

Northwest Atlantic Fisheries Organization



Report of the Scientific Council and STACFIS Shrimp Assessment Meeting

13 to 15 September 2023

Vigo, Spain

NAFO
Halifax, Nova Scotia, Canada
2023



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Report of the Scientific Council and STACFIS Shrimp Assessment Meeting.....	4
I. Plenary sessions.....	4
II. Review of Scientific Council Recommendations in 2020 and 2021.....	4
III. Standing Committee on Fisheries Science (STACFIS).....	4
IV. Management Advice.....	4
1. Request from the Commission.....	4
a) Northern Shrimp in Division 3M.....	5
b) Northern Shrimp in Division 3LNO.....	8
2. Requests from Coastal States.....	11
a) Northern shrimp in Denmark Strait and off East Greenland.....	12
b) Northern shrimp in Subarea 1 and Division 0A.....	14
V. Other Matters.....	17
1. Scheduling of Future Meetings.....	17
a) Scientific Council meetings.....	17
b) NAFO/ICES Joint Groups.....	17
c) Commission- Scientific Council Joint Working Groups.....	17
2. Topics for Future Special Sessions.....	17
3. Other Business.....	17
a) FIRMS Classification for NAFO Stocks.....	17
VI. Adoption of Reports.....	18
VII. Adjournment.....	18
Appendix I. Report of Standing Committee on Fisheries Science (STACFIS).....	19
I. Opening.....	19
II. General Review.....	19
1. Review of Research Recommendations in 2021 and 2022.....	19
2. Review of Catches.....	19
III. Stock Assessments.....	19
1. Northern Shrimp (<i>Pandalus borealis</i>) on Flemish Cap (NAFO Division 3M).....	19
2. Northern shrimp (<i>Pandalus borealis</i>) on the Grand Bank (NAFO Divisions 3LNO).....	24
3. Northern shrimp (<i>Pandalus borealis</i>) off West Greenland (NAFO Subarea 0 and Subarea 1).....	31
4. Northern shrimp (<i>Pandalus borealis</i>) in the Denmark Strait and off East Greenland (ICES Divisions 14b and 5a).....	42
Appendix II. Provisional Agenda – Scientific Council shrimp Assessment Meeting.....	52
Annex 1. Commission's Request for Scientific Advice on Management in 2024 and Beyond of Certain Stocks in Subareas 2, 3 and 4 and Other Matters.....	53
Annex 2. Denmark (on behalf of Greenland) Coastal State Request for Scientific Advice - 2024.....	59
Annex 3. Canada's Request for Coastal State Advice - 2024.....	60
Appendix III. Provisional Agenda – STACFIS.....	61

Appendix IV. Designated Experts for Preliminary Assessment of Certain NAFO Stocks	62
Appendix V. List of SCR and SCS Documents	63
Appendix VI. List of Participants	64

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**REPORT OF THE SCIENTIFIC COUNCIL AND STACFIS SHRIMP ASSESSMENT MEETING
13-15 September 2023, Vigo, Spain**

Chair: Diana González Troncoso (EU)

Rapporteur: Tom Blasdale

I. PLENARY SESSIONS

Scientific Council met from 13 to 15 September 2023 at the Hotel Ciudad de Vigo, Vigo, Spain 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 13 September and welcomed participants. The provisional agenda was adopted as circulated. The Scientific Council Coordinator was appointed as rapporteur.

II. REVIEW OF SCIENTIFIC COUNCIL RECOMMENDATIONS IN 2020 AND 2021

Recommendations from 2021 and 2022 are considered in the relevant sections of this report.

III. STANDING COMMITTEE ON FISHERIES SCIENCE (STACFIS)

Due to conflicts arising from ICES policy in relation to the war in Ukraine, it was not possible to hold the planned September meeting of NIPAG in 2023. Shrimp stocks in the NAFO Regulatory Area (NRA) and Greenland were therefore assessed by Scientific Council and STACFIS.

The September 2023 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 SC June 2023 meeting (SCS Doc. 23/18).

a) Northern shrimp in Division 3M

Advice September 2023 for 2024











Recommendation

The stock continues to be below B_{lim} .

To be consistent with the Precautionary Approach, Scientific Council advises that no directed fishery should occur in 2024.

Management objectives

No explicit management plan or management objectives defined by the Commission. Convention general principles are applied. Advice is based on qualitative evaluation of biomass indices in relation to historic levels, and provided in the context of the precautionary approach framework (FC Doc. 04/18).

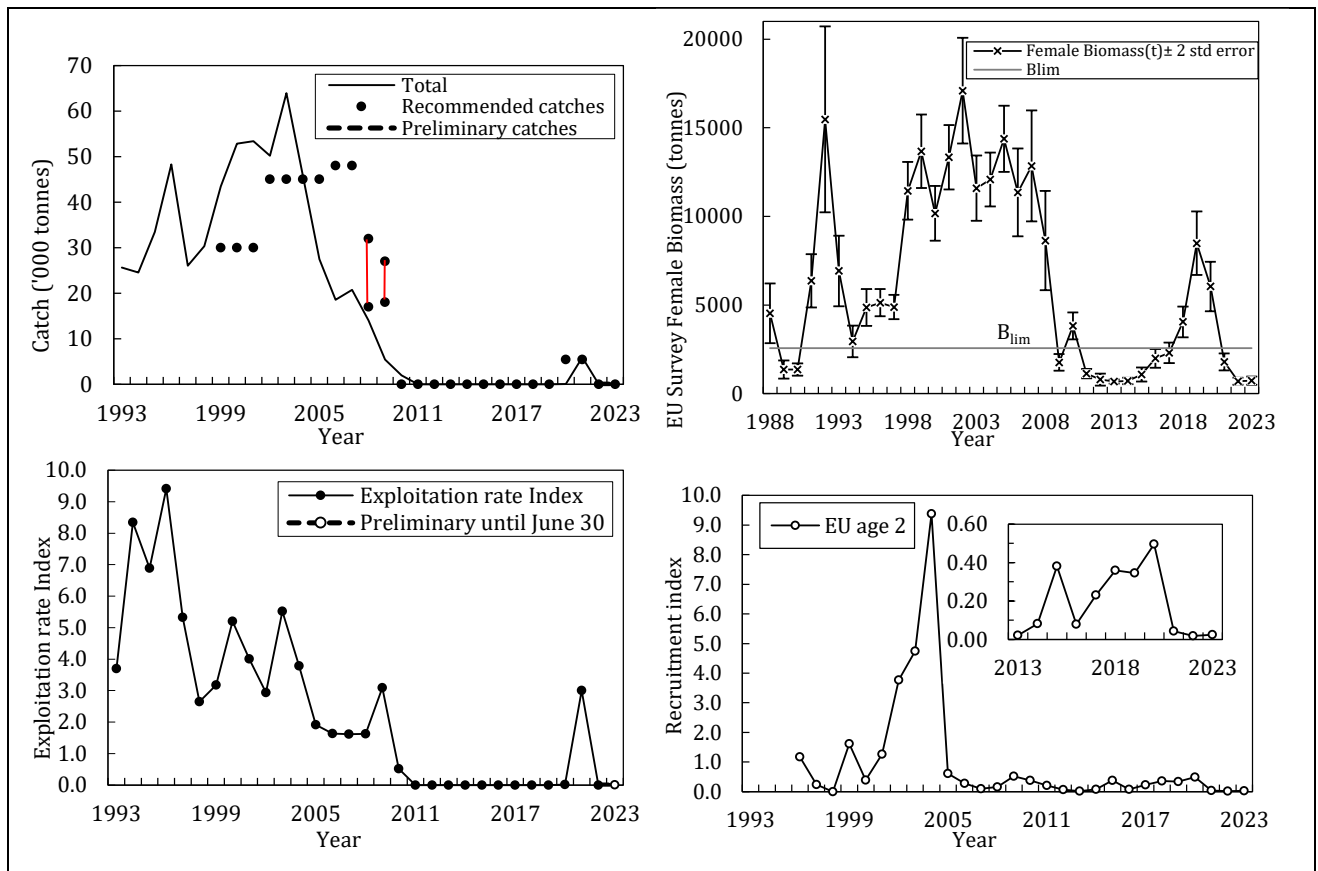
Convention Principle	Status	Comment	
Restore to or maintain at B_{msy}		$B < B_{lim}$	 OK
Eliminate Overfishing (Stock)		F_{lim} undefined, F level is not a concern	 Intermediate
Eliminate Overfishing (Ecosystem)		Total EPU catches $< 2TCI$	 Not accomplished
Apply Precautionary Approach		B_{lim} defined, F_{lim} undefined	 Unknown
Minimize harmful impacts on living marine resources and ecosystems		No directed fishing	
Preserve marine biodiversity		Cannot be evaluated	

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.



Reference points

Scientific Council considers that a female survey biomass index of 15% of its maximum observed level provides a proxy for B_{lim} (SCS Doc. 04/12). 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 to the NAFO Annual Meeting in September 2024.

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 (SCR Docs. 16/35 and 18/24), suggest that predation by cod (*Gadus morhua*) and redfish (*Sebastes* sp.), 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. It is uncertain whether this represents a causal relationship and/or covariance as a result of some environmental factor.

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

Ecosystem sustainability of catches

The impact of bottom fishing activities on 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

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 that year was zero and is expected to be at the same level in 2023.

Recent catches ('000 t) and agreed effort by the NAFO Commission were as follows:

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
NIPAG	0	0	0	0	0	0	0.1	5.7 ³	0	N/A
STATLANT 21	0	0	0	0	0	0	0.0	5.9	N/A	N/A
Effort ² (Agreed Days)	0	0	0	0	0	0	2.6	2.6	ndf	ndf
Effort days used	0	0	0	0	0	0	0.0	0.5	0	0 ¹
SC Recommended Catches (tonnes)	ndf	ndf	ndf	ndf	ndf	ndf	5.4	5.4	0	0

¹ preliminary until 30 June

² effort regulated

³ CESAG method

Effects of the fishery on the ecosystem

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

Special comments

SC **recommended** 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; SCS Doc. 04/12; FC Doc. 04/18

b) Northern shrimp in Division 3LNO











Advice September 2023 for 2024-2025

Recommendation

No directed fishery in 2024 and 2025 as the stock is below B_{lim} with no indication of short-term recovery.

Management objectives

No explicit management plan or management objectives have been defined by the Commission. Convention General Principles are applied. Advice is based on qualitative evaluation of biomass indices in relation to historic levels and provided in the context of the precautionary approach framework (FC Doc. 04/18).

Convention Principle	Status	Comment	
Restore to or maintain at B_{msy}		$B < B_{lim}$	 OK
Eliminate Overfishing (Stock)		F_{lim} undefined, F level is not a concern	 Intermediate
Eliminate Overfishing (Ecosystem)		Total EPU catches $< 2TCI$	 Not accomplished
Apply Precautionary Approach		B_{lim} defined, F_{lim} undefined	 Unknown
Minimize harmful impacts on living marine resources and ecosystems		No directed fishing	
Preserve marine biodiversity		Cannot be evaluated	

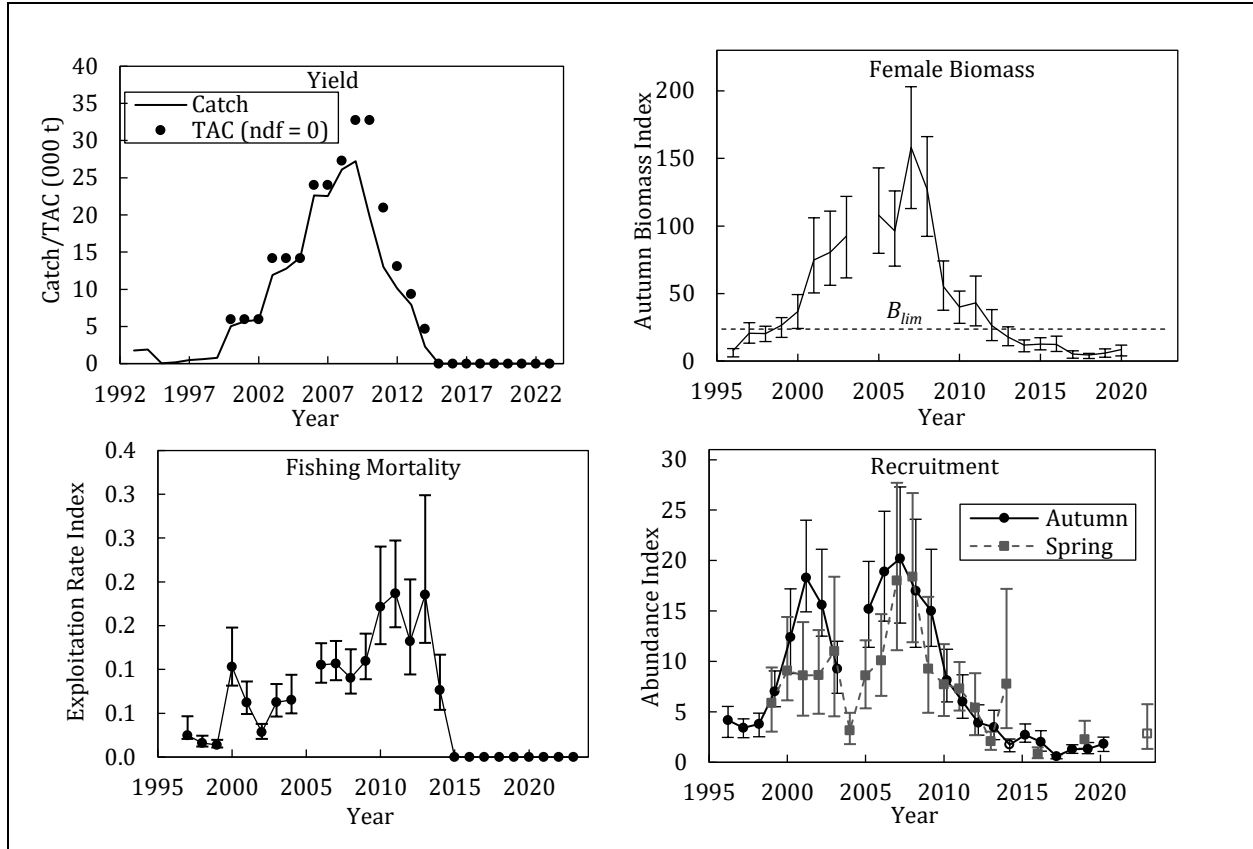
Management Unit

The stock in Div. 3LNO is assessed and managed as a discrete population (see special comments).

Stock Status

Based on the autumn 2020 survey, the risk of the stock being below B_{lim} is greater than 95%. More recent biomass indices from other surveys show no indication of recovery. In addition, recruitment remains very low.





Reference points

Scientific Council considers that a female survey biomass index of 15% of its maximum observed level provides a proxy for B_{lim} (SCS Doc. 04/12).

Projections

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

Assessment

Based upon a qualitative evaluation of trends in stock biomass, fishing mortality proxy and recruitment. Input data are research survey indices and fishery catches.

Next full assessment is planned for 2025.

Human impact

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

Biological and Environmental Interactions

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

After reaching record-high conditions in 2010-2011 (warmest conditions since 1980), the bottom temperature in 3LNO had cooled down to near-normal conditions in 2014-2018 and a warming trend has been emerging since. Direct effects of temperature on shrimp distribution, recruitment, growth and survival are poorly understood.

Predation (by cod, Greenland halibut and redfish), low abundance of high energy prey (such as capelin) and environmental factors (including phytoplankton bloom dynamics) appear to be important drivers of the decline of northern shrimp in Divs. 2J3KL.

Ecosystem sustainability of catches

Shrimp is included in the benthivore guild of the Grand Bank (3LNO) EPU. Other NAFO managed stocks in this guild within the EPU include 3LNOPs thorny skate, 3NO witch flounder, 3LNO American plaice, and 3LNO Yellowtail flounder. The Catch/TCI is below the 2TCI ecosystem reference point (3LNO Benthivore Catch2022/TCI=0.80) indicating a low risk of ecosystem overfishing.

Fishery

The fishery, until 2014, was a directed bottom trawl fishery and there is little or no bycatch of shrimp in other trawl fisheries. The fishery in Div. 3LNO is regulated by quota.

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

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TAC ¹	4.7	ndf	Ndf	ndf	ndf	ndf	ndf	ndf	ndf	ndf
STATLANT 21	2.3	0	0	0	0	0	0	0	0	
NIPAG ²	2.3	0	0	0	0	0	0	0	0	

¹ Includes autonomous TAC as set by Denmark in respect of Faroes and Greenland.

² NIPAG catch estimates have been updated using various data sources (see p. 13, SCR. 14/048).

Effects of the fishery on the ecosystem

The fishery was closed to directed fishing beginning in 2015.

Special Comments

Shrimp in Div. 3LNO are genetically distinct from those in Div. 3M and the Gulf of Maine, but not from those further north. Work is ongoing to investigate the contribution of stocks north of Div. 3L to the production of Div. 3LNO shrimp.

Research on transport of larval shrimp indicates that most larvae that originate in Div. 3L are transported out of that division. Additionally, it was found that most recruitment in Div. 3L originates further north of the area. The results of this research have not yet been quantified in order to develop a more comprehensive recruitment index for Div. 3LNO.

Sources of information

SCR. 14/048, SCS Doc. 04/12

2. Requests from Coastal States

Requests for management advice from Denmark (on behalf of Greenland) are presented in Annex 2 of Appendix II. Requests relating to northern shrimp were addressed in the present meeting, the remainder having been previously addressed during the SC June 2023 meeting (SCS Doc. 23/18).

a) Northern shrimp in Denmark Strait and off East Greenland

Advice September 2023 for 2024

Recommendation

Catches up to 2 500t are projected to result in a very low probability (less than 10%) of the stock going below B_{lim} .

