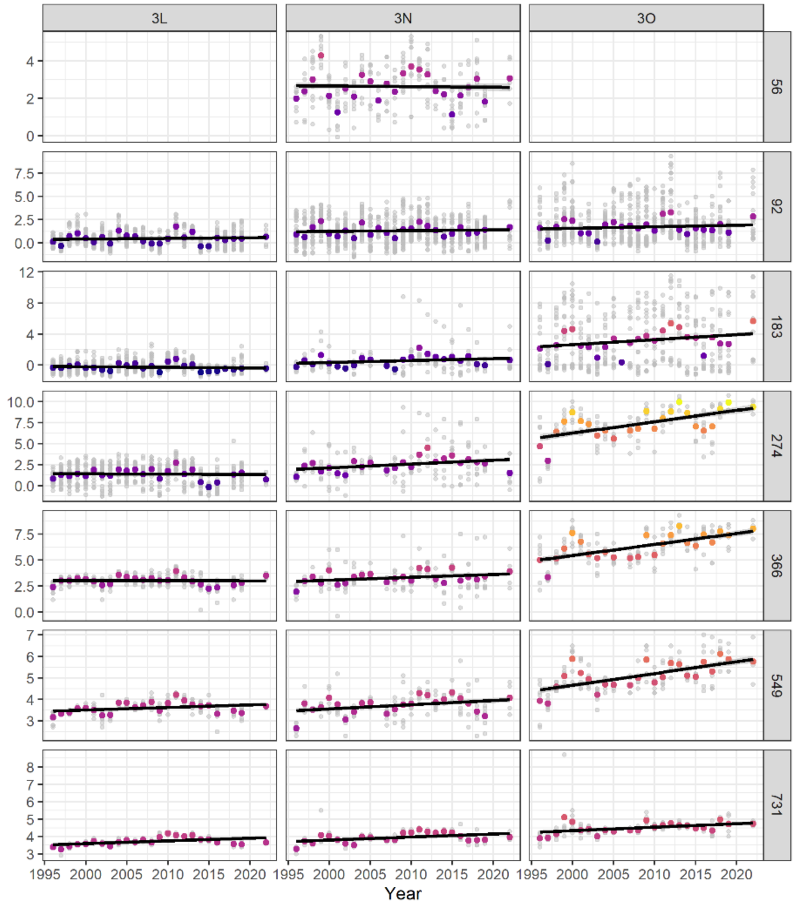


Figure 1. Average (±SD) bottom temperature by NAFO division and strata depth range (vertical panels show strata maximum depth in m) during fishing sets in the CAN-Spring survey. Trends in Fall are consistent with those observed in Spring. Coloured points indicate the average annual temp, grey points show individual measurements. Black line shows lm fit to mean annual temps.

f) Research plan of the Faroese survey in Division 3M targeting cod.

Since 2021 FAMRI (Faroe Marine Research Institute) has conducted a data gathering activities in NAFO Division 3M with the intent of developing a scientific survey. The data was presented as a complement to the EU Div. 3M bottom trawl research survey. In principle, a longline survey may provide additional information on the ecosystem in 3M. However, STACREC noted that the implemented design was insufficient (e.g. lack of proper consideration of number of hooks, stratification and catchability) to be considered as a valid scientific survey. A survey design requires a detailed survey Research Plan to properly assess the potential scientific value of the data collected.

The catch in 2021 and 2022, 630 t and 242 t, respectively suggest that the longline survey is not optimized for the collection of information with minimum impact, as would be the case for a typical scientific survey.

In both June 2021 and 2022, STACREC considered that this initiative does not fulfil the requirements of a valid scientific survey and more closely resembles a commercial fishery.

In September 2022, following the recommendations made by STACREC in June 2022, the Commission amended the Article 4 of the NCEM to provide guidelines for research vessels operating in the NRA. Among them, there is the obligation to provide the Research Plan and any changes thereof no less than thirty days in advance of the opening of the Scientific Council's June meeting for new non-recurrent surveys and research activities or if any catches retained on board during research activities will be marketed.

In May 2023, FAMRI submitted a Research Plan for the longline Faroe survey to be reviewed by the Scientific Council. A summary of this Research Plan is: *The objective is to compile a time-series of data which can potentially be incorporated to the assessment of 3M cod. The survey follows a random stratified design with 52 stations covering the NAFO 3M area at depth contours shallower than 700 m. Biological sampling including length, weight, sex and age measurements are taken in every set/station. In addition, temperature is recorded at several points in the vertical depth profile of all stations. The survey will be carried out in the months of May or June depending of vessel availability. Bottom longline gear is employed during fishing activities with around 4000 hooks in every set*.

Although some improvements were made in the Research Plan which was formerly reviewed by STACREC, it still fails in providing adequate procedures and standardization to be considered as a scientific survey. Concern was raised over the volume of catches in this survey. Given the observed catch rates, reducing the number of hooks per station is advised and should not impact catch indices. 24 hour soak time may also be leading to gear saturation and consideration should be given to shorter sets, though maintaining day/night consistency.

g) Data gathering activities conducted by Faroes (SCR 23/04):

A Faroese longline data gathering exercise was carried out in NAFO 3M during the month of June in 2022. The aim and objective of the data gathering exercise was to get an indication of the cod stock with an alternative gear and build a time series which can potentially be incorporated to the assessment. The protocol of the data gathering exercise was presented to SC. It follows a random-stratified design with 52 longline sets of 4000 hooks each covering the shallow area (< 700 m) of Flemish Cap. Biological measurements such as length, weight, sex and age readings are to be taken in every station. A total of 912 length and weight measurements along with 272 otoliths and sex readings were collected in 2022. Catch per unit of effort (CPUE) measured as the total weight of cod caught per hook (1018 gr/hook) was very similar to that in 2021 (1049 gr/hook).

8. Adjournment

The meeting was adjourned on June 15, 2023.

APPENDIX IV. REPORT OF THE STANDING COMMITTEE ON FISHERIES SCIENCE (STACFIS)

Chair: Mark Simpson Rapporteur: Tom Blasdale

I. OPENING

The Committee met from 2 June to 15 June 2023 to consider and report on matters referred to it by the Scientific Council, particularly those pertaining to the provision of scientific advice on certain fish stocks. Representatives attended from Canada, Denmark (in respect of Faroe Islands and Greenland), the European Union, Japan, Norway, the Russian Federation, Ukraine, the United Kingdom, and the United States of America. Observers from Oceans North and the Food and Agriculture Organization of the United Nations were also present. The Executive Secretary, Scientific Council Coordinator and other members of the Secretariat were in attendance. The Chair, Mark Simpson (Canada) opened the meeting by welcoming participants. The agenda was reviewed and a plan of work developed for the meeting in accordance with the Scientific Council plan of work. The provisional agenda was adopted. Owing to the limited time available during the meeting, it was not possible to consider drafts of all report sections in plenary. As in previous years, designated reviewers were assigned for each stock for which an interim monitoring update was scheduled (see SC Report). Following presentation and discussion of Full assessments, Designated Experts produced drafts of their respective report sections which were reviewed in plenary.

II. GENERAL REVIEW

1. Review of Recommendations.

STACFIS agreed that relevant stock-by-stock recommendations from previous years would be considered during the review of a stock assessment or noted within interim monitoring report as the case may be and the status presented in the relevant sections of the STACFIS report.

2. General Review of Catches and Fishing Activity

The NAFO Secretariat presented the catch estimates developed by CESAG in COM-SC CESAG-WP 22-01REV2 and made the supplementary data that went into the analyses available for SC to review. The Secretariat noted that the catches were estimated based on the strategy outlined in Annex 1 of COM-SC Doc. 17-08, amended following a recommendation from STACFIS in 2018, to include catch estimates of broken down by quarter and gear type. It was also noted that a number of contracting parties had not submitted catch submissions for 2022 at the time of the meeting, therefore many of the STATLANT 21A catches reported in the catch tables in this report should be considered provisional.

3. External Review.

Instead of having reviewers for assessments in 2023, effort was put into review of MSE work (see response to Commission request #4 (section VII.1.c,iii) and appendix IX)

III. STOCKS ASSESSMENTS

STOCKS OFF GREENLAND AND IN DAVIS STRAIT: SA 0 AND SA 1

Environmental Overview

Hydrographic conditions in this region depend on a balance of ice melt, advection of polar and sub-polar waters and atmospheric forcing, including the major winter heat loss to the atmosphere that occurs in the central Labrador Sea. The cold and fresh polar waters carried south by the east Baffin Island Current are counter balanced by warmer waters are carried northward by the offshore branch of the West Greenland Current (WGC). The water masses constituting the WGC originate from the western Irminger Basin where the East Greenland Currents (EGC) meets the Irminger Current (IC). While the EGC transports ice and cold low-salinity Surface Polar Water to the south along the eastern coast of Greenland, the IC is a branch of the North Atlantic current and transports warm and salty Atlantic Waters northwards along the Reykjanes Ridge. After the currents converge, they turn around the southern tip of Greenland, forming a single jet (the WGC) that propagates northward along the western coast of Greenland. The WGC is important for Labrador Sea Water formation, which is an essential element of the Atlantic Meridional Overturning Circulation. At the northern edge of the Labrador Sea, after receiving freshwater input from Greenland and Davis Strait, part of the WGC bifurcates southward along the Canadian shelf edge as the Labrador Current.

1. Greenland Halibut (*Reinhardtius hippoglossoides*) in Subarea 0 and 1 (Offshore)

Interim Monitoring Report (SCR Docs 20/015, 23/012,020,029,031,032,034; SCS Docs. 04/12, 23/009, 014)

a) Introduction

A TAC for Greenland halibut in Subarea 0 + 1 (offshore) was established in 1994, following the separation of the 1A inshore stock area from the offshore. In 2020 the 1B-F inshore stock areas were also separated from the offshore management area. Catches prior to 1994 varied with peaks of 20,000 t in 1975 and 1992. Since 1994 catches have increased in response to increases in TAC, increasing from approximately 9 000 t in 1994 to 36 400 t in 2019. Catch and TAC remained at 36 400 t from 2019 to 2022.

Recent catches and TACs ('000 tonnes) are as follows:

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TAC	30	30	30	32.3	32.3	36.4	36.4	36.4	36.4	29.6
SA 0	14.9	15.4	14.1	15.9	16.0	18.3	17.9	19.1[2]	18.6[3]	
SA 1	14.7	14.9	15.2	16.2	16.2	18.0	18.1	17.3	17.8[4]	
Total STACFIS[1]	29.6	30.3	29.3	32.1	32.2	36.3	36.0	36.4	36.4	

[1] Based on STATLANT, with information from Canada and Greenland authorities to exclude inshore catches.
[2] STACFIS estimate using 1.5 conversion factor for J-cut, tailed product; 1 129 t increase over reported catch.
[3] STACFIS estimate using 1.5 conversion factor for J-cut, tailed product; 653 t increase over reported catch
[4] Based on official catches from the Greenland Office of Fisheries Licenses (GLFK) because STATLANT were not available.

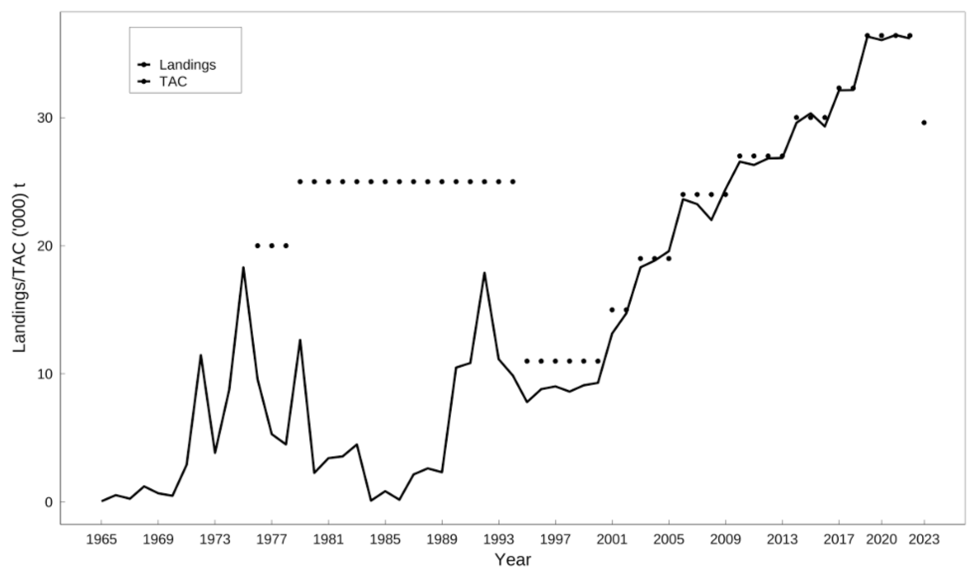


Figure 1.1. Greenland halibut in Subareas 0+1 (offshore): Total catch (black line) and TAC (dotted line)

b) Data Overview

Recent surveys are as follow:

	Division	2018	2019	2020	2021	2022
Greenland deep-water surveys	1CD	–	o	–		o
Greenland shallow survey	1AF	●	●	●		●
Canadian Baffin Bay	SA 0	–	o	–	–	o

● = complete, o = uncalibrated, – = incomplete

In the past, surveys were conducted by Russia and the Federal Republic of Germany in 0B (1987-1992) and by Greenland and Japan in 1BCD (1987-1995). Greenland and Canada began conducting surveys in 1997 and 1999, respectively.

Surveys for both Greenland (deep water survey in 1CD and shallow water survey in 1AF) and Canada (deep water survey in 0A) were completed with the RV Pâmiut. The deep water surveys used an Alfredo bottom trawl and the shallow survey a Cosmos bottom trawl. This vessel was decommissioned following the 2017 surveys. Commercial vessels were contracted to conduct surveys during 2018 to 2020 using all of the standard gear from the RV Pâmiut (cosmos trawl, doors, bridles etc.) with trawl performance monitored using Marport sensors on doors and headlines, in an effort to make the surveys as similar as possible with the previous surveys. No comparative fishing was conducted between the vessels. Trawl performance was examined in 2019 using data on net height, wing spread and door spread. Results for the RV Pâmiut, C/V Sjudarberg and C/V Helga Maria used for the shallow survey in 1AF, from which an age-1 Greenland halibut abundance index is derived, indicated gear performance was similar among the vessels and years, and the results of the surveys were comparable. However, gear performance for the deepwater 1CD and 0A-South surveys in 2019 was substantially different from that of the RV Pâmiut, particularly at depths below 700 m and the results of the 2019 surveys were not considered comparable to the previous time series. In 2022, new survey time series started with the R/V Tarajoq using a Bacalao bottom trawl in the deep water surveys in 0A and 1CD, and the Cosmos trawl in the shallow survey in 1AF.

Greenland deep-water surveys. Since 1997 Greenland has conducted buffered stratified random bottom trawl surveys during September-October in NAFO Div. 1CD, from 400 to 1500 m. Biomass in 1CD has fluctuated with a slight positive trend through most of the time series. In 2017, biomass was similar to levels seen in 2015 and 2016. There were no surveys in years 2018 and 2020, and the 2019 and 2022 estimates are not comparable to previous values.

Canada deep-water surveys. Since 1999 Canada has conducted surveys in Subarea 0. Surveys in 0A-South (to 72°N) were conducted in 1999, 2001, every second year between 2004 and 2014, annually during 2015-2017. In 2019, and in 2022. The 2006 survey had poor coverage and was not considered valid. Biomass in Div. 0A-South varied with an increasing trend from 1999 to 2016 followed by a marked decline in 2017. Surveys in 0B have been less frequent, with surveys occurring in 2000, 2001, 2011, 2013-2016 and 2022. Biomass for Div. 0B in 2016 was similar to a previous high observed in 2011. There were no surveys in years 2018 and 2020, and the 2019 and 2022 estimates are not comparable to previous values.

Combined 0A-South and 1CD Survey Index. In 2014 STACFIS adopted a recommendation from the ICES Greenland halibut benchmark meeting (ICES 2013) to create a combined survey index with which to monitor the overall Subarea 0+1 (offshore) stock. The surveys are conducted with the same vessel and gear during the fall which allows for simple addition of the survey estimates to create the index. The index remained stable at a relatively high level during 1999-2012 and therefore, based on Precautionary Approach Framework guidance from NAFO SC for stocks assessed using an index, the average over this period was accepted as a proxy for B_{msy} and B_{lim} was set as 30% of the proxy B_{msy}. The index increased between 2014 and 2016 and while it declined in 2017 it remains above B_{lim}. The decline observed in 2017 was a result of a decline in the 0A-South survey biomass. Plots for the biomass index (Figure. 1.2) and for the independent indices from 2019 and 2022 (Figure. 1.3) are included.

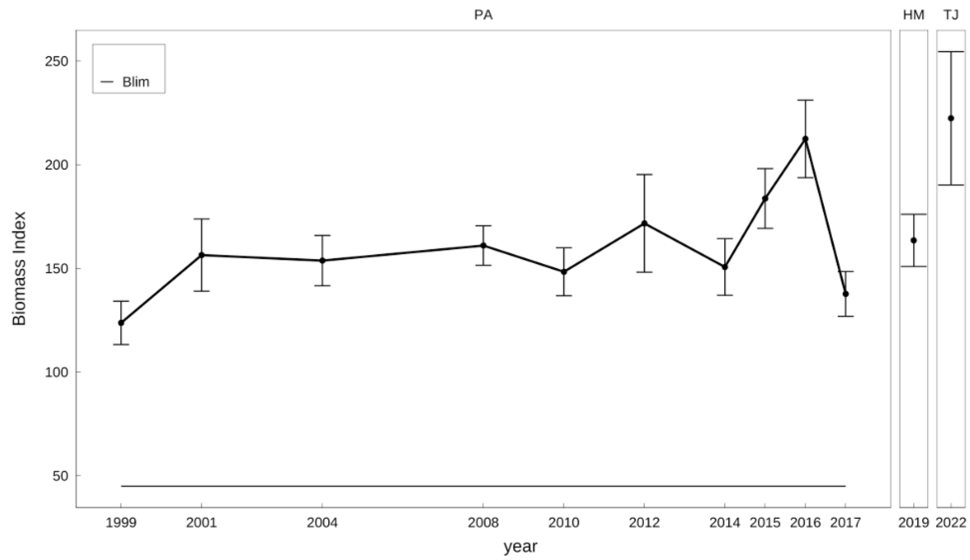


Figure 1.2. Greenland halibut in Subarea 0+1 (offshore): 0A-South and 1CD combined biomass index from surveys with the R/V Paamiut (PA:left panel), C/V Helga Maria (HM:middle panel) and R/V Tarajoq (TJ:right panel); horizontal line indicates B_{lim}.

Shallow survey 1AF: the survey has been conducted by Greenland since 1988 targeting shrimp. Since 1991 Greenland halibut data have been collected during the survey. A truncated index of biomass of fish > 35 cm fork length from that survey increased from 1991 to a high in 2004, declined until 2008 and has since varied without trend.

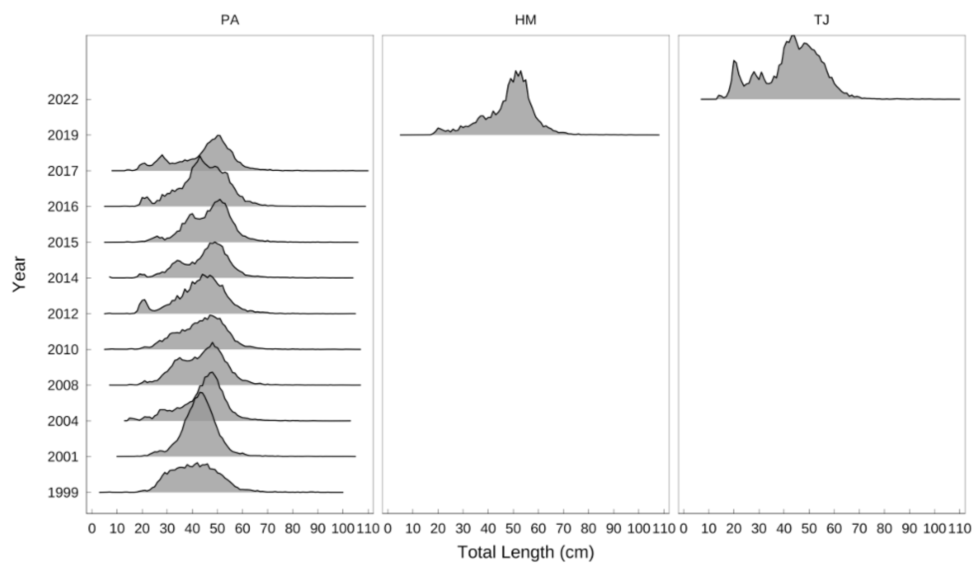


Figure 1.3. Greenland halibut in 1AF: biomass index of fish > 35 cm fork length in the shallow survey in 1AF.

Age-1 Abundance Index. The Petersen-method is used to assign Greenland halibut caught during the West Greenland shrimp survey to age 1, 2 and 3+ using length data. The number of 1 year old fish in the survey area, including Disko Bay (also area within 0A where available), is used as an age-1 index to help inform stock status (Figure 1.4). The index generally increased from 1988 to 2003, followed by a declining trend to 2010, after which the index has been variable with series high values observed in 2011, 2013 and 2017. Abundance in 2020 was near the series average, and in 2022 the index declined slightly. The survey was conducted by different vessels in 2018, 2019, 2020 and 2022 but gear performance analyses concluded the surveys were comparable.

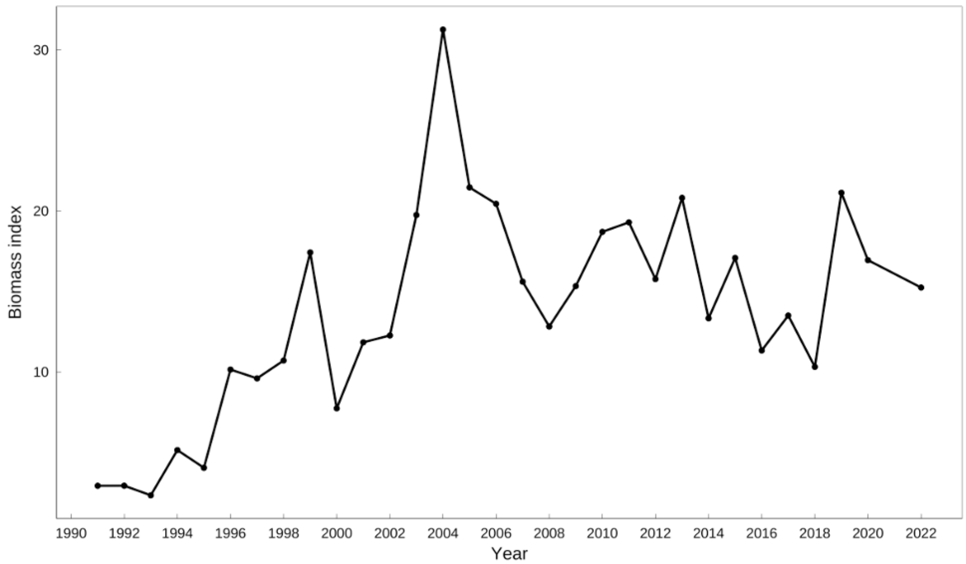


Figure 1.4. Greenland halibut in Subareas 0+1: age-1 abundance index for Subarea 1, derived from the Greenland shallow survey in 1AF (including sets in 0A where available).

c) Conclusion

The combined 1CD and 0A-South biomass index was above B_{lim} throughout the time series, 1999 to 2017. There are no index values for 2018. No surveys were completed in 2020 and 2021.

In 2020 the age-1 abundance index was near the series average and there have been high abundances in 2011, 2013 and 2017. It is unclear if age-1 abundance is representative of future recruitment but it is considered to contribute to the perception of overall stock status.

Age-based or production models are not available for estimation of precautionary reference points for this stock. In 2014 a preliminary proxy for B_{lim} was set as 30% of the mean for the combined 0A-South + Div. 1CD survey biomass index for years 1999 to 2012 (Figure 1.2). The combined 1CD and 0A-South index remained above B_{lim} during the remainder of the time series (2013-2017). This B_{lim} value was valid to 2017, but needs to be re-evaluated once a new time series is established.

In 2022, NAFO SC recommended that 2023 and 2024 harvests not exceed the average catches for the period 2013-2017. TACs for 2023 and 2024 were set at 29,640 t, the average catches during this period. In 2022 a new survey times series started with the R/V Tarajoq using the Bacalao trawl, but SC determined that the single year of new data is not sufficient to give new advice.

The next full assessment of this stock is planned for 2024.

2. Greenland Halibut (*Reinhardtius hippoglossoides*) in Subarea 1A inshore.

(SCR Doc. 23/020, 021, 022, 028, 030, 033, 037; SCS Doc. 23/1)

Interim monitoring report

a) Introduction

The fishery targeting Greenland halibut developed in the Disko Bay and south Greenland in the beginning of the twentieth century. The fishery is conducted with longlines or gillnets from small vessels, open boats and through holes in the sea ice during the winter months. Quota regulations were introduced in 2008 as a shared quota for all vessels. In 2012, the TAC was split in two components with ITQ's for vessels and shared quota for small open boats.

b) Catch history

Disko Bay

The catches remained below 1 000 pr year until 1975. Catches increased in the 1980s and peaked from 2004 to 2006 at more than 12 000 t. Since then catches have in most years been between 8 000 and 9 000 t. In 2022 catches reached 10 325 t (Figure 2.1).

Recent catches and TAC ('000 tonnes) are as follows:

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
1A Disko Bay – TAC	9.00	9.20	9.65	9.20	9.20	11.08	10.58	10.25	11.38	9.10
1A Disko Bay - Catch	9.18	8.67	10. 76	6.41	8.40	8.76	7.60	9.03	10.33	
STACFIS Total	9.18	8.67	10. 76	6.41	8.40	8.76	7.60	9.03	10.33	

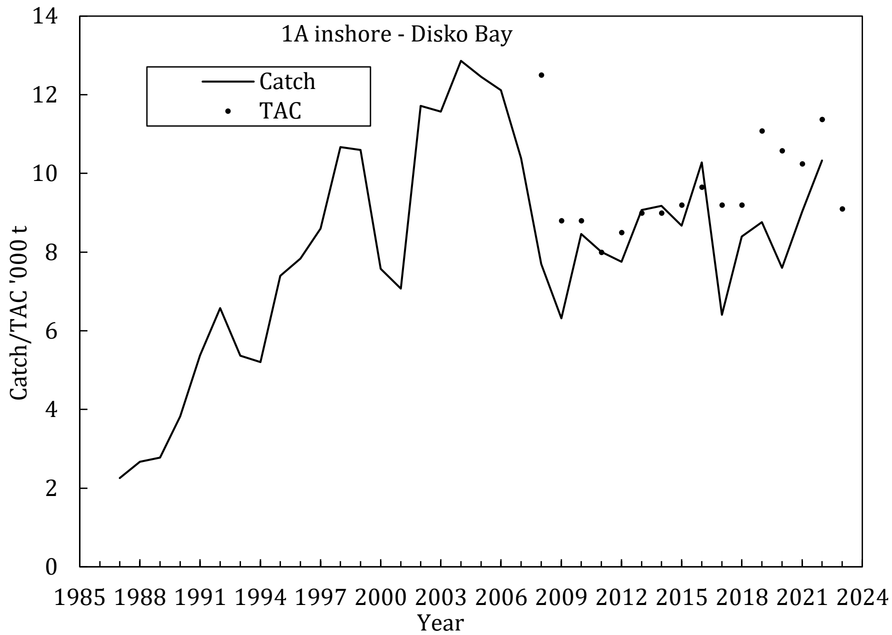


Figure 2.1. Greenland halibut in Division 1A inshore: Greenland halibut catches and TAC in t in Disko Bay.

Uummannaq

Catches in the Uummannaq fjord gradually increased from the 1980's reaching 8 425 t in 1999, but then decreased to around 5 000 in 2002. Since 2004, catches gradually increased before stabilizing around 10 000 t/year. In 2022, catches decrease slightly to 9 007 t (Figure 2.2).

Recent catches and TAC ('000 tonnes) are as follows:

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
1A Uummannaq - TAC	8.38	9.50	9.85	9.50	9.50	9.90	9.90	9.64	9.75	9.65
1A Uummannaq - catch	8.20	8.24	10.30	9.05	8.84	10.16	10.67	9.61	9.0	
STACFIS Total	8.20	8.24	10.30	9.05	8.84	10.16	10.67	9.61	9.0	

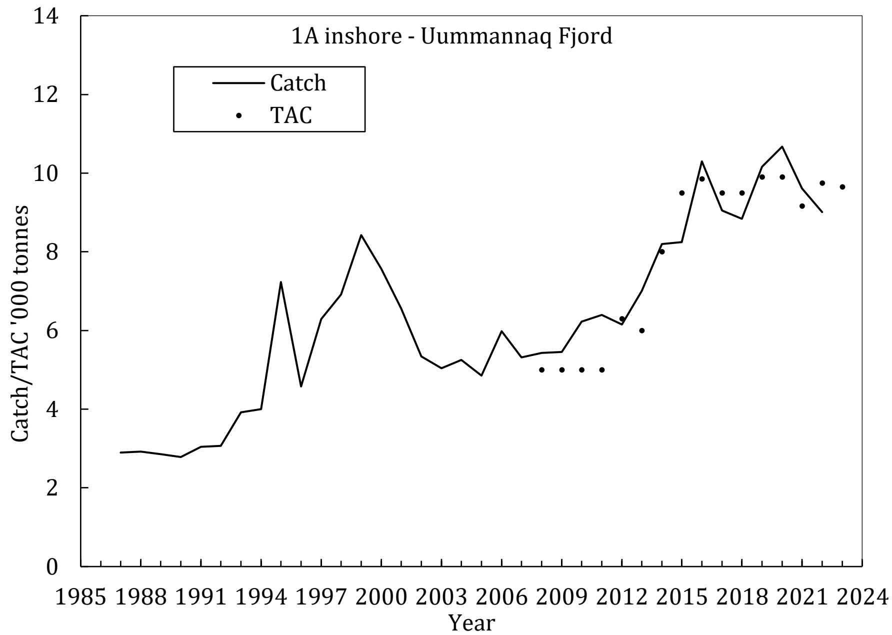


Figure 2.2. Greenland halibut in Division 1A inshore: Catches and TAC in t in Uummannaq.

Upernavik

Catches increased from the mid 1980s and peaked in 1998 at a level of 7 000 t. Landings then decreased sharply, but during the past 15 years, catch has gradually increased to a level between 7 500 and 9 000 t. (Figure 2.3).

Recent catches and TAC ('000 tonnes) are as follows:

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
1A Upernavik - TAC	9.50	9.50	9.50	9.50	9.50	8.46	8.46	9.91	10.00.	9.30
1A Upernavik - Catch	7.38	6.27	7.36	6.78	7.55	8.97	7.57	8.48	7.74	
STACFIS Total	7.38	6.27	7.36	6.78	7.55	8.97	7.57	8.48	7.74	

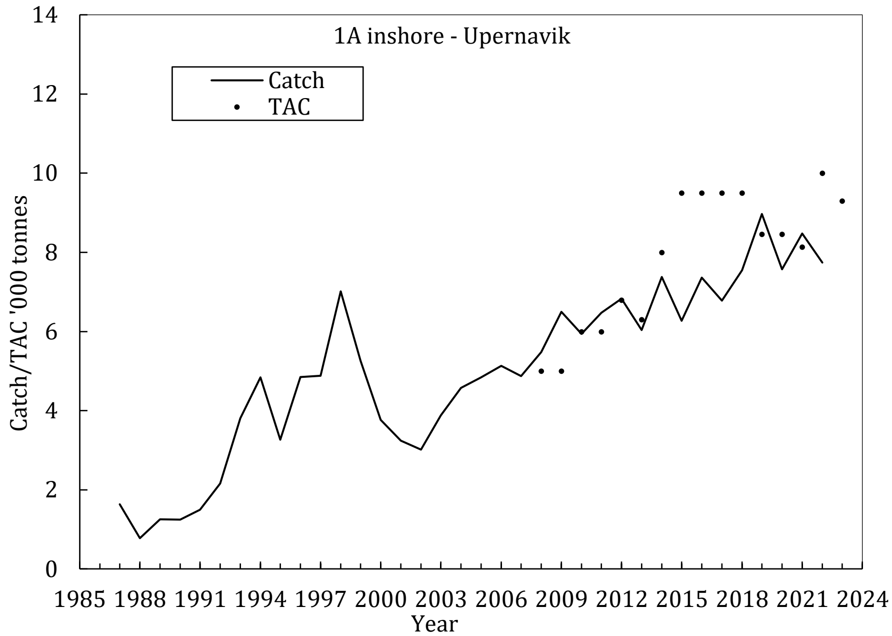


Figure 2.3. Greenland halibut in Division 1A inshore: Catches and TAC in t in Upernavik.

c) Data overview

i) Commercial fishery data

Disko Bay

The mean length in the landings gradually decreased for more than a decade in both the winter and summer longline fishery and in the overall mean length weighted by gear and fishing ground (Figure 2.4). However, the mean length in the landings has increased in both 2021 and 2022.

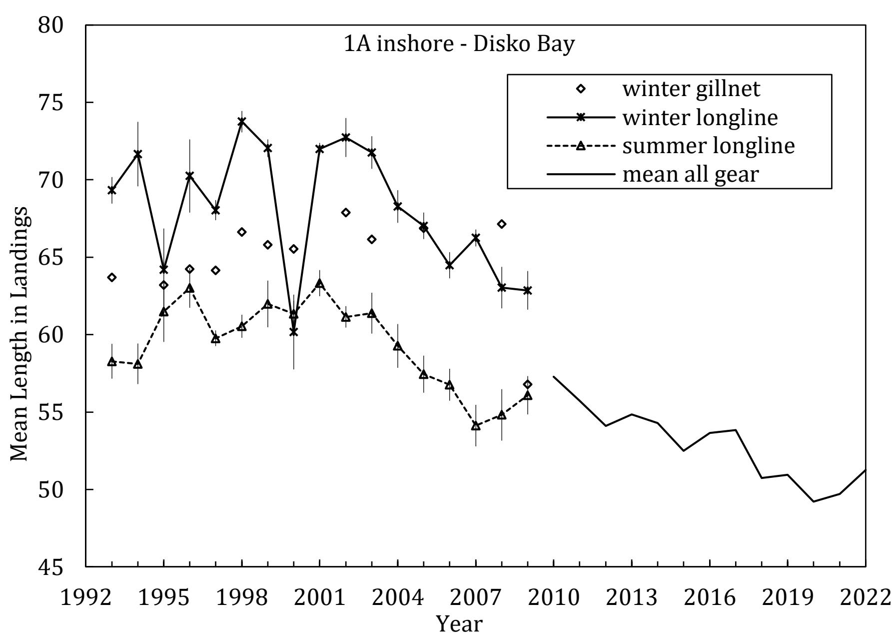


Figure 2.4. Greenland halibut in Division 1A inshore: Mean length in landings from longline fishery by season (summer and winter) and overall mean taking account of fishing ground, season and gear.

CPUE indices from the commercial catch: Two commercial CPUE indices are presented for the stock, one based on longline logbooks and one based on factory landings data (based on longline fishery). The CPUE based factory landings from longline caught Greenland halibut has between 12 000 and 16 000 observations annually in the Disko Bay and the CPUE is currently based on more than 150 000 observations.

The factory landings based CPUE on shows an initial decrease to 2017, but has gradually stabilized until 2020 and increased in 2021 and 2022. (Figure 2.5)

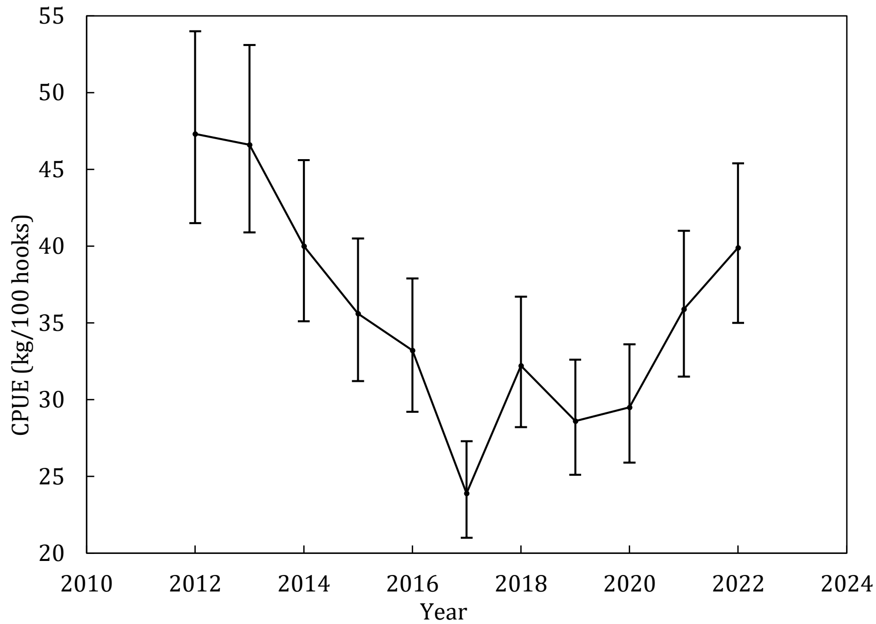


Figure 2.5. Greenland halibut in Division 1A inshore: Commercial CPUE (Kg/hook) based on factory landing reports standardized mean and 95% CI in Disko Bay.

The standardized CPUE based on longline logbooks has been calculated back to 2007. The CPUE is currently based on more than 17 000 observations. The logbook CPUE show a decreasing trend from 2007 to 2017, then stabilize and increase since 2020. (Figure 2.6). Although the CPUE is based on only the larger vessels and a different source of statistics, the CPUE shows an almost identical trend as the Factory landings longline CPUE.

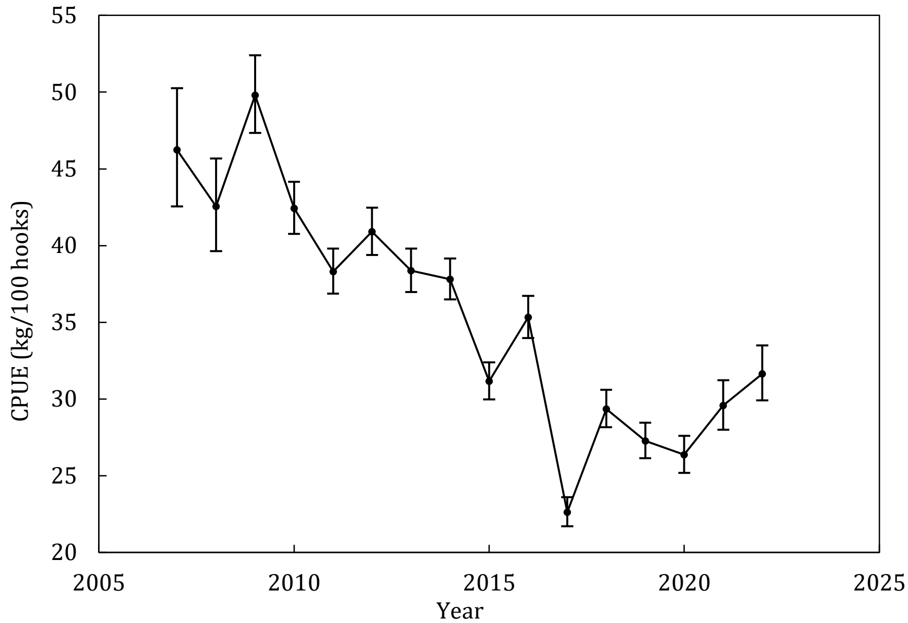


Figure 2.6. Greenland halibut in Division 1A inshore: Commercial CPUE (kg/1000 hooks) based on logbooks standardized mean and 95% CI in Disko Bay.

Uummannaq

Length frequencies from the commercial catch is available through biological sampling programs and in recent years also directly from automatic fish graders installed in factories. Logbooks and factory landings data provide valuable data on catch, effort, gear and location.

In **1A Uummannaq,** the length distributions in the commercial landings have gradually decreased since 1993 (Figure 2.7). In 2021 the Mean length in the landings decrease by 4 cm in just one year, from 57 cm in 2020 to 53 cm in 2021. Grader data has not been received and the number of commercial samples from Uummannaq is low. Therefore the 2022 estimate is uncertain.

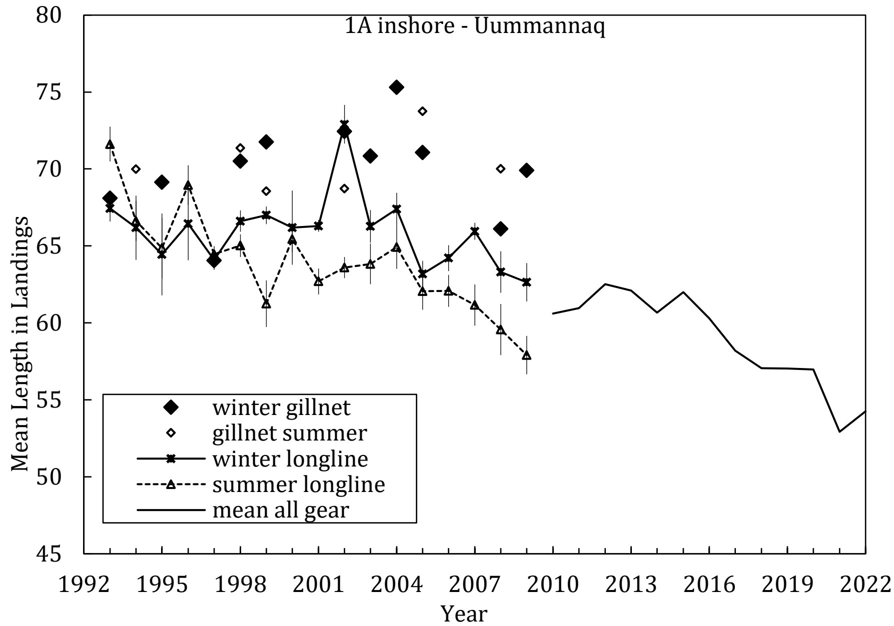


Figure 2.7. Greenland halibut in Division 1A inshore: Mean length in landings from longline and gillnet fishery by season and overall mean weighted by gear.

CPUE indices from the commercial catch: Two commercial CPUE indices are presented for the stock, one based on longline logbooks and one based on factory landings data (based on longline fishery). The CPUE based on factory landings data from of longline caught Greenland halibut in Uummannaq has between 12 000 and 18 000 observations annually and the CPUE is currently based on more than 160 000 observations.

The CPUE based on factory landings, shows a substantial decrease from 2012 to 2017 and slow decrease thereafter (Figure 2.8).

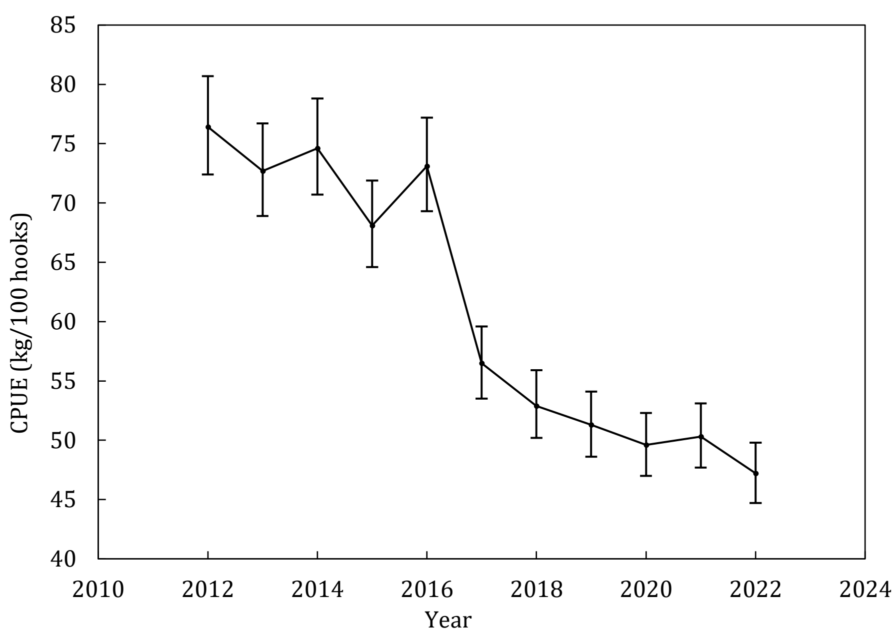


Figure 2.8. Greenland halibut in Division 1A inshore: Commercial CPUE (Kg/hook) based on factory landing reports from all factories in Uummannaq.

The standardized CPUE based on longline logbooks from fishery in the Uummannaq area is based on more than14 000 individual landings. There has been a general decline in CPUE since around 2014 (Figure 2.9).

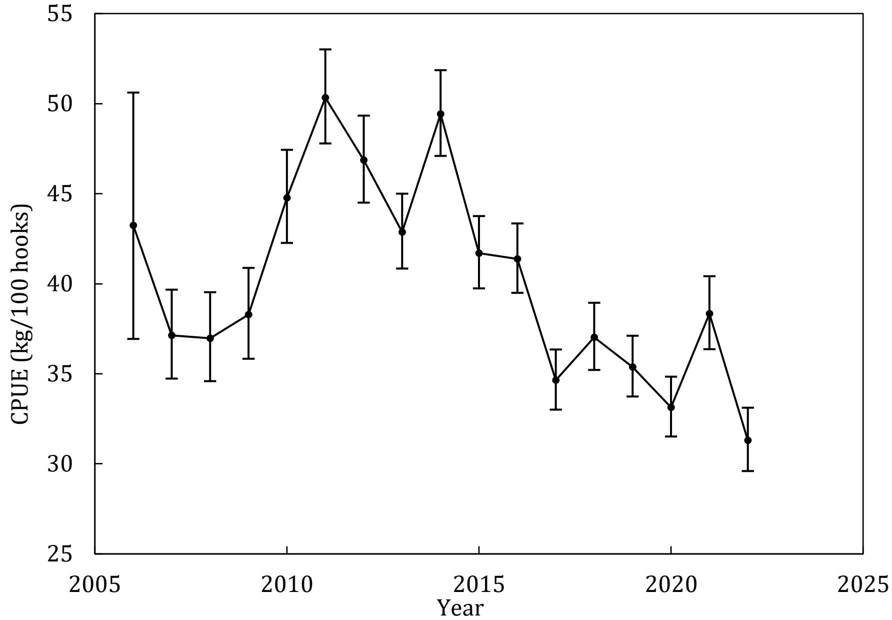


Figure 2.9. Greenland halibut in Division 1A inshore: Longline logbooks - Standardized mean and 95% CI CPUE based on logbooks from vessels larger than 30ft in Uummannaq.

Upernavik

Length frequencies from the commercial catch is available through biological sampling programs and in recent years also directly from automatic fish graders installed in factories. Logbooks and factory landings data provide valuable data on catch, effort, gear and location. A scientific gillnet survey conducted with R/V Sanna was fully implemented in 2015.

In Upernavik, the mean length in the commercial landings decreased from 1993 to 1998. From 1999 to 2009, the mean length in the longline fishery remained constant, but has since then decreased further (Figure 2.10).

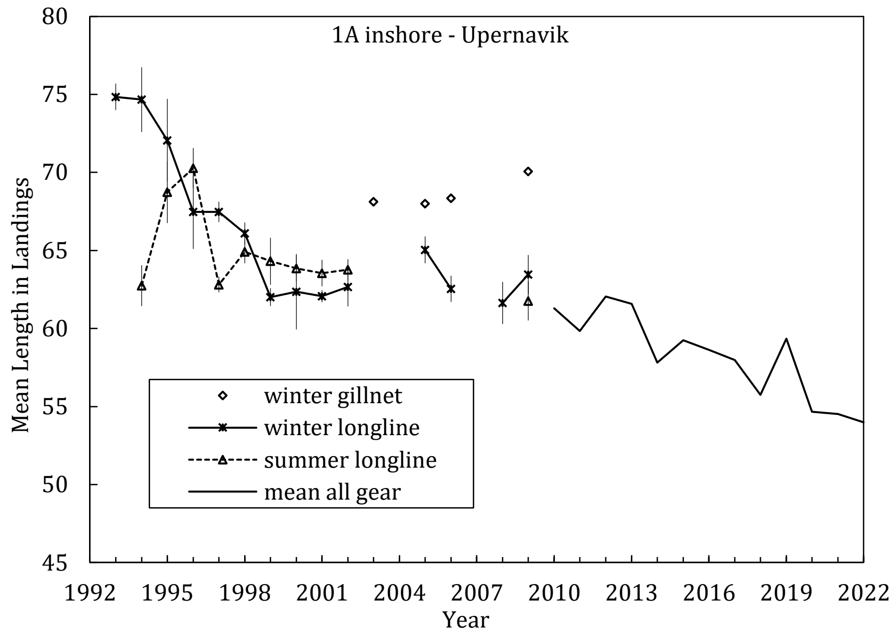


Figure 2.10. Greenland halibut in Division 1A inshore: mean length in landings from longline fishery by season (summer and winter) and after 2010 overall mean taking account of fishing ground, season and gear.

CPUE indices from the commercial catch: two commercial CPUE indices are presented for the stock, one based on longline logbooks and one based on factory landings data. The CPUE based on factory landings data from of longline fishery in the Upernavik area has between 10 000 and 17 000 individual observations annually and the CPUE is currently based on more than 140 000 observations.

The CPUE based on factory landings, shows a gradual decrease from 2012 to 2017. Since then, the CPUE has been relatively stable (Figure 2.11).

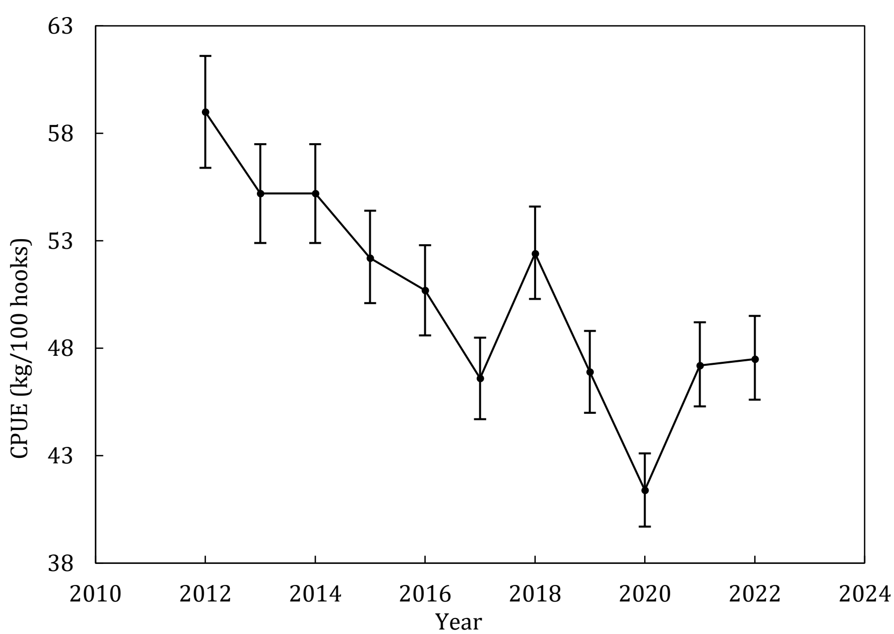


Figure 2.11. Greenland halibut in Division 1A inshore: Commercial CPUE (Kg/hook) based on factory landing reports from all factories in Upernavik.

The standardised CPUE based on longline logbooks from fishery in the Upernavik area is based on more than 24 000 observations. Disregarding the outlier year 2020, the CPUE has been stable since 2015 (Figure 2.12).

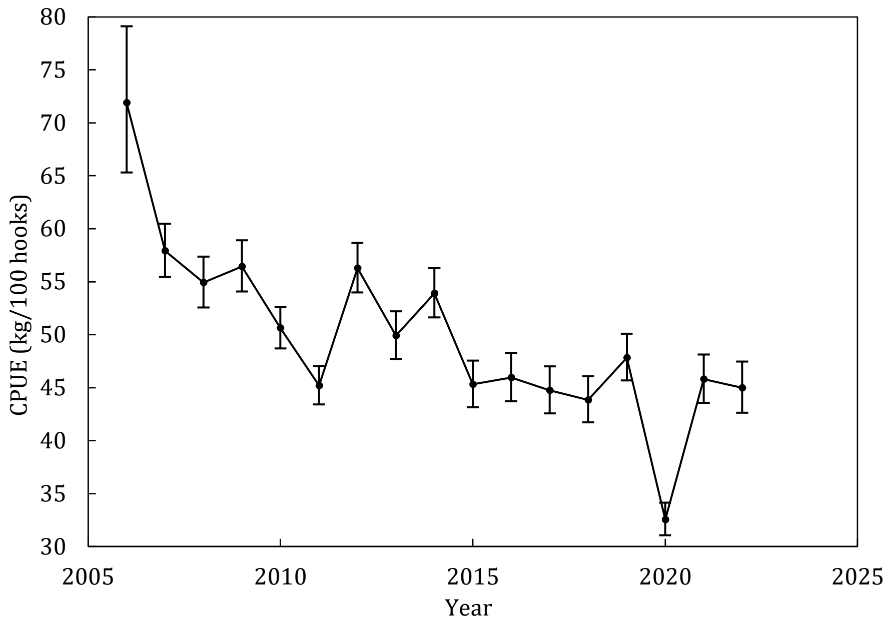


Figure 2.12. Greenland halibut in Division 1A inshore: Longline logbooks - Standardized mean and 95% CI CPUE based on logbooks from vessels larger than 30ft since 2006.

ii) Research survey data

Disko Bay

Recent surveys are as follow:

	Division	2018	2019	2020	2021	2022
Greenland shrimp and fish survey	1A inshore	●	●	●	–	●
Disko Bay scientific gillnet survey	Disko Bay	●	●	●	●	●

● = complete, o = uncalibrated, – = incomplete

The Greenland shrimp and fish survey covers the Greenland shelf from 72N off West Greenland to 67N off East Greenland at depths from 50-600m. The survey started in 1991 with R/V Paamiut. The gear was changed in the Greenland-SFW survey in 2005, thus interrupting the survey index. R/V Pâmiut was decommissioned in 2017 and commercial vessels (2018, 2019, 2020) and the new research vessel, R/V Tarajoq (2022) using Pâmiut gear has been used to update indices since 2018. Analysis of trawl performance between Paamiut, the chartered commercial vessels and the new research vessel, have indicated that the indices are comparable.

The Disko Bay part of Greenland Shrimp and Fish Survey (Div 1Ainshore) indicated an increasing biomass during the 1990s. After the gear change in 2005, the biomass indices gradually decreased but stabilized after 2014 (Figure 2.13). In both 2020 and 2022 the biomass index increased. The Abundance index is highly influenced by the annual numbers of age one recruits observed in the survey.

