Northwest Atlantic Fisheries Organization

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SCIENTIFIC COUNCIL MEETING – 20 - 24 SEPTEMBER 2021

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Scientific Council Annual Meeting Participants

20- 24 September 2021

SC participants from left to right:

First row: Tom Blasdale, Karen Dwyer, Margaret Treble, Laura Wheeland, Mariano Koen-Alonso

Second row: Mark Simpson, Diana González Troncoso, Ricardo Alpoim, Adolfo Merino, Irene Garrido

Third row: Liivika Näks, Lisa Readdy, Miguel Caetano, Herlé Goraguer, Kenji Taki

Fourth row: Carmen Fernández, Valerii Paramonov, Carsten Hvingel, Konstantin Fomin, Andrew Kenny

Fifth row: Kathy Sosebee

Missing from photo: Leigh Edgar, Ellen Kenchington, Martha Krohn, Brian Healey, José Miguel Casas Sanchez, Pablo Durán Muñoz, Fernando González-Costas, Mar Sacau-Cuadrado, Sergey Melnikov, Anna Ridiger

REPORT OF SCIENTIFIC COUNCIL MEETING

20-24 September 2021

Chair: Carmen Fernández Rapporteur: Tom Blasdale

I. PLENARY SESSIONS

The Scientific Council (SC) and its Standing Committees met by correspondence from 20 to 24 September 2021 to consider the various matters in its agenda. Representatives attended from Canada, the European Union, France (in respect of St. Pierre et Miquelon), Japan, Norway, the Russian Federation, Ukraine, the United Kingdom and the United States of America. The Executive Secretary, Scientific Council Coordinator and other members of the Secretariat were in attendance.

The Council was called to order at 08:00 Halifax time (11:00 UTC) on 20 September 2021. The provisional agenda was **adopted,** and the Scientific Council Coordinator was appointed the rapporteur. The opening session was adjourned at 13:00 on 20 September 2021.

The final session was called to order at 08:00 on 24 September 2021. The Council considered and **adopted** the reports of the STACFEN, STACPUB, STACREC and STACFIS Standing Committees and agreed that the report of this meeting would be finalized by correspondence. The meeting was adjourned at 13:00 hours on 24 September 2021.

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

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

There were no Scientific Council recommendation requiring immediate attention at this meeting. A detailed review of recommendations was deferred to the June 2022 meeting.

III. JOINT SESSION OF COMMISSION AND SCIENTIFIC COUNCIL

The Commission and Scientific Council met in joint sessions on 20 and 21 September to discuss the 2018 NAFO performance review, the Scientific Council's response to requests for advice from the Commission, the reports of the joint SC/Commission Working Groups and other matters of common interest.

1. Implementation of 2018 Performance Review Recommendations

The President referred to the COM Working Paper 21-17 that outlined the status of the implementation of the recommendations of the 2018 Performance Review Panel.

As agreed at the 2019 Annual Meeting, the NAFO Secretariat will provide an annual update on progress the Organization has made in addressing the recommendations of the 2018 Performance Review Panel on the basis of the "*Action Plan for the Implementation of the Recommendations from the 2018 Report of the NAFO Performance Review Panel*" (COM Doc. 19-32).

2. Presentation of scientific advice by the Chair of the Scientific Council

a) Response of the Scientific Council to the Commission's request for scientific advice

The Chair of the Scientific Council (SC), Carmen Fernández (EU), presented this year's scientific advice. The advice represents the response of SC to the request from the Commission (COM Doc. 20-16). The scientific

advice on fish stocks and on other topics were formulated mainly during the SC meeting in June 2021 (SCS Doc. 21-14REV), except for the shrimp stocks in 3M and in 3LNO, which were formulated on 08 September 2021 during the NAFO/ICES *Pandalus* Assessment Group (NIPAG) meeting.

The advice relating to risk-based management strategies, ecosystem approach to fisheries management, and bycatch and discards was taken on by working groups at their subsequent meetings (see meeting summaries by the working group chairs, later in this section of the SC report). A summary of the SC advice on fish stocks in which the Commission took management actions at this meeting is presented in the table below. The detailed advice and responses to the Commission requests are contained in the above-mentioned documents.

Fish Stock	SC Advice
3M Cod	Yield of less than or equal to 5000 tonnes in 2022 results in a very low probability (≤10%) of SSB being below B_{lim} in 2023 and a very low probability of exceeding F_{lim}. However, given the present low level of the SSB and projected decline of total biomass under any fishing scenario, in order to promote growth in SSB, SC advises catches of no more than 3000 tonnes in 2022.
3M Redfish	SC advises that catches do not exceed $F_{0.1}$ level, given the life history of the stock. This corresponds to a TAC of 10 933 t in 2022 and 11 171 t in 2023.
3M Shrimp	To be consistent with the precautionary approach, SC advises that no directed fishery should occur in 2022.
3NO Cod	No directed fishing in 2022 to 2024 to allow for stock rebuilding.
3LNO American plaice	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.
3LNO Yellowtail founder	Fishing mortality up to 85% F_{msy}, corresponding to catches of 22 100 t, 20 800 t, and 19 900 t in 2022 to 2024 respectively, have risk of no more than 30% of exceeding F_{lim}.
3NOPs White hake	For 2022-2023. Catches of white hake in 3NO should not increase. Average annual total catches of the most recent five years were around 400 tonnes.
3NO Capelin	For 2022-2024. No directed fishery.
2+3KLMNO Greenland halibut	The TAC for 2022 derived from the HCR is 15 864 t. This is 4% lower than the 2021 TAC (16 498 t). Exceptional Circumstances are not occurring. The disruption of the 2021 Canadian Spring 3LNO survey, in addition to the years 2020 and 2017, will trigger Exceptional Circumstances next year.
3LNO Shrimp	No directed fishery in 2022 and 2023 as the stock is below B_{lim} with no indication of short-term recovery.

b) Feedback to the Scientific Council regarding the advice and its work during this meeting

A feedback question pertaining to 3M cod was forwarded to SC. Specifically, it requests SC to re-run projections for this stock with actual catches taken by the Faroe Islands 3M cod survey (630.6 tonnes) included in the assumed catches for 2021. The SC response to the question is presented in section VIII.2 of this report.

c) Other issues as determined by the Chairs of the Commission and the Scientific Council

The SC Chair brought forward two issues:

1) SC noted that with the information currently available, SC considers the Faroe Islands 3M cod survey initiative conducted in June 2021 did not fulfil the requirements of a valid scientific survey and more closely resembles a commercial fishery. SC further noted that protocols from Article 4 in the Conservation and Enforcement Measures (NAFO COM Doc 21/01) do not require review of proposed survey research plans and confirmation of their scientific validity by SC. In this regard, SC **recommends** that the Commission amend this

procedure to include a scientific review of proposed research surveys in the NRA to ensure scientific best practices are followed (COM-SC WP 21-15).

In reaction to this recommendation, Denmark (in respect to Faroe Islands and Greenland) issued a statement. It is presented in COM-SC WP 21-16.

The deliberations in addressing the issue of the Faroese survey continued at the Commission. They are reflected in the agenda items 21.a and 28 in this report.

2) In presenting the SC response to the Commission request pertaining to the development of a 3–5-year work plan and recalling the discussions at the Joint Commission-Scientific Council Working Group on Risk-based Management Strategies (WG-RBMS) meeting in August 2021, the SC Chair raised concern with regards the prioritization of SC tasks. SC presented a detailed schedule and timeline outlining resource requirements in the performance of all its tasks, among which three major tasks are the PA framework review, a review and evaluation of the Greenland halibut management strategy, and the development and evaluation of a management strategy for 3LN redfish. SC noted that the PA framework review is already underway, and that it expects the Greenland halibut process to take two years and the 3LN redfish process to take three years. Given the current workload and resources available, SC indicated that it cannot perform these three major tasks simultaneously and proposed that one of the two Management Strategy Evaluations (Greenland halibut or 3LN redfish) be postponed. Further discussion on this issue is reflected in section III.3.b of this report.

3. Meeting Reports and Recommendations of the Joint Commission–Scientific Council Working Groups

a) Working Group on Improving Efficiency of NAFO Working Group Process (E-WG), 2020

The Executive Secretary referred to COM-SC Working Paper 21-06, which is the recommendation from the Joint Commission-Scientific Council Efficiency Working Group. The Working Group recommended three (3) two-week periods where intersessional meetings by STACTIC and other Working Groups may be held, namely:

- 21 February to 04 March 2022,
- 25 April to 06 May 2022, and
- 08 to 19 August 2022.

Contracting Parties are not obliged to schedule meetings during these periods, but these dates may help in future planning of intersessional meetings.

The recommendations of the Working Group were adopted by the Commission. The Commission also agreed that this Working Group continue in 2022 under the same terms of reference.

b) Joint Commission–Scientific Council Working Group on Risk-based Management Strategies (WG-RBMS), February and August 2020

The co-Chairs Fernando González (EU) and Ray Walsh (Canada) presented the August 2021 meeting report (COM-SC Doc 21-04) and the recommendations (COM-SC WP 21-07):

Key discussion items include, among others:

- PAF Review,
- Greenland halibut Management Strategy Evaluation (MSE),
- 3LN Redfish MSE,
- Prioritization of the three tasks above.

The recommendations of WG-RBMS were **adopted** by the Commission (COM-SC WP 21-08 Rev).

The co-Chairs also highlighted the issue of the prioritization among the two MSEs and the PAF review. No consensus was reached at the WG-RBMS meeting. While SC expressed that it would be extremely difficult to perform the tasks simultaneously, Canada, on the other, indicated that it had allocated funding for a position dedicated to the 3LN redfish MSE review, and considers that this will ease the workload on SC allowing both MSEs to proceed simultaneously.

At this session, the detailed schedule and timeline presented by SC outlining resource requirements in the performance of its tasks, including the PAF review and the simultaneous performance of the two MSEs, was further discussed. Canada informed about its deliverables in advancing the review of 3LN redfish MSE (COM-SC Working Paper 21-12).

Further discussion on this issue continued again at the respective sessions of the Commission and SC. To further inform the discussion and help with the decision, SC noted the following, pertaining to the Greenland halibut Harvest Control Rule (COM WP 21-44):

1) The Greenland halibut Harvest Control Rule in the current NAFO CEM (COM. Doc. 21-01) was scientifically tested through an MSE process extending beyond 2023 (until 2037).

2) The management regime includes the HCR plus a protocol to deal with exceptional circumstances which is applied annually. In addition, update assessments based on the base-case SCAA and SSM models are done every 3 years. These update assessments were last conducted in 2020 and therefore would be repeated in 2023.

Therefore, the SC concluded a short-term extension of this management regime beyond 2023 does not pose any problem from a scientific perspective, and can be reliably applied, but is not recommended to extend for more than 3 years before a full review of the MSE is conducted.

c) Joint Commission–Scientific Council Working Group on Ecosystems Approach Framework to Fisheries Management (WG-EAFFM), August 2020

The co-Chairs Andrew Kenny (EU) and Elizabethann Mencher (USA) presented the July 2021 meeting report (COM-SC Doc. 21-03) and the recommendations (COM-SC WP 21-08).

Key discussion items include, among others:

- Significant Adverse Impact (SAI)
- Vulnerable Marine Ecosystem (VME) closures
- EAF Roadmap and the 2022 Workshop
- Review of Chapter II – NCEM measures.

The recommendations of WG-EAFFM were **adopted** by the Commission

In addition, the proposal revising the boundaries of Fogo, Corner Rise and Newfoundland Seamount mount closures was adopted by the Commission.

d) Joint Commission–Scientific Council Catch Estimation Strategy Advisory Group (CESAG), April 2020

The co-Chairs of CESAG, Katherine Sosebee (USA) and Temur Tairov (Russian Federation), presented the April meeting report (COM-SC Doc. 21-02) and the recommendations (COM-SC WP 21-09).

Key discussion items, among others:

- 2020 catch estimates conducted by the Secretariat and forwarded to SC
- Observer program best practices.

The recommendations of CESAG were **adopted** by the Commission.

4. Formulation of Request to the Scientific Council for Scientific Advice on the Management in 2023 and Beyond of Certain Stocks in Subareas 2, 3, 4 and 6 and Other Matters

In accordance with the procedure outlined in FC Doc. 12-26, a steering committee was formed to assist in the drafting of the Commission request. The committee consisted of the SC Coordinator and representatives from Canada and EU.

The Commission request to SC was developed and presented by the committee was adopted by the Commission (COM WP 21-20). Request items pertaining to fish stock assessments, 2+3KLMNO Greenland halibut and 3LN redfish MSE processes, Precautionary Approach Framework (PAF) are considered the priority items for the June 2022 Scientific Council meeting subject to resources and COVID-related restrictions.

IV. FISHERIES ENVIRONMENT

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

V. PUBLICATIONS

The Council adopted the Report of the Standing Committee on Publications (STACPUB) as presented by the Chair, Margaret Treble. The full report of STACPUB is in Appendix II.

VI. RESEARCH COORDINATION

The Council adopted the Report of the Standing Committee on Research Coordination (STACREC) as presented by the Chair, Karen Dwyer. The full report of STACREC is in Appendix III.

VII. FISHERIES SCIENCE

The Council adopted the Report of the Standing Committee on Fisheries Science (STACFIS) as presented by the Chair, Katherine Sosebee. The full report of STACFIS is at Appendix IV.

VIII. REQUESTS FROM THE COMMISSION

1. Requests deferred from the June Meeting

i) Continue the evaluation of scientific trawl surveys in VME closed areas (COM request #3)

Although progress on this request has occurred in the last months, time constraints prevented the SC from discussing and preparing a response during this meeting. Therefore, it was deferred to the June 2022 meeting.

2. Requests Received from the Commission during the Annual Meeting

From United Kingdom regarding 3M cod:

Feedback Request

Scientific surveys normally harvest relatively small quantities of fish to derive information about stock status. In the case of the 2021 Faroese longline survey on Flemish Cap, the survey catches amount to 630.6t, equating to an additional 42% of the agreed TAC for 2021 of 1,500t. In order to take account of the impact of this catch on the advice provided for 2022, the UK proposes the following request to the SC:

The Commission requests that the SC run additional projections assuming a total catch level of 2,130.6t in 2021, to be made available to CPs as soon as possible during the Annual Meeting.

Scientific Council responded:

In June 2021, projections with a catch in 2021 equal to the approved TAC = 1500t were run, given the results in Tables 1a and 2a as in the advisory sheet of the 3M cod. New projections incorporating the catches in the Faroese survey during June 2021 (630.6t), so with a catch in 2021 = 2130.6t, were performed with the same scenarios as in June 2021, given the results shown in Tables 1b and 2b.

Increasing the catches in 2021, the Yield in 2022 onwards declines slightly in all the scenarios with projecting Fs, the risk of SSB being below Blim is slightly higher and the probability of the SSB in 2024 being above SSB in 2021 is lower.

While risks of the stock declining below Blim in the next 2 years remain similar with the two levels of catch, the additional catches increase the probability that the stock will decline.

Table 1a. Results with a catch in 2021 of 1500t.

	B		SSB		Yield
	Median and 80% CI				
F_{bar} = Fsq (median = 0.131)					
2021	45787	(40635 - 51559)	27058	(23458 - 31446)	1500
2022	42969	(37884 - 48389)	24420	(21335 - 27970)	6525
2023	34733	(29703 - 40345)	18598	(15605 - 21773)	5291
2024	29999	(24718 - 36318)	19822	(16344 - 23723)	
F_{bar} = 0					
2021	45787	(40635 - 51559)	27058	(23458 - 31446)	1500
2022	42969	(37884 - 48389)	24420	(21335 - 27970)	0
2023	41143	(36076 - 46765)	24071	(21037 - 27322)	0
2024	42102	(36620 - 48376)	30514	(27027 - 34628)	
F_{bar} = 3/4F_{lim} (median = 0.147)					
2021	45787	(40635 - 51559)	27058	(23458 - 31446)	1500
2022	42969	(37884 - 48389)	24420	(21335 - 27970)	7160
2023	34111	(29091 - 39726)	18092	(15086 - 21246)	5694
2024	28966	(23642 - 35277)	18923	(15516 - 22770)	
F_{bar} = 1/2F_{lim} (median = 0.098)					
2021	45787	(40635 - 51559)	27058	(23458 - 31446)	1500
2022	42969	(37884 - 48389)	24420	(21335 - 27970)	5000
2023	36238	(31192 - 41834)	19854	(16887 - 23067)	4254
2024	32578	(27213 - 38900)	22092	(18612 - 25996)	
Catch = 1500 tons					
2021	45787	(40635 - 51559)	27058	(23458 - 31446)	1500
2022	42969	(37884 - 48389)	24420	(21335 - 27970)	1500
2023	39661	(34603 - 45288)	22807	(19826 - 26087)	1500
2024	38994	(33591 - 45246)	27691	(24211 - 31752)	
Catch = 1875 tons					
2021	45787	(40635 - 51559)	27058	(23458 - 31446)	1500
2022	42969	(37884 - 48389)	24420	(21335 - 27970)	1875
2023	39291	(34238 - 44913)	22482	(19454 - 25735)	1875
2024	38216	(32795 - 44488)	27028	(23511 - 31085)	
Catch = 2250 tons					
2021	45787	(40635 - 51559)	27058	(23458 - 31446)	1500
2022	42969	(37884 - 48389)	24420	(21335 - 27970)	2250
2023	38923	(33871 - 44544)	22151	(19150 - 25412)	2250
2024	37438	(32028 - 43736)	26354	(22862 - 30373)	
Catch = 3000 tons					
2021	45787	(40635 - 51559)	27058	(23458 - 31446)	1500
2022	42969	(37884 - 48389)	24420	(21335 - 27970)	3000
2023	38196	(33139 - 43808)	21520	(18528 - 24739)	3000
2024	35865	(30453 - 42155)	24986	(21477 - 28888)	

Table 1b. Results with a catch in 2021 of 2130.6t (=1500 + 630.6).

