

Northwest Atlantic Fisheries Organization



Report of the Scientific Council Meeting

10 September 2019
By WebEx

NAFO
Dartmouth, Nova Scotia, Canada
2019



Report of the Scientific Council Meeting

10 September 2019
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**REPORT OF SCIENTIFIC COUNCIL MEETING
10 September 2019 via WebEx**

Chair: Brian Healey

Rapporteur: Tom Blasdale

1. Opening

Scientific Council, in conjunction with the NAFO/ICES *Pandalus* Assessment Group, met by WebEx on 10 September 2019, to formulate management advice for northern shrimp in NAFO Divisions 3M and 3LNO. Representatives attended from Canada, Denmark (in respect of the Faroe Islands and Greenland), the European Union, Norway and the United States of America. A full list of participants is included in Appendix V.

The Chair, Brian Healey opened the meeting 08:30 ADT by welcoming participants. The provisional agenda was adopted as circulated. The Scientific Council Coordinator was appointed as rapporteur.

2. Review of relevant recommendations and advice from 2018

There were no general recommendations. SC agreed that relevant stock-by-stock recommendations from previous years would be reviewed during the presentation of a stock assessment the status presented in the relevant sections of the NIPAG report

3. Formulation of Advice

The response from Scientific Council is:

a) Northern Shrimp in Division 3M

Advice September 2019 for 2020










Recommendation

Scientific Council notes the continuous increase of biomass over 5 years and that it now has a very low probability of being below B_{lim} .

Scientific Council considers that there is sufficient evidence to allow a small amount of directed fishing on this stock. Considering the uncertainty about the future recruitments and the response of the resource to resumed exploitation, Scientific Council advises that the catch in 2020 should not exceed the 2009 level (5 448 tonnes).

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).

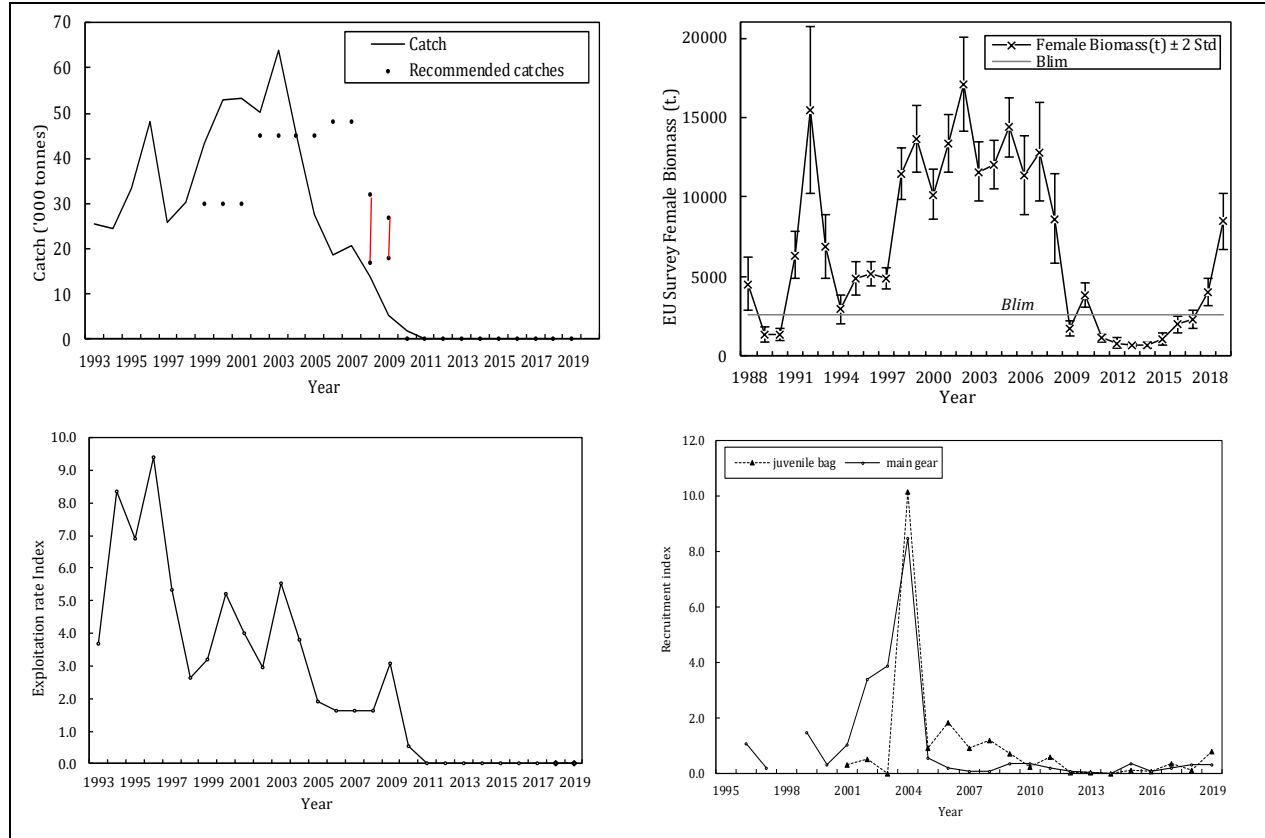
| <i>Convention General Principles</i> | <i>Status</i> | <i>Comment/consideration</i> | |
|--|---|--|--|
| Restore to or maintain at B_{msy} |  | Stock well above B_{lim} . B_{msy} is unknown. |  OK |
| Eliminate overfishing |  | No directed fishery has occurred in recent years |  Intermediate |
| Apply Precautionary Approach |  | B_{lim} defined. No fishing mortality reference point defined |  Not accomplished |
| Minimise harmful impacts on living marine resources and ecosystems |  | VME closures in effect, no directed fishery in recent years, sorting grids mandatory |  Unknown |
| Preserve marine biodiversity |  | Cannot be evaluated | |