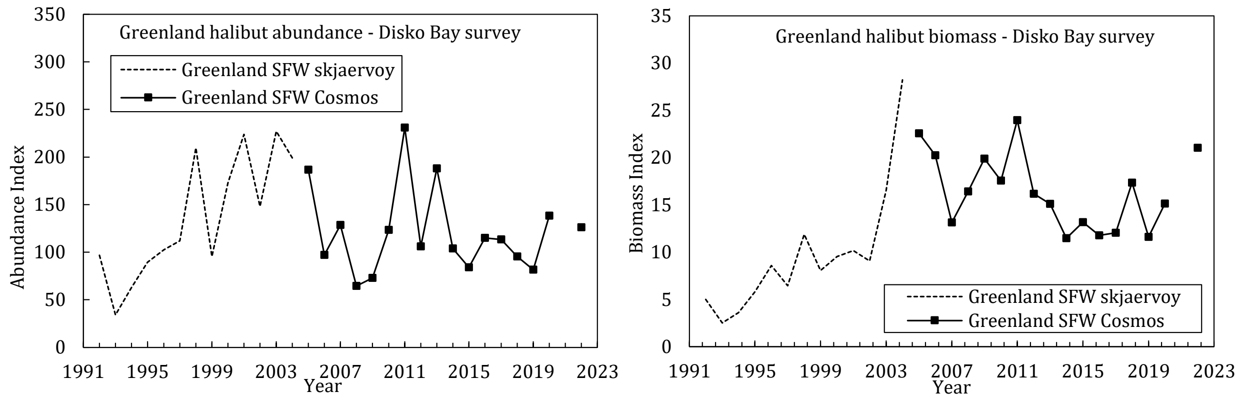


Figure 2.13. Greenland halibut in Division 1A inshore: Abundance and biomass indices in the Disko bay from the Greenland Shrimp Fish trawl survey.

The Disko Bay scientific gillnet survey, catch in Numbers-Per-Unit-Effort (NPUE) can be taken as an Index of abundance and the gillnet Catch-Per-Unit-Effort can be taken as an index of Biomass. From 2017 the NPUE and CPUE gradually increased to the highest levels observed in the timeseries in 2021(Figure 2.14) However, in 2022 the NPUE decrease to around average levels and the CPUE just below.

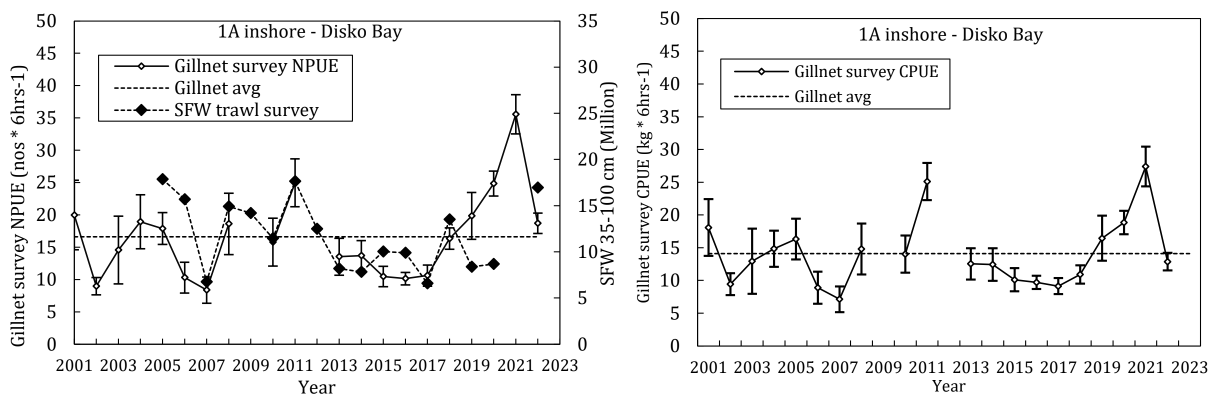


Figure 2.14. Greenland halibut in Division 1A inshore: Gillnet survey NPUE and CPUE +/-SE.

Uummannaq

Recent surveys are as follow:

	Division	2018	2019	2020	2021	2022
Uummannaq scientific gillnet survey	Uummannaq	●	●	●	●	●

● = complete, o = uncalibrated, – = incomplete

The Uummannaq scientific gillnet survey indices declined from 2015-2018 and have since increased. (Figure 2.15). The high NPUE observed in 2020 and 2021 was mainly caused by unusually high numbers of small Greenland halibut around 40 cm in the survey. Over the survey time series a shift in the length distribution has occurred towards smaller fish. Therefore, the decrease in CPUE from 2015 to 2018 is greater than the decrease in NPUE.

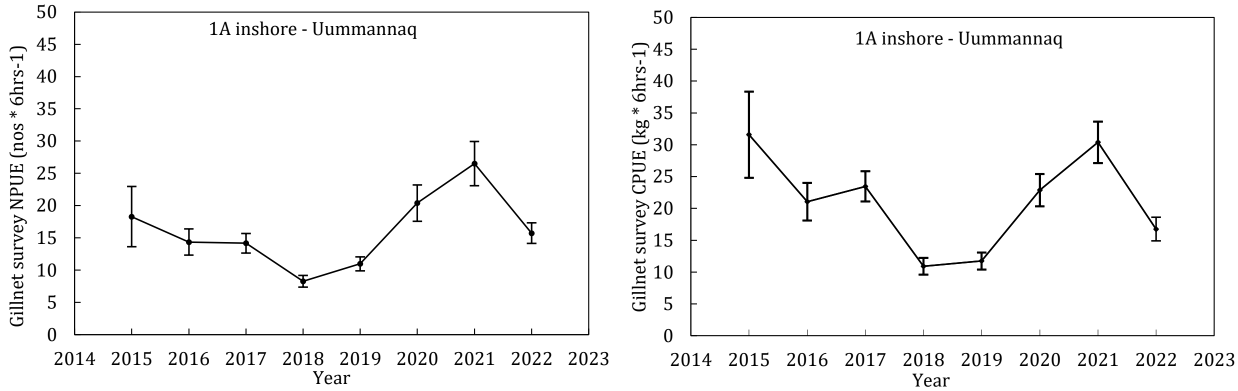


Figure 2.15. Greenland halibut in Division 1A inshore: Gillnet survey NPUE and CPUE +/-SE.

Upernavik

Recent surveys are as follow:

	Division	2018	2019	2020	2021	2022
Upernavik scientific gillnet survey	Upernavik	●	●	●	●	●

● = complete, o = uncalibrated, – = incomplete

The Upernavik scientific gillnet survey NPUE and CPUE has gradually decreased from the record high 2020 level (Figure 2.16).

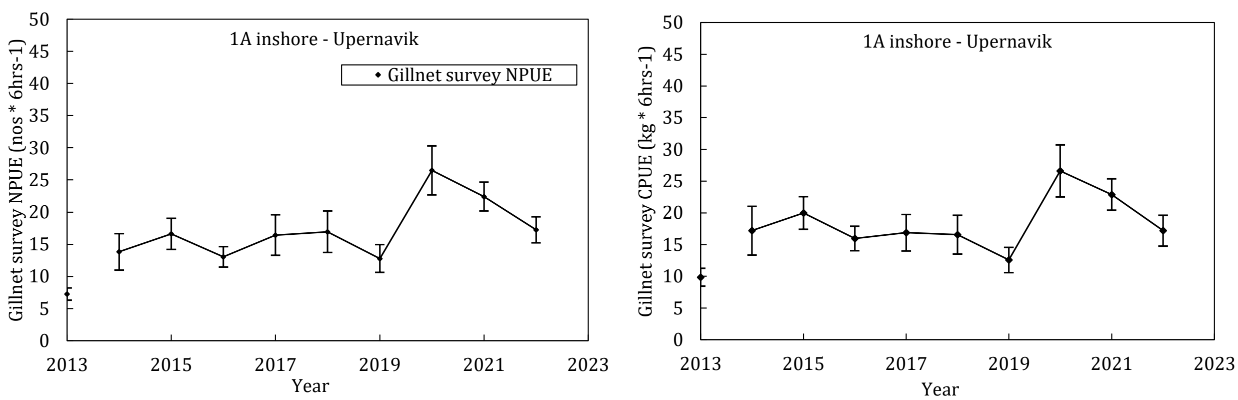


Figure 2.16. Greenland halibut in Division 1A inshore: gillnet survey NPUE (left) and CPUE (right) +/-SE.

d) Conclusion:

Disko Bay

The ICES Harvest Control Rule 3.2 for data limited stocks combined with the survey index from the Greenland shrimp and fish survey, has been used to formulate the advice since 2016. In 2022, catch advice was increased to 5.215 t.

The Gillnet CPUE is the only decreasing index in 2022. The Shrimp and fish survey biomass index and the commercial CPUE's increase. The mean length in the landings also increase. The increasing CPUE is expected with the growth of the previously identified strong 2015 YC. Based on the updated indices there is no change in the status of the stock.

Uummannaq

This stock underwent full assessment in 2022. The ICES Harvest Control Rule 3.2 for data limited stocks combined with the Uummannaq gillnet survey index was used to formulate the advice. For 2023-2024 annual catch advice was not to exceed 5153 t. (catch advised for 2021 and 2022=5153*0.996)

The commercial CPUE based on factory landings data decrease slightly in 2022. In the updated CPUE series based on logbooks have been relatively stable since 2017. Although the 2022 gillnet survey CPUE and NPUE decrease from 2021 the indices remain close to the time series mean. The updated indices do not indicate a significant change in the status of the stock.

Upernavik

This stock underwent full assessment in 2022. The ICES Harvest Control Rule 3.2 for data limited stocks combined with the survey gillnet survey index was formulate the advice. For 2023-2024 annual catch advice was not to exceed 6070t.

In the updated CPUE series based on logbooks have been relatively stable since 2015. The commercial CPUE based on factory landings data also has remained stable since 2017. Although the 2022 gillnet survey CPUE and NPUE decrease from 2021 the indices remain at or slightly above the timeseries mean. The updated indices do not indicate a change in the status of the stock.

These stocks will next be assessed in 2024

e) Research recommendations

Disko Bay

STACFIS **recommended** that *work continue on the surplus production model in a Bayesian framework.*

3. Demersal Redfish (*Sebastes* spp.) in Subarea 1

Full assessment (SCR Doc. 20/052, 23/012, 013, 020 ; SCS Doc. 23/13)

a) Introduction

There are two demersal redfish species of commercial importance in NAFO Subarea 1, golden redfish (*Sebastes norvegicus*) and demersal deep-sea redfish (*Sebastes mentella*). Connectivity to other redfish stocks off East Greenland, the Irminger Sea, the Newfoundland and Labrador Shelf, and Iceland is unclear.

Fisheries and Catches: Both redfish species (*S. norvegicus and S. mentella*) are included as redfish in the catch statistics.

The fishery targeting demersal redfish in SA1 increased during the 1950s and peaked in 1962 at more than 60,000 t. Catches then decreased and have remained below 1,000 tons per year after 1986 with few exceptions. Official catches from 1974-1977 are uncertain with evidence of overreported catches (cod and other species reported as redfish) and until 2002 underreporting of redfish taken as bycatch in the shrimp fishery. Studies of bycatch in the shrimp fishery estimated catch of redfish to be more than 14,000 t in 1988 and 4,000 t in 1994. To reduce the bycatch of fish in the shrimp fishery, 22mm sorting grids have been mandatory since 2002. Sorting grids and poor recruitment have since then limited the bycatch of redfish in the shrimp fishery to very low levels.

Since 2019, the reported bycatches of redfish from shrimp trawlers has gradually increased from 1t in 2019 to 198 t in 2022; based on size (typically <20 cm) these redfish are primarily recruits. A further 22 t were reported from trawlers targeting Greenland halibut. Besides these, 67 t of commercially sized redfish were landed to factories caught in fjords in west Greenland (Figure 3.1).

Recent catches and TAC ('000 tonnes) are as follows:

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TAC	1	1	1	1	1	0	0	0	0	0
STATLANT 21	0.25	0.19	0.16	0.23	0.19	0.10	0.21	0.36	0.26	
STACFIS	0.17	0.26	0.17	0.24	0.19	0.14	0.20	0.26	0.29	

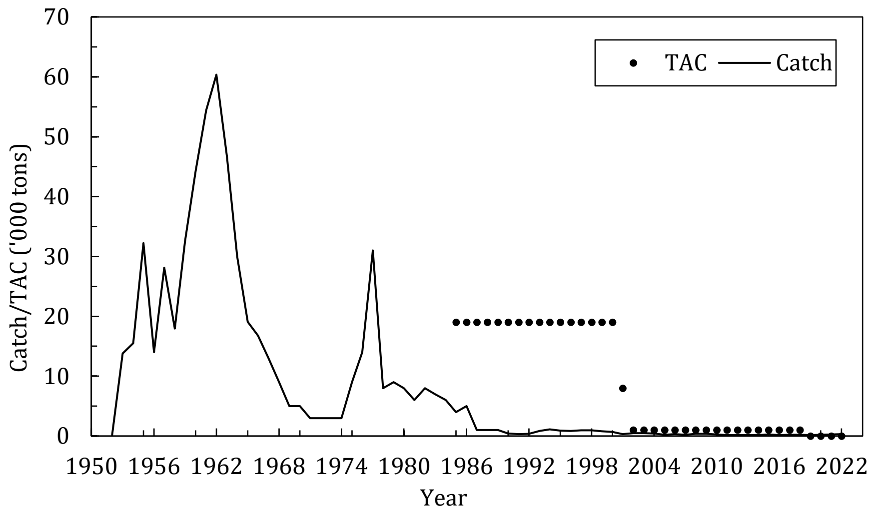


Figure. 3.1. Demersal redfish in Subarea 1: catches and TAC.

a) Data overview

i) Research survey data

Recent surveys are as follow:

	Div.	2018	2019	2020	2021	2022
EU-Germany	1C to 1F	–	–	●	–	–
Greenland Shrimp and Fish Survey	Div. 1A-1F	●	●	●	–	●

● = complete, o = uncalibrated, – = incomplete

The EU-Germany survey (RV Walther Herwig III) covers the shelf from 0-400 m in East Greenland south of 66N and in West Greenland divisions 1C to 1F, from 1982. The survey has had limited coverage in West Greenland in recent years and most recent updates are prior to 2015 and 2020. The Greenland deep-sea survey covers the shelf from 400-1500 m in divisions 1C and 1D. This survey was carried out from 1997 to 2017 by R/V Pâmiut and with a chartered commercial vessel in 2019. A new R/V Tarajoq time series was initiated in 2022 and the Alfredo trawl was replaced by a Bacalao trawl.

The Greenland Shrimp and Fish Survey in Div. 1A-1F covers the shelf in West Greenland south of 72N from 0-600 m (1992-2020 and 2022). The Greenland shrimp and fish survey has a more appropriate depth and geographical coverage with regards to redfish distribution and covers a much larger area than other surveys . However, no separation of redfish species was made prior to 2006. The effect of the vessel change was examined in both offshore Greenland surveys and it was found that the changes had a minimal effect at depth< 700 m, where the redfish occurs. Besides the recent surveys, another index is available from a joint Greenland-Japan offshore survey (RV Shinkai Maru) occurred from 1987 to 1995 in divisions 1B to 1D from 400 -1500 m.

Golden redfish (Sebastes norvegicus)

The EU-Germany survey biomass index decreased in the 1980's and was at a very low level in the 1990s (Figure 3.2). Increasing biomass indices of golden redfish were observed from 2005 to 2015, but the updated indices in 2016 and 2020 were at a lower level.

The Greenland shrimp and fish survey biomass index increased gradually from 2006 to 2016 and decreased thereafter. High indices in 2016 and 2019 were due to single hauls of large adults Golden redfish (45-70 cm) that provided the majority of the total biomass estimate in those years. The EU-Germany survey and the Greenland shrimp and fish survey show similar overall trends with decreasing indices in the most recent decade. The Greenland deep-sea survey and the historic Greenland-Japan survey is less informative due to limited survey depth overlap with the depth distribution of Golden redfish.

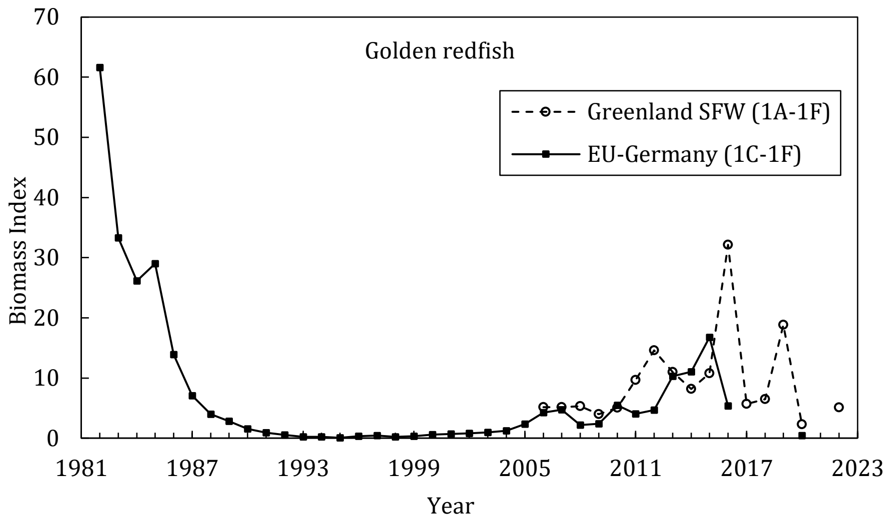


Figure. 3.2. Golden redfish biomass indices in the EU-Germany survey and the Greenland shrimp and fish survey. (no surveys in 2021)

Demersal deep-sea redfish (Sebastes mentella)

The Greenland-Japan survey (1BCD 400-1500m) biomass index gradually decreased from 1987 to 1995 (Figure 3.3). The Greenland deep-sea survey (1CD 400-1500m) had low biomass indices from 1997 to 2006 (Figure 3.3). After 2006, the Greenland deep-sea survey and the Greenland shrimp and fish survey biomass indices show similar increasing trends (Figure 3.3). Both surveys had decreasing biomass indices since 2013 (excluding outlier years in 2016). The high 2016 biomass index in the Greenland shrimp and fish survey was caused by a single haul in division 1D of adult deep-sea redfish between 25 and 40 cm and is not considered reflective of population trends. The EU-Germany survey is less informative due to limited survey depth overlap with the depth distribution of deep-sea redfish.

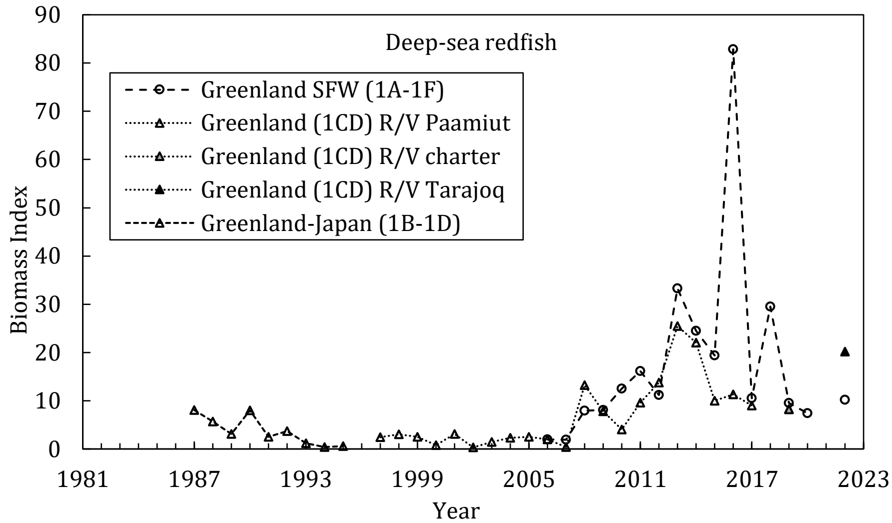


Figure. 3.3. Demersal deep-sea redfish survey biomass from the Greenland shrimp and fish survey, the Greenland deep-sea survey and the Greenland-Japan survey.

Juvenile redfish (<17cm both species combined)

The EU-Germany survey regularly found juvenile redfish from 1984 to 2000. From 2001 to 2011, the abundance of juvenile redfish in the survey gradually decreased to a low level and from 2012 to 2015 no redfish less than 17 cm were identified in the survey. (Figure 3.4). Recent recruitment is unknown due to lack of surveys.

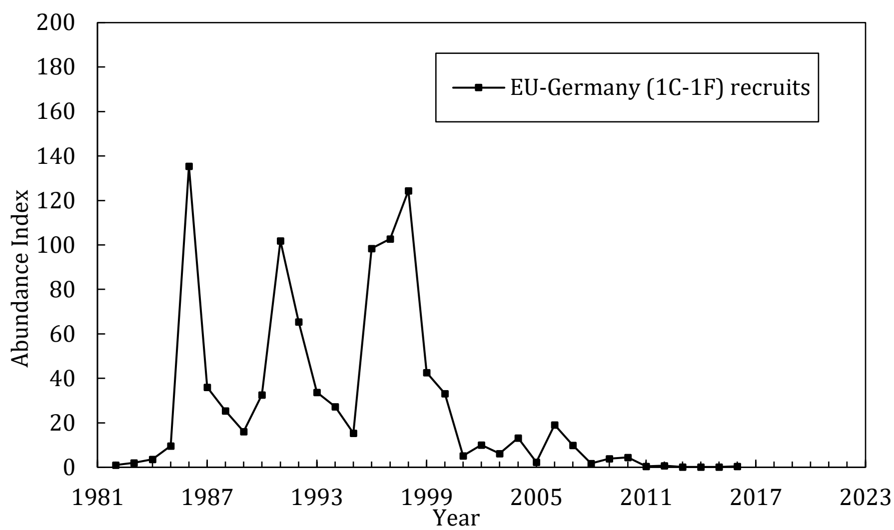


Figure. 3.4. Juvenile redfish abundance indices for the EU-Germany survey (*Sebastes sp.* <17cm) .

b) Assessment results

Assessment: No analytical assessment could be performed for either of the stocks.

Golden redfish (*Sebastes norvegicus*)

Biomass: Updated indices in the Greenland shrimp and fish survey and the EU-Germany survey indicate that the biomass remains far below the 1980s level.

Fishing mortality: Unknown

Recruitment: Unknown.

State of the stock: Survey indices indicate that the biomass remains far below historical levels. Recruitment is unknown. Fishing mortality is unknown; however current catch levels of commercially sized redfish are low.

Deep-sea redfish (*Sebastes mentella)*

Biomass: The biomass indices in the Greenland-Japan survey decreased from 1987 to 1995. Biomass indices in the Greenland deep-sea survey and the Greenland Shrimp and fish remained low until 2007. However, these surveys both show that the biomass of deep-sea redfish was increasing from 2008 to 2013-2017 and slowly decreasing in the most recent 7-10 years.

Fishing mortality: Unknown

Recruitment: Unknown.

State of the stock: Biomass is slowly decreasing. Recruitment is unknown. Fishing mortality is unknown; however current catch levels of commercially sized redfish are low.

This stock will next be assessed in 2026.

c) Research Recommendations

SC **recommends** that *species composition and length-frequency distribution data from the Greenland shrimp and fish survey should be re-analysed to inform on recruitment for this stock.*

4. Wolffish in Subarea 1

Full assessment (SCR Doc. 20/056, 23/020; SCS Doc. 23/14)

a) Introduction

Three species of wolffish are common in Greenland. Only Atlantic wolffish (*Anarhichas lupus*) and spotted wolffish (*Anarhichas minor*) are of commercial interest. Northern wolffish (*Anarhichas denticulatus*) is an unwanted discarded bycatch. Atlantic wolffish has a more southern distribution and seems more connected to the offshore banks and the coastal areas. Spotted wolffish can be found further north in West Greenland than Atlantic wolffish both in the fjords and offshore.

Fisheries and catches: Wolffish are primarily taken as a bycatch in other fisheries. The commercial fishery for wolffish in West Greenland occurred from the 1950s to 1979 with catches of around 5 000 t per year. (Figure 4.1). After 1980, the cod fishery gradually stopped in West Greenland and catches of wolffish also decreased during this period. To minimize by-catch in the shrimp fishery, offshore trawlers targeting shrimp have been equipped with 22mm grid separators since 2002 and inshore (Disko Bay) trawlers since 2011. Since 2015, reported catches have been at a lower level. The decrease is likely related to more profitable species being targeted. In 2022, 165 t of wolffish was landed to factories mostly taken as bycatch in inshore small boat fisheries and 10 t was reported from offshore vessels.

Recent catches and TACs ('000 tonnes) are as follows:

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Atlantic wolffish TAC		1.00	1.00	1.00	1.00	0	0	0	0	0
Spotted wolffish TAC		1.03	1.03	1.02	0.97	0	0	0	0	0
Combined wolffish TAC	1	2.03	2.03	2.03	1.97	0	0	0	0	0
STATLANT 21	0.91	0.40	0.24	0.24	0.27	0.19	0.24	0.25	0.17	
STACFIS	0.91	0.40	0.20	0.24	0.26	0.19	0.25	0.25	0.17	

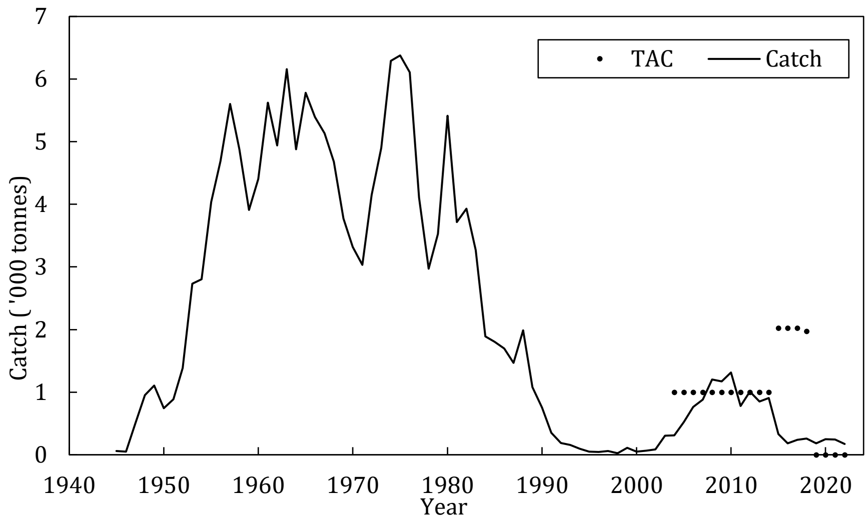


Figure 4.1. Wolffish in NAFO Subarea 1: Catches and TACs for Atlantic wolffish and spotted wolffish combined.

b) Data Overview

i) Research survey data

Indices for Atlantic wolffish and spotted wolffish are derived the EU-Germany survey and the Greenland shrimp and fish survey.

The EU-Germany survey covers the Greenland shelf from 67 N off West Greenland to 66N off East Greenland at depths from 0-400m (R/V Walther Herwig III). The survey started in 1982. Latest sufficient index updates are 2015 and 2020.

The Greenland shrimp and fish survey covers the Greenland shelf from 72N off West Greenland to 67N off East Greenland at depths from 50-600m. The survey started in 1991 with R/V Paamiut. The gear was changed in the Greenland-SFW survey in 2005, thus interrupting the survey index. R/V Pâmiut was decommissioned in 2017 and commercial vessels (2018, 2019, 2020) and the new research vessel, R/V Tarajoq (2022) using Pâmiut gear has been used to update indices since 2018. Analysis of trawl performance between Paamiut, the chartered commercial vessels and the new research vessel, have indicated that the indices are comparable. The Greenland-SFW survey has a more appropriate geographical coverage in relation to wolffish than the EU-Germany survey. Both surveys cover the main depth distribution of wolffish.

Atlantic wolffish:

The Biomass index decreased substantially from 1982 to 1984 and continued to decrease until the late 1990's. Biomass was low from 1995 to 2015 (Figure 4.2). The EU-Germany abundance index of Atlantic wolffish was stable from 1982 to 2005 and then gradually decreased (Figure 4.2). However, the decrease may be related to a gradual reduction of the the surveyed area.

The Greenland Shrimp and fish survey biomass index slowly increased both before and after the gear change in 2005 (Figure 4.2) The abundance index has gradually increased throughout the time series (disregard the two extreme outlier years 2005 and 2015) (Figure 4.2). The increasing abundance and biomass in the Greenland SFW survey has partly been observed in divisions 1A-B, thus outside the EU-Germany survey area.

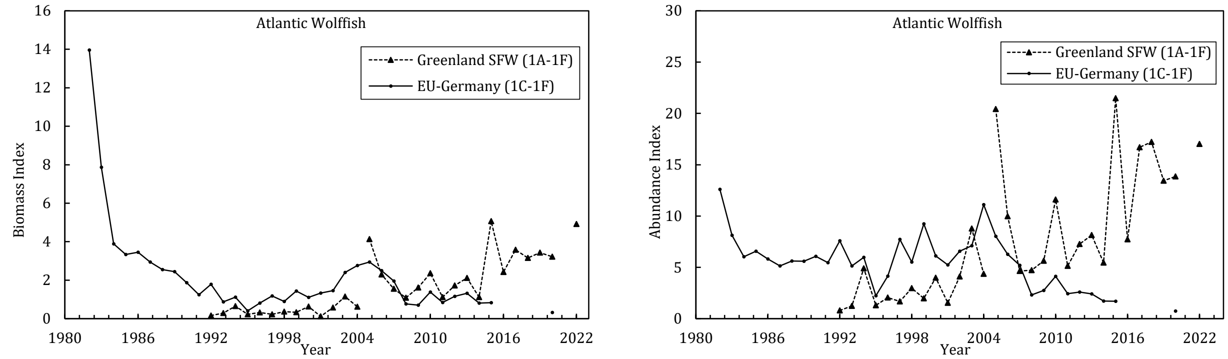


Figure. 4.2. Atlantic wolffish survey biomass index (left) and abundance index (right) from the surveys.

Spotted wolffish:

The EU-Germany survey biomass index decreased from 1982 to 1984 and remained at low levels during the 1990s (Figure 4.3). From 2004, the survey biomass increased, and the recent indices in 2013 to 2015 and 2020, were at the level observed at the beginning of the 1980s (Figure 4.3).

The Greenland SFW survey biomass index was at low levels during the 1990s. Since 2010, survey biomass index has continued to increase (Figure 4.3).

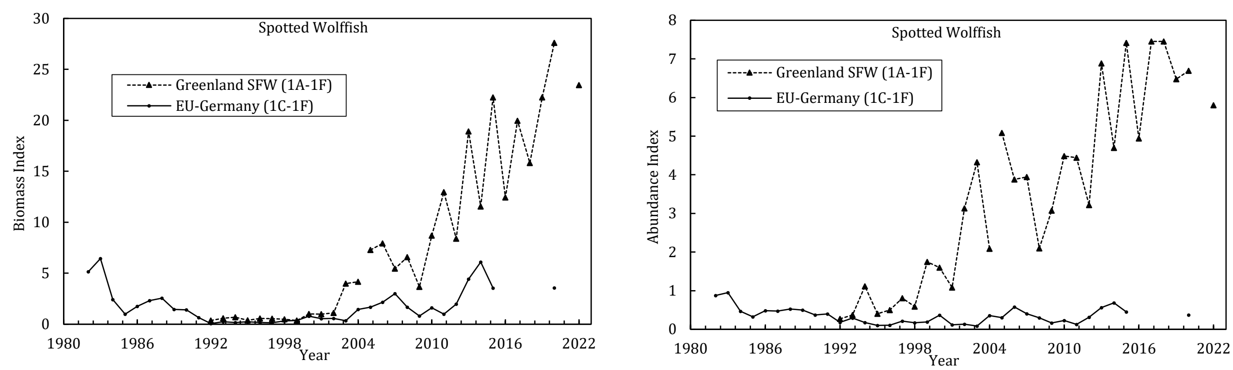


Figure. 4.3. Spotted wolffish survey biomass index (left) and abundance index (right) from the Greenland SFW and the EU-Germany survey.

c) Assessment results

Atlantic wolffish

Biomass: The biomass index of the EU-Germany survey was below the long term average. The survey biomass and abundance indices continue to increase in the Greenland Shrimp and fish survey.

Fishing mortality: Unknown

Recruitment: Unknown.

State of the stock: The biomass remains below the higher level of the 1980s. Recruitment and fishing mortality are unknown.

Spotted wolffish

Biomass: Although the EU-Germany survey has had poor coverage in West Greenland since 2015, the most recent updated biomass indices (2013 - 2015 and 2020) were close to the indices observed in the beginning of the 1980's. The survey biomass and abundance indices in the Greenland SFW survey continue to increase.

Fishing mortality: Unknown.

Recruitment: Unknown.

State of the stock: Biomass in recent years is close to the higher levels observed in the early 1980s. Recruitment and fishing mortality are unknown.

These stocks will next be assessed in 2026.

d) Research Recommendations

SC **recommends** *investigation of fishing mortality and recruitment proxies.*

STOCKS ON THE FLEMISH CAP (NAFO DIVISION 3M)

Environmental Overview

The water masses characteristic of the Flemish Cap area are a mixture of Labrador Current Slope Water and North Atlantic Current water, generally warmer and saltier than the sub-polar Newfoundland Shelf waters with a temperature range of 3-4°C and salinities in the range of 34-34.75. The general circulation in the vicinity of the Flemish Cap consists of the offshore branch of the Labrador Current which flows through the Flemish Pass on the Grand Bank side and a jet that flows eastward north of the Cap and then southward east of the Cap. To the south, the Gulf Stream flows to the northeast to form the North Atlantic Current and influences waters around the southern areas of the Cap. In the absence of strong wind forcing the circulation over the central Flemish Cap is dominated by a topographically induced anti-cyclonic (clockwise) gyre. Variation in the abiotic environment influences the distribution and biological production of Newfoundland and Labrador Shelf and Slope waters where arctic, boreal, and temperate species coexist. The elevated temperatures on the Flemish Cap result in relatively ice-free conditions that may allow longer phytoplankton growing seasons compared to the Grand Banks where cooler conditions prevail. The entrainment of nutrient-rich North Atlantic Current water around the Flemish Cap generally supports higher primary and secondary production compared with the adjacent shelf waters. The stability of this circulation pattern may also influence the retention of ichthyoplankton on the Grand Bank which may influence year-class strength of various fish and invertebrate species.

5. Golden Redfish (*Sebastes norvegicus*) in Division 3M

Interim Monitoring Report (SCR Doc. 21/34, 23/003, 040; SCS Doc. 21/05,06, 22/06,13)

a) Introduction

There are three species of redfish that are commercially fished on Flemish Cap; deep-sea redfish (*Sebastes mentella*), golden redfish (*Sebastes norvegicus*) and Acadian redfish (*Sebastes fasciatus*). The term beaked redfish is used for *S. mentella* and *S. fasciatus* combined. Because of difficulties with identification and separation, all three species are reported together as 'redfish' in the commercial fishery. All stocks have both pelagic and demersal concentrations and long recruitment process to the bottom. Redfish species are long lived with slow growth.

The separation of the three species is made in the EU research survey. This requires extensive sampling effort by trained experts to examine internal features of individual redfish. The percentage per depth range of the three species in the EU Flemish Cap surveys, was used to separate the Div. 3M commercial catches into golden and beaked redfish. This method is also applied in assessments of beaked redfish.

i) Description of the fishery

Catches of golden redfish in Division 3M increased from 1,158 tonnes in 2006 to a peak of 7662 tonnes in 2009. In 2010, catches decreased and remained relatively stable until 2014 between 2000 and 3000 tonnes. After 2014, catches decreased continuously to low levels over 2016 to 2020. Catches of golden redfish increase to 1,100 tonnes in 2022. EU-Portugal, EU-Spain, the Russian Federation and EU-Estonia are responsible for the bulk of the redfish landings over the last two decades.

Recent catches and TACs ('000 t) are as follows:

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TAC[1]	6.5	6.7	7.0	7.0	10.5	10.5	8.6	8.4	10.9	11.2
STATLANT 21[1]	6.4	6.9	6.6	7.1	10.5	10.5	8.6	8.6	NA[4]	
STACFIS Total catch[1, 2]	7.4	6.9	6.6	7.1	10.5	10.5	8.8	8.3	10.0	
STACFIS Catch[3]	2.9	1.7	0.4	0.3	0.1	0.3	0.1	0.4	1.1	

[1] TAC, STATLANT 21 and STACFIS Total catch refer to all three redfish species combined.
[2] STACFIS total catch on 2011-2014 based on the average 2006-2010 bias.
[3] STACFIS golden redfish catch estimate, based on golden redfish proportions on observed catch.
[4]STATLANT 21a data for 2022 were not yet available at the time of writing

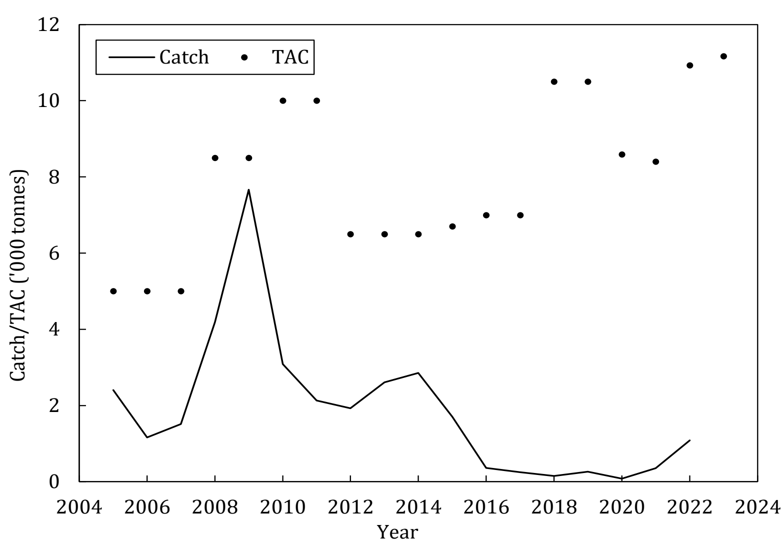


Figure 5.1. Golden redfish in Div. 3M: Golden redfish catches and TACs of all three redfish species combined.

b) Data Overview

Recent surveys are as follow:

	Div.	2018	2019	2020	2021	2022
EU	3M	●	●	●	●	●

● = complete, o = uncalibrated, – = incomplete

Research surveys

The 1988-2022 EU survey biomass and abundance indices for golden redfish are presented in Figure 5.2. Besides some sporadic small peaks, the survey stock abundance and biomass oscillated since the beginning (1988) of the series until 2003 at low levels. From 2004 to 2008 both abundance and biomass increased substantially due to recruitment. Since then, biomass and abundance declined and in 2022 are at low levels. Survey results are noisy, with the characteristic variance of redfish indices, but broad trends show through the noise.

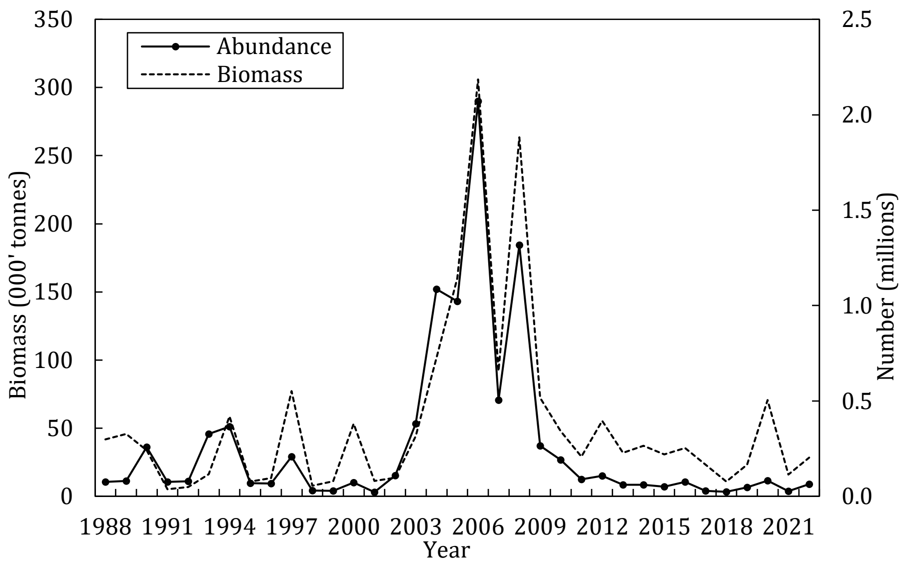


Figure 5.2. Golden redfish in Div. 3M: EU biomass and abundance indices, 1988-2022.

c) Conclusions

Stock status has not changed.

Given the current situation of the stock, it was not considered appropriate to apply any assessment model or to give advice for golden redfish separately. Nevertheless, as in previous years, advice for golden redfish is given indirectly based on the Div. 3M beaked redfish assessment (advice of 3M redfish applies the current percentage of golden redfish). SC will continue to monitor the golden redfish stock status and provide advice as part of the beaked redfish advice.

The next assessment of the stock is planned when the dynamic of the stock changes.

6. Cod (*Gadus morhua*) in Division 3M

Full Assessment (SCS Doc. 23/05REV, 23/06, 23/08, 23/13 and SCR Doc. 23/03, 23/04 and 23/09)

a) Introduction

The cod fishery on Flemish Cap has traditionally been a directed fishery by Portuguese trawlers and gillnetters, Spanish pair-trawlers and Faroese longliners. Cod has also been taken as bycatch in the directed redfish fishery by Portuguese trawlers. Estimated bycatch in the Div. 3M shrimp fisheries is low.

The mean reported catch was 32 000 t from 1963 to 1979 with high inter annual variability. Reported catches declined after 1980, when a TAC of 13 000 t was established, but Scientific Council regularly expressed its concern about the reliability of some catches reported in the period since 1963, particularly those since 1980. Alternative estimates of the annual total catch since 1988 were made available in 1995 (Figure 6.1), including non-reported catches and catches from non-Contracting Parties.

The fishery was under moratorium between 1999 and 2009. Annual bycatches between 2000 and 2005 were estimated to be below 60 t, increasing since then until the reopening of the fishery in 2010 with a TAC of 5 500 tons. Since 2013, catches have remained at the level of the TAC.

Recent catches and TACs ('000 tonnes) are as follows:

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TAC	14.1	14.5	13.8	13.9	13.9	11.1	17.5	8.5	1.5	4.0	6.1
STATLANT 21	13.5	14.4	12.8	13.8	13.9	10.5	13.0	8.5	2.6	NA[1]	
STACFIS	14.0	14.3	13.8	14.0	13.9	11.5	17.5	8.5	2.1	4.0	

[14]STATLANT 21a data for 2022 were not yet available at the time of writing

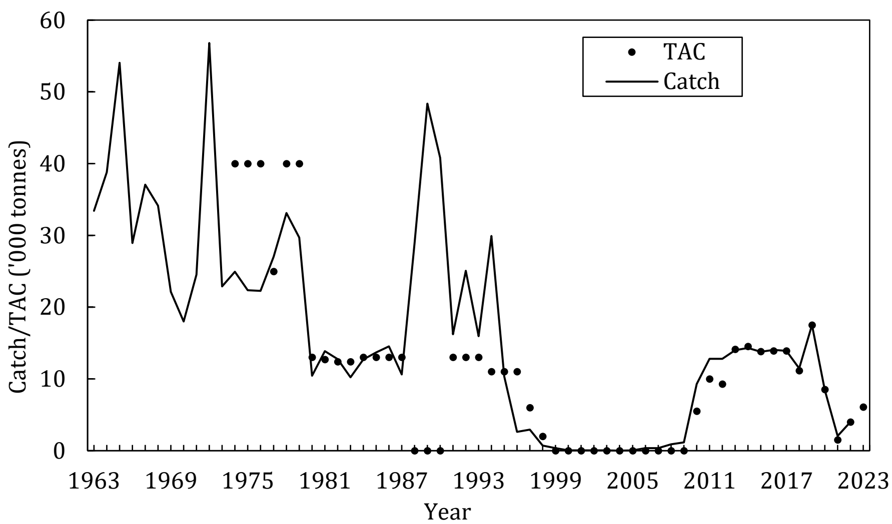


Figure 6.1. Cod in Division 3M: STACFIS catches and TAC.

b) Data Overview

i) Commercial Fisheries

In 2022 six countries fished cod in Div. 3M: trawlers from EU-Estonia, EU-Portugal, EU-Spain, and Russia and longliners from Faroes and Norway.

Length and age compositions from the commercial catches are available from 1972 to 2022 with the exception of the 2002 to 2005 period. In 2022 there were commercial length distributions from EU-Estonia, EU-Portugal, EU-Spain, Faroes and Norway. The Faroese survey catches are included in the total Faroese commercial catches, so the samples from the Faroes longline survey were used with the commercial ones to obtain the length distribution of the commercial Faroes catches. The commercial samples from Estonia were not used since many of them do not represent the total catch (Figure 6.2). In 2022, the total commercial length distribution presents two modes at the same level, one around 51-55 cm and another around 66 cm. Since 2013, the commercial catch at age data has been generated using Age Length Keys from the EU survey. Since 2015, ages 5 to 8+ have been the most abundant in the catch.

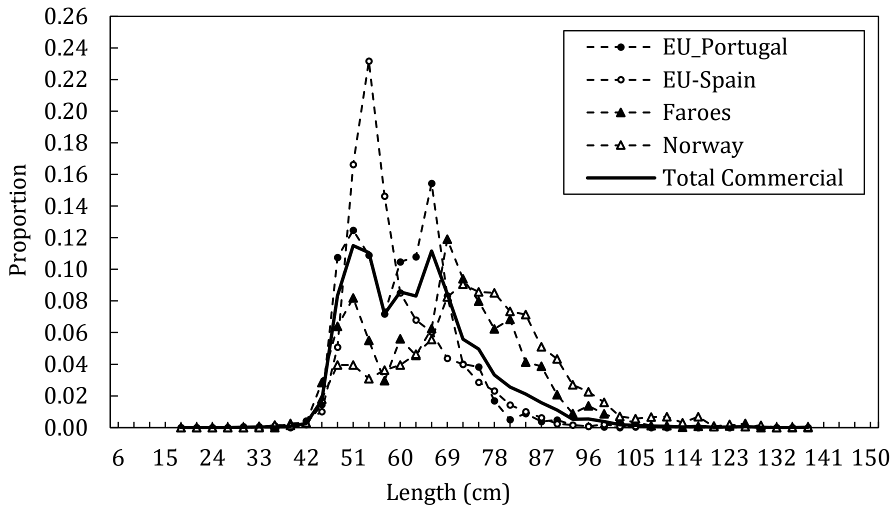


Figure 6.2. Cod in Division 3M: Length distribution of the commercial catches in 2022.

ii) Research surveys

Recent surveys are as follow:

	Div.	2018	2019	2020	2021	2022
EU	3M	●	●	●	●	●

● = complete, o = uncalibrated, – = incomplete

Canadian survey. Canada conducted research surveys on Flemish Cap from 1978 to 1985 on board the R/V *Gadus Atlantica*, fishing with a lined Engels 145 otter trawl. The surveys were conducted annually in January-February covering depths between 130 and 728 m. From a high value in 1978, a general decrease in biomass and abundance can be seen until 1985, reaching the lowest level in 1982 (Figure 6.3).

EU survey. The EU Flemish Cap survey has been conducted since 1988 in summer with a *Lofoten* gear type. The survey indices showed a general decline in biomass going from a peak value in 1989 to the lowest observed level in 2003. Biomass index increased from 2004 to 2014 and has decreased since. The growth of several strong year classes over 2005 to 2012 contributed to the increase in the biomass. Abundance rapidly increased between 2005 and 2011, declined from 2012 to ~~2016~~ 2019. This low level in 2019 was followed by a slight increase in both indices, remained stable since then. The difference in timing of the peaks in biomass and abundance over 2011-2018 is driven by the very large 2009 and 2010 year classes.

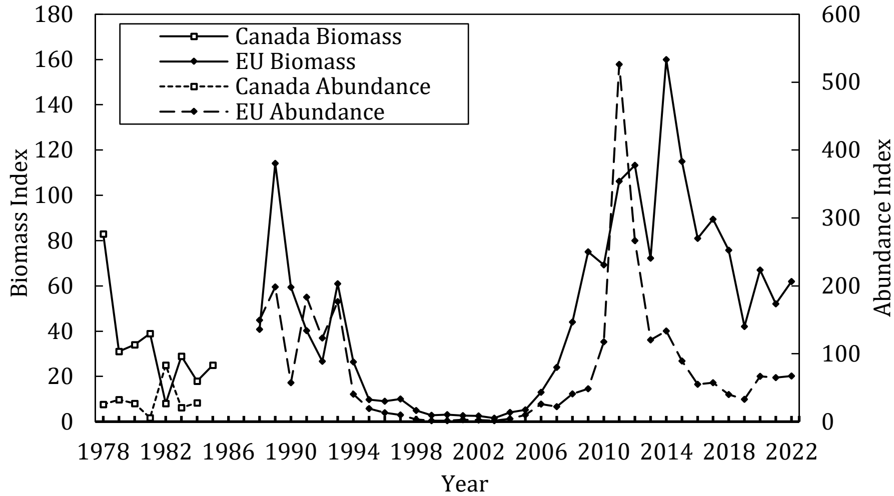


Figure 6.3. Cod in Division 3M: Survey abundance and biomass estimates from Canadian survey (1978-1985) and EU Flemish Cap survey (1988-2022).

iii) Recruitment

Three peaks in recruitment can be seen in 1982-1983, 1991-1992 and 2010-2012. Since 2019, recruitment has increased slightly after a period of 4 years with very low values, although in 2022 recruitment was low. (Figure 6.4).

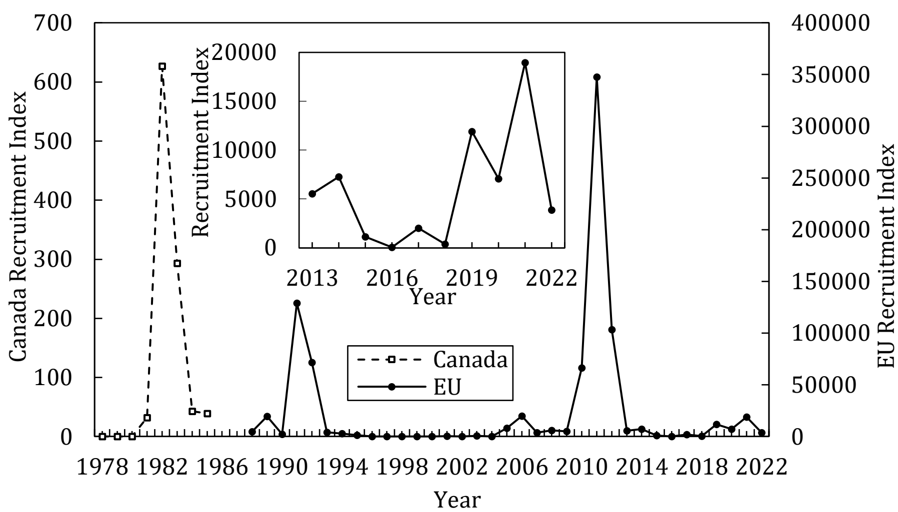


Figure 6.4. Cod in Division 3M: Number at age 1 in the Canadian survey (1978-1985) and EU survey (1988-2022). Inset plot, depicts recruitment since 2013.

iv) Biological parameters

The 2022 age indices were derived from the 2022 EU survey ALK. Mean weight-at-age in the stock and in the catch had been decreasing continuously since the reopening of the fishery, until 2017-2019. Since then, a general slight increase can be observed in older ages (5+). Mean-weight in catch has a similar pattern (Figures. 6.5 and 6.6).

Maturity ogives are available from the EU Flemish Cap survey for almost all years between 1988 and 2021. These were modelled using a Bayesian framework with missing values replaced with interpolations from adjacent years. There was a continuous decline of the A50 (age at which 50% of fish are mature), going from above 5 years old in the late 1980s to just below 3 years old in 2002 and 2003. An upward trend is present in A50 from 2005 to 2016, remaining since then quite stable around 5 years old. (Figure 6.7).

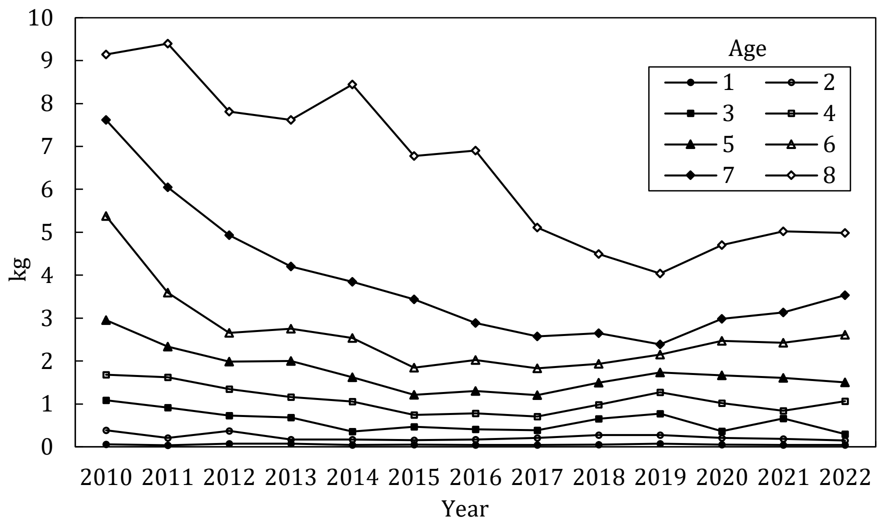


Figure 6.5. Cod in Division 3M: Mean weight-at-age in the stock for the 2010-2022 surveys.

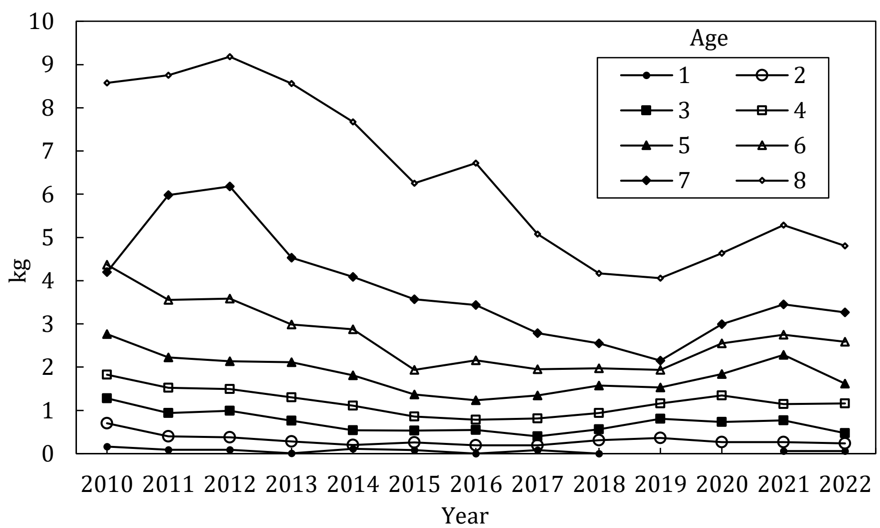


Figure 6.6. Cod in Division 3M: Mean weight-at-age in the catch for 2010-2022.