	B		SSB		Yield
	Median and 80% CI				
F_{bar} = Fsq (median = 0.131)					
2021	45786	(40483 - 51538)	27071	(23429 - 31417)	2131
2022	42271	(37161 - 47408)	23874	(20789 - 27401)	6390
2023	34327	(29418 - 39829)	18272	(15306 - 21461)	5218
2024	29732	(24494 - 35909)	19570	(16108 - 23461)	
F_{bar} = 0					
2021	45786	(40483 - 51538)	27071	(23429 - 31417)	2131
2022	42271	(37161 - 47408)	23874	(20789 - 27401)	0
2023	40614	(35672 - 46166)	23620	(20612 - 26889)	0
2024	41588	(36298 - 47813)	30092	(26522 - 34166)	
F_{bar} = 3/4F_{lim} (median = 0.147)					
2021	45786	(40483 - 51538)	27071	(23429 - 31417)	2131
2022	42271	(37161 - 47408)	23874	(20789 - 27401)	7015
2023	33716	(28813 - 39207)	17754	(14808 - 20916)	5630
2024	28653	(23481 - 34842)	18644	(15219 - 22524)	
F_{bar} = 1/2F_{lim} (median = 0.098)					
2021	45786	(40483 - 51538)	27071	(23429 - 31417)	2131
2022	42271	(37161 - 47408)	23874	(20789 - 27401)	4901
2023	35791	(30868 - 41296)	19511	(16496 - 22691)	4205
2024	32279	(26951 - 38463)	21792	(18255 - 25694)	
Catch = 1500 tons					
2021	45786	(40483 - 51538)	27071	(23429 - 31417)	2131
2022	42271	(37161 - 47408)	23874	(20789 - 27401)	1500
2023	39131	(34196 - 44679)	22355	(19318 - 25569)	1500
2024	38516	(33179 - 44695)	27308	(23764 - 31342)	
Catch = 1875 tons					
2021	45786	(40483 - 51538)	27071	(23429 - 31417)	2131
2022	42271	(37161 - 47408)	23874	(20789 - 27401)	1875
2023	38764	(33827 - 44305)	22065	(18991 - 25288)	1875
2024	37749	(32396 - 43904)	26607	(23104 - 30608)	
Catch = 2250 tons					
2021	45786	(40483 - 51538)	27071	(23429 - 31417)	2131
2022	42271	(37161 - 47408)	23874	(20789 - 27401)	2250
2023	38399	(33459 - 43930)	21723	(18688 - 24960)	2250
2024	36966	(31635 - 43121)	25919	(22429 - 29956)	
Catch = 3000 tons					
2021	45786	(40483 - 51538)	27071	(23429 - 31417)	2131
2022	42271	(37161 - 47408)	23874	(20789 - 27401)	3000
2023	37665	(32721 - 43186)	21095	(18085 - 24336)	3000
2024	35411	(30063 - 41567)	24536	(21050 - 28527)	

Table 2a. Risk with a catch in 2021 of 1500t.

	Yield			$P(SSB < B_{lim})$				$P(F_{bar} > F_{lim})$			
	2021	2022	2023	2021	2022	2023	2024	2021	2022	2023	$P(SSB_{24} > SSB_{21})$
$F_{bar} = F_{sq} = 0.131$	1500	6525	5291	<1%	<1%	13%	8%	<1%	<1%	<1%	1%
$F_{bar} = 0$	1500	0	0	<1%	<1%	<1%	<1%	<1%	<1%	<1%	90%
$F_{bar} = 3/4F_{lim} = 0.147$	1500	7160	5694	<1%	<1%	17%	13%	<1%	1%	2%	<1%
$F_{bar} = 1/2F_{lim} = 0.098$	1500	5000	4254	<1%	<1%	5%	1%	<1%	<1%	<1%	4%
Catch = 1500 tons	1500	1500	1500	<1%	<1%	1%	<1%	<1%	<1%	<1%	58%
Catch = 1875 tons	1500	1875	1875	<1%	<1%	1%	<1%	<1%	<1%	<1%	48%
Catch = 2250 tons	1500	2250	2250	<1%	<1%	1%	<1%	<1%	<1%	<1%	36%
Catch = 3000 tons	1500	3000	3000	<1%	<1%	2%	<1%	<1%	<1%	<1%	20%

Table 2b. Risk with a catch in 2021 of 2130.6t (=1500t + 630.6t).

	Yield			$P(SSB < B_{lim})$				$P(F_{bar} > F_{lim})$			
	2021	2022	2023	2021	2022	2023	2024	2021	2022	2023	$P(SSB_{24} > SSB_{21})$
$F_{bar} = F_{sq} = 0.131$	2131	6390	5218	<1%	<1%	15%	9%	<1%	<1%	<1%	<1%
$F_{bar} = 0$	2131	0	0	<1%	<1%	<1%	<1%	<1%	<1%	<1%	87%
$F_{bar} = 3/4F_{lim} = 0.147$	2131	7015	5630	<1%	<1%	20%	15%	<1%	1%	2%	<1%
$F_{bar} = 1/2F_{lim} = 0.098$	2131	4901	4205	<1%	<1%	6%	2%	<1%	<1%	<1%	3%
Catch = 1500 tons	2131	1500	1500	<1%	<1%	1%	<1%	<1%	<1%	<1%	52%
Catch = 1875 tons	2131	1875	1875	<1%	<1%	1%	<1%	<1%	<1%	<1%	41%
C=2250	2131	2250	2250	<1%	<1%	1%	<1%	<1%	<1%	<1%	32%
Catch = 3000 tons	2131	3000	3000	<1%	<1%	2%	<1%	<1%	<1%	<1%	16%

3. Update on progress on the NAFO PA Framework review (COM request #8)

Com. Request #8: Continue progress on the NAFO PA Framework review

The Commission requests the Scientific Council to continue progression on the review of the NAFO PA Framework in accordance to the PAF review work plan approved in 2020 (NAFO COM-SC Doc. 20-04)

Scientific Council responded:

SC reported on further progress made on addressing the mapping of objectives deliverable (ToR 1a, c, and g of the PA-WG), to consider how the objectives and general principles of the NAFO Convention can be represented in the Precautionary Approach Framework (PAF). SC recommends that there are three general conditions for re-evaluating reference points in a revised PAF. These include: 1) when the context and quality of information substantially changes; 2)when there is strong evidence of a shift in productivity regime and it is understood, has persisted, is expected to continue, if the stock is viable if managed with the revised reference points and if there is sufficient information to estimate these revised points; 3) when new information indicates that management procedures based on current reference points do not perform well for meeting the objectives and principles of the NAFO convention, or alternative management procedures based on new reference points are expected to perform better for meeting the objectives.

In any case, uncertainty in reference points should be estimated and the relative risks of current and revised reference points for stock assessment and fishery management (e.g., simulation testing) should be communicated.

Work on ToR 1 a and c were presented to Scientific Council in June and to WG-RBMS in August, and recommendations endorsed by both groups. In September, work was presented by the PA-WG to the SC on ToR 1g to determine the conditions for when/if reference points should change and/or be re-evaluated. Collectively, ToR 1 a, c, and g support the task Mapping Objectives in accordance with the PA-WG tasks and timetable (COM-SC Doc. 20-04), and deliverable 1 will be therefore considered to be complete.

PA-WG recommends that there are three general conditions for re-evaluating reference points:

1. *The decision to estimate either MSY reference points or proxies should be reconsidered when the content and quality of information substantially changes.*
2. *Reference points should be re-evaluated when there is strong evidence of a shift in productivity regime, the mechanism of the shift is understood, the current productivity has persisted, the current productivity is expected to continue, the stock would be viable if managed with the revised reference points, and there is sufficient information to estimate revised reference points. Evidence that current reference points are unsustainable is sufficient to revise reference points. Operational stock assessments should routinely test for a shift back to greater productivity.*
3. *Reference points can be revised when new information indicates that management procedures based on current reference points do not perform well for meeting the objectives and principles of the NAFO convention, or alternative management procedures based on new reference points are expected to perform better for meeting the objectives.*

In any case, uncertainty in reference points should be estimated and the relative risks of current and revised reference points for stock assessment and fishery management (e.g., simulation testing) should be communicated.

The Scientific Council supported these recommendations.

The mapping deliverable will be published as an SCR or SCS in the near future.

IX. MEETING REPORTS

a) Joint Commission – Scientific Council Working Group on the Ecosystem Approach Framework to Fisheries Management (WG-EAFFM)

This joint working group met by correspondence during 14–16 July and 20-21 July 2021 and was co-chaired by Elizabethann Mencher (USA) and Andrew Kenny (UK). The Scientific Council was advised of progress of this group by the co-chairs in their presentation of the report to the joint session of Commission and Scientific Council (see section III of this report).

b) Joint Commission–Scientific Council Working Group on Risk-based Management Strategies (WG-RBMS)

This joint working group met by correspondence during 24–26 August 2021 and was co-chaired by Fernando González (EU) and Ray Walsh (Canada). The Scientific Council was advised of progress of this group by the co-chairs in their presentation of the report to the joint session of Commission and Scientific Council (see section III of this report).

c) Joint Commission-Scientific Council Catch Estimation Strategy Advisory Group (CESAG).

CESAG met by correspondence on 13 April 2021, co-chaired by Katherine Sosebee (Scientific Council, USA) and Temur Tairov (Commission, Russian Federation). The Scientific Council was advised of progress of this group by the co-chairs in their presentation of the report to the joint session of Commission and Scientific Council (see section III of this report).

d) ICES/NAFO Working Group on Deep-water Ecology (WG-DEC)

WG-DEC met by correspondence during 7-11 June 2021 and was attended by Ellen Kenchington (Canada) representing NAFO. Consideration of the report of WG-DEC was deferred to the June 2022 SC meeting.

e) ICES/NAFO/NAMMCO Working Group on Harp and Hooded Seals (WG-HARP)

Discussion of this working group was deferred to June 2022.

X. REVIEW OF FUTURE MEETING ARRANGEMENTS

1. Scientific Council meetings

a) Scientific Council (in conjunction with NIPAG), 1 to 5 November 2021

The Scientific Council shrimp advice meeting will be held by WebEx from 1 to 5 November 2021.

b) WG-ESA, 16- 25 November 2021

The Working Group on Ecosystem Science and Assessment (WG-ESA) will meet by WebEx, from 16 to 25 November 2021.

c) Scientific Council, June 2022

Scientific Council June 2022 meeting will be held from 3 to 16 June 2022, in Halifax, Nova Scotia, Canada.

d) Scientific Council (in conjunction with NIPAG), 2022

Dates and location to be determined.

e) Scientific Council, September 2022

The Annual meeting will be held from 19 to 23 September 2022, in Lisbon, Portugal.

2. NAFO/ICES Joint Groups

a) NIPAG, 1 to 5 November 2021

The Scientific Council shrimp advice meeting will be held from 1 to 5 November 2021, by WebEx.

b) ICES – NAFO Working Group on Deep-water Ecosystem, 2022

Dates and location to be determined.

c) ICES/NAFO/NAMMCO WG-HARP

The date and location of the next ICES/NAFO/NAMMCO Working Group on Harp and Hooded Seals (WGHARP) meeting are unknown.

XI. FUTURE SPECIAL SESSIONS

No future special sessions were discussed.

XII. OTHER MATTERS

1. Initial SC considerations to address COM Req. 5.a. "Independent scientific Review of Tier 1 and its proposed application"

The Commission's Request 5 for Scientific Advice on Management in 2023 and Beyond (Com. Doc 21-20) reads:

The Commission requests that Scientific Council continue work on the sustainability of catches aspect of the Ecosystem Road Map, including:

> *a. In consultation with WG-EAFFM via co-chairs, convene independent experts to do a scientific review of; a) the estimation of fisheries production potential and total catch indices, and b) the adequacy of this analysis for their proposed use within the NAFO roadmap (Tier 1), while considering how species interactions are expected to be addressed in the future (Tier 2) within the overall Roadmap structure. The outcomes of this review would need to be tabled in June at Scientific Council to be available in advance of the planned workshop in 2022.*
>
> *b. Work to support the WG EAFFM workshop in 2022, which will explore ecosystem objectives and further develop how the Roadmap may apply to management decision making.*
>
> *c. Continue its work to develop models that support implementation of Tier 2 of the EAFM Roadmap*

In view of this request from the Commission, the SC discussed in the final day of its meeting how to address part a. and expressed the following initial considerations.

This request has one important logistical constraint which needs to be considered in the planning of the scientific review: the results of this review will need to be available before the WGEAFFM Ecosystem Objectives Workshop currently scheduled to take place in August 2022. This review is to be conducted as an SC process, which means that the review will need to be presented, discussed, and adopted/endorsed by SC at its June 2022 meeting. Given this tight timeline, the planning and organization process needs to begin immediately.

In line with similar external reviews conducted by SC (e.g. stock-assessments in support of benchmark processes), SC considers that this review needs to be overseen by WG-ESA, where the work being reviewed was originally produced, and its results documented in the final WG-ESA Report next year. This review should also be tabled at SC for full discussion and consideration, and to allow for the formal response to the COM request to be produced.

The selection of independent experts to conduct the review is therefore an urgent requirement for SC. To expedite the selection of experts it is suggested that, in the first instance, SC compile a short list of potential suitable reviewers which would then be shared with WG-EAFFM. This should be undertaken as soon as possible to enable enough time for the appointment process to be completed before the end of the year. WG-ESA would prepare material for review at its November 2021 meeting in consultation with the chairs of SC. The selected experts would then be invited (and at the same be given material to review) to an intersessional (WebEx/Teams) meeting of WG-ESA in the new year (probably in April) where they would be able to question the research, ask for clarifications if needed, and through this exercise, fully inform themselves about the nature of the research and its intended use in a management context. The invited experts would be expected to provide short written reviews in addition to their comments within 1 week after the session, and these reviews would then be appended to the WG-ESA Report to be finalised by the end of May 2022. We expect the outcome of the review to be presented to SC in June 2022 by one of the reviewers who would also be invited to the WG-EAFFM Ecosystem Objectives workshop in August 2022.

Given the nature of the work under review, the range of expertise expected to be covered in selecting independent reviewers should include ecosystem modelling, quantitative stock-assessment, and the boundary of science-management in a fisheries and/or ecosystem approaches context. This range of expertise would

ideally be covered among the 3 independent reviewers required for this process (e.g. one stock-assessment expert, one ecosystem modelling expert and one expert on the science-management interface as it pertains to fisheries and/or ecosystem approaches).

While the Terms of Reference for this review need to be consulted with WG-EAFFM via its co-chairs, based on the request, a set of ToRs for discussion are:

a) Conduct a scientific review of the analysis used for the estimation of fisheries production potential and total catch indices,

b) evaluate the adequacy of this analysis for its proposed use within the NAFO roadmap (Tier 1), while considering how species interactions are expected to be addressed in the future (Tier 2) within the overall Roadmap structure.

2. Presentation of NAFO Scientific Merit Awards

a) Presentation of NAFO Scientific Merit Award to Pierre Pepin

NAFO Scientific Council (SC) was pleased to recognize Pierre Pepin (Canada)'s impact to SC work through a Scientific Merit Award. This award celebrates the many contributions Pierre has made in advancing the development and implementation of an ecosystem approach to fisheries within NAFO as a member of the SC Working Group on Ecosystem Science and Assessment (WG-ESA) and Scientific Council since 2010, as well as during his tenure as WGESA co-chair (2016-2021).

During this time, Pierre has also provided a leading voice in many of the joint initiatives within NAFO trying to breach the gap between scientists and managers, especially within the joint COM-SC Working Groups on the Ecosystem Approach Framework to Fisheries Management (EAFFM) and Rebuilding Plans and Management Strategies (RBMS).

Pierre's scientific expertise, sharp mind, and strategic vision will be sorely missed at SC, as well as his dry humour and his never-ending passion for improving the way in which we use science to make better management decisions.

b) Presentation of NAFO Scientific Merit Award to Carmen Fernández

On behalf of Scientific Council, the SC Vice-Chair and incoming Chair, Karen Dwyer (Canada), thanked the outgoing SC Chair, Carmen Fernández (EU), for her leadership. Scientific Council would like to recognize Carmen Fernández through the Scientific merit award for her four years of service as chair of SC and chair of STACREC, as well as chair of the WG-RBMS. Carmen has also played a leadership role in a number of scientific works and initiatives in the SC.