Management objectives

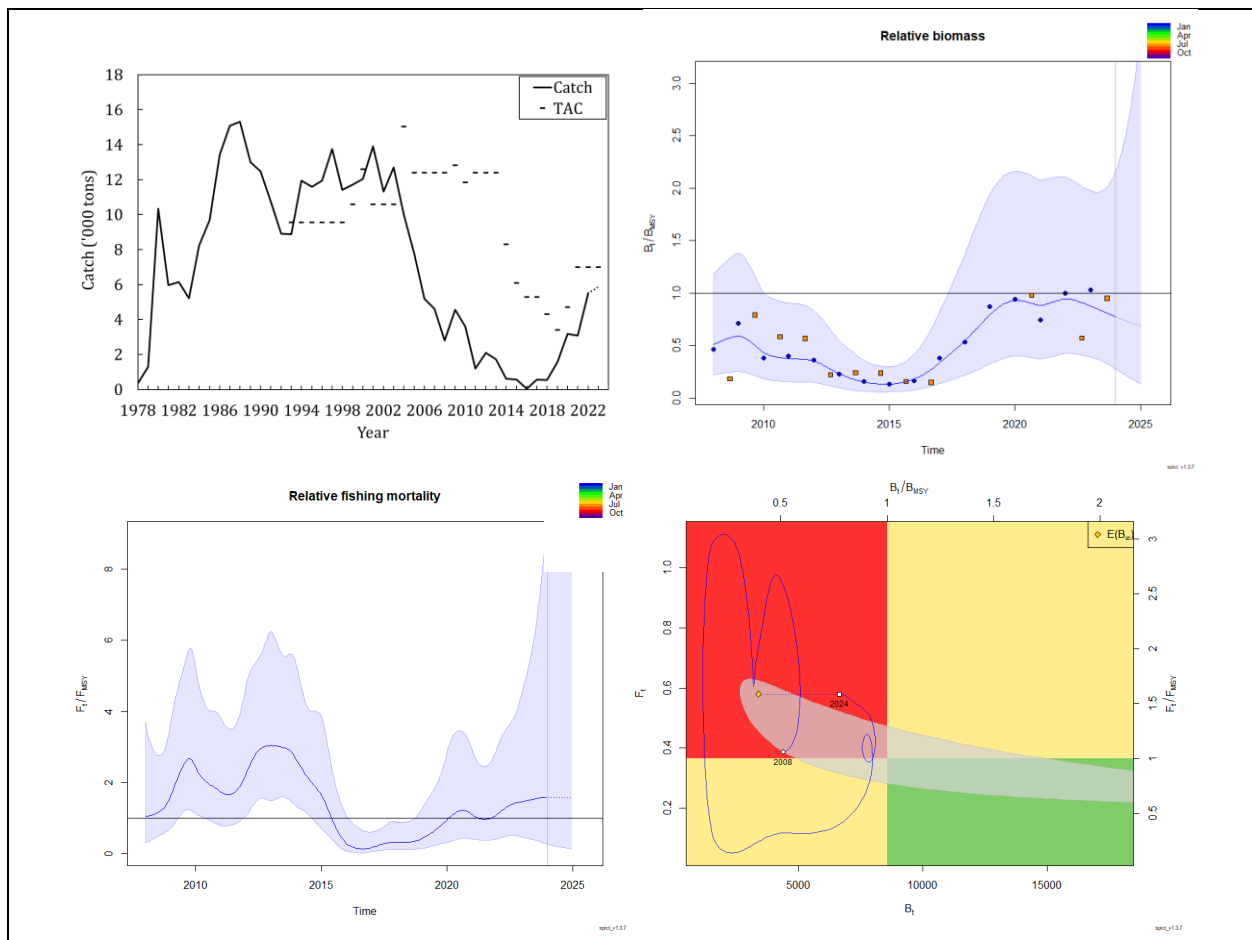
No explicit management plan or management objectives have been defined by the Government of Greenland. Advice was drafted to be consistent with the NAFO precautionary approach (FC Doc 04-12).

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} ($B/B_{msy} = 0.78$) and the probability of being below B_{lim} is less than 5%. Fishing mortality is above F_{msy} ($F/F_{msy} = 1.59$). 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. The current relative B/B_{msy} is 0.78 and the relative F/F_{msy} is 1.59. The probability of being below B_{lim} is currently very low (less than 5%)

Projections

Relative reference points are estimated for six catch options for 2024.

Catch (t)	B/B_{msy}	F/F_{msy}	Prob $B > B_{msy}$	Prob $B < B_{lim}$	Prob $F > F_{msy}$
1 500	0.96	0.56	0.47	0.02	0.32
2 000	0.90	0.77	0.43	0.03	0.42
2 500	0.83	0.99	0.39	0.06	0.50
3 000	0.77	1.24	0.36	0.10	0.57
3 500	0.71	1.51	0.33	0.15	0.63
4 000	0.64	1.81	0.31	0.20	0.68

Assessment

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

The next assessment is scheduled for 2024.

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. Cod is an important predator on shrimp. The cod stock has fluctuated in East Greenland waters since 2014. The impact on the shrimp biomass is unknown.

Ecosystem sustainability of catches

Shrimp is included in the benthivore guild. There are currently no EPU's defined nor TCI information 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:

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Enacted TAC	8.3	6.1	5.3	5.3	4.3	3.4	4.8	7.0	6.9	6.9
SC Recommended TAC	2.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0	3.0	2.0
NIPAG catch	0.6	0.6	0.0	0.6	0.5	1.6	3.2	3.1	5.6	5.9 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. 23/049, 23/050, 23/051, 21/044, FC Doc. 04-18

b) Northern shrimp in Subarea 1 and Div. 0A

Advice September 2023 for 2024




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 5%), Scientific Council advises that catches in 2024 should not exceed 95 000 t.

With regard to the Canadian harvest strategy, Scientific Council notes that catches of 95 000 t in 2024 would result in a 35% risk of exceeding Z_{msy} in 2024, and a 34% risk of exceeding Z_{msy} in 2025 and 2026, assuming catches at the same level as in 2024.

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 5%). 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. Advice was also drafted to be consistent with the NAFO precautionary approach (FC Doc. 04-12).

<i>Objective</i>	<i>Status</i>	<i>Comment/consideration</i>
Maintain risk of being above Z_{msy} not exceeding 35%		The TAC set for 2023 equates to a risk of being above Z_{msy} by the end of 2023 of 50%
Maintain the stock in the Healthy Zone (>80% of B_{msy})		The stock is above B_{msy} in 2023
Maintain risk of biomass being below B_{lim} of less than 1%		The risk of biomass in 2023 being below B_{lim} is less than 1%

 OK
 Intermediate

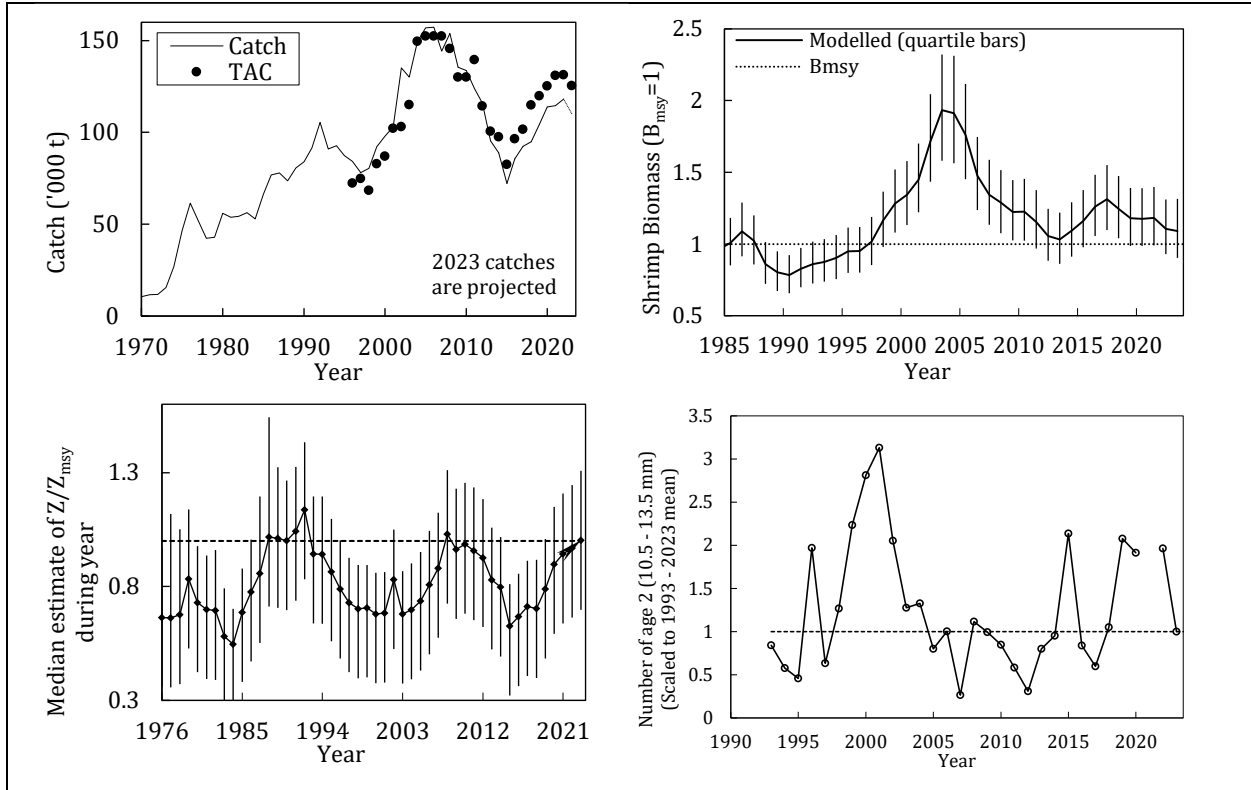
Management unit

The stock, considered distinct from all others, is distributed throughout Subarea 1, extends into Div. 0A east of 60°30’W, and is assessed as a single stock. In 2022, more than 99% of the landings were from Greenland.

Stock status

Biomass in 2023 is above B_{msy} and the probability of being below B_{lim} is very low (<1%). The probability of mortality in 2023 being above Z_{msy} is 50%. Recruitment (number of age-2 shrimp) in 2023 was near 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 precautionary reference points in 2024 – 2026 under eight catch options and subject to predation by a cod stock with an effective biomass of 17 Kt.

17 000 t cod	Risk of:	Catch option ('000 tons)							
		85	90	95	100	105	110	115	120
	falling below B_{msy} end 2024 (%)	38	38	38	39	39	40	41	42
	falling below B_{msy} y end 2025 (%)	36	37	38	40	40	42	43	44
	falling below B_{msy} end 2026 (%)	36	37	37	41	42	43	45	46
	falling below B_{lim} end 2024 (%)	0	0	0	0	0	0	0	0
	falling below B_{lim} end 2025 (%)	0	0	0	0	0	0	0	0
	falling below B_{lim} end 2026 (%)	0	0	0	0	0	0	0	0
	exceeding Z_{msy} in 2024 (%)	26	30	35	39	44	47	51	54
	exceeding Z_{msy} in 2025 (%)	26	31	34	40	44	47	51	55
	exceeding Z_{msy} in 2026 (%)	26	30	34	40	44	48	52	56
	falling below B_{msy} 80% end 2024 (%)	15	15	16	16	16	16	17	18
	falling below B_{msy} 80% end 2025 (%)	15	16	17	19	18	19	21	22
	falling below B_{msy} 80% end 2026 (%)	16	17	18	20	21	22	24	25



Assessment

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

The next assessment is scheduled for 2024.

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.

Cod is an important predator on shrimp. This assessment incorporates this interaction. Other predation is likely but not explicitly considered. Shrimps 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 no Ecosystem Production Units defined nor Total Catch Index (TCI) information for the distribution area of this stock.

Fishery

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

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

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Enacted TAC ¹	97.6	82.6	96.4	101.7	114.9	119.9	125.2	130.9	131.3	125.6
STATLANT 21	88.8	71.8	84.3	91.7	91.9	102.7	110.3	107.6	115.8	0.0
NIPAG	88.8	72.3	85.5	92.6	94.9	104.3	113.8	114.6	118.1	110.0 ²

¹ Sum of TACs autonomously set by Canada and Greenland.

² Projected to year end.

Effects of the fishery on the ecosystem

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

Special comment

The advice is subject to some uncertainty due to abnormal spatial distribution of sea ice north of 66°N in Greenland EEZ in 2023, which prevented trawling at many of the planned stations during the survey. Due to poor survey coverage in the northern survey area, it is uncertain if this year's survey results reflect the stock trajectory and status.

SC 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, 23/046, 23/047, 23/048.

V. OTHER MATTERS

1. Scheduling of Future Meetings

a) Scientific Council meetings

i) Scientific Council, 18 to 22 September 2023

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

ii) WG-ESA, 14- 23 November 2023

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

iii) Scientific Council, June 2024

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

iv) Scientific Council (in conjunction with NIPAG), 2024

Dates and location to be determined.

v) Scientific Council, September 2024

Scientific Council noted that the Annual Meeting will be held in September in Halifax, Nova Scotia.

b) NAFO/ICES Joint Groups

i) NIPAG, 2024

Dates and location to be determined.

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

Dates and location to be determined.

iii) 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 be in Spring 2024.

ii) WG-EAFFM

The joint Commission- Scientific Council Working Group on the Ecosystem approach to Fisheries Management (WG-EAFFM), August 2024, location to be decided.

iii) WG-RBMS

The joint Commission- Scientific Council Working Group on Risk Based Management Systems (WG-RBMS) April and August 2024, locations to be decided.

2. Topics for Future Special Sessions

No special session was proposed.

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	3LN Redfish 3LNOPs Thorny skate	SA0+1 Northern shrimp 3M Redfish ¹ SA2+3KLMNO Greenland halibut 3M cod	East Greenland Northern shrimp	SA1 American Plaice SA1 Spotted Wolffish
Small	3NOPs White hake 3NO Witch flounder			
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 3O Redfish SA 0+1 (Offshore) Greenland halibut Greenland halibut in Disko Bay Greenland halibut in Uummannaq Greenland halibut in Upernavik	1B-C Greenland halibut Inshore	1D Greenland halibut Inshore 1E-F Greenland halibut Inshore	SA3+4 Northern shortfin squid

¹ Fishing mortality may not be the main driver of biomass for Div. 3M Shrimp and Redfish. For many stocks, lack of surveys in recent years has impacted assessments.

VI. ADOPTION OF REPORTS

The STACFIS report was adopted on 14 September 2023 subject to editorial revision following this meeting.

VII. ADJOURNMENT

The Scientific Council meeting was adjourned at 12:00 on 15 September 2023. 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 Spain 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: Mark Simpson

Rapporteur: Tom Blasdale

I. OPENING

Due to conflicts arising from ICES policy in relation to the war in Ukraine, it was not possible to hold the planned September meeting of NIPAG in 2023. Shrimp stocks in the NAFO Regulatory Area (NRA) and Greenland were therefore assessed by Scientific Council and STACFIS.

STACFIS met from 13 to 14 September 2023 at the Hotel Ciudad de Vigo, Vigo, Spain 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, Mark Simpson (Canada) opened the meeting at 09:45 on 13 September and welcomed participants. The provisional agenda was adopted as circulated. The Scientific Council Coordinator was appointed as rapporteur.

II. GENERAL REVIEW

1. Review of Research Recommendations in 2021 and 2022

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)

(SCR Doc. 04/77, 16/35, 18/24)

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 Div. 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. Due to a new moratorium starting in 2022, there is no shrimp fishing in Div. 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. The effort directed to the shrimp fishery

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). Since 2022, due to the moratorium there was no effort directed to shrimp fishery.

Recent catches ('000 t) and effort agreed by the NAFO Commission were as follows (ndf=no directed fishery):

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
NIPAG	0	0	0	0	0	0	0.1	5.7 ³	0	N/A
STATLANT 21	0	0	0	0	0	0	0.0	5.9	N/A	N/A
Effort ² (Agreed Days)	0	0	0	0	0	0	2.6	2.6	ndf	ndf
Effort days used	0	0	0	0	0	0	0.0	0.5	0	0 ¹
SC Recommended Catches (tonnes)	ndf	Ndf	ndf	ndf	ndf	ndf	5.4	5.4	0	0

¹ Preliminary catches until June 30

² Effort regulated

³ CESAG method

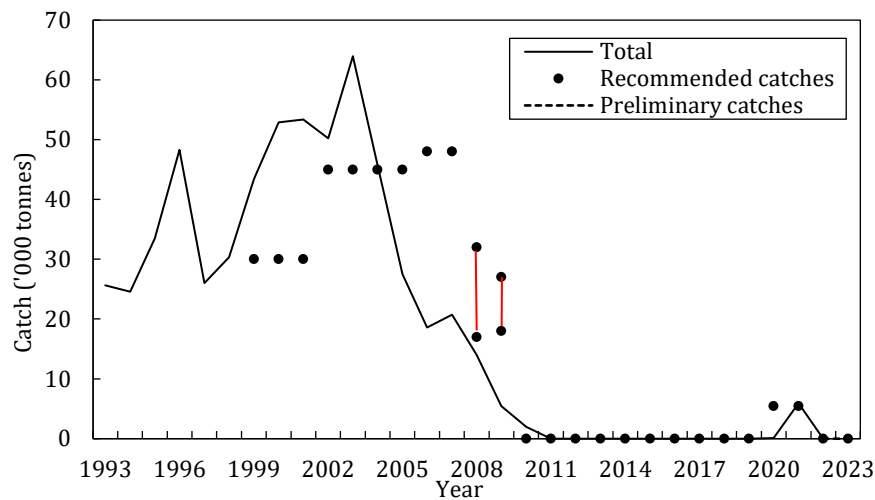


Figure 1.1. Northern shrimp in Div. 3M: Catches (STATLANT 21A, '000 t) and recommended TAC in the period 1993-2023 (red lines in 2008 and 2009 indicate the catches range recommended by SC and dashed line preliminary catches of 2023).

b) Data overview

i) Commercial fishery data

Because of the moratorium, catch and effort data were not available from 2011 - 2019 and for 2022/2023. For the fishery in 2020 and 2021, the standardized CPUE series were not analyzed for this assessment.

ii) Research Survey Data

EU Bottom Trawl Research Survey. Stratified-random trawl surveys have been conducted on Flemish Cap by the EU in Summer from 1988 to 2023. A new vessel was introduced in 2003 which continued to use the same trawl 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 (SCR Doc. 04/77).

c) Assessment

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

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



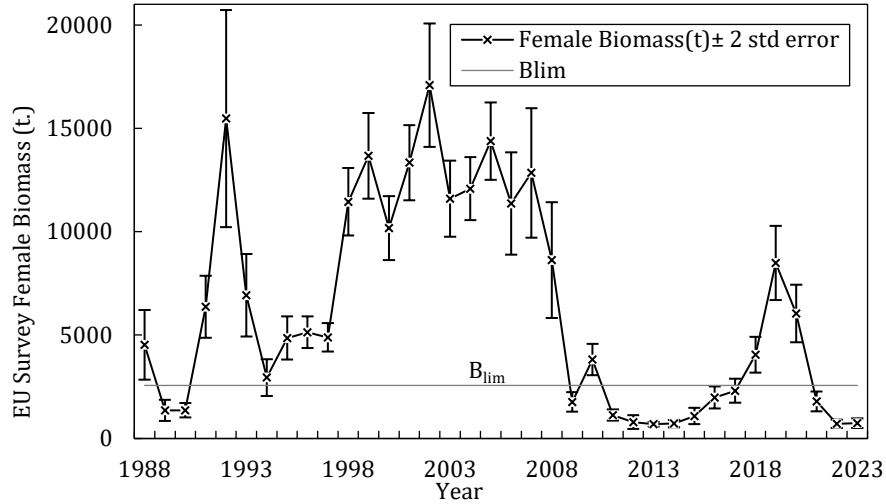


Figure 1.2. Northern shrimp in Div. 3M: Female biomass index from EU trawl surveys, 1988-2023. Error bars are 2 std. err.