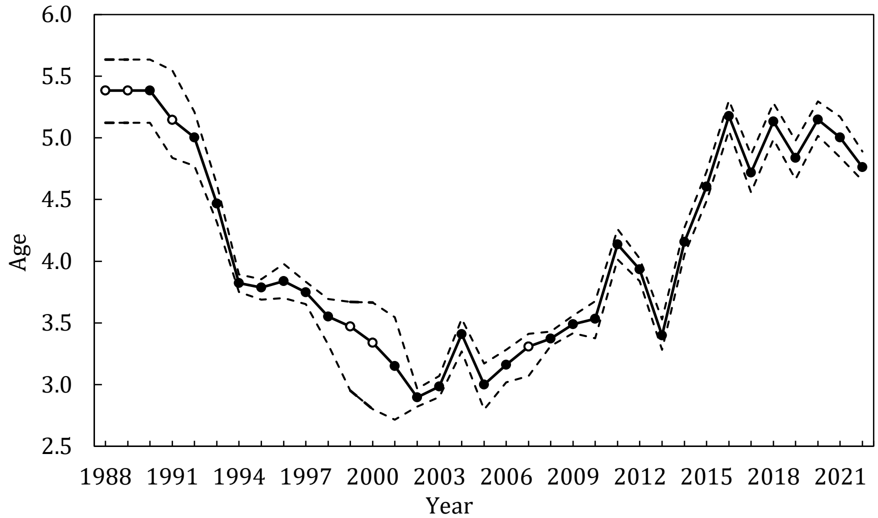


Figure 6.7. Cod in Division 3M: Age at 50% maturity (median and 90% confidence intervals) EU-Flemish Cap survey (1988-2022). Interpolated years are represented in white circles.

c) Estimation of Parameters

A Bayesian SCAA model, introduced at the 2018 benchmark, was used as the basis for the assessment of this stock with data from 1988 to 2022. Input data and settings are as follows:

Catch data: catch numbers and mean weight at age for 1988-2022, except for 2002-2005, for which only total catch is available. STACFIS estimates for total catch were used.

Tuning: numbers at age from EU Flemish Cap survey (1988-2022).

Ages: from 1 to 8+

Catchability analysis: dependent on stock size for age 1, estimated independently for ages 1 to 3 and for 4+ as a group.

Natural Mortality: M was set via a lognormal prior constant over years and variable through ages. Prior median is the same as last year assessment.

Additional priors: for recruitment in all the years, for the number-at-age for ages 2-8+ in the first year, for a year factor for F (f), for selectivity (rC), and for the natural mortality.

Likelihood components: for total catch, for catch numbers-at-age and numbers-at-age of the survey.

The model components are defined as follows:

Input data	Model component	Parameters
R 1988-2022	$LN(medrec, cvrec)$	*medrec*=45000, *cvrec*=10
N(1988,a), a=2-8+	Ages 2-7 $LN\left(median = medrec \times e^{-\sum_{age=1}^{a-1} M(age)+medFsurv(age)}, cv = cvsurv\right)$ Ages 8+ $LN\left(median = medrec \times \frac{e^{-\sum_{age=1}^{A-1}(M(age)+medFsurv(age))}}{1-e^{-M(A+)+medFsurv(A+)}}, cv = cvsurv\right)$	*medFsurv*(1,...,7)={0.0001, 0.1, 0.5, 0.7, 0.7, 0.7, 0.7} *cvsurv*=10
f(y) y=1988-2022	Year 1988 $LN(median = medf,\ cv = cvf)$ Years 1989-2022 $LN(median = AR(1)\ over\ f,\ cv = cvf)$	*medf*=0.2, *cvf*=4
rC(y,a), a=2,8+ 1988-2022	Year 1988 $LN(median = medrC(a),\ cv = cvrC(a))$ Years 1989-2022 $LN(median = last\ year\ rC,\ cv = cvrCcond)$	*medrC*(a)=c(0.01,0.3,0.6,0.9,1,1,1), *cvrC*(a)=c(4,4,4,4,4,4) *cvrCcond*=0.2
Total Catch 1988-2022	$LN\left(median = \sum_{age=1}^{A+} mu.C(y,age)\,wcatch(y,age),\ cv = cvcW\right)$ $mu.C(y,a) = N(y,a)\left(1-e^{-Z(y,a)}\right)\frac{F(y,a)}{Z(y,a)}$	*cvCW=0.077*
Catch Numbers at age, a=2,8+ 1988-2022	$LN(median = mu.C(y,a),\ cv = cv.C)$	*cv.C*=0.2
EU Survey Indices (I) 1988-2022	$I(y) \sim LN(median = \mu(y,a),\ cv = cvEU)$ $\mu(y,a) = q(a)\left(N(y,a)\frac{e^{-\alpha Z(y,a)} - e^{-\beta Z(y,a)}}{(\beta-\alpha)Z(y,a)}\right)^{\gamma(a)}$ $\gamma(a)\begin{cases}\sim N(\text{mean}=1, \text{variance}=0.25),\ if\ a=1\\ =1,\ if\ a \geq 2\end{cases}$ $\log(q(a)) \sim N(\text{mean}=0, \text{variance}=5)$	I is the survey abundance index q is the survey catchability at age N is the stock abundance index *cvEU*=0.3 α = 0.5, β = 0.58 (survey made in July) Z is the total mortality
M	$M \sim LN(medM, cvM)$	*MedM*=c(1.26,0.65,0.44,0.35,0.30,0.27,0.24,0.24) *cvM*=0.15

d) Assessment Results

Total Biomass and Abundance: The median total abundance has declined between 2012 and 2016 by 78%, remaining since then at the level of 2006-2007. Median biomass has also declined by 64% since 2012 (Figure 6.8).

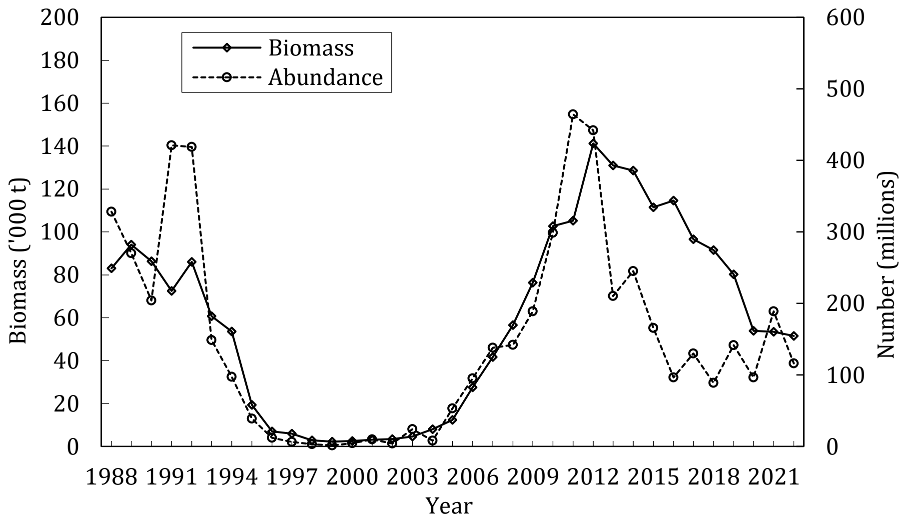


Figure 6.8. Cod in Div. 3M: Biomass and Abundance estimates.

Spawning stock biomass: Estimated median SSB (Figure 6.9) increased from 2005 to 2017, decreased until 2021 and has since been stable. The probability of being below B_{lim} in 2023 is very low (<1%).

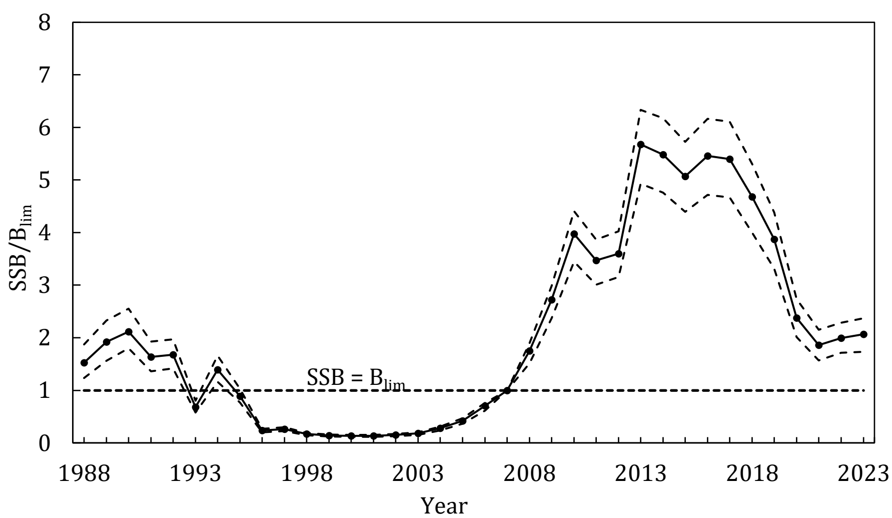


Figure 6.9. Cod in Div. 3M: Median and 80% probability intervals SSB/ Blim estimates. The horizontal dashed line corresponds to SSB = Blim.

Recruitment: Since 2013 the recruitment has oscillated around intermediate levels, much lower than those in 2011-2012 (Figure 6.10).

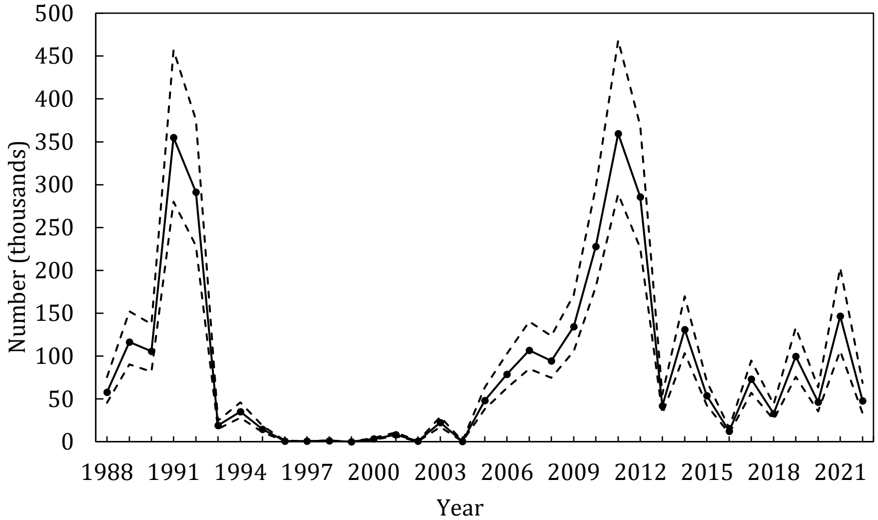


Figure 6.10. Cod in Div. 3M: Recruitment (age 1) estimates and 80% probability.

Fishing mortality: F increased in 2010 with the re-opening of the fishery but remained below F_{lim}. F has generally decreased since 2019 and in 2022 is below F_{lim} with a high probability. (Figure 6.11).

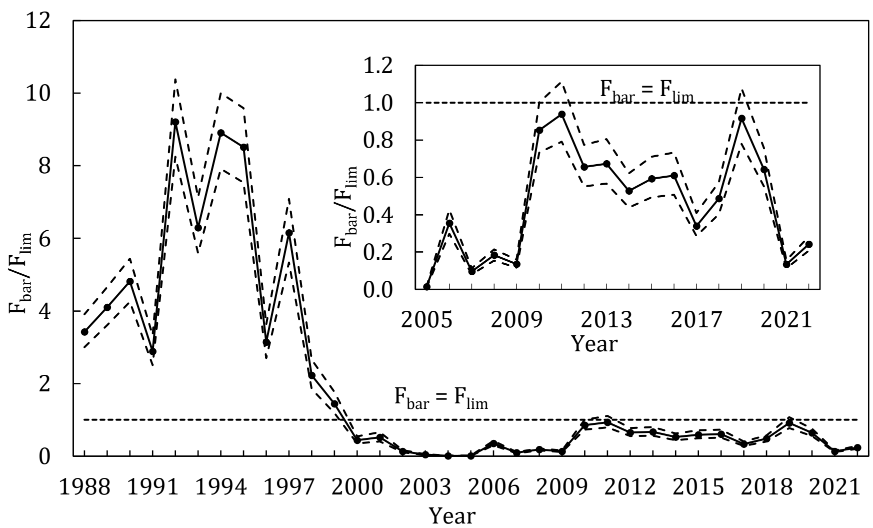


Figure 6.11. Cod in Div. 3M: F_{bar} (ages 3-5) estimates and 80% probability intervals. The horizontal dashed line corresponds to F = F_{lim}. Inset plot, depicts F_{bar} since 2005.

Natural mortality: The posterior median of M by age estimated by the model was:

Age	1	2	3	4	5	6	7	8+
Posterior	1.31	0.60	0.34	0.24	0.25	0.37	0.33	0.42

e) Retrospective analysis

A five-years retrospective analysis with the Bayesian model was conducted by eliminating successive years of catch and survey data. Figures 6.12 to 6.15 present the retrospective estimates for total biomass, age 1 recruitment, SSB and F_{bar} at ages 3-5.

Retrospective analysis shows revisions in the recruitment, mainly regarding the highest values of recruitment in the years 2009 to 2011. These corrections lead to subsequent revisions in the total biomass and SSB. No directional patterns in retrospective analysis are evident in recent years (Figures 6.12 to 6.14). There is very little evidence of a retrospective pattern in F, although the 2018 and 2019 values were revised downwards (Figure 6.15).

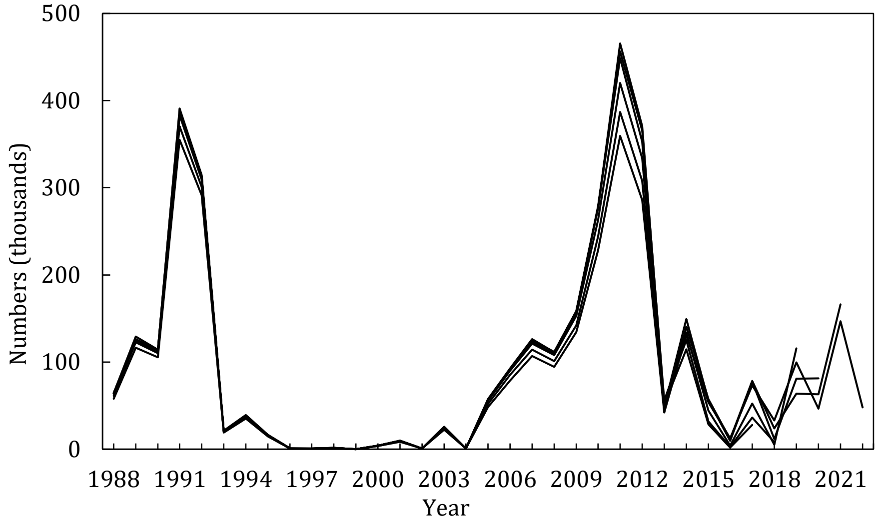


Figure 6.12. Cod in Div. 3M: Retrospective results for recruitment.

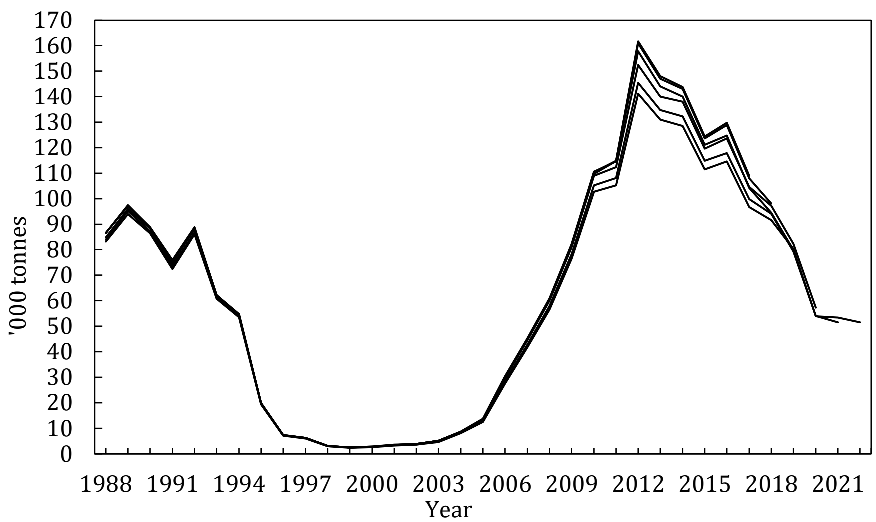


Figure 6.13. Cod in Div. 3M: Retrospective results for total biomass.

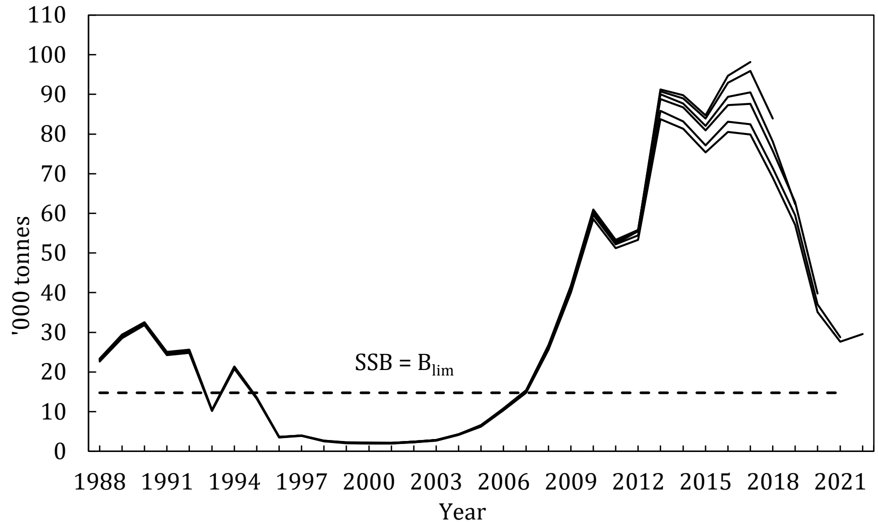


Figure 6.14. Cod in Div. 3M: Retrospective results for SSB.

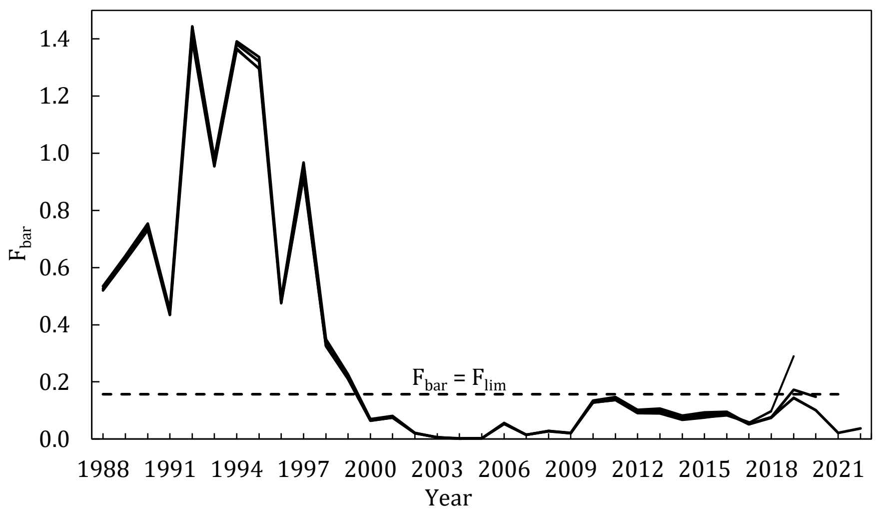


Figure 6.15. Cod in Div. 3M: Retrospective results for average fishing mortality.

f) State of the stock

SSB declined rapidly since 2017 but has remained stable during the last 3 years and is estimated to be above B_{lim}. Since 2013, recruitment has varied at intermediate levels but much lower than those observed in 2011-2012. Fishing mortality has remained below F_{lim} since the fishery reopened in 2010. F has generally decreased since 2019 and in 2022 is below F_{lim} with a high probability.

g) Reference Points

B_{lim} was set by SC as the 2007 SSB posterior distribution (median value = 14 755 tons) (Figure 6.16). F_{lim} was set by SC as $F_{30\%SPR}$ calculated with the mean 2020-2022 input data as 0.157 (median value) (Figure 6.17).

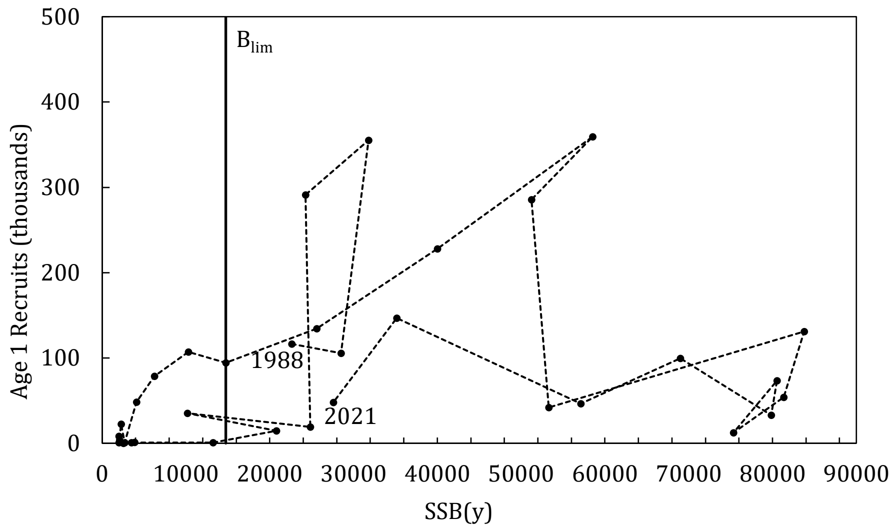


Figure 6.16. Cod in Div. 3M: Stock-Recruitment age 1 (posterior medians) plot. B_{lim} is plotted in the graph.

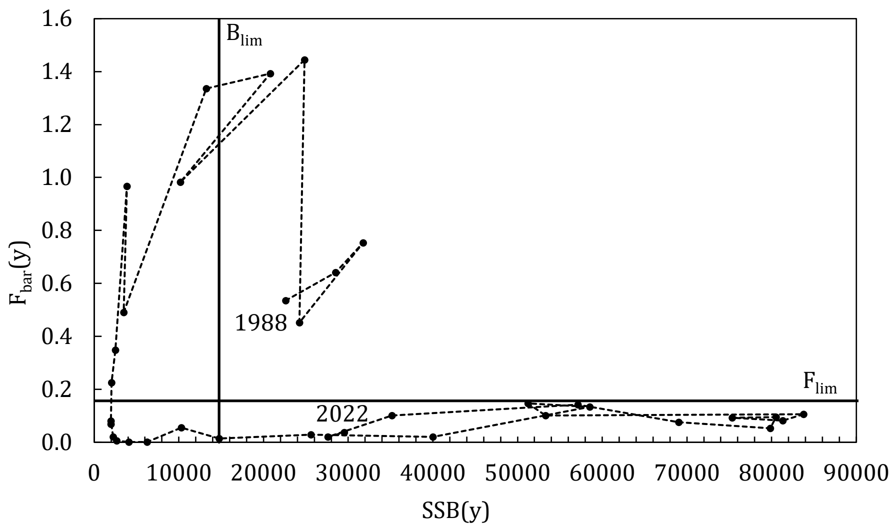


Figure 6.17. Cod in Div. 3M: Stock- F_{bar} (3-5) (posterior medians) plot. B_{lim} and F_{lim} are plotted in the graph.

h) Stock projections

The same method as last year was used to calculate the projections and the risk. A one year stochastic projection was conducted. The variability in the input data is taken from the results of the Bayesian assessment. Input data for the projections are as follows:

Numbers aged 2 to 8+ in 2022: estimated from the assessment.

Recruitments for 2023-2025: Recruits per spawner were drawn randomly from 2019-2021.

Maturity ogive for 2023-2025: Mean of the last three years (2020-2022) maturity ogive.

Natural mortality for 2023-2025: 2022 natural mortality from the assessment results.

Weight-at-age in stock and weight-at-age in catch for 2023-2025: Mean of the last three years (2020-2022) weight-at-age.

PR at age for 2023-2025: terminal year (2022) PR.

F_{bar} *(ages 3-5)*: Seven scenarios were considered:

(Scenario 1) F_{bar}=0 (no catch).

(Scenario 2) F_{bar} =F_{sq} (median value = 0.053).

(Scenario 3) F_{bar}=F_{2023} (median value = 0.058).

(Scenario 4) F_{bar}=1/2 F_{lim} (median value = 0.078).

(Scenario 5) F_{bar}=2/3 F_{lim} (median value = 0.104).

(Scenario 6) F_{bar}=3/4 F_{lim} (median value = 0.117).

(Scenario 7) F_{bar}= F_{lim} (median value = 0.157).

All scenarios assumed that the Yield for 2023 is the established TAC (6 100 t).

F_{bar} is the mean of the F at ages 3-5 and used as the indicator of overall fishing mortality; F_{sq} is the status quo F calculated as the mean of the last three years F_{bar} (2020-2022).

F_{bar} for this stock is calculated as mean F of ages 3-5, that were the most abundant ages in the catch in the past. But in recent years ages 5 to 8+ have been the most dominant in the so the appropriateness of the base case range of ages for calculating Fbar was explored. Although some differences in the value of F_{bar} can be seen in the results, the trend are the same so no reason for changing the base case was encountered.

The results indicate that under all scenarios with $F_{bar} \leq 2/3 F_{lim}$, total biomass during the projected years will decrease, whereas the SSB is projected to increase in 2025 except with F=F_{lim} (Table 6.1). The probability of SSB being below B_{lim} is very low (≤1%) in all the scenarios (Table 6.2). The probability of SSB in 2025 being above that in 2023 ranges between 14% and 100%, depending on the scenario.

Under all scenarios, the probability of F_{bar} exceeding F_{lim} is less than or equal to 2% in 2024.

Table 6.1. Medium-term projections

	B		SSB		Yield
	Median and 80% CI				
$F_{bar} = 0$					
2023	53812	(47944 - 61013)	27709	(24790 - 30794)	6100
2024	58438	(51161 - 68867)	30747	(27207 - 34601)	0
2025	65890	(56510 - 78568)	39660	(34924 - 44681)	
$F_{bar} = F_{sq}$ (median = 0.053)					
2023	53812	(47944 - 61013)	27709	(24790 - 30794)	6100
2024	58438	(51161 - 68867)	30747	(27207 - 34601)	6509
2025	59324	(50003 - 72050)	33696	(29110 - 38825)	
$F_{bar} = F_{2023}$ (median = 0.058)					
2023	53812	(47944 - 61013)	27709	(24790 - 30794)	6100
2024	58438	(51161 - 68867)	30747	(27207 - 34601)	7079
2025	58752	(49433 - 71480)	33199	(28505 - 38167)	
$F_{bar} = 1/2F_{lim}$ (median = 0.078)					
2023	53812	(47944 - 61013)	27709	(24790 - 30794)	6100
2024	58438	(51161 - 68867)	30747	(27207 - 34601)	9176
2025	56673	(47350 - 69385)	31352	(26697 - 36365)	
$F_{bar} = 2/3F_{lim}$ (median = 0.104)					
2023	53812	(47944 - 61013)	27709	(24790 - 30794)	6100
2024	58438	(51161 - 68867)	30747	(27207 - 34601)	11708
2025	54177	(44843 - 66893)	29127	(24423 - 34096)	
$F_{bar} = 3/4F_{lim}$ (median = 0.117)					
2023	53812	(47944 - 61013)	27709	(24790 - 30794)	6100
2024	58438	(51161 - 68867)	30747	(27207 - 34601)	12903
2025	53003	(43651 - 65719)	28064	(23409 - 33003)	
$F_{bar} = F_{lim}$ (median = 0.157)					
2023	53812	(47944 - 61013)	27709	(24790 - 30794)	6100
2024	58438	(51161 - 68867)	30747	(27207 - 34601)	16163
2025	49790	(40459 - 62527)	25247	(20608 - 30117)	

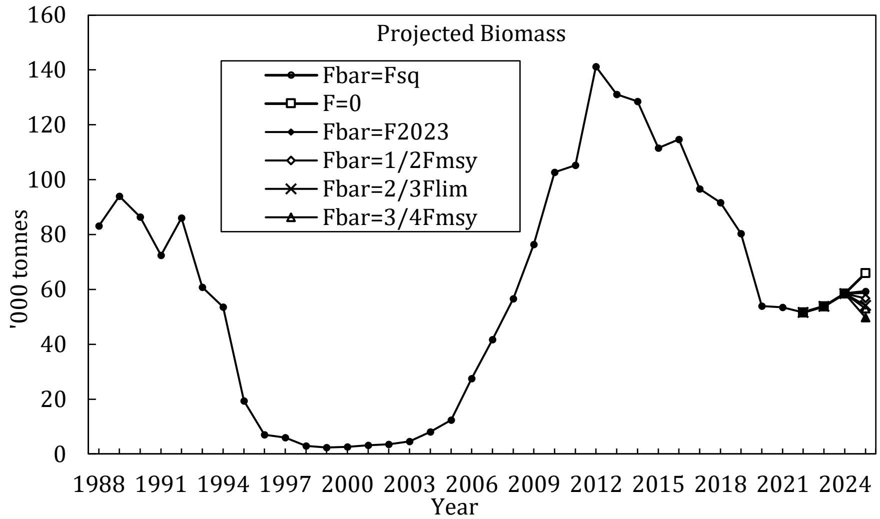


Figure 6.18. Cod in Div. 3M: Projected Total Biomass under all the Scenarios.

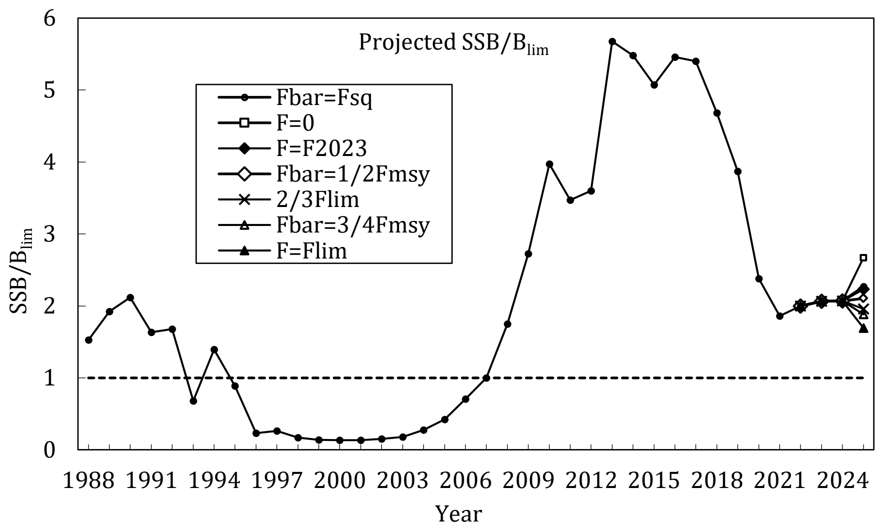


Figure 6.19. Cod in Div. 3M: Projected SSB under all the Scenarios

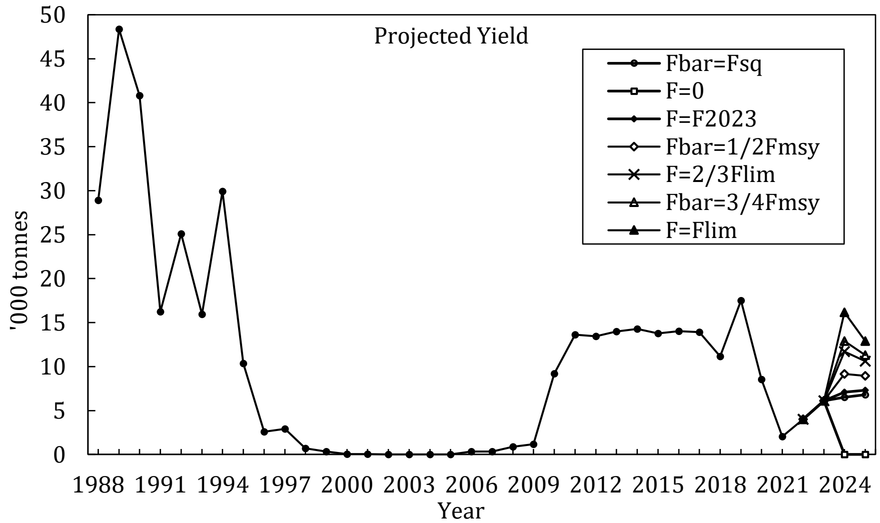


Figure 6.20. Cod in Div. 3M: Projected removals under all the Scenarios

Table 6.2 Projected yield (t) and the probability of SSB < B_{lim} and F_{bar}<F_{lim} and probability of stock growth (SSB_{2025}>SSB_{2023}) under projected F values.

	Yield		P(SSB < SSBlim)			P(F > Flim)		
	2023	2024	2023	2024	2025	2023	2024	P(SSB_{25} > SSB_{23})
F=0	6100	0	<1%	<1%	<1%	<1%	<1%	100%
Fsq = 0.053	6100	6509	<1%	<1%	<1%	<1%	<1%	100%
F2023 = 0.058	6100	7079	<1%	<1%	<1%	<1%	<1%	100%
1/2Flim = 0.078	6100	9176	<1%	<1%	<1%	<1%	<1%	94%
2/3Flim = 0.104	6100	11708	<1%	<1%	<1%	<1%	<1%	72%
3/4Flim = 0.117	6100	12903	<1%	<1%	<1%	<1%	2%	52%
Flim = 0.157	6100	16163	<1%	<1%	<1%	<1%	50%	14%

i) Research recommendations

STACFIS **recommended** that *an age reader comparison exercise be conducted.*

STATUS: An age-readers Workshop was held in November 2017 in order to reconcile the differences among age-readers of this stock. Much progress in understanding where the differences between the commercial and survey ALKs come from was made but still needs more research to completely know the problem. No progress since then was made. NAFO reiterates this recommendation.

STACFIS **encouraged** to *all Contracting Parties to provide length distribution samples from the commercial vessels fishing 3M cod*.

STATUS: NAFO reiterates this recommendation.

The next full assessment for this stock will be in 2024.

7. Beaked Redfish (*Sebastes mentella* and *Sebastes fasciatus*) in Division 3M

(SCR Doc. 23/003, 040; 21/34, SCS Doc. 22/06,13; 21/05,06)

a) Introduction

There are three species of redfish that are commercially fished on Flemish Cap; deep-sea redfish (*Sebastes mentella*), golden redfish (*Sebastes marinus = S. norvegicus*) and Acadian redfish (*Sebastes fasciatus*). The term beaked redfish is used for *S. mentella* and *S. fasciatus* combined. Because of difficulties with identification and separation, all three species are reported together as 'redfish' in the commercial fishery. All stocks have both pelagic and demersal behaviour as well as a long recruitment process to the bottom, extending to lengths up to 30-32 cm. All redfish species are long lived with slow growth. Female sexual maturity is reached at a median length of 26.5 cm for Acadian redfish, 30.1 cm for deep-sea redfish and 33.8 cm for golden redfish.

Description of the fishery

The redfish fishery in Division 3M increased from 20 000 tons in 1985 to 81 000 tons in 1990, falling continuously since then until 1998-1999, when a minimum catch of around 1 000 tons was recorded as by-catch of the Greenland halibut fishery. This drop of the 3M redfish catches was related with the simultaneous decline of stock biomass and fishing effort deployed in this fishery during the first half of the 1990's. In the 2000s catches recorded a stepwise increase, from an average level of 3 000 tons (2000-2004) to 8 000 tons (2005-2017). In 2021 and-2022, the catches were 8,333 tons and 10,043 tons, respectively. Since 2011 catches are associated with the changes in TACs. EU-Portugal, EU-Spain, the Russian Federation and EU-Estonia states are responsible for the bulk of the redfish landings over the last two decades.

Since the mid 2000's, the fishery is a blend of by-catch from cod fishery (depths above 300m, a mixture of golden and beaked redfish), catch from bottom trawl directed fishery (depths between 300-700m, primarily beaked redfish), and by-catch again from Greenland halibut fishery (bellow 700m, 100% deep sea redfish).

For 2015 the annual STACFIS catch estimate was given by the Daily Catch Reports (DCR's) by country provided by the NAFO Secretariat. For 2016 catch was calculated using the CDAG Estimation Strategy (NAFO Regulatory Area Only). The 2017 to 2022 catch estimates were obtained with the application of the CESAG method. The 1989-2022 catch estimates from those different sources are accepted as the 3M redfish landings.

Recent catches and TACs ('000 tonnes) are as follows:

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TAC	6.5	6.7	7.0	7.0	10.5	10.5	8.6	8.4	10.9	11.2
STATLANT 21	6.4	6.9	6.6	7.1	10.5	10.5	8.6	8.6	NA*	
STACFIS Total catch [1]	7.4	6.9	6.6	7.1	10.5	10.6	8.8	8.3	10.0	
STACFIS Catch [2]	4.6	5.2	6.2	6.9	10.3	10.2	8.7	7.9	8.9	

[1] STACFIS total catch on 2011-2014 based on the average 2006-2010 bias.

[3] STACFIS beaked redfish catch estimate, based on beaked redfish proportions on observed catch.

* STATLANT 21a data for 2022 were not yet available at the time of writing

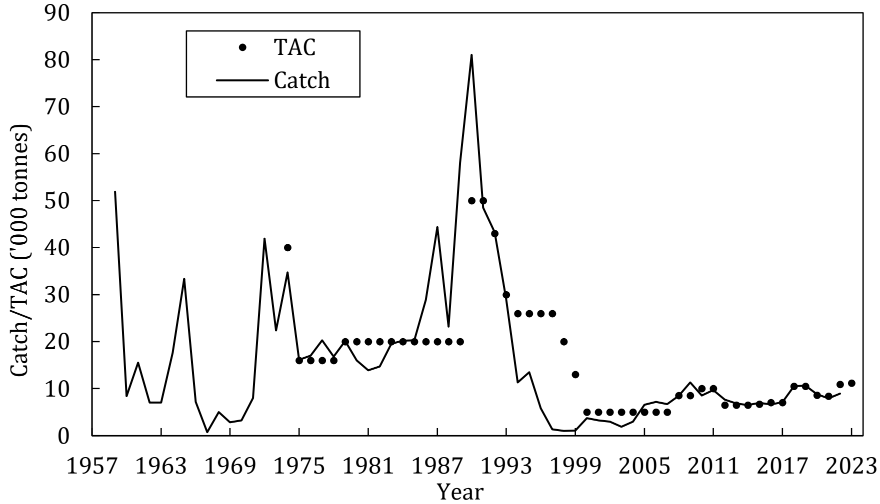


Figure 7.1. Redfish in Div. 3M: total catches and TACs.

b) Input Data

The 3M redfish assessment is focused on beaked redfish, regarded as a management unit composed of two populations from two very similar species: the Flemish Cap *S. mentella* and *S. fasciatus*. The reason for this approach is the historical dominance of this group in the 3M redfish commercial catch. During the entire series of EU Flemish Cap surveys beaked redfish also represents the majority of redfish survey biomass (72%).

Commercial fishery and by-catch data

Sampling data. Portuguese beaked redfish length frequencies were applied to the beaked redfish catch of other bottom trawl fleets with the exception of the Russian, Spanish and Japanese fleets for the years where respective length sampling data are available. In 2021 and 2022 Portuguese length frequencies were applied to other countries excluding Spain.

The available 1998-2022 3M beaked redfish commercial length weight relationships from the Portuguese commercial catch were used to compute the mean weights of all commercial catches and corresponding catch numbers at length.

Redfish by-catch in numbers at length for the Div. 3M shrimp fishery is available for 1993-2004, based on data collected on Canadian and Norwegian vessels. No bycatch information were available from 2005 onwards when the fishery was very low and hence bycatch was assumed to be negligible, and a moratorium to the Div.3M shrimp fishery was in place from 2010-2019 and in 2022 onwards. The commercial and bycatch length frequencies were summed to establish the total removals at length. These were converted to removals at age using the EU survey *S. mentella* age length keys (ALK) from 1988-2017 and *S. mentella* + *S. fasciatus* ALKs from 2018-2022 with both sexes combined. Annual length weight relationships derived from Portuguese commercial catch were used for determination of mean weights-at-age.

The 1999-2002 and 2005 cohorts dominated the overall catch through most years of the 2001-2012 interval. The 2009-2011 cohorts are the most abundant in the catch between 2014 and 2016. Larger sizes corresponding to older ages, and 11 and 12 years old fish (from 2005-2006 cohorts) were the most abundant in the catch in 2017. However most abundant ages return to much younger redfish in 2018, with ages 6 and 7 (2012-2011 cohorts) being the most abundant in the catch. Since 2020, larger sizes in the catch correspond to fish aged 8+ years older (from cohorts as old as that of 2004) dominated catches.

i) Research survey data

Recent surveys are as follow:

	Div.	2018	2019	2020	2021	2022
EU	3M	●	●	●	●	●

● = complete, o = uncalibrated, – = incomplete

EU Flemish Cap bottom trawl survey

Survey biomass was calculated based on the abundance at length and annual length weight relationships from the EU bottom trawl survey for the period 1988-2022.

Age compositions for Div. 3M beaked redfish EU survey stock and mature female stock from 1989 to 2022 were obtained using the EU survey *S. mentella* age length keys (ALK) from 1988-2017 and *S. mentella* + *S. fasciatus* ALKs from 2018-2022. Mean weights-at-age were determined using the EU survey annual length weight relationships.

Gonads from Flemish Cap beaked redfish were collected since 1994 though not every year. Maturity at length ogives from 1994 were used in previous assessments. New maturity at length ogives were estimated based on microscopic inspection of histological sections of gonads collected throughout 16 years between 1994 and 2022. Maturity data were combined for both species within each year and fitted to a logistic function. For the years in between, where data was missing, curve parameters were estimated as the weighted average of the adjacent years where maturity ogives were available. The new maturity at length results were used in the present assessment.

Survey results. The survey stock abundance and biomass declined in the first years of the survey and remained low until 2003. A sequence of above average year classes (2001-2005), including the strongest of the survey series (2002), with high survival rates and coupled to a sudden but major increase of the size of the *S. fasciatus* component, led the exploitable beaked redfish stock as a whole to a maximum in 2006. Both spawning stock and exploitable biomass were high in mid 2000s early 2010s. While the exploitable biomass index and abundance declining since 2012, spawning stock biomass (SSB) has remained high until 2017 (Figure. 7.2). There has been very low recruitment at age four in most recent years with the exception of the 2016 year class which appears in 2020. The exploitable stock biomass index was declining until 2018 and has generally increased since then.

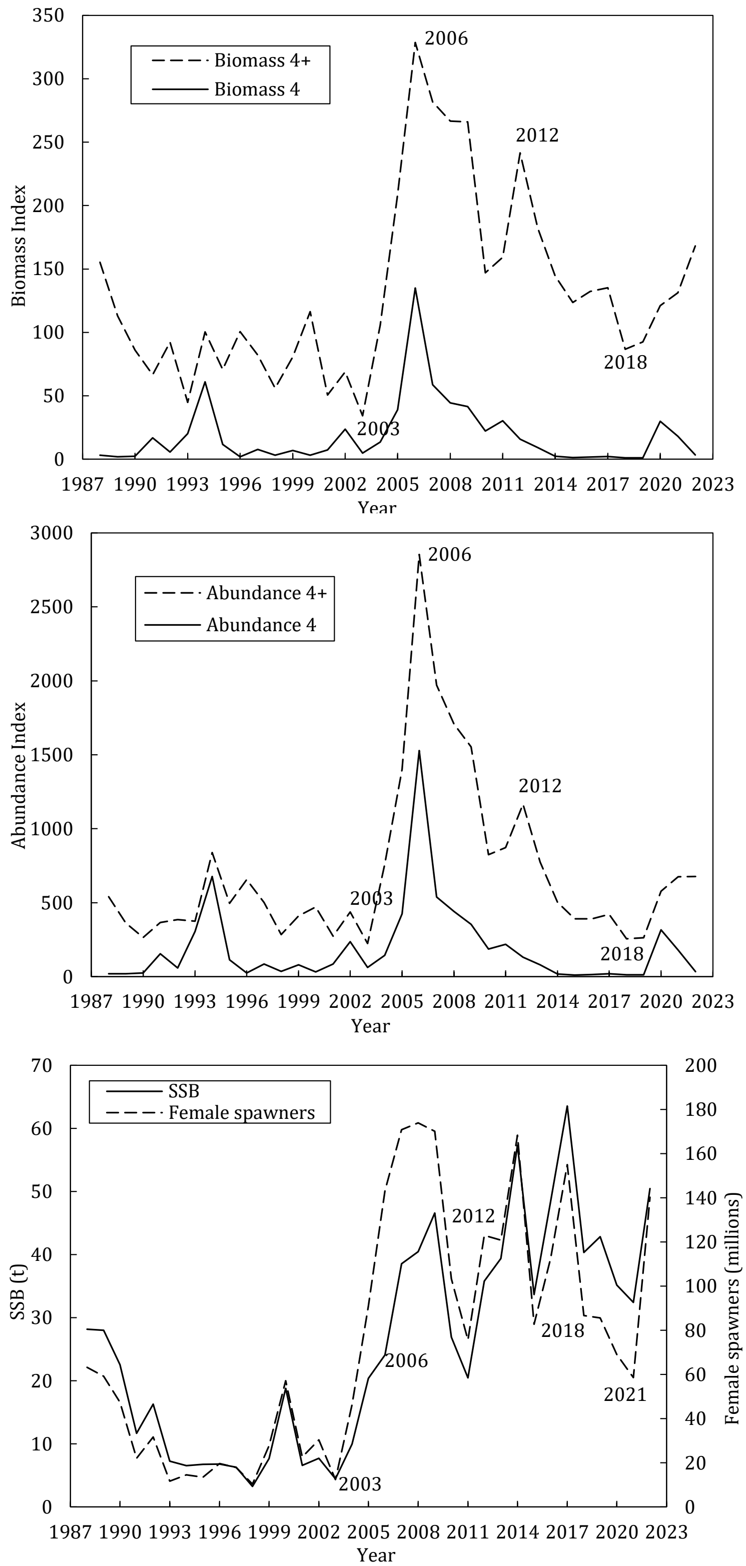


Figure 7.2. Beaked redfish in Div. 3M: exploitable biomass, female spawning biomass/abundance and recruitment at age 4 abundance from EU surveys (1988-2022).

ii) Natural mortality

In this assessment, the sensitivity analysis carried out in previous assessments was not performed, the Div. 3M cod biomass has been stable in recent years and there is no reason to suspect that the predation on redfish has changed.

c) Estimation of Parameters

The Extended Survivors Analysis (XSA) (Shepherd, 1999) was used to estimate stock size. The month of peak spawning (larval extrusion) for Div. 3M *S. mentella*, was taken to be February, and was used for the estimate of the proportion of fishing mortality and natural mortality before spawning. EU survey abundance at age was used for calibration. The XSA model specifications are the same as in the assessments since 2015, and are given below:

Catch data from 1989 to 2022, ages 4 to 19+

Fleets	**First year**	**Last year**	**First age**	**Last age**
EU summer survey (Div. 3M)	1989	2022	4	18

Tapered time weighting not applied

Catchability independent of stock size for all ages

Catchability independent of age for all ages >=16

Terminal year survivor estimates not shrunk towards a mean F

Oldest age survivor estimates not shrunk towards the mean F of previous ages

Minimum standard error for population estimates from the last true age of each cohort age = 0.5

Before 2006, *M* remained at 0.1. The rationale to select the best options for natural mortality between 2006 and 2017 are thoroughly explained in the sensitivity analysis sections of previous assessments (NAFO SCS Doc. 17/16REV). A natural mortality of 0.4 was tuned to ages 4-6 between 2006 and 2010 and extended to all ages in 2009-2010 to reflect cod predation. Since then natural mortality was assumed to be again an age independent parameter, and in 2011-2012 declined to 0.125, a level much closer to what is considered the magnitude of natural mortality on redfish stocks (0.1). However, from 2013-2014 the best fit to survey data implied again a marginal increase of *M* to 0.14. The best *M* option found since 2017 XSA assessments was a natural mortality of 0.1 from 2015 onwards. The 2023 XSA assessment run with *M* in 2021-2022 fixed at 0.10.

d) Assessment Results

The 2023 XSA diagnostics kept the main features from past assessments: high variability associated with mean catchabilities and survivors, namely at younger ages, together with a similar patchwork of *log q age* residuals that is similar to previous values. However, in most recent years a clear annual pattern of positive residuals appears again in older ages, but not as large as previous assessments. The last two years show a decrease in the magnitude of the residuals.

A retrospective XSA (2018-2022) was carried out to check patterns and magnitude of bias in the main results of recent assessments back in time (Figure 7.4). Retrospective patterns are observed in exploitable, female spawning biomass and recruitment (underestimate) and average fishing mortality, however the magnitude in this case is quite small (overestimate) for most recent years.

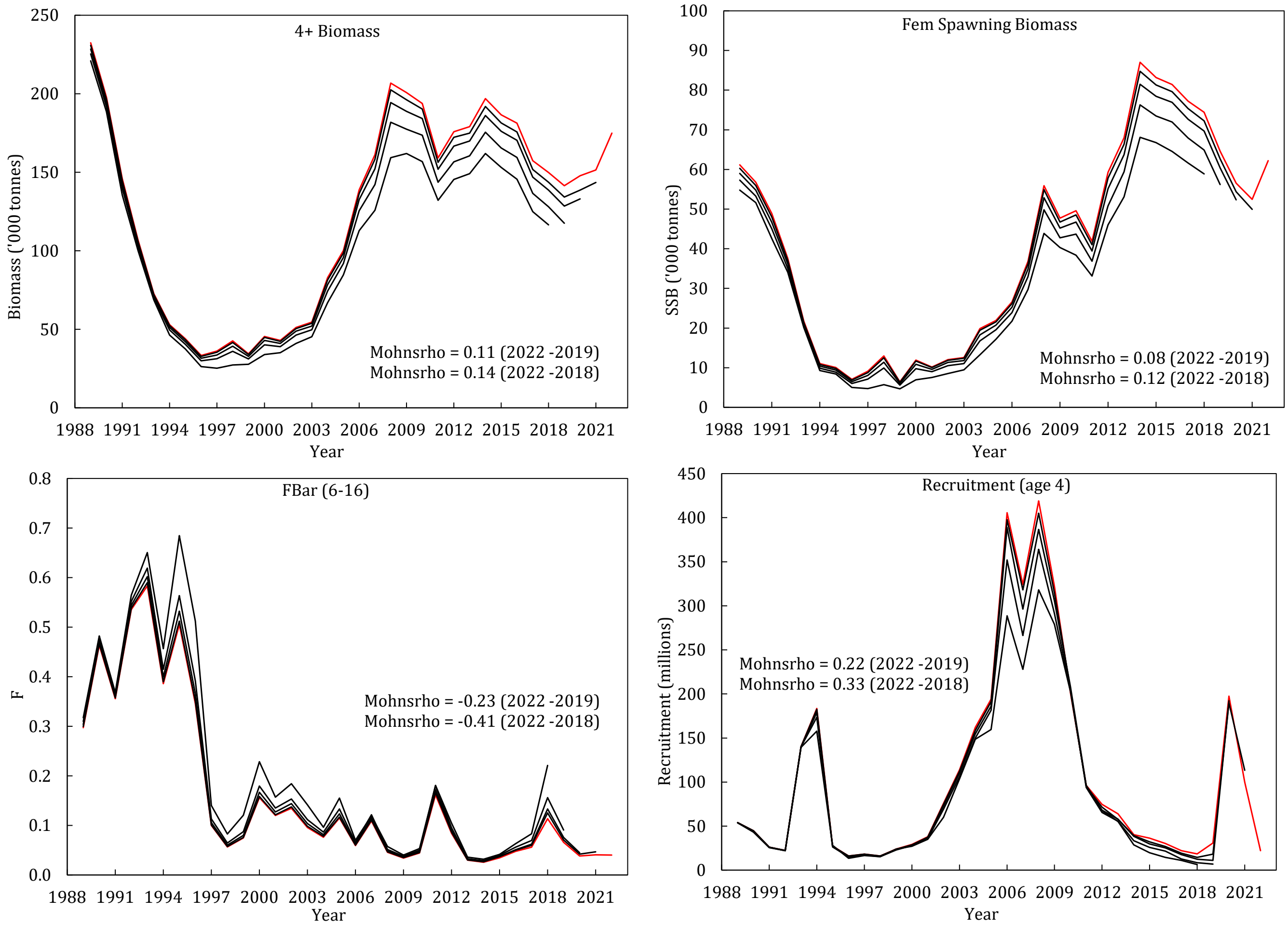


Figure 7.3. Beaked redfish in Div. 3M: XSA retrospective analysis, last year 2022-2018: exploitable 4+ biomass, female spawning stock biomass, average fishing mortality (ages 6-16) and recruitment (age 4).

Taking into account the consistency of present assessment with the previous ones, the 2023 XSA assessment was accepted with 2021-2022 natural mortality at 0.1.

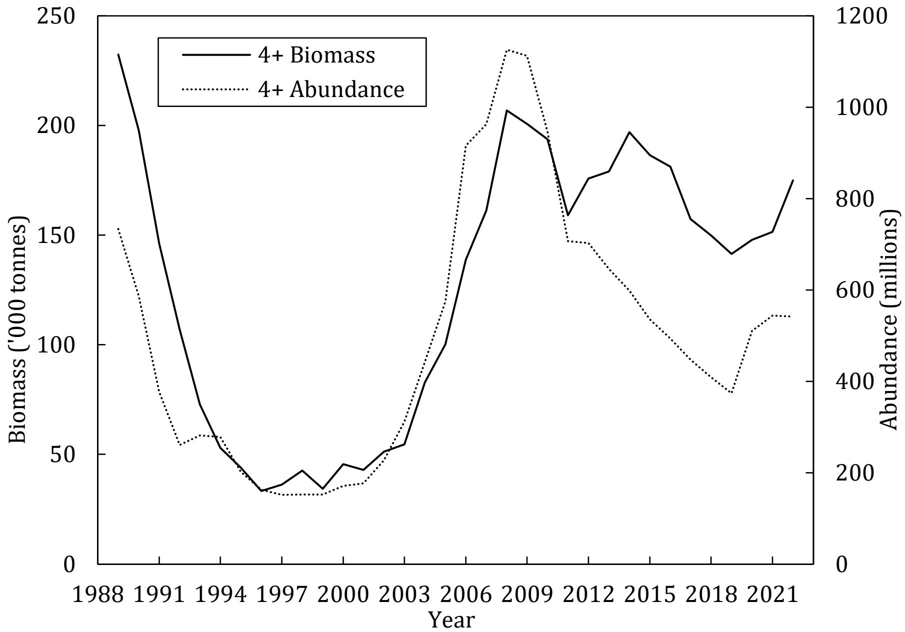


Figure 7.4. Beaked redfish in Div. 3M: age 4+ biomass and age 4+ abundance from XSA.

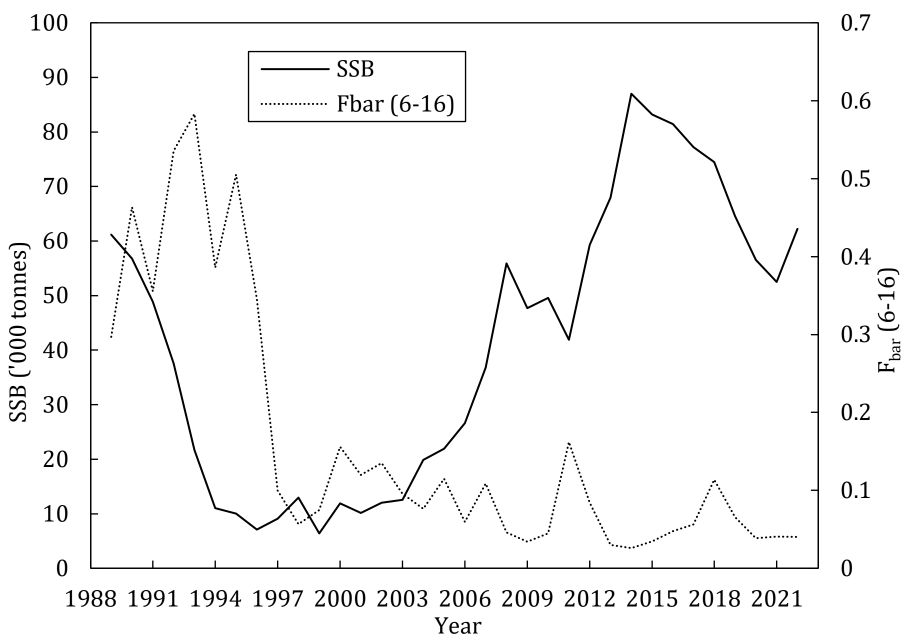


Figure 7.5. Beaked redfish in Div. 3M: female spawning biomass and fishing mortality trends from XSA.

