Northwest Atlantic Fisheries Organization

Report of the Scientific Council and STACFIS Shrimp Assessment Meeting

17 to 19 September 2024
Halifax, Canada

NAFO
2024

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REPORT OF THE SCIENTIFIC COUNCIL AND STACFIS SHRIMP ASSESSMENT MEETING
17-19 September 2024, Halifax, Canada

Chair: Diana González-Troncoso (EU) Rapporteur: NAFO Secretariat

I. PLENARY SESSIONS

Scientific Council met from 17 to 19 September 2024 at the NAFO Secretariat in Halifax, Canada to formulate management advice for northern shrimp stocks. Representatives attended from Canada, Denmark (in respect of the Faroe Islands and Greenland), the European Union, Norway, the Russian Federation and Ukraine. A full list of participants is included in Appendix VI.

The Chair, Diana González-Troncoso (EU), opened the meeting at 09:30 on 17 September and welcomed participants. The provisional agenda was adopted as circulated. The NAFO Secretariat (Dayna Bell MacCallum and Jana Aker) was appointed as rapporteur.

II. REVIEW OF SCIENTIFIC COUNCIL RECOMMENDATIONS IN 2023

Recommendations from 2023 are considered in the relevant sections of this report.

III. STANDING COMMITTEE ON FISHERIES SCIENCE (STACFIS)

The September 2024 STACFIS report is presented as Appendix I in this report.

IV. MANAGEMENT ADVICE

1. Request from the Commission

The Commission requests are given in Annex 1 of Appendix II. Requests relating to northern shrimp were addressed in the present meeting, the remainder having been previously addressed during the Scientific Council June 2024 meeting (SCS Doc. 24/16REV).

a) Northern shrimp in Division 3M

Advice September 2024 for 2025 and 2026

Recommendation

The stock remains below B_{lim}.

To be consistent with the NAFO Precautionary Approach Framework, Scientific Council advises that no directed fishery should occur in 2025 and 2026.

Management objectives

No explicit management plan or management objectives defined by the Commission. General principles from the *Convention on Cooperation in the Northwest Atlantic Fisheries* are applied.

Convention Principle	Status	Comment
Restore to or maintain at Bmsy		B < Blim
Eliminate Overfishing (Stock)		Flim undefined, F level is not a concern
Eliminate Overfishing (Ecosystem)		Total EPU catches < 2TCI
Apply Precautionary Approach		Blim defined, Flim undefined
Minimize harmful impacts on living marine resources and ecosystems		No directed fishing
Preserve marine biodiversity		Cannot be evaluated

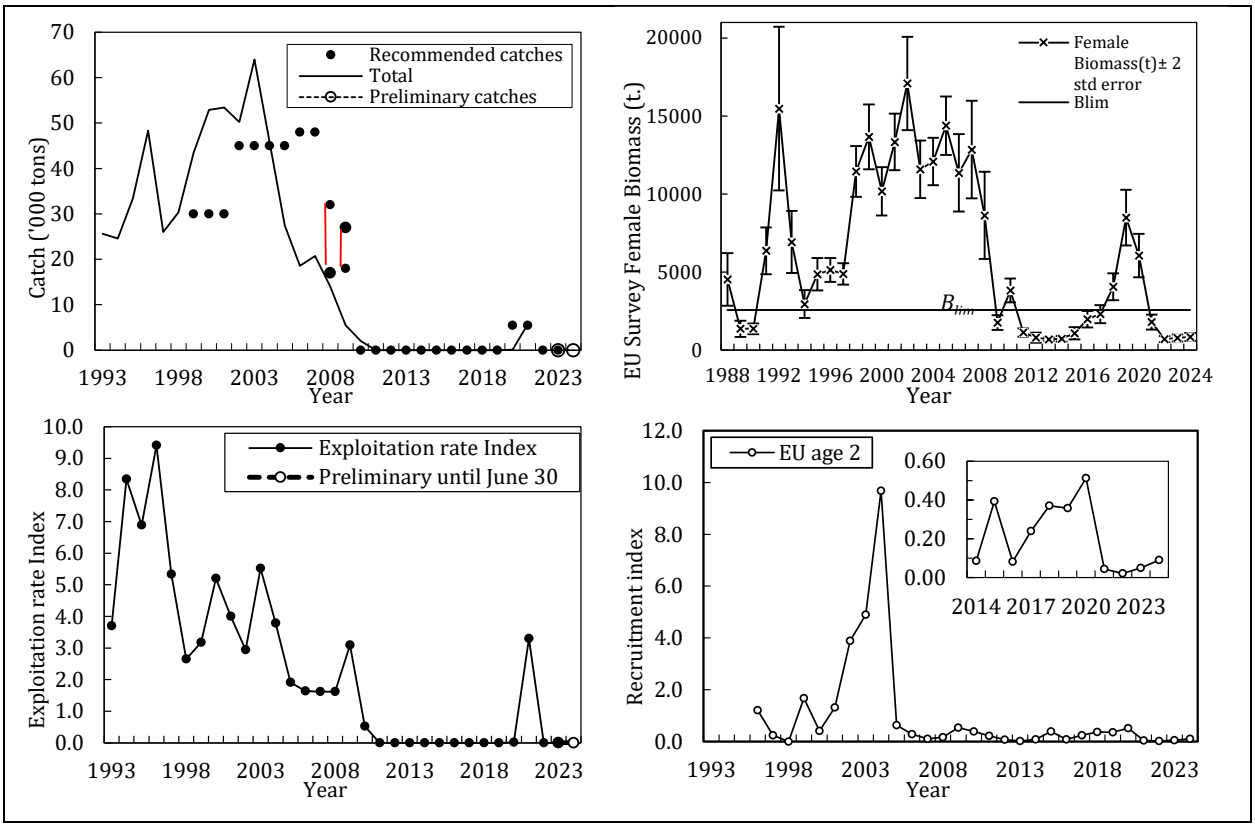
OK
Intermediate
Not accomplished
Unknown

Management unit

The northern shrimp stock on Flemish Cap is considered to be a separate population.

Stock status

Since 2021 the biomass has been below B_{lim}. Recruitment since 2021 has been the lowest of the historical series. The exploitation rate in 2022 and 2023 was zero and is expected to be at the same level in 2024.



Reference points

Scientific Council considers a proxy for B_{lim} to be 15% of the maximum observed female survey biomass. This corresponds to an index value of 2 564 t. A limit reference point for fishing mortality has not been defined.

Projections

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

Assessment

No analytical assessment is available. Evaluation of stock status is based upon fishery and research survey data.

The next assessment will take place prior the NAFO Annual Meeting in September 2026.

Human impact

Mainly fishery related mortality and low bycatch in other fisheries. Other sources (*e.g.,* pollution, shipping, oil-industry) are un-documented.

Biological and Environmental Interactions

Multispecies models suggest that predation by Atlantic cod (*Gadus morhua*) and redfish (*Sebastes* spp.), together with fishing, were the main factors driving the shrimp stock to the collapse after 2007.

Results of modelling suggest that, in unexploited conditions, cod and redfish would be expected to be a highly dominant component of the system, and large shrimp stock sizes like the ones observed in the 1998 – 2007 period would not be a stable feature in the Flemish Cap. Potential changes in environmental conditions may add uncertainty in the ecosystem modelling.

The Flemish Cap (3M) Ecosystem Production Unit (EPU), with the exception of a short-lived increase in 2005-2009, has shown a fairly stable total biomass over time despite the changes in individual stocks. This indicates no major changes in overall ecosystem productivity.

Ecosystem sustainability of catches

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

Division 3M shrimp is included in the benthivores guild of the Flemish Cap (3M) EPU. American plaice is the only other NAFO managed stock in this guild and the Division 3M EPU. The 3M Benthivore Catch/TCI (Total Catch Index) in 2023 was below the 2TCI ecosystem reference point (Catch 2023/TCI=0.01).

Fishery

This fishery is effort-regulated. A moratorium was imposed in 2011. The fishery was reopened in 2020. Fishing effort and catches were very low in 2020 but increased in 2021. With the new moratorium established in 2022, the catch in 2022-2023 was zero and is expected to be at the same level in 2024.

Recent catches (tonnes) and agreed effort by the NAFO Commission were as follows (ndf= no directed fishery):

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
STACFIS	0	0	0	0	0	79	5703[3]	0	0	0[1]
STATLANT 21	0	0	0	0	0	0	5905	NA[4]	NA[4]	
Effort[2] (Agreed Days)	ndf	ndf	ndf	ndf	ndf	2 640	2 640	ndf	ndf	ndf
Effort days used	0	0	0	0	0	19	479	0	0	0

[1] Preliminary catches until June 30
[2] Effort regulated
[3] CESAG method
[4] NA - In 2022-2023, STATLANT 21 information is incomplete.

Effects of the fishery on the ecosystem

The fishery was closed to directed fishing from 2011 to 2019 and since 2022.

Special comments

Scientific Council **recommends** that *the management of 3M shrimp be converted from the existing "effort regulation" to "catch regulation" in line with all other stocks in the NAFO Regulatory Area.*

Source of Information

SCR Docs. 16/035; 18/024; 24/059, 060; SCS Doc. 04/12

2. Requests from Coastal States

Requests for management advice from Canada and Denmark (on behalf of Greenland) are presented in Annex 2 and 3 of Appendix II. Requests relating to northern shrimp were addressed in the present meeting, the remainder having been previously addressed during the Scientific Council June 2024 meeting (SCS Doc. 24/16REV).

a) Northern shrimp in Denmark Strait and off East Greenland

Advice September 2024 for 2025

Recommendation

Catches up to 1 000 t are projected to result in a very low probability (less than 10%) of the stock going below B_{lim}.

Management objectives

No explicit management plan or management objectives have been defined by the Government of Greenland. General principles from the *Convention on Cooperation in the Northwest Atlantic Fisheries* are applied.

Objective	*Status*	*Comment/consideration*
Maintain B above B_{lim}		$B > B_{lim}$
Eliminate overfishing		F_{lim} undefined, F level is of concern

 OK

 Intermediate

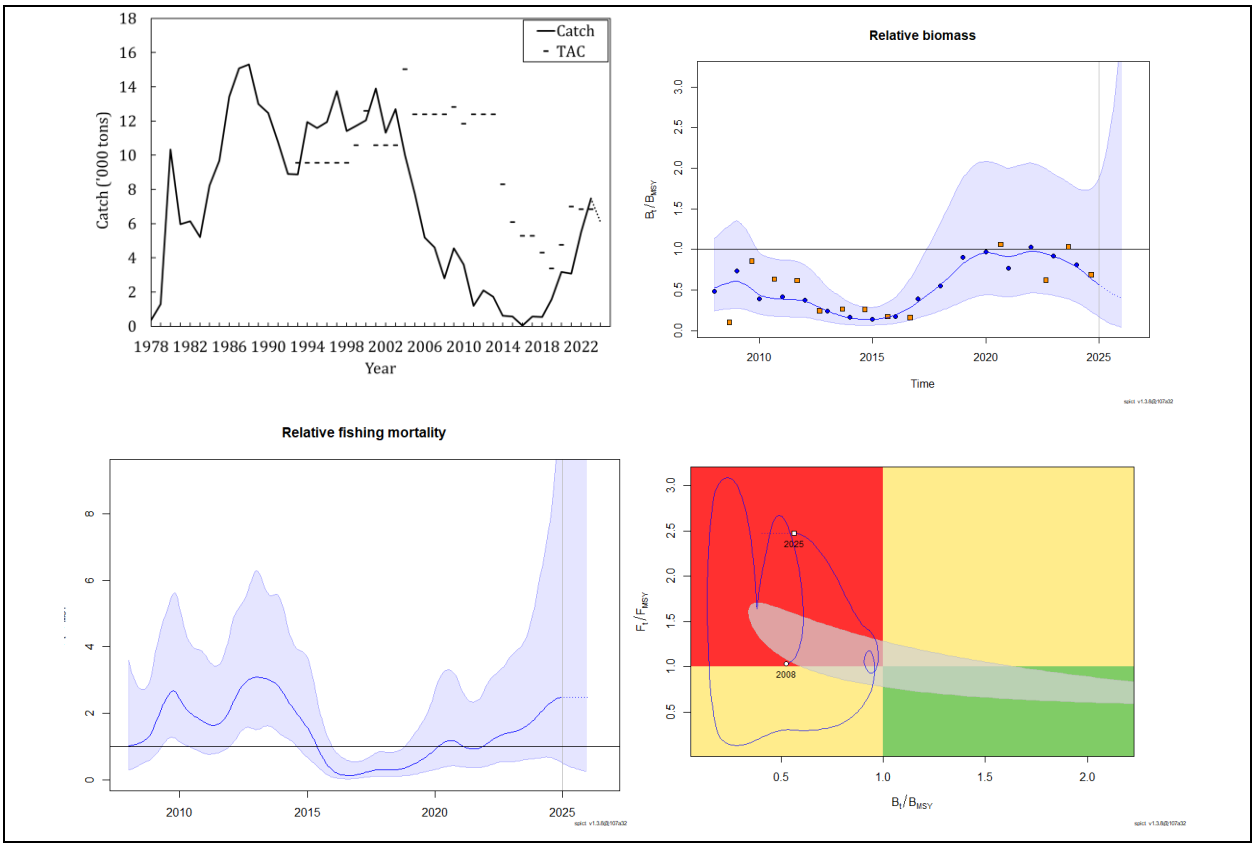
 Not accomplished

Management unit

The shrimp stock is distributed off East Greenland in ICES Div. 14b and 5a and is assessed as a single stock.

Stock status

Median biomass is below B_{msy} (B/B_{msy} = 0.58) and the probability of being below B_{lim} is 15%. Fishing mortality is above F_{msy} (F/F_{msy} = 2.47). No estimates of recruitment are available.



Reference points

B_{lim} is defined as 30% of B_{msy}. The relative reference points B_{msy} and F_{msy} are estimated within the SPiCT model.

Projections

Relative reference points are estimated for six catch options for 2025.

Catch (t)	B/B_{msy}	F/F_{msy}	Prob $B < B_{msy}$	Prob $B < B_{lim}$	Prob $F > F_{msy}$	P($B_{2026} < B_{2025}$)
1 000	0.77	0.48	0.66	0.06	0.26	0.02
1 500	0.71	0.75	0.70	0.10	0.40	0.13
2 000	0.64	1.05	0.72	0.16	0.52	0.32
2 500	0.57	1.38	0.75	0.22	0.61	0.48
3 000	0.51	1.76	0.77	0.29	0.69	0.59
3 500	0.44	2.20	0.78	0.36	0.75	0.66

Catches above 3 000 t would result in a 30% or greater probability of B falling below B_{lim} and would likely result in continued decline of the stock.

Assessment

The Surplus Production in Continuous Time (SPiCT) model was used for the assessment of this stock.

The next assessment is scheduled for 2025.

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

Biological and Environmental Interactions
There is no integrated summary information available on the structure, status and trends of the marine ecosystem for the area inhabited by this stock. Atlantic cod is an important predator on shrimp, while the predation impact is unknown.

Ecosystem sustainability of catches
Shrimp is included in the benthivore guild. There are currently neither Ecosystem Production Units (EPUs) defined nor Total Catch Index (TCI) estimated for the distribution area of this stock.

Fishery

Shrimp is caught in a directed trawl fishery. The fishery is regulated by TAC and bycatch reduction measures include move-on rules and sorting grids.

Recent catches and TAC ('000 t) were as follows:

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Enacted TAC	6.1	5.3	5.3	4.3	3.4	4.8	7.0	6.9	6.9	7.9
SC advised TAC	2.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0	2.0	2.5
STACFIS Catch	0.6	0.0	0.6	0.5	1.6	3.2	3.1	5.5	7.5	6.1[1]

[1] To June 30

Effects of the fishery on the ecosystem

Measures to reduce effects of the fishery on the ecosystem include move-on rules to protect sponges and corals.

Source of Information

SCR Docs. 21/044, 24/056, 24/057, 24/058; FC Doc. 04-18

b) Northern shrimp in Subarea 0 and Subarea 1

Advice September 2024 for 2025

Recommendation

In line with Greenland's stated management objective of maintaining a mortality risk of no more than 35% (subject to a risk of biomass being below B_{lim} of less than 1%), Scientific Council advises that catches in 2025 should not exceed 80 000 t.

With regard to the Canadian harvest strategy, Scientific Council notes that catches of 80 000 t in 2025 would result in a 33% risk of exceeding Z_{msy} in 2025, and a 32% and 31% risk of exceeding Z_{msy} in 2026 and 2027, respectively, assuming catches and the stock biomass at the same level as in 2025.

Management Objectives

A management plan and management objectives have been defined by the Government of Greenland in 2018. The objective is to maintain a mortality risk of no more than 35% (subject to a risk of biomass being below B_{lim} of less than 1%). Canada has a harvest strategy with the objective to maintain the stock in the Healthy Zone (>80% of B_{msy}); when the biomass is above 80% of B_{msy}, the risk of being above Z_{msy} should not exceed 35%, based on the 3-year projections. General principles from the *Convention on Cooperation in the Northwest Atlantic Fisheries* are applied.