Management unit

The Northern Shrimp stock on Flemish Cap is considered to be a separate population.

Stock status

The stock has shown signs of improvement since 2014, and in 2019, the stock has a very low probability of being below B_{lim} . Although recruitment has been weak in the last decade, the recruitment index (age 2) has been increasing since the lowest observed in 2014.



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

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 2020.

Human impact

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

Biological and Environmental Interactions

Multispecies models (Pérez-Rodríguez et al. 2016, Pérez-Rodríguez and D. González-Troncoso 2018), suggest that, predation by cod and redfish, together with fishing were the main factors driving the shrimp stock to the collapse after 2007. In the most recent years, decreasing redfish and cod stocks have likely resulted in reduced predation mortality on shrimp, consistent with a period of increase in the shrimp stock.

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.

Fishery

This fishery is effort-regulated. The effort allocations were reduced by 50% in 2010 and a moratorium was imposed in 2011. Catches are expected to be close to zero in 2019. Recent catches (tonnes) and agreed effort were as follows:

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|------------------------|-------|------|------|------|------|------|------|------|------|----------------|
| NIPAG | 2 000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 ¹ |
| STATLANT 21 | 1976 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Effort (Agreed Days) | 5227 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| SC Recommended Catches | ndf | ndf | ndf | ndf | ndf | ndf | ndf | ndf | ndf | ndf |

¹ preliminary. ndf=no directed fishery

Effects of the fishery on the ecosystem

The fishery was closed to directed fishing beginning in 2011.

Source of Information

SCR Doc. 19/041,

b) Northern Shrimp in Divisions 3LNO

Advice September 2019 for 2020-2021

Recommendation

No directed fishery in 2020 and 2021 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).