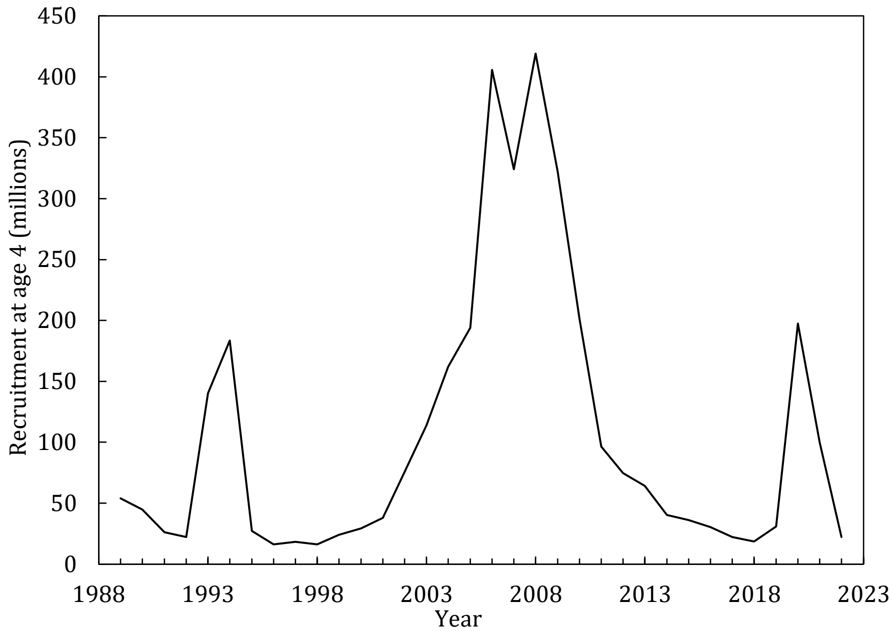


Figure 7.6. Beaked redfish in Div. 3M: recruitment at age 4.

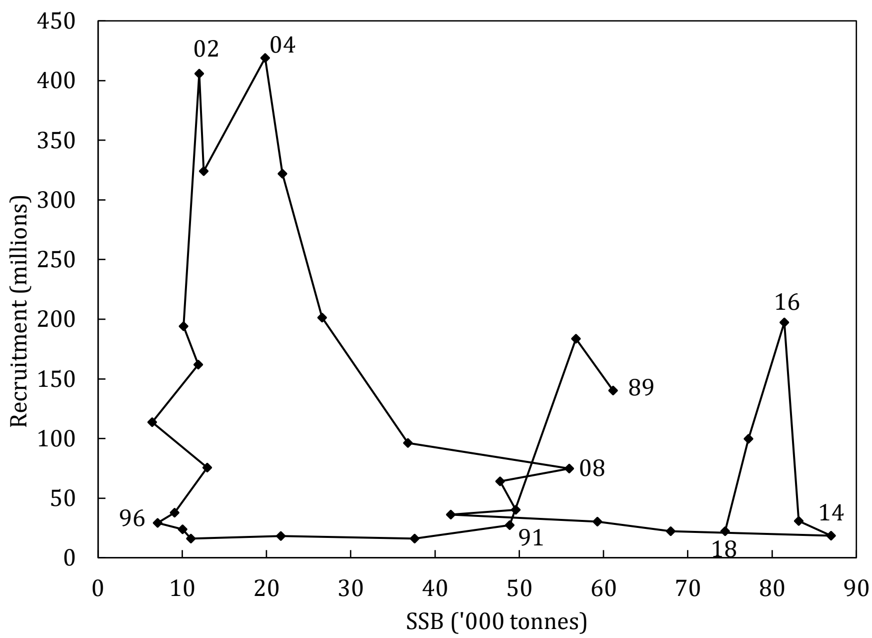


Figure 7.7. Beaked redfish in Div. 3M: Stock/Recruitment plot (labels indicate age class).

Biomass and abundance (Figure 7.4): Biomass and abundance have increased since 2018, and in 2022 are above the means of their respective series.

Spawning stock biomass (Figure 7.5): SSB has declined since 2014, but is in 2022 still well above the long term mean.

Fishing Mortality (Figure 7.5): Current fishing mortality remains relatively low compared to the 1980s and 1990s.

Recruitment (Figures 7.6 and 7.7): After an extended period of declining recruitment, the recruitment estimate for 2020 and 2021 are at or above the mean while the 2022 value is low.

State of the stock: SSB has declined since 2014, but in 2022 is still well above the long term mean. After an extended period of declining recruitment, the recruitment estimates for 2020 and 2021 are at or above the mean while the 2022 value is low. Fishing mortality remains relatively low compared to the 1980s and 1990s.

Yield per recruit analysis

In order to get proxies of $F_{0.1}$ and F_{max} in line with the most recent partial recruitment (PR) results, a new yield per recruit analysis (ypr) was performed.

The PR vector is given by the 2020-2022 average of the relative F at ages 4-18. Natural mortality (M) was kept at 0.10 through ages and years. All input weight at age and maturity at age vectors were averages from the most recent three years. In order to reduce the weight of the plus group on the final results, ages were virtually extended to age 29 with a plus group set at age 30. Mean weights and female maturity were kept constant and were the ones of the XSA 19 plus group.

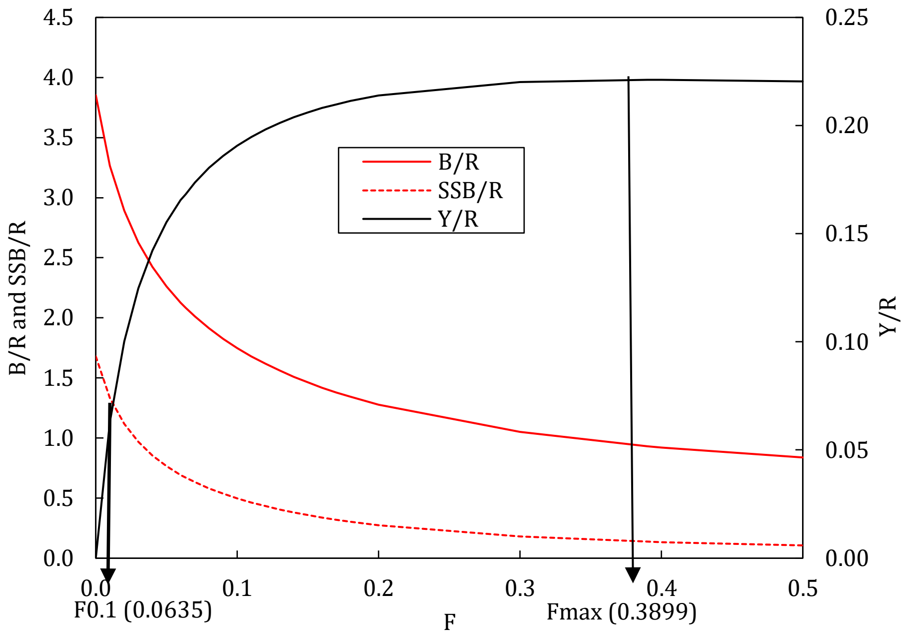


Figure **7.8.** Beaked redfish in Div. 3M: yield per recruit analysis at M=0.10 (2020-2022 average inputs)

The $F_{0.1}$ (0.0635) estimated by the 2023 ypr (Figure 7.8) was at the magnitude of the one estimated in the last assessment (0.07 in 2021) and below the previous ones of 2017, 2019 assessments (0.09 and 0.086 respectively). F_{max} is estimated at 0.3899 (0.2997 in 2021; 0.1883 in 2019 and 0.163 in 2017). F_{max} is considered to be estimated with high uncertainty associated and therefore not accepted. The $F_{0.1}$ value has been used for short term projections. The results regarding $F_{0.1}$ and F_{max} are at the moment candidates to 3M beaked redfish fishing mortality reference points that still need to be confirmed in near future.

e) Short term projections

Short term (2024-2026) projections were carried out for female spawning stock biomass (SSB) and catch, under most recent level of natural mortality (with an associated CV correspondent to an allowed variability of natural mortality between 0.08 and 0.12) and considering six options for fishing mortality and catch levels as follows:

1. No fishing, F_0
2. $F_{0.1}$
3. $F_{statusquo}$
4. F=M=0.1

5. 1.25 TAC_{2023}
6. 0.75 TAC_{2023}

Projections assume that redfish catch (all species) in 2023 is equal to the TAC ($F_{statusquo}$ is defined as the corresponding *F*). Recruitment entering in 2023 to 2025 given by the geometric mean of the most recent recruitments (age 4 XSA, 2017-2019).

Stochastic projections of yield and female spawning stock biomass (SSB) under the six *F* options were initialized with abundance for ages 5 and older at the beginning of 2024. The coefficients of variation for population at age at the beginning of 2024, were set as the internal standard errors from XSA diagnostics. For 2024 and 2025, recruitment was randomly resampled with residuals from the geometric mean of 2017-2019 recruitments (age 4 XSA, 2017-2019). All other inputs at age are the last three year averages with associated errors at age.

Short term projections are summarized on the table below:

Table 7.1. Short term projections for female SSB (50th percentile at the beginning of 2023, 90th percentile, 50th percentile and 10th percentile at the beginning of 2024-2026), yield of beaked redfish predicted for 2024 and 2025 (50th percentile) under several *F* options and TAC for all three redfish species, based on beaked redfish proportions on observed catch.

F=0

Year	SSB Median and 80% CI		Yield	TAC
2023deterministic	59314		10937	11171
2024	55090	(49792 - 63774)	0	0
2025	57333	(51786 - 66352)		
2026	58901	(52905 - 68977)		

F0.1=0.0635

Year	SSB Median and 80% CI		Yield	TAC
2023deterministic	59314		10937	11171
2024	55090	(49792 - 63774)	20243	21888
2025	50045	(45230 - 57911)		
2026	45495	(40633 - 53368)		

F=*M*=0.1

Year	SSB Median and 80% CI		Yield	TAC
2023deterministic	59314		10937	11171
2024	55090	(49792 - 63774)	30510	32988
2025	46450	(41969 - 53691)		
2026	39584	(35278 - 46516)		

FsqTAC= 0.0500

Year	SSB Median and 80% CI		Yield	TAC
2023deterministic	59314		10937	11171
2024	55090	(49792 - 63774)	16188	17503
2025	51496	(46584 - 59550)		
2026	48009	(42944 - 56417)		

1.25 TAC (*F*= 0.039355)

Year	SSB Median and 80% CI		Yield	TAC
2021deterministic	59314		10937	11171
2024	55090	(49792 - 63774)	12915	13964
2025	52661	(47650 - 60824)		
2026	50096	(44840 - 58802)		

0.75 TAC (*F*=0.0231331)

Year	SSB Median and 80% CI		Yield	TAC
2023deterministic	59314		10937	11171
2024	55090	(49792 - 63774)	7749	8378
2025	54502	(49317 - 63022)		
2026	53524	(48040 - 62834)		

average beaked redfish proportion in the 2020-2022 3M redfish catch 0.925

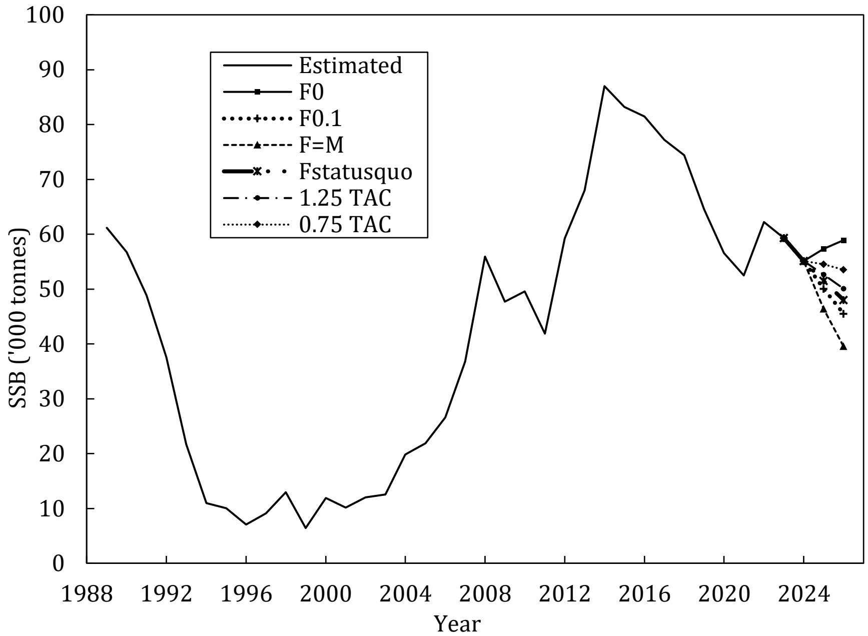


Figure 7.9. Beaked redfish in Div. 3M: SSB trajectory (1989-2022) and 2024-2026 projections (50th percentile) under several *F* options

Projection results indicate a 7% decline from 2023 to 2024 (i.e., interim year under $F_{statusquo}$). Results for the six projection scenarios show biomass declines of 1% (for *F*=0), 23% (for $F_{0.1}$), 33% (for *F*=*M*), 19% (for $F_{statusquo}$), 16% (for 1.25 TAC) and 10% (for 0.75 TAC) between 2023 and 2026.

The assessment has had a consistent tendency to underestimate stock size (both SSB and 4+biomass; see fig 7.3) for the last five years. Since the previous assessment in 2021 the fishable biomass series has therefore been revised upwards and in addition this component of the stock has increased since 2021. The potential yields estimated in the projections are therefore also more optimistic than seen in the 2021 assessment. STACFIS was not able to resolve the reason for this retrospective pattern, and this adds uncertainty to the projection results. With the exception of the *F*=0 scenario, the SSB is projected to decline, and to be at around the average for the assessment time-series (since the late 1980s) by 2026.

	$F_{0.1}$	F=M	Fsq	1.25 TAC	0.75 TAC
P(SSB_{2024}>SSB_{2023})	<10%	<10%	<10%	<10%	<10%
P(SSB_{2025}>SSB_{2023})	<10%	<10%	>10%	>10%	>10%
P(SSB_{2026}>SSB_{2023})	<10%	<10%	<10%	<10%	>10%

The probability of SSB at the beginning of 2026 being greater than it was at the beginning of 2023 is less than 10% in all scenarios expect for 0.75 TAC, not taking in consideration the scenario F=0.

f) Reference Points

There are no accepted limit reference points for this stock. Yield per recruit reference points are used in the projections and may be candidate reference points for this stock.

g) Research recommendations

STACFIS **recommends** that *input data should be investigated in order to reduce the retrospective pattern of the XSA assessment, such as the ALKs used. Other assessment models, such as those used in mixed species redfish stocks, in the Gulf of St. Laurence and NAFO Div. 0, should be explored.*

Given the uncertainty in the projections, this stock will be reassessed in 2024.

8. American Plaice (*Hippoglossoides platessoides*) in Division 3M

(SCR Doc. 20/39, 23/003, 024; SCS Doc. 21/05, 09, 22/13, 23/13)

a) Introduction

The American plaice stock occurs mainly at depths shallower than 600 m on Flemish Cap. Catches are taken mainly by otter trawl, primarily in a bycatch fishery since 1992.

Nominal catches during 1960 to 1973 varied with a peak of about 5 341 tonnes in 1965. Catches of this stock became regulated in 1974 and ranged from 275 tonnes (1993) to 5 600 tonnes (1987) until 1996. Since 1997 catches have remained low and declined to a historical minimum in 2012 (63 tonnes). Catches increased in recent years, oscillating between 120 and 300 tonnes and are taken as bycatch partially in the Div. 3M cod and redfish fisheries.

From 1979 to 1993 a TAC of 2 000 tonnes was in effect for this stock. A reduction to 1 000 tonnes was agreed for 1994 and 1995 and a moratorium was agreed to thereafter (Figure 8.1).

Recent catches and TACs ('000 tonnes) are as follows:

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TAC	ndf	ndf	ndf	ndf	ndf	ndf	ndf	ndf	ndf	ndf
STATLANT 21	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	NA	
STACFIS	0.2	0.3	0.2	0.2	0.2	0.3	0.2	0.1	0.1	

ndf No directed fishing.

[1] STATLANT 21a data for 2022 were not yet available at the time of writing.

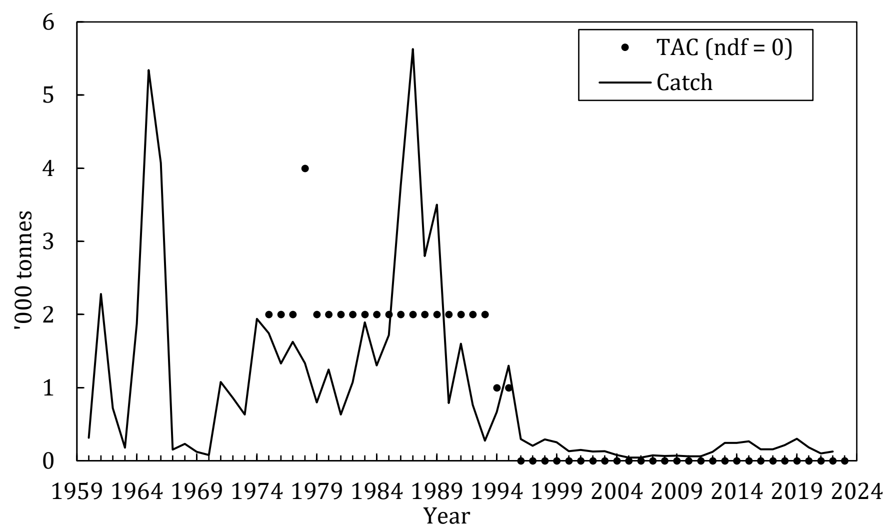


Figure 8.1. American plaice in Div. 3M: STACFIS catches and TACs. No directed fishing is plotted as 0 TAC.

b) Input Data

i) Commercial fishery data

EU-Portugal provided length composition data for the 2020-2022 trawl catches. Russia provided length composition data for the 2020 trawl catches. The length frequencies were used to estimate the length compositions for the 2020-2021 total catch. There is no dominant lengths in catches between 2020 and 2022, with catches distributed mainly between 24 and 54 cm.

ii) Research survey data

Recent surveys are as follow:

	Div.	2018	2019	2020	2021	2022
EU	3M	●	●	●	●	●

● = complete, o = uncalibrated, – = incomplete

Research surveys have been conducted by the EU since 1988.

USSR/Russia conducted surveys from 1972 to 1993 with two additional surveys conducted in 2001 and 2002. From 1972 to 1982 the USSR survey used a fixed-station design. Since 1983 USSR/Russia adopted a stratified random survey design and the USSR surveys for 1972 to 1982 were post-stratified for comparison to the new survey series. Canada conducted research vessel surveys from 1978 to 1985, and a single survey was conducted in 1996.

Although the USSR/Russia survey series (1972-1993) shows high variability, there was a decreasing trend during 1986-93. Abundance and biomass from the USSR/Russia survey in 2001 were the lowest of the series. Canadian survey biomass and abundance between 1978 and 1985 varied without trend at a level similar to that seen in the USSR/Russia survey and in 1996 were similar to estimates from the EU survey (Figure 8.2). The EU survey series had a continuous decreasing trend in abundance and biomass from the beginning of the series to 2000 and has remained low. The 2007 abundance and biomass were the lowest of the series. Since 2008, due to improved recruitment, biomass and abundance indices increased. The EU's survey biomass shows a faster upward trend until 2017 than the abundance, due to the growth of existing year classes. In recent years. the stock stabilized and is at same levels of mid-1990s, when the fishery was closed (Figure 8.2).

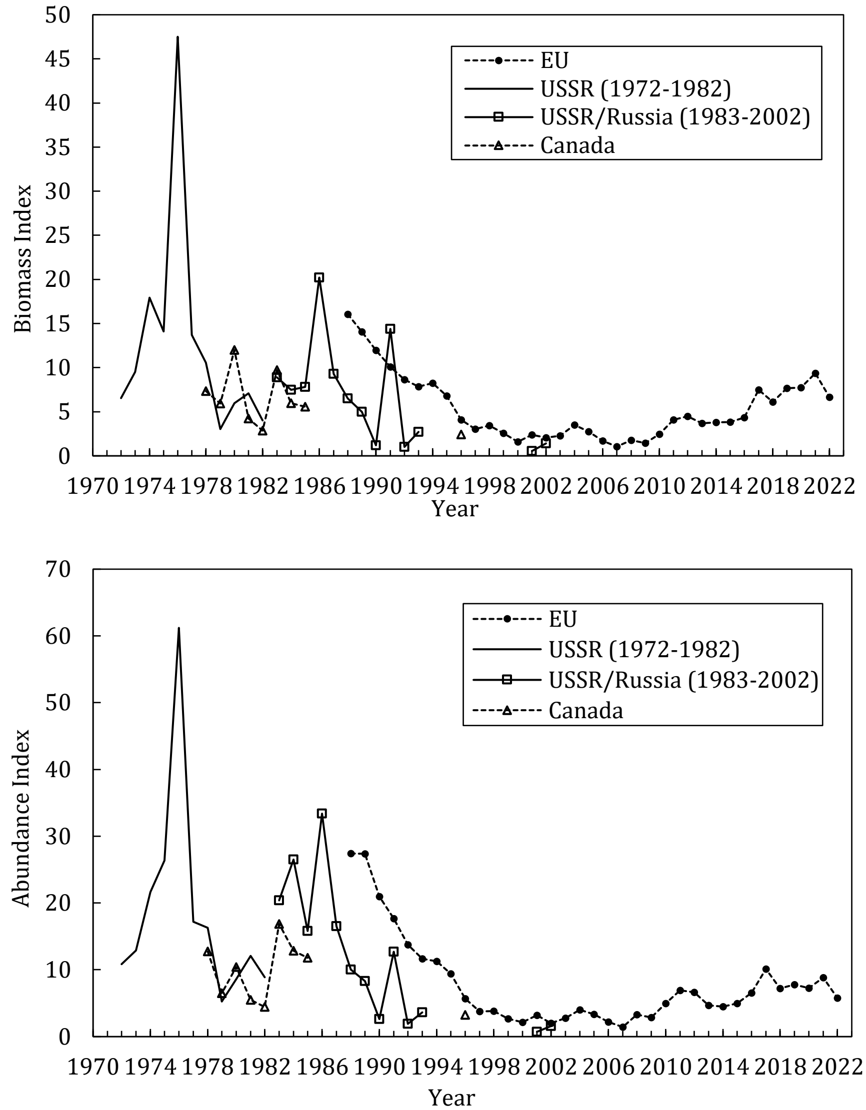


Figure 8.2. American plaice in Div. 3M: trends in survey biomass and abundance indices. EU survey data prior to 2003 have been converted to RV Vizconde Eza equivalents.

c) Estimation of Parameters

No ALKs were available for recent years (2020-2022), therefore, it was not possible to update any age-dependent data, matrices or analyses, for either the stock or the catches. The previous illustrative XSA was not updated.

A fishing mortality index (*F*) is given by the catch and EU survey total biomass ratio.

The maximum mean length for ages 1 to 4 were calculated based on the EU survey mean length at age 1988-2019 matrix. The abundances less than 16cm, 24cm, 32cm and 36cm were considered a proxy for age 1, ages 1 to 2, ages 1 to 3 and ages 1 to 4 respectively.

d) Surveys results

The fishing mortality index (C/B) declined from the mid-1980s to the mid-2000s and has since fluctuated at or below 0.1, (Figure 8.3).

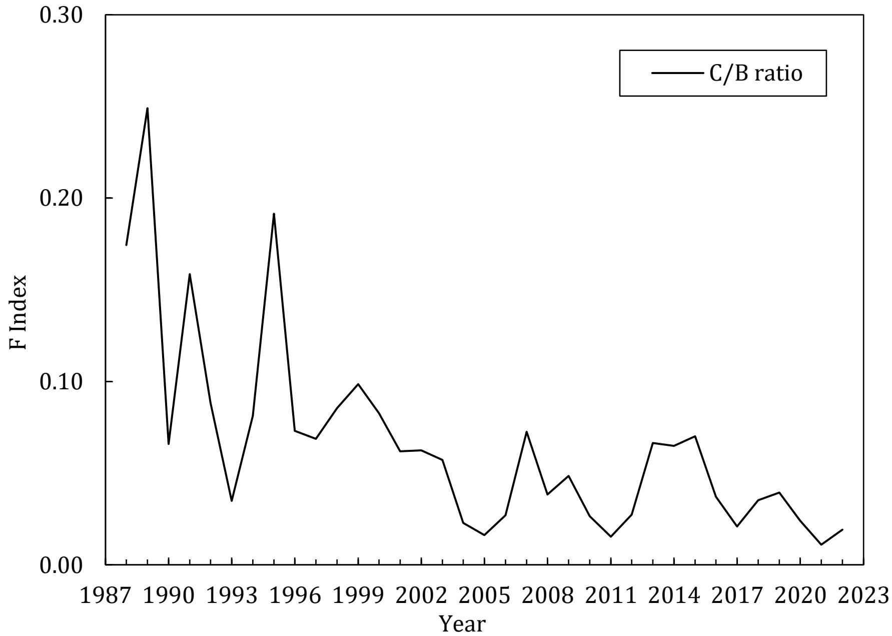


Figure 8.3. American plaice in Div. 3M: fishing mortality (catch/biomass) index from EU survey.

Recruitment was estimated to be weak from 1995 to 2007. Two pulses of recruitment were observed from 2008-2012 and 2015-2018 but with less strength than those before the mid-1990s, since then the recruitment has been poor (Figure 8.4).

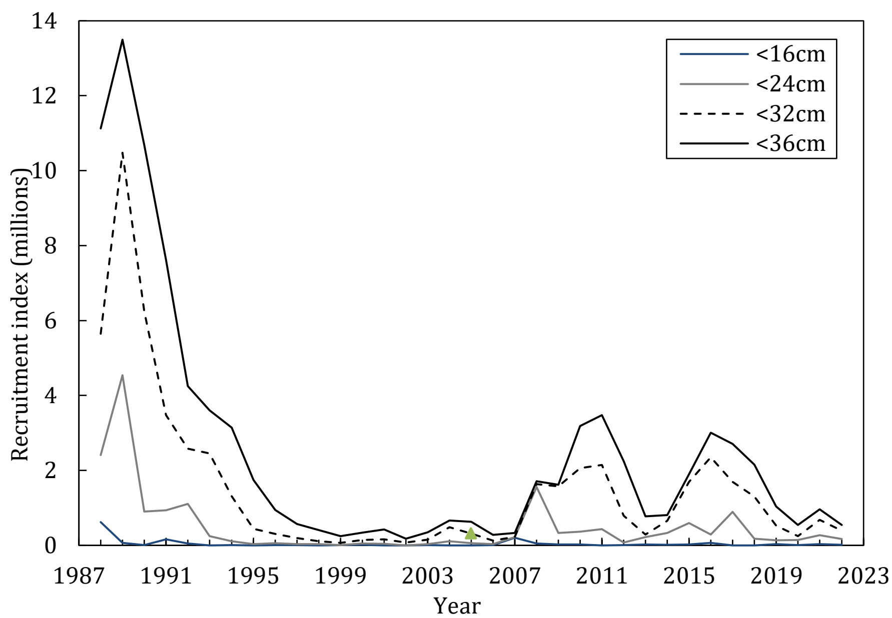


Figure 8.4. American plaice in Div. 3M: EU survey recruitment proxy. <16cm proxy for age 1; <24cm proxy for ages 1-2; <32cm proxy for ages 1-3 and <36cm proxy for ages 1-4.

e) Assessment Results

This stock is assessed based upon a qualitative evaluation of stock survey biomass trends and recruitment indices.

Biomass: Stock biomass increased from 2007 which was its lowest recorded level, and has remained stable since 2016 at a level comparable to the 1990s.

Fishing Mortality: The fishing mortality index (C/B) declined from the mid-1980s to the mid-2000s and has since fluctuated at or below 0.1.

Recruitment: Recruitment was estimated to be weak from 1995 to 2007. Two pulses of recruitment were observed from 2008-2012 and 2015-2018 but with less strength than those before the mid-1990s, since then the recruitment has been poor.

State of the Stock: The stock has increased in recent years following two recruitment pulses in 2008-2012 and 2015-2018, and recovered to levels similar to the mid-1990s. However, recruitment has been poor since 2018 while relative F remains low.

f) Reference Points

STACFIS is not able to provide proxies for biomass reference points at this time.

g) Research Recommendations

STACFIS **recommends** that *other types of models should also be explored, and that Div. 3M American plaice stock be a candidate for an assessment benchmark together with the Div. 3LNO American plaice stock or other flatfish stocks.*

STACFIS **recommends** *further investigation into whether current bycatch F levels are impeding stock recovery.*

h) Other Studies

A stock-production model for 3M American plaice was developed to complement and further explore the assessment work. The model considered observation error only and was fitted to the four available time series: 3M EU survey (1988-2022), 3M Canadian survey (1978-1985), Russian survey series 1 (1983-1993), and Russian survey series 2 (1972-1989, 1983 missing). The catch series used covered the 1960-2022 period which includes both directed catches from the commercial fishery and by-catch since the moratorium on the stock started in 1996. This model has not yet been peer-reviewed by SC and its results were presented as illustrative at the present time. Preliminary results raised concerns about the potential impact of current by-catch levels on stock recovery. STACFIS encourages this type of analyses to be further explored.

The next assessment will be in 2026.

STOCKS ON THE GRAND BANKS (NAFO DIVISIONS 3LNO)

Environmental Overview

The water mass characteristic of the Grand Bank are typical of sub-polar waters, with the presence of a cold intermediate layer (CIL) formed during winter, and which last throughout the year until the late fall. The CIL (defined as water <0°C) extends to the ocean bottom in the northern areas of 3LNO, covering the bottom with sub-zero temperatures. The CIL is thus a reliable index of ocean climate conditions in this area. Bottom temperatures are higher in southern regions of 3NO reaching 1 - 4°C, mainly due to atmospheric forcing and along the slopes of the banks below 200 m depth due to the presence of Labrador Slope Water. On the southern slopes of the Grand Bank in Div. 3O bottom temperatures may reach 4 - 8°C due to the influence of warm slope water from the Gulf Stream. The general circulation in this region consists of the relatively strong offshore Labrador Current at the shelf break and a considerably weaker branch near the coast in the Avalon Channel. Currents over the banks are very weak and the variability often exceeds the mean flow.

9. Cod (*Gadus morhua*) in NAFO Divisions 3NO

Interim Monitoring Report (SCR Doc. 23/02,07; SCS Doc. 23/05,06,08,09,12,13)

a) Introduction

This stock has been under moratorium to directed fishing since February 1994. Total bycatch during the moratorium increased from 170 t in 1995, peaked at about 4 800 t in 2003 and has been between 400 t and 1100 t since that time. The bycatch in 2022 was 357 t.

Recent TACs and catches ('000 tons) are as follows:

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TAC	ndf	ndf	ndf	ndf	ndf	ndf	ndf	ndf	ndf	ndf
STATLANT 21	0.7	0.5	0.6	0.6	0.3	0.5	0.3	2.0	NA*	
STACFIS	0.7	0.6	0.7	0.6	0.4	0.5	0.6	0.5	0.4	

ndf : No directed fishery

* STATLANT 21A data for 2022 were not yet available at the time of writing

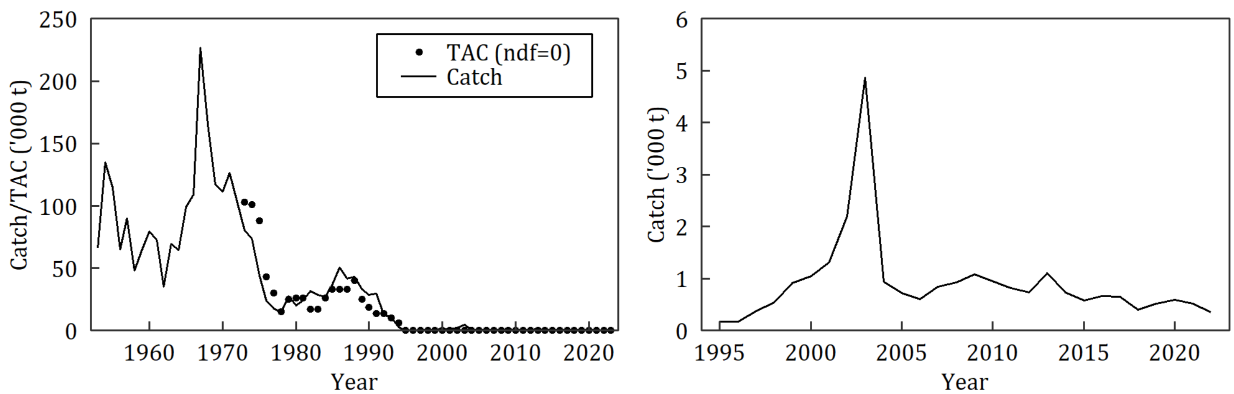


Figure 9.1. Cod in Div. 3NO: total catches and TACs. Panel at right highlights catches during the moratorium on directed fishing.

b) Data Overview

Recent surveys are as follow:

	Div.	2018	2019	2020	2021	2022
Canadian-Spring	3N	●	●	–	–	o
	3O	●	●	–	–	o
Canadian-Autumn	3N	●	●	●	–	–
	3O	●	●	●	–	–
EU	3N	●	●	–	●	●
	3O	●	●	–	●	●

● = complete, o = uncalibrated, – = incomplete

Canadian bottom trawl surveys. The spring survey biomass index declined from 1984 to 1995 and has generally remained low since that time (Figure 9.2). There was an increase in biomass during 2011-2014 but indices have subsequently declined again and the 2019 biomass indices were among the lowest in the time series. The trend in the autumn survey biomass index was similar to the spring series (Figure 9.2). There were no Canadian surveys in Divs. 3NO in spring 2020 and 2021 or Autumn 2021 and 2022. The 2022 spring survey was completed with a new research vessel and modified trawl but data have not yet been converted.

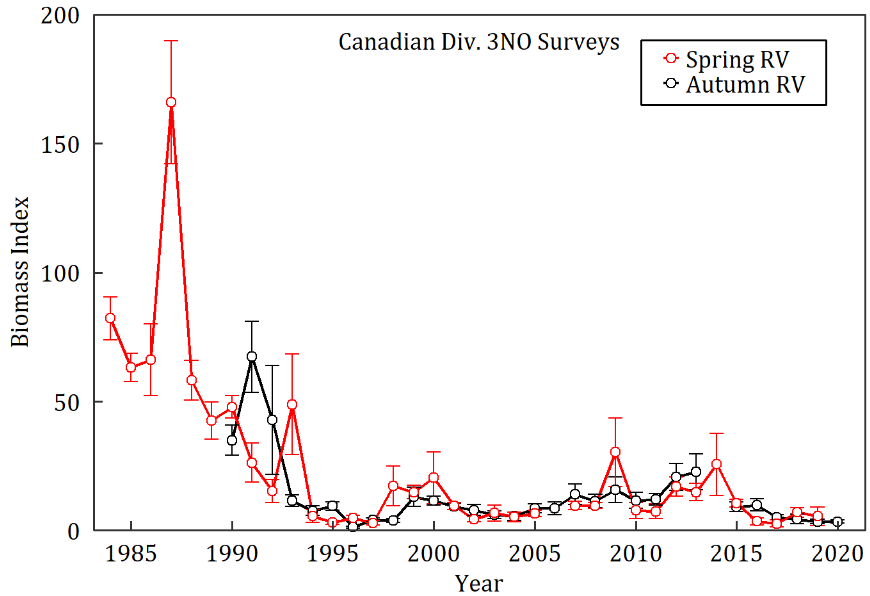


Figure 9.2. Cod in Div. 3NO: survey biomass index (+ 1 sd) from Canadian spring (grey) and autumn (white) research surveys.

EU-Spain Div. 3NO surveys. The biomass index was relatively low and stable from 1997-2008 with the exception of 1998 and 2001 (Figure 9.3). There was a considerable increase in the index from 2008-2011, followed by a decline to 2013. In 2014, the index increased to the highest value in the time series but has continually decreased in subsequent years. There was no EU-Spain survey in Divs. 3NO in 2020 but the index remained low in the 2021 and 2022 surveys.

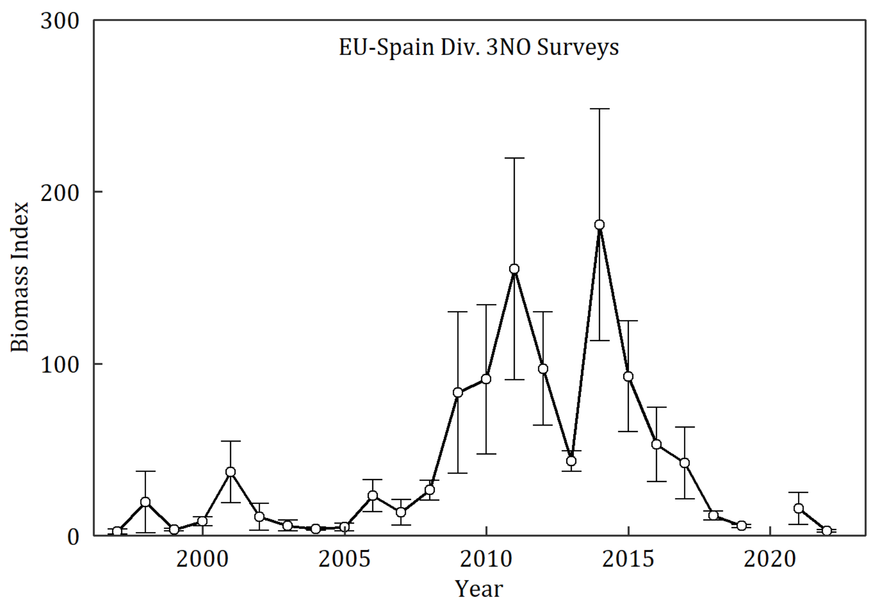


Figure 9.3. Cod in Div. 3NO: survey biomass index (+ 1 sd) from EU-Spain Div. 3NO surveys.

c) Conclusion

The most recent analytical assessment (2021) concluded that SSB was well below B_{lim} (60 000 t) in 2020. A lack of commercial sampling in 2020 prevented 2021 SSB from being estimated. Canadian RV surveys in 2022 either did not cover Divs. 3NO (autumn) or were performed by a new research vessel (spring) for which conversion factors are not yet available. The EU-Spain survey index remained low in 2022. Overall, the 2022 index does not indicate a significant change in the status of the stock.

The next full assessment of this stock was planned to be in 2025. However, until such time the appropriate data is available and a benchmark meeting has occurred, this stock will be monitored in the future by interim monitoring reports.

10. Redfish (*Sebastes mentella* and *S. fasciatus*) in Divisions 3L and 3N

Interim Monitoring Report (SCR Doc 22/05, 07, 13, 23/003; SCS Doc. 23/ 06, 09, 13)

a) Introduction

There are two species of redfish in Divisions 3L and 3N, the deep-sea redfish (*Sebastes mentella*) and the Acadian redfish (*Sebastes fasciatus*) that have been commercially fished and reported collectively as redfish in fishery statistics. Both species, occurring in Div. 3LN are managed as a single stock and are thought to belong to a large Northwest Atlantic complex ranging from the Gulf of Maine to south of Baffin Island.

Between 1959 and 1960 reported catches dropped from 44 600 to 26 600 t, oscillating over the next 25 years (1960-1985) around an average level of 21 000 t. Catches increased to a 79 000 t high in 1987 and declined steadily to a 450 t minimum in 1996. The NAFO Commission implemented a moratorium on directed fishing for this stock in 1998. Catches remained at relatively low levels (450-3 000 t) until 2009. The Commission endorsed the Scientific Council recommendations from 2011 onwards and catches steadily increased to 13 050t in 2019, the highest level recorded since 1993.

Recent catches and TACs ('000 tonnes) for redfish are as follows:

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TAC	6.5	10.4	10.4	14.2	14.2	18.1	18.1	18.1	18.1	18.1
STACFIS	5.7	9.9	8.5	11.8	11.3	13.0	11.1	10.2	9.0	
STATLANT 21	5.7	10.2	8.5	11.8	11.3	13.1	11.7	11.8	NA[1]	

[1] STATLANT 21a data for 2022 were not yet available at the time of writing

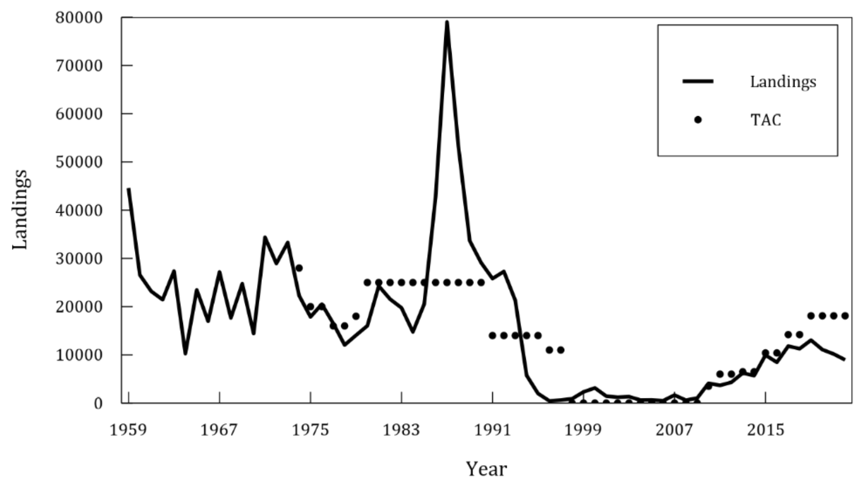


Figure 10.1. Redfish in Divs. 3LN: catches and TACs (No directed fishing is plotted as zero TAC).

i) Research survey data

Recent surveys are as follow:

	Div.	2018	2019	2020	2021	2022
Canadian-Spring	3N	●	●	–	–	o
	3L	●	●	–	–	–
Canadian - Autumn	3L	No deep(>732m)	No deep(>732m)	No deep(>732m)	–	–
	3N	●	●	●	–	–
EU	3L	●	●	–	–	–
	3N	●	●	–	●	●

● = complete, o = uncalibrated, – = incomplete

Survey data were available from Canadian stratified-random surveys during 1991-2019 in spring and 1991-2020 in autumn. There was no spring survey in 2006, 2017, 2020 or 2021, and no fall survey in 2014 or 2021. The 2022 spring survey was incomplete and there was no fall 2022 survey. Data were available from the EU-spring surveys conducted in the NAFO Regulatory Area of 3L from 2003-2019, and from 1995-2022, with the exception of 2020, in 3N.

Redfish bottom biomass from surveys in Div. 3LN remained well below average level over the 1990s and early 2000s. Clear increases of survey biomass are evident in 2007-2015, but biomass declined and/or stabilized between 2016 and 2020 (Figure 10.2). Due to the lack of major indices current status is unknown.

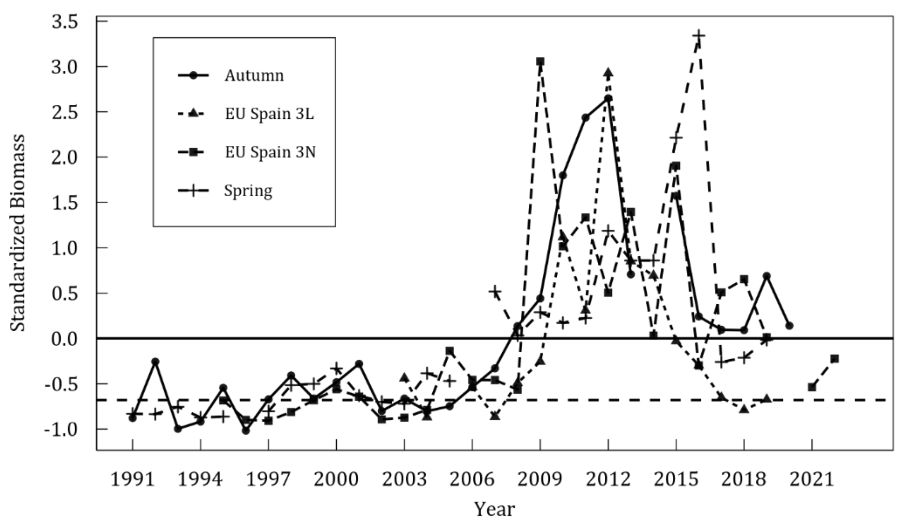


Figure 10.2. Redfish in Div. 3LN: standardized survey biomass. Each series standardized to zero mean and unit standard deviation. Dashed line represents the average of the mean standardized survey biomass index from 1991-2005 (B_{rec}).

b) Conclusion

In 2022 the stock was identified as to be above the interim limit reference point (B_{lim}). In the absence of Canadian spring surveys in 2020-2022 proxy fishing mortality cannot be determined for those years. However, it is unlikely that levels of fishing mortality have changed substantially. Given the slow growth of redfish and interpretation of year-over-year index fluctuations there is nothing to indicate a change in the status of the stock since the 2022 assessment.

c) Research Recommendations

STACFIS **recommends** that *changes in maturity be explored for this stock*.

STACFIS **recommends** that *stock boundaries and definitions as well as synchronicity with adjacent stocks be explored for this stock.*

11. American plaice (*Hippoglossoides platessoides*) in NAFO Divisions 3LNO

Interim Monitoring Report(SCR 21/025, 032, 035, 23/002, 005, 007,020,; SCS 23/006, 012, 23)

a) Introduction

American plaice supported large fisheries from the 1960s to the 1980s. However, due to the collapse of the stock in the early 1990s, there was no directed fishing in 1994 and a moratorium was put in place in 1995. Landings from by-catch increased until 2003, after which they began to decline. The majority of the catch has been taken by offshore otter trawlers. STACFIS agreed catches were 1 556t in 2021 and 828t in 2022 (Figure 11.1). American plaice are taken as by-catch mainly in the Canadian yellowtail flounder fishery, EU-Spain and EU-Portugal skate, redfish and Greenland halibut fisheries.

Recent catches and TACs ('000 tonnes) are as follows:

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TAC	ndf	ndf	ndf	ndf	ndf	ndf	ndf	ndf	ndf	ndf
STATLANT 21	1.4	1.1	1.0	1.1	0.9	1.2	1.1	0.9	NA[3]	
STACFIS	2.3[1]	1.1[2]	1.7[2]	1.2	1.0	1.2	1.2	1.6	0.8	

ndf No directed fishing.

[1] Catch was estimated using fishing effort ratio applied to 2010 STACFIS catch.

[2] Catch was estimated using STATLANT 21 data for Canadian fisheries and Daily Catch Records for fisheries in the NRA.

[3] STATLANT 21a data for 2022 were not yet available at the time of writing

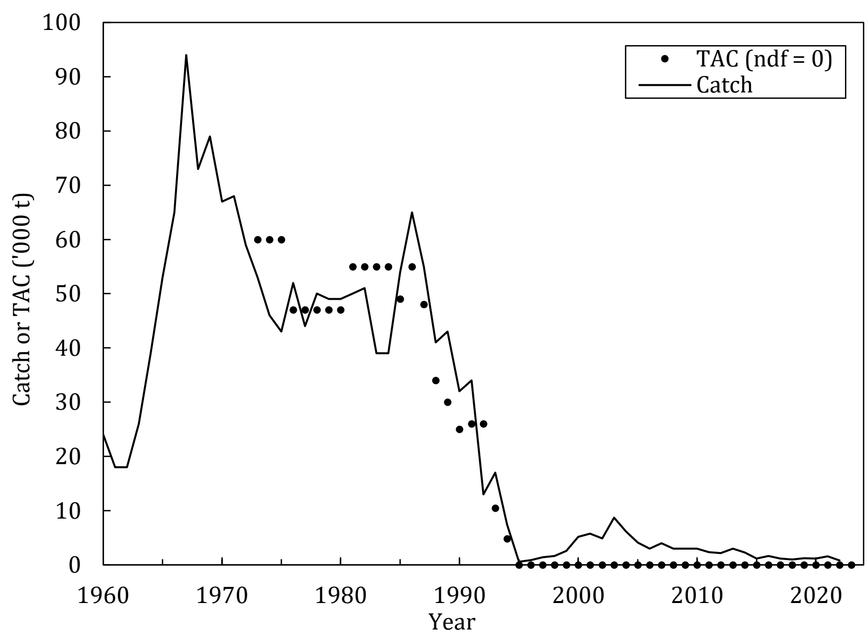


Figure 11.1. American Plaice in Div. 3LNO: estimated catches and TACs. No directed fishing is plotted as 0 TAC.

b) Research Survey Data

Recent surveys are as follow:

	Div.	2018	2019	2020	2021	2022
Canadian-Spring	3L	●	●	–	●	o
	3N	●	●	–	–	–
	3O	●	●	–	–	o
Canadian - Autumn	3L	No deep(>732m)	No deep(>732m)	No deep(>732m)	–	–
	3N	●	●	●	–	–
	3O	●	●	●	–	–
EU	3L	●	●	–	–	–
	3N	●	●	–	●	●
	3O	●	●	–	●	●

● = complete, o = uncalibrated, – = incomplete

Canadian spring survey. Due to coverage issues in the Canadian spring survey, indices are not available from 2006, 2015, 2017 nor was the spring survey in Divs. 3LNO available from 2019-2021. The survey in 2022 was carried out on a new vessel and calibration information is not yet available.

Biomass and abundance estimates from spring surveys for Div. 3LNO declined during the late 1980s-early 1990s. Biomass indices generally increased from the mid-1990s to 2014 but declined sharply after that (Figure 11.2). The abundance index follows a similar trend. Spring estimates of biomass and abundance in 2019 are the lowest since 1995 and 1998, respectively.

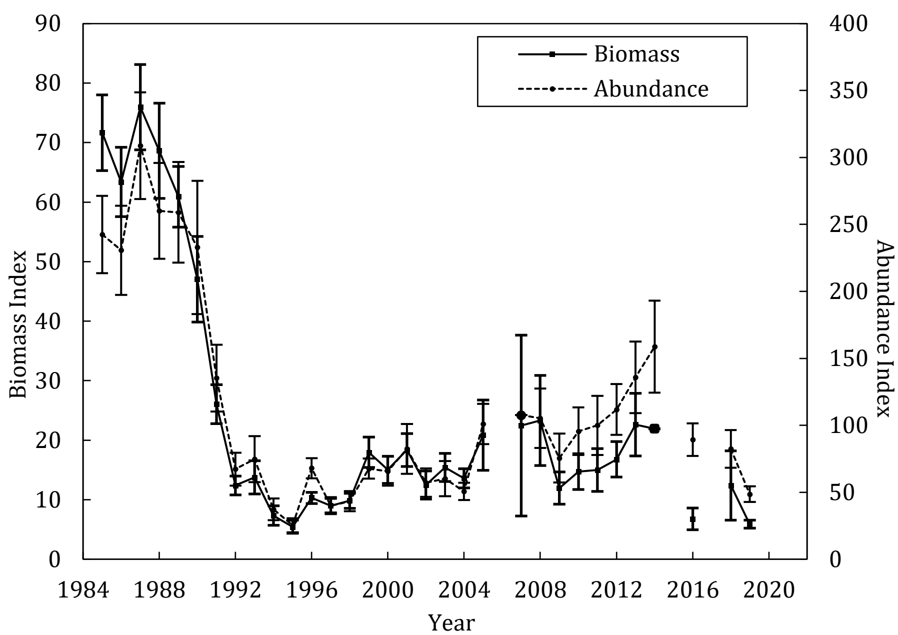


Figure 11.2. American Plaice in Div. 3LNO: biomass and abundance indices with approximate 95% confidence intervals from Canadian spring surveys. Data prior to 1996 are Campelen equivalents and since then are Campelen. Open symbols represent years where CIs extend to negative values.

Canadian autumn survey. Autumn survey points for 2004 and 2014 are excluded due to incomplete coverage of Div. 3L and 3NO, respectively. There was no autumn survey in Div. 3LNO in 2021 to 2022. Biomass and abundance indices from the autumn survey declined rapidly from 1990 to the mid-1990s, and indices have generally been below average since (Figure 11.3). There was an increase in biomass to 2013 but this did not persist.

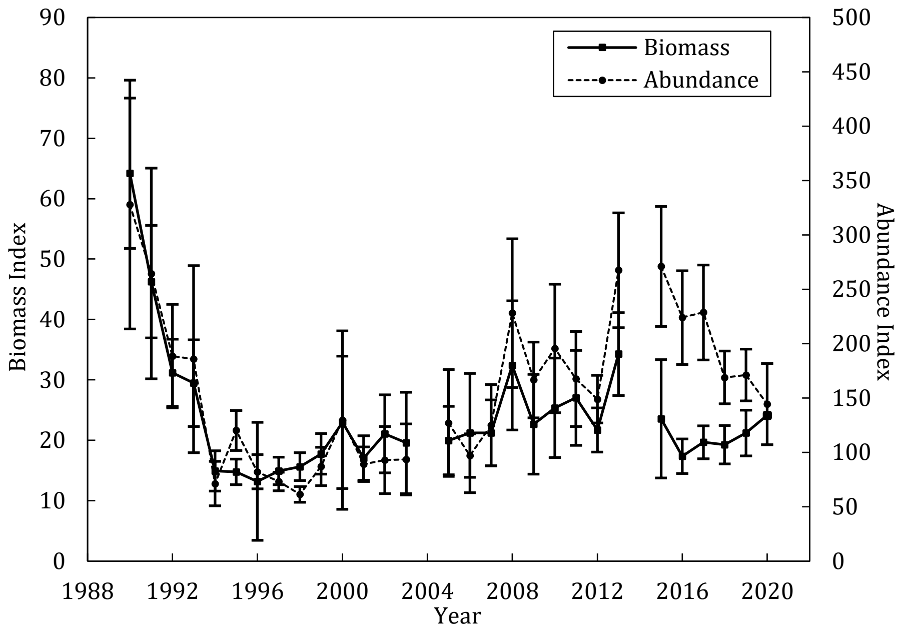


Figure 11.3. American Plaice in Div. 3LNO: biomass and abundance indices with approximate 95% confidence intervals from Canadian autumn surveys. Data prior to 1996 are Campelen equivalents and since then are Campelen.

EU-Spain Div. 3NO Survey. From 1998-2021, surveys have been conducted annually by EU-Spain in the Regulatory Area in Div. 3NO. There was no survey in 3NO in 2020. The biomass and abundance indices varied without trend for most of the time series but then subsequently declined to the lowest values in the time series in 2022 (Figure 11.4).