Carmen has piloted the SC boat for the last two years, bringing it to good port under the tremendous conditions of COVID-19. During these two years, the SC has met by videoconference and under her leadership it has managed to carry out a huge amount of work. One of Carmen's distinctive features was her high work capacity and scientific rigor in all her work. Another of Carmen's strengths is her ability to communicate the most complex scientific issues to managers in a clear and simple way. We are sure that the Commission will also miss her in the future.

The SC loses a brilliant scientist and a great colleague and bids her farewell with great sorrow, wishing her all the best in her new position and hoping to see her in the future working again in the SC.

3. SC co-Chair for CESAG

Kathy Sosebee (USA) informed SC that she is willing to continue as co-chair, subject to agreement from her institute. However, she noted that the Commission co-chair will also be from the USA and therefore SC may wish to consider electing a new co-chair in the future.

XIII. ADJOURNMENT

The meeting was adjourned at 13:00 on 24 September 2021.

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

Chair: Miguel Caetano

Due to ongoing restriction relating to the COVID-19 pandemic, the Committee met on 27 May 2021 by correspondence and videoconference to consider environment-related topics and report on conclusions to the Scientific Council. Representatives attended from Canada, Denmark (in respect of Faroe Islands and Greenland), the European Union, Japan, the Russian Federation, Ukraine, the 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 2021 meeting of STACFEN.

The Committee noted the following documents would be reviewed: SCR Doc. 21/002, 21/006, 21/007, 21/009, 21/010 21/023, 20/036, 20/037.

2. Appointment of Rapporteur

Due to the meeting characteristics, it was established that no rapporteur was appointed.

3. Adoption of the Agenda

Due to the meeting characteristics a general agenda was established by the SC.

4. Review of Recommendations in 2020

STACFEN recommended consideration of Secretariat support for an invited speaker to address emerging issues and concerns for the NAFO Convention Area during the 2022 STACFEN Meeting. Contributions from invited speakers may generate new insights and discussions within the committee regarding integration of environmental information into the stock assessment process.

STATUS: STACFEN was unable to secure a guest speaker for the June 2021 meeting due to ongoing restriction relating to the COVID-19 pandemic. This recommendation is **reiterated** and STACFEN will endeavour to have an invited speaker next year.

NAFO usually convenes a symposium on environmental issues every 10 years. The last one was held in 2011 as "ICES/NAFO Symposium on the Variability of the North Atlantic and its Marine Ecosystems during 2000-2009". STACFEN suggested that the forthcoming ICES Symposium (2021) could take the place of the next NAFO symposium. STACFEN therefore recommended that Scientific Council support participation and possible co-sponsorship.

STATUS: NAFO agreed to co-sponsor the symposium "4th Decadal Variability of the North Atlantic and its Marine Ecosystems: 2010-2019" which is advertised as an ICES-NAFO event. The symposium was postponed to April 2022 due to restrictions related to the Covid-19 pandemic. STACFEN therefore **recommends** that Scientific Council support participation in the event.

Further discussions are encouraged between STACFEN and STACFIS members on environmental data integration into the various stock assessments.

5. Oceanography and Science Data (OSD) Report for 2020 SCR 21/007

The Marine Environmental Data Section (MEDS) of the Oceans Science branch, as the Regional Environmental Data Center for NAFO, provided the annual inventory of environmental data collected in the NAFO Convention Area to the NAFO subcommittee for the environment (STACFEN). 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 year 2020 are reported.

Data and information from NAFO member countries were provided by their designated data centre. The data of highest priority are those from the standard oceanographic sections and stations, as described in NAFO SCR DOC. 88-01. Data that have been formatted and archived at MEDS are available to all members on request or are available from DFO institutes. Requests can be made by telephone (613) 990-6065, by e-mail to info@dfo-mpo.gc.ca, by completing an online order form on the MEDS web site at http://www.meds-sdmm.dfo-mpo.gc.ca/isdm-gdsi/request-commande/form-eng.asp. The following table summarizes counts for 2020 by data type.

Data observed in NAFO Convention Area in 2020

Data Type	Platform Type	Counts/Duration
Oceanographic profiles	Autonomous drifting (Argo)	4234* profiles from 178 platforms
	Moorings (Viking)	154* profiles from 4 platforms
	Gliders	4086* profiles from 5 platforms
	Ship	2771 profiles (1042 CTD; 1273 CTD*; and 456 bottle profiles) from at least 16 ships
Surface/near-surface observations	Ship (thermosalinograph)	1438* obs. from 1 ship
	Drifting buoys	1141888* obs. from 311 buoys
	Moored buoys	258546* obs. from 20 buoys**
	Fixed platforms	100204* obs. from 3 platforms
	Water level gauges	12 sites, avg. ~1 year each

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

Data observed prior to 2020 in NAFO Convention Area and acquired between January 2020 and May 2021

Data Type	Platform Type	Counts/Duration
Oceanographic profiles	Ship	4801 profiles (1489 CTD + 3302 bottle + 10 XBT profiles) from 15 ships

6. Highlights of Climate and Environmental Conditions by NAFO Subarea for 2020 (SCR Doc. 21/023)

i) SUBAREA 0 AND 1, GREENLAND AND DAVIS STRAIT

Recent Conditions in Ocean Climate and Lower Trophic Levels

- The ocean climate index in Subarea 0-1 was normal in 2020;
- The initiation of the spring bloom was delayed for a second consecutive year in 2020;
- Total spring bloom production (magnitude) was near normal in 2020.

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 counterpoised by the warmer waters 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.

Ocean Climate and Ecosystem Indicators

The ocean climate index in Subarea 0-1 has been predominantly above or near normal since the early 2000s, except for 2015 and 2018 that were below normal (Figure 1A). After being in 2019 at its highest value since the record high of 2010, the index was normal in 2020. Before the warm period of the last decade, cold conditions persisted in the early to mid-1990s. Spring bloom initiation has been oscillating between early (negative anomalies) and late (positive anomalies) timing between 2003 and 2020 but several notable late bloom onsets were recorded during the late 2010s (Figure 1B). In 2020, the initiation of the spring bloom was later than normal for a second consecutive year. Spring bloom magnitude (total production) remained mostly below to near-normal between 2003 and 2020 except for a few highly productive blooms in 2006, 2015 and 2018 (Figure 1C). The late bloom onsets of 2019 and 2020 are associated to below-normal or near-normal total production for the corresponding years (Figure 1B-C).

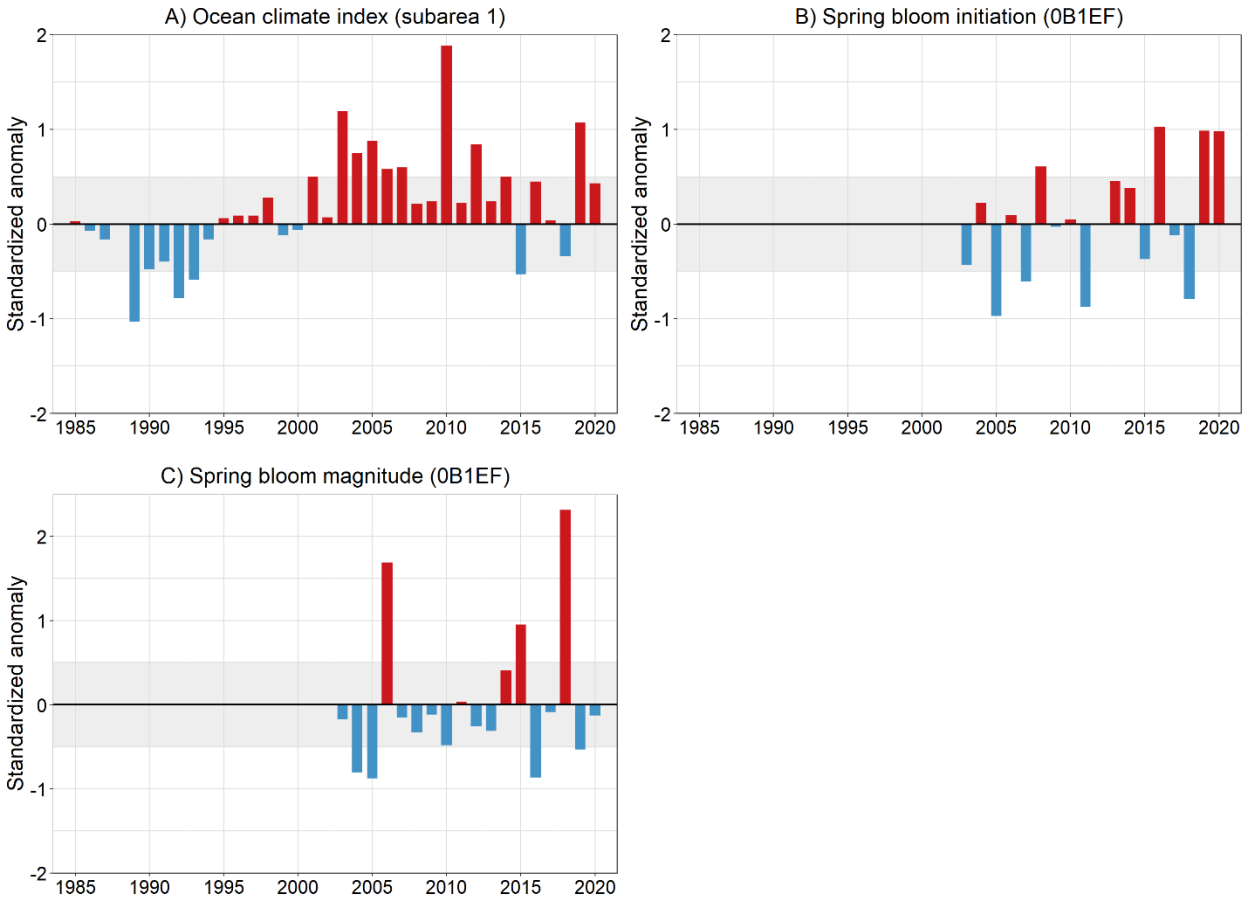

Figure 1. Environmental indices for NAFO Subarea 0 and 1. The climate index (A) for Subarea 0 and 1 is the average of 10 individual time series. These includes standardized anomalies of 4 SSTs time series, 4 temperature time series at 3 hydrographic stations and 2 air temperatures time series (see text for details). Phytoplankton spring bloom initiation (B) and magnitude (C) indices for the 2003-2020 period are derived from three satellite boxes covering NAFO Divs. 0B and 1EF (see text for details). Positive/negative anomalies indicate values above/below (or late/early timing) the long-term average for the reference period. Anomalies were calculated using the following reference periods: 1981-2010 for ocean climate index, 2003-2020 for spring bloom initiation and magnitude. Anomalies within ±0.5 SD (grey rectangle) are considered near-normal conditions.

ii) DIVISION 3M, FLEMISH CAP

Recent Conditions in Ocean Climate and Lower Trophic Levels

- After being below normal between 2015 and 2017, the ocean climate index in 3M has been normal since 2018;
- Spring bloom initiation was near normal in 2020 for a second consecutive year;
- Spring bloom magnitude was below normal in 2020 after three consecutive years of above-normal production;
- The abundance of copepod and non-copepod zooplankton was near normal in 2020 after having remained mostly above normal from 2015 to 2018;
- Zooplankton biomass was near normal in 2020 and has remained mostly near or below normal since the 2016 record-high.

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 sub-surface 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 (Figure 1). 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.

Ocean Climate and Ecosystem Indicators

The ocean climate index in Division 3M (Figure 2A) has remained mostly above normal between the late 1990s and 2013. After the record-high of 2011, the index gradually decreased reaching in 2015 its lowest value since 1993. After been below normal between 2015-2017, the index was normal between 2018 and 2020. Spring bloom initiation has been oscillating between early and late timing between 2003 and 2020 but has remained mostly near or later than normal since 2011 (Figure 2B). Spring bloom magnitude (total production) was below normal in 2020 after three consecutive years of above-normal production (Figure 2C). In general, late bloom onsets are associated with limited production (Figure 2B-C). The abundance of copepod and non-copepod zooplankton show general increasing trends throughout the 1999-2020 time series (Figure 2D-E). However, copepod abundance decreased to below or near-normal levels over the past two years after having remained above normal from 2016 to 2018 (Figure 2D). Similarly, the abundance of non-copepod zooplankton decreased to near-normal in 2019-2020 after four consecutive years of above-normal levels (Figure 2E). Total zooplankton biomass on the Flemish Cap has remained mostly below to near normal since 2015 with the exception of the record-high biomass observed in 2016 (Figure 2F).

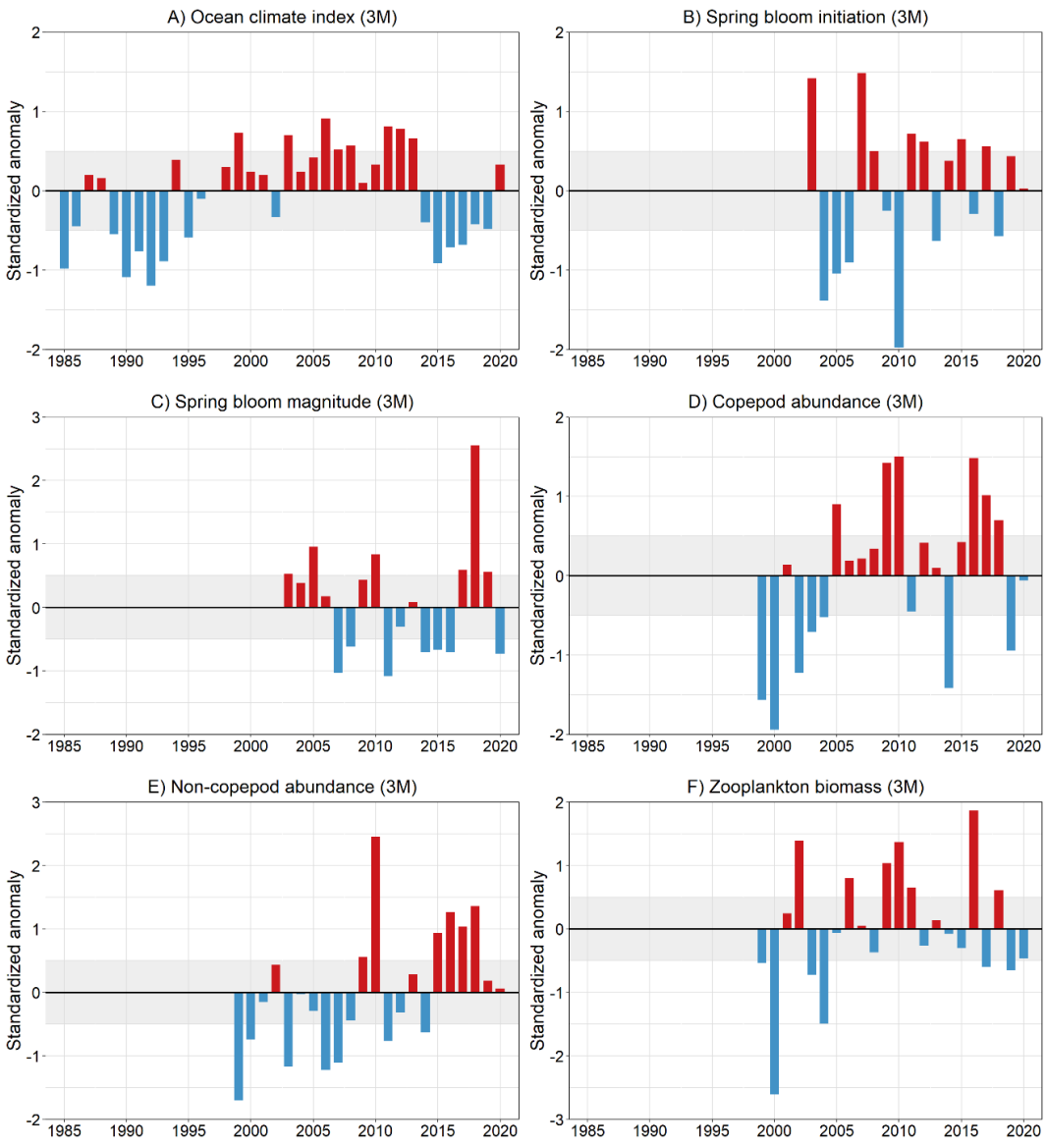

Figure 2. Environmental indices for the Flemish Cap (NAFO Div. 3M). The ocean climate index (A) for the Flemish Cap is the average of 3-time series of standardized ocean temperature anomalies of sea surface temperatures (SSTs), hydrographic section observations, and summer mean bottom temperature over the cap. Positive/negative anomalies indicate values above/below (or late/early timing) the long-term average for the reference period. Anomalies were calculated using the following reference periods: 1981-2010 for ocean climate index, 2003-2020 for spring bloom initiation and magnitude, and 1999-2020 for zooplankton abundance and biomass indices. Anomalies within ±0.5 SD (grey rectangle) are considered near-normal conditions.

iii) DIVISION 3LNO, GRAND BANKS

Recent Conditions in Ocean Climate and Lower Trophic Levels

- In 2020, the ocean climate in NAFO Divs. 3LNO - Grand Bank, was at its warmest value since the record-high of 2011, and at its third highest value since the time series started in 1985;
- Spring bloom initiation was near normal in 2020 for a 2nd consecutive year;
- Spring bloom magnitude decreased to near normal in 2020 after two consecutive year of above-normal production;
- The abundance of copepod and non-copepod zooplankton remained above normal in 2020 for a 5th consecutive year;
- Zooplankton biomass was near normal in 2020 for a second consecutive year following the above-normal levels observed in 2017 and 2018.