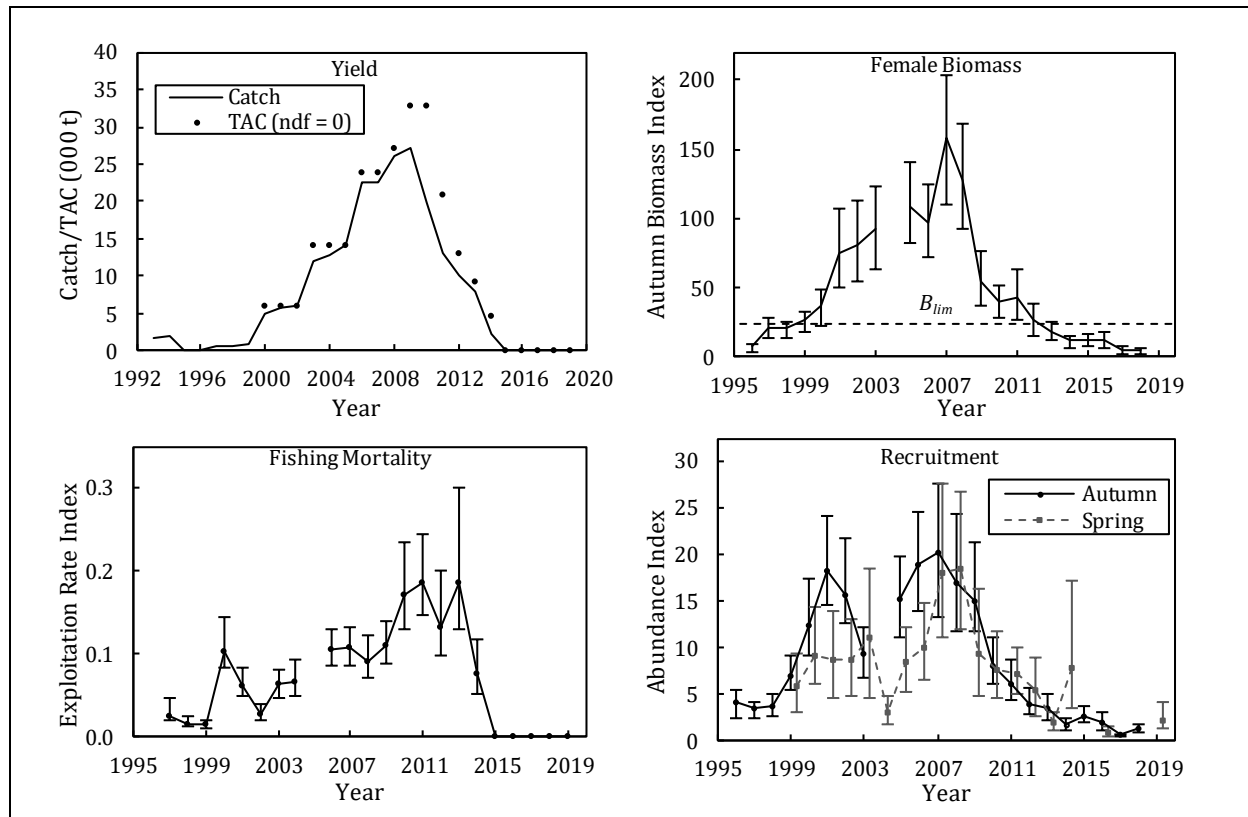
| Convention General Principles | Status | Comment/consideration | |
|--|--------|--|--------------------|
| Restore to or maintain at B_{msy} | ● | Stock below B_{lim} | ● OK |
| Eliminate overfishing | ● | No directed fishery | ● Intermediate |
| Apply Precautionary Approach | ● | B_{lim} is defined. No fishing mortality reference point defined | ● Not accomplished |
| Minimise harmful impacts on living marine resources and ecosystems | ● | No directed fishery | ● Unknown |
| 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

Currently the risk of the stock being below B_{lim} is greater than 95%. There is no indication of improved recruitment.



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 2021.

Human impact

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

Biological and Environmental Interactions

After reaching record-high conditions in 2010-2011 (warmest conditions since 1980), the bottom temperature in 3LNO have cooled down to near-normal conditions in 2014-2018. 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.

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.

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|--------------------------|-------|-------|-------|------|------|------|------|------|------|------|
| Enacted TAC ¹ | 32767 | 20971 | 13108 | 9393 | 4697 | ndf | ndf | ndf | ndf | ndf |
| STATLANT 21 | 19745 | 13013 | 10099 | 7919 | 2282 | 0 | 0 | 0 | 0 | |
| NIPAG ² | 20536 | 12900 | 10108 | 8647 | 2289 | 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

<http://www.dfo-mpo.gc.ca/Library/352955.pdf>

4. Other Matters

a) Discussion of reporting format

It was agreed that advice summary sheets will be available shortly after the meeting following implementation of agreed editorial changes by the Secretariat. Meeting participants are free to share the advice within their administrations immediately after the meeting. The full report will be published as a NAFO SCS document.

5. Adjournment

The meeting closed at 14:30 ADT on 10 September 2019.

APPENDIX I. REPORT OF THE NAFO/ICES PANDALUS ASSESSMENT GROUP (NIPAG)

Chairs: Karen Dwyer and Ole Ritzau Eigaard

Rapporteur: Tom Blasdale

I. OPENING

NIPAG met be WebEx on 10 September 2019, to assess stocks of northern shrimp in NAFO divisions 3M and 3LNO. Representatives attended from Canada, Denmark (in respect of the Faroe Islands and Greenland), the European Union, Norway and the United States of America. A full list of participants is included in Appendix V.