Recruitment: Considering the abundance at age 2 as indicator 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 were the lowest of the historical series (Figure 1.3).

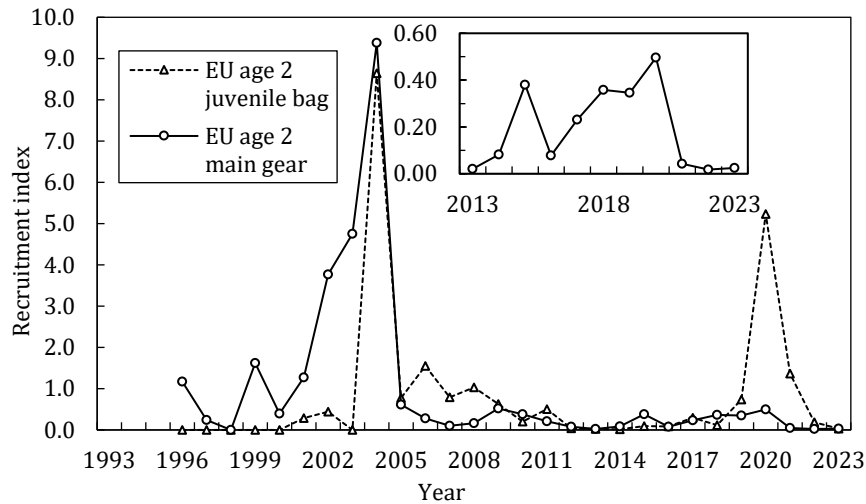


Figure 1.3. Northern shrimp in Div. 3M: Abundance indices at age 2 from the EU survey. Each series was standardized to its mean. Inset shows EU main gear on a different vertical scale for the most recent period.

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 and catches were low resulting in a very low exploitation rate (0.01). In 2021 the exploitation rate increased notably (3.4) due to the increase in the catches (5 703 t) and the decrease in the EU survey female biomass index (Figure 1.4). With the new moratorium established in 2022 the exploitation rate in that year was zero and is expected to be at the same level in 2023.

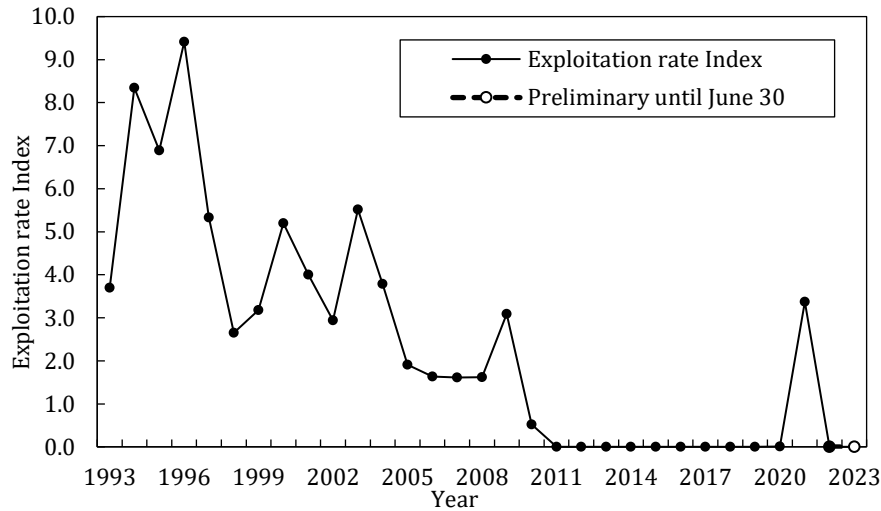


Figure. 1.4. Northern shrimp in Div. 3M: Exploitation rate index as derived by catch divided by the EU survey biomass index of the same year.

State of the stock: Since 2021 the biomass has been below B_{lim} . Recruitment since 2021 has been the lowest of the historical series.

d) Reference Points

STACFIS considers that a female survey biomass index of 15% of its maximum observed level provides a proxy for B_{lim} . This corresponds to an index value of 2 564 t (Figure 1.5). A limit reference point for fishing mortality has not been defined.

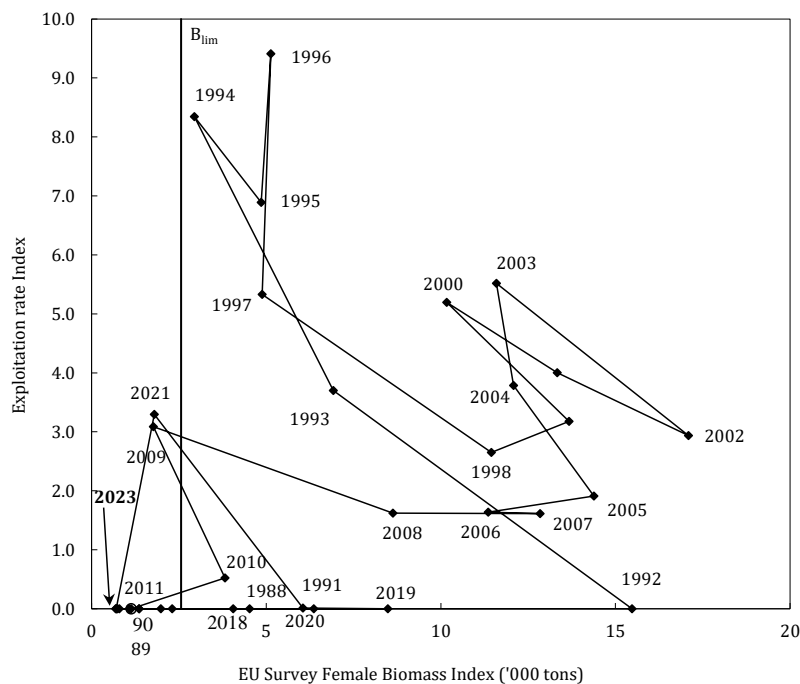


Figure. 1.5. Northern shrimp in Div. 3M: Exploitation rate index plotted against female biomass index from EU survey. Line denoting B_{lim} is drawn where biomass is 15% of the maximum point in 2002.

e) Ecosystem considerations

Multispecies models (SCR 16/35, SCR 18/24), suggest that predation by cod and redfish, together with fishing, have been 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). It is uncertain whether this represents a causal relationship and/or covariance as a result of some environmental factor.

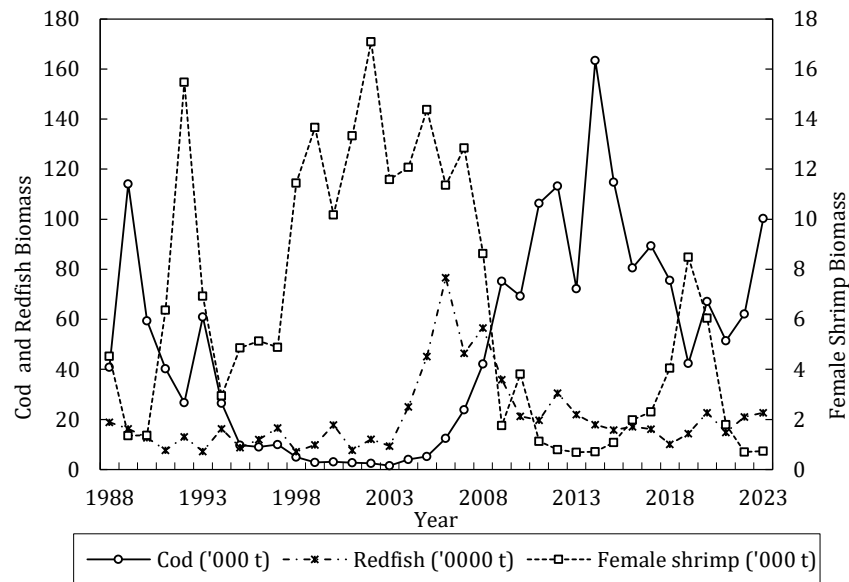


Figure 1.6. Northern shrimp in Div. 3M: Cod, redfish and female shrimp biomass from EU trawl surveys, 1988-2023. Data from 2023 for cod and redfish are preliminary.

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** that *analytical assessments for this stock should be further investigated building on work considered in previous years (SPiCT, SS3).*

The next assessment will take place prior to the NAFO Annual Meeting in September 2024.

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

(SCR. 14/048, SCS Doc. 04/12)

Environmental Overview

The water mass characteristic of the Grand Bank are typical of sub-polar waters, with the presence of a cold intermediate layer (CIL) formed during winter, and which last throughout the year until the late fall. The CIL (defined as water <0°C) extends to the ocean bottom in the northern areas of 3LNO, covering the bottom with sub-zero temperatures. The CIL is thus a reliable index of ocean climate conditions in this area. Bottom temperatures are higher in southern regions of 3NO reaching 1 - 4°C, mainly due to atmospheric forcing and along the slopes of the banks below 200 m depth due to the presence of Labrador Slope Water. On the southern slopes of the Grand Bank in Div. 3O bottom temperatures may reach 4 - 8°C due to the influence of warm slope water from the Gulf Stream. The general circulation in this region consists of the relatively strong offshore Labrador Current at the shelf break and a considerably weaker branch near the coast in the Avalon Channel. Currents over the banks are very weak and the variability often exceeds the mean flow.

a) Introduction

This shrimp stock is distributed around the edge of the Grand Bank, mainly in Div. 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 countries also have some limited involvement in this fishery. The TAC was then reduced annually until no directed fishing (ndf) was implemented in 2015 to 2023 (Fig. 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:

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TAC ¹	4.7	ndf	ndf	ndf	Ndf	ndf	Ndf	ndf	ndf	ndf
STATLANT 21	2.3	0	0	0	0	0	0	0	0	
NIPAG ²	2.3	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 NIPAG catch estimates have been updated using various data sources (see p. 13, SCR. 14/048).

³ Provisional catches for first half of 2023

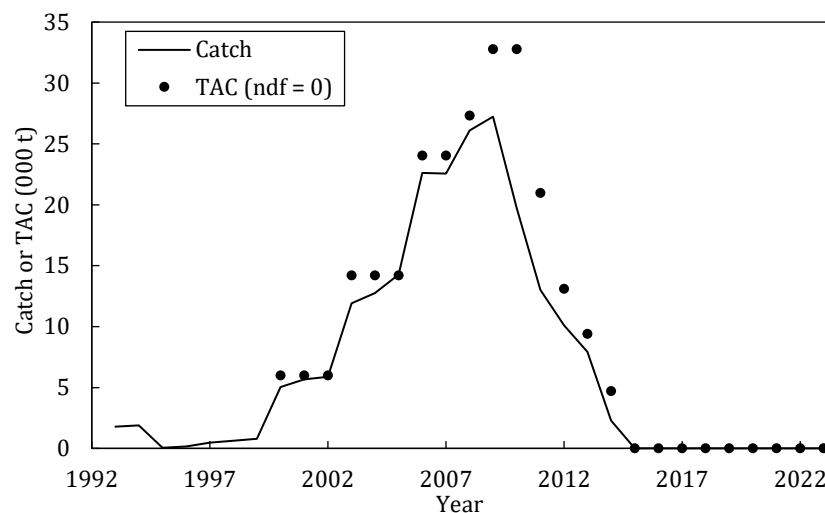


Figure 2.1. Northern shrimp in Div. 3LNO: Catches and TAC. The TAC illustrated includes the autonomous quotas set by Denmark (in respect of the Faroe Islands and Greenland). No directed fishing is plotted as zero TAC.

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 Div. 3LNO, using a Campelen 1800 shrimp trawl for spring (1999–2023) and autumn (1996–2020). 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 Div. 3LNO. The autumn 2014 survey only surveyed Div. 3L, however since about 95% of the biomass in Div. 3LNO comes from Div. 3L annually, it was considered useful as a proxy for Div. 3LNO for 2014. The spring 2023 survey was completed with 1 historic vessel and 2 new vessels and therefore required conversion factors for the continuity of the time-series, which were unavailable at the time of the assessment. However given only 67% of strata were surveyed with the historic vessel in spring, the estimate for 3LNO in 2023 is considered useful only as a proxy.

EU-Spain surveys. EU-Spain has been conducting a stratified-random survey in the NAFO Regulatory Area (NRA) part of Div. 3L since 2003 and in the NRA part of Div. 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 Div. 3L surveys in 2005 or 2020-2022 and no Div. 3NO survey in 2020.

c) Assessment

No analytical assessment is available. Evaluation of stock status is currently based upon interpretation of research survey data.

Biomass indices. In Canadian surveys, about 95% of the biomass was found in Div. 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 second lowest level in the spring time-series in 2023 (Figure 2.2). While autumn indices increased slightly from 2018 to 2020, they remained amongst the lowest levels in the autumn time-series. There have been no updated Canadian autumn surveys since 2020.

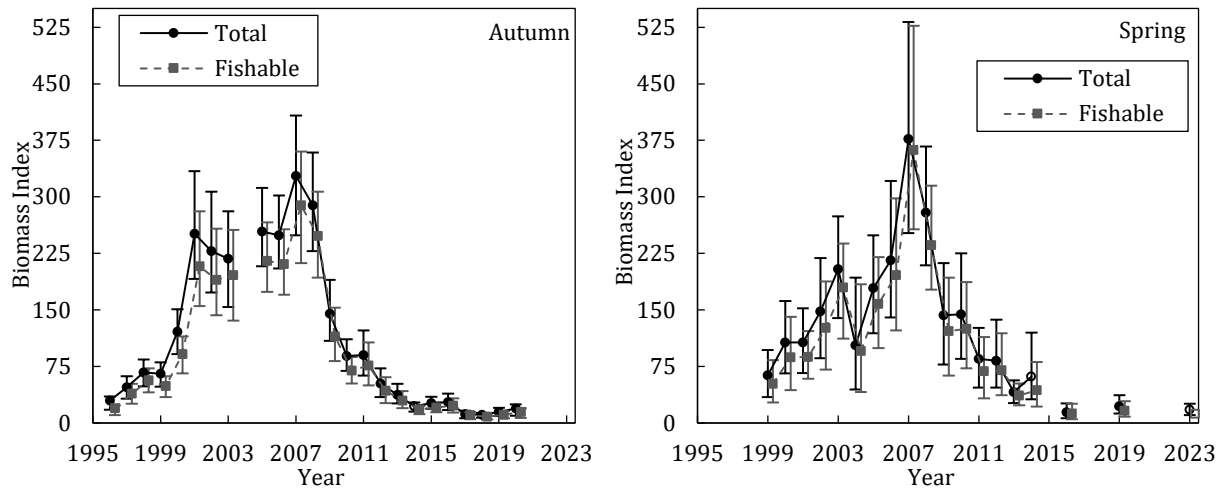


Figure 2.2. Northern shrimp in Div. 3LNO: Total and fishable biomass index estimates from Canadian autumn and spring multi-species surveys (with 95% confidence intervals). The 2014 autumn index is for Div. 3L only. There are no available biomass index estimates for autumn 2021-2022 or for spring 2015, 2017-2018 or 2020-2022. The 2023 value in the spring series is considered a proxy due to the use of new vessels without any conversion factor.

EU-Spain survey biomass indices for Div. 3L and Divs. 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 2023 survey of Divs. 3NO indicated that the biomass index has decreased since 2022; it is still far below the biomass levels of 2003-2007. The 2023 survey estimate for division 3L is the lowest in the time series. Throughout the survey time-series, more shrimp biomass has been captured in the 3L survey compared to the div. 3NO survey.

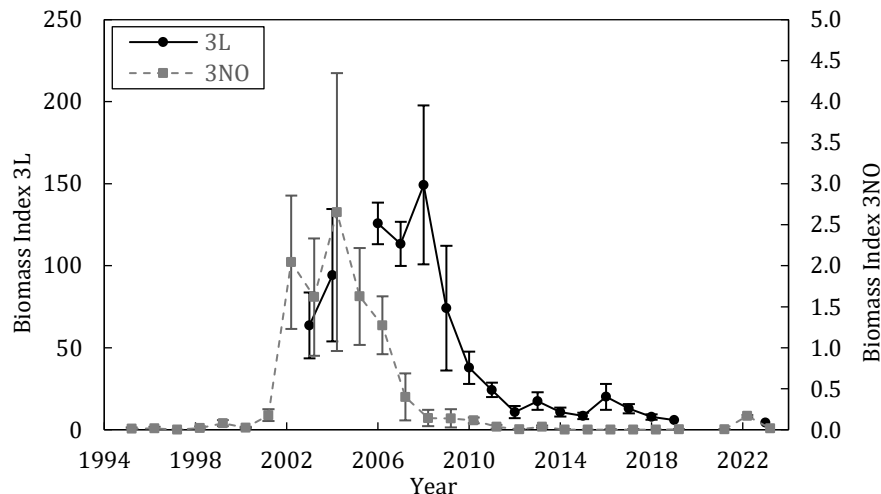


Figure 2.3. Northern shrimp in Div. 3LNO: Total biomass index estimates from EU - Spain multi-species surveys (± 1 SE) in the NAFO Regulatory Area (NRA) of Divs. 3LNO. There are no available biomass index estimates for 2020 and only Divs. 3NO were surveyed in 2005 and 2021-2022.

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).