The water mass characteristic of the Grand Bank is 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.

Ocean Climate and Ecosystem Indicators

The ocean climate index in Divs. 3LNO (Figure 3A) has remained mostly above normal between the late 1990s and 2013, reaching a peak in 2011. The index has returned to normal conditions between 2014 and 2019 (except for 2017 that was below normal). In 2020, the ocean climate index was back to above-normal value, reaching the third highest value of the entire time series started in 1985 (only 2011 and 2006 were warmest). The initiation of the spring bloom has remained near or earlier than normal on the Grand Bank since 2017 after the two notably late blooms of 2015 and 2016 (Figure 3B). Spring bloom magnitude (total production) decreased to near normal in 2020 after two consecutive years of above-normal production (Figure 3C). Spring bloom production has remained mostly near or above normal since the record low observed in 2012 (Figure 3C). The abundances of copepod and non-copepod zooplankton show clear increasing trends since the beginning of the time series in 1999 with anomalies transitioning from negative to positive around 2010 (Figure 3D-E). Both copepod and non-copepod abundances remained above normal in 2020 for a 5th consecutive year with the 4th highest anomaly of the time series (Figure 3D-E). Zooplankton biomass drastically declined on the Grand Bank between 2002 and 2014 but has increased to near or above-normal levels since 2015 (Figure 3F).

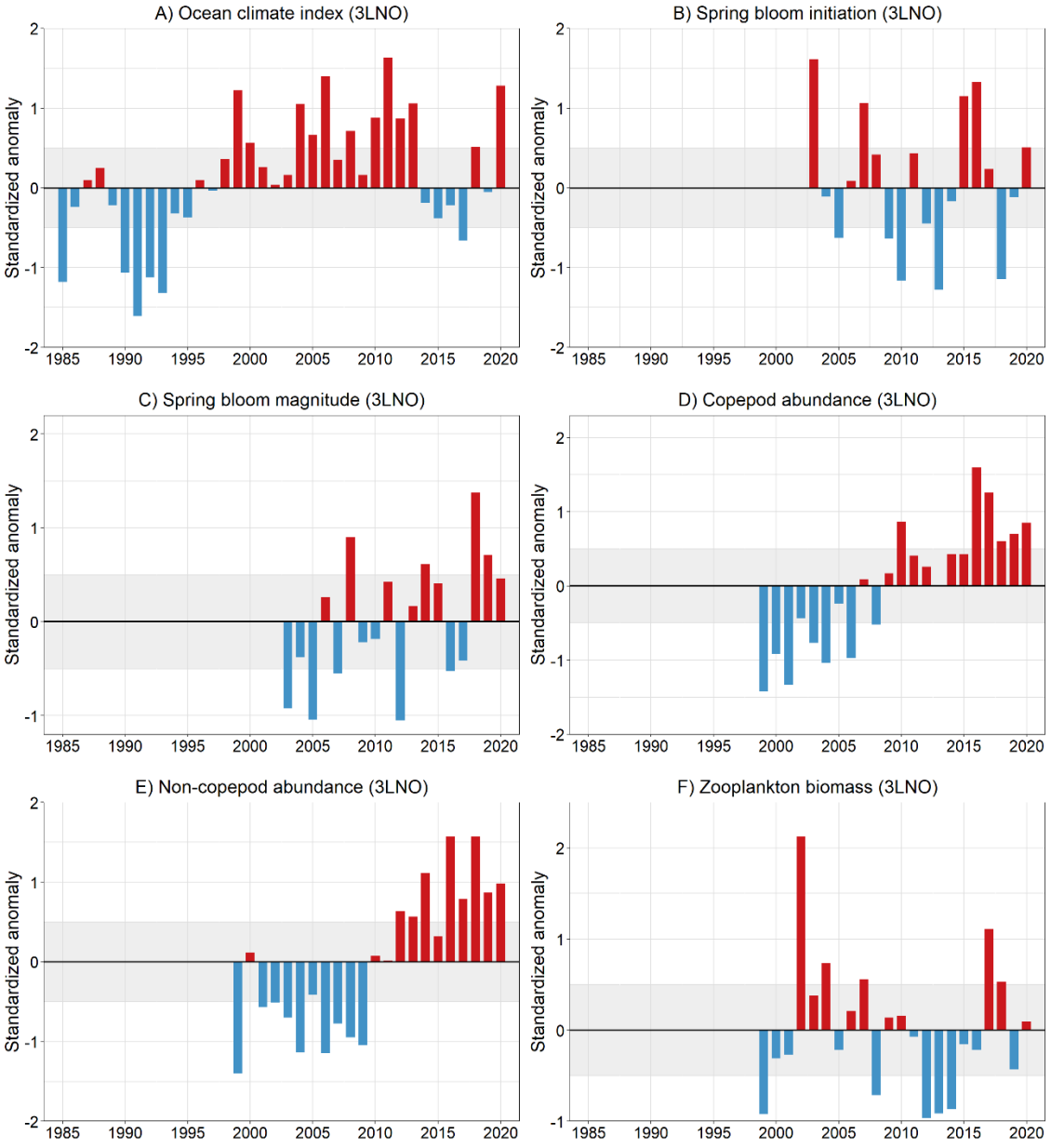

Figure 3. Environmental indices for NAFO Divisions 3LNO. The ocean climate index (A) is the average of 12 individual time series of standardized ocean temperature anomalies: SSTs for Divs. 3L, 3N and 3O, vertically average ocean temperature (0-176 m) at Station 27, mean temperature and CIL volumes over standard hydrographic sections Seal Island, Bonavista and 3L portion of Flemish Cap, and mean bottom temperature in 3LNO for spring and fall. Positive/negative anomalies indicate values above/below (or late/early timing) the long-term average for the reference period. Anomalies were calculated using the following reference periods: 1981-2010 for ocean climate index, 2003-2020 for spring bloom initiation and magnitude, and 1999-2020 for zooplankton abundance and biomass indices. Anomalies within ±0.5 SD (grey rectangle) are considered near-normal conditions.

iv) SUBAREAS 2, 3 AND 4, NEWFOUNDLAND AND LABRADOR SHELF, SCOTIAN SHELF AND GULF OF MAINE

Recent Conditions in Ocean Climate and Lower Trophic Levels

- In 2020, subareas 2, 3 and 4 were all above normal, making the cumulative anomaly the 5th warmest since 1980;
- Spring bloom initiation and magnitude were, on average, near normal in subareas 2-3-4 in 2020;
- Mean copepod abundance was above normal in 2020 and especially higher in subareas 2-3 compared to subarea 4;
- Mean abundance of non-copepod zooplankton remained above normal across subareas 2-3-4 for a 5th consecutive year and was generally higher in subareas 2-3 compared to subarea 4;
- Mean zooplankton biomass was near normal in 2020 for a 5th consecutive year and was higher in subarea 2 compared to subareas 3-4.

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, 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 south-westward 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 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.

Ocean Climate and Ecosystem Indicators

A cumulative climate index for NAFO subareas 2, 3 and 4 (from the Labrador Shelf to the Scotian Shelf) is presented in Figure 4A. After a somewhat cold period from the late 1980s to the early 1990s, the index has remained relatively high since about the mid-2000's, with 2006, 2010 and 2012 being respectively the second, third and first warmest anomalies since 1985. After a recent return to near-normal values between 2014 and 2019 (mostly driven by cooler temperatures in SA 2 and 3) the index was back to a positive anomaly in 2020 (5th warmest year since 1980).

Mean timing of the spring bloom initiation across subareas 2-3-4 remained mostly near normal between 2003 and 2020 with few early onsets in 2006 and 2010, and one year when blooms were delayed across the region

in 2015 (Figure 4B). Mean spring bloom production also remained mostly near normal throughout the time series except for the above-normal productions observed in 2003 and 2006 and for the below-normal production of 2008 (Figure 4C). Spring bloom production was lower in subarea 2 compared to subareas 3 and 4 in 2018 and 2019 and was near normal in all subareas in 2020 (Figure 4C). Mean copepod abundance across subareas 2-3-4 rapidly increased between 1999 and 2006 before levelling off to near-normal levels until 2015 (Figure 4D). Copepod abundance was especially high in subarea 2 in 2020 (Figure 4D). Anomalies have been mostly positive in all three subareas since 2010 with above-normal levels observed in 2016 and 2020 (Figure 4D). Mean abundance of non-copepod zooplankton increased in all subareas in the early 2010s and has remained above normal since 2016 (Figure 4E). In general, the abundance of non-copepods was comparatively higher in subareas 2 and 3 than in subarea 4 between 2016 and 2020 (Figure 6E). Mean zooplankton biomass in the region decreased from above-normal in 2002 to below-normal in 2015 (Figure 4F). Biomass has since remained at a near-normal level, especially due to an increase in subarea 2 and 3 (Figure 4F).

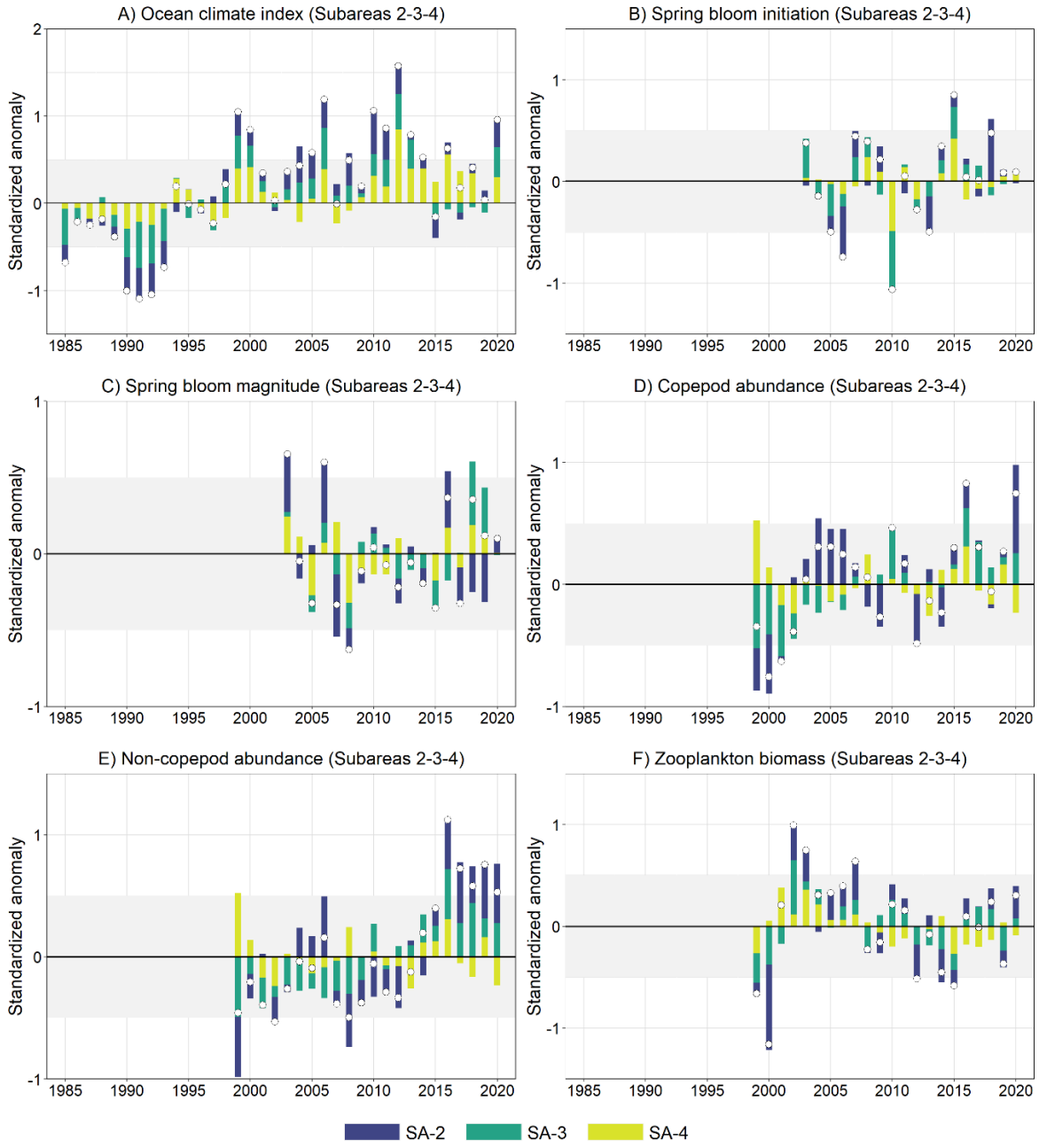

Figure 4. Environmental indices for NAFO Subareas 2-3-4. Anomalies for ocean climate index (A) are the result of the average of 8, 16 and 12 individual time series respectively for SA 2, 3 and 4. Mean positive/negative anomalies (open white circles) indicate conditions above/below (or late/early timing) the long-term average for the reference period. Colour bar height indicate the relative contribution of each subarea to the mean anomaly. Anomalies were calculated using the following reference periods: 1981-2010 for ocean climate index, 2003-2020 for spring bloom initiation and magnitude, and 1999-2020 for zooplankton abundance and biomass indices. Anomalies within ±0.5 SD (grey rectangle) are considered near-normal conditions.

7. Review of the physical, biological and chemical environment in the NAFO Convention Area during 2019

a) Subarea 1. Report on hydrographic conditions off Southwest Greenland May/June 2020 (SCR Doc. 21/002).

Hydrographic conditions were monitored at 10 hydrographic standard sections in June 2020 across the continental shelf off West Greenland. Three offshore stations have been chosen to document changes in hydrographic conditions off Southwest Greenland. The coastal water showed temperatures below the long-term mean south of the Sisimiut section. After some years with a relative saline Subpolar Mode Water mass, salinity dropped below its long-term mean.

b) Subarea 1. Hydrographic conditions off West Greenland in 2020 (SCR Doc. 21/006).

An overview of the atmospheric and hydrographic conditions off West Greenland in autumn 2020 is presented. In winter 2019/2020, the NAO index was positive for the seventh consecutive winter. The annual mean air temperature at Nuuk Weather Station in West Greenland was -0.8 °C in 2020, which was 0.6 °C above the long-term mean (1981-2010). The core properties of the water masses of the West Greenland Current (WGC) are monitored at two standard NAFO/ICES sections across the western shelf and continental slope of Greenland near Cape Desolation and Fyllas Bank. However, the Cape Desolation Section had to be abandoned due to time constraints in autumn 2020. The water properties between 0 and 50 m depth at Fyllas Bank Station 4 are used to monitor the variability of the fresh Polar Water component of the West Greenland Current. In 2020, the temperature of this water mass was 2.92 °C, which was 0.28 °C above its long-term mean (1983-2010). The salinity decreased in 2020 and was 0.38 below its long-term mean.

c) Subareas 1 and 2. Meteorological, Sea Ice, and Oceanographic Conditions in the Labrador Sea during 2020 (SCR Doc. 21/037)

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. Even though in the winter of 2020, the central Labrador Sea lost more heat to surface cooling than in the previous winter, the loss remained near-normal for a third straight year. The recent reduction in the seasonal cooling of the Labrador Sea contrasts a 27-year record high winter heat lost in 2015. The 2020 winter (Dec-Mar) NAO index was above-normal and the highest after reaching its record high in 2015. However, the sea level pressure pattern was not associated with strong westerly winds along the Labrador coast. This led to, respectively, near-normal and above-normal winter and spring air temperatures in the Labrador Basin domain. Both winter and spring sea surface temperatures in the Labrador Basin were above-normal. Winter sea ice extent was below-normal in the Davis Strait, Northern Labrador Shelf and Labrador Shelf regions. Spring sea ice extent was also below-normal in all three regions. With respect to temperature anomalies averaged annually over the central Labrador Sea, the upper 100 m layer was the coldest in the 2002-2020 period in 2015 and 2018. After 2018, this layer attained above-normal annual temperatures in 2019-2020, reaching a 2011-2020 temperature high in 2019, then slightly cooling yet remaining above-normally warm through 2020. 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. The key factor that has contributed to the recurrent deepening of convective mixing in the three straight winters following the winter of 2015 was not as much air-sea heat exchange as the water column preconditioning set by convective mixing in the previous years. Such multiyear persistence of deepening winter convection, continuing through the winter of 2018, when it exceeded 2000 m in depth, has resulted in the most voluminous, densest and deepest formation of Labrador Sea Water since 1994. In the winter of 2019, the situation has however changed with winter convection not generally exceeding 1400 m and

the intermediate layer starting to warm to the point of fully reversing the seawater density trend to negative. Even though, wintertime mixing reached marginally deeper in 2020 (by 100 m or so), and the intermediate layer slightly cooled, the negative density trend prevailed. Between 2018 and 2020, the annual mean intermediate layer density reduced by about 0.01 kg/m^3. Overall, the changes in the depth of winter convection and intermediate layer properties between these years imply that the effect of the water column preconditioning on winter convection has weakened since 2018. Vertical distributions of dissolved oxygen and CFC (anthropogenic gases used as tracers of convectively-formed water masses in the ocean) concentrations in the central Labrador Sea based on quality controlled drift-corrected measurements assembled since 1990 follow very closely multiyear events of recurrently persistent renewal of dense deep Labrador Sea water in the Atlantic Ocean. Bedford Institute of Oceanography North Atlantic model simulations suggest that the transport of the Labrador Current generally decreased between 1995 and 2014, increased between 2014 and 2019, and slightly decreased in 2020. The Atlantic meridional overturning circulation index based on this model demonstrates a general weakening trend since mid-1990s until 2004, then slight strengthening lasting until 2011, then weakening again until the overturning weakest point was reached in 2019. The overturning circulation started to strengthen in 2020, but it is too early to associate this short-term increase with a reversal of the current negative trend in the Atlantic meridional overturning circulation.

d) Subareas 2, 3 and 4. Environmental and Physical Oceanographic Conditions on the Eastern Canadian shelves during 2020 (SCR Doc. 21/009).