Objective	***Status***	***Comment/consideration***
Maintain risk of being above Z_{msy} not exceeding 35%	🔴	The projected catches for 2024 equates to a risk of being above Z_{msy} by the end of 2024 of 53%. Scientific Council noted that the mortality is higher than the risk level of 35%
Maintain the stock in the Healthy Zone (>80% of B_{msy})	🟢	The stock is close to B_{msy} in 2024
Maintain risk of biomass being below B_{lim} of less than 1%	🟢	The risk of biomass in 2024 being below B_{lim} is less than 1%

🟢 OK

🟡 Intermediate

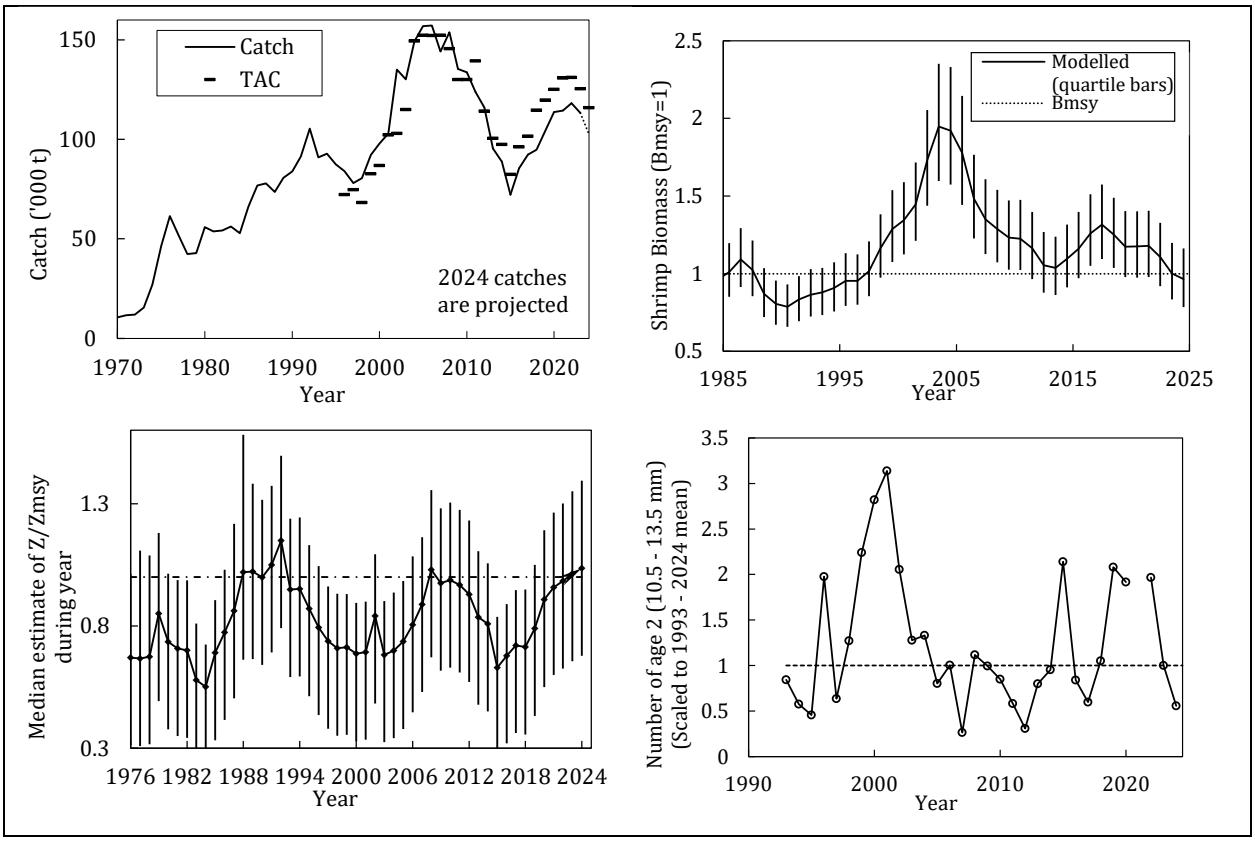
🔴 Not accomplished

Management unit

The stock is distributed throughout Subarea 1, extends into Div. 0A east of 60°30'W, and is assessed as a single stock. In 2023, more than 99% of the biomass and landings were from Greenland.

Stock status

Biomass in 2024 is close to B_{msy} and the probability of being below B_{lim} is very low (<1%). The probability of mortality in 2024 being above Z_{msy} is 53%. Recruitment (number of age-2 shrimp) in 2024 was below the time-series average.



Reference points

B_{lim} has been established as 30% B_{msy}, and Z_{msy} has been set as the mortality reference point. B_{msy} and Z_{msy} are estimated directly from the assessment model.

Projections

Predicted probabilities of transgressing reference points in 2025 – 2027 under eight catch options and subject to predation by a cod stock with an effective biomass of 17 Kt.

17 000 t cod	**Catch option ('000 tons)**							
Risk of:	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**
falling below Bmsy end 2025 (%)	51	52	52	52	53	54	54	55
falling below Bmsy end 2026 (%)	47	48	49	50	52	53	53	54
falling below Bmsy end 2027 (%)	44	44	47	48	50	52	52	54
falling below Blim end 2025 (%)	0	0	0	0	0	0	0	0
falling below Blim end 2026 (%)	0	0	0	0	0	0	0	0
falling below Blim end 2027 (%)	0	0	0	0	0	0	1	1
exceeding Zmsy in 2025 (%)	18	23	28	33	38	42	47	50
exceeding Zmsy in 2026 (%)	18	22	27	32	37	42	46	50
exceeding Zmsy in 2027 (%)	17	21	26	31	36	41	46	50
falling below Bmsy 80% end 2025 (%)	25	25	26	26	27	28	29	29
falling below Bmsy 80% end 2026 (%)	23	24	26	27	27	28	30	30
falling below Bmsy 80% end 2027 (%)	23	23	25	27	27	29	31	31

Assessment

A Schaefer surplus-production model was used for the assessment of this stock.

The next assessment is scheduled for 2025.

Human impact

Mortality related to the fishery has been documented. Other human sources (*e.g.*, pollution, shipping, oil-industry) are un-documented.

Biological and Environmental Interactions

There is no integrated summary information available on the structure, status and trends of the marine ecosystem for the area inhabited by this stock. Atlantic cod is an important predator on shrimp and this assessment incorporates this interaction. Other predation is likely but not explicitly considered. Shrimp might be important predators on, for example, fish eggs and larvae.

Ecosystem sustainability of catches

Shrimp is included in the benthivore guild. There are currently neither Ecosystem Production Units (EPUs) defined nor Total Catch Index (TCI) estimated for the distribution area of this stock.

Fishery

Shrimp are caught in a directed trawl fishery. The fishery is regulated by TAC.

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

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
TAC										
SC Advised	60	90	90	105	105	110	115	115	110	95
Enacted GRL	71.1	82.8	87.9	99.9	103.4	108.3	113.7	113.8	109.1	101.7
Greenland set aside to Canada	1.9	2.2	1	1.3	1.6	1.6	1.2	1.2	0.9	0.8
Enacted CAN	8.5	10.6	12.7	14.9	14.9	15.2	15.9	16.2	15.6	13.5
Enacted total	81.5	95.6	101.7	116.1	119.9	125.1	130.8	131.3	125.6	116
Catches (STACFIS)										
SA 1	72.3	84.4	89.4	93.2	102	113.1	114.3	118.1	113	102.5[1]
Division 0A	0	1.2	3.2	1.7	2.5	0.6	0.2	0	0	0[1]
TOTAL	72.3	85.5	92.6	94.9	104.4	113.8	114.6	118.1	113.2	
STATLANT 21										
SA 1	71.8	82.9	88.9	90.5	98.2	110.1	107.4	117.8	110.2	
Division 0A	1.4	2.8	1.4	1.3	0.2	0.2	0	0	-	

[1] Projected total catch for the year.

Effects of the fishery on the ecosystem

Measures to reduce effects of the fishery on the ecosystem include area closures, move-on rules and gear modifications to reduce damage to benthic communities and reduce bycatch.

Special comment

Scientific Council **recommends** that *the projection table should be given in projected catch increments of no less than 5 Kt due to uncertainty in calculating risk levels.*

Source of Information

SCS Doc. 13/04; FC Docs. 04-18; SCR Docs. 20/053, 20/057, 22/045, 24/052, 24/053, 24/054, 24/055.

V. OTHER MATTERS

1. Scheduling of Future Meetings

a) Scientific Council meetings

i) Scientific Council, 23 to 27 September 2024

The Scientific Council September 2024 meeting will be held in Halifax, Canada, 23-27 September 2024.

ii) WG-ESA, 12- 21 November 2024

The Working Group on Ecosystem Science and Assessment will meet at the NAFO Secretariat, Halifax, Canada, 12- 21 November 2024.

iii) Scientific Council, June 2025

The Scientific Council June meeting will be held in Halifax, Canada, 30 May - 12 June 2025.

iv) Scientific Council Shrimp, 9-11 September 2025

The Scientific Council September Shrimp 2025 meeting will be held in Halifax, Canada, 09-11 September 2025.

v) Scientific Council, 15-19 September 2025

Scientific Council noted that the Annual Meeting will be held in Halifax, Canada, 15-19 September 2025.

vi) WG-ESA, November 2025

Dates and location to be determined.

b) NAFO/ICES Joint Groups

i) NIPAG, 2025

Dates and location to be determined.

ii) ICES – NAFO Working Group on Deep-water Ecosystem (WG-DEC)

Dates and location to be determined.

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

Dates and location to be determined.

c) Commission- Scientific Council Joint Working Groups

i) CESAG

The next meeting of the Catch Estimation Strategy Advisory Group (CESAG) will take place via correspondence in the Spring of 2025, unless a meeting is required.

ii) WG-EAFFM

The joint Commission–Scientific Council Working Group on Ecosystem Approach Framework to Fisheries Management (WG-EAFFM) will take place in July 2025, location to be decided.

iii) WG-RBMS

The joint Commission–Scientific Council Working Group on Risk Based Management Systems (WG-RBMS) will take place in July 2025, locations to be decided.

2. Topics for Future Special Sessions

The Scientific Council agreed to propose an online shrimp aging workshop.

3. Other Business

a) FIRMS Classification for NAFO Stocks

Scientific Council 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		
Intermediate		3M Redfish[1] SA2+3KLMNO Greenland halibut 3M cod SA 0+1 (Offshore) Greenland halibut	SA0+1 Northern shrimp East Greenland Northern shrimp	SA1 American Plaice SA1 Spotted Wolffish
Small	3NOPs White hake 3NO Witch flounder 3LN Redfish	3O Redfish		
Depleted	3M American plaice 3LNO American plaice 3NO Cod 3LNO Northern shrimp 3M Northern shrimp[1] 6G Alfonsino			SA1 Redfish SA1 Atlantic Wolffish
Unknown	SA2+3 Roughhead grenadier 3NO Capelin	1B-C Greenland halibut Inshore	1D Greenland halibut Inshore 1E-F Greenland halibut Inshore	SA3+4 Northern shortfin squid 3LNOPs Thorny skate Greenland halibut in Uummannaq Greenland halibut in Disko Bay Greenland halibut in Upernavik

[1] Fishing mortality may not be the main driver of biomass for this stock.
For many stocks, lack of surveys in recent years has impacted assessments.

VI. ADOPTION OF REPORTS

The STACFIS report was adopted on 19 September 2024.

VII. ADJOURNMENT

The Scientific Council meeting was adjourned at 12:30 on 19 September 2024. The Chairs thanked all participants, especially the designated experts, for their hard work. The Chairs thanked the NAFO Secretariat for all of their logistical support and the NAFO Secretariat for hosting the meeting. The report was adopted at the close of the meeting, subject to a period for editorial revision following this meeting.

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

Chair: Martha Krohn Rapporteur: NAFO Secretariat

I. OPENING

STACFIS met from 17 to 19 September 2024 at the NAFO Secretariat in Halifax, Canada, to review stock assessments northern shrimp stocks. Representatives attended from Canada, Denmark (in respect of the Faroe Islands and Greenland), the European Union, Norway, the Russian Federation and Ukraine. A full list of participants is included in Appendix VI.

The Chair, Martha Krohn (Canada), opened the meeting at 09:43 on 17 September and welcomed participants. The provisional agenda was adopted as circulated. The NAFO Secretariat (Dayna Bell MacCallum and Jana Aker) was appointed as rapporteur.

II. GENERAL REVIEW

1. Review of Research Recommendations in 2023

Recommendations applicable to individual stocks are given under each stock in the "stock assessments" section of this report.

2. Review of Catches

Catches and catch histories were reviewed on a stock-by-stock basis in connection with each stock.

III. STOCK ASSESSMENTS

1. Northern shrimp (*Pandalus borealis*) on the Flemish Cap (NAFO Division 3M)

Full assessment (SCR Doc. 04/77, 16/35, 18/24, 24/59, 60)

Environmental Overview

The water masses characteristic of the Flemish Cap area are a mixture of Labrador Current Slope Water and North Atlantic Current water, generally warmer and saltier than the sub-polar Newfoundland Shelf waters with a temperature range of 3-4°C and salinities in the range of 34-34.75. The general circulation in the vicinity of the Flemish Cap consists of the offshore branch of the Labrador Current which flows through the Flemish Pass on the Grand Bank side and a jet that flows eastward north of the Cap and then southward east of the Cap. To the south, the Gulf Stream flows to the northeast to form the North Atlantic Current and influences waters around the southern areas of the Cap. In the absence of strong wind forcing the circulation over the central Flemish Cap is dominated by a topographically induced anti-cyclonic (clockwise) gyre. Variation in the abiotic environment influences the distribution and biological production of Newfoundland and Labrador Shelf and Slope waters where arctic, boreal and temperate species coexist. The elevated temperatures on the Flemish Cap result in relatively ice-free conditions that may allow longer phytoplankton growing seasons compared to the Grand Banks where cooler conditions prevail. The entrainment of nutrient-rich North Atlantic Current water around the Flemish Cap generally supports higher primary and secondary production compared with the adjacent shelf waters. The stability of this circulation pattern may also influence the retention of ichthyoplankton on the Grand Bank which may influence year-class strength of various fish and invertebrate species.

a) Introduction

The shrimp fishery in Division 3M began in 1993. Catches peaked at over 60 000 t in 2003 and declined thereafter. A moratorium was imposed from 2011 to 2019. In 2020 the fishery was resumed with very low catches that increased to 5 703 t in 2021. A new moratorium was established in 2022 in Division 3M.

Fishery and catches: This stock is under effort regulation. The fishery was reopened in 2020 after nine years under moratorium with an effort allocation of 2 640 fishing days/year. Both effort and catches in 2020 were very low (19 days and 79 t) but increased in 2021 (479 days and 5 703 t) (Figure 1.1). Due to the moratorium, there has not been effort directed to the 3M shrimp fishery since 2022.

Recent catches (tonnes) and effort agreed by the NAFO Commission were as follows (ndf=no directed fishery):

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
STACFIS	0	0	0	0	0	79	5703[3]	0	0	0[1]
STATLANT 21	0	0	0	0	0	0	5905	NA[4]	NA[4]	
Effort[2] (Agreed Days)	ndf	ndf	ndf	ndf	ndf	2 640	2 640	ndf	ndf	ndf
Effort days used	0	0	0	0	0	19	479	0	0	0

[1] Preliminary catches until June 30
[2] Effort regulated
[3] CESAG method
[4] NA - In 2022-2023, STATLANT 21 information is incomplete.

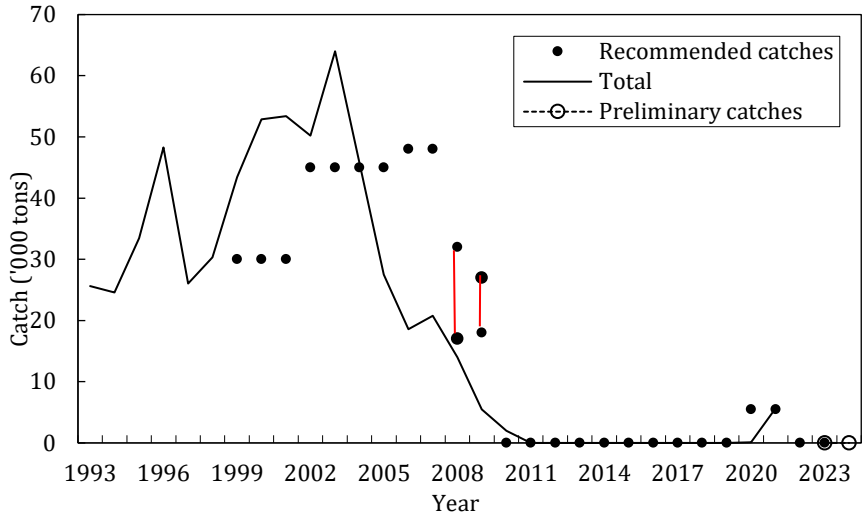


Figure 1.1. Shrimp in Division 3M: Catches (STACFIS, '000 t) and recommended TAC in the period 1993-2024 (red lines in 2008 and 2009 indicate the catches range recommended by SC and dashed line preliminary catches of 2024).

b) Data overview

i) Commercial fishery data

Because of the moratorium, catch and effort data were not available for 2011 - 2019 and for 2022 - 2024. Standardized CPUE series was not updated for 2020 or 2021.

ii) Research Survey Data

EU Bottom Trawl Research Survey. Stratified-random trawl surveys have been conducted on Flemish Cap during the summer from 1988 to 2024. A new vessel was introduced in 2003 which continued to use the same trawl as was employed since 1988. The series prior to 2003 was converted into comparable units with the new vessel using the methods accepted by STACFIS in 2004.

c) Assessment

The 3M shrimp assessment is based upon interpretation of commercial fishery information and research survey data. There is currently no analytical model.

Biomass: The survey female biomass index was stable at a high level from 1998 to 2007, and subsequently declined until 2014. From 2015 to 2019, the female biomass index increased and was well above B_{lim} in 2019. In 2020 the female biomass decreased but remained above $B_{lim.}$ Since 2021 the female biomass has been below B_{lim} (Figure 1.2).

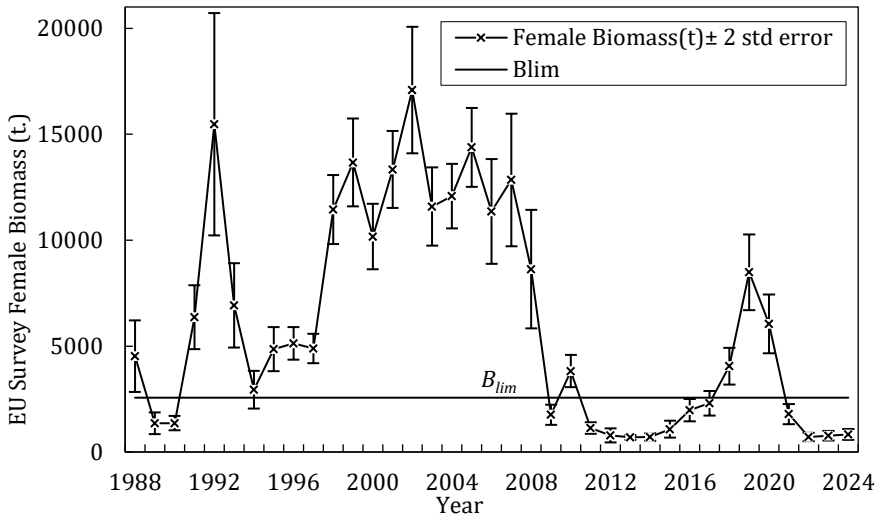


Figure. 1.2. Shrimp in Division 3M: Female biomass index from EU trawl surveys, 1988-2024. Error bars are 2 std. err.

Recruitment: Abundance at age 2 in the standard gear and in an additional small mesh size bag at the cod end of the trawl gear (juvenile bag) are used as the indicators of recruitment. Recruitment has been low since 2005, with the exception of 2020 (juvenile bag). Since 2021, the abundances at age 2 in the main gear have been among the lowest of the historical series (Figure 1.3).

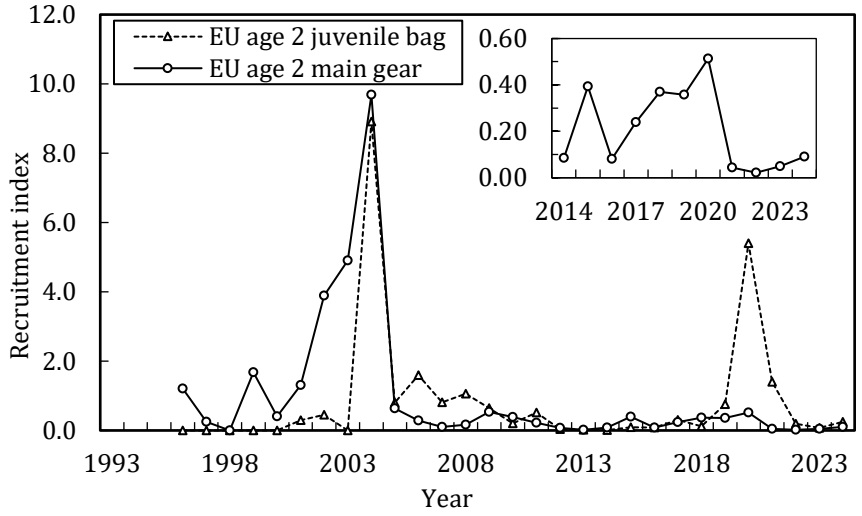


Figure. 1.3. Shrimp in Division 3M: Abundance indices at age 2 from the EU survey. Each series was standardized to its mean. Inset shows EU main gear on a different vertical scale for the most recent period.