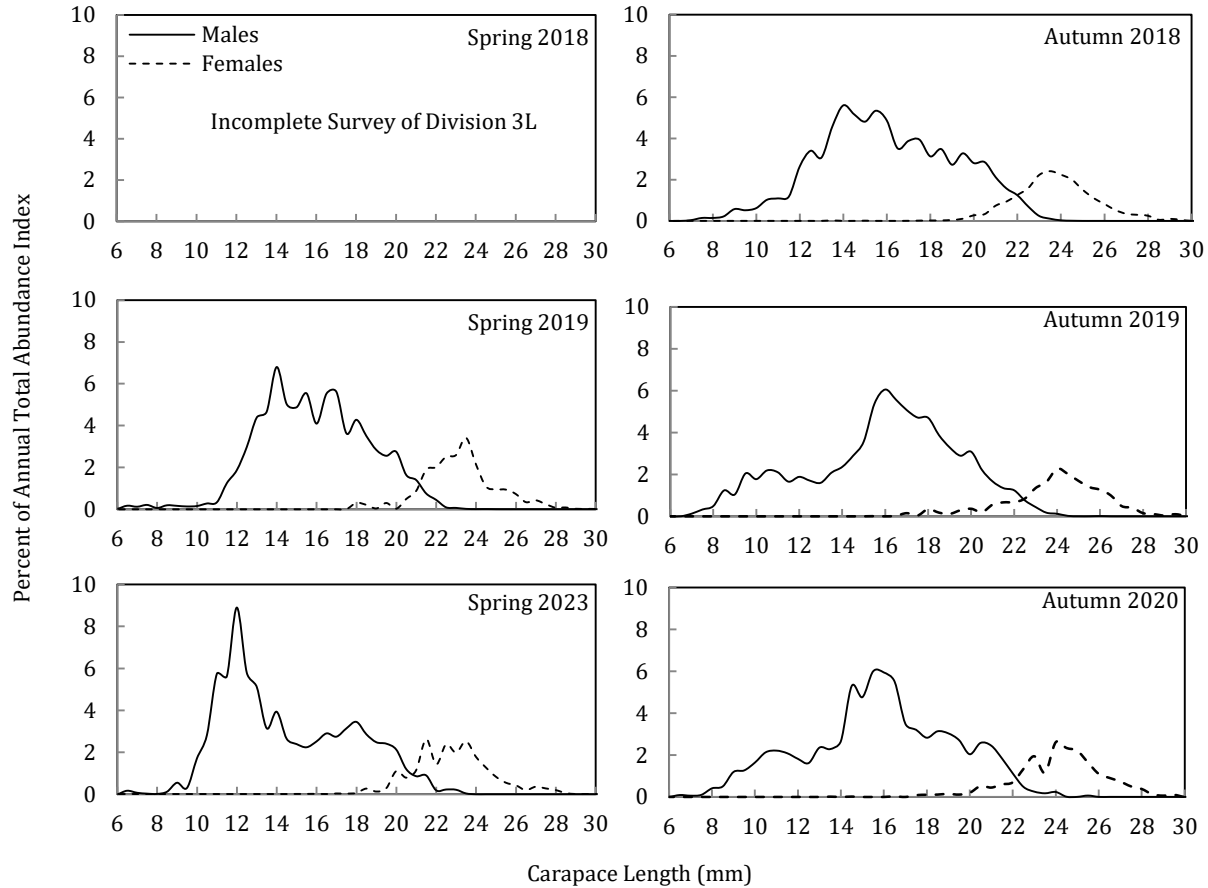


Figure 2.4. Northern shrimp in Div. 3LNO: Composition of survey catches (percentage at length) from Canadian spring and autumn multi-species survey data. No data for autumn 2021-2022 or spring 2020-2022.

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).

Research on transport of larval shrimp (Le Corre et al. 2019) indicates that most larvae that originate in Div. 3L are transported out of that division. Additionally, it was found that most recruitment in Div. 3L originates further north of the area. The results of this research have not yet been quantified in order to develop a more comprehensive recruitment index for Div. 3LNO.

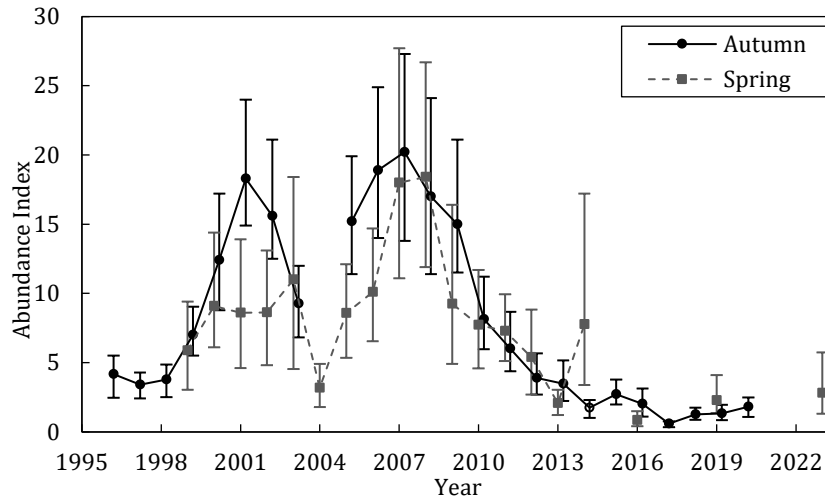


Figure 2.5. Northern shrimp in Div. 3LNO: Indices of recruitment-sized shrimp based on abundance of shrimp with 11.5 – 17 mm carapace lengths from Canadian spring and autumn multi-species surveys. Error bars represent 95% confidence intervals. The autumn index for 2014 is for Div. 3L only. The 2023 value in the spring series is considered a proxy due to the use of new vessels without any conversion factor.

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). Since there was no directed fishing in 2015-2022, the exploitation index is zero for that period of time and is expected to be zero in 2023 based on the provisional catch. Mortality due to bycatch during other fisheries is unknown.

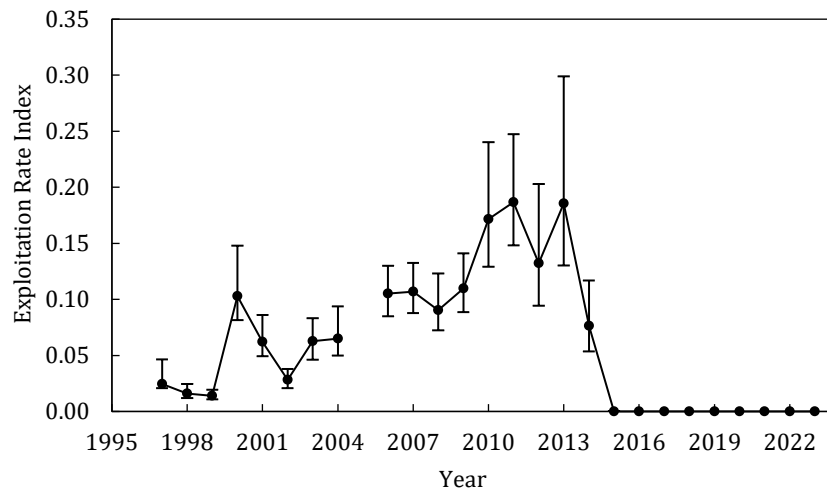


Figure 2.6. Northern shrimp in Div. 3LNO: Exploitation indices calculated as a year’s catch divided by the previous year's autumn fishable biomass index. Error bars (calculated based on estimates of fishable biomass index) indicate 95% confidence intervals.

d) State of the stock

Biomass. Canadian spring and autumn biomass indices have decreased considerably since 2007 and were among the lowest levels in the time series as of the last available surveys. In addition, recent EU 3L and 3NO survey indices are also among the lowest in those time-series.



Recruitment. Recruitment indices decreased since 2008 to very low levels.

Exploitation. The index of exploitation has been zero since 2015.

State of the Stock. Based on the autumn 2020 survey, the risk of the stock being below B_{lim} is greater than 95%. More recent biomass indices from other surveys show no indication of recovery. In addition, recruitment remains very low.

e) 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} (SCS Doc. 04/12). In 2020 the risk of being below B_{lim} was greater than 95% (Figure 2.7), there has been no Canadian survey to update the stock related to B_{lim} since. A limit reference point for fishing mortality has not been defined.

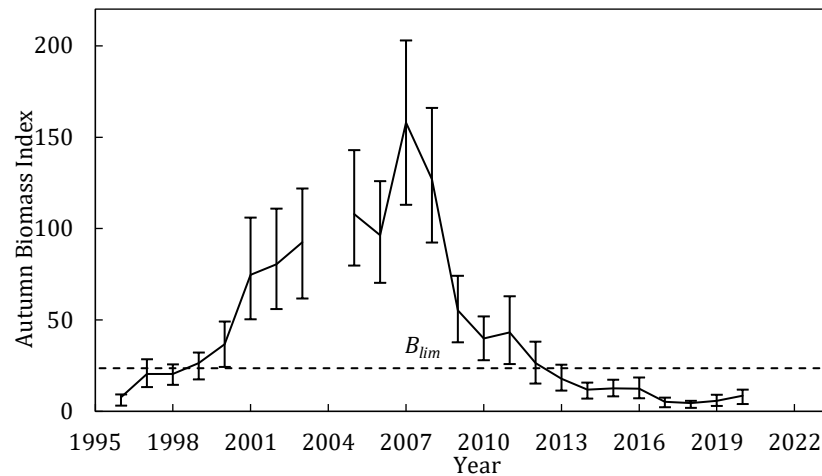


Figure 2.7. Northern shrimp in Div. 3LNO: Autumn female spawning stock biomass index (SSB) and B_{lim} . B_{lim} is defined as 15% of the maximum autumn female biomass over the time-series. Error bars indicate 95% confidence intervals. The autumn index for 2014 is for Div. 3L only.

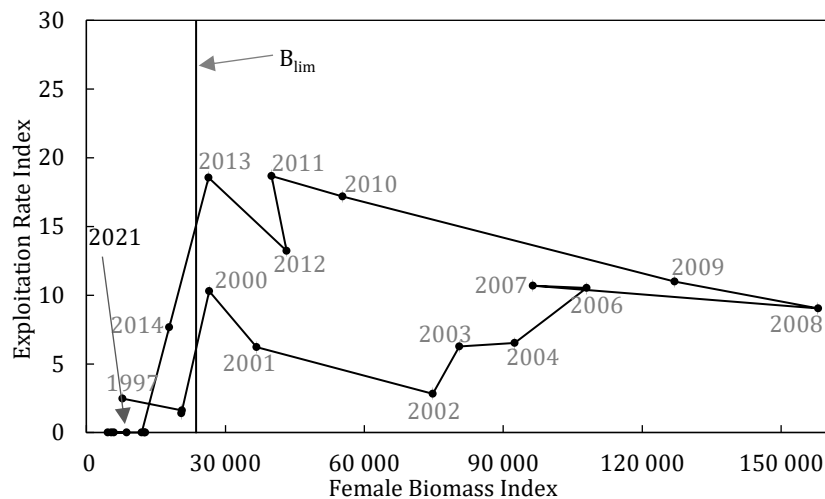


Figure 2.8. Northern shrimp in Div. 3LNO: Exploitation rate vs female SSB index from Canadian autumn survey. Vertical line denotes B_{lim} .

f) Research recommendations

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

Status: No new information was available to the current meeting and this recommendation is reiterated.

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

Status: This recommendation is reiterated.

References

Le Corre N, Pepin P, Han G, Ma Z, Snelgrove PVR. Assessing connectivity patterns among management units of the Newfoundland and Labrador shrimp population. *Fish Oceanogr.* 2019; 28:183–202. <https://doi.org/10.1111/fog.12401>.

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

(SCR Docs. 04/075, 076, 08/006, 11/053, 058, 12/044, 13/054, 20/053, 054, 058, 23/021, 045, 046, 047, 048)

Environmental Overview

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

a) Introduction

The shrimp stock off West Greenland is distributed mainly in NAFO Subarea 1 (Greenland EEZ), but a small part of the habitat, and of the stock, extends into the eastern edge of Div. 0A (Canadian EEZ). Canada has defined 'Shrimp Fishing Area 1' (Canadian SFA1), to be the part of Div. 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 (Divs. 1A– 1F). The Canadian fishery has been limited to Div. 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 shrimps is prohibited.

The enacted TAC for Greenland waters in 2023 was set at 110 000 t and, for Canadian waters, 15 583 t.

Total catches increased to an average over 150 000 t in 2005 to 2008 and decreased to 72 256 t in 2015 (Figure 3.1). Since 2016, the catches have been increasing in conjunction with increasing TACs and was 118 127 t in 2022. The projected catch for 2023 is 110 000 t in Greenlandic EEZ (Div. 1). The projected catch for Canada from Div. 0A in 2023 is expected to be low.

Recent catches, projected catch for 2023 and recommended and enacted TACs ('000 t) for northern shrimp in Sub-area 1 and Div. 0A (east of 60°30'W) are as follows:

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TAC											
Advised	80.0	80.0	60.0	90.0	90.0	105.0	105.0	110.0	115.0	115.0	110.0
Enacted ¹	100.6	97.6	82.6	96.4	101.7	114.9	119.9	125.2	130.9	131.3	125.6
Catches(NIPAG)											
SA 1	95.4	88.8	72.3	84.4	89.4	93.2	102.0	113.1	114.3	118.1	110.0 ²
Div. 0A	0.0	0.0	0.0	1.2	3.2	1.7	2.5	0.6	0.2	0	0 ²
TOTAL	95.4	88.8	72.3	85.5	92.6	94.9	104.4	113.8	114.6	118.1	110.0²
STATLANT 21											
SA 1	91.8	88.8	71.8	82.9	88.9	90.5	98.2	110.1	107.4	117.8	
Div. 0A	0.0	0.0	1.4	2.8	1.4	1.3	0.2	0.2	0.0	0.0	

¹Canada and Greenland set independent and autonomous TACs

² Projected total catches for the year.

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

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

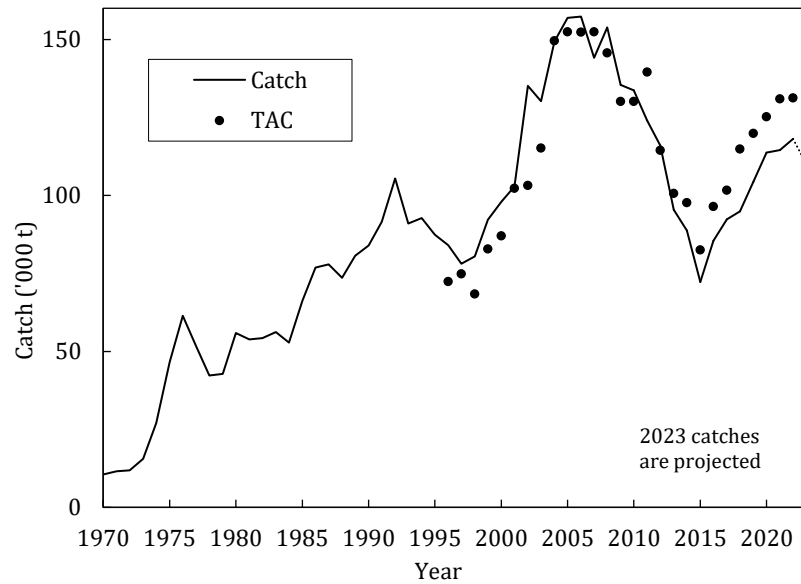


Figure 3.1. Northern shrimp in Subarea 1 and Div. 0A: Enacted TACs and total catches.

b) Data overview

i) Fisheries Data

Fishing effort and CPUE. Catch and effort data from the fishery were available from Greenland logbooks for Subarea 1 (SCR Doc. 23/046, 23/047). 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. 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 Div. 1A and part of Div. 1B (KGH-index, 1976-1990), the present offshore fleet fishing in Subarea 1 (1987-2023) and the coastal fleet fishing in coastal and inshore areas (1989-2023). CPUE for the Canadian fleet fishing in Div. 0A has not been updated because it is not possible to receive new logbook information from Canada. 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 2020. The decline has stopped and CPUE increased in 2021. Partial data from 2023 indicate CPUE for combined fleet components will decline slightly. Though, due to an abnormal coverage of ice during the first 6 months of 2023, which have limited access to traditional fishing grounds, preliminary CPUE values for the offshore fleet are subject to uncertainties.

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.

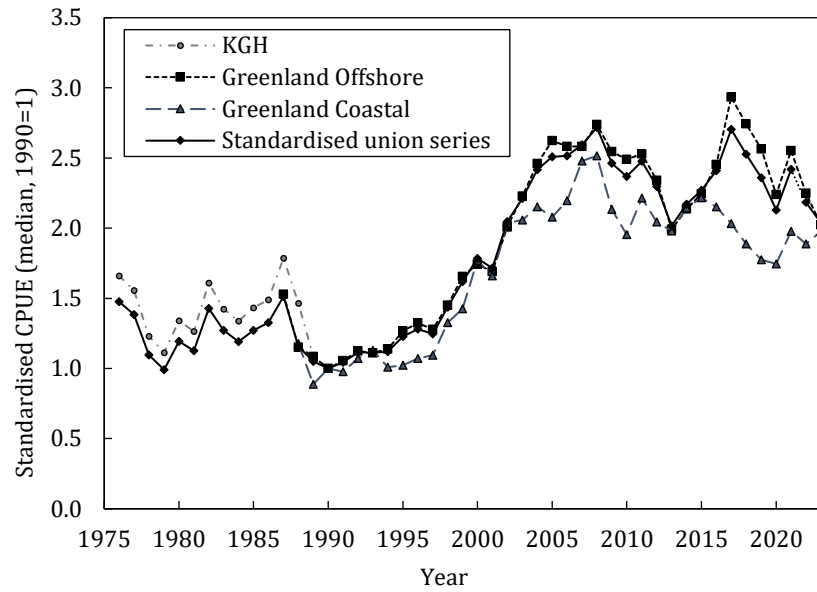


Figure 3.2. Northern shrimp in Subarea 1 and Div. 0A: Standardized CPUE index series 1976–2023. The 2023 point is based on data from 1 January to 30 June 2023.

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.