Oceanographic and meteorological observations in NAFO Subareas 2, 3 and 4 during 2020 are presented and referenced to their long-term averages. The winter North Atlantic Oscillation (NAO) index, a key indicator of the direction and intensity of the winter wind field patterns over the Northwest Atlantic was positive for a 7th consecutive year (since 2012, only 2013 was negative). The air temperatures across the NW Atlantic were about normal in the Arctic and in Labrador, and warmer than average in Newfoundland and in sites on the coast of the Scotian Shelf and the Gulf of Maine. Winter average sea ice conditions were below normal on the Newfoundland and Labrador for the first time since from 2013. Annual sea surface temperature (SST) across the NAFO Subareas 2, 3 and 4 were above normal overall for the zone for the first time since 2014. While SSTs remained below normal in parts of the Scotian Shelf in October, they were above normal on the Labrador and Newfoundland Shelf, reaching series records in 3MNO in October. The year ended with December record highs on the Scotian Shelf. The spatially averaged bottom temperature was above normal across the zone except in NAFO Divisions 2J and 3K where they were near normal. There were, however, no spring measurements in 3Ps and 3LNO due to a cancelled survey. The Labrador Current weakened to normal during 2019 and 2020 on the NL slope and has been below normal fairly consistently since 2014 on the Scotian slope.

e) Subareas 2, 3 and 4. Biogeochemical oceanographic conditions in the Northwest Atlantic during 2020 (SCR Doc. 21/010).

Biogeochemical variables collected in 2020 from coastal high-frequency monitoring stations and seasonal sampling of standard oceanographic sections covering NAFO Subareas 2-4 are presented and referenced to earlier periods when available. We review spatial and inter-annual variations in phytoplankton spring bloom indices as well as vertically integrated nitrate, chlorophyll *a*, zooplankton abundance, and zooplankton biomass inventories collected by the Atlantic Zone Monitoring Program (AZMP) and ships of opportunity in 2020. Spring bloom timing, duration, and magnitude were mostly near normal across the Canadian NW Atlantic except for the early and exceptionally long bloom observed on the Georges Bank. In general, nitrate and chlorophyll inventories remained near or above normal on the Newfoundland and Labrador shelves, Flemish Cap, Grand Bank and Gulf of St. Lawrence, and below to near normal on the Scotian Shelf. The abundance of copepod and non-copepod zooplankton increased or remained high on the Newfoundland and Labrador shelves and the Grand Bank, but generally decreased in the Gulf of St. Lawrence and on the Scotian Shelf. The abundance of large *Calanus finmarchicus* copepods increased on the northern Newfoundland and Labrador shelves and western Scotian Shelf and decreased on the Flemish Cap and the Grand Bank. The abundance of small *Pseudocalanus* spp. copepods increased on the Newfoundland and Labrador shelves, but drastically decreased

almost everywhere else. Trends in total zooplankton biomass indicated an increase for the Newfoundland and Labrador shelves, and an overall decrease for the Gulf of St. Lawrence compared to 2019.

f) Subareas 5 and 6. Hydrographic Conditions on the Northeast United States Continental Shelf in 2020 (SCR Doc. 21/036).

A brief overview is presented of the atmospheric and oceanographic conditions on the Northeast U.S. Continental Shelf during 2020. Hydrographic monitoring typically conducted by the operational oceanography programs of the Northeast Fisheries Science Center (NEFSC) were suspended for the entirety of 2020 due to the global pandemic. Time series measurements from a handful of moored buoys in the Gulf of Maine and Southern New England Shelf were examined in their place. All observations point to warmer than average conditions across the region, including in the Cold Intermediate Layer in the eastern Gulf of Maine. Moored measurements in Northeast Channel during fall indicate that warm and salty conditions persist, suggesting that the slope water entering the Gulf of Maine continues to be dominated by southern sources as they have for the past decade.

8. The Formulation of Recommendations Based on Environmental Conditions

STACFEN **recommends** *consideration of Secretariat support for an invited speaker to address emerging issues and concerns for the NAFO Convention Area during the 2022 STACFEN Meetin*g.

Contributions from invited speakers may generated new insights and discussion within the committee regarding integration of environmental information into the stock assessment process.

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

9. National Representatives

The National Representatives for hydrographic data submissions was updated by the Secretariat: E. Valdes (Cuba), Di Wan (Canada), **Vacant** (Denmark), **Vacant** (France), **Vacant** (Germany), **Vacant** (Japan), H. Sagen (Norway), **Vacant** (Portugal), E. Tel (Spain), L. J. Rickards (United Kingdom), and P. Fratantoni (USA), **Vacant** (Russian Federation).

10. Other Matters

No other subject was discussed.

11. Adjournment

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

The meeting was adjourned at 10:00 on 27 May 2021.

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

Chair: Margaret Treble Contributor: Alexis Pacey

The Committee met by Webex, on 24 September 2021, to consider publications and communications related topics and report on various matters referred to it by the Scientific Council. Representatives attended from Canada, European Union (France, Portugal, and Spain), Japan, the Russian Federation, United Kingdom, Ukraine, Norway 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 as given in the Provisional Agenda distributed prior to the meeting was adopted.

4. Review of Recommendations in 2020

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

STACPUB reiterates the recommendation from 2018 and **recommends** that *the Secretariat and Chair of STACPUB work to develop guidelines for SCS documents.*

> *STATUS: This has been completed*. The guidelines are on the NAFO website: https://www.nafo.int/Library/Science/SC-Documents.

STACPUB **recommends** that the Secretariat continue to investigate solutions that would be compatible with reference management software.

> *STATUS*: *This has been completed – A solution was found and has been implemented.* The Crossref DOIs of each article are linked by integrating DataCite coding and enabling our SQL server to connect each DOI to various reference management software programs. Two simple buttons were created to assist in downloading the citations. The copy function remains as is for users who do not have reference management software. In conjunction with this project, increasing visibility of reports and PDFs of journal articles has been completed.

STACPUB **recommends** that the Associate Editors be surveyed to determine if they would agree to have the expertise categories removed from their profiles on the JNAFS website.

> *STATUS*: *This has been completed* – The expertise categories have been removed from the Associate Editor profiles on the JNAFS website, as well as on the introductory page of the NAFO website.

5. Review of Publications

a) Journal of Northwest Atlantic Fishery Science (JNAFS)

Volume 51, Regular issue, was published and printed in December 2020, containing five articles. Currently, Volume 52 has 7 articles; one published, two in review with associate editors, two in revision/re-submit stage with the authors, one in production, and one new submission, not assigned yet to an Associate Editor.

In February 2021 an e-mail promoting JNAFS and calling for paper submissions was sent out to contacts on the NAFO and JNAFS distribution list. Similar e-mails had also been sent in 2018 and 2019, following a suggestion made in 2017 to try to increase awareness.

The Secretariat has had an increase in the number of requests to not send out printed versions of the Journal because it can be accessed online. If we stopped printing JNAFS, or printed copies only for those that specifically request a printed copy then this could also reduce publishing costs. STACPUB **recommend** *that the Secretariat stop producing printed copies of the Journal*.

b) NAFO Scientific Council Reports

The NAFO Scientific Council Reports 2020 (Redbook) volume (462 pages) was published during May 2021 online.
No copies were printed due to meetings being held virtually. Print copies are available upon request.

c) NAFO Scientific Council Studies

There were no submissions for 2020.

d) NAFO Commission-Scientific Council Reports

These reports are found in the Meeting Proceedings of the Commission from September 2019-August 2020 (362 pages) and were printed and distributed in September 2020. Five copies were made with a spiral binding. Fewer copies were printed due to meetings being held virtually.

e) Aquatic Sciences and Fisheries Abstracts (ASFA)

Most science publications and SCR documents for 2020 have been submitted to ASFA as of 30 April, 2021. SCS documents will be indexed using the new software program, OpenASFA, developed by FAO team. Training took place during the spring of 2021 and further developments and enhancements are ongoing.

f) Website link to PDFs

The Senior Pupblications/Web Manager continues to look for improvements to our ability to have easy access to reports and JNAFS articles. This has been completed and implemented. All PDFs are found in the initial article listing and below the abstract.

6. Other Matters

a) ASFA 2020 Board Meeting

Alexis attended the ASFA Board Meeting virtually, which met 13-17 September 2021. Discussions took place around the new software, OpenASFA, partnership agreements, future plans and strategies for ASFA, such as outreach and funding, and 50th anniversary celebration of ASFA's inception. Action items and discussions from the meeting will be completed when the ASFA Secretariat finalizes the report.

7. Adjournment

Meeting adjourned 24 September 2021.

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

Chair: Karen Dwyer Rapporteur: Tom Blasdale

1. Opening

The June Scientific Council meeting was preceded by a virtual meeting on May 3, during which information on biological surveys in the NAFO Regulatory Area were presented. There was a discussion about the effects of the Covid-19 pandemic on surveys carried out in 2020 and whether the assessments in June would be affected. Future surveys for 2021 were also discussed. There was only one item discussed at the June 2021 meeting for STACREC, and this was the initiation of a longline survey of the Flemish Cap (Div. 3M) carried out by the DFG. In September the meeting was reopened to discuss the results of the longline survey.

2. Appointment of Rapporteur

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

3. Review of previous recommendations from 2020 and new recommendations from 2021

Previous recommendations were not examined at the June meeting and no new recommendations were made in 2021 due to constraints to the meeting from Covid-19.

Survey-related recommendations (previous and new recommendations)

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 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 will 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.

The workshop goal was to provide best practices to deal with survey effort reduction and the need for contingency planning was also emphasized. The potential consequences of survey effort reduction were summarized, including increased uncertainty, biased outcomes, the reduced ability to detect distribution shifts, changes in productivity, etc. It was also emphasized that not all information collected may be used in stock assessment but its value in the future is unknown and may be increasingly important to address new emerging priorities.

Numerous case studies were presented from various areas of the world summarizing their surveys as well as those that provided analytical approaches to filling in gaps as well as analysis of the impacts of shortcomings.

Approaches dealing with decreasing survey coverage varied from resampling survey data to simulating distribution and abundance data, up to a complete MSE study of the impacts of changing survey coverage on stock assessment.

A follow-up meeting is planned but dates and location not yet decided.

The full report is available at: ICES. 2020. ICES Workshop on unavoidable survey effort reduction (WKUSER).

ICES Scientific Reports. 2:72. 92pp. http://doi.org/10.17895/ices.pub.7453

In 2019, STACREC made the following recommendation:

STACREC **recommends** the *following actions for future years whenever survey coverage issues arise*:

The STACREC report should contain, after the general survey presentation, a summary of the decisions and conclusions stock by stock regarding whether the survey can be used as a stock index for that year.

The mean proportion (over time) of total survey biomass in the survey strata missed that year should be calculated.

At this time, the following may be used as initial ("preliminary") guidelines based on the value of the mean proportion of total survey biomass in the survey strata missed in that year:

- If it is <10%: the survey index of that year is most likely acceptable.
- If it is between 10% and 20%: the survey index of that year is questionable and needs to be examined carefully before deciding whether it is acceptable.
- If it is >20%: the survey index of that year is most likely not acceptable. Any decision to accept it would require a clear and well justified rationale.

These are preliminary guidelines and sampling biases may also be relevant in the considerations for each specific stock and survey. In particular, the finer structure of the indices needs to be considered if they are used disaggregated by age or length in stock assessments.

It has been suggested that an added guideline might be: For age groups where there is a greater than 10% difference between total survey biomass in the survey strata missed that year in the index used (total or mean numbers), then it should be excluded from the model, if the model can handle missing values. However, there was no time to discuss this at the June 2020 meeting and therefore this discussion will be deferred to June 2021. This discussion was once again deferred to June 2022 due to lack of time at the virtual meeting.

All other recommendations will be deferred to next year (2022).

4. Fishery Statistics

a) Progress report on Secretariat activities in 2020/2021

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. It was noted that many member states did not provide data in a timely manner, and it was recommended that the Secretariat send out a reminder before the deadline(s).

Table 1. Dates of receipt of STATLANT 21A reports for 2018-2020 and 21B reports for 2018-2020 received prior to 02 June 2021

Country/component	STATLANT 21A (deadline, 1 May)			STATLANT 21B (deadline, 31 August)		
	2018	2019	2020	2018	2019	2020
CAN-CA		9 Jun 20				
CAN-SF	29 Apr 19	17 Apr 20	30 Apr 21	30 Aug 19	2 Jul 20	
CAN-G		14 May 20	5 May 21	23 Aug 19		
CAN-NL	17 May 19	30 Apr 20	30 Apr 21	4 Sep 19	31 Aug 20	31 Aug 21
CAN-Q						
CUB						
E/BUL						
E/EST	30 Apr 19	30 Apr 20	30 Apr 21	17 Dec 19	29 Jun 20	23 Aug 21
E/DNK	1 May 19	26 May 20	27 May 21	27 Aug 19	21 Aug 20	21 Jul 21
E/FRA						
E/DEU	30 Apr 19	18 May 20	30 Apr 21	19 Sep 19	29 Jun 20	30 Aug 21
E/LVA	24 Apr 19		26 Apr 21			
E/LTU	24 Apr 19			1 July 19		3 Jul 21
EU/POL						
E/PRT	30 Apr 19	29 May 20	26 Apr 21	19 Sep 19	31 Aug 20	28 Aug 21
E/ESP		14 May 20	31 May 21	12 Dec 19	24 Jun 20	7 Jun 21
GBR						
FRO	22 May 19	3 Jun 20	12 Jan 21	18 May 19	15 Dec 20	12 Jan 21
GRL	29 Apr 19	24 Apr 20	3 May 21	22 Aug 19	25 Aug 20	30 Aug 21
ISL						
JPN	23 Apr 19	8 May 20	28 Apr 21	30 Aug 19	28 Aug 20	24 Aug 21
KOR						
NOR	25 Apr 19	27 May 20	10 May 21	26 Aug 19	4 Sep 20	1 Sep 21
RUS	14 May 19	27 May 20	30 Apr 21			30 Aug 21
USA	10 Jun 19					
FRA-SP	14 Mar 19	8 May 20	21 Jun 21			
UKR						

5. Research Activities

a) Biological Sampling

i) Report on activities in 2020/2021

STACREC reviewed the list of Biological Sampling Data for 2020 prepared by the Secretariat and noted that any updates will be inserted during the summer. The SCS Document was finalized for the September 2021 Meeting.

Report by National Representatives on commercial sampling conducted

Designated experts were asked to provide some information on whether the limitations from COVID-19 impacted the ability of observers to collect commercial information. This was agreed to be done on a stock by stock basis, but overall it was seen that although there was reduced sampling from Spanish trawlers and possibly other fleets, some sampling was available for 2020.

Canada-Newfoundland (SCS Doc. 21/08, plus information within various SC assessment documents):

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: Greenland halibut (SA 2 + Div. 3KLMNO), Atlantic salmon (SA 2+3+4), Arctic char (SA 2), Atlantic cod (Div. 2GH, Div. 2J+3KL, Div. 3NO, Subdiv. 3Ps), American plaice (SA 2 + Div. 3K, Div. 3LNO, Subdiv. 3Ps), witch flounder (Div. 2J3KL, 3NO, 3Ps), yellowtail flounder (Div. 3LNO), redfish (Subarea 2 + Div. 3K, 3LN, 3O, 3P4V), Northern shrimp (Subarea 2 + Div. 3KLMNO), Iceland scallop (Div. 2HJ, Div. 3LNO, Subdiv. 3Ps, Div. 4R), sea scallop (Div. 3L, Subdiv. 3Ps), snow crab (Div. 2J+3KLNO, Subdiv. 3Ps, Div. 4R), squid (SA 3), thorny skate (Div. 3LNOPs), white hake (Div. 3NOPs), lobster (SA 2+3+4), capelin (SA 2 + Div. 3KL), and marine mammals (SA 2,3, and 4). Additionally, a summary of recent stock assessments and research projects on several of marine species are included in this report.

Denmark/Faroe Islands (SCS 21/10):

Data on catch rates were obtained from trawl and longline fisheries in NAFO Div. 3M for Atlantic cod from 2014 to 2019 2020 (n=1219, NAFO-observers). Length frequencies (NAFO-observers and crew members) were also available from 2014 to 2019 2020 (number of samples, n=219230). In addition, weight measurements were taken by crew members from 2014 to 2019 2020 (n=8394). The fishery has been conducted exclusively by longliners since 2017.