Exploitation rate: Due to the moratorium, the exploitation rate index was zero from 2011 to 2019. In 2020, the fishery resumed but the effort directed to shrimp fisheries and catches were low resulting in a very low exploitation rate (0.01). In 2021 the exploitation rate increased notably (3.3) due to an increase in catches (5 703 t) and a decrease in the EU survey female biomass index (Figure 1.4). With the moratorium re-established in 2022, the exploitation rate in 2022 and 2023 was zero and is expected to be at the same level in 2024.

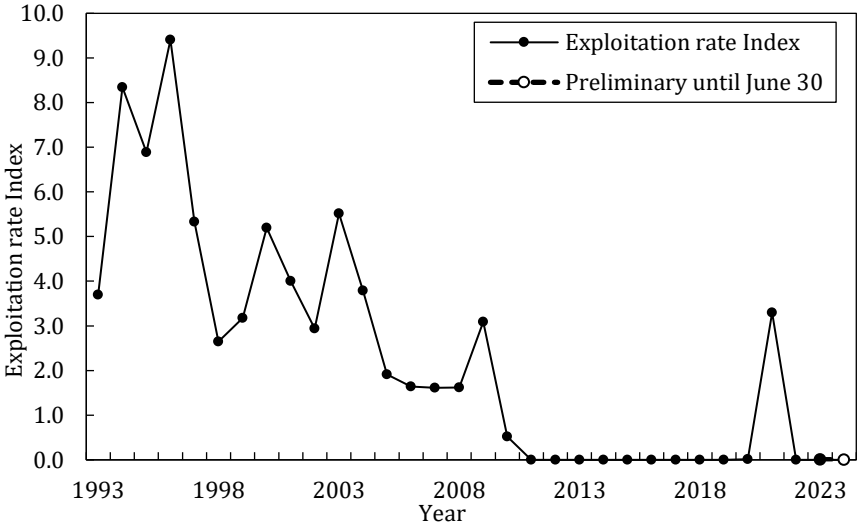


Figure. 1.4. Shrimp in Division 3M: Exploitation rate index as derived by catch divided by the EU survey biomass index of the same year.

State of the stock: Since 2021 the biomass has been below $B_{lim.}$ Recruitment since 2021 has been the lowest of the historical series. The exploitation rate in 2022 and 2023 was zero and is expected to be at the same level in 2024.

d) Reference Points

A proxy for B_{lim} has been set to 15% of the maximum observed female biomass from the survey index. This corresponds to 15% of the index in 2002 which has a value of 2 564 t (Figure 1.5). A limit reference point for fishing mortality has not been defined.

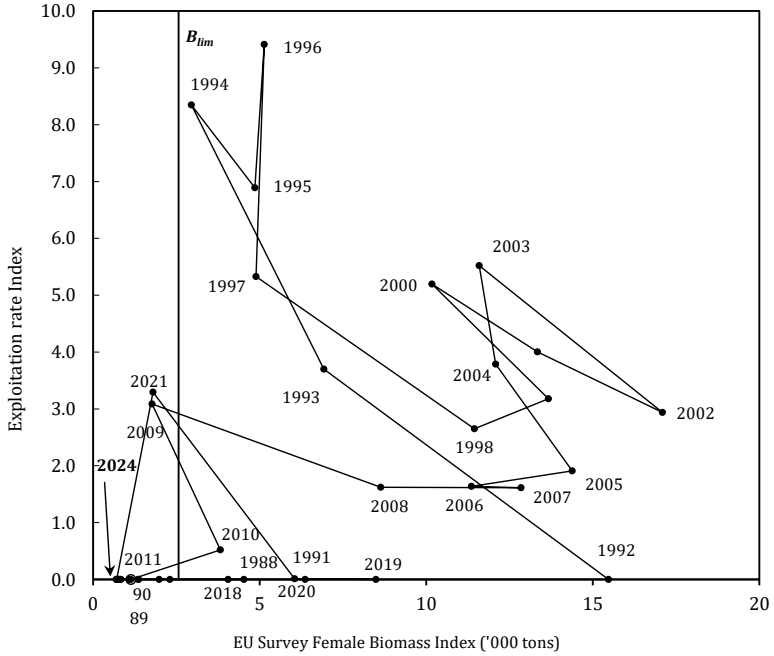


Figure. 1.5. Shrimp in Division 3M: Exploitation rate index plotted against female biomass index from EU survey.

e) Ecosystem considerations

Multispecies models suggest that predation by Atlantic cod and redfish, together with fishing, were the main factors driving the shrimp stock to the collapse after 2007. Results of modelling suggest that, in unexploited conditions, cod and redfish would be expected to be a highly dominant component of the system, and high shrimp stock sizes like the ones observed in the 1998 – 2007 period would not be a stable feature in the Flemish Cap (Figure 1.6). Potential changes in environmental conditions may add uncertainty in the ecosystem modelling.

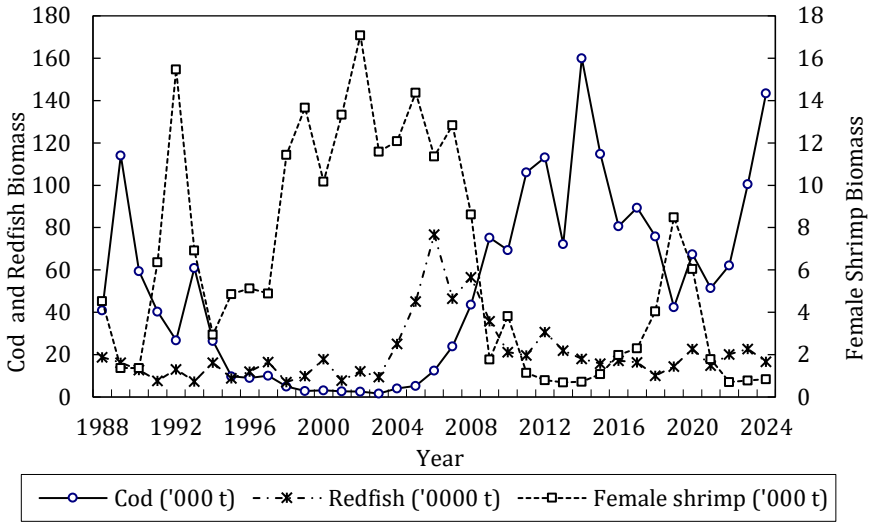


Figure. 1.6. Shrimp in Division 3M: Atlantic cod, redfish and female shrimp biomass from EU trawl surveys, 1988-2024. Data from 2024 for cod and redfish are preliminary.

f) Research Recommendations

NIPAG **recommended** in 2016 that *further exploration of the relationship between shrimp, cod and the environment be continued in WGESA and NIPAG encourages the shrimp experts to be involved in this work.*

STATUS: No progress from last year. This recommendation is reiterated.

STACFIS **recommends** *a workshop be scheduled to advance the work being done on aging*.

STACFIS **recommends** that *an estimation of potential reference points be explored.*

STACFIS **recommends** *exploration of a quantitative model for this stock.*

The next assessment will take place prior to the NAFO Annual Meeting in September 2026.

2. Northern shrimp (*Pandalus borealis*) on the Grand Bank (NAFO Divisions 3LNO)

Interim Monitoring Report (SCR Docs. 14/048, 24/037; SCS Doc. 04/12)

Environmental Overview

The water mass characteristics of the Grand Bank are typical of sub-polar waters, with the presence of a cold intermediate layer (CIL) formed during winter, which lasts 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 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 Division 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.

a) Introduction

This shrimp stock is distributed around the edge of the Grand Bank, mainly in Division 3L. The fishery began in 1993 and came under TAC control in 2000 with a 6 000 t TAC. Annual TACs were raised several times between 2000 and 2009 reaching a level of 30 000 t for 2009 and 2010. This fishery has historically been prosecuted mainly by Canada, EU-Estonia and the Faroes. Other counties also have some limited involvement in this fishery. The TAC was then reduced annually until no directed fishing (ndf) was implemented in 2015 to 2024 (Figure 2.1). The TAC entries in the table below include autonomous TACs from Denmark (in respect of the Faroe Islands and Greenland).

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

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
TAC[1]	ndf	ndf	ndf	ndf	ndf	ndf	ndf	ndf	ndf	ndf
STATLANT 21	0	0	0	0	0	0	0	NA[4]	NA[4]	
STACFIS[2]	0	0	0	0	0	0	0	0	0	0[3]

[1] Includes autonomous TAC as set by Denmark in respect of Faroes and Greenland.
[2] STACFIS catch estimates have been updated using various data sources (see p. 13, SCR Doc. 14/048).
[3] Provisional catches for first half of 2024
[4] NA - In 2022-2023, STATLANT 21 information is incomplete.

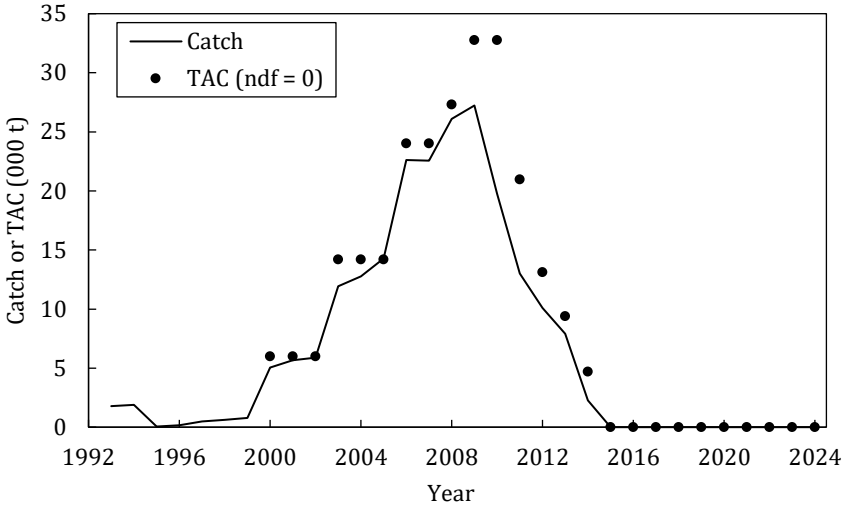


Figure 2.1. Shrimp in Divisions 3LNO: Catches and TAC. The TAC illustrated includes the autonomous quotas set by Denmark (in respect of the Faroe Islands and Greenland). No directed fishing is plotted as zero TAC.

b) Data Overview

i) Commercial fishery data

Effort and CPUE. Catch and effort data have been available from Canadian vessel logbooks and observer records since 2000; however there was no fishery from 2015 to present.

ii) Research survey data

Canadian bottom trawl surveys. Canada has conducted stratified-random surveys in Divisions 3LNO, using a Campelen 1800 shrimp trawl for spring (1999–2024) and autumn (1996–2023). The autumn surveys in 2004, 2021 and 2022, and the spring surveys in 2015, 2017-2018 and 2020-2022 were incomplete and therefore could not be used to produce biomass indices for Divisions 3LNO. The autumn 2014 survey only surveyed Division 3L, however since about 95% of the shrimp biomass in Divisions 3LNO comes from Division 3L annually, it was considered useful as a proxy for Divisions 3LNO for 2014.

The application of conversion factors to account for the differences in catchability between outgoing and new survey vessels in the Canadian fall surveys resulted in a revision of the biomass and exploitation rate indices in Divisions 3LNO (1996–2020), and recalculation of the reference point (B_{lim}). Based on additional analyses presented during the meeting showing consistency in environmental conditions (such as depth and temperature) and biological conditions (including the size distribution of shrimp caught), the conversion factors for the fall survey in Divisions 2HJ3KL were also applied in Divisions 3NO. The most recent Canadian surveys for this species cannot be directly compared to previous series in years where the Needler/Templeman were used due to a lack of conversion factors to new survey vessels for this stock. For the years when the Teleost was used for the spring surveys, it was determined there was no need for a conversion factor to compare with the new vessels (conversion factor = 1).

EU-Spain surveys. EU-Spain has been conducting a stratified-random survey in the NAFO Regulatory Area (NRA) part of Division 3L since 2003 and in the NRA part of Divisions 3NO since 1995. Prior to 2001, data were collected using a Pedreira trawl, and since 2001 they have been collected with a Campelen 1800 trawl. Pedreira trawl units have been converted to Campelen equivalents. There were no EU-Spain Division 3L surveys in 2005 or 2020-2022 and no Divisions 3NO survey in 2020.

Biomass indices. In Canadian surveys, about 95% of the biomass was found in Division 3L, distributed mainly along the northeast slope in depths from 185 to 550 m. Total, fishable (shrimp with carapace length > 17mm) and female (SSB) biomass and abundance indices follow the same trend throughout the survey time series. There was an overall increase in both the autumn and spring indices to 2007 after which they decreased by over 95% to the lowest levels in the autumn time-series in 2018 and the spring time-series in 2016 (Figure 2.2). The 2023 autumn survey indicated that the biomass indices have decreased slightly since 2020 and remain amongst the lowest levels in the autumn time-series. The 2024 spring survey indicated that the biomass indices have decreased slightly since 2023.

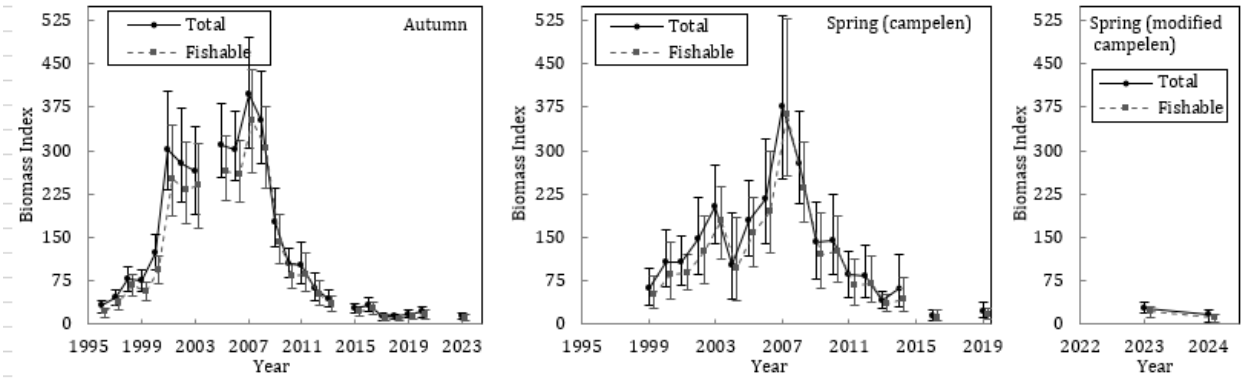


Figure 2.2. Shrimp in Divisions 3LNO: Left plot is total and fishable biomass index estimates from Canadian autumn multi-species surveys 1996 - 2023 (95% confidence intervals are given; time series corresponds to new vessels with modified Campelen). Middle plot is total and fishable biomass index estimates from Canadian spring multi-species surveys 1996 - 2019 (Campelen). Right plot is total and fishable biomass index estimates from Canadian spring multi-species surveys 2023 - 2024 (new vessels with modified Campelen; 2023 and 2024 only). The 2014 autumn index is for Division 3L only. There are no available biomass index estimates for autumn 2021-2022 or for spring 2015, 2017-2018 or 2020-2022.

EU-Spain survey biomass indices for Division 3L and Divisions 3NO, within the NRA only, increased from 2003 to 2008 followed by a 93% decrease by 2012 remaining near that level through 2019 (Figure 2.3). The 2024 survey of Divisions 3NO indicated that the biomass index is still far below the biomass levels of 2003-2007. The 2024 survey estimate for division 3L is the second lowest in the time series. Throughout the survey time-series, more than 97% shrimp biomass has been captured in the 3L survey compared to the Divisions 3NO survey.

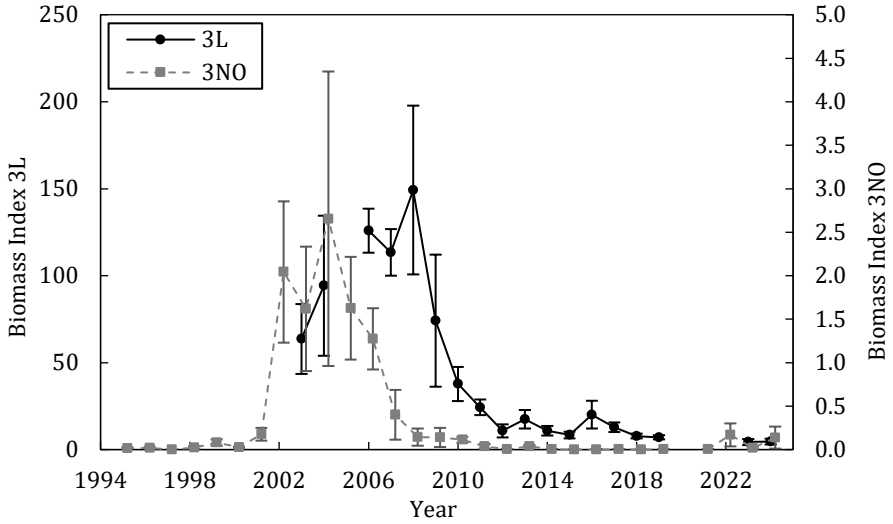


Figure 2.3. Shrimp in Divisions 3LNO: Total biomass index estimates from EU - Spain multi-species surveys (± 1 SE) in the NAFO Regulatory Area (NRA) of Divisions 3LNO. There are no available biomass index estimates for 2020 and only Divisions 3NO were surveyed in 2005 and 2021-2022.

Stock Composition. Both males and females showed a broad distribution of lengths in recent surveys indicating the presence of more than one year class (Figure 2.4).