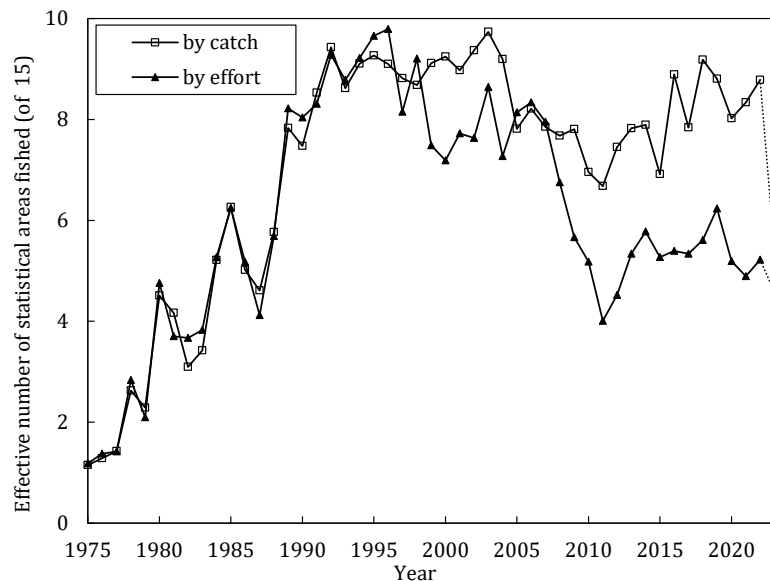


Figure 3.3. Northern shrimp in Subarea 1 and Div. 0A: Indices for the distribution of the Greenland fishery between statistical areas in 1975–2023. The 2023 point is based on data from 1 January to 30 June 2023.

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

ii) Research survey data

Greenland trawl survey. Stratified semi-systematic 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 (SCR Doc. 23/045). From 1993, the survey was extended southwards into Div. 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-min. tows, but since 2005 all tows have lasted 15 min. In 2005 the *Skjervøy 3000* survey trawl used 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 2022 the survey was 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* (SCR Doc. 20/053, 22/045, 23/045). NIPAG therefore assumed that the 2018, 2019-2020 and 2022-2023 results were directly comparable with the previous surveys, however without comparative fishing there remains some uncertainty.

In 2023, there has been an abnormal spatial distribution of sea ice 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 this year's survey results reflect the stock trajectory and status. Hence, it was assumed that the commercially important areas in north weren't 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 at 3 °C (SCR Doc. 23/045). 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 (SCR Doc. 23/045). The proportion of survey biomass in Div. 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) (SCR Doc. 23/045). Since 2017 biomass has remained stable.

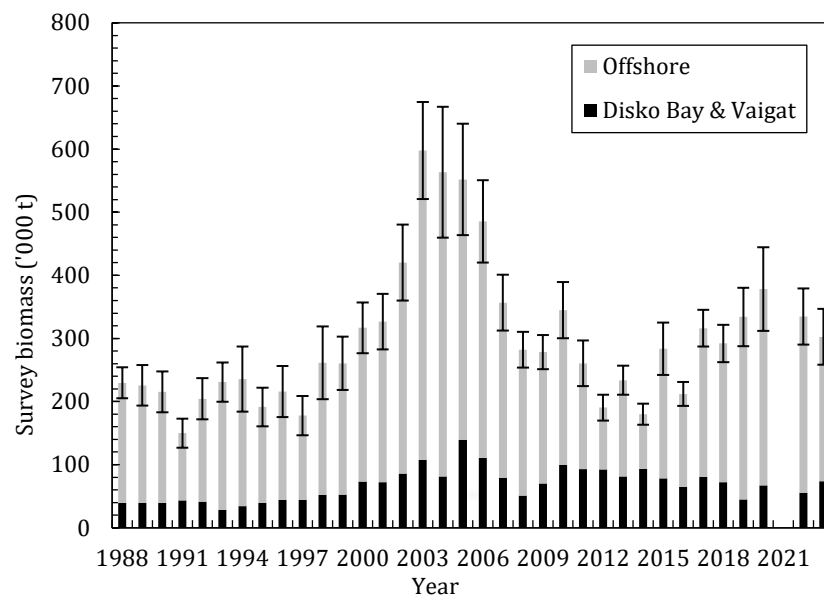


Figure 3.4. Northern shrimp in Subarea 1 and Div. 0A: Biomass index (survey mean catch rates) inshore and offshore 1988–2023 (error bars 1 SE).

Length and sex composition (SCR Doc. 23/045, 48). In 2023, in both Disko Bay and the offshore regions the proportion of fishable males in the survey were slightly below its 18-year median.. Females compose a high proportion of survey and fishable biomass indices in both regions. They were close to their 18-year median offshore, and below their 18-year median in Disko Bay (Figure 3.5).

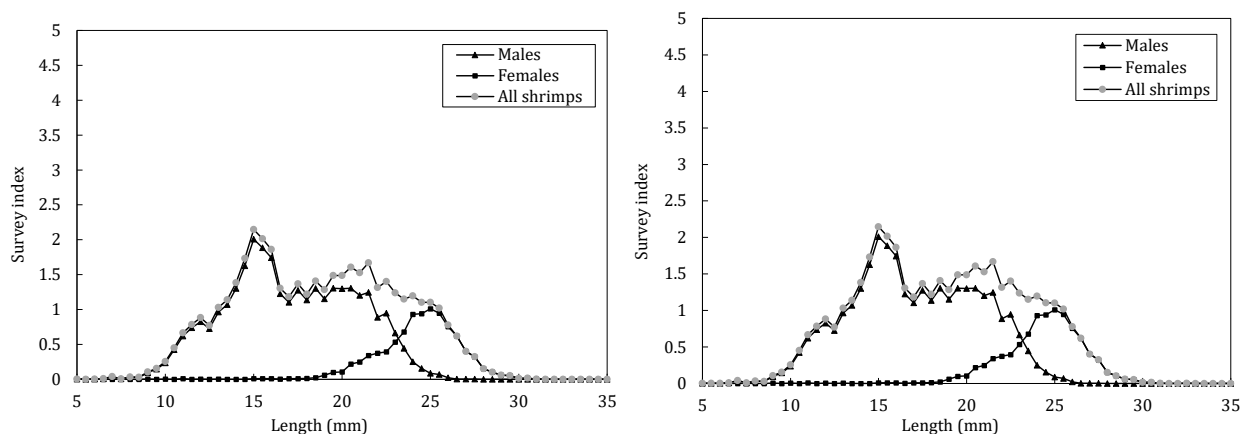


Figure 3.5. Northern shrimp in Subarea 1 and Div. 0A: Survey mean catch composition at length in offshore regions (left) and Disko Bay & Vaigat (right) at the West Greenland trawl survey in 2023.

Recruitment. The number at age-2 (10.5 to 13.5 mm) reached a peak in 2000 and 2001 and has since declined to a much lower level, with four high values in 2015, 2019, 2020 and 2022. The pre-recruit index (14–16.5 mm, expected to recruit to next year’s fishable biomass) has fluctuated at a lower level, with relatively high values in 1999-2000 and again in 2015, 2017, 2020 and 2023 (SCR Doc. 23/045, 223/048) (Figure 3.6). In 2023, numbers of age-2 and pre-recruits are close to and above the time-series average, respectively.

Linear regression was performed between the number of age-2 shrimp, pre-recruits and the fishable biomass with a lag of 2, 3 or 4 years. The correlation was significant between number of age-2 shrimp and the fishable biomass 4 years later ($R^2 = 0.57$), and between pre-recruits and fishable biomass 1 year later ($R^2 = 0.68$). Furthermore, there was also a significant relationship between number of age-2 shrimp and the number of pre-recruits 2 years later ($R^2 = 0.50$, SCR Doc. 23/045).

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 2023 numbers of age-2 shrimps as well as relative to survey biomass are much higher among offshore regions than inshore, where numbers of age-2 shrimps were at low values (SCR Doc. 23/045, 23/048). In 2022 in all regions, numbers of age-2 shrimps relative to survey biomass were at a record high level but decline in 2023 and is now close to their mean.

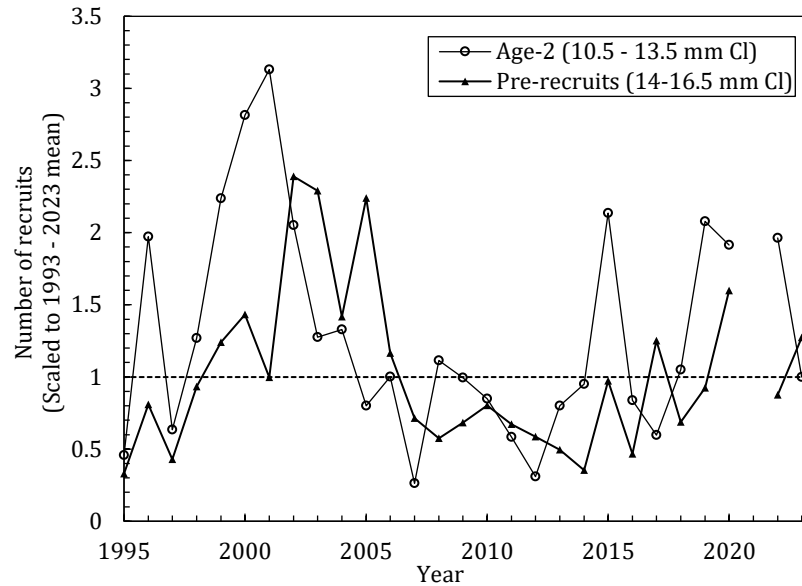


Figure 3.6. Northern shrimp in Subarea 1 and Div. 0A: Survey index of numbers at age 2 (10.5 - 13.5 mm) and index of number of pre-recruits (14-16.5 mm), 1993-2023. Indices are standardized to the series mean.

Predation index. Four distinct stocks of Atlantic cod, spawning in inshore and offshore West Greenland, East Greenland and Iceland, mix at different life stages on the West Greenland banks.

Since 2020, the overall cod stock biomass index, used within the shrimp assessment model has been computed using a state-space assessment model (SAM, SCR Doc. 20/058) 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 (SCR Doc. 14/062). Currently the cod stock in West Greenland is at a low level compared to the period before the cod collapse in the beginning of 1990s. The cod stock biomass has been slightly increasing since 2017 and was estimated to be 55 Kt in 2023 and is composed of several year-classes. The index of its overlap with the shrimp stock is still below an average of the series value. This resulted in a 2023 'effective' cod biomass index of 17 Kt (Figure 3.7, SCR Doc. 16/042, 16/047, SCR Doc. 20/058, SCR Doc. 23/048).

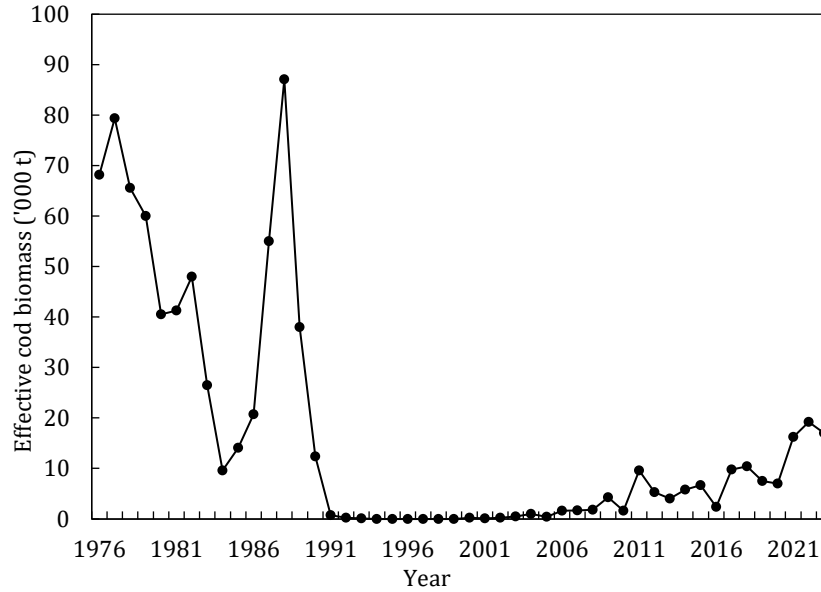


Figure 3.7. Northern shrimp in Subarea 1 and Div. 0A: Indices of the 'effective' cod biomass in Subarea 1 and Div. 0A, 1976 - 2023.

c) Assessment

A Schaefer surplus-production model of population dynamics was fitted to series of CPUE, catch, and survey biomass indices (SCR Doc. 23/048). The model includes a term for predation by Atlantic cod (Figure 3.7). Total shrimp catches for 2023 are expected to be 110 000 t.

Estimates of stock-dynamic parameters from fitting a Schaefer stock-production model to 48 years' data are given in Table 3.1. Median values from the 2022 assessment are provided for comparison. The modelled biomass (Figure 3.8) steadily declined from 2004 to 2013 but has since slightly increased and has been stable over the most recent years. The median biomass has been above B_{msy} since the late 1990s. 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 110 000 t, total mortality in 2023 is estimated to be below Z_{msy} with probability of $Z_{2023} > Z_{msy} = 50\%$. Biomass at the end of 2023 is projected to be slightly lower than in 2022 but still above B_{msy} . The probability of the biomass at the end of 2023 being below B_{msy} is 40% and the probability of being below B_{lim} is very low (<1%).

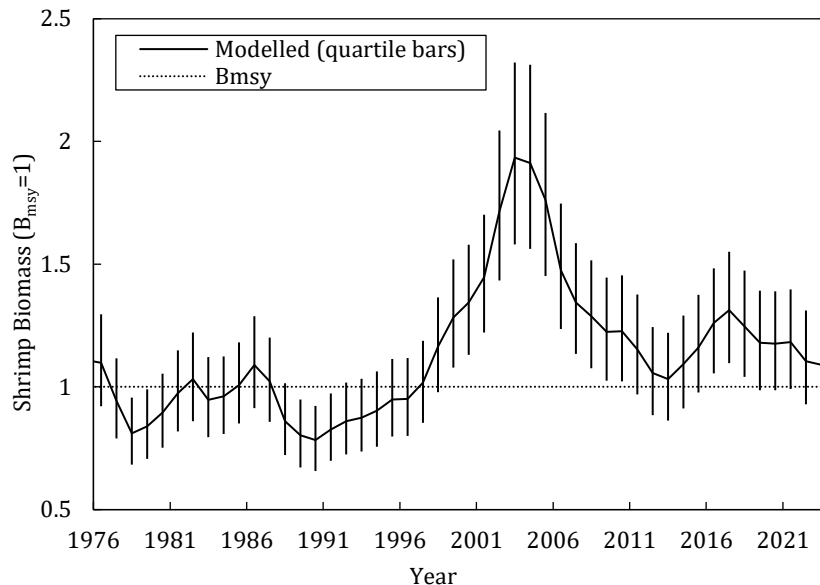


Figure 3.8. Northern shrimp in SA 1 and Div. 0A: Relative stock biomass with quartile error bars 1976–2023. Dotted line corresponds to $B = B_{msy}$.

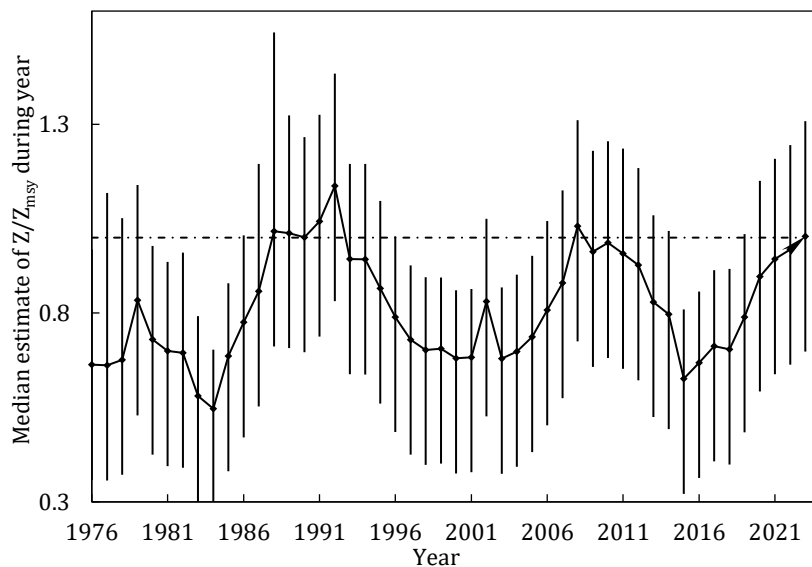


Figure 3.9. Northern shrimp in SA 1 and Div. 0A: Trajectory of the median modelled estimate of mortality relative to Z_{msy} during the years 1976–2023 with quartile error bars.

Table 3.1. Northern shrimp in Subarea 1 and Div. 0A: Estimates of stock-dynamic and parameters from fitting a Schaefer stock-production model to 48 years’ data on the West Greenland stock of the northern shrimp in 2023. The Median (2022) column shows results from last year’s assessment.