Denmark/Greenland (SCS 21/11):

Data on catch rates were obtained from trawl, gillnet and longline fisheries in NAFO Div 1A-F for American plaice, Arctic char, Atlantic halibut, Atlantic salmon, Atlantic cod, capelin, snow crab, Greenland cod, Greenland halibut, roundhead grenadier, roundnose grenadier, haddock, herring, lumpfish, polar cod, Arctic cod, deep-sea redfish, golden redfish, saithe, scallops, sea cucumber, Greenland shark, dogfish shark, Northern shrimp, skate, tusk, and wolffish. Length frequencies, from Greenland, were available for Greenland halibut trawl fishery in 1AB and 1CD, longline fishery in 1A, 1C and 1D inshore, and gillnet fishery in 1A inshore; and for cod trawl fishery offshore in Div. 1F; from the longline fishery in 1A, and 1D inshore, from the gillnet fishery 1A inshore, with handlines in 1C and 1D inshore, and from pound nets in 1C-D inshore. A total of 314 length samples were taken, and 52047 individuals, including Greenland halibut, cod and shrimp were measured, in NAFO Div. 1-F. A total of 1612 otoliths in Div. 1A-F from cod, Greenland halibut and herring were collected. Also, 562 DNA samples in 1F from cod and 1A, 1C, 1D and 1F from Greenland halibut were collected. A total of 31 stomachs from herring were collected.

EU-Germany (NAFO SCS Doc 21/07):

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

EU-Estonia (NAFO SCS Doc. 21/13):

Catch rate data was obtained from two fishing vessels in Subarea 3 (one for the full year and one for only 5 months). The main target species were redfish, cod and Greenland halibut. NAFO observers took length samples of these species and yellowtail flounder. The number of samples was reduced by almost half in 2020 but the number of fish measured was reduced by only one third compared to the previous year.

EU-Portugal (NAFO SCS Doc. 21/05):

Data on catch rates were obtained from trawl catches for: redfish (Div. 3LMNO); Greenland halibut (Div. 3LMN) and cod (Div. 3M). Data on length composition of the catch were obtained for: redfish (*S. mentella*) (Div. 3LMNO); American plaice (Div. 3MNO); cod (Div. 3MN); Greenland halibut, redfish (*S. marinus*) and roughhead grenadier (Div. 3LM); thorny skate and witch flounder (Div. 3M).

EU-Spain (NAFO SCS Doc. 21/06) :

A total of 10 Spanish trawlers operated in Div. 3LMNO NAFO Regulatory Area (NRA) during 2020, amounting to 1,200 days (19,051 hours) of fishing effort. Total catches for all species combined in Div. 3LMNO were 16,339 tons. Although there were NAFO observers (NAFO Observers Program) present, only one IEO scientific observer was onboard Spanish vessels during 2020, comprising a total of 31 observed fishing days, around 3% coverage of the total Spanish effort. Besides recording catches, discards and effort, this observer 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 2020, 37 length samples were taken, with 4,816 individuals of different species examined to obtain the length distributions.

Due to the special COVID-19 pandemic situation that has occurred in 2020, the information available on Spanish commercial fishing activity in the NRA is quite poor.

Japan (NAFO SCS Doc. 21/04):

Since 2016, one Japanese otter trawler operated in Div. 3L and 3M. The total catch including discards was 1,765 tons. Target species (main fishing Divisions) (catch) were Greenland halibut (3L) (1,075 tons), redfish (3LM) (1,058 tons). Number of size measurements in 2020 for Greenland halibut and redfish were 2,950, and 1,900 respectively. There were no catches of yellowtail flounder in 2020.

Russia (NAFO SCS Doc. 21/09):

Catch rates were available from Greenland halibut (Divs. 1ACD, 3LMN, with bycatch statistics), Atlantic cod (Div. 3LMNO), redfish (Divs. 3LN, 3M, 3O, with bycatch statistics), yellowtail flounder (Div. 3N), skates (Div. 3LMNO), witch flounder (Div. 3LMNO), roughhead grenadier (Div. 3LM), roundnose grenadier (Div. 3LN), white hake (Div. 3NO) and Atlantic halibut (3LMNO). Length frequencies were obtained from Greenland halibut (Divs. 1A, 1D, 3LMN), redfish (*Sebastes fasciatus* in Divs. 3LN, *S. mentella* in Div. 3L), roughhead grenadier (Divs. 3LM), roundnose grenadier (Divs. 3LM), witch flounder (Divs. 3L), skates (*Amblyraja radiata* in Divs. 3LM), blue wolffish (Divs. 3LM), blue antimora (*Antimora rostrata* in Divs. 3LM), black dogfish (*Centroscyllium fabricii* in Div. 3O), threebeard rockling (*Gaidropsarus vulgaris* in Div. 3L), red hake (*Urophycis chuss* in Div. 3L), greater eelpout (*Lycodes esmarkii* in Div. 3L) and Marlin-spike grenadier (*Nezumia bairdii* 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. 21/16):
The report described catches and survey indices of 37 stocks of groundfish, invertebrates and elasmobranchs. Of note, no indices for 2020 were available due to COVID-19. 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, tagging studies, and observer trips.

b) Biological Surveys

i) Review of survey activities in 2020 and early 2021 (by National Representatives and Designated Experts)

The May 3, 2021, meeting also reviewed the survey activities and data by contracting parties prior to the Scientific Council meeting in June and to evaluate whether the survey coverage was useful for stock assessments, especially pertaining to limitations of the COVID-19 pandemic. The Canadian Spring survey was not carried out in 2020, nor was the EU-Spain 3NO or 3L surveys.

Canada – Newfoundland and Labrador (SCR Doc. 21/04):

Research survey activities carried out by Canada (Newfoundland and Labrador Region) were summarized, and stock-specific details were provided. Canada-NL conducts two stratified random multispecies bottom trawl surveys per year, both using the Campelen 1800 survey trawl. In 2020, the spring multispecies survey was cancelled due to the emerging Covid-19 pandemic. The 2020 autumn RV survey went ahead with enhanced safety protocols. The autumn survey was conducted from late-August to mid-December in Divs. 2HJ3KLNO, and successfully completed 472 out of 674 planned tows (70%), covering 174 out of 211 planned strata (82%). The autumn survey fishes to a maximum depth of 1500m in 2HJ3KL and 732m in 3NO.

The cancelling of the spring survey and the reduced coverage of the autumn survey add to a recent trend of survey coverage issues in the Canada-NL surveys. In general, extensive mechanical delays during both spring and autumn surveys in recent years have resulted in reduced survey coverage, interchange of research vessels outside of their normal area coverage pattern and have extended the time required to complete surveys of the individual divisions. The autumn survey has had particular trouble covering the deep strata in Div. 2H and Div. 3L. In addition, Divs. 3NO were completely excluded from the 2014 autumn survey. Spring surveys have generally provided good coverage of the survey area prior to 2014 but coverage of Div. 3L has been poor and incomplete in three of the last five years. Deficiencies in these surveys combined with those over 1995-2008 (see Brodie and Stansbury, 2007, Healey and Brodie, 2009) impact the assessments of many groundfish and invertebrate stocks to varying degrees, uncertainties which are typically not factored into the assessment results nor management advice. Nevertheless, recent negative trends in survey indices for several Grand Bank stocks raise concern over the status of many of the fishery resources in this area and poor survey coverage results in a higher degree of uncertainty with respect to monitoring and understanding the ecosystem changes that appear to be occurring in this area.

STACREC noted continued concern over deficiencies in the spatial coverage of the Canadian surveys in recent years, and the potential impact on the ability to detect signal from noise in regard to evaluating trends in biomass and abundance of various species. The reduced survey coverage is generally considered to have led to increased, albeit unquantified, uncertainty with respect to the provision of scientific advice. In addition to impacts on individual stock assessments, deficiencies in survey coverage also add uncertainty to the results of research on environmental (STACFEN) trends and ecosystem status, functioning and productivity (WG-ESA).

Canada – Subarea 0

There was no survey in Subarea 0 during 2020.

Denmark/ Greenland (SCR 20/02, 11, 12, 13, 14,15)

Two hydrographic cruises were carried out across the continental shelf off West Greenland to sample 10 standard sections onboard the chartered Islandic C/V Helga Maria, during the period June 6 to July 26, 2020 (NAFO 1A- B), and onboard the Royal Danish Navy vessel Hdms Lauge Koch during the period May 29 to June 2, 2020 (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 were conducted onboard R/V Paamiut. In 2018-2020, two different charter vessels were used, Sjudarberg and Helga Maria, respectively, 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), in an effort to make the 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. In 2021, the survey was carried out between June 6 – July 14, onboard C/V Helga Maria using the Cosmos gear with a mesh size 20 mesh liner in the cod-end. The survey follows a buffered stratified random sampling. A total of 251 valid hauls were conducted. Survey results including biomass and abundance indices for Greenland halibut, cod, deep see redfish, golden redfish, American plaice, Atlantic wolfish, spotted wolfish, and thorny skate were presented as Scientific Council Research Documents.

The Greenland halibut gillnet surveys in 1A inshore were initiated in 2001, in the 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 2020, 38, 46 and 46 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 18 valid stations were conducted, in 2020. 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 21/05):

The Spanish bottom trawl survey in NAFO Regulatory Area Div. 3NO or 3L (Flemish Pass) was not conducted in 2020 due to the COVID pandemic.

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 30 June to 29 July 2020. The area surveyed was extended up to depths of 800 fathoms (1460 meters) following the same procedures as in previous years and 181 fishing stations planned. A total of 181 valid hauls were made (184 in total), 120 up to 730 meters depth and 61 up to 1460 meters. Survey results including abundance indices of the main commercial species and age distributions for cod, redfish, American plaice, Greenland halibut, roughhead grenadier, squid and shrimp are presented. The general indexes for this year are estimated taken into account the traditional swept area (strata 1-19, up to depths of 730 m.) and the total area surveyed (strata 1-34, up to depths of 1460 m.).

VME data from the 2020 EU (Spain and Portugal) bottom trawl groundfish survey in NAFO Regulatory Area (Div. 3M):

New data on deep-water corals and sponges were presented from the 2020 EU-Spain and Portugal bottom trawl groundfish survey. The data was made available to the NAFO WG-ESA to improve mapping of Vulnerable Marine Ecosystem (VME) species in the NAFO Regulatory Area (Divs. 3LMNO). Distribution maps of presence and catches above threshold for RV data of sponges (100 kg/tow), large gorgonians (0.6 kg/tow), small gorgonians (0.15 kg/tow) and sea pens (1.3 kg/tow) were presented.

Sponges: Sponges were recorded in 47 of the 184 tows (25.5% of the total tows analyzed), with depths ranging between 141 - 1166 m. No significant catches of sponge (≥ 100 kg/tow) were found.

Large Gorgonians: Large gorgonians were recorded in 2 of the 184 tows (1% of total tows analyzed), with depths ranging between 806 - 940 m. None of the tows had significant catches of large gorgonians (≥ 0.6 kg/tow).

Small Gorgonians: Small gorgonians were recorded in 15 tows (8.15 % of total tows analyzed), with depths ranging between 567 - 1250 m. No significant catches (> 0.2 kg/tow) were recorded.

Sea Pens: Sea pens were recorded in 59 tows (32% of total tows analyzed), with depths ranging between 182 - 1423 m. No significant catches (> 1.3 kg/tow) were recorded.

NEREIDA

Research in support of the re-assessment of NAFO Bottom Fisheries in 2021 under the EU NEREIDA project was presented in WG-ESA 2020. An update on the description and classification of the different fisheries and distribution of fishing effort in the NRA for a four-year period (2016 to 2019) was conducted. This characterization of the different demersal fisheries was done on the basis of two data sources: Haul by haul logbook information and Vessel Monitoring System (VMS) data. Two analyses were presented on the quality and coverage of VMS and logbooks data. Additionally, an overlay analysis to estimate the area of VME polygons that was overlapped by the 2016 to 2019 cumulative fishing effort and fisheries-specific effort layers was conducted.

This work was conducted as part of the NEREIDA project funded by the European Commission under Grant Agreements SI2.770786; SI2.793318 and SI2.827558.

ATLAS

Available information from EU-Spain groundfish surveys (Div. 3L, 2006-2019 period) regarding marine mammals and seabirds' distribution, behaviour and interaction with fishing were presented during 2020. The work was developed in collaboration with BIOESLE project.

Regarding seabed litter, the Spanish Institute of Oceanography (IEO) developed a protocol to be used in all the EU groundfish surveys in the NRA. It was developed in collaboration with BIOESLE and Clean Atlantic projects. The objective of the protocol is to expand the seabed litter data collection started in year 2006 in the Flemish Pass (Div. 3L) to the other areas sampled by the EU surveys: Flemish Cap (Div. 3M) and the Grand Banks (Divs. 3NO) using the same methodology and standardized forms. In 2020, data on seabed litter was collected during the EU Spain and Portugal Flemish Cap survey (Div. 3M).

An updated map showing the geographical location of oil and gas activities in NAFO Divs. 3LMN was presented during the 2020 WG-ESA. The map showed the overlap and potential conflicts between different users of the marine space (e.g. oil and gas vs. fisheries) and between users and marine environment (oil and gas vs. VMEs). Furthermore, an update on oil and gas incidents that occurred within the NAFO Convention area during 2020 year was presented. Both map and incidents list were obtained from publicly available information

USA (SCS Doc. 21/16):

The US conducted a spring survey in 2020 covering NAFO Subarea 6 aboard the FSV *Henry B. Bigelow*. Due to COVID-19 pandemic only 133 stations out of the normal 350-380 were successfully completed. No fall survey was conducted.

c) Other Research Activities

No items were reported for this section.

6. 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, but it is an item to be discussed in a future STACREC meeting.

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 has been ongoing for the past two years and further discussion will continue in June 2022 (or the next face-to-face meeting).

National Research Reports: STACREC concluded that these reports are useful, and they should continue to be produced. Discussions will continue in the future on the best format for the National Research Reports. The needed direction may be towards a National Sampling Report instead of a National Research Report. It was noted that a tool, e.g. Rmarkdown, could be useful for producing consistent reports.

Further discussion will be deferred until June 2022.

List of biological sampling data: This information is annually collated into an SCS document in Excel format. It was concluded that there is utility in the information provided in the current tables and in having the information publicly available as is the case with the current SCS document. No changes were suggested at this stage.

RV surveys on a stock by stock basis: STACREC will continue to develop a format for these tables. It was agreed in 2019 that STACREC members preferred Excel spreadsheets rather than text files.

Inventories of biological surveys: STACREC recommended that this information no longer be collected in 2020 and that the SCS be discontinued after 2019, subject to confirmation in September 2019.

List of tag releases: STACREC recommended that this information no longer be collected in 2020 and that the SCS be discontinued after 2019.

c) Review of Greenland halibut deep-water surveys in Northwest Atlantic Fisheries Organization Divisions Subareas 0 and 1 offshore (SCR 21/008)

Research surveys have been conducted in Northwest Atlantic Fisheries Organization (NAFO) Subarea 1 by Greenland since 1997 and in Subarea 0 by Canada since 1999, using the R/V Paamiut fishing with an Alfredo III bottom trawl. Indices from Divs. 0A-South and 1CD are combined to provide an overall index for the Greenland halibut stock in NAFO 0+1 offshore. The surveys follow a depth stratified random sampling design and until 2003 sets were selected using a random number draw of grid cells within depth strata. In 2004, the

independent and random placement of stations was replaced by a buffered random sampling to automatically avoid selecting stations in adjacent cells. The Greenlandic surveys also adopted a variance-based approach to determine the number of stations to allocate to each stratum. This method optimizes set distribution among the depth strata based on variance in Greenland halibut biomass from past surveys, instead of having the same number of stations proportional to the strata area each year. In 2021, surveys will be conducted with a new vessel (R/V Tarajoq) and a new trawl gear (Bacalao 476). These changes in vessel and gear provide an opportunity to review past practices and improve the surveys. The research document presents proposed changes in survey design and sampling protocols for review and comment by members of STACREC.

d) Faroese longline survey of cod in Div. 3M (SCWP 21/012)

During the June 2021 SC meeting, a letter from the Faroe Marine Research Institute was forwarded by the NAFO secretariat to CPs and NAFO officials, indicating that this institute would be conducting a scientific survey in NAFO Division 3M during June/July 2021. This prompted SC to request, via STACREC, a presentation about this planned survey. A presentation was given to STACREC describing this longline survey. This survey was presented by the Faeroe Islands as a complement to the EU Div. 3M bottom trawl research survey. It is a longline survey in waters less than 600 m, with approximately 100 sets with 6000 hooks each. The survey is conducted by a commercial fishing vessel without scientific personnel on board, and where catch will be recorded, identified, and sampled (length, weight and otoliths) by the fishing crew. This is primarily a cod survey, however Atlantic halibut and other bycatch (including VME species) would be expected to be caught.