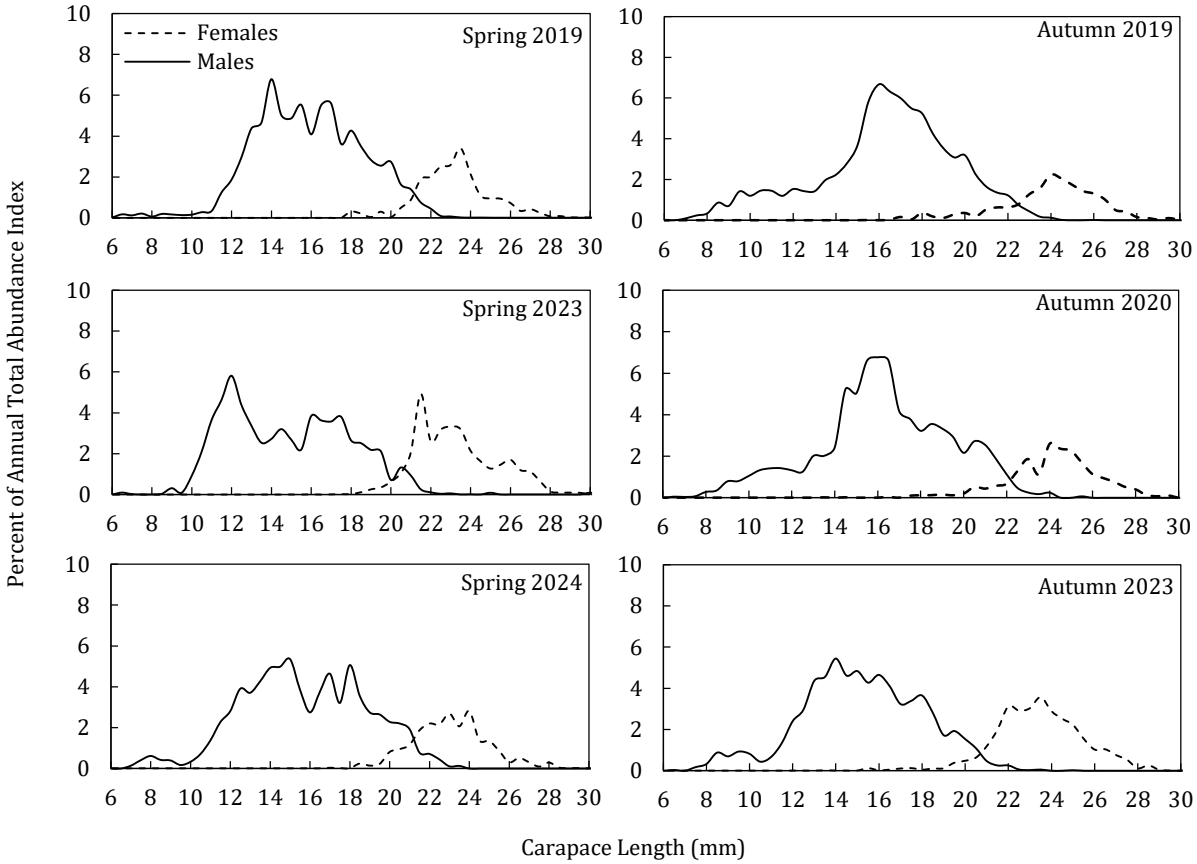


Figure 2.4. Shrimp in Divisions 3LNO: Composition of survey catches (percentage at length) from Canadian spring and autumn multi-species survey data. No data for autumn 2021-2022 or spring 2020-2022.

Recruitment indices. Recruitment indices were based upon abundance indices of shrimp with carapace lengths of 11.5 – 17 mm from Canadian multi-species survey data. The 2006 – 2008 indices were among the highest in both spring and autumn time-series but have since declined to very low levels (Figure 2.5). It is unclear if the survey indices of shrimp <17mm carapace length is representative of recruitment.

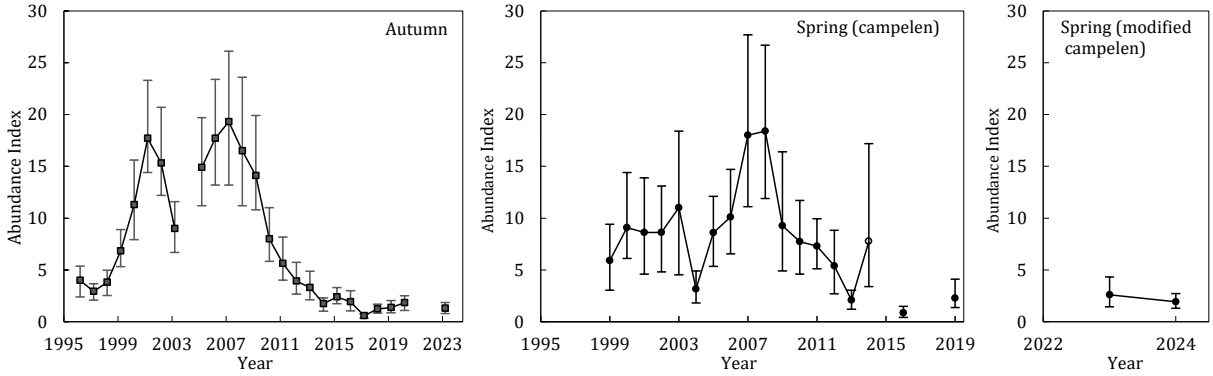


Figure 2.5. Shrimp in Divisions 3LNO: Indices of recruitment-sized shrimp based on abundance of shrimp with 11.5 – 17 mm carapace lengths from Canadian autumn (left plot) and spring (middle and right plots) multi-species surveys. Error bars represent 95% confidence intervals. The autumn time series corresponds to new vessels with modified Campelen and index for 2014 is for Division 3L only. Middle plot is recruitment abundance index estimates from Canadian spring multi-species surveys 1996 - 2019 (Campelen). Right plot is recruitment abundance index estimates from Canadian spring multi-species surveys 2023 - 2024 (new vessels with modified Campelen; 2023 and 2024 only). There are no available recruitment abundance index estimates for autumn 2021-2022 or for spring 2015, 2017-2018 or 2020-2022.

Exploitation index. An index of exploitation was derived by dividing the catch in a given year by the fishable biomass index from the previous autumn survey. The exploitation index generally increased throughout the course of the fishery until dropping sharply in 2014 (Figure 2.6). There has been no directed fishing since 2015, the exploitation index is zero for that period of time. Mortality due to bycatch during other fisheries is unknown.

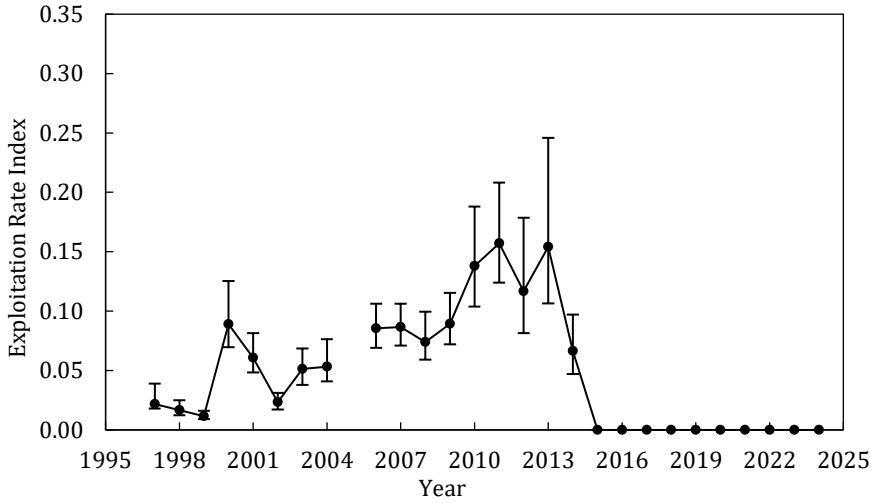


Figure 2.6. Shrimp in Divisions 3LNO: Exploitation indices calculated as a year's catch divided by the previous year's autumn fishable biomass index. Error bars (calculated based on estimates of fishable biomass index) indicate 95% confidence intervals.

c) Reference points.

The point at which a valid index of female spawning stock size has declined to 15% of its highest observed value is considered to be B_{lim}. In 2023 the risk of being below B_{lim} was greater than 95% (Figure 2.7). A limit reference point for fishing mortality has not been defined.

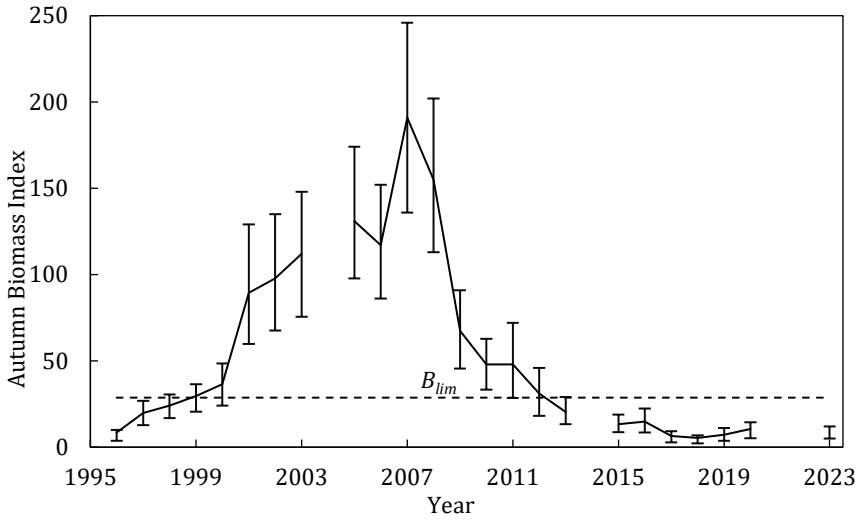


Figure 2.7. Shrimp in Divisions 3LNO: Autumn female spawning stock biomass index (SSB) and B_{lim}. B_{lim} is defined as 15% of the maximum autumn female biomass over the time-series. Error bars indicate 95% confidence intervals. The autumn index for 2014 is for Division 3L only.

d) Conclusions

Based on the autumn 2023 survey, the risk of the stock being below B_{lim} is greater than 95%. Biomass indices from other surveys show no indication of recovery. In addition, recruitment remains very low.

e) Research recommendations

NIPAG **recommended in 2015** that *ecosystem information related to the role of shrimp as prey in the Grand Bank (i.e. Divisions 3LNO) Ecosystem be presented to NIPAG.*

Status: Available information was presented to the current meeting and will be presented annually.

NIPAG **recommends in 2018** that *further work on the development of a recruitment index for Div. 3LNO be completed.*

Status: Work is in progress to develop a shrimp population model.

STACFIS **recommends** that *an estimation of potential reference points be explored*.

3. Northern shrimp (*Pandalus borealis*) off West Greenland (NAFO Subarea 0 and Subarea 1)

Full Assessment (SCR Docs. 04/075, 076, 08/006, 11/053, 058, 12/044, 13/054, 20/053, 054, 058, 24/021, 052, 053, 054, 055)

Environmental Overview

Hydrographic conditions in this region depend on a balance of ice melt, advection of polar and sub-polar waters and atmospheric forcing, including the major winter heat loss to the atmosphere that occurs in the central Labrador Sea. The cold and fresh polar waters carried south by the east Baffin Island Current are counter balanced by warmer waters that are carried northward by the offshore branch of the West Greenland Current (WGC). The water masses constituting the WGC originate from the western Irminger Basin where the East Greenland Current (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.

a) Introduction

The shrimp stock off West Greenland is distributed mainly in NAFO Subarea 1 (Greenland Exclusive Economic Zone (EEZ)), but a small part of the habitat, and of the stock, extends into the eastern edge of Division 0A (Canadian EEZ). Canada has defined 'Shrimp Fishing Area 1' (Canadian SFA1) to be the part of Division 0A lying east of 60°30'W, i.e., east of the deepest water in this part of Davis Strait.

The stock is assessed as a single population.

i) Commercial Fisheries data

The Greenland fishery exploits the stock in Subarea 1 (Divisions 1A– 1F). The Canadian fishery has been limited to Division 0A.

The Canadian fleet and the Greenland offshore fleets have been restricted by areas and quotas since 1977. The Greenland coastal fleet has privileged access to inshore areas (primarily Disko Bay and Vaigat in the north, and Julianehåb Bay in the south). Sorting grids are required in both the Greenland and the Canadian fleets to reduce bycatch of fish. Discarding of shrimp is prohibited.

The TAC for Greenland waters in 2024 was set at 102 500 t and, for Canadian waters, 13 490 t.

Total catch increased to an average over 150 000 t from 2005 to 2008 and decreased to 72 256 t in 2015 (Figure 3.1). Since 2016, the catch has been increasing in conjunction with increasing TACs and was 113 223 t in 2023. The projected catch for 2024 is 102 500 t in Greenlandic EEZ (Subarea 1). The projected catch for Canada from Division 0A in 2024 is expected to be low.

There are differences between the Scientific Council advised TAC and the total enacted TAC. This is due to the fact that Greenland sets an enacted TAC based on the advice from Scientific Council, whereas Canada independently sets a TAC based on 14.2% of the advised TAC. In some years, total catch exceeded the Scientific Council advised TAC due to banking and borrowing rules in Greenland, as well as the autonomous TAC in Canada.

Recent catches, projected catch for 2024, and recommended and enacted TACs ('000 t) for northern shrimp in Subarea 1 and Division 0A (east of 60°30'W) are as follows:

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
TAC										
SC Advised	60	90	90	105	105	110	115	115	110	95
Enacted GRL	71.1	82.8	87.9	99.9	103.4	108.3	113.7	113.8	109.1	101.7
Greenland set aside to Canada	1.9	2.2	1	1.3	1.6	1.6	1.2	1.2	0.9	0.8
Enacted CAN	8.5	10.6	12.7	14.9	14.9	15.2	15.9	16.2	15.6	13.5
Enacted total	81.5	95.6	101.7	116.1	119.9	125.1	130.8	131.3	125.6	116
Catches (STACFIS)										
SA 1	72.3	84.4	89.4	93.2	102	113.1	114.3	118.1	113	102.5[1]
Division 0A	0	1.2	3.2	1.7	2.5	0.6	0.2	0	0	0[1]
TOTAL	72.3	85.5	92.6	94.9	104.4	113.8	114.6	118.1	113.2	
STATLANT 21										
SA 1	71.8	82.9	88.9	90.5	98.2	110.1	107.4	117.8	110.2	
Division 0A	1.4	2.8	1.4	1.3	0.2	0.2	0	0	-	

[1] Projected total catch for the year.

Since the early 2000s the Greenlandic fishery has moved north and currently about 80% of the total catch is taken in Division 1A and 1B.

Canadian fishing effort has been sporadic and catches variable. In 2016 fishing increased in the Canadian EEZ with catches reaching a maximum of 3 215t in 2017 and have since declined to very low levels in 2021 and 2022, and zero catches in 2023 and 2024.

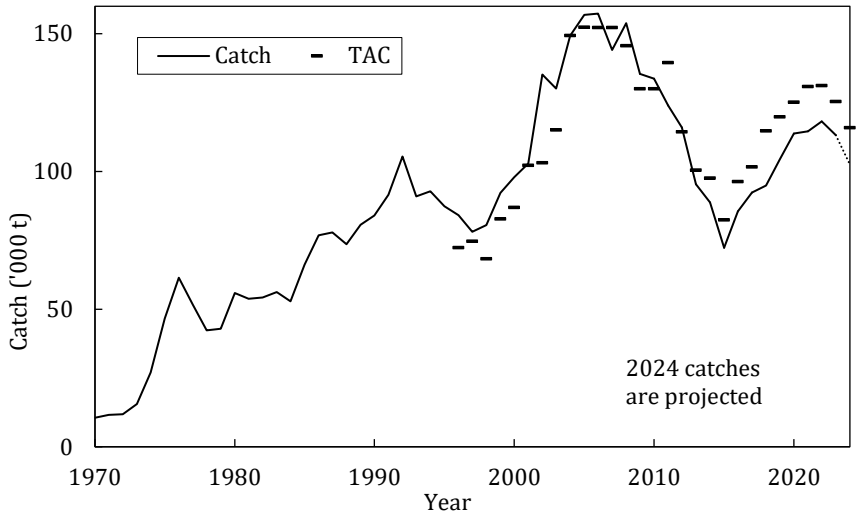


Figure 3.1. Northern shrimp in Subarea 0 and Subarea 1: Total enacted TACs and total catches.

b) Data overview

i) Commercial Fisheries Data

Fishing effort and CPUE. Catch and effort data from the fishery were available from Greenland logbooks for Subarea 1. In recent years both the distribution of the Greenland fishery and fishing power have changed significantly: for example, larger vessels have been allowed in a limited part of coastal areas; the coastal fleet has fished outside Disko Bay; the offshore fleet now commonly uses double trawls or triple trawls. Furthermore, quota transfers between the two fleets are now allowed.

CPUEs were standardized by linearized multiplicative models including terms for vessel, month, gear type, year and statistical area. Standardized CPUE series were done separately for three different fleets (Figure 3.2); the early offshore fleet fishing in Division 1A and part of Division 1B (Royal Greenlandic Trade (KGH)-index, 1976-1990), the present offshore fleet fishing in Subarea 1 (1987-2024) and the coastal fleet fishing in coastal and inshore areas (1989-2024). CPUE for the Canadian fleet fishing in Division 0A has not been updated because it is not possible to receive new logbook information from Canada due to privacy constraints. In the recent years the CPUE of the coastal fleet has remained stable, while the CPUE of the offshore fleet increased to 2017 and declined until 2023. Partial data from 2024 indicate CPUE for combined fleet components will decline slightly.

The three CPUE series are combined by assuming they all reflect the overall biomass series scaled by a constant fleet factor, and that the errors had mean zero and variances inversely proportional to the fishing ground of the fleet. The estimation was done in a Bayesian framework.

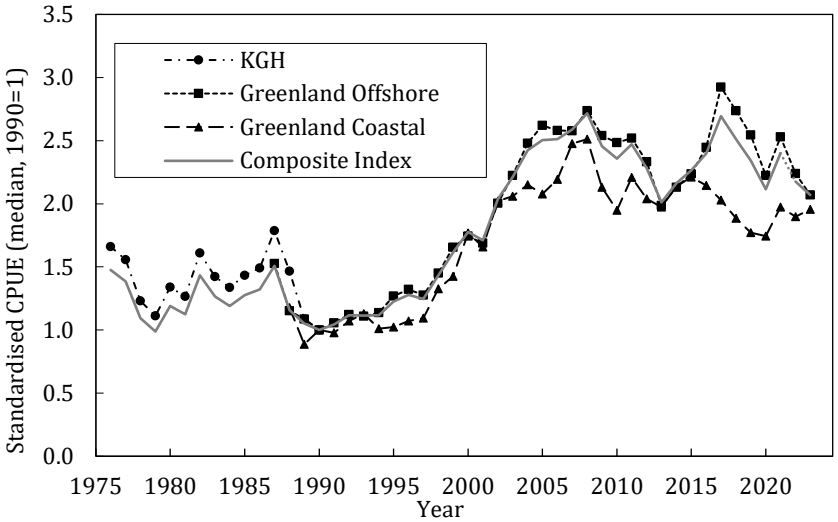


Figure 3.2. Northern shrimp in Subarea 0 and Subarea 1: Standardized CPUE index series 1976–2024. The 2024 point is based on data from 1 January to 30 June 2024.

The distribution of catch and effort among statistical areas was summarized using Simpson's diversity index to calculate an 'effective' number of statistical areas being fished as an index of how widely the fishery is distributed (Figure 3.3). The 'effective' number of statistical areas being fished in Subarea 1 reached a plateau in 1992–2003. The range of the fishery has since contracted northwards, and the 'effective' number of statistical areas being fished has decreased.