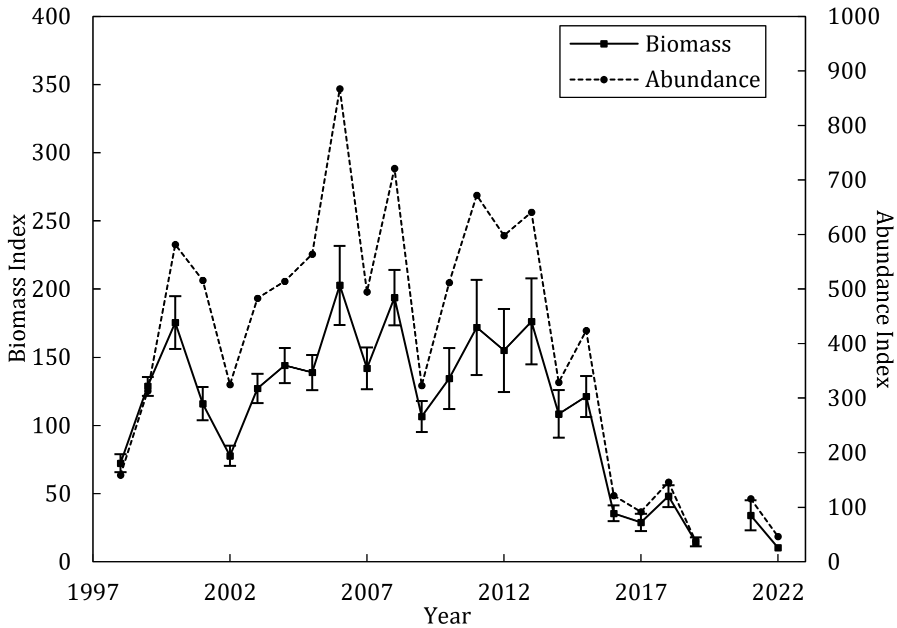


Figure 11.4. American Plaice in Div. 3LNO: biomass and abundance indices from the EU-Spain Div. 3NO survey (Data prior to 2001 are Campelen equivalents and since then are Campelen).

EU-Spain Div. 3L Survey. Since 2003 surveys have been conducted annually by EU-Spain in the Regulatory Area in Div. 3L. Surveys in 3L were not completed in 2005 or 2020 to 2022. The biomass and abundance indices increased from 2010 to 2015, and subsequently declined to 2019 (Figure 11.5).

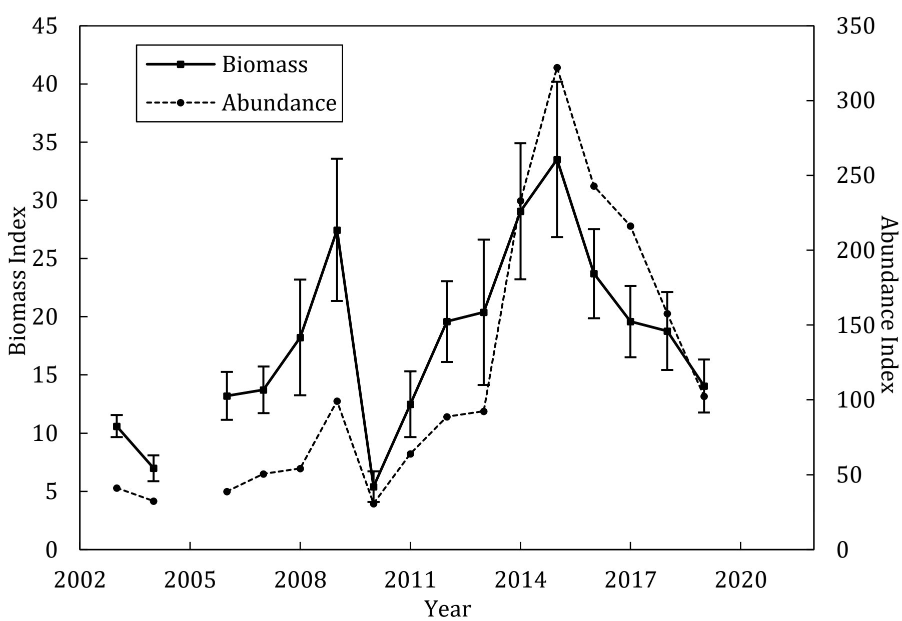


Figure 11.5. American Plaice in Div. 3LNO: biomass and abundance indices from the EU-Spain Div. 3L survey.

c) Conclusion

Based on available data, there is nothing to indicate a change in the status of the stock since the 2022 interim monitoring report.

The next full assessment of this stock was planned to be in 2024. However, until such time the appropriate data is available and a benchmark meeting has occurred, this stock will be monitored in the future by interim monitoring reports.

d) Research Recommendations

STACFIS **recommends** that *investigations be undertaken to compare ages obtained by current and former Canadian age readers.*

STATUS: Work is ongoing. This recommendation is reiterated.

STACFIS **recommended** that *investigations be undertaken to reexamine which survey indices are included in the model.*

STATUS: Work is ongoing. This recommendation is reiterated.

12. Yellowtail Flounder (*Limanda ferruginea*) in Divisions 3L, 3N and 3O

(SCR 23/016, 23/002, 22/018; SCS 23/05, 23/06, 23/09, 23/13)

a) Introduction

There was a moratorium on directed fishing from 1994 to 1997, and small catches were taken as by-catch in other fisheries. The fishery was re-opened in 1998 and catches increased from 4 400 t to 14 100 t in 2001 (Figure 12.1). Catches from 2001 to 2005 ranged from 11 000 t to 14 000 t. The catch in 2006 was only 930 t, due to corporate restructuring and a labour dispute in the Canadian fishing industry. From 2007 to 2018, catches continued to be influenced by industry related factors, remaining below the TAC and in some years, were very low. From 2019 to 2021, catches were higher and ranged from 12 800 t to 14 800 t. In 2022, catches were lower than the previous two years, at 10 600 t.

Recent catches and TACs ('000 tonnes) are as follows:

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TAC	17	17	17	17	17	17	17	17	20	20
STATLANT 21	8.0	6.7	8.3	9.2	8.6	12.3	14.0	16.1	NA*	
STACFIS	8.0	6.9	9.3	9.2	8.7	12.8	14.8	14.6	10.6	

* STATLANT 21a data for 2022 were not yet available at the time of writing

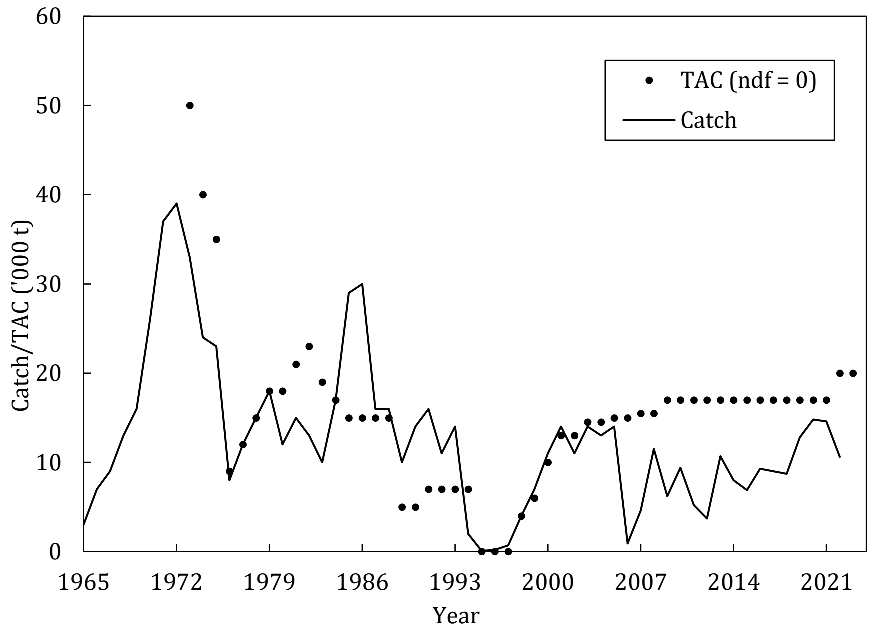


Figure 12.1. Yellowtail flounder in Div. 3LNO: catches and TACs. No directed fishing is plotted as 0 TAC.

b) Data Overview

i) Research survey data

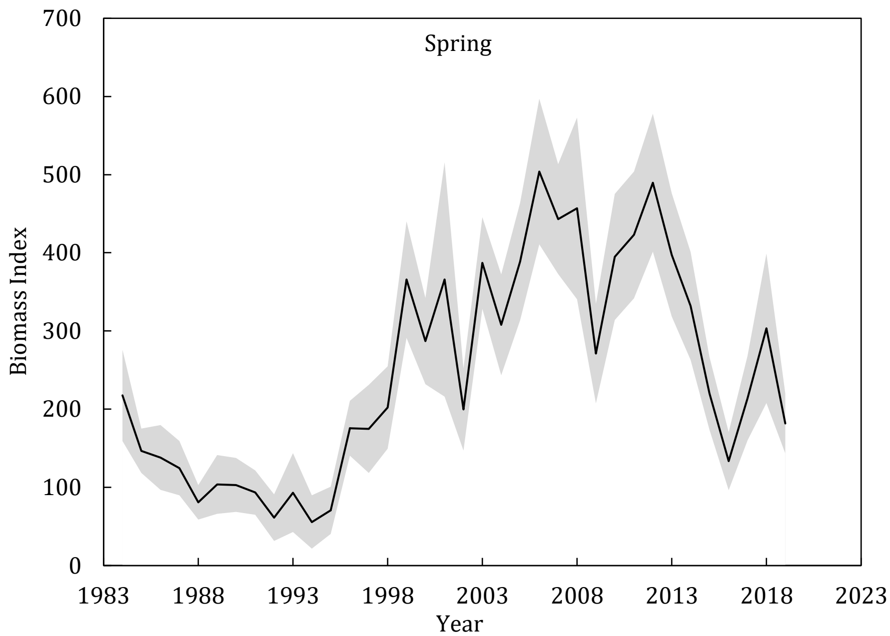
Recent surveys are as follow:

	Div.	2018	2019	2020	2021	2022
Canadian-Spring	3N	●	●	–	–	o
	3O	●	●	–	–	o
	3L	●	●	–	–	–
Canadian - Autumn	3L	No deep(>732m)	No deep(>732m)	No deep(>732m)	–	–
	3N	●	●	●	–	–
	3O	●	●	●	–	–
EU	3N	●	●	–	●	●
	3O	●	●	–	●	●

● = complete, o = uncalibrated, – = incomplete

Canadian stratified-random spring surveys. Although variable, the spring survey biomass index increased from 1995 to 1999 and since fluctuated at a high level to 2012 with a general decline thereafter. The 2006 and 2015 surveys did not cover the stock area and are not considered representative. There were no spring surveys of Divs. 3LNO from 2019-2021.

The survey in 2022 was carried out on a new vessel and calibration information is not yet available.



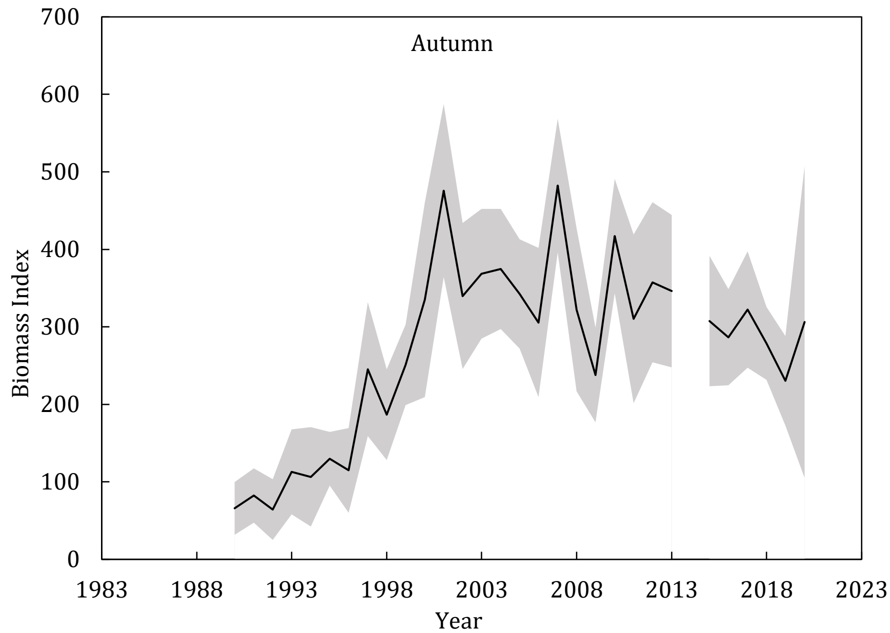


Figure 12.2. Yellowtail flounder in Div. 3LNO: indices of biomass with 95% confidence intervals, from Canadian spring and autumn surveys. Values are Campelen units or, prior to autumn 1995, Campelen equivalent units. The Canadian autumn series does not include 2014 nor 2021-22. The 2015, 2016 and 2020-21 spring surveys were incomplete. Information from the 2022 Canadian spring survey (new vessel) is not yet available for use in this assessment.

Canadian stratified-random autumn surveys. The autumn survey biomass index for Div. 3LNO increased steadily from the early-1990s to 2001, and although variable, it was relatively high (Figure 12.2), and shown a general decline from 2007-2020. The 2014 survey was incomplete due to problems with the research vessel, and results are not considered representative. There has been no autumn survey in Div. 3LNO since 2020.

EU-Spain stratified-random spring surveys in the NAFO Regulatory Area of Div. 3NO. The biomass index of yellowtail flounder increased sharply up to 1999 and remained relatively stable until 2013. Since then, biomass estimates have declined and the 2022 estimate is the second lowest in the time series (Figure 12.3). Trends are in general agreement with the Canadian series which covers the entire stock area.

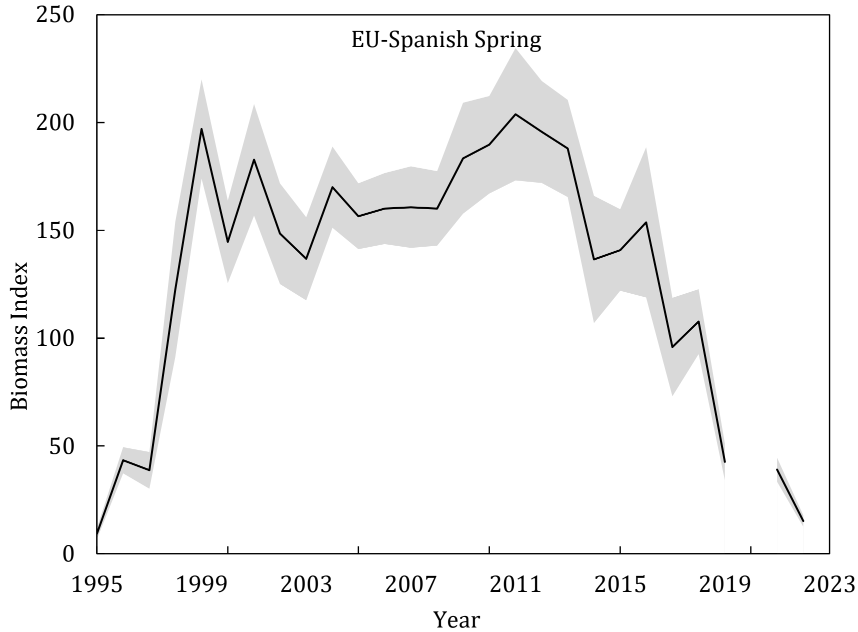


Figure 12.3. Yellowtail flounder in Div. 3LNO: index of biomass from the EU-Spain spring surveys in the Regulatory Area of Div. 3NO ±1SD. Values are Campelen units or, prior to 2001, Campelen equivalent units. There was no survey in 2020.

Stock distribution. In all surveys, yellowtail flounder were most abundant in Div. 3N, in strata on the Southeast Shoal and those immediately to the west (360, 361, 375 & 376), which straddle the Canadian 200 mile limit. Yellowtail flounder appeared to be more abundant in the Regulatory Area of Div. 3N in the 1999-2017 surveys than from 1984-1995, and the stock continued to occupy the northern portion of its range in Div. 3L, similar to the mid-1980s when overall stock size was also relatively large. The vast majority of the stock is found in waters shallower than 93 m in both seasons. In the absence of surveys that cover the entire stock area since 2020, stock distribution in relation to previous years is unknown.

c) Estimation of Parameters.

A Schaefer surplus production model in a Bayesian framework was used for the assessment of this stock. The input data were catch from 1965-2022, Canadian spring survey series from 1984-2019 (no 2006, 2015 nor 2020-2022), the Canadian autumn survey series from 1990-2020 (no 2014, nor 2021-22), Canadian Yankee survey series (1971-1982), Russian survey series (1984-1991) and 3NO Spanish survey (1995-2022; no 2020). The model set up was identical to that used in the 2021 assessment. Only catch and information from the Spanish surveys in 2021 and 2022 were available to update the model for this assessment. The Spanish survey covers only about 9 percent of the total stock area but survey trends are in general agreement with Canadian surveys. In the absence of Canadian surveys in recent years, there were slight increases in model process error, and residuals associated with the Spanish survey were higher than seen in previous assessments. The model results and fit, however, remained very similar to the previous assessment. Relative estimates of biomass and fishing mortality are more uncertain (wider confidence limits) in this assessment for the two most recent years where only one survey is available to inform the model.

The priors used in the model were:

Initial population size	**Pin~dunif(0.5, 1)**	**uniform(0.5 to 1)**
Intrinsic rate of natural increase	r ~ dunif(0.01,1)	uniform (0.01 to 1)
Carrying capacity	K~dlnorm(2.703,0.2167)	lognormal (mean, precision)
Survey catchability	q ~dgamma(1,1)	gamma(shape, rate)
Process error	sigma ~ dunif(0,5) isigma2= $sigma^{-2}$	uniform(0 to 5)
Observation error	tau~dgamma(1,1) itau2 = 1/tau	gamma(shape, rate)

d) Assessment Results

Recruitment: Total numbers of juveniles (<22 cm) from spring and autumn surveys by Canada and spring surveys by EU-Spain are given in Figure 12.4 scaled to each series mean. The spring survey by EU-Spain showed lower than average numbers of small fish from 2007-2019, but in 2021 the recruitment index was about average before declining again in 2022. In the absence of surveys from the whole stock area in recent years, current recruitment is unknown.

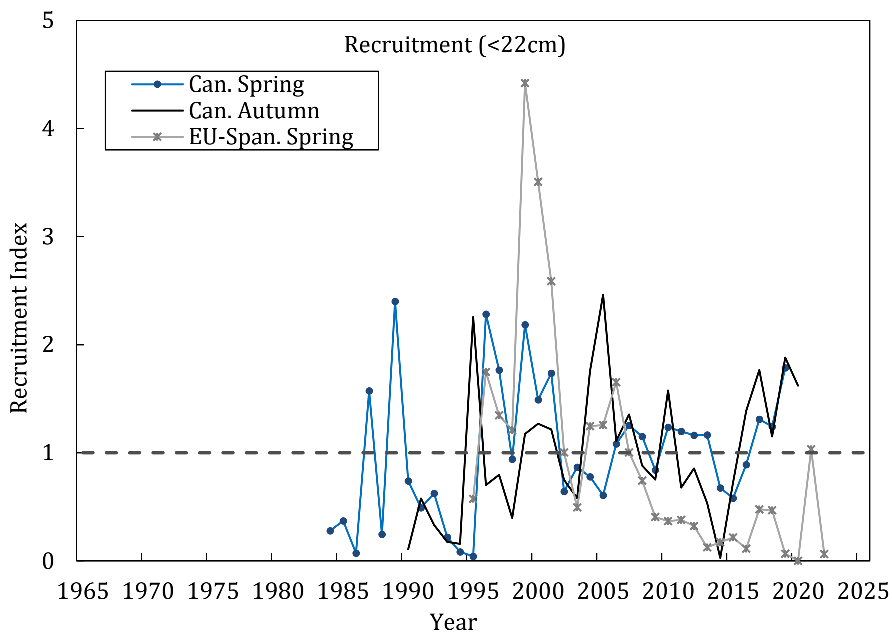


Figure 12.4. Yellowtail flounder in Div. 3LNO: Juvenile abundance indices from spring and autumn surveys by Canada and spring surveys by EU-Spain. Each series is scaled to its mean (horizontal line).

Bayesian Stock Production Model: The surplus production model results indicate that stock size increased rapidly after the moratorium in the mid-1990s, levelled off from 2001-2012, and although it has declined in recent years to be near B_{msy}, has remained well above $B_{lim.}$ Estimates from the model suggests that a maximum sustainable yield (MSY) of 18 390 tons can be produced by total stock biomass of 91 110 tons (B_{msy}) at a fishing mortality rate (F_{msy}) of 0.20.

Biomass: Relative biomass increased from 1994 to 2001, remained stable until 2012 and then declined to 2022 to very near B_{msy}, but well above B_{lim} (Figure 12.5).

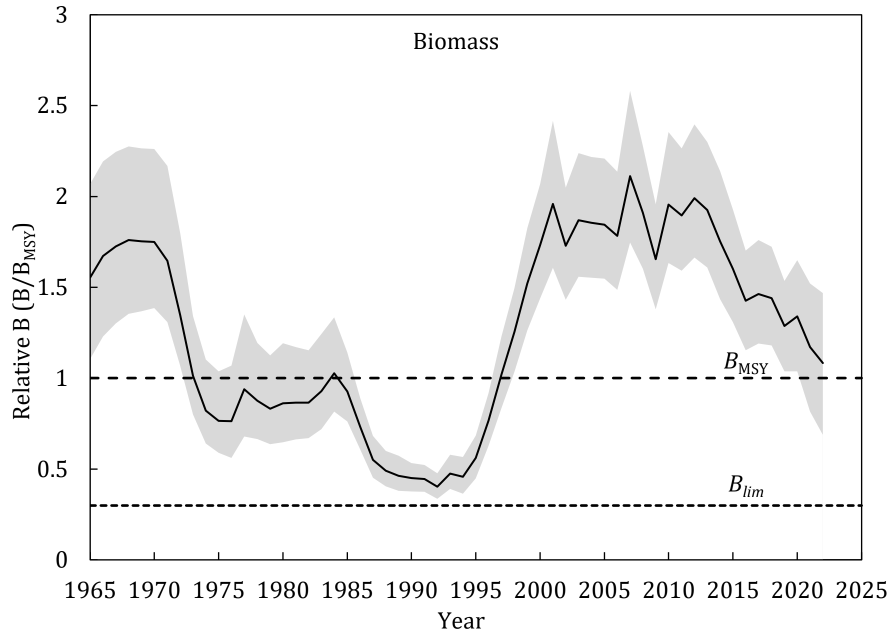


Figure 12.5. Yellowtail flounder in Div. 3LNO: relative biomass trends with 90% confidence intervals.

In some years since the moratorium, the catch remained below the estimated surplus production levels and was low enough to allow the stock to grow. Catches in a number of years (2000-2005; 2010-2014) have also exceeded surplus production and declines in stock size towards B_{msy} have been noted. In 2022, the catch is near the surplus production level (Figure 12.6).

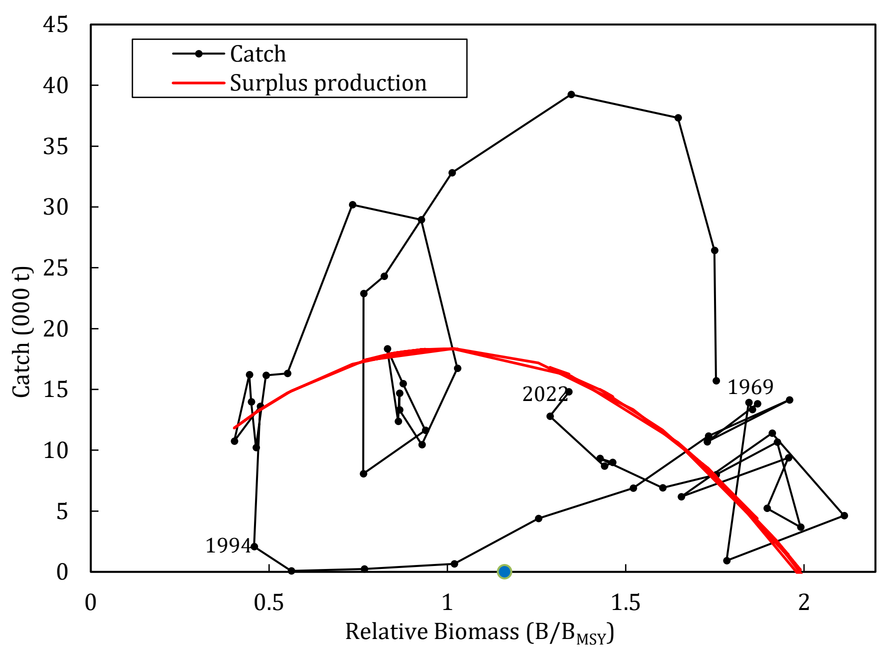


Figure 12.6. Yellowtail flounder in Div. 3LNO: catch trajectory.

Fishing Mortality: Relative fishing mortality has been below F_{lim}=F_{msy} since 1993 (Figure 12.7), however an increasing trend has been observed since 2015.

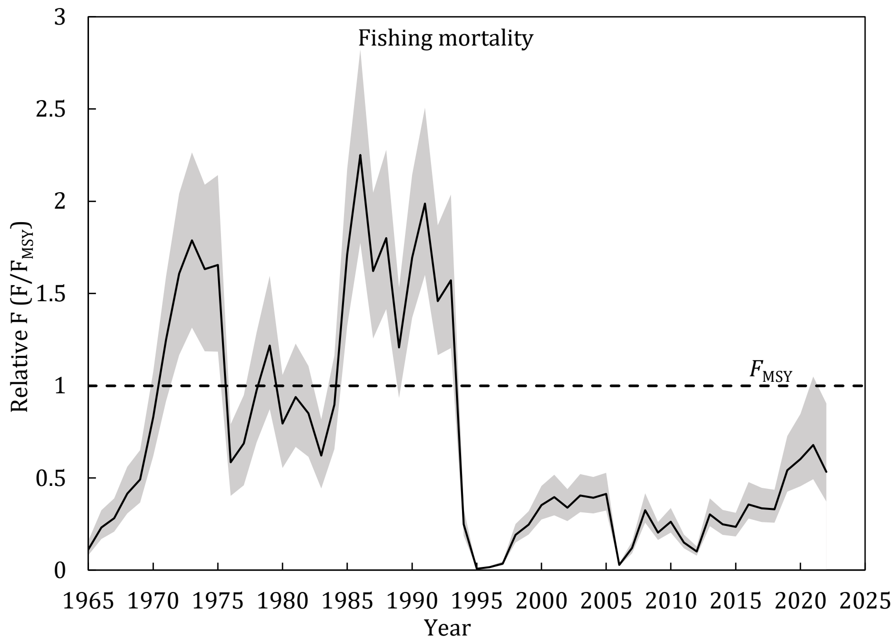


Figure 12.7. Yellowtail flounder in Div. 3LNO: relative fishing mortality trends with 90% confidence intervals.

State of the Stock: The stock size has decreased since 2012, but remains above B_{msy} with a probability of 0.61. There is very low risk (<1%) of the stock being below B_{lim} and a very low risk of F being above F_{lim}=F_{msy} (7%). Recent recruitment is unknown.

e) Medium Term Considerations:

Medium-term projections were carried forward to the year 2026 for two catch scenarios in 2023: $Catch_{2023}$=average 2021 and 2022 (12 600 t) and $Catch_{2023}$=TAC=20 000 t. Constant fishing mortality was applied from 2023-2026 at several levels of F (F=0, $F_{status\ quo}$, 75% F_{msy}, and 85% F_{msy}, and F_{msy}). Results were similar for both scenarios. At the end of the projection period, the risk of biomass being below B_{lim} is 6% or less in all cases (Table 12.1; Figure 12.8).

For the $F_{status\ quo}$ projections, probability that F > F_{lim}=F_{msy} in 2025-2026 was from 0.10 to 0.12 in the medium term for both scenarios (Table 12.2). At 75% F_{msy}, the probability that F > F_{lim} was between 0.26 and 0.28 in the medium term. Projected at the level of 85% F_{lim}, the probability that F > F_{lim} ranges between 0.35 and 0.36 and for F_{msy} projections, this probability increased to 0.50. For biomass projections, in all scenarios for 2024-2026, the probability of biomass being below B_{lim} was 0.06 or less. The probability that biomass in 2026 is greater than B_{2023} is 0.60, 0.49, 0.44 and 0.38 for projections of $F_{status\ quo}$, 75% F_{msy}, 85% F_{msy}, and F_{msy} respectively, in the $Catch_{2023}$=TAC=20 000 t scenario.

Table 12.1. Medium-term projections for yellowtail flounder with two catch options in 2023. Estimates for yield and relative biomass (B/B_{msy}) with 80% confidence interval are shown, for projected F values of F0, $F_{status\ quo}$, 75%F_{msy}, 85%F_{msy} and F_{msy}. Catch in 2023 was assumed at 12 600 t (average catch 2021-2022) or 20 000 t (TAC).

Projections with catch in 2023= avg catch 2021-2022 (12 600 t)			Projections with $Catch_{2023}$= 20 000 t (TAC)		
Year	Yield ('000t) median	Projected relative Biomass(B/B_{msy}) median (80% CL)	Year	Yield ('000t) median	Projected relative Biomass(B/B_{msy}) median (80% CL)
F =0			*F* =0		
2024	0.00	1.21 (0.69, 1.71)	2024	0.00	1.13 (0.61, 1.62)
2025	0.00	1.39 (0.81, 1.92)	2025	0.00	1.32 (0.74, 1.84)
2026	0.00	1.55 (0.93, 2.07)	2026	0.00	1.49 (0.86, 2.02)
$F_{status\ quo}$ = 0.107			$F_{status\ quo}$ = 0.107		
2024	11.60	1.21 (0.69, 1.71)	2024	10.79	1.13 (0.61, 1.62)
2025	12.02	1.27 (0.7, 1.77)	2025	11.37	1.2 (0.63, 1.71)
2026	12.34	1.31 (0.71, 1.81)	2026	11.83	1.26 (0.65, 1.77)
75% F_{MSY} =0.151			75% F_{MSY} =0.151		
2024	16.69	1.21 (0.69, 1.71)	2024	15.56	1.13 (0.61, 1.62)
2025	16.67	1.21 (0.65, 1.71)	2025	15.81	1.15 (0.59, 1.65)
2026	16.64	1.21 (0.62, 1.71)	2026	15.99	1.16 (0.56, 1.67)
85% F_{MSY} =0.173			85% F_{MSY} =0.173		
2024	18.92	1.21 (0.69, 1.71)	2024	17.63	1.13 (0.61, 1.62)
2025	18.51	1.19 (0.63, 1.68)	2025	17.56	1.13 (0.57, 1.62)
2026	18.2	1.17 (0.58, 1.66)	2026	17.48	1.12 (0.52, 1.63)
F_{MSY} =0.202			F_{MSY} =0.202		
2024	22.26	1.21 (0.69, 1.71)	2024	20.74	1.13 (0.61, 1.62)
2025	21.10	1.15 (0.6, 1.64)	2025	20.03	1.09 (0.54, 1.58)
2026	20.26	1.1 (0.52, 1.6)	2026	19.46	1.06 (0.46, 1.56)

Table 12.2. Yield (000 t) and risk (%) of $B_y<B_{msy}$ and $F_y>F_{msy}$ ($F_{lim}=F_{msy}$) at projected F values of F0, $F_{status\ quo}$, 75% F_{msy}, 85% F_{msy} and F_{msy}. Catch in 2023 was assumed at 12 600 t (average catch 2021-2022) or 20 000 t (TAC).

	Yield ('000t)		$P(F>F_{lim})$			$P(B<B_{lim})$			$P(B<B_{MSY})$			
$Catch_{2023}$=20 000t	2024	2025	2024	2025	2026	2024	2025	2026	2024	2025	2026	$P(B_{2026}<B_{2023})$
F =0	0	0	46%	<1%	<1%	2%	1%	<1%	37%	23%	15%	16%
$F_{status\ quo}$ = 0.107	10.79	11.37	46%	11%	12%	2%	2%	3%	37%	32%	28%	40%
75% F_{MSY} = 0.151	15.56	15.81	46%	27%	28%	2%	3%	4%	37%	36%	35%	51%
85% F_{MSY} =0.173	17.63	17.56	46%	36%	36%	2%	3%	4%	37%	38%	39%	56%
F_{MSY} =0.202	20.74	20.03	46%	50%	50%	2%	4%	6%	37%	41%	44%	62%

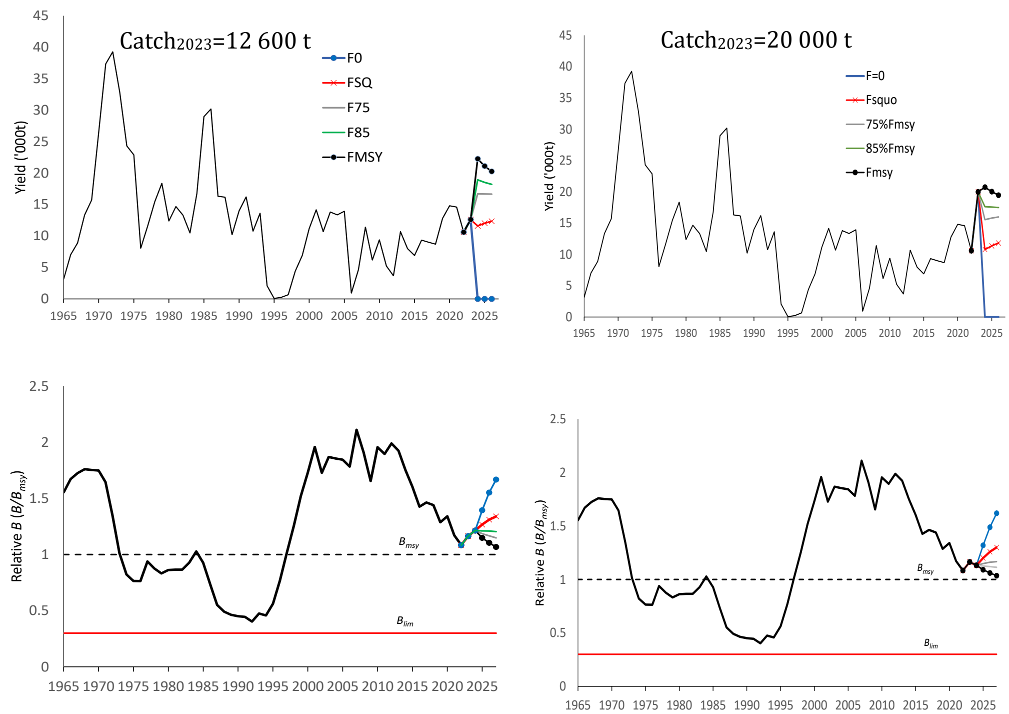


Figure 12.8. Yellowtail flounder in Div. 3LNO: stochastic projections from 2024-2026 at five levels of F (F=0, $F_{status\ quo}$, 75% F_{msy}, 85% F_{msy} and F_{msy}) for two $catch_{2023}$ scenarios (12 600 t and 20 000 t). Top panels shows projected yield and lower panels are projected relative biomass ratios (B/B_{msy}).

f) Reference Points:

The stock is presently 1.1 times B_{msy} (B_{msy}=91.1 kt) and F is below F_{msy} (Figure 12.9). Scientific Council considers that 30% B_{msy} is a suitable limit reference point (B_{lim}) for stocks where a production model is used. At present, the risk of the stock being below B_{lim} = 30% B_{msy} is very low (<1%) and risk of the stock being above F_{lim}= F_{msy} is very low (7%). The stock is in the safe zone as defined in the NAFO Precautionary Approach Framework.

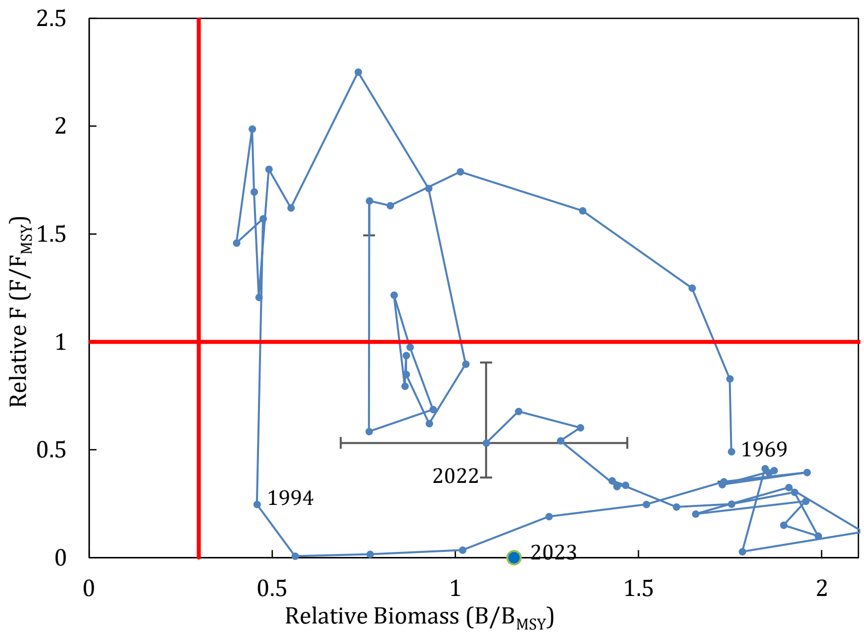


Figure 12.9. Yellowtail flounder in Div. 3LNO: stock trajectory estimated in the surplus production analysis, under a precautionary approach framework (80%CL on 2022).

The next assessment is planned for 2025.

13. Witch Flounder (*Glyptocephalus cynoglossus*) in Divisions 3N and 3O

Interim Monitoring Report (SCR Docs, 22/005, 007, 014, 23/002; SCS 22/06, 09, 10, 13, 23/5, 9, 10, 12)

a) Introduction

From 1972 to 1984, reported catch of witch flounder in NAFO Divs. 3NO ranged from a high of about 9 200 t in 1972 to a low of about 2 400 tonnes (t) in 1980 and 1981 (Figure 13.1). Catches increased to around 9 000 t in the mid-1980s but then declined steadily to less than 1 200 t in 1995. A moratorium on directed fishing was imposed in 1995 and remained in effect until 2014. During the moratorium, bycatch averaged below 500 t. The NAFO Fisheries Commission reintroduced a 1 000 t TAC for 2015 and in 2015 set a TAC for 2016, 2017, and 2018 at 2 172 t, 2 225 t, and 1 116 t respectively. Not all Contracting Parties with quota resumed directed fishing for witch flounder until 2019, when participation in the fishery was more representative. Catch since 2015 has been below the TAC. In 2022, total catch was estimated to be 622 t.

Recent catches and TACs ('000 tonnes) are as follows:

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TAC	ndf	1.0	2.2	2.2	1.1	1.2	1.2	1.2	1.2	1.2
STATLANT 21	0.3	0.4	1.0	0.6	0.6	0.9	0.6	0.8	N/A*	
STACFIS	0.3	0.4	1.1	0.7	0.7	0.9	0.7	0.6	0.6	

ndf = no directed fishery.
* STATLANT 21a data for 2022 were not yet available at the time of writing

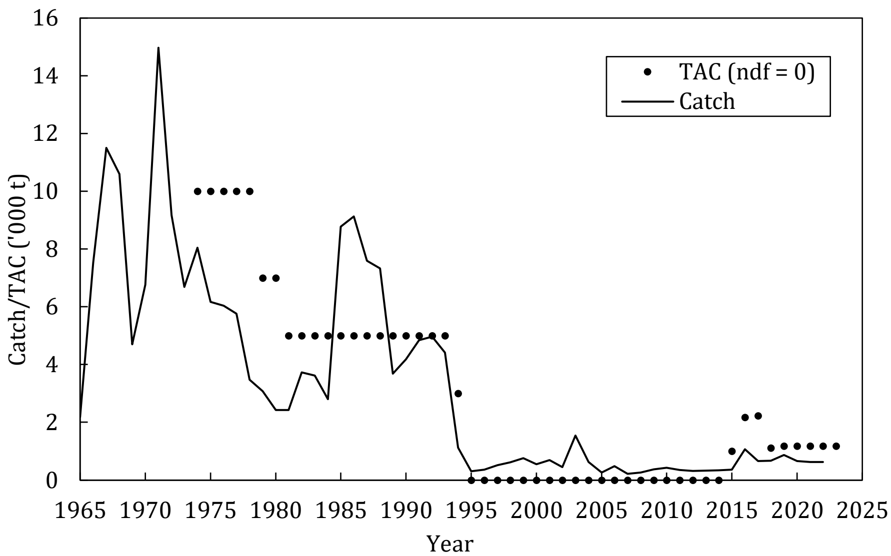


Figure 13.1. Witch flounder in Divs. 3NO: Catch and TAC ('000 tonnes).

b) Data Overview

i) Research survey data

Recent surveys are as follow:

	Div.	2018	2019	2020	2021	2022
Canadian-Spring	3N	●	●	–	–	o
	3O	●	●	–	–	o
Canadian - Autumn	3N	●	●	●	–	–
	3O	●	●	●	–	–
EU	3N	●	●	–	●	●
	3O	●	●	–	●	●

● = complete, o = uncalibrated, – = incomplete

Canadian spring RV survey. Spring surveys were not conducted between 2019-2021. The survey in 2022 was carried out on a new vessel and calibration information is not yet available. Due to substantial coverage deficiencies, values from 2006 are not presented, and there was no survey in 2021. The biomass index, although variable, had shown a general decreasing trend from 1985 to 1998, a general increasing trend from 1998 to 2003, and a general decreasing trend from 2003 to 2010. From 2010 to 2013 the index increased to values near the series high from 1987 (Figure 13.2). Biomass indices declined substantially from a high in 2013 to a value 51% of the time series average in 2015. Biomass indices have been relatively stable since 2015 (Figure 13.2).

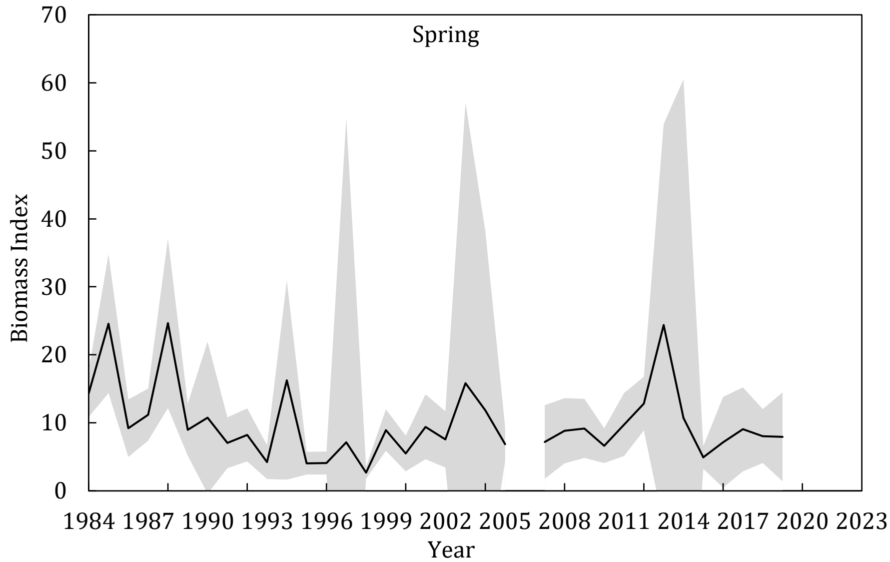


Figure 13.2. Witch flounder in NAFO Divs. 3NO: survey biomass indices from Canadian spring surveys 1984-2019 (95% confidence limits are given). Values are Campelen units or, prior to 1996, Campelen equivalent units. Surveys have not been conducted since 2019.

Canadian autumn RV survey. Autumn surveys have not been conducted since 2020. Due to operational difficulties there was no 2014 autumn survey. The biomass indices showed a general increasing trend from 1996 to 2009 but declined to 54% of the time series average in 2016 (Figure 13.4). Biomass indices increased slightly from 2016 to 2019, then decreased in 2020.

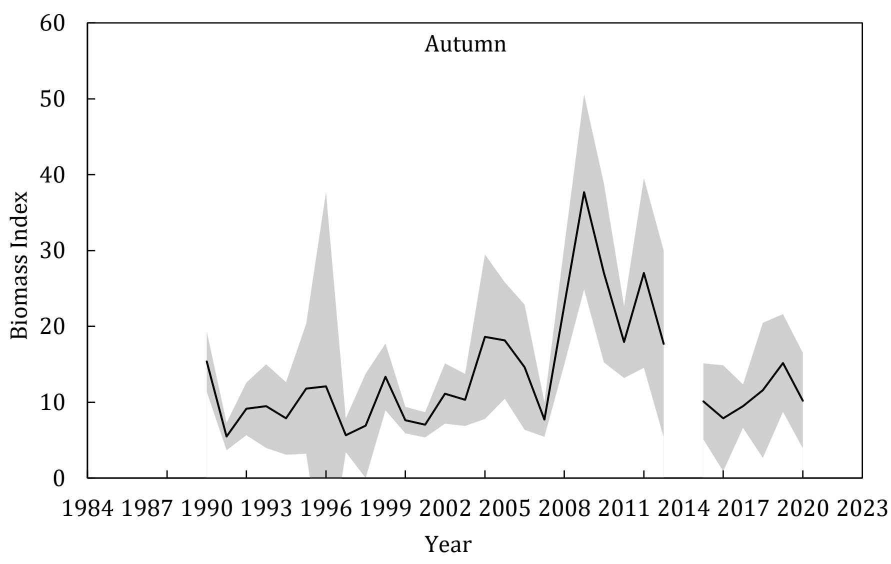


Figure 13.3. Witch flounder in Divs. 3NO: biomass indices from Canadian autumn surveys 1990-2020 (95% confidence limits are given). Values are Campelen units or, prior to 1996, Campelen equivalent units. Surveys have not been conducted since 2020.

EU-Spain RV spring survey. Surveys have been conducted annually from 1995 to 2019 by EU-Spain in the NAFO Regulatory Area in Divs. 3NO to a maximum depth of 1,450 m (since 1998). In 2001, the vessel (*Playa de Menduiña*) and survey gear (Pedreira) were replaced by the R/V *Vizconde de Eza* using a Campelen trawl (NAFO SCR 05/25). Data for witch flounder prior to 2001 have not been converted and therefore data from the two time series cannot be compared. In the Pedreira series, the biomass increased from 1995-2000 but declined in 2001. In the Campelen series, the biomass has been variable, but relatively stable over the time series, however biomass declined over 2017 to 2022, and in 2022 the estimate was the lowest in the series. No survey was conducted in 2020 (Figure 13.5).

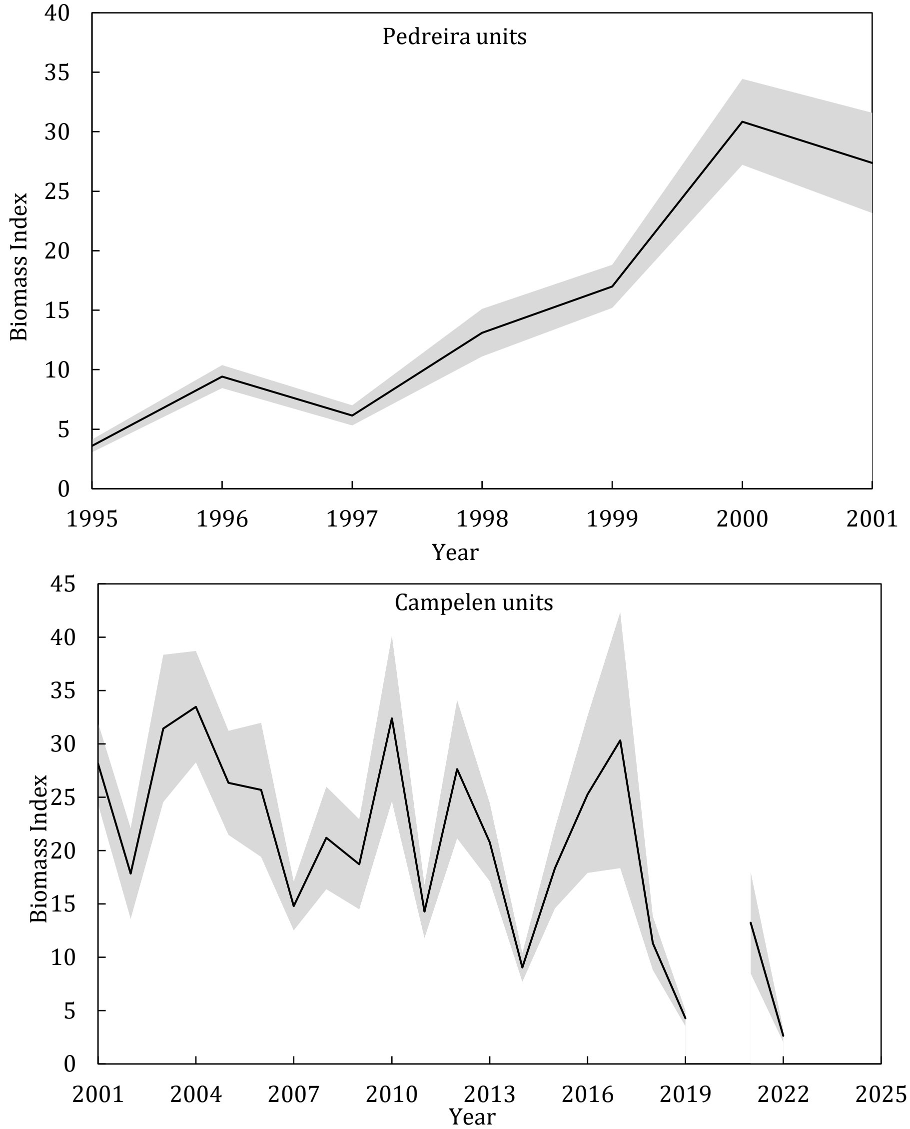


Figure 13.4. Witch flounder in Divs. 3NO: biomass indices from EU-Spanish Div. 3NO spring surveys (± 1 standard deviation). Data from 1995-2001 is in Pedreira units; data from 2001-2022 are Campelen units. Both values are presented for 2001. No survey was conducted in 2020.

Stock distribution. Analysis of distribution data from the surveys show that this stock is mainly distributed in Div. 3O along the southwestern slopes of the Grand Bank. In most years the distribution is concentrated toward the slopes but in certain years, an increased percentage may be distributed in shallower water. In the absence of surveys that cover the entire stock area since 2020, stock distribution in relation to previous years is unknown.

Recruitment: With the exception of the growth of the stock following improved recruitment in the late 1990s, it is unclear if the recruitment index (survey number of fish<21 cm; Figure 13.5) is representative. Nevertheless, the recruitment index in 2019 was the highest in the time series. The small fish did not appear in the 2020 Canadian autumn survey, however, and the recruitment index was again below average. The recruitment index could not be updated for 2021 or 2022.

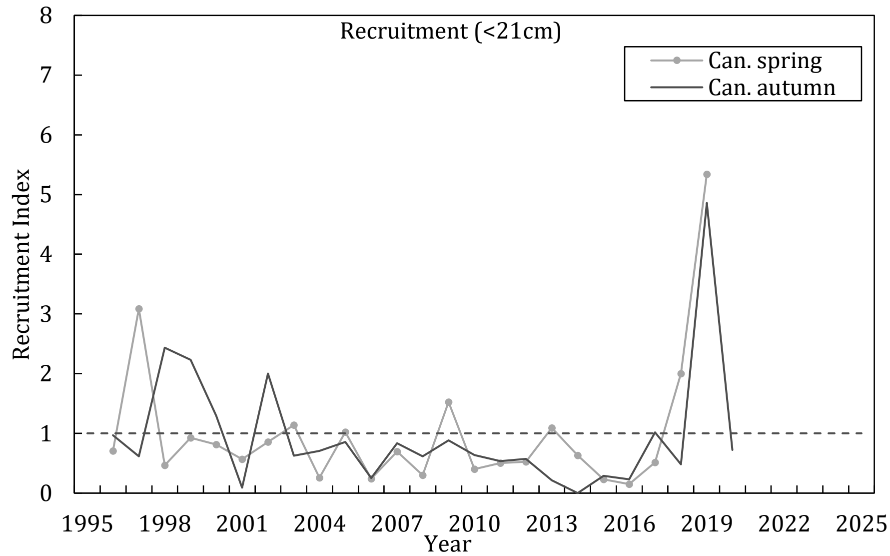


Figure 13.5. Recruitment index of witch flounder (<21cm) from spring and autumn Canadian RV surveys in NAFO Divs.3NO 1996-2020. No survey data available in autumn 2014, 2020-2022, nor for spring 2006, 2019-2022.

c) Conclusion

The most recent (2022) analytical assessment using a Bayesian stock production model concluded that the stock size increased from 1994 to 2013 and then declined during 2013-2015 and has since increased slightly. In 2022 the stock was at 49% B_{msy}. (60 510 t). There was 9% risk of the stock being below B_{lim} and a <1% risk of F being above F_{lim} (F_{msy} =0.062). There were no Canadian surveys in spring 2019-2021 nor autumn 2021-2022. Data from a spring survey on a new vessel in 2022 was not available for this assessment. The only information available are the 3NO Spanish spring survey outside of the EEZ and catch. The Spanish survey estimate is the lowest in the time series and catch is about half of the TAC.

The next full assessment of this stock is planned for 2024.

14. Capelin (*Mallotus villosus*) in Divisions 3NO

Interim Monitoring Report (SCR 22/007, 23/002; SCS 23/06, 23/09, 23/12)

a) Introduction

The fishery for capelin started in 1971. Catches were high in the mid-1970s with a maximum catch of 132 000 t in 1975 (Figure 14.1). The stock has been under a moratorium to directed fishing since 1992. No catches reported from 1993 to 2013. Small catches (mostly discards) occurred from 2016 to 2020.

Recent catches and TACs (tonnes) are as follows:

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TAC	ndf	ndf	ndf	ndf	ndf	ndf	ndf	ndf	ndf	ndf*
STATLANT 21A	0	0	5	0	0	0	0	0	N/A	
Catch (STACFIS)	1	0	4	1	2	2	1	0	0	

* ndf = no directed fishing

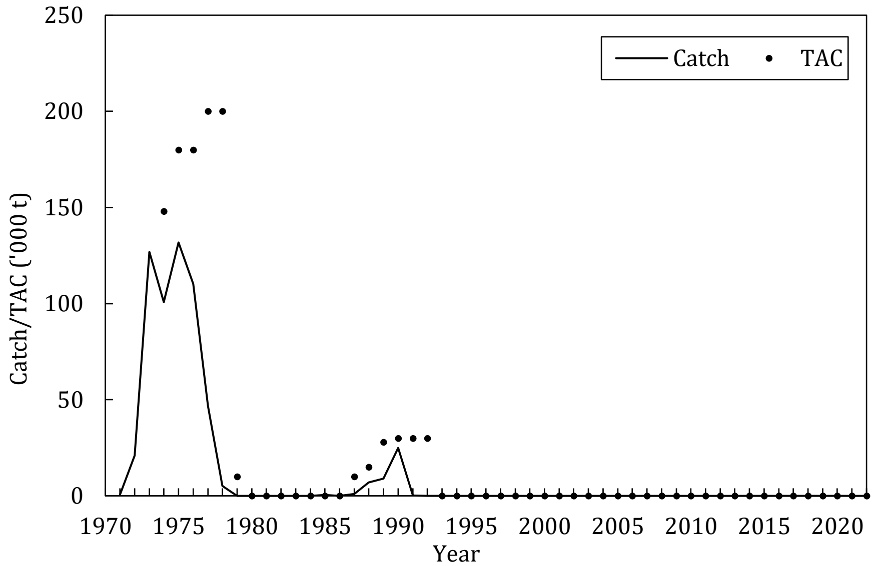


Figure 14.1. Capelin in Div. 3NO: catches and TACs.

b) Data Overview

i) Research survey data

Recent surveys are as follow:

	Div.	2018	2019	2020	2021	2022
Canadian-Spring	3N	●	●	–	–	o
	3O	●	●	–	–	o
EU	3N	●	●	–	●	●
	3O	●	●	–	●	●

● = complete, o = uncalibrated, – = incomplete

Trawl acoustic surveys of capelin on the Grand Bank previously conducted by Russia and Canada on a regular basis have not been carried out since 1995. In recent years, STACFIS has recommended carrying out trawl-acoustic surveys to allow comparison with the historical time series. However, this recommendation has not been acted upon. Available indicators of stock dynamics currently include the capelin biomass index from Canadian spring stratified-random bottom trawl surveys. This index varied greatly from 1995-2019 without any clear trend (Figure 14.2). In 2016, the biomass indices declined to the historical minimum of 3.8 thousand tons. After increasing to 78.7 thousand tons in 2017, the index decreased to 17.3 thousand tons in 2019. There were no spring surveys in Divs. 3NO from 2019-2021.