In principle, a longline survey may provide additional information on the ecosystem in 3M. However, STACREC noted that the proposed survey design was insufficient (e.g. lack of proper consideration of number of hooks, stratification, catchability) to consider this as a valid scientific survey; an appropriate survey design, together with objectives and detailed survey protocols, is required to properly assess the potential scientific value of the data collected.

Moreover, in September 2021, STACREC was made aware that the catch from this survey totalled 630 t, accounting for removals equal to roughly 42% of the TAC of 1500 t. For context, the EU bottom trawl survey of Div. 3M which constitutes the most important fishery independent data for the assessment, took about 7 t in total of cod in 2021. This indicates that the Faroe Islands longline survey is not optimized for the collection of information with minimum impact, as would be the case for a typical scientific survey.

With the information currently available, STACREC considers that this initiative does not fulfil the requirements of a valid scientific survey and more closely resembles a commercial fishery.

STACREC notes that protocols from Article 4 in the Conservation and Enforcement Measures (NAFO COM Doc 21/01) do not require review of proposed survey research plans and confirmation of their scientific validity by SC. **STACREC recommends** that the Commission amend this procedure to include a scientific review of proposed research surveys in the NRA to ensure scientific best practices are followed.

7. Adjournment

The meeting was adjourned on September 24, 2021.

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

Chair: Katherine Sosebee Rapporteur: Tom Blasdale

I. OPENING

The Committee met by correspondence from 20 to 24 September 2021 to consider the various matters in its agenda. Representatives attended from Canada, Denmark (in respect of Faroe Islands and Greenland), the European Union, France (in respect of St. Pierre et Miquelon) Japan, Norway, the Russian Federation, the United Kingdom and the United States of America. The Executive Secretary, Scientific Council Coordinator and other members of the Secretariat were in attendance.

II. ASSESSMENTS DEFERRED FROM THE JUNE 2020 MEETING.

1. Northern Shortfin Squid (*Illex illecebrosus*) in SAs 3+4

Interim Monitoring Report (SCR Doc. 98/59, 75; 6/45; 16/21, 34REV; 19/ 42; 20/2, 10REV, 11; SCS Doc. 21/05, 06, 16)

a) Introduction

Illex illecebrosus has a lifespan of less than one year and is considered a single stock throughout its range from Newfoundland to Florida, in NAFO Subareas 2-6. However, the Subareas 3+4 and Subareas 5+6 stock components are assessed and managed separately by NAFO and the U.S.A. Mid-Atlantic Fishery Management Council, respectively. The Canada Department of Fisheries and Oceans (DFO) has no fishery management plan for the *Illex* fisheries that occur within their Exclusive Economic Zone (EEZ) in Subarea 3, the Newfoundland commercial and recreational inshore jig fisheries, and Subarea 4 (the historical Scotian Shelf bottom trawl fishery). The small *Illex* fishery that occurs off St. Pierre et Miquelon within the EEZ of France (in respect of St. Pierre et Miquelon) is also not managed. The stock assessment is data-poor and in-season stock assessments and annual biomass projections are not currently possible. Therefore, as of 2019, the SA 3+4 *Illex* assessments have been conducted in September instead of June to be able to incorporate the Div. 4VWX July survey indices for the current year. Indices of relative biomass and mean body weight were computed using data from the Div. 4VWX July surveys conducted by the DFO. These indices were used to assess stock status (i.e., whether the Subareas 3+4 stock component was at a low or high productivity level) during the current year. The Subareas 3+4 nominal catch divided by the Div. 4VWX biomass index was used to assess annual relative exploitation rates. Such rates can only be computed through year *t*-1 because squid catch data for the current year are not generally available in time for the September assessment.

b) Data Overview

Since 1999, there has been no directed fishery for *Illex* in Subarea 4 and most of the catches from Subareas 3+4 have been primarily from the Subarea 3 inshore jig fishery. However, there were no catches from Subarea 3 during 2013-2015. During 1999-2011, catches from Subareas 3+4 were low during most years (average = 1078 t), compared to catches during 1976-1981 (average = 80 645 t), and ranged between about 57 t in 2001 to 6 981 t in 2006 (Figure 1.1). During 2007-2015, catches were much lower and averaged 351 t during 2007-2011 and 27 t during 2012-2015. However, recent catches increased more than fourfold between 2017 (383 t) and 2018 (1 545 t) then gradually increased to 3 872 t in 2020, which was 54% greater than the 1982-2016 low productivity period average (2 510 t) but well below the 1976-1981 high productivity period average (80 645 t). During 2000-2020, only 3 % of the 34 000-t TAC for Subareas 3+4 was harvested on average, with a peak of 21% in 2006 and 11% in 2020. Only 11% of the Subareas 3+4 catch was harvested within the NRA during 2020. Thus, catches in Subareas 3+4 are not limited by the current NAFO quota. There is no quota for the jig fishery that occurs within Canada's EEZ.

Recent catches and TACs ('000 t) are as follows:

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
TAC SA 3+4	34	34	34	34	34	34	34	34	34	34
STATLANT 21 SA 3+4	0.2[1]	<0.1[1]	0.1[1]	0.1[1]	<0.1[1]	<0.1[1]	0.4[1]	1.4[1]	2.8[1]	3.9[1]
STATLANT 21 SA 5+6[2]	18.2	11.7	3.8	8.8	2.4	6.7	22.5	24.1		
STACFIS SA 3+4	0.1	<0.1	<0.1	<0.1	<0.1	0.2	0.4	1.5	2.9	3.9
STACFIS SA 5+6[2]	18.8	11.7	3.8	8.8	2.4	6.7	22.5	24.1	27.2	28.1
STACFIS Total SA 3-6[3]	18.9	11.7	3.8	8.8	2.4	6.9	22.9	25.6	30.1	32.0

[1] Includes catches (<0.1 t to 53 t during 2011-2020) reported as 'Unspecified Squid' from Subarea 4 because they were likely *I. illecebrosus* based on the geographic distribution of this species versus *Doryteuthis pealeii*.

[2] Catches from Subareas 5+6 are included because there is no basis for considering separate stocks in Subareas 3+4 and Subareas 5+6. USA STATLANT 21 catches were not reported to NAFO for any species during 2019 and 2020.

[3] STACFIS Total SA 3-6 catches were computed as catches harvested in the NRA (2011-2017 from STALANT 21 database; 2018 onward from NAFO CESAG database) plus catches recorded in the USA and CA (Newfoundland and Maritimes Regions) commercial catch databases.

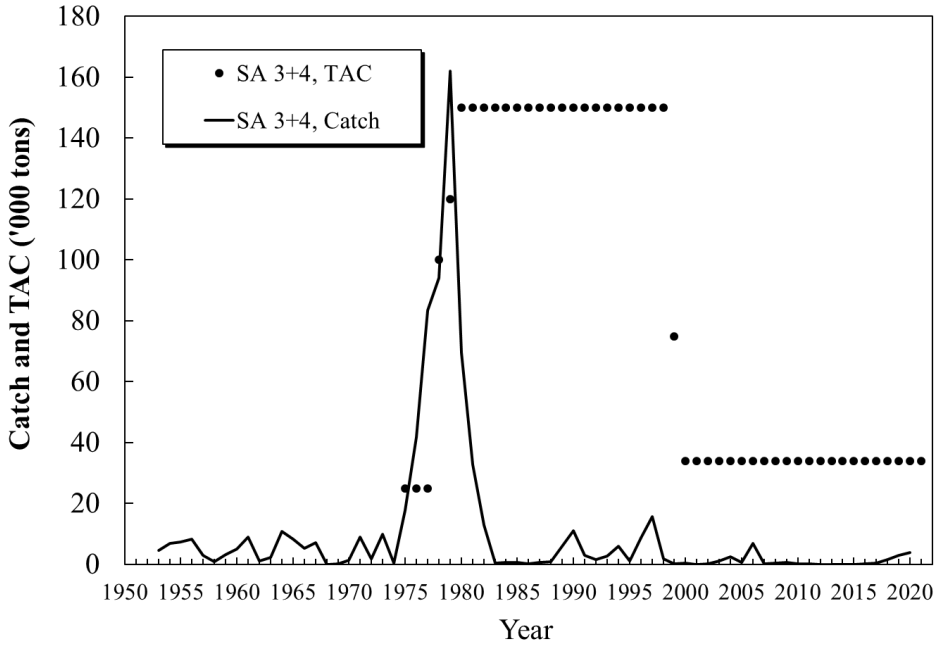

Figure 1.1. Northern shortfin squid in Subareas 3+4: nominal catches and TACs.

Relative biomass indices, derived using data from the Canadian surveys conducted during July in Div. 4VWX, exhibited several distinct periods. Biomass indices averaged 13.2 kg per tow during the high productivity period (1976-1981) and 2.6 kg per tow during the low productivity period (1982-2016). A third distinct period in biomass trend occurred from 2017 onward and consisted of very high biomass indices during two non-consecutive years followed by a large decrease in 2020. Biomass indices fluctuated widely after 2003 (Figure 1.2), but generally declined between 2004 and 2013, from a level near the high productivity period mean of 13.2 to the lowest level on record, respectively. During 2014-2016, biomass indices remained much lower than 2.6 kg per tow, but then increased in 2017 (16.1 kg per tow) to the third highest level of the time series and was greater than the 1976-1981 high productivity period average. However, during 1982-2016, each year of high biomass (i.e., 1992, 2004 and 2006) during the low productivity period was followed by a much lower biomass level. Persistence of the high 2017 biomass level could not be confirmed in 2018 because a biomass

index was not computed due to inadequate sampling of a majority of the *Illex* strata due to survey vessel mechanical problems. The 2019 biomass index was twice as high (32.1) as the 2017 index and was the second highest value in the time series. However, during 2020, the biomass index (8.2) decreased to a level below the high productivity period average but remained higher than all but two of the biomass indices during 1982-2016. The 2021 biomass index could not be computed because a new survey vessel and trawl were used to conduct the 2021 July Div. 4VWX survey and there are currently no conversion factors available with which to standardize the 2021 biomass index with the rest of the time series.

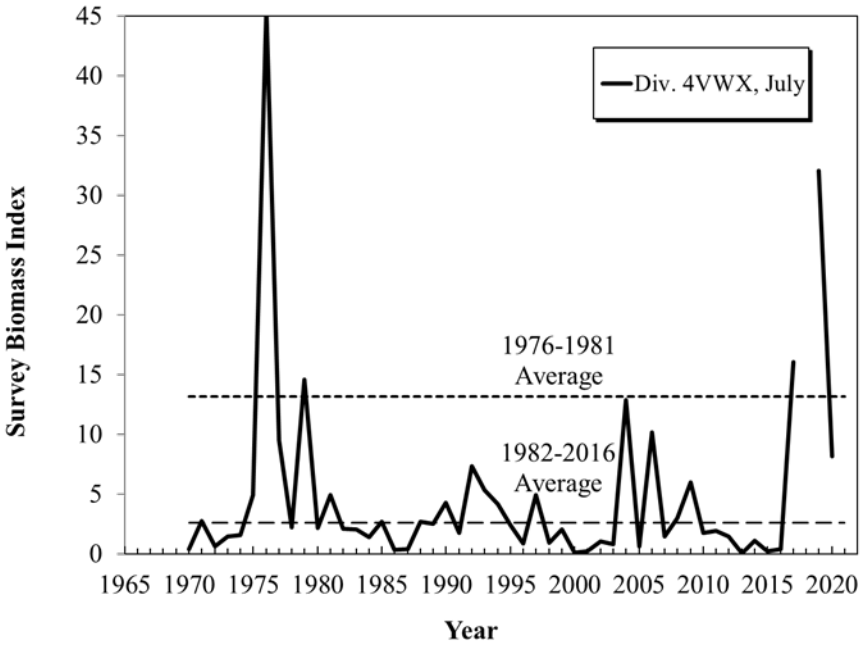

Figure 1.2. Northern shortfin squid in Subareas 3+4: survey biomass indices from the July survey in Div. 4VWX.

The mean body weight of squid caught during the July Div. 4VWX surveys averaged 150 g during the 1976-1981 high productivity period (1976-1981) and 80 g during the low productivity period (1982-2016). Mean body weight increased from the lowest level of the time series in 1983 (27 g) to the second highest level of the low productivity period (121 g) in 1999 (Figure 1.3). Between 2000 and 2006, mean body weight increased to a low productivity period peak of 137 g, but then gradually declined to 42 g in 2013. Following wide fluctuations around the low productivity average during 2014-2016, mean body weight increased to a level similar to 2006 in 2017 (134 g). For the reason explained above, mean body weight was not computed for 2018, so it is unknown whether mean body weight was above the high productivity period average for two consecutive years. During the 2019 assessment, the Scientific Council noted that the 2019 mean body weight (164 g) was above the high productivity period average for the first time since 1979 and concluded that the status of the Subareas 3+4 stock component may be moving toward a high productivity period. However, this level of high body weight did not persist for a second year and instead dropped below the high productivity period average in 2020 (123 g) but was greater than all but one year during 1982-2016. As noted in the biomass section above, there are no data available with which to compute the 2021 body weight index.

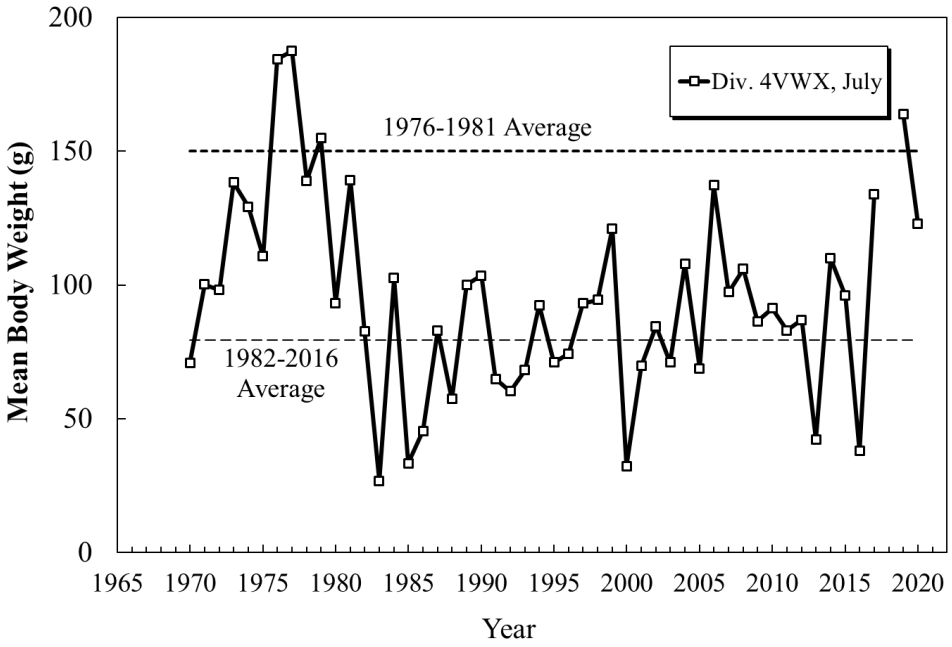

Figure 1.3. Northern shortfin squid in Subareas 3+4: mean body weights of squid from the July survey in Div. 4VWX.

Catch/biomass ratios (SA 3+4 nominal catch/Division 4VWX July survey biomass index) / 10 000) have been well below the 1982-2016 mean (0.12) during most years since 2001 and the ratio was 0.05 in 2020 (Figure 1.4). There is no Div. 4VWX biomass index available for 2021 for the reasons previously described. Although the survey index for the current year would normally be available, the Subareas 3+4 catches are never available in time for the September assessments.

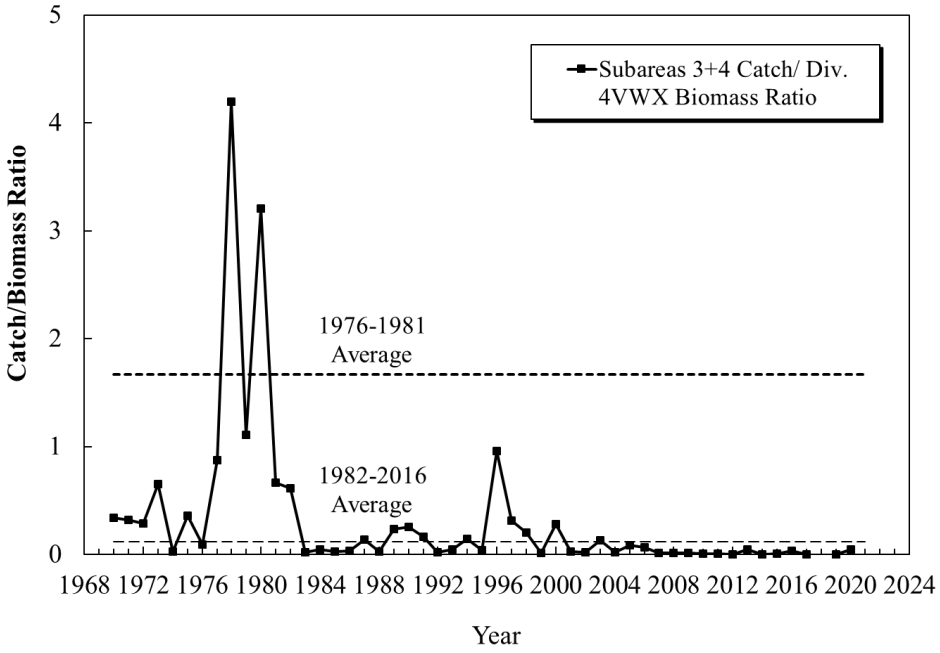

Figure 1.4. Northern shortfin squid in Subareas 3+4: catch/biomass ratios (SA 3+4 nominal catch/Division 4VWX July survey biomass index) / 10 000).

c) Conclusion

In 2020, the Scientific Council concluded (and the Commission adopted) that the large decrease in biomass and mean body size indices, from above the high productivity period average in 2019 to below it in 2020, and the continued low exploitation rates in recent years do not support an increase in the status quo catch advice (34 000 t).