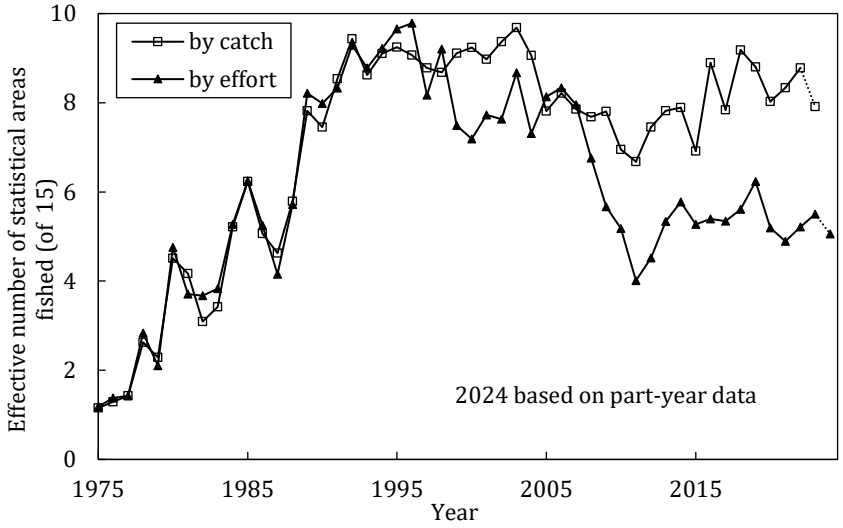


Figure 3.3. Northern shrimp in Subarea 0 and Subarea 1: Indices for the distribution of the Greenland fishery between statistical areas in 1975–2024. The 2024 point is based on data from 1 January to 30 June 2024.

Catch composition. There is no biological sampling program from the fishery that is adequate to provide catch composition data for the assessment.

ii) Research survey data

Greenland trawl survey. Random stratified trawl surveys designed primarily to estimate shrimp stock biomass have been conducted since 1988 in offshore areas and since 1991 also inshore in Subarea 1. From 1993, the survey was extended southwards into Division 1E and 1F. A cod-end liner of 22 mm stretched mesh has been used since 1993. From its inception until 1998 the survey used 60-minute tows, but since 2005 all tows have lasted 15 minutes. In 2005 the *Skjervøy 3000* survey trawl was replaced by a *Cosmos 2000* with rock-hopper ground gear. Calibration trials were conducted, and the earlier data were adjusted.

In 2018 and 2019-2020, the annual trawl survey was conducted with two different chartered vessels during the same time of year as the usual survey, and in 2021 no survey was conducted due to vessel unavailability. Since 2022 the survey has been conducted with the new Greenlandic research vessel *Tarajoq*. All the standard gears were identical to those used at the research vessel *Paamiut* (such as Cosmos trawl, doors, all equipment such as bridles etc., *Marport* sensors on doors and headlines), and all the standard research protocols were followed in an attempt to make the surveys as identical as possible with the previous years' survey with the research vessel *Paamiut*. It is therefore assumed that the 2018, 2019-2020 and 2022-2024 results were directly comparable with the previous surveys, however without comparative fishing there remains some uncertainty.

In 2023, there was heavy ice coverage north of 66°N in the Greenland EEZ, which prevented trawling at many planned stations during the survey. Due to poor survey coverage in the northern survey area, it is uncertain if the 2023 survey results reflect the stock trajectory and status. Hence, it was assumed that the commercially important areas in north were not covered properly. In order to compensate for the un-surveyed area, an average of the past five-year values of biomass and density in the un-surveyed stratum/strata were used to replace missing values for 2023 assessment of the West Greenland shrimp stock.

The survey average bottom temperature increased from about 1.7°C in 1990–1993 to about 3.1°C in 1997–2014 but declined to 2.1°C in 2018. In 2022/2023 bottom-temperature was 3°C and there was an increase to 3.3°C in 2024. About 80% of the survey biomass is in water 200–400 m deep throughout the time series. Since 2001 most of the survey biomass has been in water 200–300 m deep. The proportion of survey biomass in Division 1E–F has been low in recent years and the distribution of survey biomass, like that of the fishery, has become more northerly.

Biomass. The survey index of total biomass remained fairly stable from 1988 to 1997. It then increased until 2003. Subsequent values declined, with the second lowest level in the last 22 years occurring in 2014 (Figure 3.4). Since 2017 biomass has remained relatively stable but showed a decline in 2024.

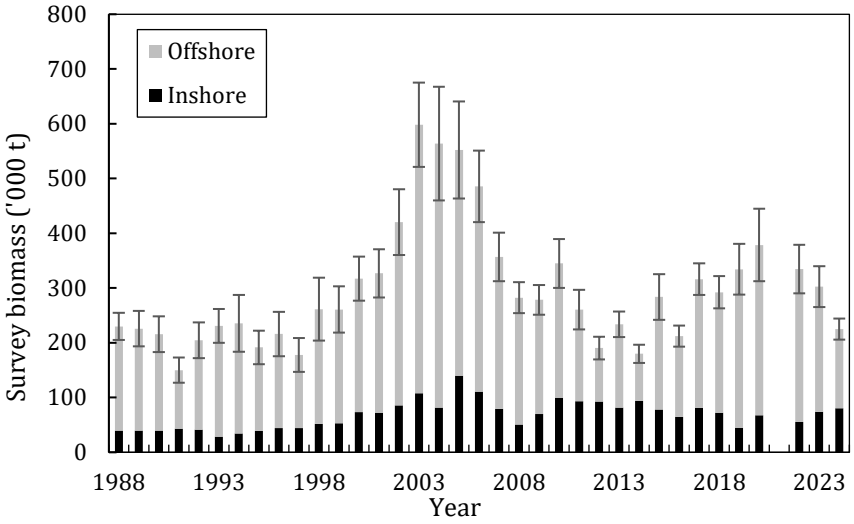


Figure 3.4. Northern shrimp in Subarea 0 and Subarea 1: Biomass index (survey mean catch rates) inshore (Disko Bay and Vaigat) and offshore 1988–2024 (error bars ±1 SE).

Length and sex composition. In 2024, in Disko Bay the proportion of fishable males in the survey was in the upper quartile of the 19-year series, whereas the proportion of fishable males in the offshore regions was in the lower quartile. Females compose a high proportion of survey and fishable biomass indices in both regions. They were above their 19-year median offshore, and slightly below their 19-year median in Disko Bay (Figure 3.5).

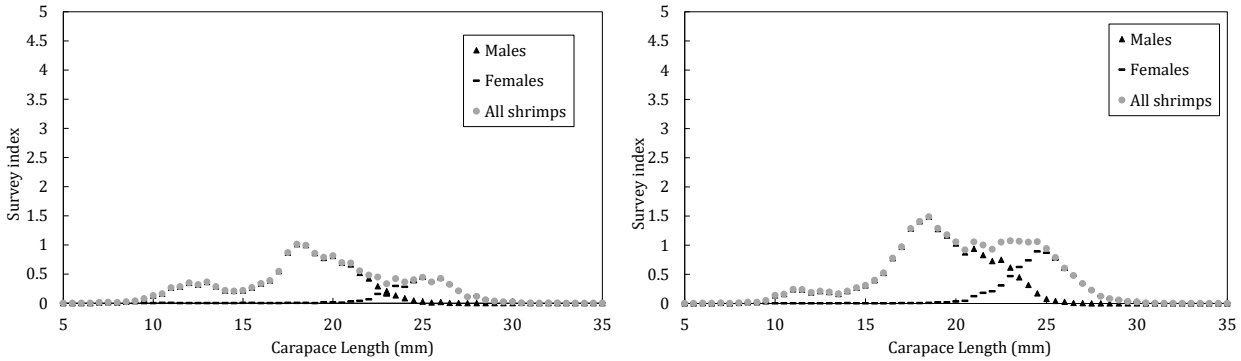


Figure 3.5. Northern shrimp in Subarea 0 and Subarea 1: Survey mean catch composition at length in offshore regions (left) and Disko Bay & Vaigat (right) in the West Greenland trawl survey in 2024.

Recruitment. Since 2014, age-2 (10.5 to 13.5 mm) recruitment has been variable and in 2023 and 2024 it has been below average (Figure 3.6).

The stock composition in Disko Bay has historically been characterized by a higher proportion of young shrimps than that offshore; exceptions were in 2017 - 2020 and 2023, where proportions of younger shrimps offshore were much higher both in numbers and relative to survey biomass. In 2024 numbers of age-2 shrimps as well as relative to survey biomass are almost the same among offshore regions and inshore, where numbers of pre-recruits are higher among offshore than inshore. In 2022 in all regions, numbers of age-2 shrimp relative to survey biomass were at a record high level but have declined since 2023 and in 2024 are in the lower 20-year quartile.

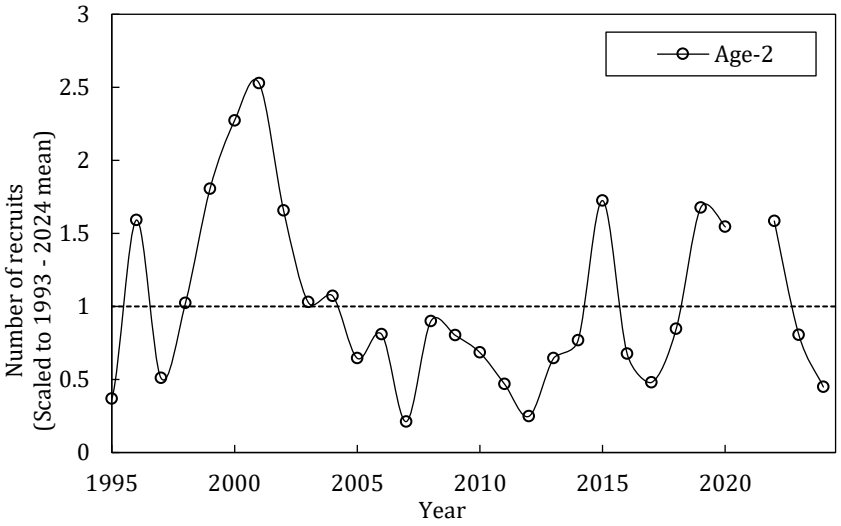


Figure 3.6. Northern shrimp in Subarea 0 and Subarea 1: Survey index of numbers at age 2 (10.5 - 13.5 mm), 1993-2024. Indices are standardized to the series mean.

Predation index. Since 2020, the overall Atlantic cod stock biomass index used within the shrimp assessment model has been computed using a state-space assessment model (SAM) based on catch at age in the commercial fishery and the Greenland trawl survey.

Indices of cod biomass are adjusted by a measure of the overlap between the stocks of cod and shrimp to obtain an index of 'effective' cod biomass, which is entered in the assessment model. Currently the cod stock in West Greenland is at a low level compared to the period before the cod collapse in the beginning of the 1990s. The cod stock biomass has been increasing slightly since 2017 and was estimated to be 56 Kt in 2024 and is composed of several year-classes. The index of its overlap with the shrimp stock is still below the time series average. This resulted in a 2024 'effective' cod biomass index of 17 Kt (Figure 3.7).

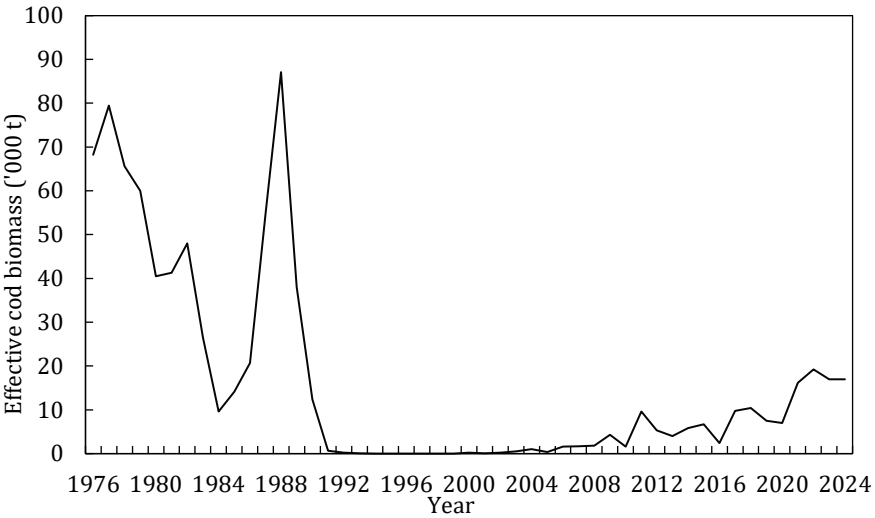


Figure 3.7. Northern shrimp in Subarea 0 and Subarea 1: Indices of the 'effective' cod biomass in Subarea 1 and Division 0A, 1976 - 2024.

c) Assessment

A Schaefer surplus-production model of population dynamics was fitted to series of CPUE, catch, and survey fishable biomass indices (considered shrimp larger than 17mm carapace length (CL)). The model includes a term for predation by Atlantic cod (Figure 3.7). Total shrimp catches for 2024 are expected to be 102 500 t.

Estimates of stock-dynamic parameters from fitting a Schaefer stock-production model to 49 years' data are given in Table 3.1. Median values from the 2023 assessment are provided for comparison. The modelled biomass (Figure 3.8) declined steadily from 2004 to 2013, increased slightly until 2017 and has declined since 2022. Biomass at the end of 2024 is projected to be slightly lower than in 2022 and 2023 and is almost at B_{msy}. The probability of the biomass at the end of 2024 being below B_{msy} is 55% and the probability of being below B_{lim} is very low (<1%). Mortality has generally been close to or below Z_{msy} during the modelled period (Figure 3.9). Estimates of total mortality have increased in the most recent years. Assuming catches of 102 500 t, total mortality in 2024 is estimated to be close to Z_{msy} with probability of $Z_{2024} > Z_{msy}$ = 53%.

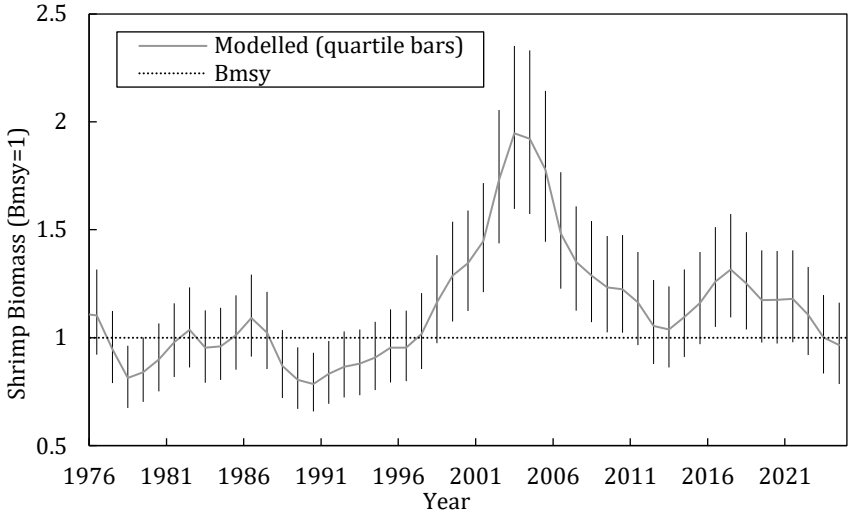


Figure 3.8. Northern shrimp in Subarea 0 and Subarea 1: Relative stock biomass with quartile error bars 1976–2024. Dotted line corresponds to $B = B_{msy.}$

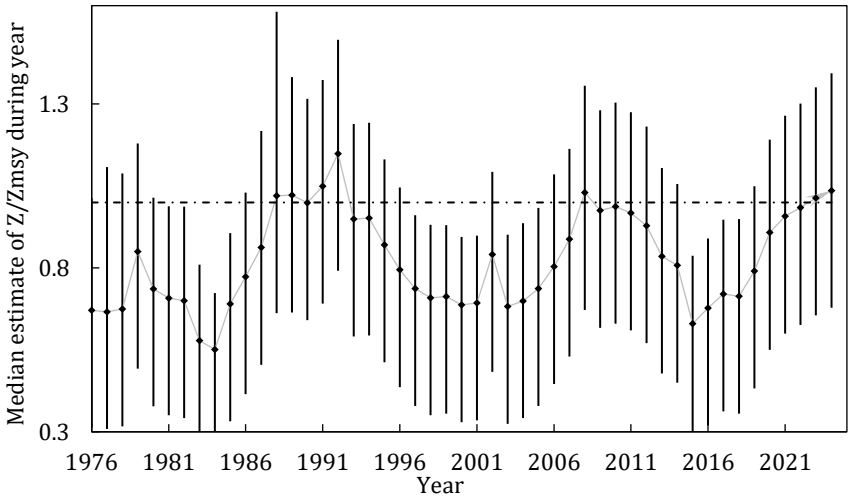


Figure 3.9. Northern shrimp in Subarea 0 and Subarea 1: Trajectory of the median modelled estimate of mortality relative to Z_{msy} during the years 1976–2024 with quartile error bars.

Table 3.1. Northern shrimp in Subarea 0 and Subarea 1: Estimates of stock dynamic and parameters from fitting a Schaefer stock-production model to the West Greenland northern shrimp stock in 2024. The Median (2023) column shows results from last year's assessment.

	Mean	S.D.	25%	Median	75%	Est. mode	Median (2023)
Max.sustainable yield	128.4	55.9	98.3	118.0	144.2	97.2	119.4
B/Bmsy, end current year (proj.)(%)	98.8	27.4	78.6	96.6	116.3	92.1	109.0
Biomass risk, end current year(%)	55.3	49.7	–	–	–	–	–
Z/Zmsy, current year (proj.)(%)	–	–	72.7	103.6	139.4	–	100.3
Carrying capacity	3558	2054	1984	2940	4710	1704	2754
Max. sustainable yield ratio (%)	9.3	5.3	5.5	8.5	12.1	7.0	9.1
Survey catchability (%)	18.6	13.4	9.0	14.9	24.3	7.4	16.4
CPUE(1) catchability	1.1	0.8	0.5	0.9	1.4	0.5	0.9
CPUE(2) catchability	1.6	1.2	0.8	1.3	2.1	0.7	1.5
Effective cod biomass 2024 (Kt)	22.2	38.7	12.7	16.6	21.2	5.3	17.1
$P_{50\%}$ *(prey biomass index with consumption 50% of max.)*	4.1	7.2	0.2	1.3	4.5	-4.2	1.4
V_{max} *(maximum consumption per cod)*	2.0	2.3	0.4	1.0	2.9	-1.1	1.1
CV of process (%)	12.2	2.6	10.4	12.0	13.8	11.7	11.8
CV of survey fit (%)	18.5	2.9	16.5	18.3	20.3	17.7	18.3
CV of CPUE (1) fit (%)	7.0	1.4	5.9	6.7	7.7	6.1	6.6
CV of CPUE (2) fit (%)	7.0	1.8	5.7	6.5	7.8	5.6	6.6

A six-year retrospective analysis was performed (Figure 3.10) and results were found to be relatively stable.