The survey in 2022 was carried out on a new vessel and calibration information is not yet available.

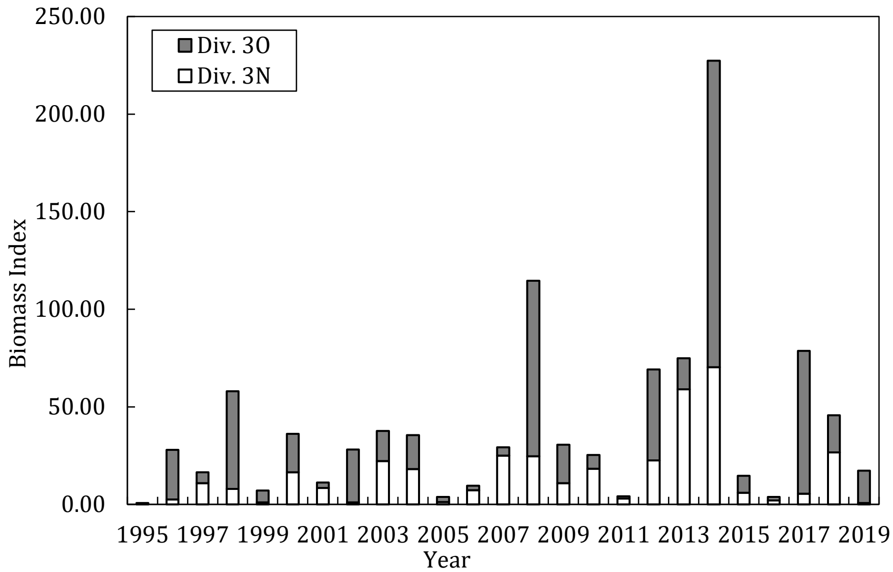


Figure 14.2. Capelin in Div. 3NO: survey biomass index (bottom trawl) from Canadian spring survey in 1995-2019.

Data from EU-Spain trawl surveys in Divs. 3NO for 1995-2022 are also available (Figure 14.3). Data from 1995-2000 are from the C/V "Playa de Menduíña", transformed to be comparable with the 2001-2022 R/V "Vizconde de Eza" data. It should be noted there is a gap in data for 2020, because of the pandemic.

Capelin biomass was at a maximum level in 2012 (151.4 thousand tons). Between 2014 and 2017 biomass sharply declined from 85.5 thousand tons to 5.2 thousand tons. For 2022, a notable increase (up to 86.4 thousand tons) in biomass has been recorded.

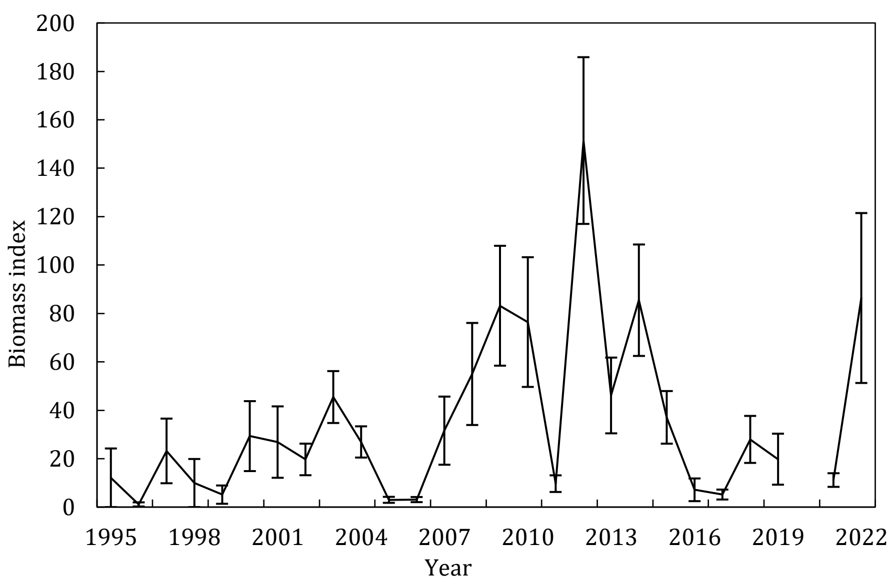


Figure 14.3. Biomass index and standard deviations of capelin (1995-2022) based on EU-Spain trawl 3NO surveys.

c) Conclusion

An acoustic survey series that terminated in 1994 indicated a stock at a low level. Biomass indices from bottom trawl surveys since that time have not indicated any change in stock status, although the validity of such surveys for monitoring the dynamics of pelagic species is questionable.

d) Research recommendations

STACFIS reiterates its **recommendation** that *initial investigations to evaluate the status of capelin in Div. 3NO should utilize trawl acoustic surveys to allow comparison with the historical time series.*

Commission has excluded the capelin from its triennial request for full assessment until such time conditions change to warrant a full assessment.

15. Redfish *(Sebastes mentella* and *Sebastes fasciatus*) in Division 3O

Interim Monitoring Report (SCR Doc. 22/05, 07, 044, 23/002 ; SCS Doc. 21/05, 06, 08, 09; 23/06,12,13)

a) Introduction

There are two species of redfish that have been commercially fished in Div. 3O; the deep-sea redfish *(Sebastes mentella)* and the Acadian redfish *(Sebastes fasciatus*). The external characteristics are very similar, making them difficult to distinguish, and as a consequence, they are reported collectively as "redfish" in the commercial fishery statistics and RV surveys. Within Canada's fishery zone, redfish in Div. 3O have been under TAC regulation since 1974 and with a minimum size limit of 22 cm since 1995. Catch was only regulated by mesh size in the NRA of Div. 3O prior to the Fisheries Commission adopting a TAC in 2004. Initially, TAC was implemented at a level of 20 000 tons for 2005-2008 and has remained at that level. This TAC applies to the entire area of Div. 3O.

Nominal catches have ranged between 3 000 tons and 35 000 tons since 1960, and have been below 10 000t since 2007. Catch in 2022 was 3 900 tons, the lowest since 2004.

Recent catches and TACs ('000 tonnes) are as follows:

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TAC	20	20	20	20	20	20	20	20	20	20
STATLANT 21	7.5	7.9	8.6	7.3	6.1	6.6	7.3	5.4	NA*	
STACFIS	7.5	8.4	9.0	7.5	6.1	6.5	7.3	5.6	3.9	

* STATLANT 21a data for 2022 were not yet available at the time of writing

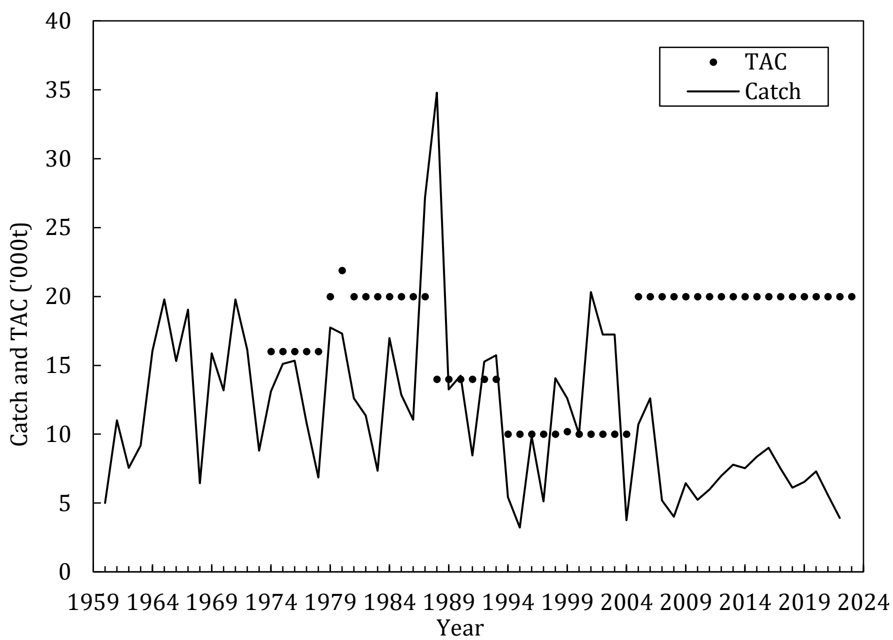


Figure 15.1. Redfish in Div. 3O: Catches and TACs. TACs prior to 2004 were applied only to Canadian waters.

b) Data Overview

i) Research survey data

Recent surveys are as follow:

	Div.	2018	2019	2020	2021	2022
Canadian-Spring	3O	●	●	–	–	o
Canadian - Autumn	3O	●	●	●	–	–
EU	3O	●	●	–	●	●

● = complete, o = uncalibrated, – = incomplete

Survey data were available from Canadian stratified-random surveys during 1991-2019 in spring and 1991-2020 in autumn. There was no spring survey in 2006, 2020, or 2021. The 2022 spring survey in Div. 3O was completed with the new vessel CCGS *John Cabot* which is not calibrated to the previous series; these data are not presented here. There were no autumn surveys conducted in Div. 3O in 2014 2021 or 2022. Data were available from EU-Spain spring surveys conducted in the NAFO Regulatory Area (NRA) of Div. 3O from 1997 to 2022, with the exception of 2020.

Results of bottom trawl surveys for redfish in Div. 3O have shown a considerable amount of variability, making it difficult to interpret interannual changes. However, trends across the three survey series are consistent and show indices generally at or above the time-series mean during two periods: the mid to late 1990s, and during 2009 to 2015. All available surveys since 2018 have been below their long term mean. (Figure 15.2). The EU-Spain surveys have been low during 2018-2019 and 2021-2022, after a lengthy declining trend. However it should be noted that the EU survey only covers a portion of the stock area.

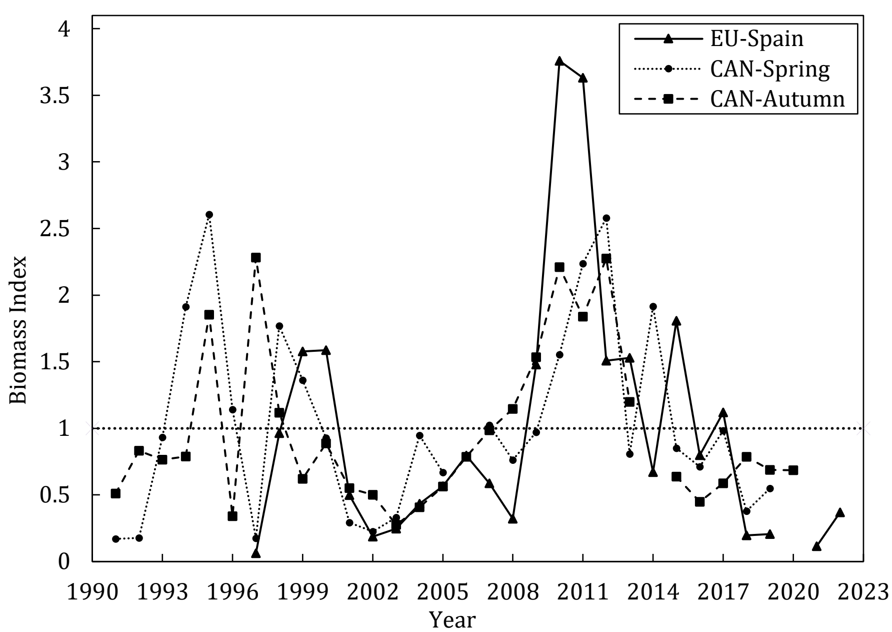


Figure 15.2. Redfish in Div. 3O: Survey biomass indices from Canada and EU-Spain (Campelen equivalent estimates prior to autumn 1995 in the Canadian surveys and prior to 2001 in the EU-Spain surveys). Indices were normalized by dividing by their time-series means over 1997-2020.

c) Conclusion

In 2020 the stock was above the limit reference point (B_{lim} = 0.3 B_{msy} proxy) with a high probability [P(B2020> B_{lim})> 0.99], below an interim survey-based proxy for B_{msy}. Given the slow growth of redfish and interpretation of interannual index fluctuations there is nothing to indicate a change in the status of the stock since the 2022 assessment. Because there are no stock-wide biomass indices for 2022, stock status is unknown in relation to B_{lim}. However, recent recruitment has been low and the 2022 biomass index for the EU-Spain survey has only increased slightly from the second lowest point in the time series.

The next full assessment of the stock is scheduled for 2025.

d) Research Recommendations

STACFIS **recommend** that *for Redfish in Div. 3O, work continue on developing an assessment model for the stock. Aging should be conducted for redfish sampled during select years to support model development*

STACFIS **recommends** that *stock boundaries and definitions as well as synchronicity with adjacent stocks be explored.*

STACFIS **recommends** that *the reference point for this stock be reviewed at the 2028 assessment, or earlier if there are considerable advances in an analytical approach for this stock, or a significant change in available data or the understanding of stock dynamics.*

16. Thorny Skate (*Amblyraja radiata*) in Divisions 3L, 3N, 3O and Subdivision 3Ps

Interim Monitoring Report (SCR Doc.22/26 ; SCS Doc. 23/06,09,12,13)

a) Introduction

Thorny skate in Subdiv. 3Ps and Divs. 3LNO have a continuous distribution and are considered a single stock unit. A portion of the stock is managed by Canada and France (3Ps) and a portion is managed by NAFO (3LNO).

Catch History

Commercial catches of skates contain a mix of skate species. However, thorny skate dominates, comprising about 95% of skate species taken in Canadian and EU-Spain catches. Thus, the skate fishery on the Grand Banks can be considered a fishery for thorny skate. The TAC has been 7 000 t over the period 2013-2023. In Subdiv. 3Ps, Canada established a TAC of 1 050 tons in 1997, which has not changed.

Catches from the NRA of Divs. 3LNO increased in the mid-1980s with the commencement of a directed fishery for Thorny Skate. The main participants in this new fishery were EU-Spain, EU-Portugal, USSR, and the Republic of Korea. Catches from all countries in Divs. 3LNOPs over 1985-1991 averaged 17 058 t; with a peak of 28 408 t in 1991 (STATLANT-21). From 1992-1995, catches of thorny skate declined to an average of 7 554 t; however, there are substantial uncertainties concerning reported skate catches prior to 1996. Average STACFIS-agreed catch for Divs. 3LNO in 2015-2021 was 3 617 t and 707 t in Subdiv. 3Ps. STACFIS catch in 2022 totaled 3 526 t for Divs. 3LNO and 219 t for Subdiv. 3Ps.

Recent catches and TACs (000 tonnes) are as follows:

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Divs. 3LNO:										
TAC	7	7	7	7	7	7	7	7	7	7
STATLANT-21	4.5	3.3	3.5	4.2	.1	3.7	4.0	4.0	NA[1]	
STACFIS	4.5	3.4	3.5	4.5	2.4	3.7	4.3	3.7	3.5	
Subdiv. 3Ps:										
TAC	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05
STATLANT-21	.2	.2	.7	.6	1.1	0.9	0.8	0.7	0.2	
Divs. 3LNOPs:										
STATLANT-21	4.7	3.6	4.1	4.8	2.3	4.6	4.8	4.7	NA	
STACFIS	4.7	3.7	4.1	5.1	3.5	4.6	5.1	4.4	3.7	

[1] STATLANT 21a data for 2022 were not yet available at the time of writing

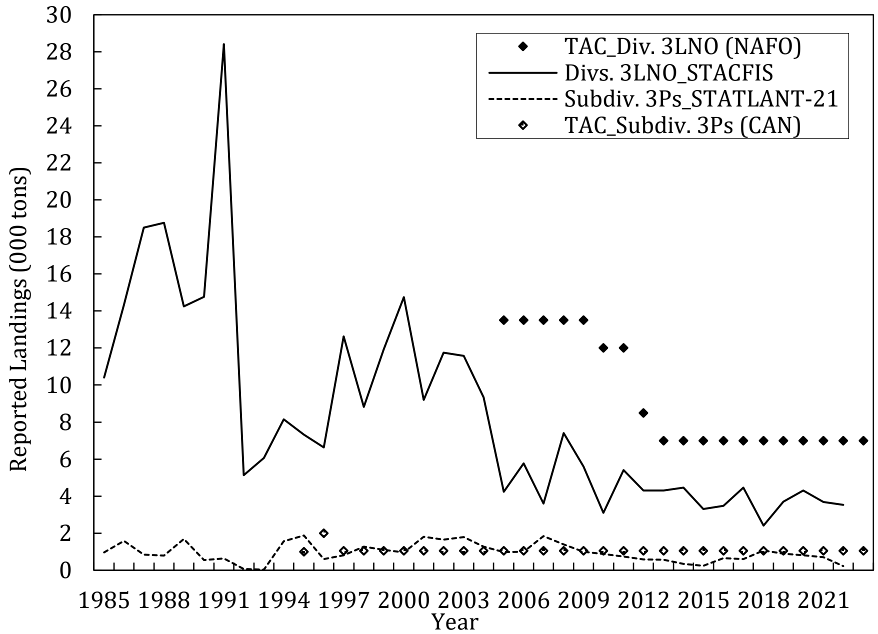


Figure 16.1. Thorny skate in Divs. 3LNO and Subdiv. 3Ps, 1985-2022: reported landings and TAC.

b) Data Overview

i) Research surveys

Recent surveys are as follow:

	Div.	2018	2019	2020	2021	2022
Canadian-Spring	3Ps	●	●	–	●	o
	3N	●	●	–	–	o
	3O	●	●	–	–	o
	3L	●	●	–	–	–
Canadian - Autumn	3L	No deep(>732m)	No deep(>732m)	No deep(>732m)	–	–
	3N	●	●	●	–	–
	3O	●	●	●	–	–
EU	3L	●	●	–	–	–
	3N	●	●	–	●	●
	3O	●	●	–	●	●

● = complete, o = uncalibrated, – = incomplete

Canadian spring surveys. Stratified-random research surveys were conducted by Canada in Divs. 3LNO and Subdiv. 3Ps in spring; using a Yankee 41.5 otter trawl in 1972-1982, an Engel 145 otter trawl in 1984-1995, and a Campelen 1800 shrimp trawl in 1996-2019. Subdiv. 3Ps was not surveyed in 2006, nor was the deeper portion (>103 m) of Divs. 3NO in that year, due to mechanical difficulties on Canadian research vessels. In 2015 and 2017. There were no spring surveys in Divs. 3LNO from 2019-2021. The survey in 2022 was on a new vessel and information is not yet available.

Total survey biomass in Divs. 3LNOPs fluctuated, but remained stable at low levels from 2007 to 2019. Due to lack of Canadian spring surveys in Divs. 3LNOPs since 2019 current status relative to B_{lim} cannot be determined. (Figure 16.2).

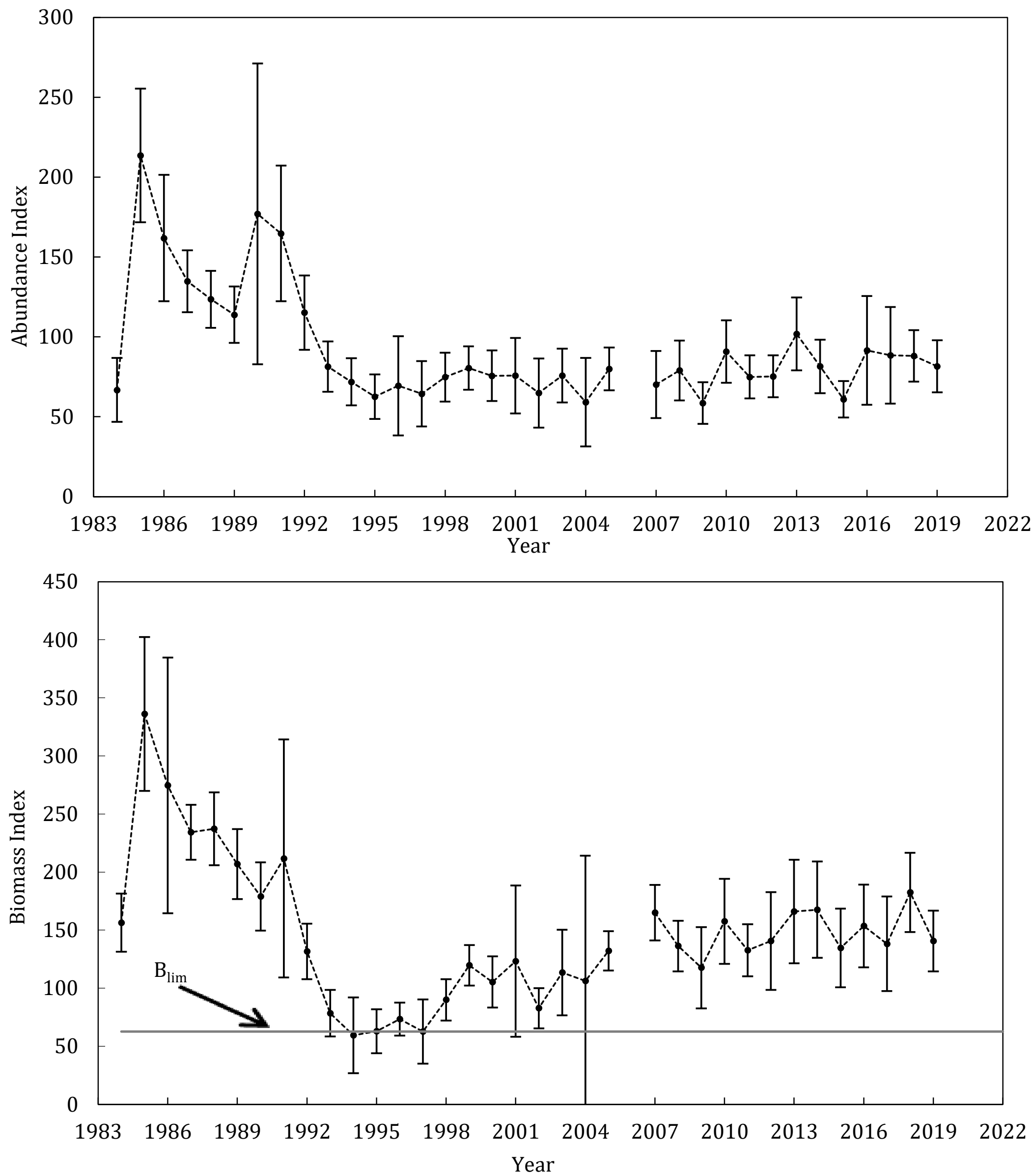
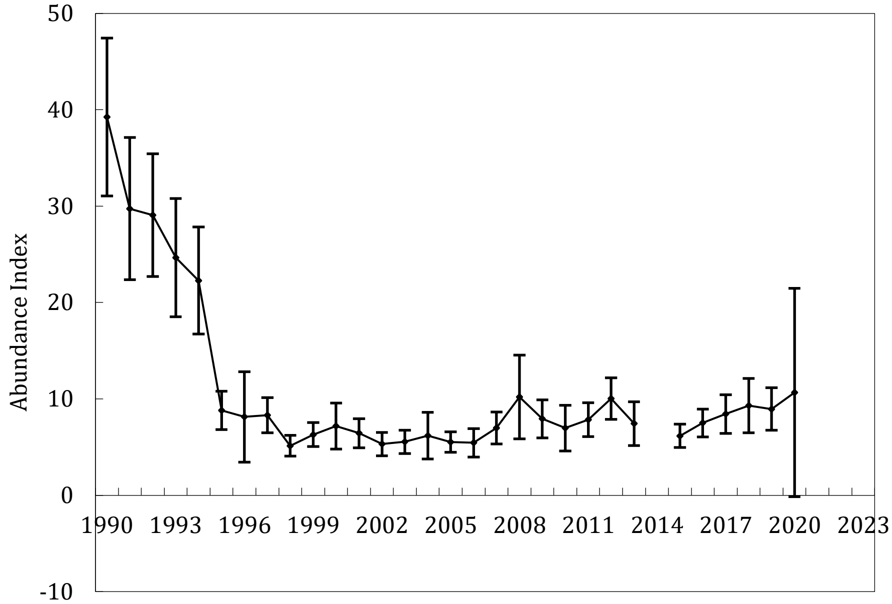


Figure 16.2. Thorny skate in Divs. 3LNOPs, 1984-2022: abundance (top panel) and biomass (bottom panel with B_{lim} shown [blue horizontal line]) indices from Canadian spring surveys. The survey in NAFO Div. 3L was incomplete in 2015 and 2017. There were no spring surveys in Divs. 3LNO from 2019-2021. The survey in 2022 was on a new vessel and information is not yet available.

Canadian autumn surveys. Stratified-random research surveys have been conducted by Canada in Divs. 3LNO in the autumn, using an Engel 145 otter trawl in 1990-1994 and a Campelen 1800 shrimp trawl in 1995-2020, to depths of ~1 450 m.

Autumn survey indices, similar to spring estimates, declined during the early 1990s. Catch rates have been stable at very low levels since 1995 (Figure 16.2). Biomass and abundance indices for the autumn 2020 survey were similar to those observed in 2019, but were highly uncertain. Divs. 3NO were not sampled in 2014 due to mechanical difficulties on Canadian research vessels. Autumn indices of abundance and biomass are, on average, higher than spring estimates. This is expected, because thorny skates are found deeper than the maximum depths surveyed in spring (~750 m), and are more deeply distributed during winter/spring.



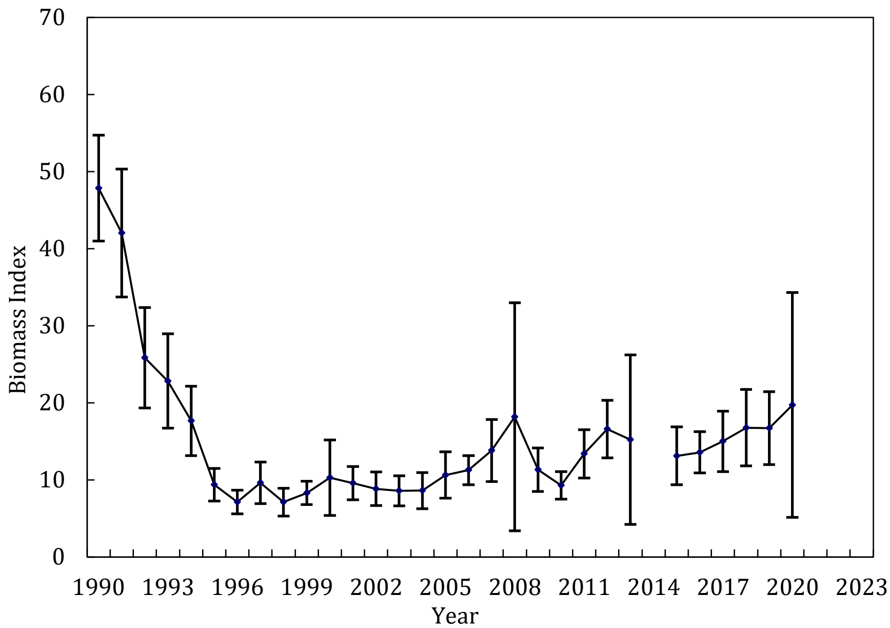


Figure 16.3. Thorny skate in Divs. 3LNOPs: 1990-2022: abundance (top panel) and biomass (bottom panel) indices from Canadian autumn surveys. The survey was not conducted in 2021 or 2022.

EU-Spain Divs. 3NO Survey. EU-Spain survey indices (Campelen or equivalent) are available for 1997-2022(except for 2020). The survey only occurs in the NAFO Regulatory Area, thus not sampling the entire Divisions. The biomass trajectory from the EU-Spain surveys was similar to that of the Canadian spring surveys until 2006 (Figure 16.3). Since 2007, the two indices diverged with an overall increase in the Canadian survey and a decline in the EU-Spain index to its lowest level in 2019.

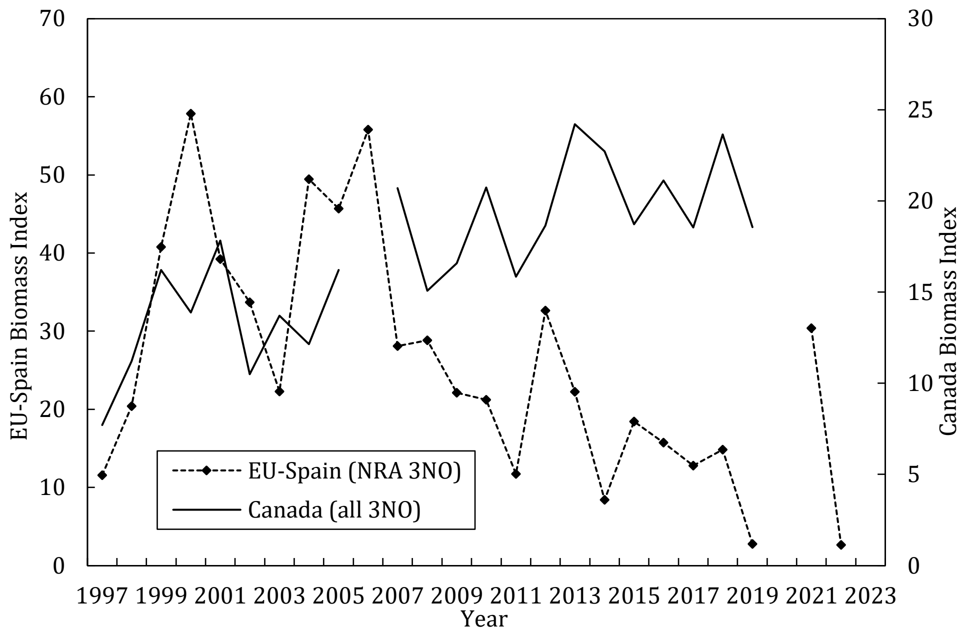


Figure 16.4. Thorny skate in Divs. 3LNOPs: biomass indices from the EU-Spain survey and the Canadian spring survey (1997-2022).

EU-Spain Div. 3L survey. EU-Spain survey indices (Campelen trawl) are available for 2003-2019 (excluding 2005). The survey only occurs in the NAFO Regulatory Area (Flemish Pass), thus not sampling the entire Division. Both the EU-Spain and Canadian autumn Div. 3L biomass indices generally declined from 2007-2011, while the Canadian spring index was more variable during this period (Figure 16.4). The Canadian autumn biomass index followed an increasing trend since 2011, while the Canadian spring index fluctuated at lower levels (Figure 16.5). Neither the Canadian spring 3L nor the EU-Spain index has been available since 2019.

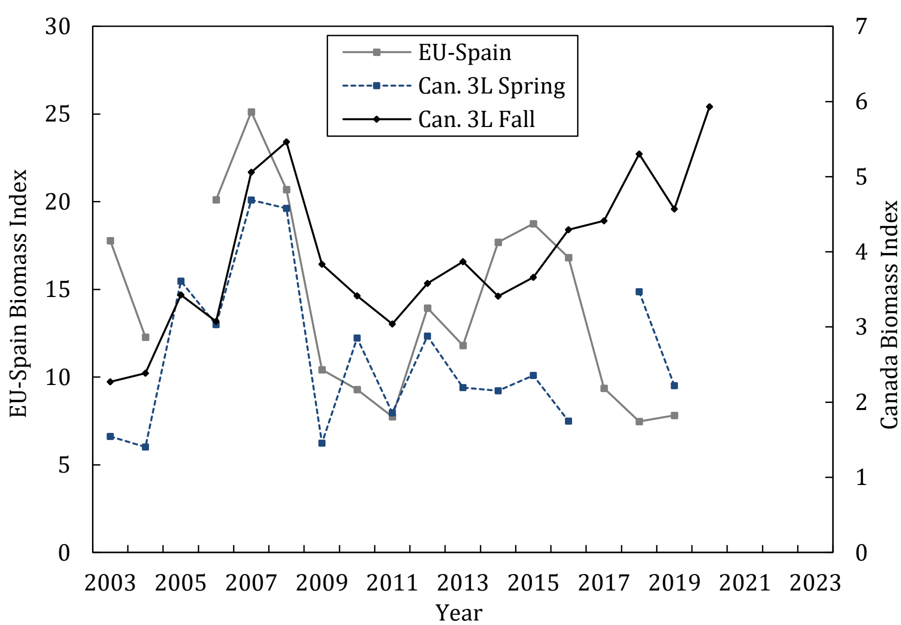


Figure 16.5. Thorny skate in Div. 3LNOPs: Biomass indices from EU-Spain Div. 3L survey and the Canadian spring and autumn surveys of Div. 3L in 2003-2022. The Canadian 3L and EU-3L surveys have not been conducted since 2019. The Canadian Autumn survey did not occur in 2021 or 2022.

c) Conclusion

Due to a lack of recent surveys, updated abundance and biomass indices are unavailable and the current status of the stock is unknown. Catches remain stable.

The next full assessment of this stock is planned for 2024.

17. White hake (*Urophycis tenuis*) in Divisions 3N, 3O, and Subdivision 3Ps

Full assessment (SCR Doc. 23/36; SCS Doc. 23/06,09,12,13)

a) Introduction

Canada commenced a directed fishery for white hake in 1988 in Div. 3NO and Subdiv. 3Ps. All Canadian landings prior to 1988 were as bycatch in various groundfish fisheries. EU-Spain and EU-Portugal commenced a directed fishery in 2002, and Russia in 2003, in the NAFO Regulatory Area (NRA) of Div. 3NO.

A TAC in Div. 3NO for white hake was first implemented by Fisheries Commission in 2005 at 8 500 tons, and then reduced to 6 000 t for 2010-2011. The TAC in Div. 3NO for 2012 was 5 000 t, and 1 000 t for 2013-2023. Canada has implemented a TAC of 500 t for Subdiv. 3Ps for 2018-2024.

From 1970-2009, white hake landings in Div. 3NO fluctuated, averaging approximately 2 000 t, exceeding 5 000 t in only three years during that period. Landings peaked in 1987 at approximately 8 100 t (Figure 17.1). With the restriction of fishing by other countries to areas outside Canada's 200-mile limit in 1992, non-Canadian landings fell to zero. Landings were low in 1995-2001 (422-t average), then increased to 6 718 t in 2002 and 4 823 t in 2003; following recruitment of the large 1999 year-class. STACFIS-agreed catches decreased to an average of 333 t in 2009-2018. Catch in 2021 and 2022 were 509 and 531 respectively t in 2022.

Commercial catches of white hake in Subdiv. 3Ps were less variable than 3NO, averaging 1 114 t in 1985-93, then decreasing to an average of 619 t in 1994-2002 (Figure 17.1). Subsequently, catches increased to an average of 1 174 t in 2004-2007, then decreased to a 300-t average in 2009-2018. Catch in 2021 and 2022 were 145 and 118t respectively.

Recent catches and TACs (000 tonnes) are as follows:

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Div. 3NO:										
TAC	1	1	1	1	1	1	1	1[1]	1[1]	1[1]
STATLANT-21	0.3	0.4	0.4	0.5	0.4	0.3	0.3	0.5	NA*	
STACFIS	0.3	0.5	0.4	0.5	0.4	0.3	0.3	0.5	0.5	
Subdiv. 3Ps:										
TAC					0.5	0.5	0.5	0.5	0.5	0.5
STATLANT-21	0.4	0.3	0.4	0.3	0.3	0.3	0.2	0.1	0.1	

[1]May change in-season. See NAFO FC Doc. 19/01

* STATLANT 21a data for NAFO Divisions 3NO in 2022 were not yet available at the time of writing

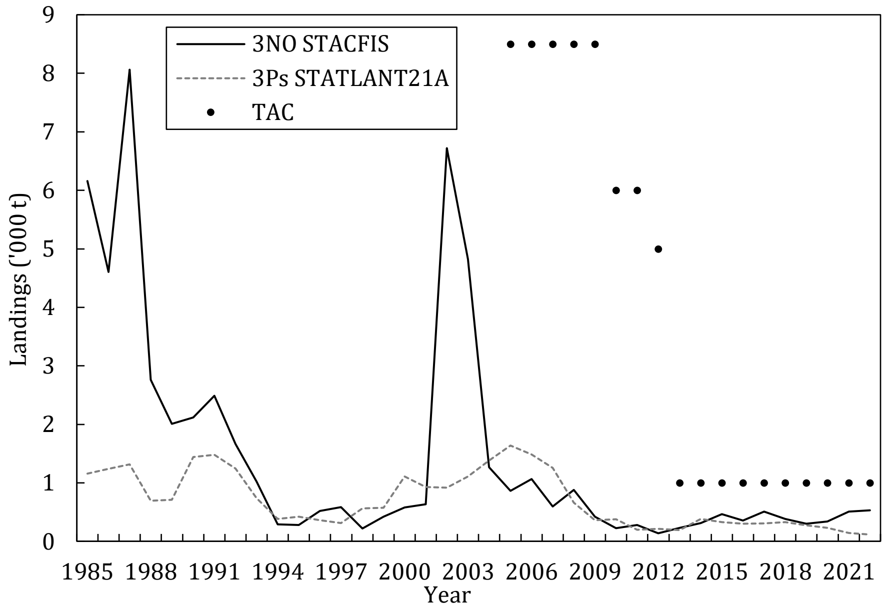


Figure 17.1. White hake in Div. 3NO and Subdiv. 3Ps: Total reported landings of White hake in the NRA of NAFO Division 3NO (STACFIS), and Subdivision 3Ps (STATLANT-21A). The Total Allowable Catch (TAC) in the NRA of Div. 3NO is also indicated on this graph.

b) Input Data

i) Commercial fishery data

Length composition. Length frequencies were available for Canada (1994-2022), EU-Spain (2002, 2004, 2012, 2014-2022), EU-Portugal (2003-2004, 2006-2016, 2021-2022), and Russia (2000-2007, 2013-2016, 2019-2020). Length ranges appeared to be highly variable depending on gear types, years, and locations.

ii) Research survey data

Recent surveys are as follow:

	Div.	2018	2019	2020	2021	2022
Canadian-Spring	3Ps	●	●	–	●	o
	3N	●	●	–	–	o
	3O	●	●	–	–	o
Canadian -Fall	3N	●	●	●	–	–
	3O	●	●	●	–	–
EU	3N	●	●	–	●	●
	3O	●	●	–	●	●

● = complete, o = uncalibrated, – = incomplete

Canadian stratified-random bottom trawl surveys.
Canadian spring surveys have been conducted using different trawls: a Yankee 41.5 bottom trawl prior to 1984, an Engel 145 bottom trawl from 1984 to 1995, and a Campelen 1800 trawl thereafter. Canadian autumn surveys in Div. 3NO employed an Engel 145 trawl from 1990 to 1994, followed by a Campelen 1800 trawl from 1995 to 2020. Due to the absence of survey catch rate conversion factors for white hake, each gear type is treated as a separate time-series. The survey in 2022 was carried out on a new vessel and calibration information is not yet available. Results from comparative fishing experiments are expected to be available for SC in 2024.

Survey information is available for 3Ps in 1972 – 2022, but missing from 2006 and 2020, while 2022 was carried out with a new vessel. Data from Canadian spring Div. 3NO is missing in 2006, 2020, 2021, while 2022 was carried out at a reduced allocation of sets with a new vessel. Canadian fall surveys were carried out from 1990-2020 with 2021 and 2022 missing.

Abundance and biomass indices of white hake from the Canadian spring research surveys in Div. 3NOPs are presented in Figure 17.2a. From 2007-2019, the population remained at a level similar to that previously observed in the Campelen time series for 1996-1998. The dominant feature of the white hake abundance time-series was the very large peak observed over 2000-2001. In recent years, spring abundance of this species increased in 2011, but declined to relatively stable levels over 2012-2018. Biomass of this stock increased in 2000, generated by the very large 1999 year-class. Subsequently, the biomass index decreased until 2009, then increased to 2014, and declined slightly over 2015- 2018.

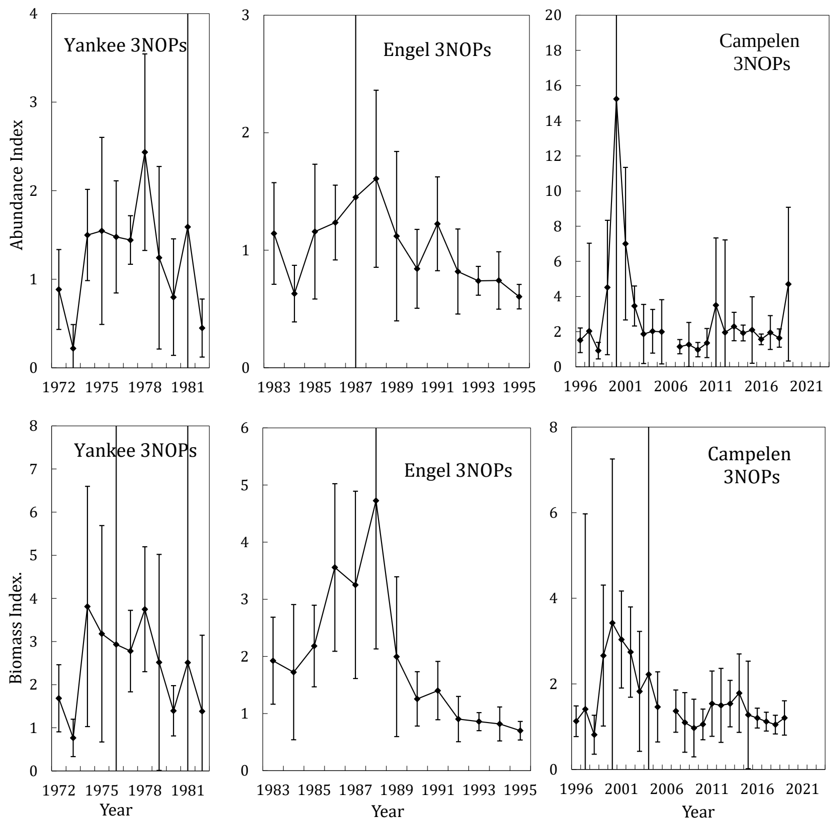


Figure 17.2a. White hake in Div. 3NO and Subdiv. 3Ps: abundance (top panels) and biomass (bottom panels) indices from Canadian spring research surveys, 1972-2019. Estimates from 2006 are not shown, since survey coverage in that year was incomplete. Yankee, Engel, and Campelen time series are not standardized, and thus are presented on separate panels. Error bars are 95% confidence limits. The bounds of the error bars in 1976, 1981, 1987, 2000, 2012, and 2015 in some panels extend above/below the graph limits.

Canadian autumn surveys of Div. 3NO have the peak in abundance represented by the very large 1999 year-class (Figure 17.2b). Autumn indices then declined to levels similar to those observed during 1996-1998 until 2010. In 2011-2013, both biomass and abundance appear to have slightly increased then declined over 2015-2018. This survey was not completed in 2014, or 2021-2022; thus, no recent updates are available.

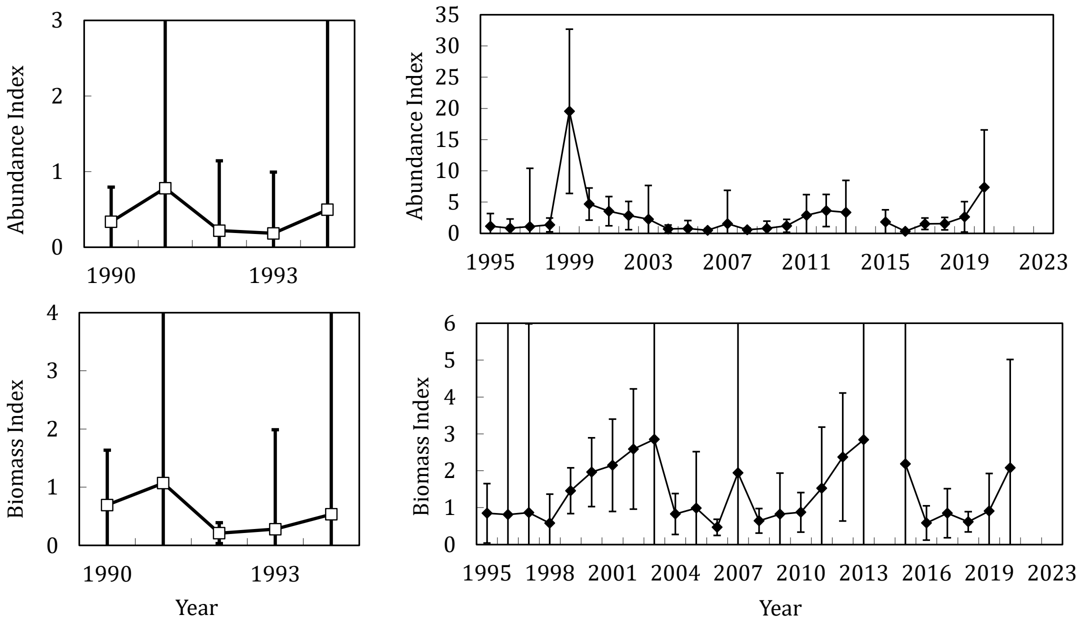


Figure 17.2b. White hake in Div. 3NO: abundance (top panels) and biomass indices (bottom panels) from Canadian autumn surveys, 1990-2020. Engel (□, 1990-1994) and Campelen (♦, 1995-2020) time series are not standardized. Estimates from 2014 are not shown, since survey coverage in that year was incomplete. Error bars are 95% confidence limits. The bounds of the error bars in 1990-1994, 2002-2009, 2013, 2015, 2019, and 2020 in some panels extend above/below the graph limits. This survey was not conducted in 2021 or 2022.

EU-Spanish stratified-random bottom trawl surveys in the NRA. EU-Spain biomass indices in the NAFO Regulatory Area (NRA) of Div. 3NO were available for white hake from 2001 to 2022; although this survey was not conducted in 2020 due to COVID-19 (Figure 17.3). EU-Spain surveys were conducted with Campelen gear (similar to that used in Canadian surveys) in the spring to a depth of 1 400 m. This survey covers only 10% of the total stock area. The EU-Spain biomass index was highest in 2001, then declined to its lowest level in 2008 and has remained variable since then (Figure 17.3). The overall trend is similar to that of the Canadian spring survey index with a time lag.

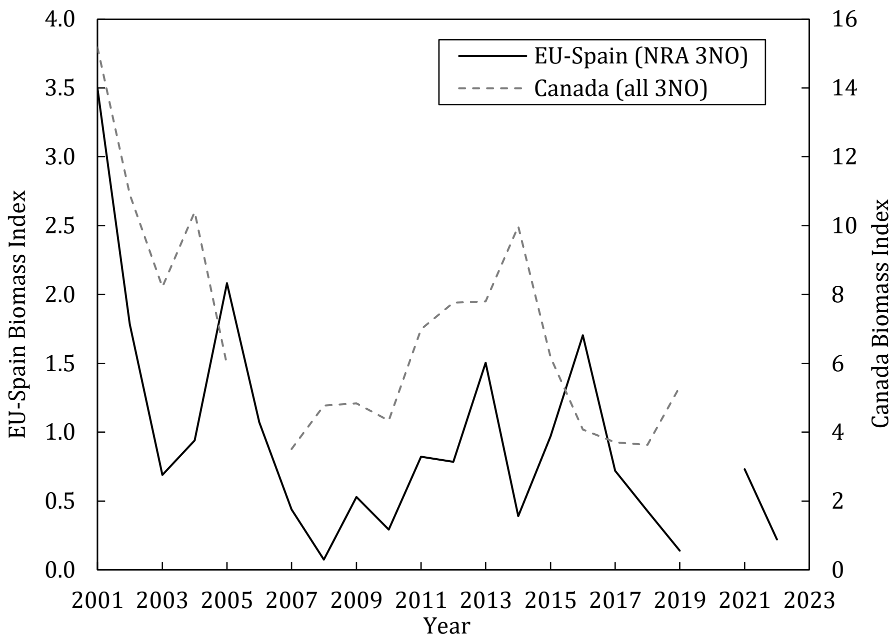


Figure 17.3. White hake in the NRA of Div. 3NO: Biomass indices from EU-Spain Campelen spring surveys in 2001-2022 compared to Canadian spring survey indices in all of Div. 3NO. Estimates from 2006 Canadian survey are not shown, since survey coverage in that year was incomplete. This Canadian survey has not been completed since 2019.

c) Biological studies

i) Distribution.

White hake in Div. 3NO and Subdiv. 3Ps are confined largely to an area associated with the warmest bottom temperatures (4-8°C) along the southwest edge of the Grand Banks, edge of the Laurentian Channel, and southwest coast of Newfoundland.

White hake distribute in different locations during various stages of their life cycle. Fish <26 cm in length (1^{st} year fish) occur almost exclusively on the Grand Bank in shallow water. Juveniles (2+ years) are widely spread, and a high proportion of white hake in the Laurentian Channel area of Subdiv. 3Ps are juveniles. Mature adults concentrate on the southern slope of the Bank in Div. 3NO, and along the Laurentian Channel in Subdiv. 3Ps.

ii) Recruitment

In Canadian spring research surveys, the number of white hake less than 27 cm in length is assumed to be an index of recruitment at Age 1. The recruitment index in 2000 was very large, but no large value has been observed during 2001-2018 (Figure 17.4). Recruitment was higher in 2019, but is not comparable to the very high recruitment observed in 2000. Canadian spring surveys have not been completed since 2019; thereby preventing subsequent updates to this index.

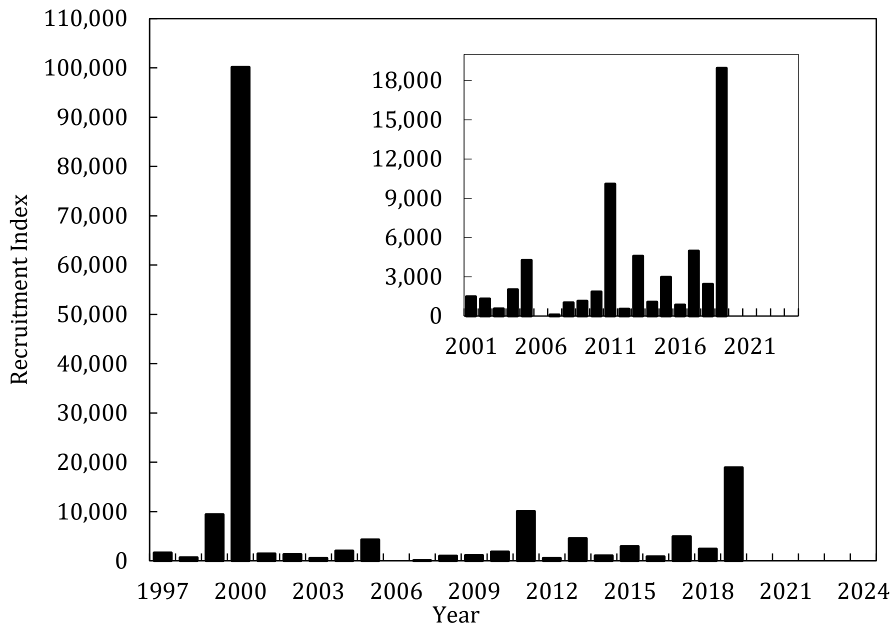


Figure 17.4. White hake in Div. 3NO and Subdiv. 3Ps: recruitment index for age 1 males and females (combined) from Canadian Campelen spring surveys in Div. 3NO and Subdiv. 3Ps in 1997-2019. Estimates from 2006 are not shown, since survey coverage in that year was incomplete, and no survey occurred in 2020-2022. Inset plot depicts 2001-2022 on a smaller scale.

d) Assessment Results

This stock is assessed based upon a qualitative evaluation of stock survey biomass trends and recruitment indices. The Canadian spring survey which is the primary status indicator has not been available since 2019.

Biomass. Biomass of this stock increased in 1999 and 2000, generated by the large recruitment observed in those years. Subsequently, the biomass index decreased and remained variable, but lower up to 2019. Canadian spring surveys have not been completed since 2019 therefore, stock status is unknown.

Recruitment. Recruitment in 2000 was very large, but no large year class has been observed since then. Recruitment was higher in 2019, but not comparable to the very high recruitment observed in 2000. No information is available on recruitment since 2019 so current levels of recruitment are unknown.

Relative F (commercial landings/Canadian spring survey biomass). Using STACFIS-agreed commercial landings and Canadian spring survey biomass index, estimates of relative *F* were calculated for white hake in Div. 3NO and Div. 3NOPs. Relative fishing mortality (Rel. *F*) has fluctuated, but increased considerably in 2002-2003 (Figure 17.5). Relative *F* estimates were low between 2010 and 2019. Due to a lack of Canadian spring surveys, this index cannot be updated; however, catches in Div. 3NO increased from less than 300 t in 2020 to more than 500 t in 2021 and 2022.

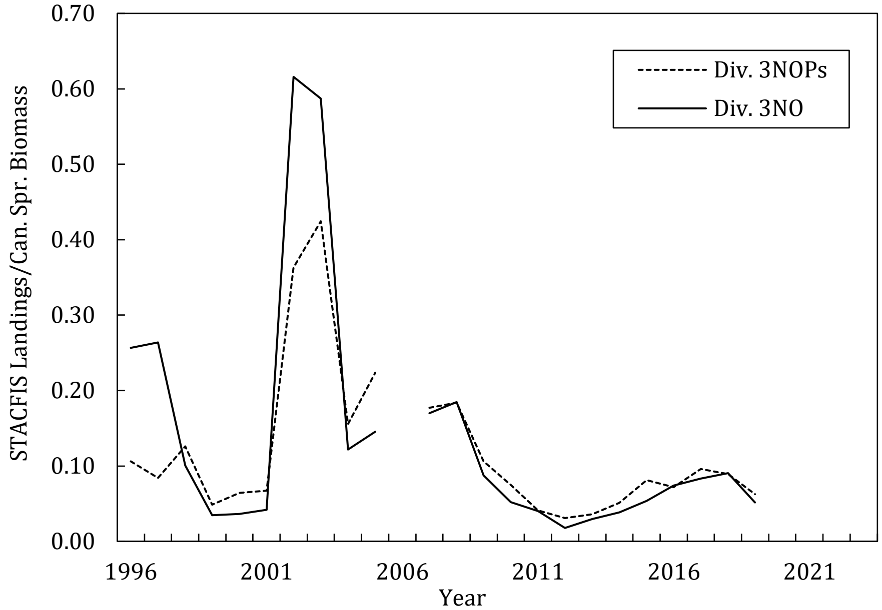


Figure 17.5. White hake in Div. 3NO and Subdiv. 3Ps: estimates of relative *F* from STACFIS-agreed commercial landings/Canadian Campelen spring survey biomass (1996-2019). Estimates from 2006 and 2020-2022 are not shown due to incomplete surveys.