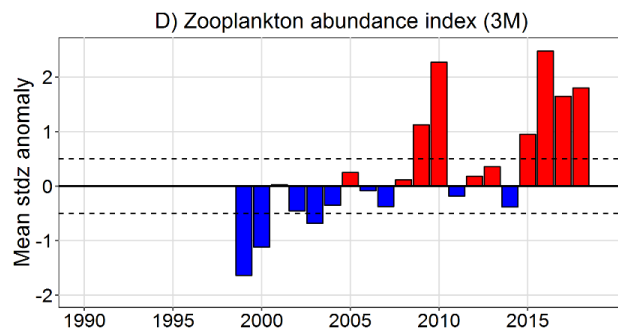
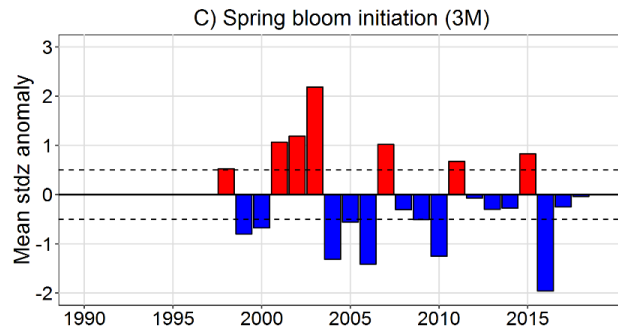
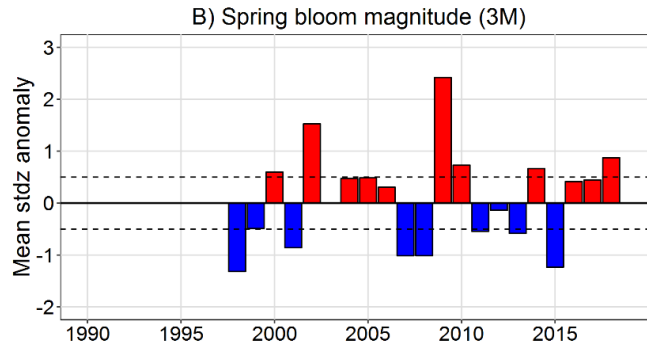
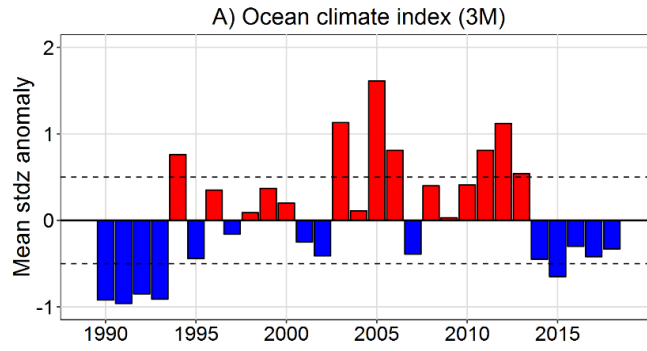
The co-Chairs, Karen Dwyer (NAFO chair) and Ole Ritzau Eigaard (ICES chair) opened the meeting by welcoming participants. The provisional agenda was adopted as circulated. The Scientific Council Coordinator was appointed as rapporteur.

II. STOCKS ASSESSMENTS**1. Northern Shrimp (*Pandalus borealis*) on the Flemish Cap (NAFO Div. 3M)**

(SCR Doc. 19/041)

a) Environmental Overview**Recent Conditions in Ocean Climate and Lower Trophic Levels**

- The ocean climate index for 2018 in SA3 – Flemish Cap, after being predominantly above normal since 2003, was negative but within the range of normal conditions between 2014 and 2018 (except 2015 where it was below normal).
- Total production of the spring bloom (magnitude) on the Flemish Cap was above normal in 2018 after three years of below or near normal production. Spring bloom initiation remained near normal in 2018 for a second consecutive year.
- Zooplankton abundance has remained above normal since 2015 with three of the four highest anomalies for the time series observed during that period.
- Zooplankton biomass increased to near normal levels in 2018 after the time series record low observed in 2017.