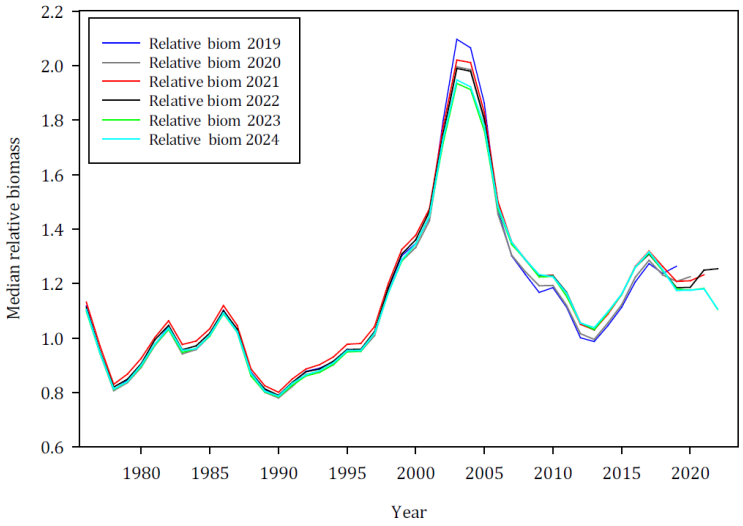


Figure 3.10. Northern shrimp in Subarea 0 and Subarea 1: Retrospective plots of the relative biomass B/B_{msy} 2019 to 2024. Mohn's rho is estimated to 0.08.

d) State of the stock

Biomass. Biomass in 2024 is close to B_{msy} and the probability of being below B_{lim} is very low (<1%).

Mortality. Assuming catches of 102 500 t in 2024 and an effective cod biomass of 17 Kt, the probability of being above Z_{msy} is 53%.

Recruitment. In 2024 numbers of age-2 were below the time-series average. Prospects for future recruitment are expected to be poor.

State of the Stock. Biomass in 2024 is close to B_{msy} and the probability of being below B_{lim} is very low (<1%). The probability of mortality in 2024 being above Z_{msy} is 53%. Recruitment (number of age-2 shrimp) in 2024 was below the time-series average.

e) Reference points

B_{lim} has been established as 30% B_{msy}, and Z_{msy} has been set as the mortality reference point. B_{msy} and Z_{msy} are estimated directly from the assessment model (Figure 3.11).

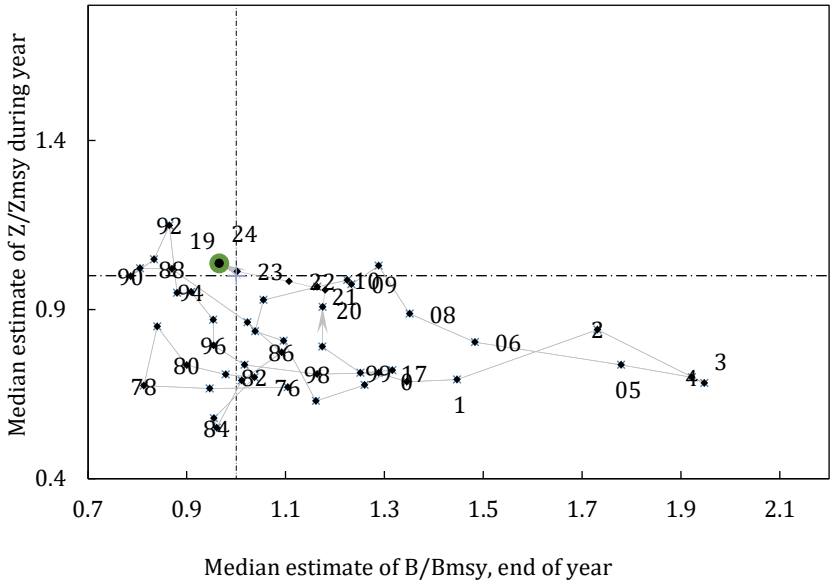


Figure 3.11. Northern shrimp in Subarea 0 and Subarea 1: Trajectory of relative biomass and relative mortality, 1976–2024. The green dot is the current year.

f) Projections

Three years projections (2025–2027) under eight catch options are presented. Predation by the cod stock was quantitively considered using an 'effective' biomass of 17 Kt (the estimated value for 2024 was 16.6 Kt).

17 000 t cod	Catch option ('000 tons)							
Risk of:	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**
falling below Bmsy end 2025 (%)	51	52	52	52	53	54	54	55
falling below Bmsy end 2026 (%)	47	48	49	50	52	53	53	54
falling below Bmsy end 2027 (%)	44	44	47	48	50	52	52	54
falling below Blim end 2025 (%)	0	0	0	0	0	0	0	0
falling below Blim end 2026 (%)	0	0	0	0	0	0	0	0
falling below Blim end 2027 (%)	0	0	0	0	0	0	1	1
exceeding Zmsy in 2025 (%)	18	23	28	33	38	42	47	50
exceeding Zmsy in 2026 (%)	18	22	27	32	37	42	46	50
exceeding Zmsy in 2027 (%)	17	21	26	31	36	41	46	50
falling below Bmsy 80% end 2025 (%)	25	25	26	26	27	28	29	29
falling below Bmsy 80% end 2026 (%)	23	24	26	27	27	28	30	30
falling below Bmsy 80% end 2027 (%)	23	23	25	27	27	29	31	31

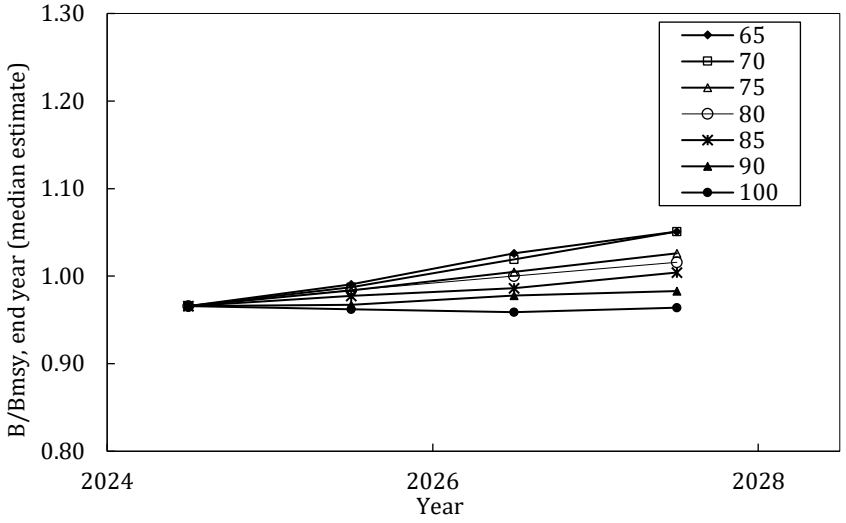


Figure 3.12. Northern shrimp in Subarea 0 and Subarea 1: Median estimates of year-end biomass trajectory for 2025–2027 with annual catches at 65–100 Kt and an 'effective' cod stock assumed at 17 Kt.

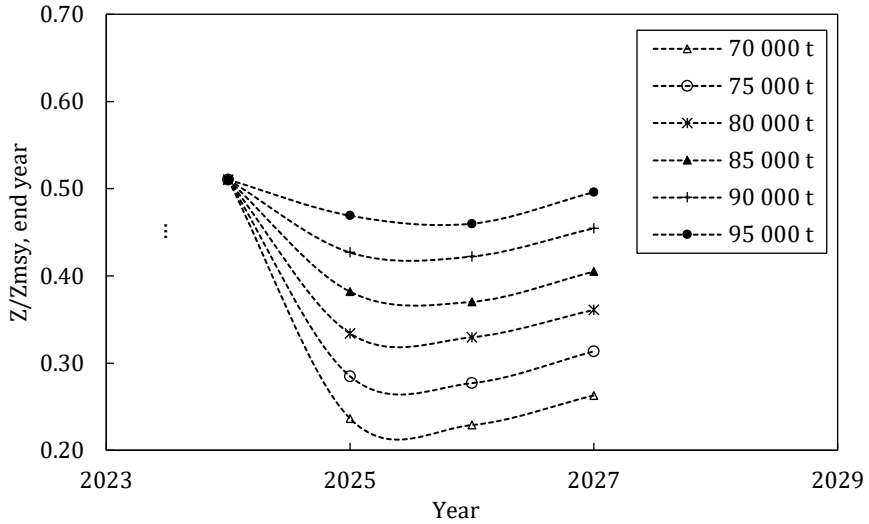


Figure 3.13. Northern shrimp in Subarea 0 and Subarea 1: Risks of exceeding mortality precautionary limits with annual catches at 70–95 Kt projected for 2025–2027 with an 'effective' cod stock assumed at 17 Kt.

g) Research recommendations

STACFIS **recommends** *increasing commercial sampling of catch composition to cover both Canadian and Greenlandic fleets.*

In progress. Sampling has occurred since 2022 in the Greenlandic fleets. Whenever catches in Canadian SFA 1 are realized, sampling for size determination is advised.

STACFIS **recommends** *developing a joint Canadian and Greenlandic sampling program to determine predation pressure from various fish species.*

In progress.

STACFIS **recommends** *exploring the effects of the borrowing and banking system on the sustainability of the stock.*

STACFIS **recommends** that *a benchmark be undertaken for this stock in the next few years.*

4. Northern shrimp (*Pandalus borealis*) in the Denmark Strait and off East Greenland (ICES Divisions 14b and 5a)

Full assessment (SCR Docs. 04/012, 24/056, 24/057, 24/058)

Environmental Overview

Oceanography

In the region of East Greenland, South of Denmark Strait, the polar waters are constrained to a narrow coastal region on the shelf, which means that warmer and more saline Atlantic waters, originating from the Subtropical Gyre and transported by the Irminger Current, are more prevalent. The region is dominated by an inflow of multi-year ice from the Central Arctic Ocean, with maximum coverage in March and minimum in September. In the region drift ice is seasonal (early spring), transported from the region further north. Much of the waters in the region are stratified shelf waters, with cold and fresher polar waters overlaying warmer and more saline Atlantic waters.

Ecosystem changes

Sea ice coverage in the area north of the region has been diminishing in the several past decades, including a decrease in winter maximum sea ice extent since the start of satellite records in 1979, and a weak decline in summer minimum ice coverage since 2006.

Surface waters on the narrow south-eastern Greenland shelf and in the area north of Denmark Strait are 1–2°C warmer than the mean conditions for 1981–2010 for much of the year. In contrast, surface waters in the south-eastern reaches of the region have cooled by up to 2°C. Surface salinity has increased in the open waters of the ecoregion but decreased in the East Greenland shelf waters and Irminger Sea surface waters.

a) Introduction

Northern shrimp off East Greenland in ICES Div. 14b and 5a are assessed as a single stock.

i) Fishery and catches

A multinational fleet exploits the stock. During the most recent ten years, vessels from Greenland, EU, the Faroe Islands and Norway have fished in the Greenland EEZ. Only Icelandic vessels are allowed to fish in the Icelandic EEZ. At all times of the year access to these fishing grounds depends strongly on ice conditions.

In the Greenland EEZ, the minimum permitted mesh size in the cod-end is 40 mm but most trawlers used 44 mm in the cod-end. The fishery is managed by catch quotas allocated to national fleets. In the Icelandic EEZ, the mesh size is 40 mm and there are no catch limits, however, there have been no catches by Iceland since 2005. In both EEZs, sorting grids with 22-mm bar spacing to reduce by-catch of fish are mandatory. Discarding shrimp is prohibited in both areas.

The fishery started in 1978 and during the period 1985 to 2003 the total catches fluctuated between 9 000 t and 15 000 t. From 2004 to 2016 the total catch decreased to 49 t. Catches increased to 7 466 t in 2023 (Figure 4.1). Since 2012, little to no fishery has taken place in the southern area.

Catches in the first half year of 2024 are 6 089 t. For 2024 logbooks for one foreign vessel were not available. Total catches for this vessel have been provided by the Greenland Fishery and License Control and are 225 t, these are included in the total catches. It has not been possible to include information on CPUE and effort for this vessel, and all further analysis are based solely on available logbooks in 2024.

Since 2014, the fishing effort has been historically low and concentrated in a relatively small area.

Recent catches and TACs ('000 tons) for shrimp in the Denmark Strait and off East Greenland (ICES Div. 14b and 5a) are as follows:

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024[1]
Recommended TAC, total area	2.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0	2.0	2.5
Enacted TAC, Greenland	6.1	5.3	5.3	4.3	3.4	4.8	7.0	6.9	6.9	7.9
North of 65°N, Greenland EEZ	0.6	0.0	0.6	0.5	1.6	3.2	3.1	5.5	7.5	6.1
North of 65°N, Iceland EEZ	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
North of 65°N, total	0.6	0.0	0.6	0.5	1.6	3.2	3.1	5.5	7.5	6.1
South of 65°N, Greenland EEZ	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL STACFIS	0.6	0.0	0.6	0.5	1.6	3.2	3.1	5.5	7.5	6.1

[1]Catches until July 2024

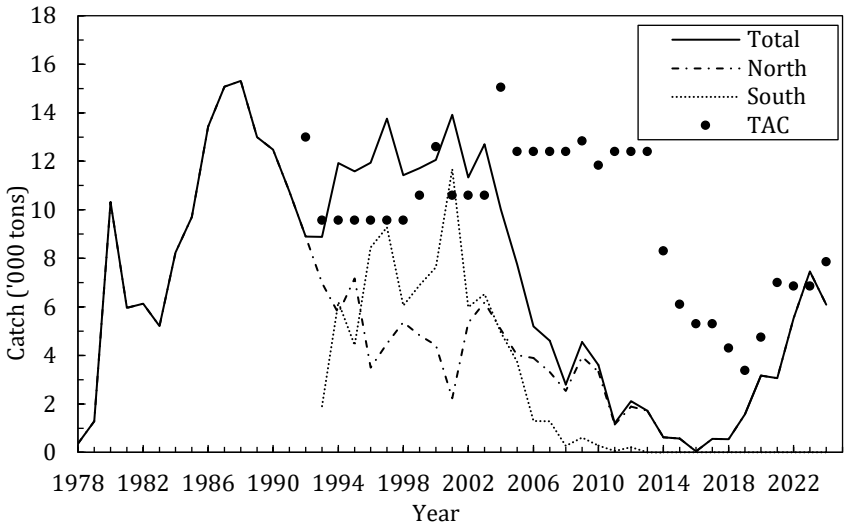


Figure 4.1. Northern shrimp in Denmark Strait and off East Greenland: Catch and TAC (2024 catches until June 30th).

b) Input data

i) Commercial fishery data

Fishing effort and CPUE. Data on catch and effort (hours fished) on a haul-by-haul basis from logbooks from Greenland, Iceland, Faroe Islands and EU since 1980 and from Norway since 2000 are used. Catch-Per-Unit-Effort (CPUE) and total annual effort were calculated. Since 2004, more than 60% of all hauls were performed with double trawl, this is not accounted for in the CPUE index used in the assessment and in the effort timeseries.

The CPUE index for the total areas increased from 1993 to 2009, followed by a continuous decline to a low value in 2015 and increased to record high levels in 2022 and since dropped (Figure 4.2). The drop in CPUE in 2021 is likely related to changes in the fishing pattern. In 2021 the EU fleet in the northern area started fishing in April, which is later than previous years when large portion of the catch was taken in February/March.

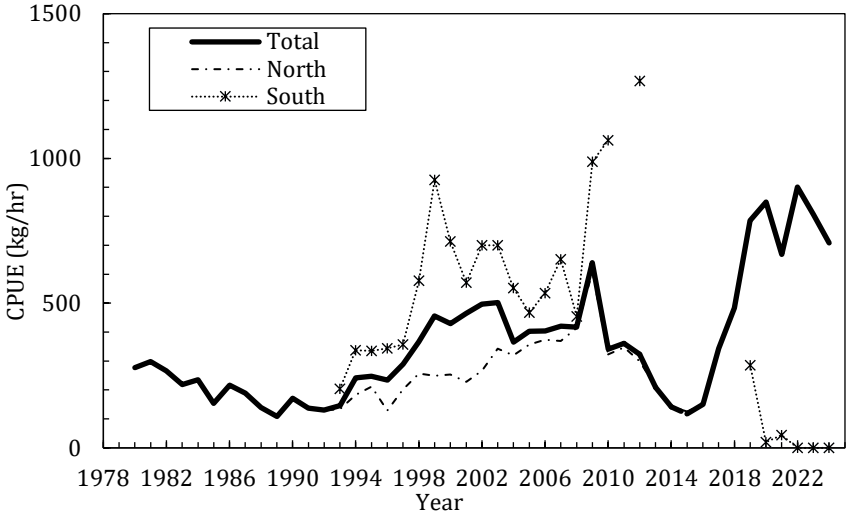


Figure 4.2. Northern shrimp in Denmark Strait and off East Greenland: Annual CPUE index. 2024 includes data until June 30th.

It should be noted that data from one foreign vessel for which logbooks were not available are not included in the 2024 CPUE and effort values. As most of the fishing has been conducted in the northern area the overall CPUE index is dominated by the CPUE index for this area.

Fishing effort has been relatively low in recent years (from 300 fishing hours in 2016 to 9 267 fishing hours in 2023, and the preliminary number for 2024 is 8 604, Figure 4.3) which is concentrated in a relatively small area north of 65°N and west of 30°W.

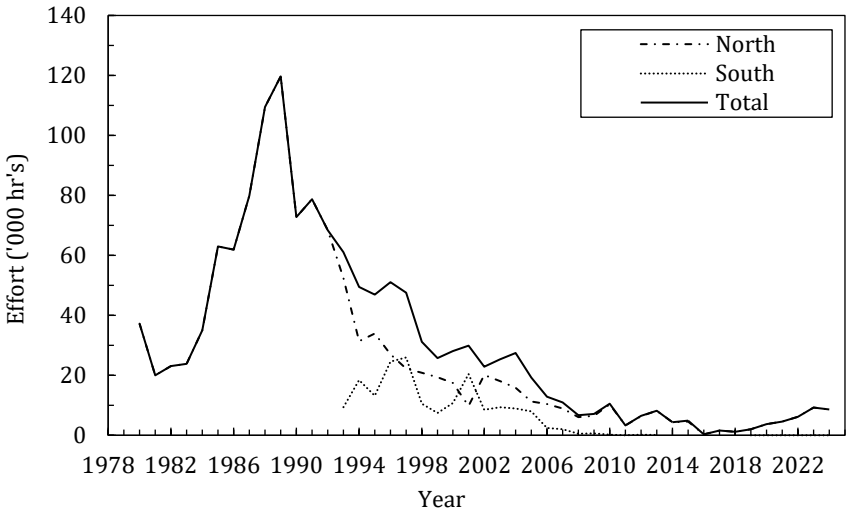


Figure 4.3. Northern shrimp in Denmark Strait and off East Greenland: Annual effort ('000 hrs). 2024 includes data until June 30th.

ii) Research survey data

Trawl surveys have been conducted to assess the stock status of northern shrimp in the East Greenland area since 2008. Due to the lack of research vessels, no survey was conducted from 2017 – 2019 or in 2021. The survey was conducted with the chartered fishing vessel *Helga Maria* in 2020 and in 2022-2024 with the new research vessel *Tarajoq* using the same gear configuration as in previous years. It is therefore assumed that the 2020 and 2022-2024 results were directly comparable with the previous surveys, however without comparative fishing (comparing survey vessels) there remains some uncertainty.