State of the stock.

Stock status is unknown. No information is available on recruitment and relative fishing mortality since 2019.

e) Reference Points

No precautionary reference points have been established for this stock.

f) Research Recommendations

STACFIS **recommended** that *age determination should be conducted on otolith samples collected during annual Canadian surveys (1972-2019); thereby allowing age-based analyses of this population.*

Otoliths are being collected, and aging has begun. STACFIS reiterates this recommendation.

STACFIS **recommended** that *survey conversion factors between the Engel and Campelen gear be investigated for this stock.*

No progress. STACFIS reiterates this recommendation.

STACFIS **recommended** that *work continue on the development of population models and reference point proxies.*

Various formulations of a surplus production model were explored in a state-space (SPICT) and in a Bayesian framework, and work is continuing.

The next full assessment of this stock is planned for 2025.

WIDELY DISTRIBUTED STOCKS: SA 2, SA 3 AND SA 4

Environmental Overview

The water mass characteristics of Newfoundland and Labrador Shelf are typical of sub-polar waters with a sub-surface temperature range of -1-2°C and salinities of 32-33.5. Labrador Slope Water flows southward along the shelf edge and into the Flemish Pass region, this water mass is generally warmer and saltier than the sub-polar shelf waters with a temperature range of 3-4°C and salinities in the range of 34-34.75. On average bottom temperatures remain < 0°C over most of the northern Grand Banks but increase to 1-4°C in southern regions and along the slopes of the banks below 200 m. North of the Grand Bank, in Div. 3K, bottom temperatures are generally warmer (1-3°C) except for the shallow inshore regions where they are mainly <0°C. In the deeper waters of the Flemish Pass and across the Flemish Cap bottom temperatures generally range from 3-4°C. Throughout most of the year the cold, relatively fresh water overlying the shelf is separated from the warmer higher-density water of the continental slope region by a strong temperature and density front. This winter-formed water mass is generally referred to as the Cold Intermediate Layer (CIL) and is considered a robust index of ocean climate conditions. In general, shelf water masses undergo seasonal modification in their properties due to the seasonal cycles of air-sea heat flux, wind-forced mixing and ice formation and melt, leading to intense vertical and horizontal gradients particularly along the frontal boundaries separating the shelf and slope water masses.

Temperature and salinity conditions in the Scotian Shelf, Bay of Fundy and Gulf of Maine regions are determined by many processes: heat transfer between the ocean and atmosphere, inflow from the Gulf of St. Lawrence supplemented by flow from the Newfoundland Shelf, exchange with offshore slope waters, local mixing, freshwater runoff, direct precipitation and melting of sea-ice. The Nova Scotia Current is the dominant inflow, originating in the Gulf of St. Lawrence and entering the region through Cabot Strait. The Current, whose path is strongly affected by topography, has a general southwestward drift over the Scotian Shelf and continues into the Gulf of Maine where it contributes to the counter-clockwise mean circulation. The properties of shelf waters are modified by mixing with offshore waters from the continental slope. These offshore waters are generally of two types, Warm Slope Water, with temperatures in the range of 8-13°C and salinities from 34.7-35.6, and Labrador Slope Water, with temperatures from 3.5°C to 8°C and salinities from 34.3 to 35. Shelf water properties have large seasonal cycles, east-west and inshore-offshore gradients, and vary with depth.

18. Roughhead Grenadier (*Macrourus berglax*) in Subareas 2 and 3

Interim Monitoring Report (SCR Doc. 98/57, SCS Doc. 23/06, SCS Doc. 22/07, Doc. 22/09 and SCR 98/57, 22/04, 22/05, 22/07)

a) Introduction

The stock structure of this species in the North Atlantic remains unclear because there is little information on the number of different populations that may exist and the relationships between them. Roughhead grenadier is distributed throughout NAFO Subareas 0 to 3 in depths between 300 and 2 000 m. However, for assessment purposes, NAFO Scientific Council considers the population of Subareas 2 and 3 as a single stock.

A substantial part of the grenadier catches in Subarea 3 previously reported as roundnose grenadier was actually roughhead grenadier. To correct the catch statistics STACFIS (NAFO SCR 98/57) revised and approved roughhead grenadier catch statistics since 1987. In the period 2007-2012, catches for Subarea 2+3 roughhead grenadier were stable at levels around one thousand tons. In the period 2013-2022 catches were quite stable at a lower level, around 400 ton (Figure 18.1). Most of the catches were taken in Divs. 3KLMN by Spain, Canada, Portugal, Japan and Russia fleets. From 2015 to 2021 all catches were from Subarea 3 and, in 2022, a small portion of catches were recorded from Subarea 2. Since 2015 all catches are from Subarea 3. There is no TAC for this stock.

Recent catches ('000 tonnes) are as follow:

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
STATLANT 21A	0.6	0.2	0.1	0.1	0.1	0.2	0.2	0.2	NA*	
STACFIS	0.6	0.2	0.3	0.4	0.5	0.4	0.4	0.4	0.5	

* STATLANT 21A data for 2022 were not yet available at the time of writing

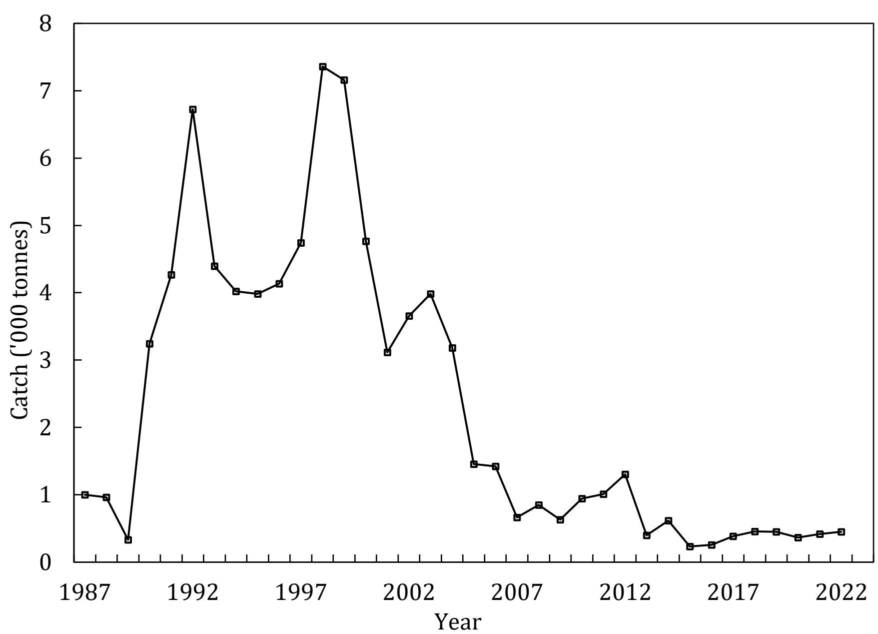


Figure 18.1. Roughhead grenadier in Subareas 2+3: STACFIS catches.

b) Data Overview

i) Surveys

Recent surveys are as follow:

	Div.	2018	2019	2020	2021	2022
Canadian - Fall	2J	●	No deep(>750m)	●	No deep(>1000m)	–
	3K	No deep(>750m)	No deep(>750m)	●	Limited deep	–
EU	3M	●	●	●	●	●
	3L	●	●	–	–	–
	3N	●	●	–	●	●
	3O	●	●	–	●	●

● = complete, o = uncalibrated, – = incomplete

There are no survey indices available covering the total distribution, in depth and area, of this stock. According to other information, this species is predominately at depths ranging from 800 to 1500 m, therefore the best survey indicators of stock biomass should be the series extending to 1500 meters depth as they cover the depth distribution of Roughhead grenadier fairly well. Figure 18.2 presents the biomass indices for the following series extending to 1500 meters depth: Canadian fall 2J+3K Engel (1978-1994) and Canadian fall 2J+3K Campelen (1995-2020), EU 3NO (1997-2022), EU 3L (2006-2019) and EU Flemish Cap (to1400 m; 2004-2022). Survey coverage deficiencies within Divs. 2J3K were such that the 2008, 2018, 2019, 2021 and 2022 index from Canadian fall Divs. 2J3K could not be considered comparable to that of the other years. In 2020 the EU 3NO survey have not been carried out due to the pandemic situation. In 2020-2022 period, the EU 3L survey have not been carried out due to the pandemic situation and mechanical problems. Survey biomass indices showed a general increasing trend in the period 1995-2004. Although the indices are variable across the past decade, there is a general decreasing trend with the exception of the Canadian 2J3K survey, which had increased up to 2020. The two series available in 2022 show values for that are near the series minimum.

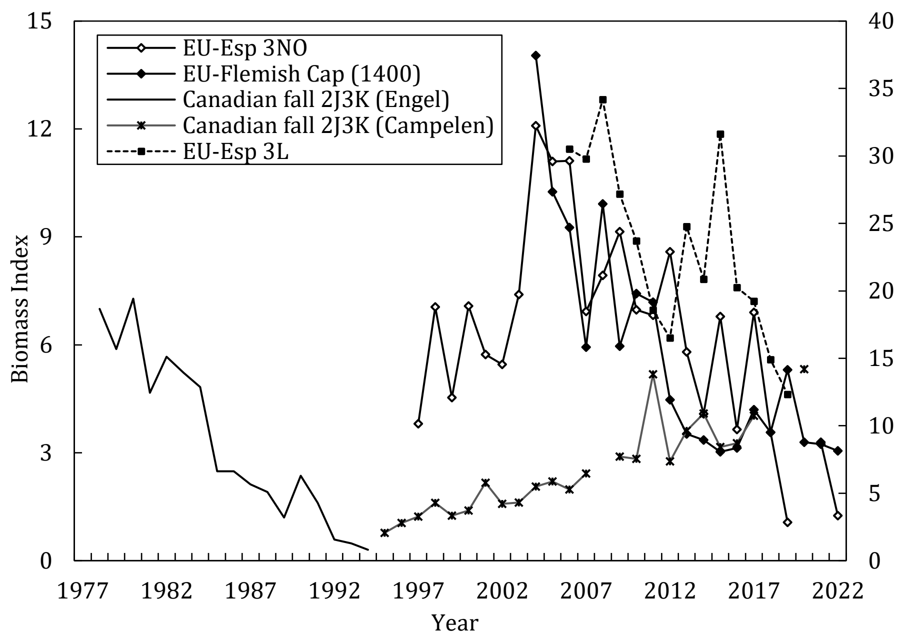


Figure 18.2. Roughhead grenadier in Subareas 2+3: Survey biomass indices.

The catch-biomass (C/B) ratios showed a clear declining trend from 1995-2005 and since then have been stable at low levels with the exception of the of the 3NO survey index in the year 2019 and 2022 (Figure 18.3). The (C/B) ratio of the Flemish Cap series presents a slightly increasing trend in recent years.

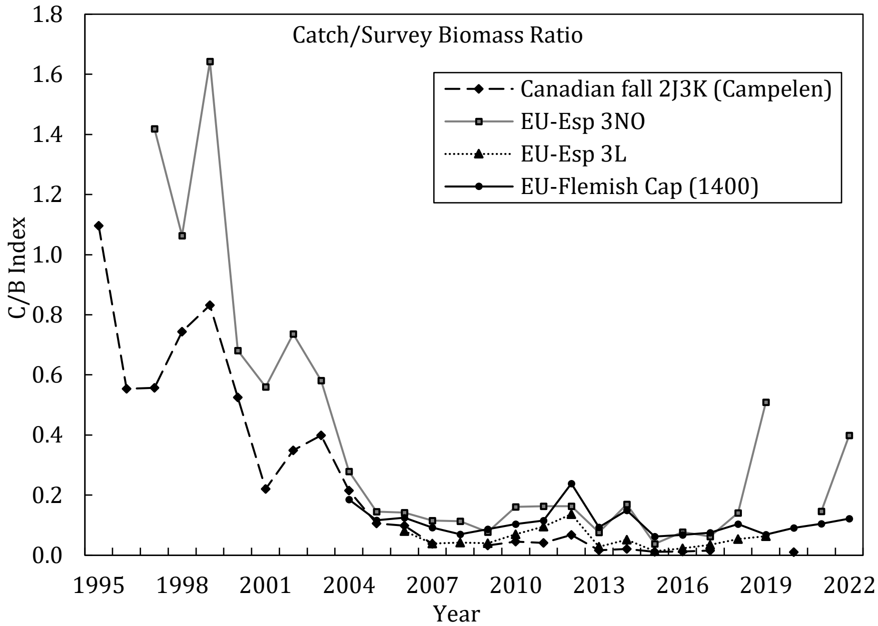


Figure 18.3. Roughhead grenadier in Subareas 2+3: catch/biomass indices based upon Canadian Autumn (Campelen series), EU-Spanish Div. 3NO, EU-Spanish 3L and EU-Flemish Cap (to 1400 m depth) surveys.

c) Conclusion

Lack of survey indices in recent years limits our understanding of stock status since 2019, but available data

indicate that there is a general decrease over the past decade with the exception of the Canadian 2J3K survey, which had increased to 2019, however there has been no survey index available since. Note that the two survey series available in 2022 show values for that year close to the minimum of the series. Fishing mortality indices have remained at low levels since 2005 with the exception of the of the 3NO survey index in the year 2019 and 2022. The Flemish Cap series presents a slightly increasing trend in recent years. The indices available for the current year are close to the minimum of the series.

This stock will be monitored in future by interim monitoring reports until such time conditions change to warrant a full assessment.

19. Greenland Halibut (*Reinhardtius hippoglossoides*) in Subarea 2 + Divisions 3KLMNO

Interim monitoring report (SCS 23/06, 09, 12, 13; SCR Doc. 17/26, 19/31, 20/47, 22/07, 23/003; FC Doc. 03/13, 10/12, 13/23, 16/20; Com Doc 17/17)

a) Introduction

Fishery and Catches: TACs prior to 1995 were set autonomously by Canada; subsequent TACs have been established by NAFO Fisheries Commission (FC). Catches increased sharply in 1990 due to a developing fishery in the NAFO Regulatory Area in Divs. 3LMNO and continued at high levels during 1991-94. The catch was only 15 000 to 20 000 t per year in 1995 to 1998. The catch increased after 1998 and by 2001 was estimated to be 38 000 t, the highest since 1994. The estimated catch for 2002 was 34 000 t. The 2003 catch could not be precisely estimated, but was believed to be within the range of 32 000 t to 38 500 t. In 2003, a fifteen year rebuilding plan was implemented by Fisheries Commission for this stock (FC Doc. 03/13). Though much lower than values of the early 2000s, estimated catch over 2004-2010 exceeded the TAC by considerable margins. TAC over-runs have ranged from 22%-64%, despite considerable reductions in effort. The STACFIS estimate of catch for 2010 was 26 170 t (64% over-run). In 2010, Fisheries Commission implemented a survey-based Management Procedure, which incorporates a harvest control rule (HCR) (FC Doc. 10/12) to generate annual TACs over at least 2011-2014, through which period the catch exceeded the TAC in every year. In 2013

Fisheries Commission extended the 2010 management approach to set the TACs for 2015–2017 (FC Doc. 13/23), but did not apply the HCR in 2017, rather setting the TAC equal to the 2016 TAC (FC Doc. 16/20). TACs since 2018 have been based on the HCR adopted in 2017 (Com Doc 17/17). Catches have closely tracked TACs since 2015. The TAC in 2022 was 15 864 t and 15 673 t were caught. The TAC for 2023 is 15 156 t.

Recent catches and TACs ('000 tonnes) are as follows:

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TAC	15.4	15.6	14.8	14.8	16.5	16.5	16.9	16.5	15.9	15.2
STATLANT 21	15.7	15.0	13.0	14.7	16.2	16.3	16.3	15.0	NA*	--
STACFIS	21.4	15.3	14.9	14.8	16.6	16.5	16.3	15.0	15.7	--

* STATLANT 21A data for 2022 were not yet available at the time of writing

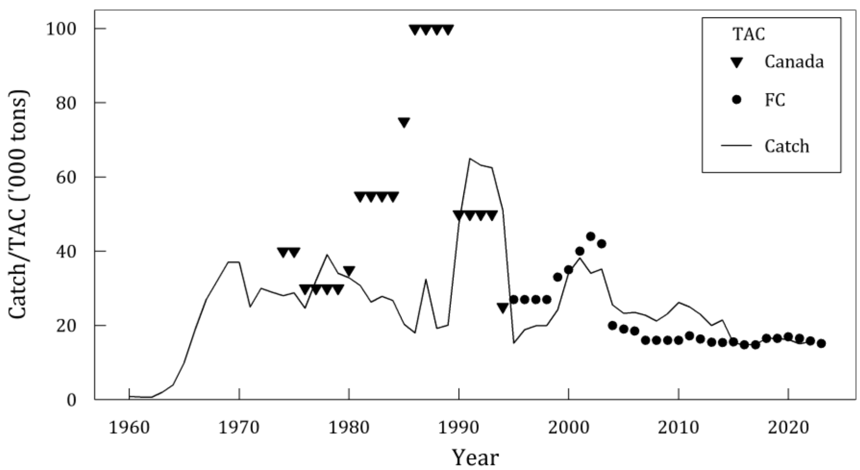


Figure 19.1. Greenland halibut in Subarea 2 + Divs. 3KLMNO: TACs and STACFIS catches.

b) Data Overview

Recent surveys are as follow:

	Div.	2018	2019	2020	2021	2022
Canadian-Spring	3N	●	●	–	–	o
	3O	●	●	–	–	o
	3L	●	●	–	–	–
Canadian - Autumn	2H	●	Incomplete deep(>750m)	No deep(>750m)	No deep(>1000m)	–
	2J	●	No deep(>750m)	●	No deep(>1000m)	–
	3K	No deep(>750m)	No deep(>750m)	●	Limited deep	–
	3L	No deep(>732m)	No deep(>732m)	No deep(>732m)	–	–
	3N	●	●	●	–	–
	3O	●	●	●	–	–
EU	3M	●	●	●	●	●
	3N	●	●	–	●	●
	3O	●	●	–	●	●

● = complete, o = uncalibrated, – = incomplete

Abundance and biomass indices were available from research vessel surveys by Canada in Divs. 2+3KLNO (1978-2021; all Canadian surveys were interrupted in 2022 by comparative fishing experiments), EU in Div. 3M (1988-2022) and EU-Spain in Divs. 3NO (1995-2022). Different years are examined to represent population trends from the different surveys. For the Canadian autumn survey in Divs. 2J3K the years are 1978-2021 (excluding 2008 due to coverage issues); from the Canadian spring survey in Divs. 3LNO 1996-2020 (excluding 2006, 2015, 2017 due to survey coverage issues; the survey was not conducted in 2020 due to the COVID-19 pandemic; the survey was not conducted in 2021 due to vessel issues); for the Canadian autumn survey in Divs. 3LNO to 730 m from 1996-2021 (excluding 2014 and 2021 due to coverage issues); for the survey in Div. 3M to 700 m 1988-2022, and to 1400 m 2004-2022; and for the survey by EU-Spain in Divs. 3NO 1997-2021 (this survey was not conducted in 2020 due to the COVID-19 pandemic).

i) Research survey data

STACFIS reiterated that most research vessel survey series providing information on the abundance of Greenland halibut are deficient in various ways and to varying degrees. Variation in divisional and depth coverage creates problems in comparing results from different years (SCR Doc. 19/31). A single survey series which covers the entire stock area is not available. A subset of standardized (depth and area) stratified random survey indices have been used to monitor trends in resource status, and are described below.

Canadian stratified-random autumn surveys in Divs. 2J and 3K: Abundance and biomass indices from the Canadian autumn survey of Divs. 2J3K have shown a series of increases and decreases since 1996 (Fig. 19.2). The abundance index decreased between 1996-2005, increased between 2005-2011 and, following a decrease in 2012, the index has remained relatively low and stable. The biomass index has fluctuated since 1996, with local maxima around 1999, 2007 and 2014, and local minima around 2002, 2010 and 2017; the index has been relatively low since 2017, with a potential increase in 2021. Levels in 2022 are unknown as comparative fishing experiments were conducted in lieu of the survey.

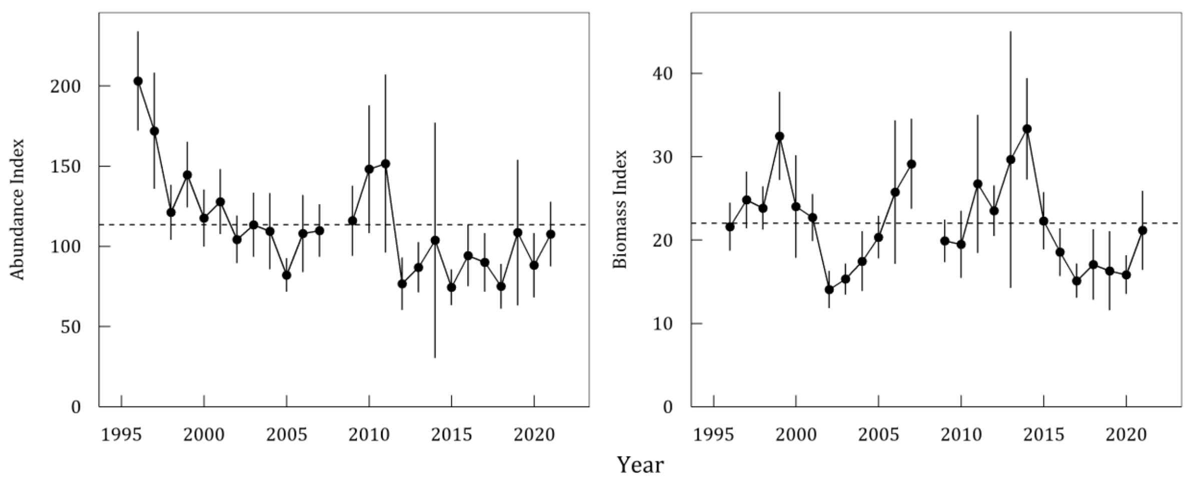


Figure 19.2. Greenland halibut in Subarea 2 + Divs. 3KLMNO: abundance (left) and biomass (right) indices (with 95% CI) from Canadian autumn surveys in Divs. 2J and 3K. The 2008 survey was not completed. The dotted line represents the time-series average.

Canadian stratified-random spring surveys in Divs. 3LNO: Abundance and biomass indices from the Canadian spring surveys in Divs. 3LNO (Figure 19.3) declined from relatively high values in the late 1990s and has been relatively low in most years thereafter. The 2015 and 2017 surveys were incomplete and are not considered representative of the population. Abundance and biomass indices from 2018 and 2019 have increased from 2016 levels. Trends since 2019 are unknown due to recent survey interruptions.

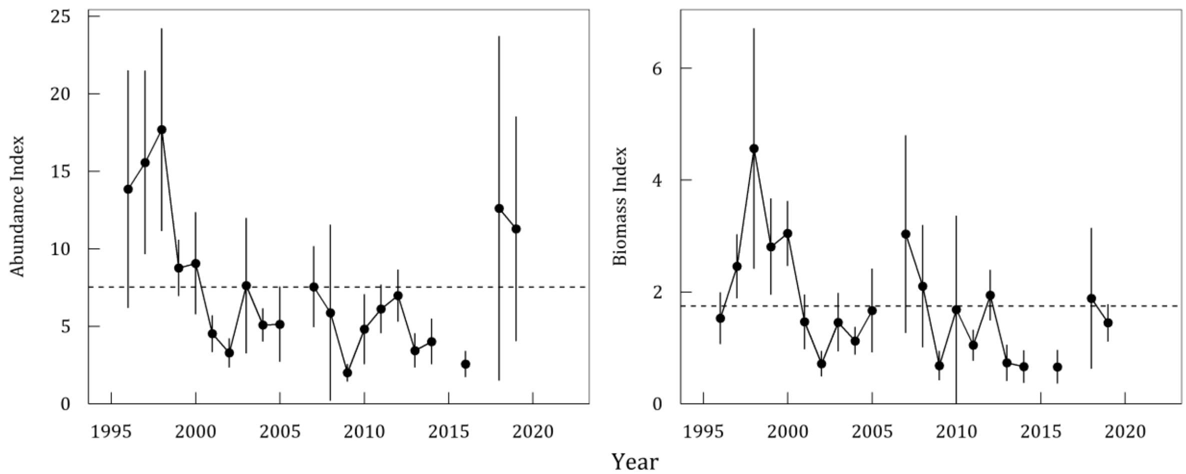


Figure 19.3. Greenland halibut in Subarea 2 + Divs. 3KLMNO: abundance (left) and biomass (right) indices (with 95% CI) from Canadian spring surveys in Divs. 3LNO. The dotted line represents the time-series average.

Canadian stratified-random autumn surveys in Divs. 3LNO: Time series of abundance and biomass were developed from the Canadian autumn surveys from 1996-2020 to a depth of 730 m. The abundance index from the Canadian autumn surveys in Divs. 3LNO (Figure 19.4) declined from relatively high values in the late 1990s and has been relatively low in most years thereafter. The biomass index declined from 1998 to 2002 and then increased to 2005, to a level near that of the beginning of the time series. Abundance and biomass indices have been increasing since 2015; the abundance index has increased above levels observed between 1999-2010 and the biomass index has reached levels near those between 2005-2008. Trends since 2020 are unknown due to recent missing surveys.

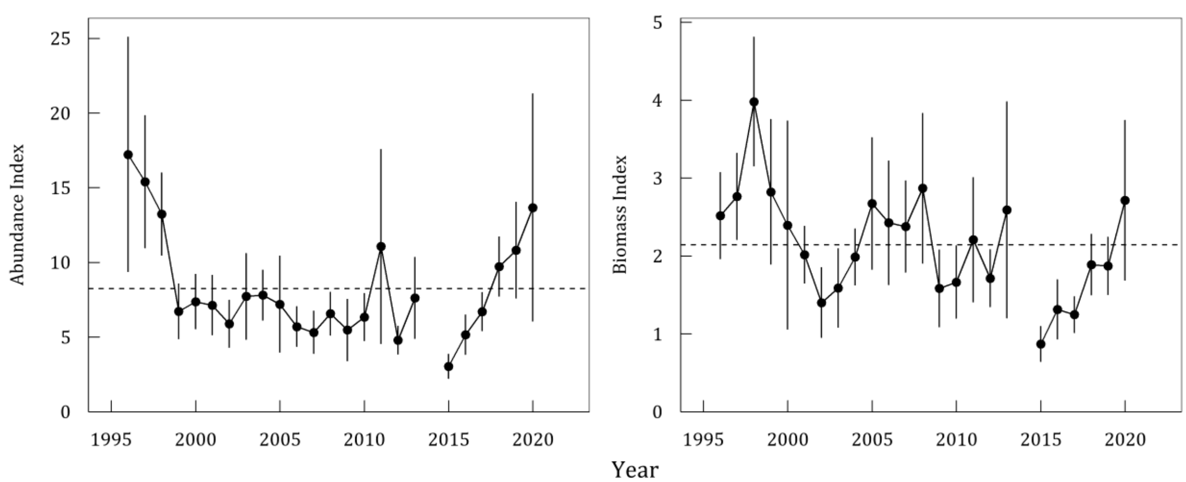


Figure 19.4. Greenland halibut in Subarea 2 + Divs. 3KLMNO: abundance (left) and biomass (right) indices (with 95% CI) from Canadian autumn surveys in Divs. 3LNO. The dotted line represents the time-series average.

EU stratified-random surveys in Divs. 3M (Flemish Cap): Surveys conducted by the EU in Div. 3M during summer indicate that the Greenland halibut biomass index in depths to 730 m increased to a maximum value in 1998 (Figure 19.5). This biomass index declined continually over 1998-2002. The 2002-2008 results were relatively stable, with the exception of an anomalously low value in 2003. From 2009 to 2013 the index decreased to its lowest observed value. Since 2010, the index has remained below the series average. The Flemish Cap survey was extended to cover depths down to 1460 m beginning in 2004. Biomass estimates over the full depth range doubled over 2005-2008 but then declined to below the time series average in 2012 and

2013. From 2015-2017 the index has been variable but above the average of the time series, with 2015 and 2017 being the highest in the series. The index has since declined, falling below the time series average since 2019.

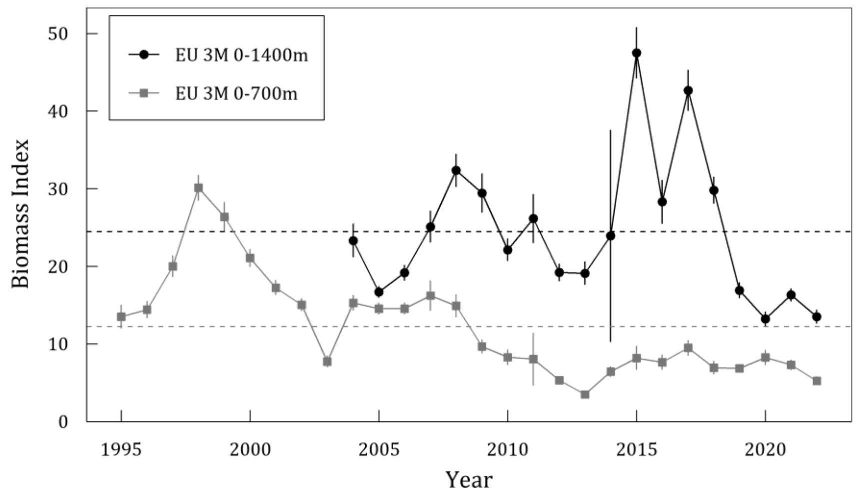


Figure 19.5. Greenland halibut in Subarea 2 + Divs. 3KLMNO: Biomass index (± 1 S.E.) from EU Flemish Cap surveys in Div. 3M. Grey squares: biomass index for depths <730 m. Black circles: biomass index for all depths <1460 m. Dotted lines represent time-series averages.

EU-Spain stratified-random surveys in NAFO Regulatory Area of Divs. 3LNO: The biomass index for the survey of the NRA in Divs. 3NO generally declined over 1999 to 2006 (Figure 19.6) but increased four-fold over 2006-2009. The survey index increased from 2013 to 2017 but since declined to levels closer to the time series average. The biomass index for the survey of the NRA in Div. 3L increased from 2006 to 2008. After declining to lower levels in 2011 and 2012 it increased to a time series high in 2017, declining substantially in 2018 and increased again in 2019. This survey was not conducted in 2020 due to the COVID-19 pandemic. Indices from 2021 and 2022 indicate a potential increase.

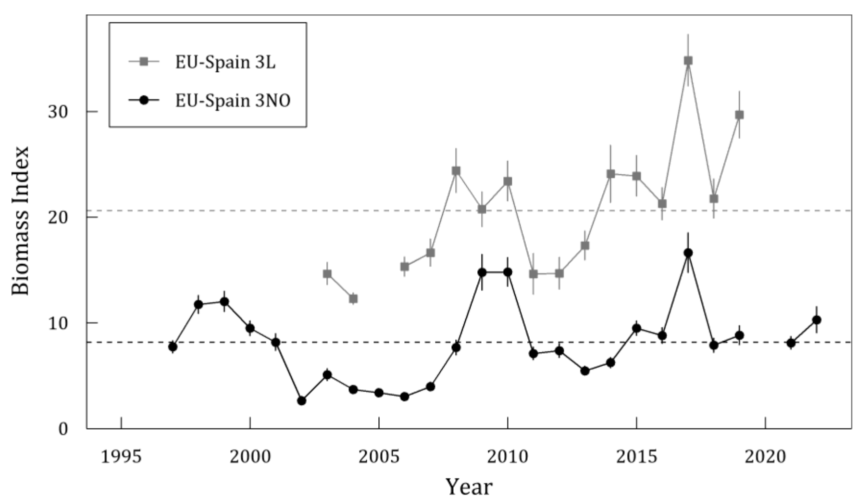


Figure 19.6. Greenland halibut in Subarea 2 + Divs. 3KLMNO: biomass index (±1 SE) from EU-Spain spring surveys in the NRA of Divs. 3NO and Div. 3L. Dotted lines represent time-series averages.

Summary of research survey data trends.

These surveys provide coverage of the majority of the spatial distribution of the stock and the area from which the majority of catches are taken. Over 1995-2007, indices from the majority of the surveys generally provided a consistent signal in stock biomass (Figure 19.7). Results since 2007 show greater divergence which complicates interpretation of overall status; the overall trend since 2007 is unclear.

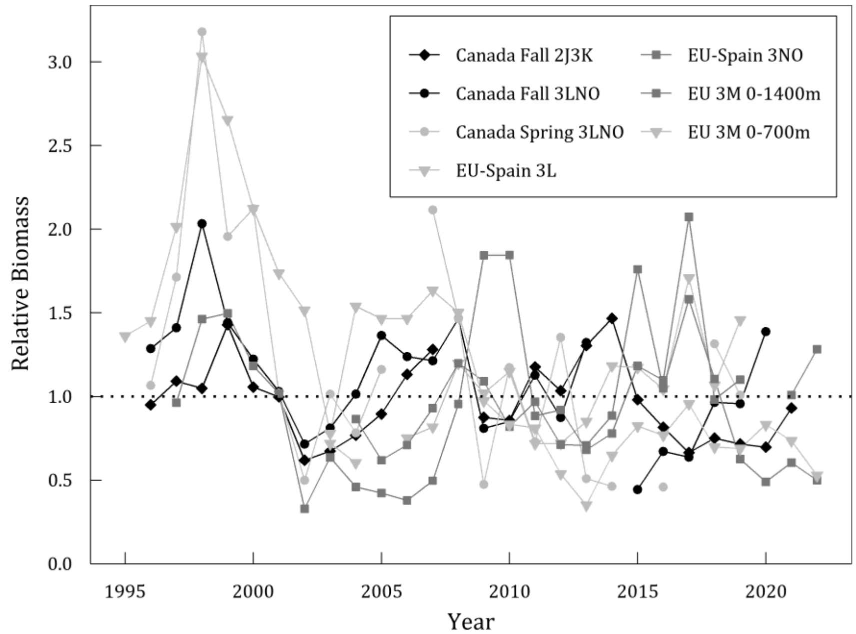


Figure 19.7. Greenland halibut in Subarea 2 + Divs. 3KLMNO: Relative biomass indices from Canadian autumn surveys in Divs. 2J3K, Canadian spring surveys in Divs. 3LNO, Canadian autumn surveys in Divs. 3LNO, EU survey of Div. 3M, and EU-Spain surveys of the NRA of Divs. 3NO. Each series is scaled to its average and the average line is shown as thin dotted line.

Recruitment from surveys.

Abundance indices at age 4 from surveys were examined as a measure of recruitment. Year classes from all surveys were above average between 1993-1994 and below average between 2009-2013. After three very large year classes of 2000-2002 in the EU survey of Div. 3M, abundance at age 4 fell below average for 12 years. There are some positive signals in recent years as estimates of the most recent year class (2015 to 2018) are near the time series average.

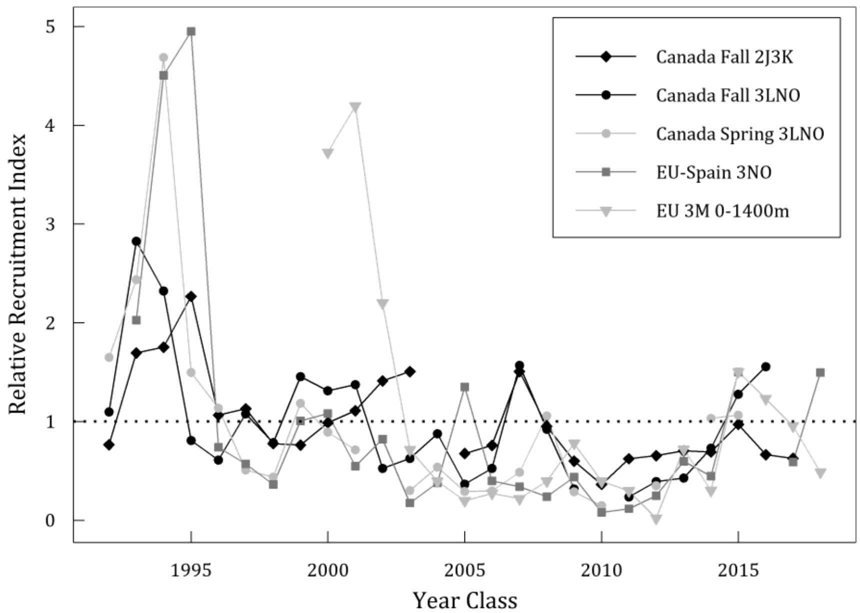


Figure 19.8. Greenland halibut in Subarea 2 + Divs. 3KLMNO: Relative recruitment indices from Canadian autumn surveys in Divs. 2J3K, Canadian spring surveys in Divs. 3LNO, and EU survey of Div. 3M. Each series is scaled to its average, which is shown using a dotted line.

c) Conclusion

Biomass: Survey indices since 2007 are variable which complicates the interpretation of overall status. The five surveys that are used in the HCR show differing trends over this period. Since 2020, only two out of six available survey indices was above its time series mean.

Recruitment: Results of all surveys indicate that recruitment (age 4) has recently returned to average levels following a series of below average years.

State of the stock: Though divergent trends in the survey indices complicate interpretations of the state of the stock, the survey indices are not deviating significantly from expectations under the accepted management procedure. Most survey indices are within the 95% probability envelopes from the base case SCAA (SCR Doc. 17/26; Figure 19.9) and revamped SSM simulations (SCR Doc. 20/47; Figure 19.10). The composite index suggests that the stock is stable and the most recent value is within the 80% probability envelope from both models.

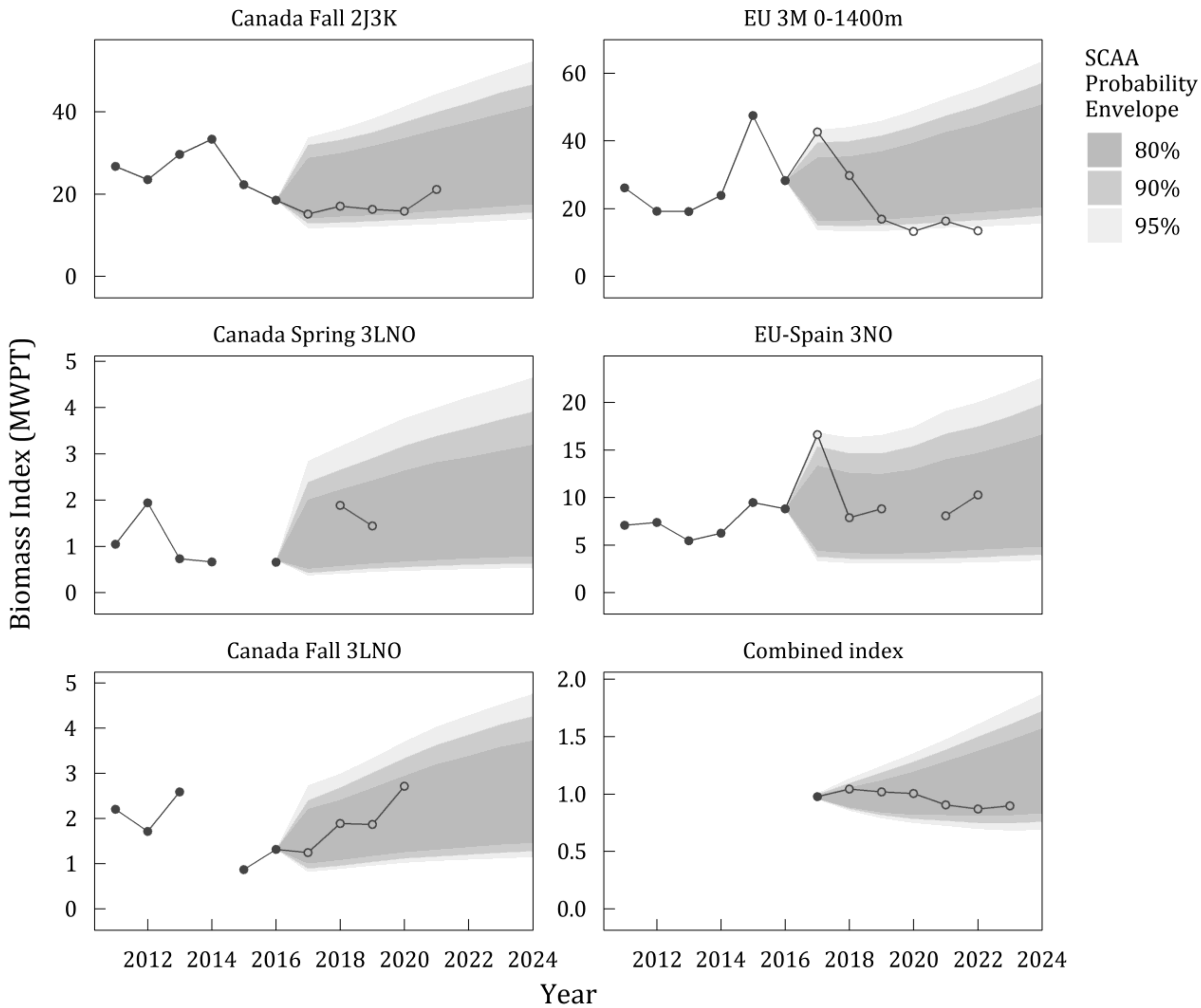


Figure 19.9. Greenland Halibut in Subarea 2 + Divs. 3KLMNO. Mean weight per tow from Canadian autumn surveys in Divs. 2J3K, Canadian spring surveys in Divs. 3LNO, Canadian autumn surveys in Divs. 3LNO, EU Flemish Cap surveys (to 1400m depth) in Div. 3M and EU-Spain surveys in 3NO. The figure also shows the combined index used in the target based component of the HCR. For the survey and combined indices, 80%, 90% and 95% probability envelopes from the SCAA base case simulation are shown. Index values observed from 2017 onward are shown using open circles.

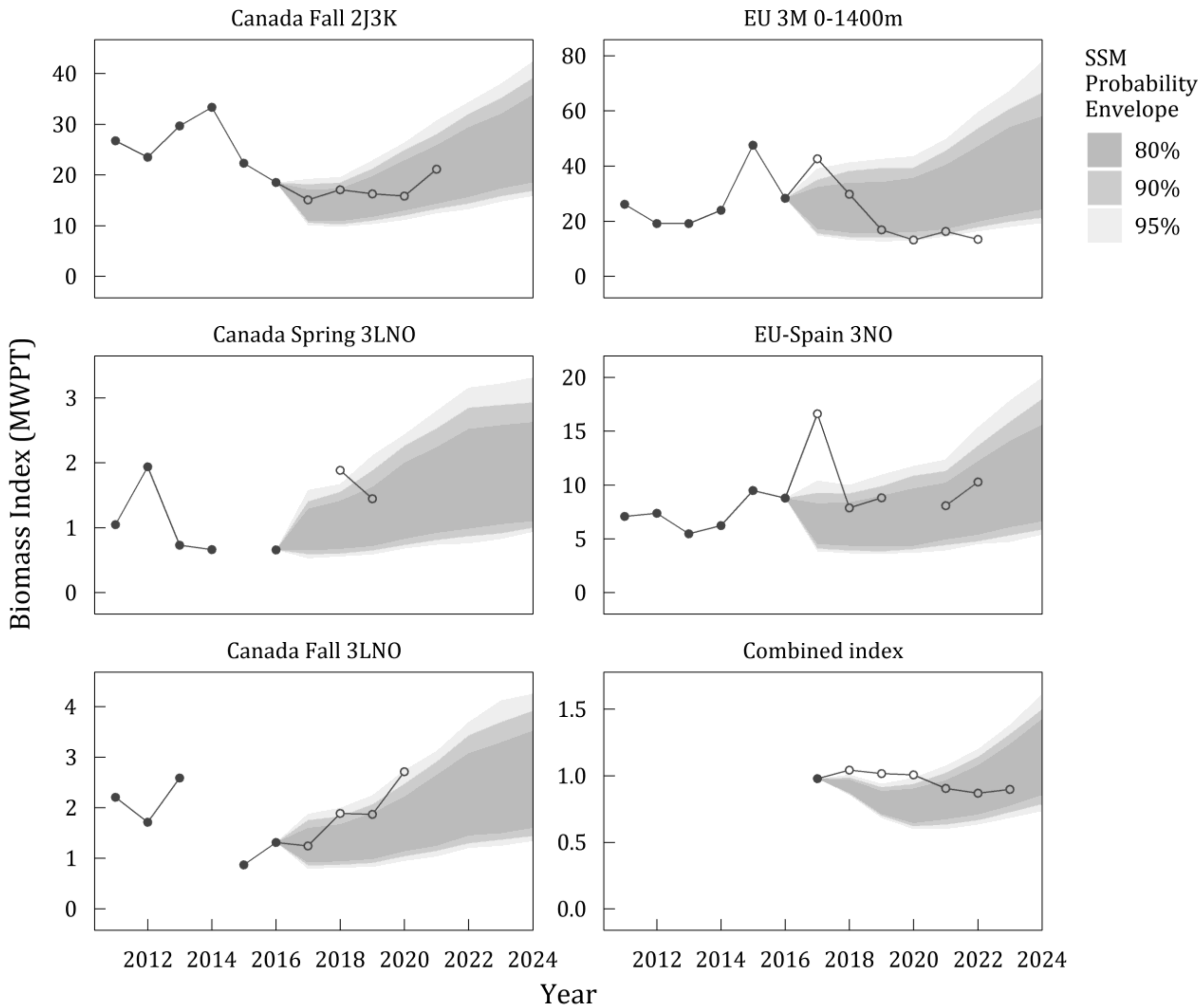


Figure 19.10. Greenland Halibut in Subarea 2 + Divs. 3KLMNO. Mean weight per tow from Canadian autumn surveys in Divs. 2J3K, Canadian spring surveys in Divs. 3LNO, Canadian autumn surveys in Divs. 3LNO, EU Flemish Cap surveys (to 1400m depth) in Div. 3M and EU-Spain surveys in 3NO. The figure also shows the combined index used in the target based component of the HCR. For the survey and combined indices, 80%, 90% and 95% probability envelopes from the SSM base case simulation are shown. Index values observed from 2017 onward are shown using open circles.

d) Research recommendation

The divergence in survey indices could be the result of movement of fish or because of transient age effects as a result of changing recruitment when different surveys cover differing age-ranges. STACFIS recommends that tagging and/or telemetry studies be undertaken to help elucidate movement of 2+3KLMNO Greenland halibut.

20. Northern shortfin squid (*Illex illecebrosus*) in Subareas 3+4

Deferred to the NAFO Annual Meeting in September 2023.

21. Splendid alfonsino (*Beryx splendens*) in Subareas 6

Interim Monitoring Report (SCR 15/06, 20/36)

a) Introduction

Alfonsino is an oceanic demersal species which forms distinct aggregations, at 300–950 m depth, on top of seamounts in the North Atlantic. Stock structure in the NAFO Area is unknown. Until more complete data on stock structure is obtained it is considered that separate populations live on each seamount of Div 6G.

Most published growth studies suggest maximum life span between 10 and 20 years. The observed variability in the maximum age / length depends on the geographic region. Sexual maturation was found to begin at age 2 and at a mean length of 18 cm. By age 5–6 years, all individuals were mature at 25–30 cm fork length. On the Corner Rise Seamounts, alfonsino were observed to spawn from May-June to August-September.

As a consequence of the species' association with seamounts, their life-history, and their aggregation behaviour, this species is easily overexploited and can only sustain low rates of exploitation.

Description of the Fishery

Historically, catches of alfonsino in the NAFO Regulatory Area (NRA) have been reported from Div. 6E-H, with the bulk of those catches from the Corner Rise area Div. 6G. The development of the Corner Rise fishery was initiated in 1976. Commercial aggregations of alfonsino on the Corner Rise have been found on three seamounts. Two of them named "Kükenthal" (also known as "Perspektivnaya") and "C-3" ("Vybornaya") are located in NRA. One more bank named "Milne Edwards" ("Rezervnaya") is located in the Central Western Atlantic.

Russian vessels fished these areas during some periods between 1976 and 1999 using pelagic trawls. A directed commercial fishery had been conducted since 2005 by Spanish vessels. Since 2006 virtually all the effort has been made in the Kükenthal seamount with pelagic trawl gear.

Fishery was closed in 2020 based on scientific advice that the stock was depleted.

b) Data Overview

i) Commercial fishery data

The Russian fishery started in 1976 with a catch of 10 200 t (Figure 21.1). Thereafter the catches ranged between 10 and 3 500 t. There was no fishing effort from 1988-1993, 1998 and 2000–2003. From 2005 to 2019, an alfonsino directed fishery in Kükenthal seamount was conducted by Spanish vessels using a pelagic trawl gear, where catches have ranged between 1 and 1 187 t, with no fishery in 2008. In the 2020-2022 period, the fishery has been closed and alfonsino catches were zero.

Recent catches (tonnes), effort and CPUE (Kg/hr fished) for the alfonsino fishery on Kükenthal Peak.

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Catch (t)	118	122	127	51	2	1	0	0	0	
Effort (days on ground)	15	13	16	12	8	8	0	0	0	
Effort (hours fished)	117	92	116	68	33	33	0	0	0	
CPUE (Kg/hour)	1009	1326	1095	750	61	42				
Effort (vessels)	2	2	1	1	1	1	0	0	0	

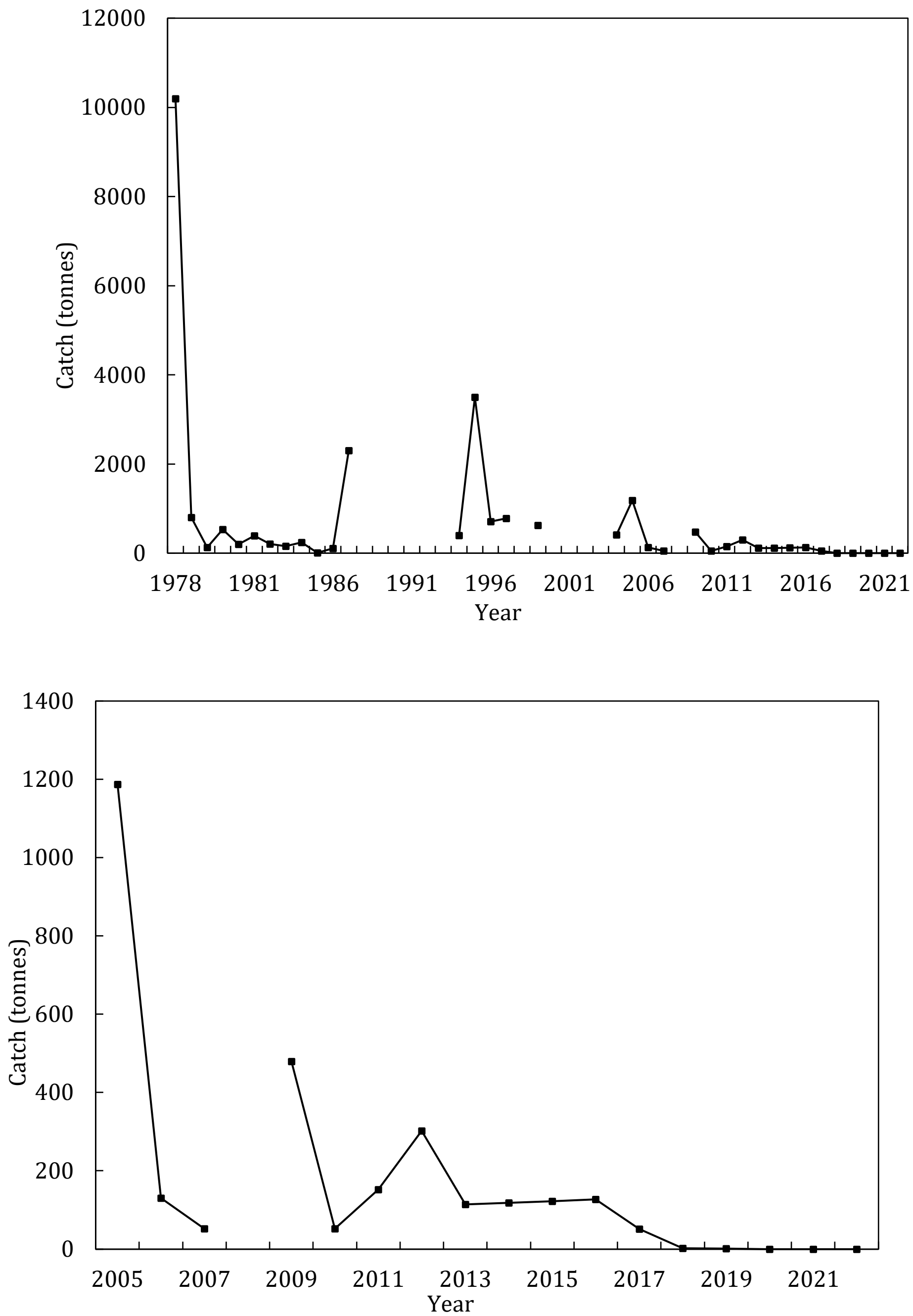


Figure 21.1. Alfonsino catches from Div. 6G. Top panel illustrates the whole catch series (1978-2022) and bottom panel illustrates the catch series since 2005.

The available commercial length distributions in percentage by year (2007, 2009, 2012 and 2016-2019) are presented in Figure 21.2. It can be observed in the period 2007-2018 that these length distributions have a slight decrease in the mode over time. Catches in this period are in the 30-50 cm range with a mode around or bigger than 40 cm. The 2019 length distribution shows a smaller range with a mode around 38 cm.