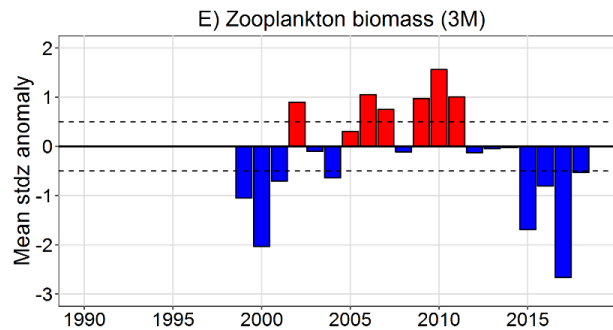


Figure 1.1. Environmental indices for Flemish Cap (in NAFO Div. 3M) during 1990-2018. The ocean climate index (A) for Flemish Cap is the average of 3 time series of standardized ocean temperature anomalies: sea surface temperatures (SSTs) for Flemish Cap, mean temperature over the offshore portion of Flemish Cap hydrographic section (stations FC-15 to FC-35) summer mean bottom temperature over the cap. SSTs time series and observations along Flemish Cap hydrographic section are presented in Cyr et al. (2019). Bottom temperatures are derived using the same procedure used in Cyr et al. (2019), but only for the top 1000m of the cap. Data used for this calculation is mostly from (although not limited to) the EU summer survey which did not occur in 2018. Phytoplankton spring bloom magnitude (B) and duration (C) indices for the 1998-2018 period are derived from one satellite Ocean Colour box (Flemish Pass) located in NAFO Div. 3M. the Flemish Pass. Zooplankton abundance (D) and biomass (E) indices for the 1999-2018 period are derived from a subset of eleven AZMP sampling stations covering the Flemish Pass, the Flemish Cap, and the outer shelf break. The Zooplankton abundance index includes total copepod and non-copepod abundances. Positive/negative anomalies indicate conditions above/below (or late/early timing) the long-term average for the reference period. All anomalies are mean standardized anomaly calculated using the following reference periods: ocean climate index, 1981-2010; phytoplankton indices (magnitude and peak timing): 1998-2015; zooplankton indices (abundance and biomass): 1999-2015. Anomalies within ± 0.5 SD (horizontal dashed lines) are considered normal conditions.

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 is thought to influence the distribution and biological production of Newfoundland and Labrador Shelf and Slope waters, given the overlap between arctic, boreal, and temperate species. The elevated temperatures on the Cap as a result of relatively ice-free conditions, may allow longer growing seasons and permit higher rates of productivity of fish and invertebrates on a physiological basis compared to cooler conditions prevailing on the Grand Banks and along the western Slope waters. The entrainment of North Atlantic Current water around the Flemish Cap, rich in inorganic dissolved nutrients 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 bank which may influence year-class strength of various fish and invertebrate species.

Ocean Climate and Ecosystem Indicators

The ocean climate index in Subarea 3 (Div. 3M) was mostly above normal from the mid-1990’s to 2013. The index has declined since 2013 reaching a 22-year record-low in 2015. The ocean climate index was however normal during the period 2016-2018 (Figure 1.1A).

Spring bloom total production (magnitude) was above normal in 2018 after three consecutive years of low or normal production. Production in 2018 was the highest observed since the 2008 time series record high (Figure 1.1B). The timing of the spring bloom initiation was normal in 2018 for a second consecutive year after the time series record low observed in 2016. Spring bloom initiation mainly occurred earlier than, or near the normal timing for the region since 2004 (Figure 1.1C).

Zooplankton abundance was above normal in 2018 for 4th consecutive year after having remained near normal during from 2011-2014 following the time series record high observed in 2010 (Figure 1.1D). Zooplankton biomass increased to near normal in 2018 after three consecutive years of below normal levels, including a time-series record low in 2017 (Figure 1.1E).

b) Introduction

The shrimp fishery in Div. 3M is now under moratorium. This fishery began in 1993. Catches peaked at over 60 000 t in 2003 and declined thereafter.

Fishery and catches: A moratorium was imposed in 2011. Catches are expected to be close to zero in 2019. Recent catches (t) were as follows (ndf=no directed fishery):

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|-----------------------------------|------|------|------|------|------|------|------|------|------|----------------|
| NIPAG | 2000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 ¹ |
| STATLANT 21 | 1976 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| SC Recommended Catches | ndf | ndf | ndf | ndf | ndf | ndf | ndf | ndf | ndf | ndf |
| Effort ² (Agreed Days) | 5227 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

1 To September 2019

2 Effort regulated

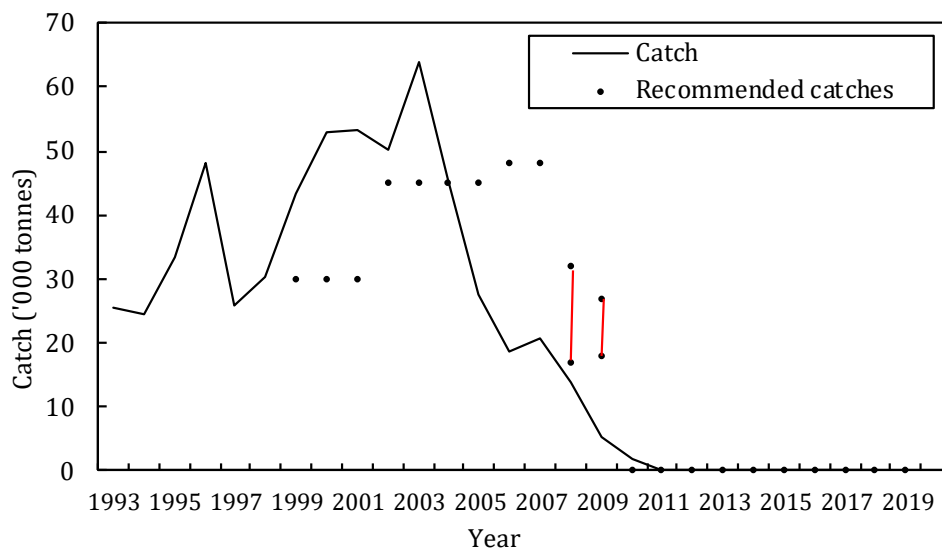


Figure. 1.2. Shrimp in Div. 3M: Catches (t) of shrimp on Flemish Cap and catches recommended in the period 1993-2019. In 2008 and 2009, SC recommended catches within a range.