	Mean	S.D.	25%	Median	75%	Est. mode	Median (2022)
Max.sustainable yield	128.6	51.9	100.7	119.4	143.8	101.0	124.5
B/B_{msy} , end current year (proj.)(%)	112.2	30.3	90.2	109.0	131.4	102.6	125.4
Biomass risk, end current year(%)	37.9	48.5	-	-	-	-	-
Z/Z_{msy} , current year (proj.)(%)	-	-	71.2	100.3	130.8	-	92.4
Carrying capacity	3297	1893	1880	2754	4216	1668	3047
Max. sustainable yield ratio (%)	9.9	5.4	6.1	9.1	12.8	7.3	8.8
Survey catchability (%)	19.5	13.1	9.9	16.4	25.4	10.2	14.3
CPUE(1) catchability	1.1	0.7	0.6	0.9	1.5	0.6	0.8
CPUE(2) catchability	1.7	1.2	0.9	1.5	2.2	0.9	1.3
Effective cod biomass 2023 (Kt)	22.4	31.8	13.1	17.1	21.6	6.6	19.2
$P_{50\%}$ (prey biomass index with consumption 50% of max.)	4.3	7.8	0.3	1.4	4.7	-4.3	1.3
V_{max} (maximum consumption per cod)	2.1	2.4	0.4	1.1	3.0	-1.0	0.9
CV of process (%)	12.1	2.7	10.2	11.8	13.7	11.4	12.4
CV of survey fit (%)	18.6	3.1	16.4	18.3	20.5	17.8	17.8
CV of CPUE (1) fit (%)	6.9	1.4	5.9	6.6	7.7	6.1	6.7
CV of CPUE (2) fit (%)	7.1	1.9	5.7	6.6	8.0	5.5	6.6

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

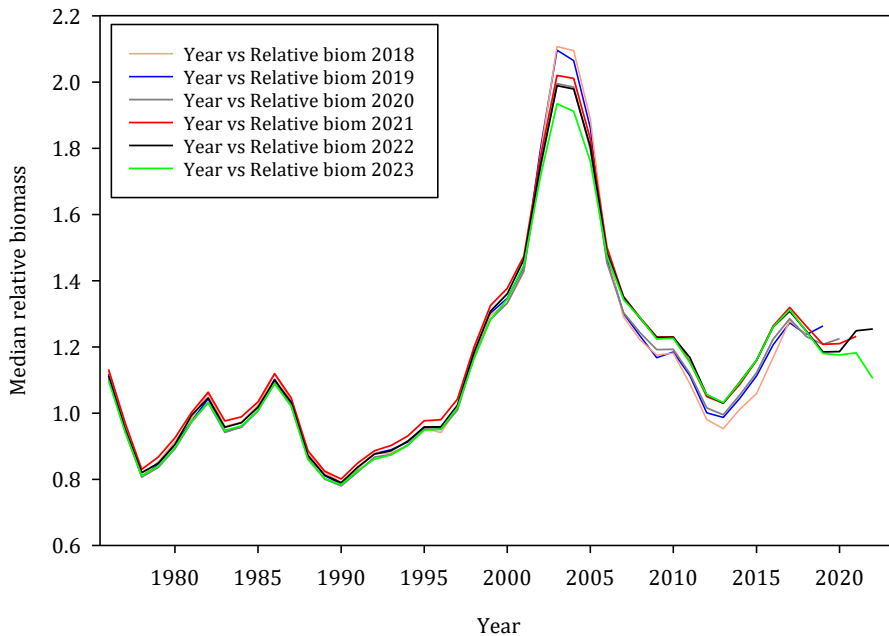


Figure 3.10. Northern shrimp in Subarea 1 and Div. 0A: Retrospective plots of the relative biomass B/B_{msy} 2018 to 2023. Mohn’s rho is estimated to 0.05.

d) State of the stock

Biomass. Biomass in 2023 is above B_{msy} and the probability of being below B_{lim} is very low (<1%).

Mortality. Assuming catches of 110 000 t in 2023 and an effective cod biomass of 17 Kt, the probability of being above Z_{msy} is 50%.

Recruitment. In 2023 numbers of age-2 were near the time-series average.



State of the Stock. Biomass in 2023 is above B_{msy} and the probability of being below B_{lim} is very low (<1%). The probability of mortality in 2023 being above Z_{msy} is 50%. Recruitment (number of age-2 shrimp) in 2023 was near 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 (SCR Doc. 23/048).

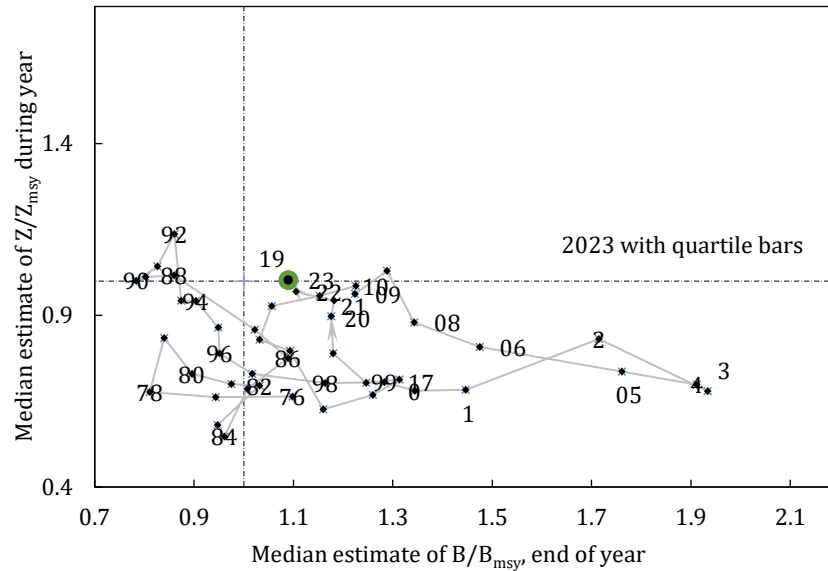


Figure 3.11. Northern shrimp in Subarea 1 and Div. 0A: Trajectory of relative biomass and relative mortality, 1976–2023.

f) Projections

Three years projections for years 2024–2026 under eight catch options and subject to predation by the cod stock with an ‘effective’ biomass of 17 kt (the estimated value for 2023 was 17.1 Kt) were evaluated. Additional projections assuming ‘effective’ cod biomasses of 16 Kt and 18 Kt were conducted but results indicated small differences in risk probabilities (SCR Doc 23/048).

17 000 t cod Risk of:	Catch option ('000 tons)							
	85	90	95	100	105	110	115	120
falling below Bmsy end 2024 (%)	38	38	38	39	39	40	41	42
falling below Bmsy end 2025 (%)	36	37	38	40	40	42	43	44
falling below Bmsy end 2026 (%)	36	37	37	41	42	43	45	46
falling below Blim end 2024 (%)	0	0	0	0	0	0	0	0
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
exceeding Zmsy in 2024 (%)	26	30	35	39	44	47	51	54
exceeding Zmsy in 2025 (%)	26	31	34	40	44	47	51	55
exceeding Zmsy in 2026 (%)	26	30	34	40	44	48	52	56
falling below Bmsy 80% end 2024 (%)	15	15	16	16	16	16	17	18
falling below Bmsy 80% end 2025 (%)	15	16	17	19	18	19	21	22
falling below Bmsy 80% end 2026 (%)	16	17	18	20	21	22	24	25



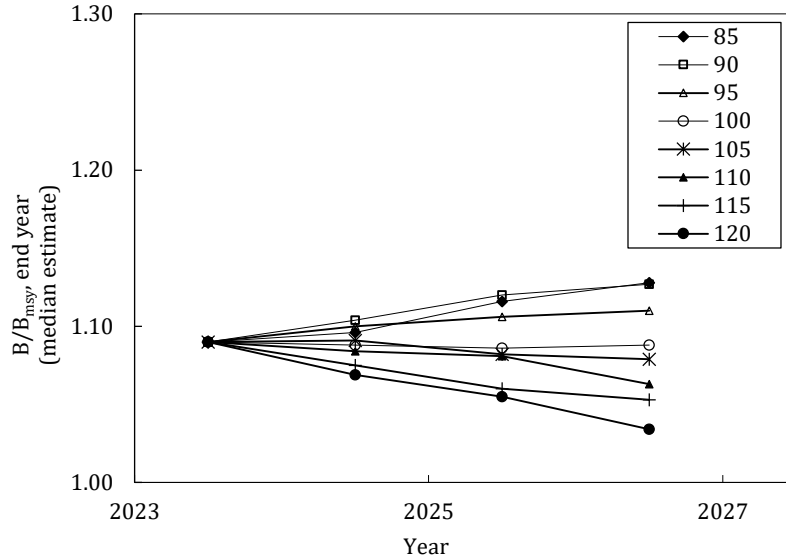


Figure 3.12. Northern shrimp in Subarea 1 and Div. 0A: Median estimates of year-end biomass trajectory for 2024–2026 with annual catches at 85 –120 Kt. and an ‘effective’ cod stock assumed at 17 Kt.

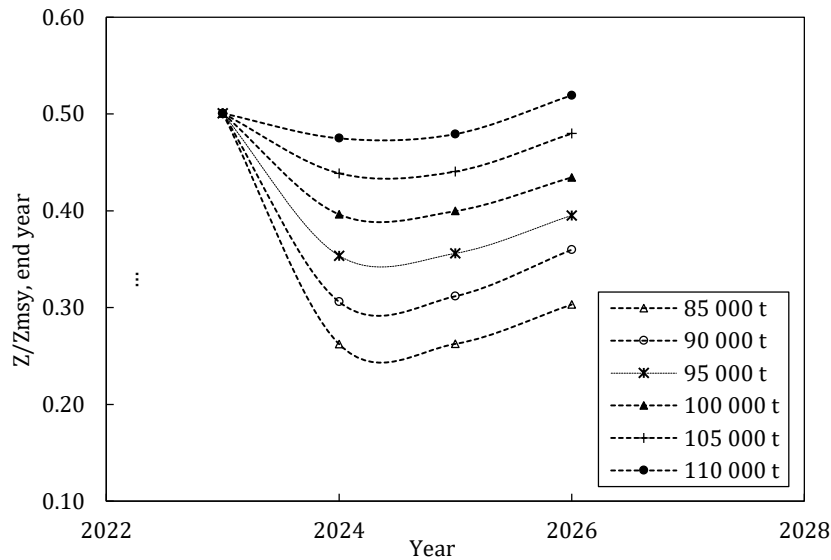


Figure 3.13. Northern shrimp in Subarea 1 and Div. 0A: Risks of exceeding mortality precautionary limits with annual catches at 85–110 Kt projected for 2024–2026 with an ‘effective’ cod stock assumed at 17 Kt.

g) Research recommendations

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

In progress. Sampling has occurred in 2022 and 2023 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.



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

(SCR Docs. 04/012, 23/049, 23/050, 23/051)

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 (ICES, 2020).

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 (ICES, 2023).

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 (ICES, 2023).

a) Introduction

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

i) Fishery and catches

A multinational fleet exploits the stock. During the 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 any time 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. Between 2004 and 2016 the total catch decreased to 49 t in 2016. Catches have since then increased to 5 295 t in 2022 (Figure 4.1). Since 2012, no or very little fishery has taken place in the southern area.

Catches in the first half year of 2023 were 5 867 t based on available logbooks. For 2022 logbooks for two foreign vessels were not available. Total catches for those two vessels have been provided by the Greenland Fishery and License Control and are 1 347 t for 2022. The total catches for 2022 are therefore 5 516 t. It has not been possible to include information on CPUE and effort for the two foreign vessels mentioned above, and all further analysis are based solely on available logbooks in 2022. Since 2014, the fishing effort has been historically low and concentrated in a relatively small area.

Recent catches and TACs ('000 t) for shrimp in the Denmark Strait and off East Greenland (ICES Div. 14b and 5a) are as follows:

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023 ¹
Recommended TAC, total area	2.0	2.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0	2.0
Actual TAC, Greenland	8.3	6.1	5.3	5.3	4.3	3.4	4.8	7.0	6.9	6.9
North of 65°N, Greenland EEZ	0.6	0.6	0.0	0.6	0.5	1.6	3.2	3.1	5.5	5.9
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	0.6	0.0	0.6	0.5	1.6	3.2	3.1	5.5	5.9
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 NIPAG	0.6	0.6	0.0	0.6	0.5	1.6	3.2	3.1	5.5	5.9

¹ Catches until July 2023

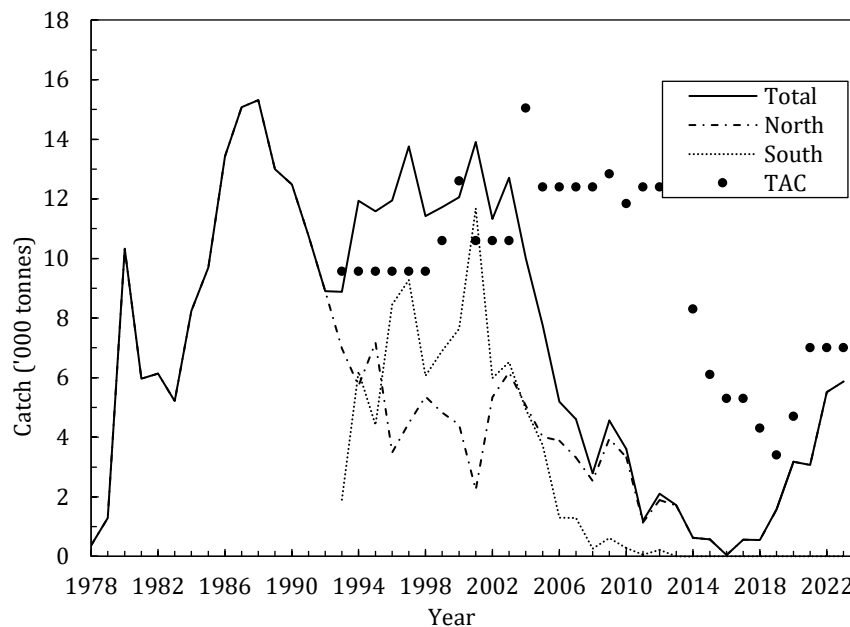


Figure 4.1. Northern shrimp in Denmark Strait and off East Greenland: Catch and TAC (2023 catches until June 30th).

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 (SCR Doc. 23/050). Since 2004, more than 60% of all hauls were performed with double trawl, this is not accounted for in the CPUE index 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 has been increasing since (Figure 4.2), reaching record high levels in 2022 and 2023. The drop in CPUE in 2021 is likely related to changes in the fishing pattern (SCR Doc. 23/050). In 2021 EU fleet in the northern area started fishing in April, which is later than previous years when the larger portion of the catch was taken in February/March.

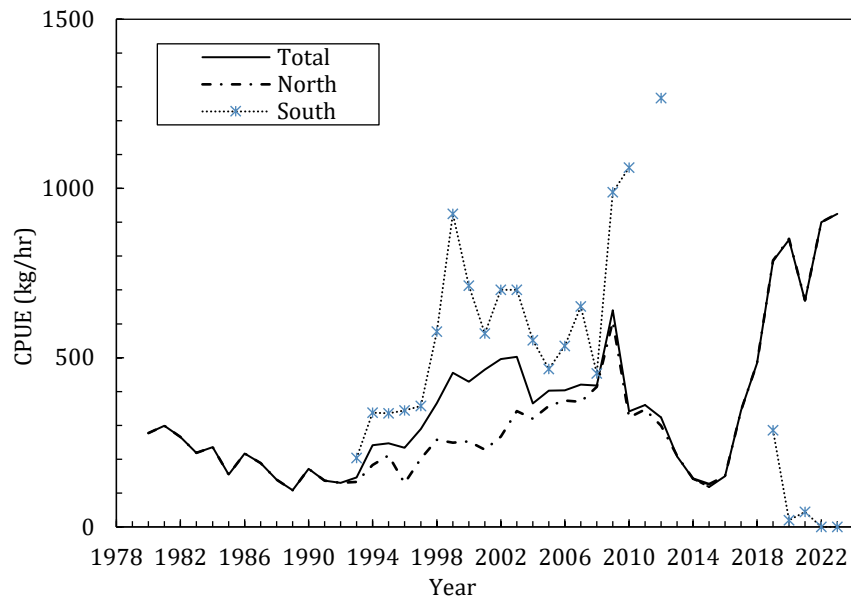


Figure 4.2. Northern shrimp in Denmark Strait and off East Greenland: Annual CPUE index. 2023 data until June 30th.

It should be noted that the two foreign vessels for which logbooks were not available are not included in the 2022 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.

The fishing effort has been relatively low in recent years (from 300 fishing hours in 2016 to 6 341 fishing hours in 2023, Figure 4.3) which is concentrated in a relatively small area north of 65°N and west of 30°W.

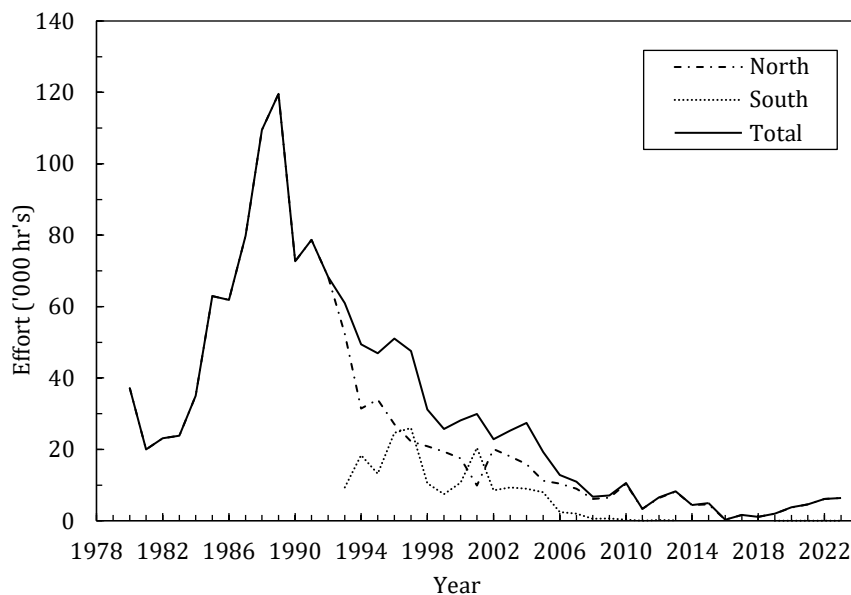


Figure 4.3. Northern shrimp in Denmark Strait and off East Greenland: Annual effort ('000 hrs). 2023 data until June 30th.

ii) Research survey data

Trawl surveys have been conducted to assess the stock status of northern shrimp in the East Greenland area since 2008 (SCR Doc. 23/049). Due to the lack of research vessels, no survey was conducted in the period 2017 to 2019 and in 2021. In 2020 the survey was conducted with the chartered fishing vessel *Helga Maria* and in

2022 with the new research vessel *Tarajoq* using the same gear configuration as in previous years (SCR Doc. 20/060, 22/45, and 22/049). NIPAG therefore assumed that the 2020 and 2022-2023 results were directly comparable with the previous surveys, however without comparative fishing 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 and 2021. The 2020 estimate is the highest in the time series (Figure 4.4) but the 2022 biomass index has dropped to a level similar to 2010-2011. The 2023 survey biomass index is at a similar level as 2020.