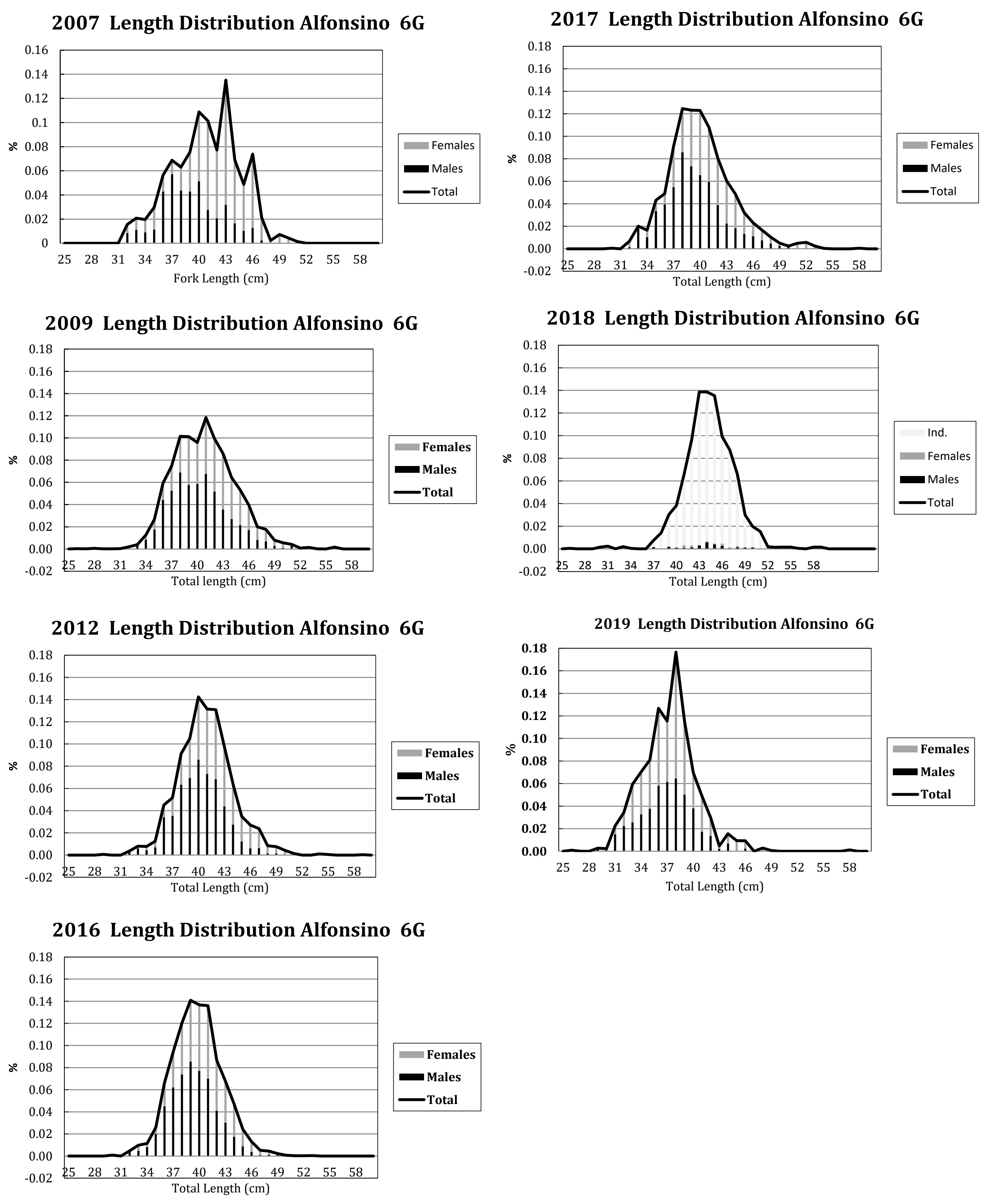


Figure 21.2. Length distributions of alfonsino catches from Div. 6G.

ii) Surveys

The only information available is the retrospective data from Russian research, exploratory and fishing cruises presented by Vinnichenko (2015). This data covers the period ending in 1995. The alfonsino biomass estimated on Corner Rise with this data was around 11,000-12,000 t. It should be taken into consideration that the data with a time limitation of mainly 20-30 years were used for the calculations mentioned above. Based on this information; the greatest biomass of mature alfonsino (distribution depths of 400-950 m) was registered on the "Kükenthal" seamount. On the "C-3" and "Milne Edwards" seamounts, the biomass was much lower.

An acoustic survey plan to collect alfonsino data and estimate its biomass has been presented to the SC for discussion (SCR 20/36). The SC concluded that the presented acoustic survey plan could be appropriate to recollect fishery independent information that can help the future evaluation of this stock.

c) Conclusion

No analytical or survey based assessment were possible. The most recent assessment, in 2019, concluded that the stock appears to be depleted. There is no new information available to update the evaluation carried out in 2019 and ratified in the IMR of 2020. Fishery was closed in 2020-2022 period.

d) Special comments

Periods of decline in catches have been observed several times in the past after several years of fishing. In the past, catches have increased after a period of low/no removals however, it is unknown if this corresponded to stock recovery. In the absence of new data (e.g. from an exploratory fishery or survey) there will be no basis to update the present assessment.

e) Research Recommendations

SC **recommended** in 2019 that *fishery independent information should be collected on this stock, and especially important given the fishery is closed and there will not be CPUE or any other fishery independent information to monitor whether there is any recovery.* For this purpose, an acoustic survey plan has been presented and discussed by the SC in 2021. The SC concluded that the presented acoustic survey plan could be appropriate to recollect fishery independent information that can help the future evaluation of this stock.

IV. OTHER MATTERS

1. FIRMS Classification for NAFO Stocks

Due to lack of time, STACFIS did not review the FIRMS classification of stocks managed by NAFO in June 2023. This task has been deferred to the September SC meeting.

2. Other Business

Workload issues have prevented SC from performing the necessary work related to the assessments of multiple NAFO stocks. For example, in 2021 SC emphasized the need for new analytical assessment models for both 3NO cod and 3LNO American plaice. However, under recent workload levels it has not been possible to conduct the framework meetings necessary to evaluate new models for these stocks. Considering these circumstances, along with the fact that both stocks are currently well below their respective biomass limit reference points, and that no new data are available in recent years from Canadian surveys, SC has decided that the scheduled 2024 assessments for both stocks will be deferred until such time as new data are available and new assessment models can be evaluated. In the meantime, interim monitoring reports will be produced annually for both stocks.

V. ADJOURNMENT

The meeting was adjourned on 15 June 2023.

APPENDIX V. AGENDA - SCIENTIFIC COUNCIL MEETING, 02 - 15 JUNE 2023

I. Opening (Scientific Council Chair: Karen Dwyer)
   1. Appointment of Rapporteur
   2 Presentation and Report of Proxy Votes
   3. Adoption of Agenda
   4. Attendance of Observers
   5. Appointment of Designated Experts
   6. Plan of Work
   7. Housekeeping issues

II. Review of Scientific Council Recommendations in 2022

III. Fisheries Environment (STACFEN Chair: Miguel Caetano)
   1. Opening
   2. Appointment of Rapporteur
   3. Adoption of Agenda
   4. Review of Recommendations in 2022
   5. Invited speaker
   6. Department of Fisheries and Oceans Canada, Oceans Science Branch, Marine Environmental Data Section (MEDS) Report for 2022
   7. Review of the physical, biological and chemical environment in the NAFO Convention Area during 2022
   8. Formulation of recommendations based on environmental conditions during 2022
   9. Other Matters
   10. Adjournment

IV. Publications (STACPUB Chair: Rick Rideout)
   1. Opening
   2. Appointment of Rapporteur
   3. Adoption of Agenda
   4. Review of Recommendations in 2022
   5. Review of Publications
      a) Annual Summary
         i) Journal of Northwest Atlantic Fishery Science (JNAFS)
         ii) Scientific Council Studies
         iii) Scientific Council Reports
   6. Other Matters
      a) Deadlines for report drafting
   7. Adjournment

V. Research Coordination (STACREC Chair: Diana González-Troncoso)
   1. Opening
   2. Appointment of Rapporteur
   3. Review of Recommendations in 2022
   4. Fishery Statistics
      a) Progress report on Secretariat activities in 2022/2023
         i) Presentation of catch estimates from the CESAG, daily catch reports and STATLANT 21A and 21B
   5. Research Activities
      a) Biological sampling
         i) Report on activities in 2022/2023
         ii) Report by National Representatives on commercial sampling conducted
         iii) Report on data availability for stock assessments (by Designated Experts)
      b) Biological surveys

i) Review of survey activities in 2022 and early 2023 (by National Representatives and Designated Experts)
ii) Surveys planned for 2023 and early 2024
c) Tagging activities
d) Other research activities
6. Review of SCR and SCS Documents
7. Other Matters
a) Update on Canadian survey comparative fishing and conversion factors for new vessels
b) Update on inshore tagging of Greenland Halibut in 0A

8. Adjournment

VI. Fisheries Science (STACFIS Chair: Mark Simpson)
I. Opening
II. General Review of Catches and Fishing Activity
III. Stock Assessments
1. Greenland halibut (*Reinhardtius hippoglossoides*) in SA 0+1 offshore (evaluate new data/full assessment)
2. Greenland halibut (*Reinhardtius hippoglossoides*) Div. 1A inshore Divs. 1BC inshore, Div. 1D inshore and Divs. 1EF inshore (monitor)
3. Demersal redfish and deep-sea redfish (*Sebastes* spp.) in SA 1 (full assessment)
4. Wolffish in SA 1 (full assessment)
5. Golden redfish (*Sebastes norvegicus* aka *S. marinus*) in Div. 3M (monitor)
6. Cod (*Gadus morhua*) in Div. 3M (full assessment)
7. Redfish (*Sebastes mentella* and *Sebastes fasciatus*) in Div. 3M (full assessment)
8. American plaice (*Hippoglossoides platessoides*) in Div. 3M (full assessment)
9. Cod (*Gadus morhua*) in Divs. 3NO (monitor)
10. Redfish (*Sebastes mentella* and *Sebastes fasciatus*) in Divs. 3L and 3N (monitor)
11. American plaice (*Hippoglossoides platessoides*) in Divs. 3LNO (monitor)
12. Yellowtail flounder (*Limanda ferruginea*) in Divs. 3LNO (full assessment)
13. Witch flounder (*Glyptocephalus cynoglossus*) in Divs. 3NO (monitor)
14. Capelin (*Mallotus villosus*) in Divs. 3NO (monitor)
15. Redfish (*Sebastes mentella* and *Sebastes fasciatus*) in Div. 3O (monitor)
16. Thorny skate (*Amblyraja radiata*) in Divs. 3LNO and Subdiv. 3PS (monitor)
17. White hake (*Urophycis tenuis*) in Divs. 3NO and Subdiv. 3PS (full assessment)
18. Roughhead grenadier (*Macrourus berglax*) in SA 2 and 3 (monitor)
19. Greenland halibut (*Reinhardtius hippoglossoides*) in SA 2 + Divs. 3KLMNO (under management strategy: (monitor, COM request #2)
20. Northern shortfin squid (*Illex illecebrosus*) in SA 3+4 (monitor)
21. Splendid alfonsino (*Beryx splendens*) in SA 6 (monitor)

IV. Other Matters
a) FIRMS Classification for NAFO Stocks
b) Other Business

V. Adjournment

VII. Management Advice and Responses to Special Requests (See Annex 1)
1. Fisheries Commission (Annex 1)
a) Request for Advice on TACs and Other Management Measures (Item 1, Annex 1)
For 2024
- cod in Div. 3M

For 2024 and 2025
- redfish in Div. 3M
- yellowtail flounder in Divs. 3LNO
- white hake in Divs. 3NO

For 2024, 2025 and 2026
- American plaice in Div. 3M

b) Monitoring of Stocks for which Multi-year Advice was provided in 2021 or 2022 (Item 1)
- golden redfish in Div. 3M
- cod in Divs. 3NO
- American plaice in Divs. 3LNO
- redfish in Divs. 3LN
- witch flounder in Divs. 3NO
- capelin in Divs. 3NO
- redfish (*Sebastes mentella* and *Sebastes fasciatus*) in Div. 3O
- alfonsino stocks in the NAFO Regulatory Area
- roughhead grenadier in Subareas 2 and 3
- thorny skate in Divs. 3LNO
- Northern shortfin squid in SA 3+4

c) Special Requests for Management Advice

i) Greenland halibut in SA2 + Divs. 3KLMNO: monitor, compute the TAC using the agreed HCR and determine whether exceptional circumstances are occurring (request #2, Commission priority)

ii) continue the evaluation of trawl surveys on VMEs (request #3)

iii) continue to advance work on the 2+3KLMNO Greenland halibut and 3LN redfish MSE processes (request #4, Commission priority)

iv) include summary information on TCI in stock summary sheets and ecosystem summary sheets. (request #5a)

v) work to support WG-EAFFM in exploring management considerations for occasions in which the 2TCI ecosystem reference point were to be exceeded and effective methods to communicate TCI-related information to the Commission, in particular for when 2TCI is, or expected to be exceeded (request #5b).

vi) complete the development of the 3LNO ecosystem summary sheet (ESS), advance as much as possible the development of the 3M ESS, and continue working, if capacity allows, toward undertaking a joint Workshop with ICES on reporting on North Atlantic ecosystems (request #5c).

vii) complete the re-assessment of previously recommended closures of 7a, 11a, 14a and 14b (request #6a)

viii) support the Secretariat in creating standardized data layers (request #6b)

ix) continue working with WG-EAFFM towards developing operational objectives for the protection of VMEs and biodiversity in the NRA (request #6c).

x) continue progression on the review of the NAFO PA Framework in accordance to the PAF review work plan (request #7, Commission priority)

xi) update the 3-5 year work plan (request #8)

xii) presentation of any new results from stock assessments and the scientific advice of pelagic *Sebastes mentella* (ICES Divisions V, XII and XIV; NAFO 1) (request #9)

xiii) include any new Canadian stock assessments for cod 2J3KL (Canada), witch flounder 2J3KL (Canada) as an annex to the SC's annual report (request #10)

xiv) ongoing analysis of the Flemish Cap cod fishery (request #11)

xv) potential impact of activities other than fishing in the Convention Area (request #12, conditional on CPs providing appropriate additional expertise to SC).

2. Coastal States
   a) Request by Denmark (Greenland) for Advice on Management in 2024 (Annex 2)
      i) Golden redfish, demersal deep-sea redfish, Atlantic wolffish and spotted wolfish in Subarea 1
      ii) Atlantic Wolffish and Spotted Wolffish in Subarea 1
      iii) Monitoring of Stocks for which Multi-year Advice was provided in 2021 or 2022;
         - Greenland halibut, inshore, Northwest Greenland (Item 3)

   b) Request by Canada and Greenland for Advice on Management in 2024 (Annex 2, Annex 3)
      i) Greenland Halibut, offshore (evaluate whether the data collected in 2022 is sufficient to reconsider the harvest recommendation for 2024).

VIII. Review of Future Meetings Arrangements
1. Scientific Council shrimp meeting, 11 to 15 September 2023
2. Scientific Council, 18 to 22 September 2023
3. WG-ESA, 14 to 23 November 2023
4. Scientific Council, June 2024
5. Scientific Council (in conjunction with NIPAG), 2024
6. Scientific Council, Sep. 2024
7. WG-ESA, Nov. 2024
8. NAFO/ICES Joint Groups
   a) NIPAG
   b) WG-DEC
   c) WG-HARP

IX. Arrangements for Special Sessions
1. Topics for future Special Sessions

X. Meeting Reports
1. Working Group on Ecosystem Science and Assessment (WG-ESA), 15-24 Nov. 2022
2. Report from ICES-NAFO Working Group on Deepwater Ecosystems (WG-DEC), 16-20 May 2022
3. Meetings attended by the Secretariat

XI. Review of Scientific Council Working Procedures/Protocol
1. General Plan of Work for September 2023 Annual Meeting
2. Priority actions for Scientific Council from the Performance Review Panel WG (adopted by the NAFO Commission in September 2019):

XII. Other Matters
1. Designated Experts
2. Election of Chairs
3. Budget items
4. Other Business
   a) NAFO internship program 2024

XIII. Adoption of Committee Reports
1. STACFEN

2. STACREC
3. STACPUB
4. STACFIS

XIV. Scientific Council Recommendations to Commission

XV. Adoption of Scientific Council Report

XVI. Adjournment

ANNEX 1. COMMISSION'S REQUEST FOR SCIENTIFIC ADVICE ON MANAGEMENT IN 2024 AND BEYOND OF CERTAIN STOCKS IN SUBAREAS 2, 3 AND 4 AND OTHER MATTERS

(from SCS Doc. 23/01)

Following a request from the Scientific Council, the Commission agreed that items 1, 2, 4 and 7 should be the priority for the June 2023 Scientific Council meeting subject to resources and COVID-related restrictions.

1. The Commission requests that the Scientific Council provide advice for the management of the fish stocks below according to the assessment frequency presented below. In keeping with the NAFO Precautionary Approach Framework (FC Doc. 04/18), the advice should be provided as a range of management options and a risk analysis for each option without a single TAC recommendation. The Commission will decide upon the acceptable risk level in the context of the entirety of the SC advice for each stock guided and as foreseen by the Precautionary Approach.

Yearly basis	Two-year basis	Three-year basis
Cod in Div. 3M Northern shrimp in Div. 3M	Redfish in Div. 3M Thorny skate in Div. 3LNO Witch flounder in Div. 3NO Redfish in Div. 3LN White hake in Div. 3NO Yellowtail flounder in Div. 3LNO Northern shrimp in Div. 3LNO	American plaice in Div. 3LNO American plaice in Div. 3M Northern shortfin squid in SA 3+4 Redfish in Div. 3O Cod in Div. 3NO

Advice should be provided using the guidance provided in **Annexes A or B as appropriate**, or using the predetermined Harvest Control Rules in the cases where they exist (currently Greenland halibut 2+3KLMNO). However, for 3M shrimp supplementary advice in terms of fishing-days should also be considered to the extent feasible.

To implement this schedule of assessments, the Scientific Council is requested to conduct a full assessment of these stocks as follows:

- In 2023, advice should be provided for 2024 for Cod in Div. 3M and Northern shrimp in Div. 3M.
- With respect to Northern shrimp in Div. 3M, Scientific Council is requested to provide its advice to the Commission prior to the 2023 Annual Meeting based on the survey data up to and including 2023.
- In 2023, advice should be provided for 2024 and 2025 for: Redfish in Div. 3M, White hake in Div. 3NO, Yellowtail flounder in Div. 3LNO and Northern shrimp in Div. 3LNO.
- In 2023, advice should be provided for 2024, 2025 and 2026 for: American plaice in Div. 3M.

The Commission also requests the Scientific Council to continue to monitor the status of all other stocks annually and, should a significant change be observed in stock status (e.g. from surveys) or in bycatch in other fisheries, provide updated advice as appropriate.

2. The Commission requests the Scientific Council to monitor the status of Greenland halibut in Subarea 2 + Div 3KLMNO annually to compute the TAC using the agreed HCR and determine whether exceptional

circumstances are occurring. If exceptional circumstances are occurring, the exceptional circumstances protocol will provide guidance on what steps should be taken.

3. The Commission requests that Scientific Council continue its evaluation of the impact of scientific trawl surveys on VME in closed areas and the effect of excluding surveys from these areas on stock assessments.
4. The Commission requests that Scientific Council continue to advance work on the 2+3KLMNO Greenland halibut and 3LN redfish MSE processes during 2022-2023, as per the approved 2023 workplan [COM-SC RBMS WP 22/07], in particular :
   a. Review and finalize the data series to be used for the two MSEs;
   b. For the Greenland Halibut MSE: (1) propose, review and finalize Operating Models (OMs) to be used; and (2) Test Candidate Management Procedures (CMPs) to support the RBMS recommendation of an HCR to the Commission; and
   c. For the 3LN Redfish MSE: (1) Proposal of an initial review of Operating Models; and (2) work to support the development of performance statistics and CMPs.
5. The Commission requests that the Scientific Council continue to work on tiers 1 and 2 of the Roadmap, specifically to:
   a. Include on a regular basis summary information on TCI in stock summary sheets (including indications of other NAFO managed stocks within the corresponding guild) and ecosystem summary sheets.
   b. Work to support WG-EAFFM in exploring:
      i. Management considerations for occasions in which the 2TCI ecosystem reference point were to be exceeded, similar to those when exceptional circumstances are triggered within MSE.
      ii. Effective methods to communicate TCI-related information to the Commission, in particular for when 2TCI is, or expected to be exceeded.
   c. Complete the development of the 3LNO ecosystem summary sheet (ESS), advance as much as possible the development of the 3M ESS, and continue working, if capacity allows, toward undertaking a joint Workshop with ICES (International Council for the Exploration of the Sea) on reporting on North Atlantic ecosystems.
6. In relation to the habitat impact assessment component of the Roadmap (VME and SAI analyses), the Commission requests that Scientific Council to:
   a. Complete the re-assessment of its previously recommended closures of 7a, 11a, 14a and 14b, incorporating catch and effort data for fisheries of shrimp from 2020 and 2021 into the fishing impact assessments. This work is needed for the 2023 WG-EAFFM meeting;
   b. Support the Secretariat in creating standardized data layers (using GIS), and products with supporting documentation (including metadata) for periodic reassessment purposes required to support the implementation of the NAFO Roadmap towards an Ecosystem Approach; and
   c. Continue working with WG-EAFFM towards developing operational objectives for the protection of VMEs and biodiversity in the NRA.
7. The Commission requests Scientific Council to continue progression on the review of the NAFO PA Framework in accordance to the PAF review work plan approved in 2020 and revised in 2022 (NAFO COM-SC Doc. 20-04), specifically:
   a. Develop a small set of revised PA frameworks based on the conclusions of the first PA Framework workshop to inform RBMS in proposing a draft revised framework in 2023; and
   b. Apply in an illustrative way the revised PA frameworks to selected NAFO stocks, and consider how the SC advice may have differed under the revised PA Frameworks to inform RBMS in proposing a draft revised framework in 2023
8. The Commission requests Scientific Council to update the 3-5 year work plan, which reflects requests arising from the 2022 Annual Meeting, other multi-year stock assessments and other scientific inquiries already planned for the near future. The work plan should identify what resources are necessary to successfully address these issues, gaps in current resources to meet those needs and proposed prioritization by the Scientific Council of upcoming work based on those gaps.
9. The Commission requests that any new results from stock assessments and the scientific advice of Pelagic Sebastes mentella (ICES Divisions V, XII and XIV; NAFO 1) to be presented to the Scientific Council, and

request the Scientific Council to prepare a summary of these assessments to be included in its annual report.

10. The Commission requests that any new Canadian stock assessments for Cod 2J3KL and Witch flounder 2J3KL be included as an annex to the Scientific Council's annual report.
11. The Commission requests Scientific Council, jointly with the Secretariat, to conduct ongoing analysis of the Flemish Cap cod fishery data by 2023 in order to:
    a. monitor the consequences of the management decisions (including the analysis of the redistribution of the fishing effort along the year and its potential effects on ecosystems, the variation of the cod catch composition in lengths/ages, and the bycatch levels of other fish species, benthos in general, and VME taxa in particular); and
    b. carry out any additional monitoring that would be required, including Div. 3M cod caught as bycatch in other fisheries during the closed period.
12. The Commission requests Secretariat and the Scientific Council with other international organizations, such as the FAO and ICES to inform the Scientific Council's work related to the potential impact of activities other than fishing in the Convention Area. This would be conditional on CPs providing appropriate additional expertise to Scientific Council.

ANNEX A: Guidance for providing advice on Stocks Assessed with an Analytical Model

The Commission request the Scientific Council to consider the following in assessing and projecting future stock levels for those stocks listed above. These evaluations should provide the information necessary for the Fisheries Commission to consider the balance between risks and yield levels, in determining its management of these stocks:

1. For stocks assessed with a production model, the advice should include updated time series of:

- Catch and TAC of recent years
- Catch to relative biomass
- Relative Biomass
- Relative Fishing mortality
- Stock trajectory against reference points
- And any information the Scientific Council deems appropriate.

Stochastic short-term projections (3 years) should be performed with the following constant fishing mortality levels as appropriate:

- For stocks opened to direct fishing: 2/3 F_{msy}, 3/4 F_{msy}, 85% F_{msy}, 90% F_{msy},95% F_{msy}, F_{msy} 0.75 X $F_{status\ quo}$, $F_{status\ qu}$,1.25 X Status quo, F=0; TAC Status quo, 85% TAC Status quo, 90% TAC Status quo, 95% TAC Status quo
- For stocks under a moratorium to direct fishing: $F_{status\ quo}$, F = 0.

The first year of the projection should assume a catch equal to the agreed TAC for that year.

Results from stochastic short-term projection should include:

- The 10%, 50% and 90% percentiles of the yield, total biomass, spawning stock biomass and exploitable biomass for each year of the projections
- The risks of stock population parameters increasing above or falling below available biomass and fishing mortality reference points. The table indicated below should guide the Scientific Council in presenting the short-term projections.

				Limit reference points														
				P(F>F_{lim})			P(B<B_{lim})				P(F>F_{msy})			P(B<B_{msy})				P(B2026> B2023)
F in 2023 and following years*	Yield 2023 (50%)	Yield 2024 (50%)	Yield 2025 (50%)	2023	2024	2025	2023	2024	2025		2023	2024	2025	2023	2024	2025		
2/3 F_{msy}	t	t	t	%	%	%	%	%	%		%	%	%	%	%	%		%
3/4 F_{msy}	t	t	t	%	%	%	%	%	%		%	%	%	%	%	%		%
85% F_{msy}	t	t	t	%	%	%	%	%	%		%	%	%	%	%	%		%
90% F_{msy}																		
95% F_{msy}																		
F_{msy}	t	t	t	%	%	%	%	%	%		%	%	%	%	%	%		%
0.75 X $F_{status\ quo}$	t	t	t	%	%	%	%	%	%		%	%	%	%	%	%		%
$F_{status\ quo}$	t	t	t	%	%	%	%	%	%		%	%	%	%	%	%		%
1.25 X $F_{status\ quo}$	t	t	t	%	%	%	%	%	%		%	%	%	%	%	%		%
F=0	t	t	t	%	%	%	%	%	%		%	%	%	%	%	%		%
$TAC_{status\ quo}$																		
85% $TAC_{status\ quo}$																		
90% $TAC_{status\ quo}$																		
95% $TAC_{status\ quo}$																		

2. For stock assessed with an age-structured model, information should be provided on stock size, spawning stock sizes, recruitment prospects, historical fishing mortality. Graphs and/or tables should be provided for all of the following for the longest time-period possible:

- historical yield and fishing mortality;
- spawning stock biomass and recruitment levels;
- Stock trajectory against reference points

And any information the Scientific Council deems appropriate
Stochastic short-term projections (3 years) should be performed with the following constant fishing mortality levels as appropriate:

- For stocks opened to direct fishing: $F_{0.1}$, F_{max}, 2/3 F_{max}, 3/4 F_{max}, 85% F_{max}, 75% $F_{status\ quo}$, $F_{status\ quo}$, 125% $F_{status\ quo}$,
- For stocks under a moratorium to direct fishing: $F_{status\ quo}$, F = 0.
  The first year of the projection should assume a catch equal to the agreed TAC for that year.

Results from stochastic short-term projection should include:

- The 10%, 50% and 90% percentiles of the yield, total biomass, spawning stock biomass and exploitable biomass for each year of the projections
- The risks of stock population parameters increasing above or falling below available biomass and fishing mortality reference points. The table indicated below should guide the Scientific Council in presenting the short-term projections.

				Limit reference points $P(F.>F_{lim})$			$P(B<B_{lim})$			$P(F>F0.1)$			$P(F>F_{max})$			P(B2026 > B2023)
F in 2023 and following years*	Yield 2023	Yield 2024	Yield 2025	2023	2024	2025	2023	2024	2025	2023	2024	2025	2023	2024	2025	
F0.1	t	t	t	%	%	%	%	%	%	%	%	%	%	%	%	%
F_{max}	t	t	t	%	%	%	%	%	%	%	%	%	%	%	%	%
66% F_{max}	t	t	t	%	%	%	%	%	%	%	%	%	%	%	%	%
75% F_{max}	t	t	t	%	%	%	%	%	%	%	%	%	%	%	%	%
85% F_{max}	t	t	t	%	%	%	%	%	%	%	%	%	%	%	%	%
0.75 X $F_{status\ quo}$	t	t	t	%	%	%	%	%	%	%	%	%	%	%	%	%
$F_{status\ quo}$	t	t	t	%	%	%	%	%	%	%	%	%	%	%	%	%
1.25 X $F_{status\ quo}$	t	t	t	%	%	%	%	%	%	%	%	%	%	%	%	%

ANNEX B. Guidance for providing advice on Stocks Assessed without a Population Model

For those resources for which only general biological and/or catch data are available, few standard criteria exist on which to base advice. The stock status should be evaluated in the context of management requirements for long-term sustainability and the advice provided should be consistent with the precautionary approach.

The following graphs should be presented, for one or several surveys, for the longest time-period possible:

a. time trends of survey abundance estimates
b. an age or size range chosen to represent the spawning population
c. an age or size-range chosen to represent the exploited population
d. recruitment proxy or index for an age or size-range chosen to represent the recruiting population.
e. fishing mortality proxy, such as the ratio of reported commercial catches to a measure of the exploited population.
f. Stock trajectory against reference points

And any information the Scientific Council deems appropriate.

ANNEX 2. DENMARK (ON BEHALF OF GREENLAND) REQUESTS FOR SCIENTIFIC ADVICE ON MANAGEMENT IN 2024 AND BEYOND OF CERTAIN STOCKS IN SUBAREA 0 AND 1

(from SCS Doc. 23/03)

Denmark (on behalf of Greenland) hereby requests for scientific advice on management in 2024 of certain stocks in NAFO Subareas 0 and 1. Denmark (on behalf of Greenland) requests the Scientific Council for advice on the following species:

1. Golden Redfish and Demersal Deep-Sea Redfish

Advice on Golden redfish (*Sebastes marinus*) and demersal deep-sea redfish (*Sebastes mentella*) in Subarea 1 was in June 2020 given for 2021-2023. The Scientific Council is requested to provide advice on appropriate TAC levels for 2024 to 2026.

2. Atlantic Wolffish and Spotted Wolffish

Advice on Atlantic Wolffish (*Anarhichas lupus*) and Spotted Wolffish (*Anarhichas minor*) in Subarea 1 was in June 2020 given for 2021-2023. The Scientific Council is requested to provide advice on appropriate TAC levels for 2024 to 2026.

3. Greenland Halibut, Offshore

Advice on Greenland Halibut, Offshore in Subareas 0 and 1 was in 2022 given for 2023 and 2024. The Scientific Council is requested to evaluate whether the data collected in 2022 is sufficient to reconsider the harvest recommendation for 2024. If so, the Scientific Council is requested to provide updated advice on appropriate TAC levels for 2024, taking the new data into account.

4. Greenland Halibut, Inshore, West Greenland

Advice on the inshore stocks of Greenland Halibut in Subarea 1 was in 2022 given for 2023-2024. The Scientific Council is requested to continue its monitoring of the above stocks and provide updated advice in the event of significant changes in stock levels. Scientific Council are also requested to evaluate the performance of an appropriate analytical assessment model and its perception of the stock trajectory.

5. Northern Shrimp, West Greenland

The Scientific Council is requested, before October, to provide advice on the scientific basis for management of Northern Shrimp (*Pandalus borealis*) in Subareas 0 and 1 in 2024. The advice is requested to be in line with Greenland's stated management objective of maintaining a mortality risk of no more than 35% in the first-year prediction and to provide a catch option table ranging with 5,000 tonne increments. Future catch options should be provided for as many yearsas data allows for.

6. Northern Shrimp, East Greenland

The Scientific Council is in cooperation with ICES requested to provide advice on the scientific basis for management of Northern Shrimp (*Pandalus borealis*) in Denmark Strait and adjacent waters east of southern Greenland in 2023 and for as many years ahead as data allows for.

ANNEX 3. REQUESTS FROM CANADA FOR ADVICE ON MANAGEMENT IN 2024

(from SCS Doc. 23/04)

Canada would like to submit its request to the Scientific Council for advice on the following species:

1. Greenland halibut (Subarea 0 + 1 (offshore)

In 2022, advice on Greenland Halibut in Subareas 0 and 1 (offshore) was given for 2023 and 2024. The Scientific Council is requested to evaluate whether the data collected in 2022 is sufficient to reconsider the harvest recommendation for 2024. If so, the Scientific Council is requested to provide an updated assessment of status and trends in the total stock area throughout its range and to advise on the 2024 TAC level.

2. Shrimp (Subarea 1 and Division 0A)

Canada requests the Scientific Council to consider the following options in assessing and projecting future stock levels for Shrimp in Subarea 1 and Division 0A:

The status of the stock should be determined and risk-based advice provided for catch options corresponding to Z_{msy}, in 5,000-10,000t increments (subject to the discretion of Scientific Council), with forecasts for 2024 to 2026. These options should be evaluated in relation to Canada's Harvest Strategy (2022 revised version attached) and NAFO's Precautionary Approach Framework, and presented in the form of risk analyses related to B_{msy}, 80% B_{msy}, B_{lim} (30% B_{msy}) and Z_{msy}.

Presentation of the results should include graphs and/or tables related to the following:

- Historical and current yield, biomass relative to B_{msy}, total mortality relative to Z_{msy}, and recruitment (or proxy) levels for the longest time period possible;
- Total mortality (Z) and fishable biomass for a range of projected catch options (as noted above) for the years 2024 to 2026. Projections should include both catch options and a range of effective cod predation biomass levels considered appropriate by the Scientific Council. Results should include risk analyses of falling below: B_{MSY}, 80% B_{msy} and B_{lim} (30% B_{msy}), and of being above Z_{msy} based on the 3-year projections, consistent with the Harvest Decision Rules in Canada's Harvest Strategy; and
- Total area fished for the longest time period possible.

Please provide the advice relative to Canada's Harvest Strategy as part of the formal advice (i.e., grey box in the advice summary sheet).

APPENDIX VI: EXPERTS FOR PRELIMINARY ASSESSMENT OF CERTAIN STOCKS

Designated Experts for 2023:

From the Science Branch, Northwest Atlantic Fisheries Centre, Department of Fisheries and Oceans, St. John's, Newfoundland & Labrador, Canada

Cod in Div. 3NO	Rick Rideout	rick.rideout@dfo-mpo.gc.ca
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Redfish Div. 3LN	Andrea Perreault	andrea.perreault@dfo-mpo.gc.ca
American Plaice in Div. 3LNO	Katherine Skanes	katherine.skanes@dfo-mpo.gc.ca
Witch flounder in Div. 3NO	Dawn Maddock Parsons	dawn.parsons@dfo-mpo.gc.ca
Yellowtail flounder in Div. 3LNO	Dawn Maddock Parsons	dawn.parsons@dfo-mpo.gc.ca
Greenland halibut in SA 2+3KLMNO	Paul Regular	paul.regular@dfo-mpo.gc.ca
Northern shrimp in Div. 3LNO	Nicolas Le Corre	nicolas.lecorre@dfo-mpo.gc.ca

From the Instituto Español de Oceanografia, Vigo (Pontevedra), Spain

Roughhead grenadier in SA 2+3	Fernando Gonzalez-Costas	fernando.gonzalez@ieo.csic.es
Splendid alfonsino in Subarea 6	Fernando Gonzalez-Costas	fernando.gonzalez@ieo.csic.es
Cod in Div. 3M	Irene Garrido Fernández	irene.garrido@ieo.csic.es
Northern Shrimp in Div. 3M	Jose Miguel Casas Sanchez	mikel.casas@ieo.csic.es

From the Instituto Nacional de Recursos Biológicos (INRB/IPMA), Lisbon, Portugal

American plaice in Div. 3M	Ricardo Alpoim	ralpoim@ipma.pt
Golden redfish in Div. 3M	Ricardo Alpoim	ralpoim@ipma.pt
Redfish in Div. 3M	Ricardo Alpoim	ralpoim@ipma.pt

From the Greenland Institute of Natural Resources, Nuuk, Greenland

Greenland halibut in SA 0+1	Adriana Nogueira	adno@natur.gl
Demersal Redfish in SA1	Rasmus Nygaard	rany@natur.gl
Wolfish in SA1	Rasmus Nygaard	rany@natur.gl
Greenland halibut in Div. 1 inshore	Rasmus Nygaard	rany@natur.gl
Northern shrimp in SA 0+1	AnnDorte Burmeister	anndorte@natur.gl
Northern shrimp in Denmark Strait	Tanja B. Buch	TaBb@natur.gl

From Knipovich Polar Research Institute of Marine Fisheries and Oceanography (PINRO), Russian Federation

Capelin in Div. 3NO	Konstantin Fomin	fomin@pinro.ru

From National Marine Fisheries Service, NEFSC, Woods Hole, Massachusetts, United States of America

Northern Shortfin Squid in SA 3 & 4	Lisa Hendrickson	lisa.hendrickson@noaa.gov
Thorny skate in Div. 3LNO	Katherine Sosebee	katherine.sosebee@noaa.gov
White hake in Div. 3NO	Katherine Sosebee	katherine.sosebee@noaa.gov

APPENDIX VII. LIST OF SCR AND SCS DOCUMENTS

SCR Documents			
Serial No.	**Doc. No.**	**Author(s)**	**Title**
N7371	SCR Doc. 23-01	Perreault A., Rogers B., Varkey D.	Data selection for 3LN redfish in preparation for an updated management strategy evaluation
N7379	SCR Doc. 23-02	Irene Garrido, Diana González-Troncoso, Fernando González-Costas, Esther Román and Lupe Ramilo	Results of the Spanish survey in NAFO Div. 3NO
N7381	SCR Doc. 23-03	Diana González-Troncoso, Sonia Rábade, Jose Miguel Casas Sánchez, Irene Garrido, Mariña Fabeiro, Esther Román and Ricardo Alpoim	Results from Bottom Trawl Survey on Flemish Cap of June-July 2022
N7384	SCR Doc. 23-04	Luis Ridao Cruz and Petur Steingrund	Survey results of the longline survey on NAFO Division 3M
N7387	SCR Doc. 23-05	John Mortensen	Report on hydrographic conditions off West Greenland June-July 2022
N7392	SCR Doc. 23-06	Rideout, R.M., Regular, P.M.	Examining inconsistencies in the NAFO Scientific Council traffic light approach used to provide science advice, and the development of consistent rules within a Shiny Application
N7394	SCR Doc. 23-07	Paul Regular	Data proposed for use in Operating Models for the 2023 Management Strategy Evaluation Review for Greenland Halibut in NAFO Subarea 2 and Divisions 3KLMNO
N7395	SCR Doc. 23-08	RA Rademeyer and DS Butterworth	Updated SCAA Base Case Assessment and sensitivities for Greenland Halibut
N7396	SCR Doc. 23-09	Irene Garrido, Diana González-Troncoso and Fernando González-Costas	Assessment of the Cod Stock in NAFO Division 3M
N7397	SCR Doc. 23-10REV_ADD	RA Rademeyer and DS Butterworth	Results for Greenland Halibut Candidate Management Procedure Trials
N7398	SCR Doc. 23-11	Irene Garrido, Fernando González-Costas and Diana González-Troncoso	Analysis of the Flemish Cap cod fishery: monitoring of the consequences of the management decisions
N7399	SCR Doc. 23-12	Adriana Nogueira1, Daniel Estévez-Barcia1	Results for Greenland halibut survey in NAFO Divisions 1C-1D for the period 1997-2017, 2019 and 2022
N7400	SCR Doc. 23-13	Rasmus Nygaard, Søren L. Post, Anja Retzel, Karl Zinglersen, Lars Heilmann, Sofie R. Jeremiassen, Signe Jeremiassen, Louise Mølgaard and Jørgen Sethsen.	Biomass and Abundance of Demersal Fish Stocks in the Nuuk fjord and Ameralik fjord derived from the GINR Shrimp and fish inshore (SFI) survey.
N7401	SCR Doc. 23-14	Nick Gullage, Paul M. Regular, Divya Varkey	Update of Base Case SSM and Investigation of Impacts of EU-Spain 3L Survey Data for Greenland Halibut in NAFO Subarea 2 and Divisions 3KLMNO - DRAFT
N7402	SCR Doc. 23-15	N. Gullage, P.M. Regular, D. Varkey	Exploring the effect of missing survey indices on TAC for Greenland halibut in NAFO Subarea 2 and Divisions 3KLMNO
N7403	SCR Doc. 23-16	D. Maddock Parsons, Katherine Skanes and Rick Rideout.	2023 Assessment of Yellowtail Flounder in NAFO Divisions 3LNO
N7404	SCR Doc. 23-17	D. Bélanger, G. Maillet, P. Pepin	Biogeochemical oceanographic conditions in the Northwest Atlantic (NAFO subareas 2-3-4) during 2022

N7405	SCR Doc. 23-18	Paula Fratantoni	Hydrographic Conditions on the Northeast United States Continental Shelf in 2022 – NAFO Subareas 5 and 6
N7406	SCR Doc. 23-19	Trajce Alcinov	NAFO STACFEN MEDS Report 2022
N7407	SCR Doc. 23-20	Nygaard and Nogueira	Biomass and Abundance of Demersal Fish Stocks off West and East Greenland estimated from the Greenland Institute of Natural resources (GINR) Shrimp and Fish Survey (SFW), 1990-2020, and 2022
N7408	SCR Doc. 23-21	Rasmus Nygaard	Trawl and gillnet survey results from the Disko Bay, NAFO Division 1A Inshore
N7409	SCR Doc. 23-22	Rasmus Nygaard	Survey results from the Uummannaq gillnet survey in NAFO Division 1A inshore.
N7410	SCR Doc. 23-23	Irene Garrido Dawn Parsons, Fernando González-Costas and Diana González-Troncoso	Precautionary Approach Review progress: Different advices produced under the alternative PA frameworks for example stocks (3M cod and 3LNO yellowtail flounder)
N7411	SCR Doc. 23-24	R. Alpoim	An Assessment of American Plaice (Hippoglossoides platessoides) in NAFO Division 3M
N7413	SCR Doc. 23-25	P. Gonçalves, R. Alpoim, A. Ávila de Melo	Redfish Div. 3M: Biological Reference Points
N7414	SCR Doc. 23-26	Perreault A., Hatefi F.	Preliminary operating models for the 3LN redfish management strategy evaluation
N7415	SCR Doc. 23-27	Perreault A., Hatefi F.	Supplementary Materials for: Preliminary operating models for the 3LN redfish management strategy evaluation
N7417	SCR Doc. 23-28	Rasmus Nygaard	Commercial data for the Greenland halibut fishery in Uummannaq
N7418	SCR Doc. 23-29	Kevin J. Hedges	Report on Greenland halibut (Reinhardtius hippoglossoides) caught during the 2022 trawl survey in Subarea 0
N7419	SCR Doc. 23-30	Rasmus Nygaard	Commercial data for the Greenland halibut fishery in the Upernavik area.
N7420	SCR Doc. 23-31	Adriana Nogueira, AnnDorte Burmeister, Kevin J. Hedges, Alex Kokkalis	Applying a stochastic surplus production model (SPiCT) to the Greenland halibut Sub. 0+1 offshore
N7421	SCR Doc. 23-32	A. Nogueira, H. Christiansen and K.J. Hedges	Comparison of vessels used for the the 1A-F west Greenland shelf surveys
N7422	SCR Doc. 23-33	Rasmus Nygaard	Commercial data for the Greenland halibut fishery in the Disko Bay.
N7423	SCR Doc. 23-34	A. Nogueira, K.J. Hedges	Data available for the Greenland Halibut Stock Component inNAFO Subarea 0 + 1 (offshore)
N7424	SCR Doc. 23-35	Divya Varkey, Nick Gullage, Paul M. Regular, Rajeev Kumar	Review and Update of the State-Space Management Strategy Evaluation for Greenland Halibut in NAFO Subarea 2 and Divisions 3KLMNO with mseSurv
N7425	SCR Doc. 23-36	K. Sosebee, M.R. Simpson, and C.M. Miri	An Assessment of White Hake (Urophycis tenuis, Mitchill 1815) in NAFO Divisions 3N, 3O, and Subdivision 3Ps
N7426	SCR Doc. 23-37	Rasmus Nygaard	Survey results from the Upernavik Gillnet survey, NAFO Division 1Ainshore.
N7427	SCR Doc. 23-38	Igor Yashayaev	2022 Oceanographic Conditions in the Labrador Sea in the Context of Seasonal, Interannual and Multidecadal Changes
N7428	SCR Doc. 23-39	Rasmus Nygaard	Assessment of Demersal Redfish in NAFO Subarea 1
N7429	SCR Doc. 23-40	R. Alpoim , P. Gonçalves, A. Ávila de Melo, F. Saborido-Rey, M. Fabeiro, Sonia Rábade, D. González-Troncoso, F. González-Costas and M. Pochtar .	An update assessment of beaked redfish (S. mentella and S. fasciatus) in NAFO Division 3M
N7430	SCR Doc. 23-41	Rasmus Nygaard	Assessment of wolffish in NAFO subarea 1

N7431	SCR Doc. 23-42	L. Wheeland, S. Trueman, and R.M. Rideout	Coverage of the 2022 Canadian (Newfoundland And Labrador Region) Multi-Species RV Bottom Trawl Survey with notes on Comparative Fishing
N7435	SCR Doc. 23-43	RA Rademeyer and DS Butterworth	SCAA Base Case Operating Model and Robustness tests for Greenland Halibut
N7437	SCR Doc. 23-44	RA Rademeyer and DS Butterworth	Results for Greenland Halibut Candidate Management Procedure Trials for the final SCAA Reference Set trials

SCS Documents			
Serial No.	**Doc. No.**	**Author**	**Title**
N7370	SCS Doc. 23/01	NAFO	The Commission's Request for Scientific Advice on Management in 2024 and Beyond of Certain Stocks in Subareas 2, 3 and 4 and Other Matters
N7375	SCS Doc. 23-02	Japan Fisheries Research and Education Agency, Japan	National Research Report of Japan (2023)
N7376	SCS Doc. 23-03	Denmark (in respect of Greenland)	Denmark (on behalf of Greenland) Coastal State Request for Scientific Advice - 2024
N7377	SCS Doc. 23-04	Canada	Canada Coastal State Request for Scientific Advice- 2024
N7378	SCS Doc. 23-05REV	L. Näks	Estonian Research Report for 2022
N7380	SCS Doc. 23-06	F. González-Costas, G. Ramilo, E. Román, J. Lorenzo, D. González-Troncoso, M. Sacau, P. Duran, J. L. del Rio and R. Blanco.	Spanish Research Report for 2022
N7382	SCS Doc. 23-07	NAFO	NAFO Precautionary Approach Working Group (PA-WG) Meeting Report, February 2023
N7383	SCS Doc. 23-08	Luis Ridao Cruz	Faroese Research Report 2022
N7388	SCS Doc. 23-09	K. Fomin and M. Pochtar	Russian Research Report for 2022
N7389	SCS Doc. 23-10	NAFO	Report of the Scientific Council- MSE Data Input Finalization, 31 January 2023
N7390	SCS Doc. 23-11	NAFO	Report of the NAFO Scientific Council MSE Meeting, 16 March 2023
N7391	SCS Doc. 23-12	Skanes and Simpson	Canadian Research Report for 2023 - DRAFT
N7393	SCS Doc. 23-13	J. Vargas and R. Alpoim	Portuguese Research Report for 2022
N7412	SCS Doc. 23-14	Adriana Nogueira and Ramus Nygaard	Denmark/Greenland Research Report for 2022
N7416	SCS Doc. 23-15	K.A. Sosebee	United States Research Report for 2022
N7432	SCS Doc. 23-16	H. O. Fock and C. Stransky	German Research Report for 2022
N7436	SCS Doc. 23-17	NAFO	Report of the Scientific Council pre- WG-RBMS Meeting , 14 July 2023
N7438	SCS Doc. 23-18	NAFO	Report of the Scientific Council Meeting , 02-15 June 2023

APPENDIX VIII. LIST OF PARTICIPANTS, 02 – 15 JUNE 2023

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APPENDIX IX. REVIWERS' COMMENTS

1. Management Strategy Evaluation Operating Model Review for Redfish and Greenland Halibut

Reviewer: Mackenzie Mazur

It is clear a lot of work and thought has been put into the operating models, and many model types and sensitivities were explored. The results were presented in a variety of different visualizations, which was helpful. Although the documentation was overwhelming as someone new to this analysis, the presentations clearly described and summarized a large amount of results and work, which was helpful for a reviewer. Attending the meeting in-person was valuable, and I felt it resulted in more in-depth conversations than would happen virtually. As a result, I did not have any major concerns or comments but instead some suggestions that were mostly discussed during the meeting.

Overall Recommendations:
-The dashboard used to show the results for the SSM model for Greenland halibut was a great way to visualize model diagnostics and outputs, and I recommend that this type of dashboard is used more often to view results.

-The worm plots that show individual trajectories are helpful visualizations, especially for species like redfish with episodic recruitment. If the redfish operating model captures the episodic recruitment (which hopefully it does), then worm plots can show how the management strategies respond to episodic recruitment, which may not be apparent when visualizing the median and CIs only.

-Include retrospective pattern plots with at least seven peels and Mohn's Rho values to understand retrospective bias in the operating models. If Mohn's Rho values for each model are calculated with the same number of peels, the retrospective biases can be compared across models.

-For robustness/alternative OMs, I recommend documenting why each alternative OM was considered and document all OMs that were simulated (even if the results are not shown since they are not that different from the base case OM results). This will be worthwhile so that readers understand why and what OMs have been considered.

Redfish Operating Model Recommendations:

-The uncertainties in the age-structured model can be used to inform the uncertainties that are explored in the alternative/robustness operating models. Also, if specific parameters continue to have large uncertainty, it may be worthwhile having a scenario where the observation model or estimation model is wrong to understand the impact of incorrect assumptions.

-Given the uncertainty in the continuation of surveys in the future, it may be worthwhile to have an operating model that is informed by a standardized non-targeted commercial CPUE index. If the index is for non-targeted catch or bycatch, then the index will more likely capture the real trends in stock dynamics than a targeted catch commercial CPUE, which might exhibit hyperdepletion or hyperstability. Additionally, scenarios with gaps in survey data in the projections would also be worthwhile.

-One option for projecting episodic recruitment events that are not well understood is to randomly draw from an empirical cumulative distribution function with past recruitments.

-Perhaps the largest uncertainty for redfish is recruitment, which stems from the stock-recruitment relationship, which stems from spawning-stock biomass, which ultimately stems from maturity. Given maturity is so uncertain, it may be a worthwhile parameter to explore in an OM. Different OMs could have different maturity at length relationships, which could provide a better understanding of the importance of understanding maturity-length relationships for redfish. However, this would require a considerable amount of effort, so it may not be worthwhile at this time, but should be considered in future MSEs for redfish.

Greenland Halibut Operating Model Recommendations:

-Given that the inclusion of the EU-Spain 3L data had a negligible impact, I suggest including it in the operating model.

-Given that the Canadian 2J3K autumn survey has high selectivity at low ages in both the SSM and SCAA models, which seems unrealistic for a trawl survey, and the highest weight in the management procedure, I recommend an operating model that explores this assumption. A OM that natural mortality that varies with age would address the selectivity concern, as well as the uncertainty in natural mortality.

-The robustness/alternative OMs evaluated thus far were based on uncertainties in 2017. It seems like 2023's uncertainties revolve mostly around the surveys, so perhaps some robustness/alternative OMs should be replaced with OMs that focus on survey uncertainty (i.e. missing years of survey data). A couple of OM scenarios with different gaps in survey data in the projection period (one extreme and one less extreme) would be valuable, since the surveys seemed to be the largest uncertainties discussed during the meeting. These scenarios would help address the question: what if we don't have data from all the surveys?

2. Review of Management Strategy Evaluation for Greenland halibut and 3LN redfish

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Summary

The background documentation of the Management Strategy Evaluation for Greenland halibut (GHL) and 3LN redfish (RED) was reviewed. For GHL, the MSEs of 2017 and 2023 have been reviewed and for RED, the MSEs of 2014 and 2023. For both stocks, meeting reports and working documents describe the path of adopting a risk-based management strategy and the process of evaluating Candidate Management Procedures (CMP) within the MSE. These include the initial establishment of timelines, the adoption of management objectives and the development of the MSE numerical framework including Operating Models (OMs), identifying abundance indices developed from survey data as part of Harvest Control Rules (HCR) and, Exceptional Circumstances (EC) protocols.

In general, the MSE frameworks appear to be high quality and robust to the main sources of uncertainty identified for the two stocks. The recommendations to the Commission are well justified on the MP evaluations. A few comments and recommendations for improvement raised during the meeting are provided.

General comments

After the reviews of the 2010 MSEs for GHL and RED, the NAFO Commission requested new MSE developments in 2014 (RED) and 2017 (GHL). Both requests included the exploration of models to be used for condition OMs and the adoption of long-term management objectives that include maintaining the stocks at safe levels (e.g. above the biomass at MSY while maintaining the TAC as high as possible).

Both MSEs have explored OMs conditioned from the stock assessment models (biomass production models, age structured models and Bayesian approximations).

For both stocks, relatively similar performance indicators were developed that include probabilities and risks of achieving/maintaining the stocks at or above B_{MSY}, of exceeding F_{MSY}, of breaching limit reference points (LRP), maximizing yield in different timeframes and reducing the variability of stock biomass and TAC.

There has been a priority to evaluate model-free HCRs for these stocks that calculate TAC directly from abundance indices from surveys. Looking at the large number of abundance indices used, this seems a good option. Also, the correlation of indices has been explored, which is a good practice in MSE.

With regards to the specific requests from the NAFO Commission for MSE developments of 2+3KLMNO Greenland halibut and 3LD redfish, the Scientific Council in 2023 need to:

- Review and finalize the data series for the two MSEs.
- For GHL:
    - To propose, review and finalize OMs.
    - To test CMP to support recommendation for adoption.
- For the RED:
    - To propose an initial review of OMs.
    - To support development of performance statistics and CMPs.

Specific notes on MSEs

1) Redfish MSE

- First steps of this new MSE
- Preliminary OMs are built from stock assessment models including:
    1. Biomass production models as starter.
    2. Age-structured models (Age structured Catch at Length).
- It may be reasonable to start in 1960 but the catch for the period 60-80 is somewhat near the maximum of the time series except for the peak in 1987. But the models (both the SPiCT and the SSSPM) don't seem to get any signal because there is no CPUE prior to 1975 and the biomass remains on average at

almost pristine levels for the entire period 1960-1980 and fishing mortality quite low relative to FMSY, with such large catches. For exploratory analysis, some runs could be made fixing the biomass level in 1960 (or even 1975) closer to the BMSY and this may produce some runs where the biomass trend is a bit more dynamic in the early years and not drastic after 1984 where the fishing mortality is estimated to increase a lot. This is somewhat surprising because in reality, there is only one year of catch that is very high. Before 1984, catch and the biomass of the stock seem very stable at those harvest levels.

- It would be a good idea to plot the production function together with time series of catch and surplus. The figure shown in the Supplementary material could be improved for a better interpretation of what happened in the mid 1980s.
- Also, it would be good to increase the exploration of process error, this may suggest changes in the recruitment regime or some other event not included in the assessments period. The figure that compares ACL against the NL index seems a good starting point.

2) Greenland halibut:

- OMs: Support to the discussions, both models seem well justified and for both the addition of the new EU Spain index does not produce major changes with regards to model output. The group seems to support the addition of the new index. This seems reasonable to me.
- The updated model seems very consistent with previous MSE simulations.
- Uncertainty in OMs refers to changes during the simulation period, no new (past) realities are investigated, i.e. (different values of biological parameters for the assessment period). From the explanations during the meeting it seems that this was discussed earlier on, and the group agrees to keep one interpretation of the past and different options for the future (overcatch, recruitment events etc).
- Surprised for the relatively flat production function. It was explained that this is because recruitment is disconnected from the biomass and thus, even at very high levels of F there will be a pool of recruits to the fishery. This has probably been discussed within the group but may need to be clearly explained to the Commission.
- One OM assumes a 10% overcatch in the simulation period. From the explanation, I understand that the abundance index will pick the signal of biomass declining more than expected and this will produce a lower TAC in the following management period. Overall, this will make the CMP robust to the potential implementation problems. However, as noted during the meeting, care should be placed on explaining the aim and interpretation of this result and it may encourage the CPCs to reduce efforts on TAC monitoring.
- The MSE could be used to evaluate the potential implications of one or more indices not being updated during the simulation period. This would allow evaluating the potential impact of this EC.
- About the CMP, these are variations of the MP adopted in 2017 with weightings to each of the indices re-calculated.
- Another analysis that was somewhat done (not in the MSE section) was to evaluate the potential impact of not having one ore more index available for the application of the MP. The MSE could be used to support (or not) the application of the MP if MSE simulations are developed with one or more indices not being updated. This would allow evaluating the potential implication of this EC in advance.
- Also, potential problems with Canadian surveys make it difficult to simulate them from the estimated biomass during the simulations. To address this a workplan has been put in place.
- A set of robustness tests have also been scheduled to evaluate some of the issues discussed within the group. These include options for biological processes and availability of data (natural mortality, stock recruitment relationship, changes in selectivity and lack of Canadian surveys). All these seem realistic and useful for the application of the HCR.