c) Input Data

i) Commercial fishery data

Time series of size and sex composition data were available mainly from Iceland and Faroes between 1993 and 2005. Because of the moratorium catch and effort data have not been available since 2010, and therefore the standardized CPUE series has not been extended.

ii) Research Survey Data

EU Bottom Trawl Research Survey. Stratified-random trawl surveys have been conducted on Flemish Cap by the EU in July from 1988 to 2019. A new vessel was introduced in 2003 which continued to use the same trawl employed since 1988. In addition, there were differences in cod-end mesh sizes utilized in the 1994 and 1998 surveys that have likely resulted in biased estimates of total survey biomass. Nevertheless, for this assessment, the series prior to 2003 were converted into comparable units with the new vessel using the methods accepted by STACFIS in 2004 (NAFO 2004 SC Rep., SCR Doc. 04/77).

d) Assessment

No analytical assessment is available. Evaluation of stock status is based upon interpretation of commercial fishery up to 2010, and research survey data.

SSB: The survey female biomass index (Figure 1.3) was stable at a high level from 1998 to 2007 and has declined since then until 2014. Since 2015 the biomass index has been increasing successively. In 2019 the female biomass increased markedly and the estimated biomass is now well above B_{lim} . The probability that B_{2019} is below B_{lim} is very low.

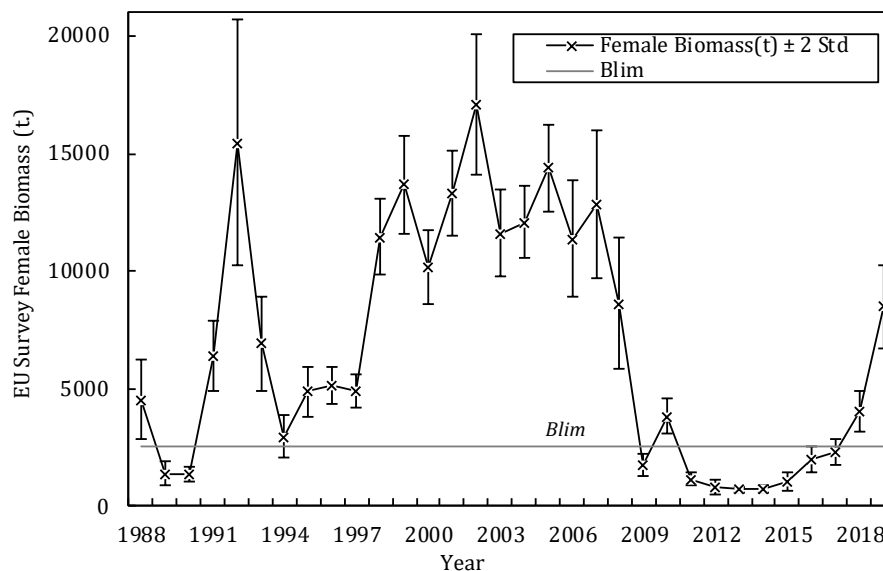


Figure 1.3. Shrimp in Div. 3M: Female biomass index from EU trawl surveys, 1988-2019. Error bars are 2 std. err.

Recruitment: Age information is not available for this stock, however growth rates in the first three years allow the identification of cohorts. All year-classes from the 2002 cohort to 2017 have been weak. The recruitment index, however, has been increasing since the lowest observed in 2014 but remains well below the time series high (Figure 1.4). In 2019 the year-class corresponding to the 2018 cohort (pre-recruits; not shown) was stronger than in recent years, but it is unclear how this will impact future dynamics.