Biomass. The survey biomass index decreased from 2009 to 2012 and then remained at a low level until 2016, there are no estimates for 2017-2019 or for 2021. The 2020 estimate is the highest in the time series (Figure 4.4) but the 2022 biomass index dropped to a level similar to 2010-2011 and increased again in 2023. The 2024 survey biomass index is at a similar level as 2022.

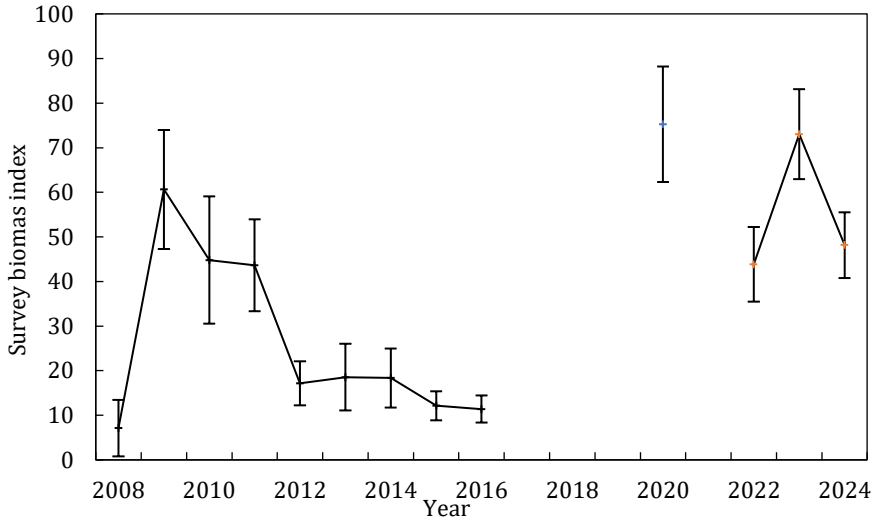


Figure 4.4. Northern shrimp in Denmark Strait and off East Greenland: Survey biomass index from 2008 (± 1 SE). No survey was carried out in the period 2017 - 2019 or in 2021. Black points represent R/V *Paamiut,* blue is Helga Maria, and orange is R/V *Tarajoq.*

The surveys conducted since 2008 indicate that the shrimp stock is concentrated in the area north of 65°N (Figure 4.5).

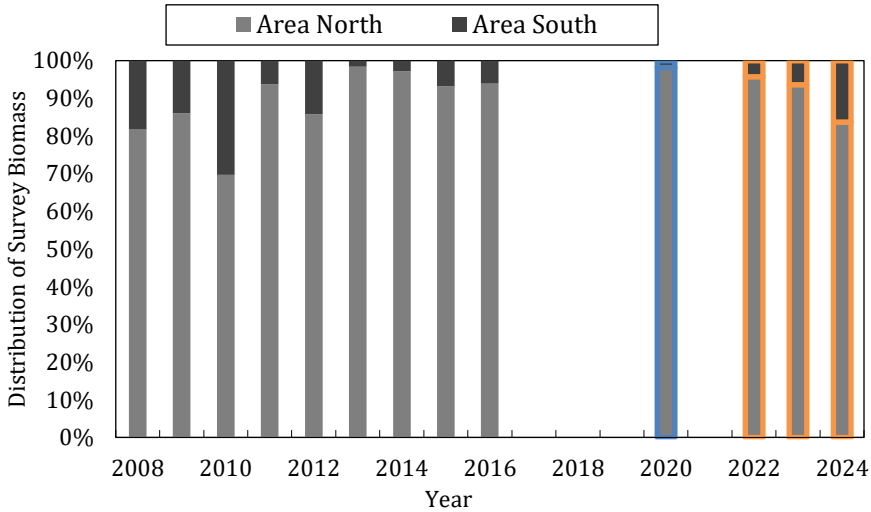


Figure 4.5. Northern shrimp in Denmark Strait and off East Greenland: Distribution of survey biomass north and south of 65°N (in %) from 2008. No survey was carried out in the period 2017 - 2019 and in 2021. No outline in figure represents R/V *Paamiut*, blue is Helga Maria, and orange is R/V *Tarajoq*.

Stock composition. The stock in East Greenland consists of roughly equal proportions of males and females in most years. The proportion of females fluctuates between 40-60% of the biomass in all years except 2009 and 2020. In 2009 and 2020, the biomass of females was 34% and 37%, respectively. In 2024, 52% of the biomass was composed of females.

Very few males smaller than 20 mm carapace length (CL) are caught in the survey, but in 2022 there was a small peak in male shrimps smaller than 20 mm CL (Figure 4.6). Scarcity of smaller shrimp in the survey area suggests that the total area of distribution and recruitment patterns of the stock are still unknown.

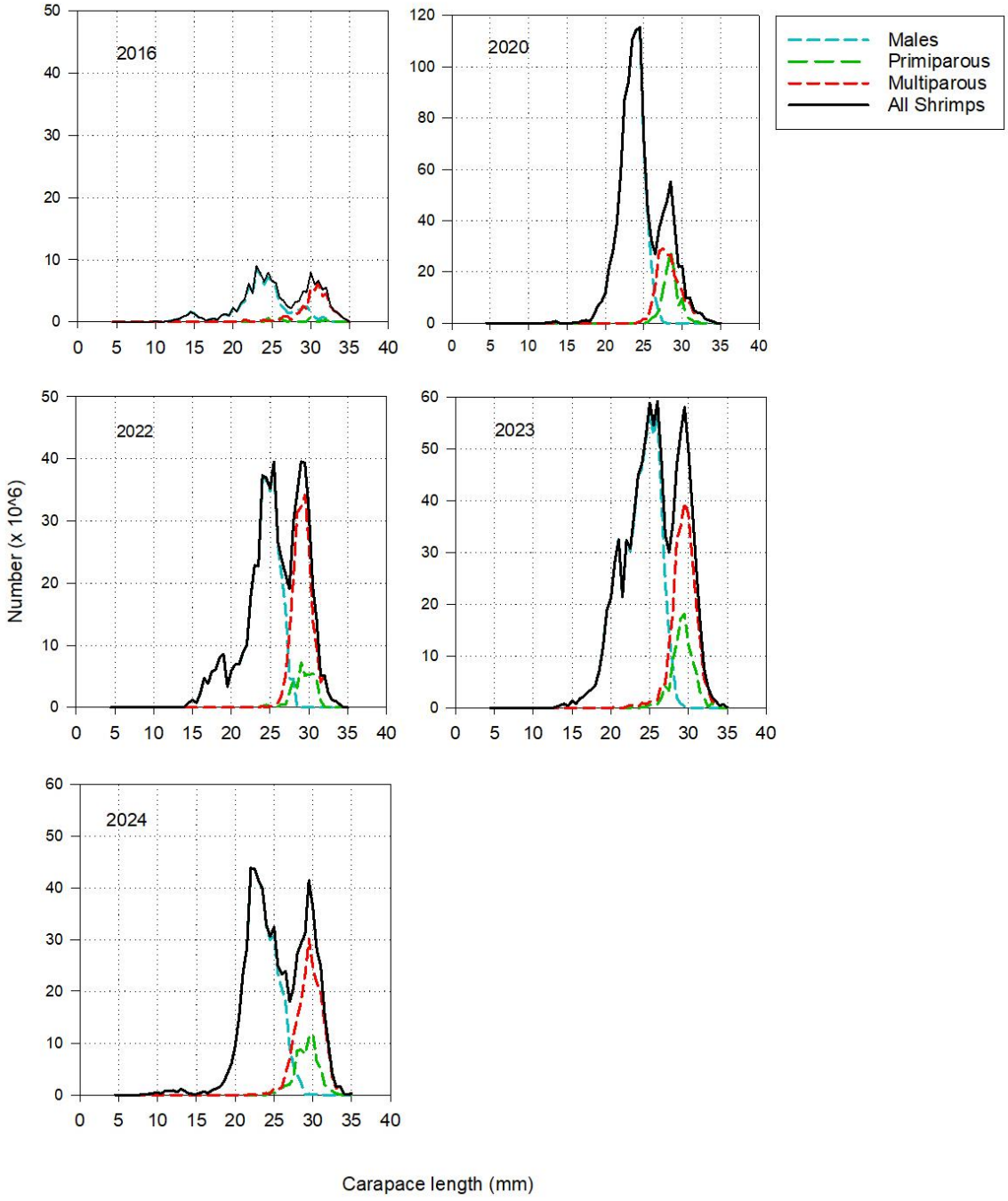


Figure 4.6. Northern shrimp in Denmark Strait and off East Greenland: Numbers of shrimp by length group (CL) in the total survey area in 2016 - 2024. No survey was carried out in the period 2017 - 2019 and in 2021.

c) Assessment results

During the 2021 NIPAG meeting a comprehensive sensitivity analysis of the surplus production model in continuous time (SPiCT) was presented. During the 2022 SC shrimp meeting an updated SPiCT model was accepted for this stock. The model has been updated with the most recent data and is used for the basis of the advice.

The SPiCT model was fitted to series of CPUE, catch and survey biomass indices. The time-series were truncated to fit with the survey time-series. The relative B/B_{msy} projected to the end of 2024 is 0.58, and the relative F/F_{msy} is 2.47 (Figure 4.7).

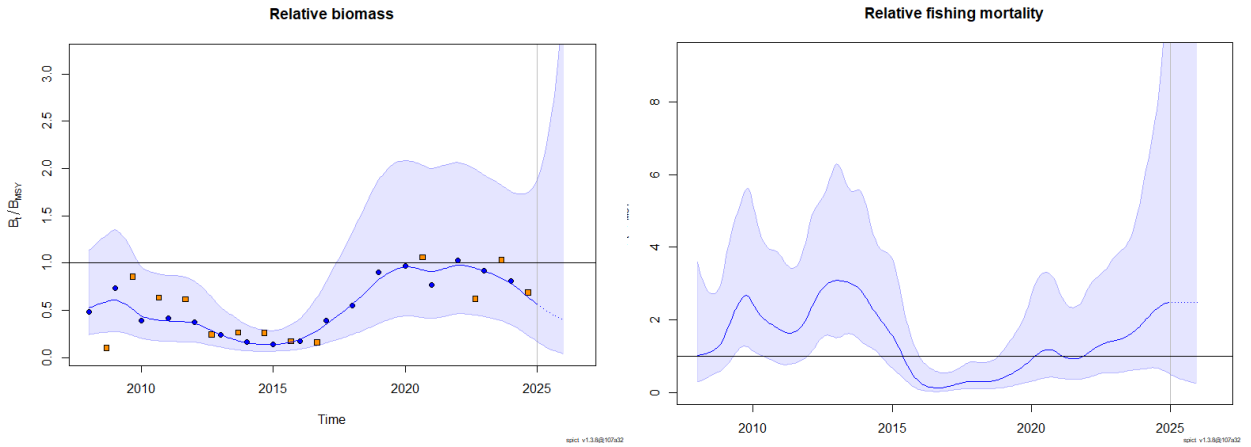


Figure 4.7. Northern shrimp in Denmark Strait and off East Greenland: Relative biomass and fishing mortality. Orange squares are the survey index and the blue circles are the CPUE index (the colour of the symbols denotes the seasonality of the data within the model, orange is July/August and blue in beginning of the year). The grey vertical line corresponds to the time of the last observation. The dotted line is the prediction for the next year given a constant *F*.

Estimates of stock-dynamic parameters from the SPiCT model are given in Table 4.1. These are in line with parameters estimated in 2023.

Table 4.1. Shrimp in Denmark Strait and off East Greenland: Results from the SPiCT model.

	Estimate	CI lower	CI upper	log.est	2023 estimate
alpha1 (noise term for CPUE, $\alpha = SD_{Index}/SD_{Biomass}$)	1.42	0.20	10.05	0.35	1.49
alpha2 (noise term for survey, $\alpha = SD_{Index}/SD_{Biomass}$)	6.92	1.25	38.43	1.93	5.68
beta ($\beta = SD_{Catch}/SD_F$)	0.54	0.18	1.57	-0.62	0.54
r (intrinsic population growth rate)	0.73	0.48	1.11	-0.32	0.73
m (SPiCT parameter)	3227.23	1898.44	5486.07	8.08	3171
K (Carrying capacity)	17689.67	7429.54	42118.94	9.78	17263
q1 (Catchability for CPUE)	0.10	0.06	0.16	-2.31	0.11
q2 (Catchability for survey)	1.12	0.63	2.02	0.12	1.25
*n (*shape of the production curve, set to 2)	2.00	2.00	2.00	0.69	2.00
sdb (Standard deviation, biomass)	0.09	0.02	0.49	-2.40	0.09
sdf (Standard deviation, fishing mortality)	0.84	0.44	1.61	-0.17	0.85
sdi1 (Standard deviation, CPUE)	0.13	0.07	0.25	-2.05	0.13
sdi2 (Standard deviation, Survey)	0.63	0.42	0.92	-0.47	0.51
Sdc (Standard deviation, catch)	0.45	0.25	0.83	-0.79	0.46
B (Biomass end of 2024)	5061	1816	14103	8.53	6693*
F (Fishing mortality end of 2024)	0.90	0.20	4.05	-0.11	0.58*
Relative reference points					
B/B_{msy}, end current year (proj.) (%)	0.58	0.18	1.84	-0.55	0.78
$F/F_{msy,}$ end current year (proj.) (%)	2.47	0.54	11.39	0.91	1.59

*end of 2023

A five-year retrospective analysis was performed (Figure 4.8) and results were found to be consistent for biomass and fishing mortality with respect to the removal of successive years.

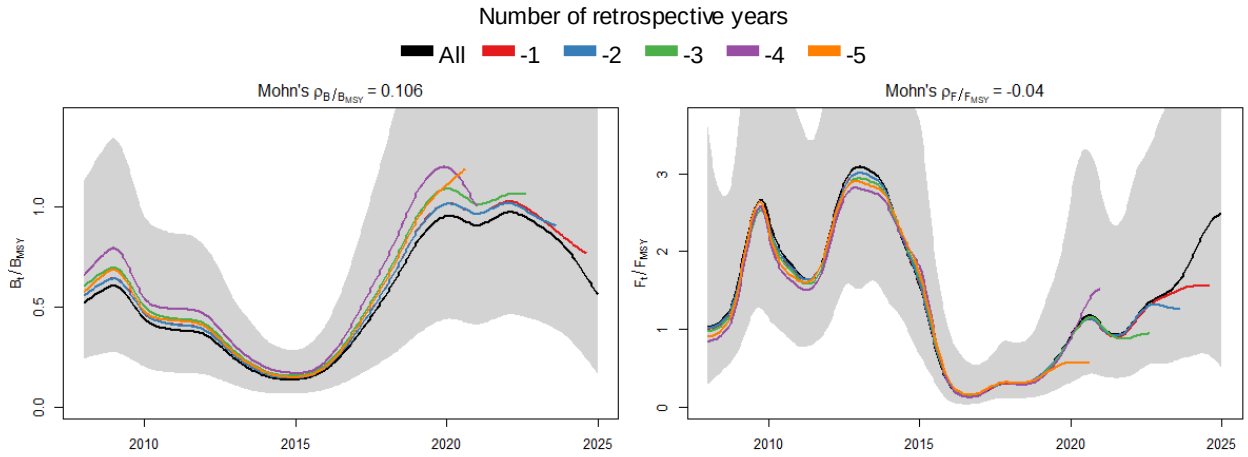


Figure 4.8. Northern shrimp in Denmark Strait and off East Greenland: Five years retrospective plots of fishing mortality and fishable biomass. Confidence intervals are 95%

d) State of the stock

Biomass. Median biomass is below B_{msy} (B/B_{msy} = 0.58) and the probability of being below B_{lim} is 15%.

Fishing mortality. Fishing mortality is above F_{msy} (F/F_{msy} = 2.47).

Recruitment. No estimates of recruitment are available.

State of the stock. Median biomass is below B_{msy} (B/B_{msy} = 0.58) and the probability of being below B_{lim} is 15%. Fishing mortality is above F_{msy} (F/F_{msy} = 2.47). No estimates of recruitment are available.

e) Reference points

B_{lim} is defined as 30% of B_{msy}. The relative reference points B_{msy} and F_{msy} are estimated within the SPiCT model (Figure 4.9).

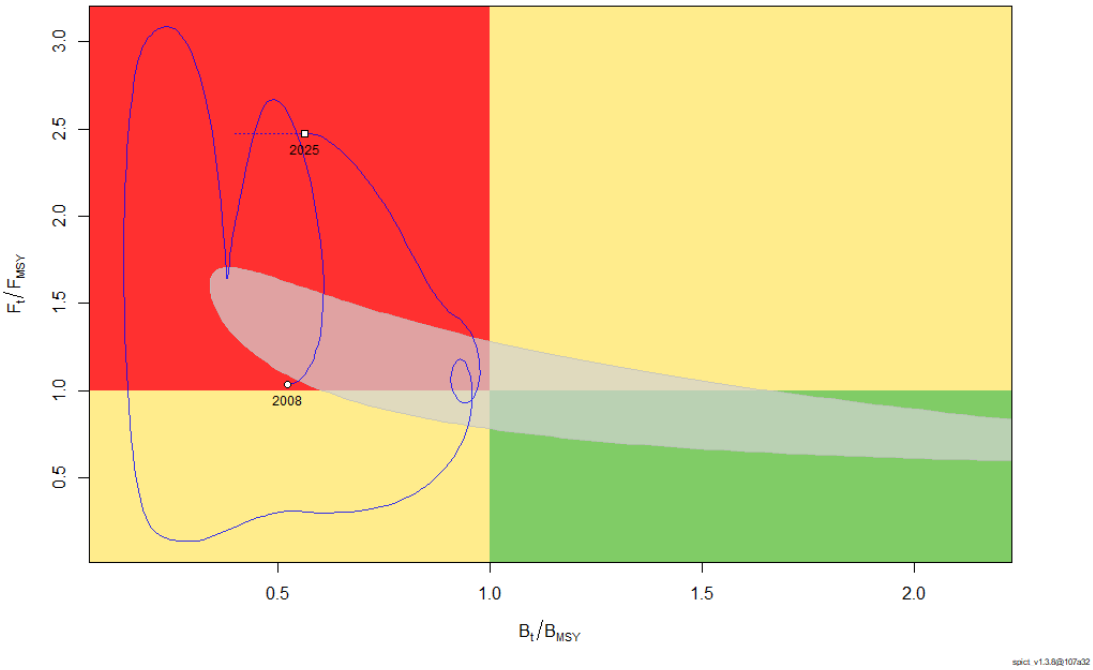


Figure 4.9. Northern shrimp in Denmark Strait and off East Greenland: Biomass vs fishing mortality 2008 – 2024. The grey shaded area indicates the 95% confidence region of the reference points F_{msy} and B_{msy} pairs estimated in the model.

f) Projections

One year projections to 2025 under six catch options were evaluated.