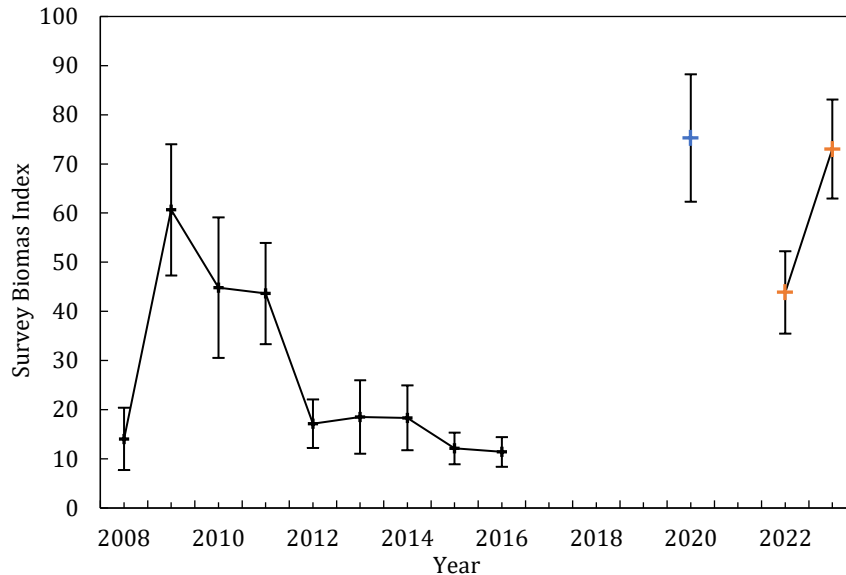


Figure 4.4. Northern shrimp in Denmark Strait and off East Greenland: Survey biomass index from 2008 - 2016, 2020 and 2022-2023 (± 1 SE). No survey was carried out in the period 2017 - 2019 and in 2021. Black points in figure represent R/V *Pamiut*, blue is *Helga Maria*, and orange is R/V *Tarajoq*.

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

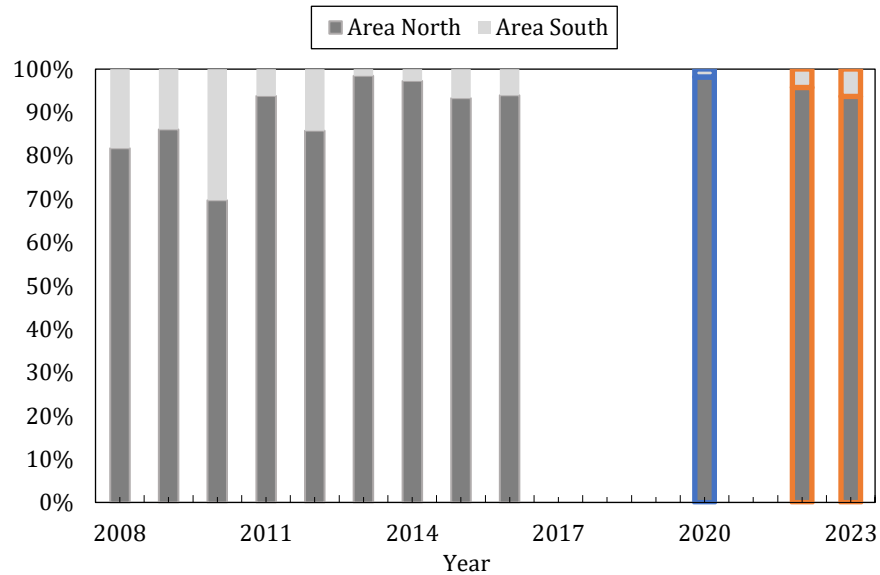


Figure 4.5. Northern shrimp in Denmark Strait and off East Greenland: Distribution of survey biomass north and south of 65°N (in %) from 2008 - 2016, 2020 and 2022-2023. No survey was carried out in the period 2017 - 2019 and in 2021. No outline in figure represents R/V *Pamiut*, blue is Helga Maria, and orange is R/V *Tarajoq*.

Stock composition. The demography of the surveyed 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 (SCR Doc. 22/049). In 2023, 47% 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 shrimps in the survey area stresses that the total area of distribution and recruitment patterns of the stock are still unknown.

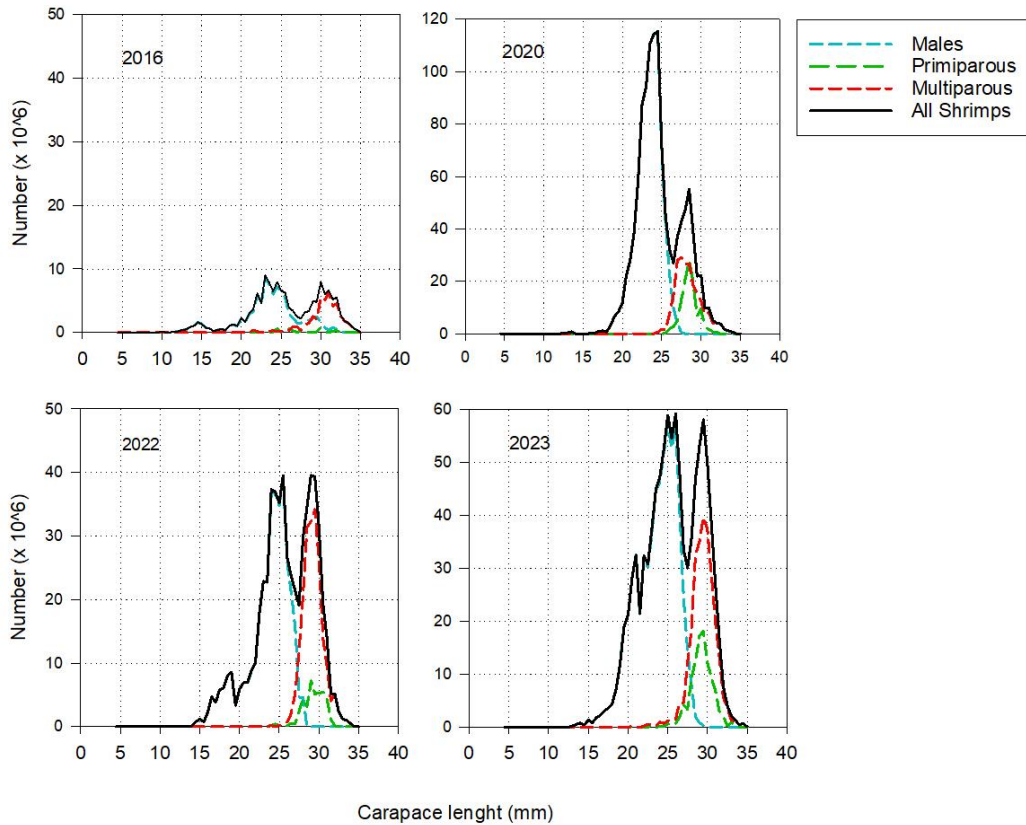


Figure 4.6. Northern shrimp in Denmark Strait and off East Greenland: Numbers of shrimp by length group (CL) in the total survey area in 2016, 2020 and 2022-2023. No survey was carried out in the period 2017 - 2019 and in 2021.

c) Assessment results

During the 2021 NIPAG meeting a comprehensive sensitivity analysis of the surplus production model in continuous time (SPiCT) was presented (SCR Doc. 21/044). During the 2022 SC shrimp meeting an updated SPiCT model was presented and accepted as a valid assessment tool for this stock (SCR Doc. 22/051) based on a review of the model diagnostics. The model that was accepted in 2022 has now been updated with the most recent data and is used for the basis of the advice (SCR Doc. 23/051).

The SPiCT model was fitted to series of CPUE, catch and survey biomass indices (SCR Doc 23/051). The time-series were truncated to fit with the survey time-series. The relative B/B_{msy} projected to the end of 2023 is 0.78, and the relative F/F_{msy} is 1.59 (Figure 4.7).

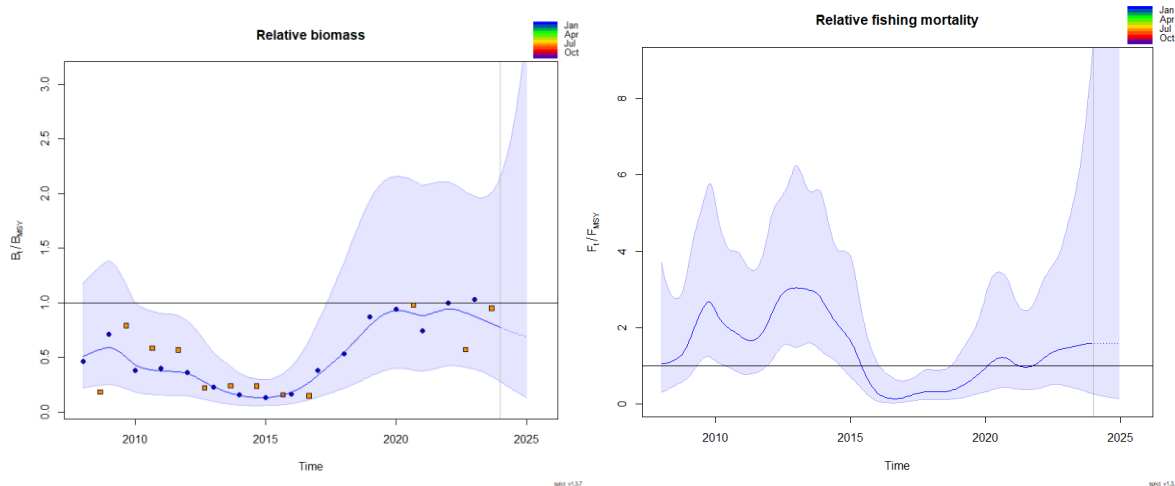


Figure 4.7. Northern shrimp in Denmark Strait and off East Greenland: Main results of the SPiCT model with n fixed to 2.

Estimates of stock-dynamic parameters from the SPiCT model are given in Table 4.1. These are in line with parameters estimated in 2022.

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

	Estimate	CI lower	CI upper	log.est	2022 estimate
<i>alpha1</i> (noise term for CPUE, $\alpha = SD_{Index}/SD_{Biomass}$)	1.49	0.21	10.63	0.40	1.53
<i>alpha2</i> (noise term for survey, $\alpha = SD_{Index}/SD_{Biomass}$)	5.68	0.99	32.55	1.74	7.18
<i>beta</i> ($\beta = SD_{Catch}/SD_F$)	0.54	0.17	1.70	-0.62	0.47
<i>r</i> (intrinsic population growth rate)	0.73	0.48	1.13	-0.31	0.79
<i>m</i> (SPiCT parameter)	3171	1744	5769	8.06	2894
<i>K</i> (Carrying capacity)	17263	6725	44311	9.76	14608
<i>q1</i> (Catchability for CPUE)	0.11	0.06	0.17	-2.25	0.12
<i>q2</i> (Catchability for survey)	1.25	0.70	2.21	0.22	1.35
<i>n</i> (shape of the production curve, set to 2)	2.00	2.00	2.00	0.69	2.00
<i>sdb</i> (Standard deviation, biomass)	0.09	0.02	0.50	-2.41	0.07
<i>sdf</i> (Standard deviation, fishing mortality)	0.85	0.43	1.71	-0.16	0.93
<i>sdi1</i> (Standard deviation, CPUE)	0.13	0.07	0.26	-2.01	0.11
<i>sdi2</i> (Standard deviation, Survey)	0.51	0.34	0.77	-0.68	0.52
<i>Sdc</i> (Standard deviation, catch)	0.46	0.24	0.86	-0.78	0.44
<i>B</i> (Biomass end of 2023)	6693	2849	15727	8.81	6199*
<i>F</i> (Fishing mortality end of 2023)	0.58	0.11	3.16	-0.55	0.65*
Relative reference points					
<i>B/B_{msy}</i> , end current year (proj.) (%)	0.78	0.29	2.12	-0.25	0.85
<i>F/F_{msy}</i> , end current year (proj.) (%)	1.59	0.28	8.97	0.46	1.63

*end of 2022

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.

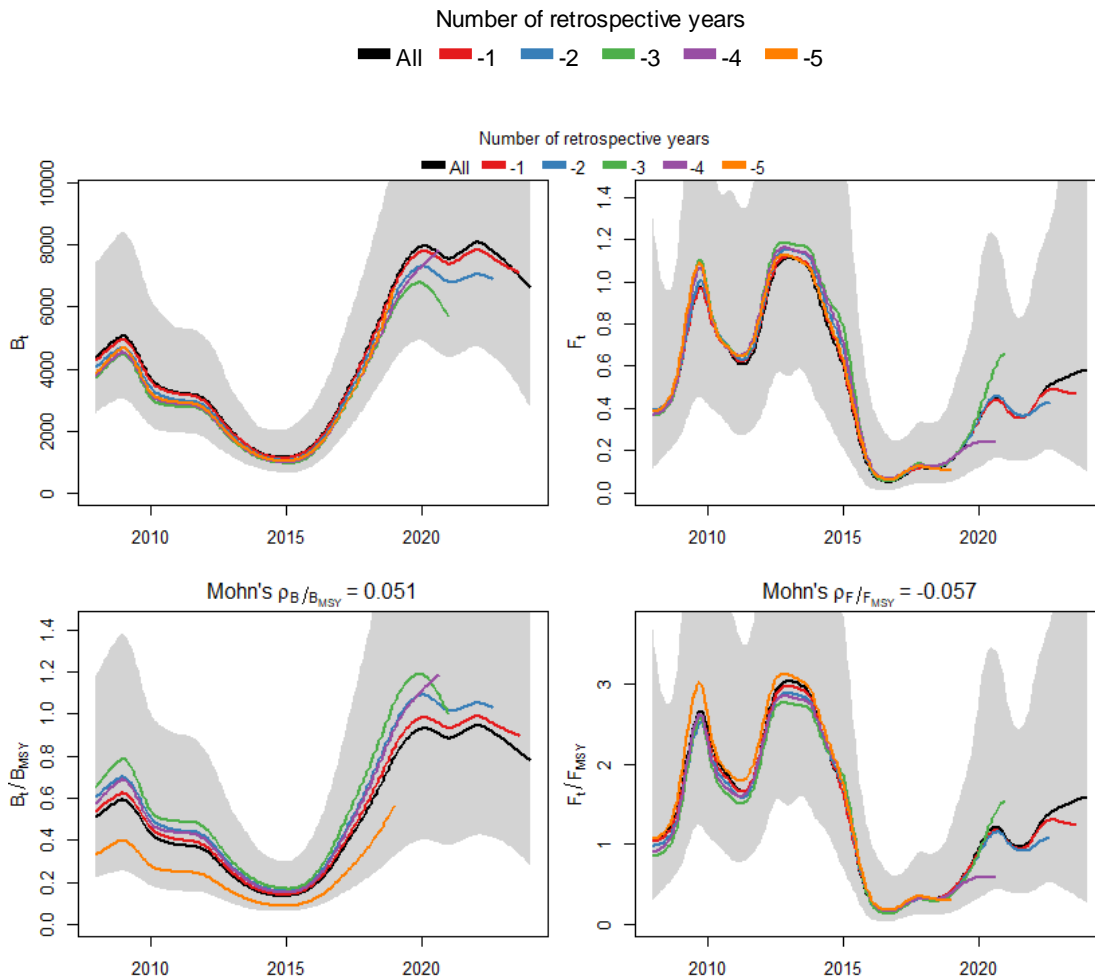


Figure 4.8. Northern shrimp in Denmark Strait and off East Greenland: Five years retrospective plots of fishing mortality and fishable biomass. Confidence intervals are 95%

d) State of the stock

Biomass. Median biomass is below B_{msy} ($B/B_{msy} = 0.78$) and the probability of being below B_{lim} is less than 5%.

Fishing mortality. Fishing mortality is above F_{msy} ($F/F_{msy} = 1.59$).

Recruitment. No estimates of recruitment are available.

State of the stock. Median biomass is below B_{msy} ($B/B_{msy} = 0.78$) and the probability of being below B_{lim} is less than 5%. Fishing mortality is above F_{msy} ($F/F_{msy} = 1.59$). 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. The current relative B/B_{msy} is 0.78 and the relative F/F_{msy} is 1.59. The probability of being below B_{lim} is currently very low (0.034).



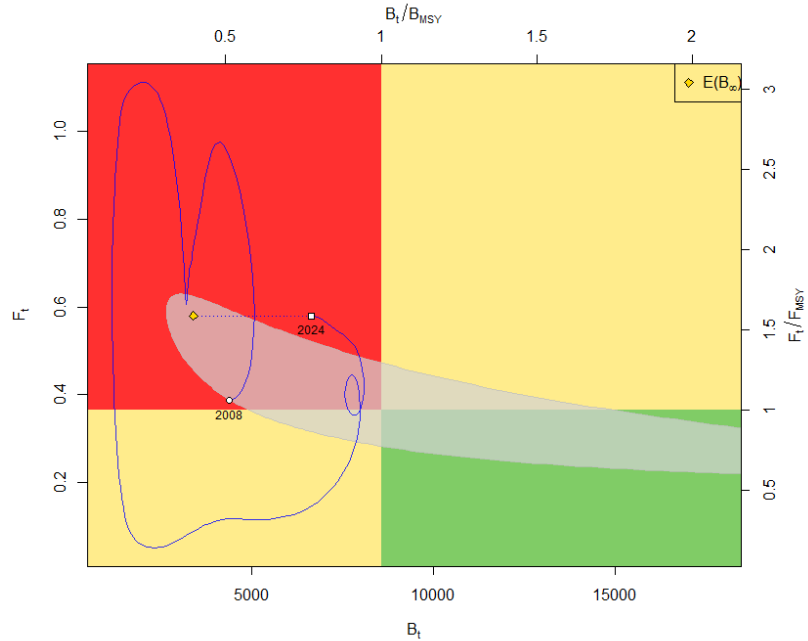


Figure 4.9. Northern shrimp in Denmark Strait and off East Greenland: Biomass vs fishing mortality 2008 – 2023.

f) Projections

One year projection for 2024 under six catch options were evaluated.

Catch (t)	B/Bmsy	F/Fmsy	Prob B > Bmsy	Prob B < Blim	Prob F > Fmsy
1500	0.96	0.56	0.47	0.02	0.32
2000	0.90	0.77	0.43	0.03	0.42
2500	0.84	0.99	0.39	0.06	0.50
3000	0.77	1.24	0.36	0.10	0.57
3500	0.71	1.51	0.33	0.14	0.63
4000	0.64	1.81	0.31	0.20	0.68

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.*

This recommendation is reiterated.

STACFIS **recommends** *exploration of available 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

Hotel Ciudad de Vigo, Vigo, Spain
13-15 September 2023

- I. Opening (Chair: Mark Simpson)
 1. Appointment of Rapporteur
 2. Adoption of Agenda
 3. Attendance of Observers
 4. Plan of Work
- II. Review of Recommendations in 2022
- III. Fisheries Science (STACFIS Chair: Mark Simpson)
- 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
 - b) Northern Shrimp in Div. 3LNO
 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 Div. 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 2024 AND BEYOND OF CERTAIN STOCKS IN SUBAREAS 2, 3 AND 4 AND OTHER MATTERS

(From [SCS Doc. 23/01](#))

Following a request from the Scientific Council, the Commission agreed that items 1, 2, 4 and 7 should be the priority for the June 2023 Scientific Council meeting subject to resources and COVID-related restrictions.