Without a 2021 biomass index for the July Div. 4VWX survey, the survey in Subareas 3+4 that covers the largest area of *Illex* habitat at a time when the species has fully migrated onto the Scotian Shelf, there are no data available with which to change this advice, and therefore, the status quo catch advice of 34 000 t is recommended for 2022.

The next assessment is planned for 2022.

d) Research Recommendation

In 2013, STACFIS **recommended** that *gear/vessel conversion factors be computed to standardize the 1970-2003 relative abundance and biomass indices from the July Div. 4VWX surveys.*

STATUS: No progress has been made.

III. OTHER MATTERS

1. Nomination of Designated Experts (DE)

Kathy Sosebee (USA) will take over as DE for white hake and skate subject to agreement by her managers.

Ricardo Alpoim (EU) will continue as DE for redfish in Division 3M and provisionally for redfish in 3LN- for no more than one year. Canada will consider whether their new hire will take this over as DE for this stock.

2. Other matters

a) Review of SCR and SCS Documents

No SCRs were submitted to this meeting.

b) FIRMS Classification for NAFO Stocks

STACFIS reiterates that the Stock Classification system is not intended as a means to convey the scientific advice to the Commission and should not be used as such. Its purpose is to respond to a request by FIRMS to provide such a classification for their purposes. The category choices do not fully describe the status of some stocks. Scientific advice to the Commission is to be found in the Scientific Council report in the summary sheet for each stock.

Stock Size (incl. structure)	Fishing Mortality			
	None–Low	Moderate	High	Unknown
Virgin–Large	3LNO Yellowtail Flounder 3LN Redfish			
Intermediate	SA3+4 Northern shortfin squid	SA0+1 Northern shrimp[1] DS Northern shrimp[1] SA 0+1 (Offshore) Greenland halibut 3M Redfish[3] SA2+3KLMNO Greenland halibut	3M cod	Greenland halibut in Disko Bay[2] SA1 American Plaice SA1 Spotted Wolffish
Small	3NOPs White hake 3NO Witch flounder 3LNOPs Thorny skate			Greenland halibut in Uummannaq[2] Greenland halibut in Upernavik[2]
Depleted	3M American plaice 3LNO American plaice 3NO Cod 3LNO Northern shrimp			SA1 Redfish SA1 Atlantic Wolffish 3M Northern shrimp[3]
Unknown	SA2+3 Roughhead grenadier 3NO Capelin 3O Redfish	1B-C Greenland halibut Inshore	1D Greenland halibut Inshore 1E-F Greenland halibut Inshore	6G Alfonsino

[1] Will be re-assessed at the SC shrimp meeting in October 2021
[2] Assessed as Greenland halibut in Div. 1A inshore
[3] Fishing mortality may not be the main driver of biomass for Div. 3M Shrimp and Redfish

3. Other business

No other items were discussed

IV. ADJOURNMENT

The meeting was adjourned on 24 September 2021.

APPENDIX V. SCIENTIFIC COUNCIL AGENDA, SEPTEMBER 2021

I. Plenary Session

1. Opening
2. Appointment of Rapporteur
3. Adoption of Agenda
4. Plan of Work

II. Review of Scientific Council Recommendations

III. Joint Session of Commission and Scientific Council

1. Implementation of 2018 Performance Review Panel recommendations
2. Presentation of scientific advice by the Chair of the Scientific Council
   a. Response of the Scientific Council to the Commission's request for scientific advice
   b. Feedback to the SC regarding the advice and its work during this meeting
   c. Other issues as determined by the Chair of the Commission and of the Scientific Council
3. Meeting Reports and Recommendations of the Joint Commission–Scientific Council Working Groups
   a. Working Group on Improving Efficiency of NAFO Working Group Process (E-WG), 2021
   b. Joint Commission–Scientific Council Working Group on Risk-based Management Strategies (WG-RBMS), August 2021
   c. Joint Commission–Scientific Council Working Group on Ecosystems Approach Framework to Fisheries Management (WG-EAFFM), July 2021
   d. Joint Commission–Scientific Council Catch Estimation Strategy Advisory Group (CESAG), 2021
4. Formulation of Request to the Scientific Council for Scientific Advice on Management in 2022 and beyond of Certain Stocks in Subareas 2, 3 and 4 and Other Matters

IV. Fisheries Environment (STACFEN Chair: Miguel Caetano)

1. Opening
2. Appointment of Rapporteur
3. Review of the report from June 2021
4. Other Matters
5. Adjournment

V. Publications (STACPUB Chair: Margaret Treble)

1. Opening
2. Appointment of Rapporteur
3. Adoption of Agenda
4. Review of the report from June 2021
5. Review of Recommendations in 2020
6. Review of Publications
   a. Annual Summary
      i. Journal of Northwest Atlantic Fishery Science (JNAFS)
      ii. Scientific Council Studies
      iii. Scientific Council Reports
7. Other Matters
8. Adjournment

VI. Research Coordination (STACREC Chair: Karen Dwyer)

1. Opening
2. Appointment of Rapporteur
3. Review of the report from June 2021
4. Review of Recommendations in 2020
5. Fishery Statistics
    a. Progress report on Secretariat activities in 2020/2021
        i. Presentation of catch estimates from the CESAG, daily catch reports and STATLANT 21A and 21B
6. Research Activities
    a. Biological sampling
        i. Report on activities in 2020/2021
        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 2020 and early 2021 (by National Representatives and Designated Experts)
        ii. Surveys planned for 2021 and early 2022
    c. Tagging activities
    d. Other research activities
7. Review of SCR and SCS Documents
8. Other Matters
    a. Summary of progress on previous recommendations
    b. Review of proposed changes to NAFO gear codes
9. Adjournment

VII. Fisheries Science (STACFIS Chair: Katherine Sosebee)

1. Opening
2. Nomination of Designated Experts
3. Other Matters
    a. Review of SCR and SCS Documents
    b. Review of FIRMS classification of NAFO stocks
    c. Other Business

VIII. Requests from the Commission

1. Requests/advice requested by the Commission (in NAFO/COM Doc. 20-16) deferred from the June 2021 Scientific Council Meeting
2. *Ad hoc* Requests from Current Meeting
3. Further progress on items related to COM requests (in NAFO/COM Doc. 20-16)
    a. COM request #8: NAFO PA Framework review
    Progress from PA-WG meetings in 2021

IX. Review of Future Meeting Arrangements

X. Future Special Sessions

1. Progress on 2021 symposium with ICES on Decadal Hydro-Biological Variability of the North Atlantic for the decade 2010-2019
2. Information concerning Flatfish Symposium 2022
3. Other potential future topics

XI. Other Matters

5. Implementation of 2018 Performance Review Panel recommendations
4. Meeting reports
   a. ICES/NAFO Working Group on Deep-water Ecology (WG-DEC)
   b. ICES/NAFO/NAMMCO Working Group on Harp and Hooded Seals (WG-HARP)

XII. Adoption of Reports

1. Committee Reports of STACFEN, STACPUB, STACFIS and STACREC
2. Report of Scientific Council

XIII. Adjournment

Annex 1. The Commission's Request for Scientific Advice on Management in 2022 and Beyond of Certain Stocks in Subareas 2, 3 and 4 and Other Matters

(NAFO/COM Doc. 20-16; NAFO/SCS Doc. 21-01)

Following a request from the Scientific Council, the Commission agreed that items 1, 2, 8 and 11 should be the priority for the June 2021 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	Redfish in Div. 3M	American Plaice in Div. 3LNO
Northern shrimp in Div. 3M	Northern shrimp in Div. 3LNO	American Plaice in Div. 3M
	Thorny skate in Div. 3LNO	Capelin in Div. 3NO
	Witch flounder in Div. 3NO	Northern shortfin squid in SA 3+4
	Redfish in Div. 3LN	Redfish in Div. 3O
	White hake in Div. 3NO	Yellowtail flounder in Div. 3LNO
		Cod in Div. 3NO

To implement this schedule of assessments, the Scientific Council is requested to conduct a full assessment of these stocks as follows:

In 2021, advice should be provided for 2022 for Cod in Div. 3M and Northern shrimp in Div. 3M. With respect to Northern shrimp in Div. 3M, SC is requested to provide its advice to the Commission prior to the 2021 Annual Meeting based on the survey data up to and including 2021.

In 2021, advice should be provided for 2022 and 2023 for: Redfish in Div. 3M, Northern shrimp in Div. 3LNO, and White hake in Div. 3NO

In 2021, advice should be provided for 2022, 2023 and 2024 for: American plaice in Div. 3LNO, Capelin in Div. 3NO, Cod in Div. 3NO, Yellowtail flounder in Div. 3LNO

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).

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 the 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 the Scientific Council to implement the steps of the Action plan relevant to the Scientific Council and in particular the tasks identified under section 2.2 of the Action Plan, for progression in the management and minimization of Bycatch and discards (COM Doc. 17-26).

- Tasks outlined in Tasks 3.1 and 3.2 of the NAFO Action Plan in the Management and Minimization of Bycatch and Discards (COM Doc. 17-26).

5. The Commission requests that Scientific Council continue to refine work on the Ecosystem Road Map:

   - Continue to test the reliability of the ecosystem production potential model and other related models
   - Report on these results to WG-EAFFM and WG-RBMS to further develop how it may apply to management decisions
   - Develop options of how ecosystem advice could inform management decisions, an issue which is directly linked to the results of the foreseen EAFM roadmap workshop.
   - Continue its work to develop models that support implementation of Tier 2 of the EAFM Roadmap."

6. The Commission requests that the Scientific Council, in preparation of the re-assessment of NAFO bottom fisheries in 2021 and discussion on VME fishery closures:

   - Assess the overlap of NAFO fisheries with VME to evaluate fishery specific impacts in addition to the cumulative impacts for NRA fisheries;
   - Consider clearer objective ranking processes and options for objective weighting criteria for the overall assessment of significant adverse impacts and the risk of future adverse impacts;
   - Maintain efforts to assess all of the six FAO criteria including the three FAO functional SAI criteria which could not be evaluated in the current assessment.
   - Provide input and analysis of potential management options, with the goal of supporting meaningful and effective discussions between scientists and managers at the 2021 WG-EAFFM meeting;
   - Continue to work on the VME indicator species as listed in Annex IE, Section VI to prepare for the next assessment.

7. The Commission requests that the Scientific Council review the proposed revisions to Annex I.E, Part VI as reflected in COM-SC EAFFM-WP 18-01, for consistency with the taxa list annexed to the VME guide and recommend updates as necessary.

8. The Commission requests the Scientific Council to continue progression on the review of the NAFO PA Framework in accordance to the PAF review work plan approved in 2020 (NAFO COM-SC Doc. 20-04)

9. The Commission requests that the Scientific Council Work with WG-BDS to identify areas and times where bycatch and discards of Greenland sharks have a higher rate of occurrence in time for consideration by the Commission in 2021 to inform the development of measures to reduce bycatch in the NRA.

10. The Commission requests the Scientific Council to continue to develop a 3-5 year work plan, which reflects requests arising from the 2020 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.

11. The Commission requests that the Scientific Council, carry out a scoping exercise to provide guidance to the WG-RBMS on the process of conducting of a full review/evaluation of the management strategy of Div. 3LN redfish.

12. The Commission requests the Scientific Council review submitted protocols for a survey methodology to inform the assessment of Splendid Alfonsino. The Scientific Council to report on the outcome of this work at next Commission annual meeting.

13. The Commission requests that results from stock assessments and the scientific advice of Cod 2J3KL (Canada), Witch 2J3KL (Canada) and Pelagic Sebastes mentella (ICES Divisions V, XII and XIV; NAFO 1) to be presented to the Scientific Council (SC), and request the SC to prepare a summary of these assessments to be included in its annual report.

14. The Commission requests the Scientific Council, jointly with the Secretariat, to conduct ongoing analysis of the Flemish Cap cod fishery data by 2022 in order to:

    (1) 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

    (2) carry out any additional monitoring that would be required, including Div. 3M cod caught as bycatch in other fisheries during the closed period.

15. The Commission requests the Scientific Council, in its future work, to consider whether other measures, such as depth restrictions, spatial and mesh changes, could reduce the catch of juvenile and immature cod across all fisheries in 3M.

16. The Commission requests the Scientific Council to continue to monitor and provide updates resulting from relevant research related to the potential impact of activities other than fishing in the Convention Area. Further, that the Secretariat and the Scientific Council work with other international organizations, such as the FAO and ICES, to bring in additional expertise to inform the Scientific Council's work.

17. The Commission requests the Scientific Council to provide information to the Commission at its next annual meeting on sea turtles, sea birds, and marine mammals that are present in NAFO Regulatory Area based on available data.

18. The Commission requests that the Scientific Council proceed with developing the ecosystem summary sheets for 3M and 3LNO move toward undertaking a joint Workshop with ICES (International Council for the Exploration of the Sea) as part of a peer review of North Atlantic ecosystems.

ANNEX A: Guidance for providing advice on Stocks Assessed with an Analytical Model

The Commission requests 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													
				$P(F>F_{lim})$			$P(B<B_{lim})$			$P(F>F_{msy})$			$P(B<B_{msy})$				$P(B2024 > B2020)$
F in 2022 and following years*	Yield 2022 (50%)	Yield 2023 (50%)	Yield 2024 (50%)	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024		
2/3 Fmsy	t	t	t	%	%	%	%	%	%	%	%	%	%	%	%		%
3/4 Fmsy	t	t	t	%	%	%	%	%	%	%	%	%	%	%	%		%
85% Fmsy	t	t	t	%	%	%	%	%	%	%	%	%	%	%	%		%
90% Fmsy																	
95% Fmsy																	
Fmsy	t	t	t	%	%	%	%	%	%	%	%	%	%	%	%		%
0.75 X Fstatus quo	t	t	t	%	%	%	%	%	%	%	%	%	%	%	%		%
Fstatus quo	t	t	t	%	%	%	%	%	%	%	%	%	%	%	%		%
1.25 X 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(B2024 > B2020)
F in 2022 and following years*	Yield 2022	Yield 2023	Yield 2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	2022	2023	2024	
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_{2018}	t	t	t	%	%	%	%	%	%	%	%	%	%	%	%	%
F_{2018}	t	t	t	%	%	%	%	%	%	%	%	%	%	%	%	%
1.25 X F_{2018}	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.

APPENDIX VI: EXPERTS FOR PRELIMINARY ASSESSMENT OF CERTAIN STOCKS

The Designated Experts for 2021 were:

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	Danny Ings	danny.ings@dfo-mpo.gc.ca
American Plaice in Div. 3LNO	Laura Wheeland	laura.wheeland@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	Katherine Skanes	katherine.skanes@dfo-mpo.gc.ca
Thorny skate in Div. 3LNO	Mark Simpson	mark.simpson2@dfo-mpo.gc.ca
White hake in Div. 3NO	Mark Simpson	mark.simpson2@dfo-mpo.gc.ca

From the Department of Fisheries and Oceans, Winnipeg, Manitoba, Canada

Greenland halibut in SA 0+1	Margaret Treble	margart.treble@dfo-mpo.gc.ca

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

Roughhead grenadier in SA 2+3	Fernando González -Costas	fernando.gonzalez@ieo.es
Splendid alfonsino in Subarea 6	Fernando González -Costas	fernando.gonzalez@ieo.es
Cod in Div. 3M	Diana González -Troncoso	diana.gonzalez@ieo.es
Shrimp in Div. 3M	Jose Miguel Casas Sanchez	mikel.casas@ieo.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
Redfish in Div. 3LN	Ricardo Alpoim	ralpoim@ipma.pt

From the Greenland Institute of Natural Resources, Nuuk, Greenland

Redfish in SA1	Rasmus Nygaard	rany@natur.gl
Other Finfish in SA1	Rasmus Nygaard	rany@natur.gl
Greenland halibut in Div. 1A	Rasmus Nygaard	rany@natur.gl
Northern shrimp in SA 0+1	AnnDorte Burmeister	anndorte@natur.gl

Northern shrimp in Denmark Strait	Frank Rigét	frri@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

APPENDIX VII. LIST OF SUMMARY (SCS) DOCUMENTS

Summary Documents (SCS)

SCS Doc. 21/12	N7171	NAFO	List of Biological Sampling Data for 2020
SCS Doc. 21/13	N7172	Estonia	Estonian Research Report for 2020
SCS Doc. 21/16	N7235	United States of America	United States Research Report for 2020
SCS Doc. 21/17	N7249	NAFO	Report of the Scientific Council, 20-24 September 2021

APPENDIX VIII. LIST OF PARTICIPANTS, SEPTEMBER 2021

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