Catch (t)	B/B_{msy}	F/F_{msy}	Prob $B < B_{msy}$	Prob $B < B_{lim}$	Prob $F > F_{msy}$	$P(B_{2026} < B_{2025})$
1 000	0.77	0.48	0.66	0.06	0.26	0.02
1 500	0.71	0.75	0.70	0.10	0.40	0.13
2 000	0.64	1.05	0.72	0.16	0.52	0.32
2 500	0.57	1.38	0.75	0.22	0.61	0.48
3 000	0.51	1.76	0.77	0.29	0.69	0.59
3 500	0.44	2.20	0.78	0.36	0.75	0.66

Catches above 3 000 t would result in a 30% or greater probability of B falling below B_{lim} and would likely result in continued decline of the stock.

g) Research recommendations

STACFIS **recommends** *commercial sampling of catch composition.*

This recommendation is reiterated and the work should be continued to improve coverage of the fleet.

STACFIS **recommends** *exploration of the use of SPiCT for two and three year projections.*

Work is in progress. This recommendation is reiterated.

STACFIS **recommends** *exploration of available historical data from the east Greenland stock.*

This recommendation is reiterated.

STACFIS **recommends** *development of possible harvest control rules for this fishery.*

This recommendation is reiterated.

h) References

ICES, 2020, ICES Ecosystem Overviews Greenland Sea ecoregion. Published 10 December 2020 ICES Advice 2020 – https://doi.org/10.17895/ices.advice.763

ICES. 2023. Greenland Sea ecoregion – Ecosystem overview. In Report of the ICES Advisory Committee, 2023. ICES Advice 2023, section 10.1, https://doi.org/10.17895/ices.advice.22664881

APPENDIX II. PROVISIONAL AGENDA – SCIENTIFIC COUNCIL SHRIMP ASSESSEMENT MEETING

NAFO Secretariat

Halifax, Canada

17–19 September 2024

I. Opening (Chair: Diana González-Troncoso)

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

II. Review of Recommendations in 2023

III. Fisheries Science (STACFIS Chair: Martha Krohn)

IV. Formulation of Advice (see Annexes 1–3)

1. Request for Advice on TACs and Other Management Measures (Item 1, Annex I)
   a) Northern shrimp in Div. 3M
2. Requests from Coastal States (Items 5 and 6 of Annex II, item 2 of Annex III)
   a) Northern shrimp off West Greenland (Subareas 0 and 1)
   b) Northern shrimp in Denmark Strait and off East Greenland (ICES Divisions XIVb and Va)

V. Other Matters

1. Scheduling of Future Meetings
2. Topics for Future Special Sessions
3. Other Business

VI. Adoption of Scientific Council and STACFIS Reports

VII. Adjournment

ANNEX 1. COMMISSION'S REQUEST FOR SCIENTIFIC ADVICE ON MANAGEMENT IN 2025 AND BEYOND OF CERTAIN STOCKS IN SUBAREAS 2, 3 AND 4 AND OTHER MATTERS

(From SCS Doc. 24/01)

Following a request from the Scientific Council, the Commission agreed that items 1, 2, 3 and 7 should be the priority for the June 2024 Scientific Council meeting subject to resources.

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	Interim Monitoring Only
Cod in Div. 3M	Redfish in Div. 3M Thorny skate in Div. 3LNO Witch flounder in Div. 3NO Redfish in Div. 3LN White hake in Div. 3NO Yellowtail flounder in Div. 3LNO Northern shrimp 3LNO Northern shrimp in Div. 3M	American plaice in Div. 3LNO American plaice in Div. 3M Northern shortfin squid in SA 3+4 Redfish in Div. 3O Cod in Div 3NO	SA 6 Alfonsino SA 2-3 Roughhead Grenadier Capelin in 3NO

Advice should be provided using the guidance provided in **Annexes A or B as appropriate**, or using the predetermined Harvest Control Rules in the cases where they exist (currently Greenland halibut 2+3KLMNO). For 3M shrimp supplementary advice in terms of fishing-days could also be considered as appropriate.

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

- In 2024, advice should be provided for 2025 for: Cod in Div. 3M and Redfish in Div. 3LN.
- In 2024, advice should be provided for 2025 and 2026 for: Redfish in Div. 3M, Thorny skate in Div. 3LNO, Witch flounder in Div. 3NO, and Northern shrimp in 3M.
    - With respect to Northern shrimp in Div. 3M, Scientific Council is requested to provide its advice to the Commission prior to the 2024 Annual Meeting based on the survey data up to and including 2024.
- In 2024, advice should be provided for 2025, 2026 and 2027 for: American plaice in Div. 3LNO.

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 most recently agreed HCR and determine whether exceptional circumstances are occurring. If exceptional circumstances are occurring, the exceptional circumstances protocol will provide guidance on what steps should be taken.

3. The Commission requests that Scientific Council continue to advance work on the 2+3KLMNO Greenland halibut and 3LN redfish MSE processes during 2023-2024, as per the approved 2024 workplan [COM-SC RBMS-WP 23-06 (Rev. 3)]:
    a. For the Greenland Halibut MSE: test Candidate Management Procedures (CMP) performance against established management objectives and initial discussions on exceptional circumstances protocol.
    b. For the 3LN Redfish MSE: (1) review and finalize Operating Models, (2) review any further work on performance statistics; (3) select the CMP(s) for RBMS consideration and potential testing against established management objectives.

4. The Commission requests that the Scientific Council continue to work on tiers 1 and 2 of the Roadmap, specifically to:
    a. Annually provide catch information in relation to 2TCI, including recent cumulative catch levels and a scoping of expected cumulative catch levels;
    b. As practicable and taking into account Scientific Council capacity constraints, develop stock summary sheets for NAFO managed stocks that are evaluated using HCR or MSE processes.

5. In relation to the habitat impact assessment component of the Roadmap (VME and SAI analyses), the Commission requests that Scientific Council:
    a. Support the Secretariat in developing a centralized data repository using ArcGIS online to host the data and data-products for scientific advice;
    b. Continue working with WG-EAFFM towards developing operational objectives for the protection of VMEs and biodiversity in the NRA; and
    c. Work towards the reassessment of VMEs and impact of bottom fisheries on VMEs for 2026.

6. The Commission requests Scientific Council to continue progression on the review of the NAFO PA Framework in accordance to the PAF review work plan approved in 2020 and revised in 2023 (NAFO COM-SC RBMS-WP 23-19 (Revised)), specifically to undertake testing of the Provisional Draft PA Framework (COM-SC RBMS-WP 23-20 (Revised)).

7. The Commission requests Scientific Council to update the 3-5 year work plan, which reflects requests arising from the 2023 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.

8. The Commission requests that any new Canadian stock assessments for Cod 2J3KL and Witch flounder 2J3KL, and any new ICES stock assessments for Pelagic *Sebastes mentella* (ICES Divisions V, XII and XIV; NAFO 1) be included as an annex to the Scientific Council's annual report.

9. The Commission requestions the SC to monitor and provide regular updates on relevant research related to the potential impacts of activities other than fishing in the Convention Area, subject to the capacity of the Scientific Council.

10. The Commission requests that the Scientific Council at its 2024 meeting: summarize the information it currently has available regarding the current and future impacts of climate change on NAFO-managed stocks, non-target species, and associated ecosystems; and identify any consequential data gaps, research needs and opportunities for productive research.

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

The Commission request the Scientific Council to consider the following in assessing and projecting future stock levels for those stocks listed above. These evaluations should provide the information necessary for the Fisheries Commission to consider the balance between risks and yield levels, in determining its management of these stocks:

1. For stocks assessed with a production model, the advice should include updated time series of:

- Catch and TAC of recent years
- Catch to relative biomass
- Relative Biomass
- Relative Fishing mortality
- Stock trajectory against reference points
- And any information the Scientific Council deems appropriate.

Stochastic short-term projections (3 years) should be performed with the following constant fishing mortality levels as appropriate:

- For stocks opened to direct fishing: 2/3 F_{msy}, 3/4 F_{msy}, 85% F_{msy}, 90% F_{msy},95% F_{msy}, F_{msy} 0.75 X $F_{status\ quo}$, $F_{status\ qu}$,1.25 X Status quo, F=0; TAC Status quo, 85% TAC Status quo, 90% TAC Status quo, 95% TAC Status quo
- For stocks under a moratorium to direct fishing: $F_{status\ quo}$, F = 0.

The first year of the projection should assume a catch equal to the agreed TAC for that year. In instances where Scientific Council expects catches to be significantly different from the agreed TAC, an additional projection could be provided based on the best available catch estimation.

Results from stochastic short-term projection should include:

- The 10%, 50% and 90% percentiles of the yield, total biomass, spawning stock biomass and exploitable biomass for each year of the projections
- The risks of stock population parameters increasing above or falling below available biomass and fishing mortality reference points. The table indicated below should guide the Scientific Council in presenting the short-term projections.

				Limit reference points															
				$P(F>F_{lim})$			$P(B<B_{lim})$				$P(F>F_{msy})$			$P(B<B_{msy})$				$P(B2026 > B2024)$
F in 2025 and following years	Yield 2024 (50%)	Yield 2025 (50%)	Yield 2026 (50%)	2024	2025	2026	2024	2025	2026		2024	2025	2026	2024	2025	2026		
2/3 Fmsy	t	t	t	%	%	%	%	%	%		%	%	%	%	%	%		%
3/4 Fmsy	t	t	t	%	%	%	%	%	%		%	%	%	%	%	%		%
85% Fmsy	t	t	t	%	%	%	%	%	%		%	%	%	%	%	%		%
90% Fmsy	t	t	t															
95% Fmsy	t	t	t															
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(B2026> B2024)
F in 2025 and following years*	Yield 2024	Yield 2025	Yield 2026	2024	2025	2026	2024	2025	2026	2024	2025	2026	2024	2025	2026		
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.

ANNEX 2. DENMARK (ON BEHALF OF GREENLAND) COASTAL STATE REQUEST FOR SCIENTIFIC ADVICE - 2025

(from SCS Doc. 24/03)

Denmark (on behalf of Greenland) hereby requests for scientific advice on management in 2025 of certain stocks in NAFO Subareas 0 and 1. Denmark (on behalf of Greenland) requests the Scientific Council for advice on the following species:

1. Golden Redfish and Demersal Deep-Sea Redfish

Advice on Golden redfish (*Sebastes marinus*) and demersal deep-sea redfish (*Sebastes mentella*) in Subarea 1 was in June 2023 given for 2024-2026. The Scientific Council is requested to continue its monitoring of the above stocks and provide updated advice as appropriate in the event of significant changes in stock levels.

2. Atlantic Wolffish and Spotted Wolffish

Advice on Atlantic Wolffish (*Anarhichas lupus*) and Spotted Wolffish (*Anarhichas minor*) in Subarea 1 was in June 2023 given for 2024-2026. The Scientific Council is requested to continue its monitoring of the above stocks and provide updated advice as appropriate in the event of significant changes in stock levels.

3. Greenland Halibut, Offshore

Advice on Greenland Halibut, Offshore in Subareas 0 and 1 was in 2022 given for 2023 and 2024. Denmark (on behalf of Greenland) requests the Scientific Council to provide updated advice on appropriate TAC levels for 2025 to 2026.

4. Greenland Halibut, Inshore, West Greenland

Advice on the inshore stocks of Greenland Halibut in Subarea 1 was in 2022 given for 2023-2024. Denmark (on behalf of Greenland) requests the Scientific Council to provide advice on appropriate TAC levels for 2025 to 2026. If appropriate, Denmark (on behalf of Greenland) would request the Scientific Council to use an MSY-approach.

5. Northern Shrimp, West Greenland

Subject to the concurrence of Canada as regards to Subareas 0 and 1, Denmark (on behalf of Greenland) requests the Scientific Council before December 2024 to provide advice on the scientific basis for management of Northern Shrimp (*Pandalus borealis*) in Subareas 0 and 1 in 2025 in line with Greenland's stated management objective of maintaining a mortality risk of no more than 35% in the first year prediction and to provide a catch option table ranging with 5,000 t increments. Future catch options should be provided for as many years as data allows for.

6. Northern Shrimp, East Greenland

Furthermore, the Scientific Council is in cooperation with ICES requested to provide advice on the scientific basis for management of Northern Shrimp (*Pandalus borealis*) in Denmark Strait and adjacent waters east of southern Greenland in 2025 and for as many years ahead as data allows for.

ANNEX 3. CANADA'S REQUEST FOR COASTAL STATE ADVICE - 2025

(from SCS Doc. 24/04)

Canada would like to submit its request to the Scientific Council for advice on the following species:

1. Greenland halibut (Subarea 0 + 1 (offshore))

The Scientific Council is requested to provide an overall assessment of status and trends in the total stock area throughout its range and to specifically advise on TAC levels for 2025 and 2026. The stock status should be evaluated in the context of management requirements for long-term sustainability and the advice provided should be consistent with NAFO's Precautionary Approach Framework.

It is noted that at this time only general biological advice and/or catch data are available, and few standard criteria exist on which to base advice. Canada encourages the Scientific Council to continue to explore a model-based approach to bridge survey time series (i.e. data from the RV Paamiut and RV Tarajoq), and opportunities to develop risk-based advice in the future, noting that data conditions do not allow for such advice at this time.

2. Northern shrimp (Subarea 1 and Division 0A)

Canada requests that the Scientific Council consider the following options in assessing and projecting future stock levels for Northern shrimp (*Pandalus borealis*) in Subarea 1 and Division 0A:

The status of the stock should be determined and risk-based advice provided for catch options corresponding to Z_{msy} in 5,000t increments with forecasts for 2025 to 2027 (inclusive). These options should be evaluated in relation to Canada's Harvest Strategy (2022 revised version attached) and NAFO's Precautionary Approach Framework.

Presentation of the results should include graphs and/or tables related to the following:

- Historical and current yield, biomass relative to B_{msy}, total mortality relative to Z_{msy}, and recruitment (or proxy) levels for the longest time period possible;
- Total mortality (Z) and fishable biomass for a range of projected catch options (as noted above) for the years 2025 to 2027. Projections should include both catch options and a range of effective cod predation biomass levels considered appropriate by the Scientific Council. Results should include risk analyses of falling below: B_{msy}, 80% B_{msy} and B_{lim} (30% B_{msy}), and of being above Z_{msy} based on the 3-year projections, consistent with the Harvest Decision Rules in Canada's Harvest Strategy; and
- Total area fished for the longest time period possible.

Please provide the advice relative to Canada's Harvest Strategy as part of the formal advice (i.e., grey box in the advice summary sheet).

APPENDIX III. PROVISIONAL AGENDA – STACFIS

17-19 September 2024

Halifax, Canada

I. Opening (Martha Krohn)

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

II. General Review

1. Review of Recommendations in 2023
2. Review of Catches

III. Stock Assessments

1. Northern shrimp (*Pandalus borealis*) on the Flemish Cap (NAFO Division 3M) (Full assessment)
2. Northern shrimp (*Pandalus borealis*) on the Grand Bank (NAFO Divisions 3LNO) (Interim Monitoring)
3. Northern shrimp (*Pandalus borealis*) off West Greenland (NAFO Subarea 0 and Subarea 1) (Full assessment)
4. Northern shrimp (*Pandalus borealis*) in the Denmark Strait and off East Greenland (ICES Divisions XIVb and Va) (Full assessment)

IV. Other Business

1. FIRMS Classification for NAFO Shrimp Stocks

V. Adjournment

APPENDIX IV. DESIGNATED EXPERTS FOR PRELIMINARY ASSESSMENT OF CERTAIN NAFO STOCKS

The following is the list of Designated Experts for 2024 assessments:

From the Science Branch, Northwest Atlantic Fisheries Centre, Department of Fisheries and Oceans, P. O. Box 5667, St. John's, NL, Canada A1C 5X1, Canada

Northern shrimp in Divisions 3LNO	Nicolas le Corre	nicolas.lecorre@dfo-mpo.gc.ca

From the Instituto Español de Oceanografia, Aptdo 1552, E-36200 Vigo (Pontevedra), Spain

Shrimp in Division 3M	Jose Miguel Casas Sanchez	mikel.casas@ieo.csic.es

From the Greenland Institute of Natural Resources, P. O. Box 570, DK-3900 Nuuk, Greenland

Northern shrimp in Subarea 0+1	AnnDorte Burmeister	anndorte@natur.gl
Northern shrimp in Denmark Strait	Tanja B. Buch	TaBb@natur.gl

APPENDIX V. LIST OF SCR AND SCS DOCUMENTS

RESEARCH DOCUMENTS (SCR)

Serial No.	SCR Document	Author(s)	Title
N7562	SCR Doc. 24/052	Burmeister and Buch	The West Greenland trawl survey for *Pandalus borealis* 2024 with reference to earlier results
N7563	SCR Doc. 24/053	Burmeister	The Fishery for Northern Shrimp (*Pandalus borealis*) off West Greenland, 1970–2024
N7564	SCR Doc. 24/054	Burmeister	Catch Table Update for the West Greenland Shrimp Fishery
N7565	SCR Doc. 24/055	Burmeister and Buch	A provisional Assessment of the shrimp stock off West Greenland in 2024
N7566	SCR Doc. 24/056	Buch and Burmeister	Results of the East Greenland Bottom Trawl Survey for Northern shrimp (*Pandalus borealis)*
N7567	SCR Doc. 24/057	Buch and Burmeister	The Fishery for Northern Shrimp (*Pandalus borealis*) in Denmark Strait / off East Greenland 1978 – 2024
N7568	SCR Doc. 24/058	Buch and Burmeister	Applying a stochastic surplus production model (SPiCT) to the East Greenland Stock of Northern Shrimp
N7572	SCR Doc. 24/059	J. M. Casas	Northern Shrimp (*Pandalus borealis*) on Flemish Cap Surveys 2024
N7573	SCR Doc. 24/060	J. M. Casas	Division 3M Northern shrimp (*Pandalus borealis*) – Interim Monitoring Update
N7574	SCR Doc. 24/061	Casas, J.M., E. Román-Marcote and V.M. Pajón	Northern Shrimp (*Pandalus borealis*, Krøyer) from EU-Spain Bottom Trawl

SUMMARY DOCUMENTS (SCS)

Serial No.	SCS Document	Author(s)	Title
N7597	SCS Doc. 24/18	NAFO	Report of the Scientific Council and STACFIS Shrimp Assessment Meeting, 17-19 September 2024

APPENDIX VI. LIST OF PARTICIPANTS, 17-19 SEPTEMBER 2024

CHAIRS	
González Troncoso, Diana *Scientific Council Chair*	Instituto Español de Oceanografia, Vigo (Pontevedra), Spain E-mail: diana.gonzalez@ieo.csic.es
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