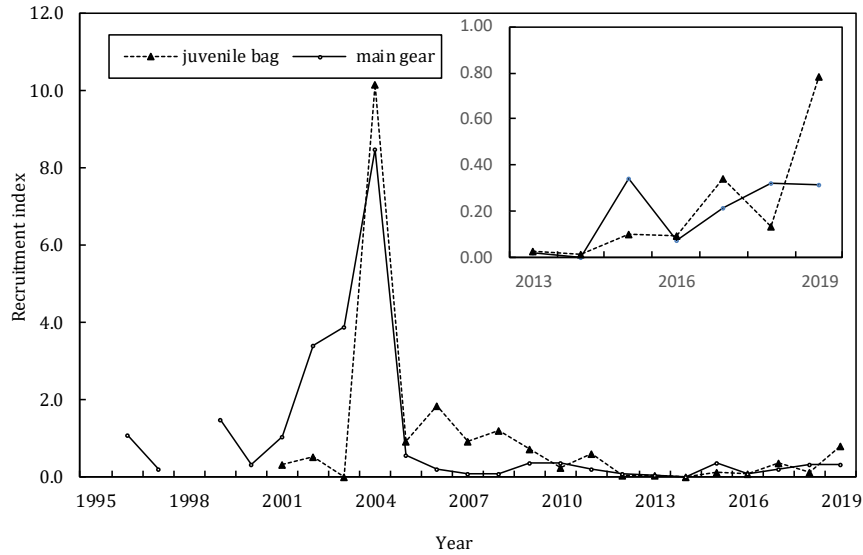


Figure 1.4. Shrimp in Div. 3M: Abundance indices at age 2 (around 17mm CL) from the EU survey. Each series was standardized to its mean. Inset shows the years 2013 to 2019 on an expanded vertical scale.

Exploitation rate: Because of low catches, followed by the moratorium, the exploitation rate index declined to zero and has remained at that level since 2011.

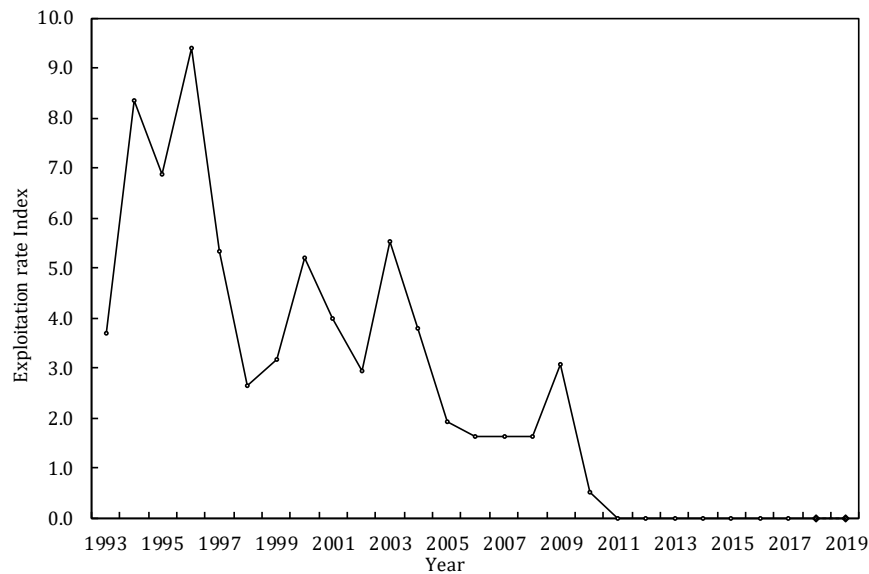


Figure 1.5. Shrimp in Div. 3M: exploitation rate index as derived by catch divided by the EU survey biomass index of the same year. Values in 2018 and 2019 are preliminary.

e) State of the stock

The stock has shown signs of improvement since 2014, and in 2019 the stock has a very low probability of being below B_{lim} . Although recruitment has been in the last decade, the recruitment index (age 2) has been increasing since the lowest observed in 2014.

f) Reference Points

Scientific Council considers that a female survey biomass index of 15% of its maximum observed level provides a proxy for B_{lim} . A limit reference point for fishing mortality has not been defined.

g) Ecosystem considerations

Multispecies models (Pérez-Rodríguez et al. 2016, Pérez-Rodríguez and D. González-Troncoso 2018), suggest that, predation by cod and redfish, together with fishing have been the main factors driving the shrimp stock to the collapse after 2007. In the most recent years, decreasing redfish and cod stocks have likely resulted in reduced predation mortality on shrimp, consistent with a period of increase in the shrimp stock.