1. The Commission requests that the Scientific Council provide advice for the management of the fish stocks below according to the assessment frequency presented below. In keeping with the NAFO Precautionary Approach Framework (FC Doc. 04/18), the advice should be provided as a range of management options and a risk analysis for each option without a single TAC recommendation. The Commission will decide upon the acceptable risk level in the context of the entirety of the SC advice for each stock guided and as foreseen by the Precautionary Approach.

Yearly basis	Two-year basis	Three-year basis
Cod in Div. 3M Northern shrimp in Div. 3M	Redfish in Div. 3M Thorny skate in Div. 3LNO Witch flounder in Div. 3NO Redfish in Div. 3LN White hake in Div. 3NO Yellowtail flounder in Div. 3LNO Northern shrimp in Div. 3LNO	American plaice in Div. 3LNO American plaice in Div. 3M Northern shortfin squid in SA 3+4 Redfish in Div. 3O Cod in Div. 3NO

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

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

- In 2023, advice should be provided for 2024 for Cod in Div. 3M and Northern shrimp in Div. 3M.
- With respect to Northern shrimp in Div. 3M, Scientific Council is requested to provide its advice to the Commission prior to the 2023 Annual Meeting based on the survey data up to and including 2023.
- In 2023, advice should be provided for 2024 and 2025 for: Redfish in Div. 3M, White hake in Div. 3NO, Yellowtail flounder in Div. 3LNO and Northern shrimp in Div. 3LNO.
- In 2023, advice should be provided for 2024, 2025 and 2026 for: American plaice in Div. 3M.

The Commission also requests the Scientific Council to continue to monitor the status of all other stocks annually and, should a significant change be observed in stock status (e.g. from surveys) or in bycatch in other fisheries, provide updated advice as appropriate.

2. The Commission requests the Scientific Council to monitor the status of Greenland halibut in Subarea 2 + Div 3KLMNO annually to compute the TAC using the agreed HCR and determine whether exceptional circumstances are occurring. If exceptional circumstances are occurring, the exceptional circumstances protocol will provide guidance on what steps should be taken.
3. The Commission requests that Scientific Council continue its evaluation of the impact of scientific trawl surveys on VME in closed areas and the effect of excluding surveys from these areas on stock assessments.

4. The Commission requests that Scientific Council continue to advance work on the 2+3KLMNO Greenland halibut and 3LN redfish MSE processes during 2022-2023, as per the approved 2023 workplan [COM-SC RBMS WP 22/07], in particular :
 - a. Review and finalize the data series to be used for the two MSEs;
 - b. For the Greenland Halibut MSE: (1) propose, review and finalize Operating Models (OMs) to be used; and (2) Test Candidate Management Procedures (CMPs) to support the RBMS recommendation of an HCR to the Commission; and
 - c. For the 3LN Redfish MSE: (1) Proposal of an initial review of Operating Models; and (2) work to support the development of performance statistics and CMPs.
5. The Commission requests that the Scientific Council continue to work on tiers 1 and 2 of the Roadmap, specifically to:
 - a. Include on a regular basis summary information on TCI in stock summary sheets (including indications of other NAFO managed stocks within the corresponding guild) and ecosystem summary sheets.
 - b. Work to support WG-EAFFM in exploring:
 - i. Management considerations for occasions in which the 2TCI ecosystem reference point were to be exceeded, similar to those when exceptional circumstances are triggered within MSE.
 - ii. Effective methods to communicate TCI-related information to the Commission, in particular for when 2TCI is, or expected to be exceeded.
 - c. Complete the development of the 3LNO ecosystem summary sheet (ESS), advance as much as possible the development of the 3M ESS, and continue working, if capacity allows, toward undertaking a joint Workshop with ICES (International Council for the Exploration of the Sea) on reporting on North Atlantic ecosystems.
6. In relation to the habitat impact assessment component of the Roadmap (VME and SAI analyses), the Commission requests that Scientific Council to:
 - a. Complete the re-assessment of its previously recommended closures of 7a, 11a, 14a and 14b, incorporating catch and effort data for fisheries of shrimp from 2020 and 2021 into the fishing impact assessments. This work is needed for the 2023 WG-EAFFM meeting;
 - b. Support the Secretariat in creating standardized data layers (using GIS), and products with supporting documentation (including metadata) for periodic reassessment purposes required to support the implementation of the NAFO Roadmap towards an Ecosystem Approach; and
 - c. Continue working with WG-EAFFM towards developing operational objectives for the protection of VMEs and biodiversity in the NRA.
7. The Commission requests Scientific Council to continue progression on the review of the NAFO PA Framework in accordance to the PAF review work plan approved in 2020 and revised in 2022 (NAFO COM-SC Doc. 20-04), specifically:
 - a. Develop a small set of revised PA frameworks based on the conclusions of the first PA Framework workshop to inform RBMS in proposing a draft revised framework in 2023; and

- b. Apply in an illustrative way the revised PA frameworks to selected NAFO stocks, and consider how the SC advice may have differed under the revised PA Frameworks to inform RBMS in proposing a draft revised framework in 2023
8. The Commission requests Scientific Council to update the 3-5 year work plan, which reflects requests arising from the 2022 Annual Meeting, other multi-year stock assessments and other scientific inquiries already planned for the near future. The work plan should identify what resources are necessary to successfully address these issues, gaps in current resources to meet those needs and proposed prioritization by the Scientific Council of upcoming work based on those gaps.
9. The Commission requests that any new results from stock assessments and the scientific advice of Pelagic *Sebastes mentella* (ICES Divisions V, XII and XIV; NAFO 1) to be presented to the Scientific Council, and request the Scientific Council to prepare a summary of these assessments to be included in its annual report.
10. The Commission requests that any new Canadian stock assessments for Cod 2J3KL and Witch flounder 2J3KL be included as an annex to the Scientific Council's annual report.
11. The Commission requests Scientific Council, jointly with the Secretariat, to conduct ongoing analysis of the Flemish Cap cod fishery data by 2023 in order to:
 - a. monitor the consequences of the management decisions (including the analysis of the redistribution of the fishing effort along the year and its potential effects on ecosystems, the variation of the cod catch composition in lengths/ages, and the bycatch levels of other fish species, benthos in general, and VME taxa in particular); and
 - b. carry out any additional monitoring that would be required, including Div. 3M cod caught as bycatch in other fisheries during the closed period.
12. The Commission requests Secretariat and the Scientific Council with other international organizations, such as the FAO and ICES to inform the Scientific Council's work related to the potential impact of activities other than fishing in the Convention Area. This would be conditional on CPs providing appropriate additional expertise to Scientific Council.

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

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

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

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

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

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

The first year of the projection should assume a catch equal to the agreed TAC for that year.

Results from stochastic short-term projection should include:

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

F in 2023 and following years*	Yield 2023 (50%)	Yield 2024 (50%)	Yield 2025 (50%)	Limit reference points						P(B ₂₀₂₆ > B ₂₀₂₃)						
				P(F>F _{lim})			P(B<B _{lim})				P(F>F _{msy})			P(B<B _{msy})		
				2023	2024	2025	2023	2024	2025		2023	2024	2025	2023	2024	2025
$2/3 F_{msy}$	t	t	t	%	%	%	%	%	%	%	%	%	%	%	%	
$3/4 F_{msy}$	t	t	t	%	%	%	%	%	%	%	%	%	%	%	%	
$85\% F_{msy}$	t	t	t	%	%	%	%	%	%	%	%	%	%	%	%	
$90\% F_{msy}$																
$95\% F_{msy}$																
F_{msy}	t	t	t	%	%	%	%	%	%	%	%	%	%	%	%	
$0.75 \times F_{status\ quo}$	t	t	t	%	%	%	%	%	%	%	%	%	%	%	%	
$F_{status\ quo}$	t	t	t	%	%	%	%	%	%	%	%	%	%	%	%	
$1.25 \times F_{status\ quo}$	t	t	t	%	%	%	%	%	%	%	%	%	%	%	%	
$F=0$	t	t	t	%	%	%	%	%	%	%	%	%	%	%	%	
$TAC_{status\ quo}$																
$85\% TAC_{status\ quo}$																
$90\% TAC_{status\ quo}$																
$95\% TAC_{status\ quo}$																



2. For stock assessed with an age-structured model, information should be provided on stock size, spawning stock sizes, recruitment prospects, historical fishing mortality. Graphs and/or tables should be provided for all of the following for the longest time-period possible:
 - historical yield and fishing mortality;
 - spawning stock biomass and recruitment levels;
 - Stock trajectory against reference points

And any information the Scientific Council deems appropriate

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

- For stocks opened to direct fishing: $F_{0.1}$, F_{max} , $2/3 F_{max}$, $3/4 F_{max}$, $85\% F_{max}$, $75\% F_{status\ quo}$, $F_{status\ quo}$, $125\% F_{status\ quo}$,
 - For stocks under a moratorium to direct fishing: $F_{status\ quo}$, $F = 0$.

The first year of the projection should assume a catch equal to the agreed TAC for that year.

Results from stochastic short-term projection should include:

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

F in 2023 and following years*	Yield 2023	Yield 2024	Yield 2025	Limit reference points						P(B ₂₀₂₆ > B ₂₀₂₃)						
				P(F.>F _{lim})			P(B<B _{lim})				P(F>F _{0.1})			P(F>F _{max})		
				2023	2024	2025	2023	2024	2025		2023	2024	2025	2023	2024	2025
F _{0.1}	t	t	t	%	%	%	%	%	%	%	%	%	%	%	%	%
F _{max}	t	t	t	%	%	%	%	%	%	%	%	%	%	%	%	%
66% F _{max}	t	t	t	%	%	%	%	%	%	%	%	%	%	%	%	%
75% F _{max}	t	t	t	%	%	%	%	%	%	%	%	%	%	%	%	%
85% F _{max}	t	t	t	%	%	%	%	%	%	%	%	%	%	%	%	%
0.75 X F _{status quo}	t	t	t	%	%	%	%	%	%	%	%	%	%	%	%	%
F _{status quo}	t	t	t	%	%	%	%	%	%	%	%	%	%	%	%	%
1.25 X F _{status quo}	t	t	t	%	%	%	%	%	%	%	%	%	%	%	%	%



ANNEX B. Guidance for providing advice on Stocks Assessed without a Population Model

For those resources for which only general biological and/or catch data are available, few standard criteria exist on which to base advice. The stock status should be evaluated in the context of management requirements for long-term sustainability and the advice provided should be consistent with the precautionary approach.

The following graphs should be presented, for one or several surveys, for the longest time-period possible:

- a. time trends of survey abundance estimates
- b. an age or size range chosen to represent the spawning population
- c. an age or size-range chosen to represent the exploited population
- d. recruitment proxy or index for an age or size-range chosen to represent the recruiting population.
- e. fishing mortality proxy, such as the ratio of reported commercial catches to a measure of the exploited population.
- f. Stock trajectory against reference points

And any information the Scientific Council deems appropriate.

**ANNEX 2. DENMARK (ON BEHALF OF GREENLAND) COASTAL STATE REQUEST FOR SCIENTIFIC
ADVICE - 2024**

(from [SCS Doc. 23/03](#))

Denmark (on behalf of Greenland) hereby requests for scientific advice on management in 2024 of certain stocks in NAFO Subareas 0 and 1. Denmark (on behalf of Greenland) requests the Scientific Council for advice on the following species:

1. Golden Redfish and Demersal Deep-Sea Redfish

Advice on Golden redfish (*Sebastes marinus*) and demersal deep-sea redfish (*Sebastes mentella*) in Subarea 1 was in June 2020 given for 2021-2023. The Scientific Council is requested to provide advice on appropriate TAC levels for 2024 to 2026.

2. Atlantic Wolffish and Spotted Wolffish

Advice on Atlantic Wolffish (*Anarhichas lupus*) and Spotted Wolffish (*Anarhichas minor*) in Subarea 1 was in June 2020 given for 2021-2023. The Scientific Council is requested to provide advice on appropriate TAC levels for 2024 to 2026.

3. Greenland Halibut, Offshore

Advice on Greenland Halibut, Offshore in Subareas 0 and 1 was in 2022 given for 2023 and 2024. The Scientific Council is requested to evaluate whether the data collected in 2022 is sufficient to reconsider the harvest recommendation for 2024. If so, the Scientific Council is requested to provide updated advice on appropriate TAC levels for 2024, taking the new data into account.

4. Greenland Halibut, Inshore, West Greenland

Advice on the inshore stocks of Greenland Halibut in Subarea 1 was in 2022 given for 2023-2024. The Scientific Council is requested to continue its monitoring of the above stocks and provide updated advice in the event of significant changes in stock levels. Scientific Council are also requested to evaluate the performance of an appropriate analytical assessment model and its perception of the stock trajectory.

5. Northern Shrimp, West Greenland

The Scientific Council is requested, before October, to provide advice on the scientific basis for management of Northern Shrimp (*Pandalus borealis*) in Subareas 0 and 1 in 2024. The advice is requested to be in line with Greenland's stated management objective of maintaining a mortality risk of no more than 35% in the first-year prediction and to provide a catch option table ranging with 5,000 tonne increments. Future catch options should be provided for as many years as data allows for.

6. Northern Shrimp, East Greenland

The Scientific Council is in cooperation with ICES requested to provide advice on the scientific basis for management of Northern Shrimp (*Pandalus borealis*) in Denmark Strait and adjacent waters east of southern Greenland in 2023 and for as many years ahead as data allows for.

ANNEX 3. CANADA'S REQUEST FOR COASTAL STATE ADVICE - 2024

(from [SCS Doc. 23/04](#))

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

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

In 2022, advice on Greenland Halibut in Subareas 0 and 1 (offshore) was given for 2023 and 2024. The Scientific Council is requested to evaluate whether the data collected in 2022 is sufficient to reconsider the harvest recommendation for 2024. If so, the Scientific Council is requested to provide an updated assessment of status and trends in the total stock area throughout its range and to advise on the 2024 TAC level.

2. Shrimp (Subarea 1 and Division 0A)

Canada requests the Scientific Council to consider the following options in assessing and projecting future stock levels for Shrimp in Subarea 1 and Division 0A:

The status of the stock should be determined and risk-based advice provided for catch options corresponding to Z_{msy} , in 5,000-10,000t increments (subject to the discretion of Scientific Council), with forecasts for 2024 to 2026. These options should be evaluated in relation to Canada's Harvest Strategy (2022 revised version attached) and NAFO's Precautionary Approach Framework, and presented in the form of risk analyses related to B_{msy} , 80% B_{msy} , B_{lim} (30% B_{msy}) and Z_{msy} .

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

- Historical and current yield, biomass relative to B_{msy} , total mortality relative to Z_{msy} , and recruitment (or proxy) levels for the longest time period possible;
- Total mortality (Z) and fishable biomass for a range of projected catch options (as noted above) for the years 2024 to 2026. Projections should include both catch options and a range of effective cod predation biomass levels considered appropriate by the Scientific Council. Results should include risk analyses of falling below: B_{MSY} , 80% B_{msy} and B_{lim} (30% B_{msy}), and of being above Z_{msy} based on the 3-year projections, consistent with the Harvest Decision Rules in Canada's Harvest Strategy; and
- Total area fished for the longest time period possible.

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

APPENDIX III. PROVISIONAL AGENDA – STACFIS

13-15 September 2023

- I. Opening (Mark Simpson)
 1. Appointment of Rapporteur
 2. Adoption of Agenda
 3. Plan of Work
- II. General Review
 1. Review of Recommendations in 2022
 2. Review of Catches
- III. Stock Assessments
 - Northern shrimp (*Pandalus borealis*) on the Flemish Cap (NAFO Div. 3M) (Full assessment)
 - Northern shrimp (*Pandalus borealis*) on the Grand Bank (NAFO Div. 3LNO) (Full assessment)
 - Northern shrimp (*Pandalus borealis*) off West Greenland (NAFO SA 0 and SA 1) (Full assessment)
 - Northern shrimp (*Pandalus borealis*) in the Denmark Strait and off East Greenland (ICES Div. 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 2022 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 Oceanografía, 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)**

SCR No.	Serial No.	Author(s)	Title
N7443	SCR Doc. 23/45	Burmeister and Buch	The West Greenland trawl survey for <i>Pandalus borealis</i> 2023 with reference to earlier results
N7444	SCR Doc. 23/46	Burmeister and Buch	The Fishery for Northern Shrimp (<i>Pandalus borealis</i>) off West Greenland, 1970–2023
N7445	SCR Doc. 23/47	Burmeister	Catch Table Update for the West Greenland Shrimp Fishery
N7446	SCR Doc. 23/48	Burmeister and Buch	A provisional Assessment of the shrimp stock off West Greenland in 2023
N7447	SCR Doc. 23/49	Buch and Burmeister	Results of the Greenland Bottom Trawl Survey for Northern shrimp (<i>Pandalus borealis</i>) Off East Greenland (ICES Subarea XIV b), 2008-2023
N7448	SCR Doc. 23/50	Buch and Burmeister	The Fishery for Northern Shrimp (<i>Pandalus borealis</i>) in Denmark Strait / off East Greenland 1978 – 2023
N7449	SCR Doc. 23/51	Buch and Burmeister	Applying a stochastic surplus production model (SPiCT) to the East Greenland Stock of Northern Shrimp
N7452	SCR Doc. 23/52	J. M. Casas and R. Manuel	Northern Shrimp (<i>Pandalus borealis</i>) on Flemish Cap Surveys 2023
N7453	SCR Doc. 23/53	Casas, J.M.	Division 3M Northern shrimp (<i>Pandalus borealis</i>) – Interim Monitoring Update
N7454	SCR Doc. 23/54	Casas, J.M., E. Román-Marcote and M. Álvarez	Northern Shrimp (<i>Pandalus borealis</i> , Krøyer) from EU-Spain Bottom Trawl Survey 2023 in NAFO Div. 3LNO

SUMMARY DOCUMENTS (SCS)

SCS No.	Serial No.	Author(s)	Title
N7456	SCS Doc. 23/20	NAFO	Scientific Council and STACFIS Shrimp Assessment Meeting, 13-15 September 2023

APPENDIX VI. LIST OF PARTICIPANTS, 13-15 SEPTEMBER 2023

CHAIRS	
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