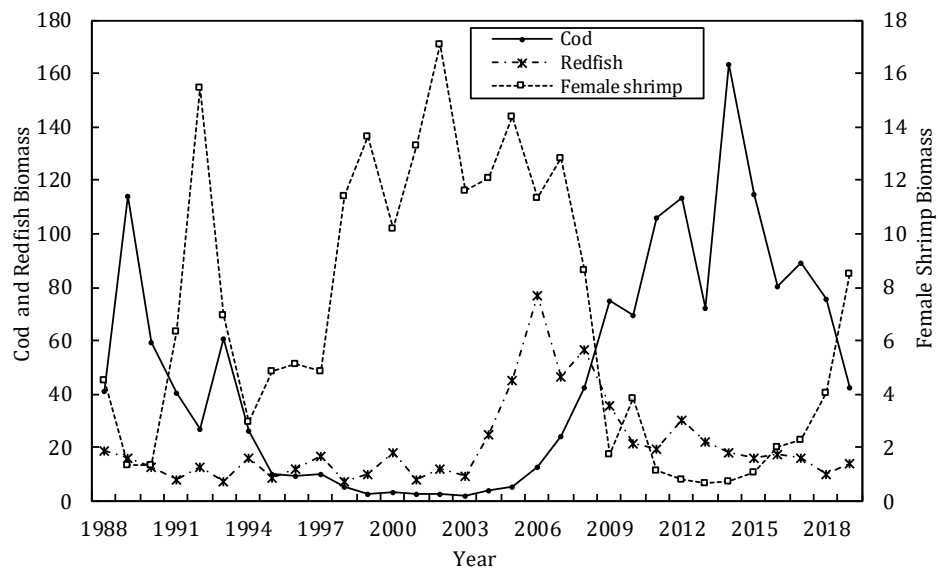


Figure. 1.6. Shrimp in Div. 3M: Cod, Redfish and Female shrimp biomass from EU trawl surveys, 1988-2019.

h) Research Recommendations

For Northern Shrimp in Div. 3M 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: Work continues on the Flemish Cap multispecies model (GadCap). This recommendation is reiterated.

References

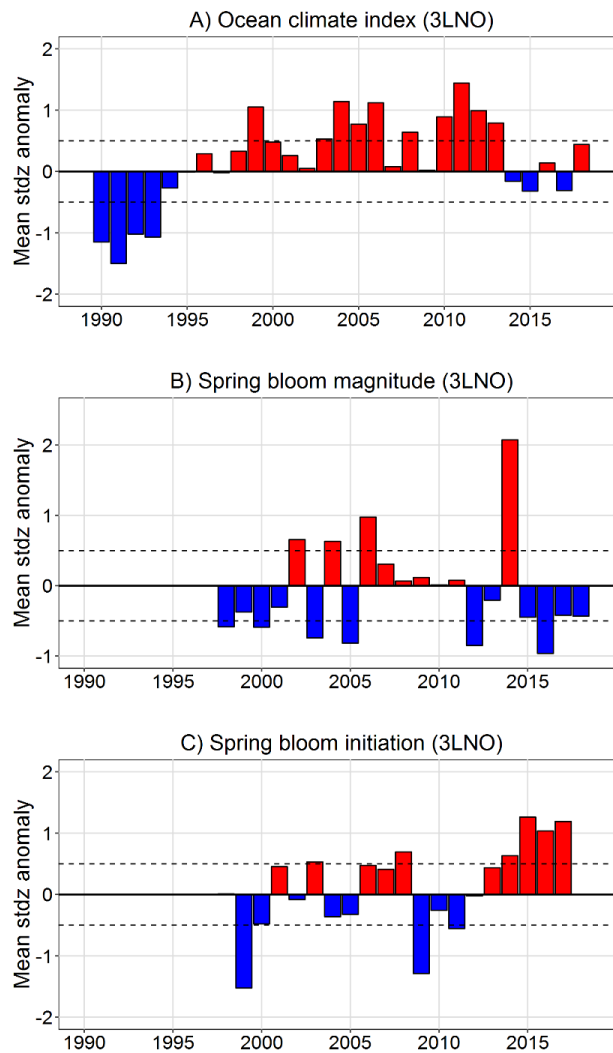
Pérez-Rodríguez, A. and D. González-Troncoso. 2018. Update of the Flemish Cap multispecies model GadCap as part of the EU SC05 project: "Multispecies Fisheries Assessment for NAFO". NAFO SCR Doc.18/024, Serial No.N6808.

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

a) Environmental Overview

Recent Conditions in Ocean Climate and Lower Trophic Levels

- Following more than a decade of above average ocean climate conditions in NAFO Divs. 3LNO (Grand Bank), the ocean climate index since 2014 has been close to its long term average, with 2018 being the warmest of this 5-year period.
- Spring bloom total production (magnitude) was near normal in 2018 for a 2nd consecutive year. Spring bloom initiation was later than normal in 2018 for fourth consecutive year.
- Zooplankton abundance reached its highest level of the time series in 2018 and has remained above normal over nine of the past ten years.
- Zooplankton biomass was below normal in 2018 for a 4th consecutive year.



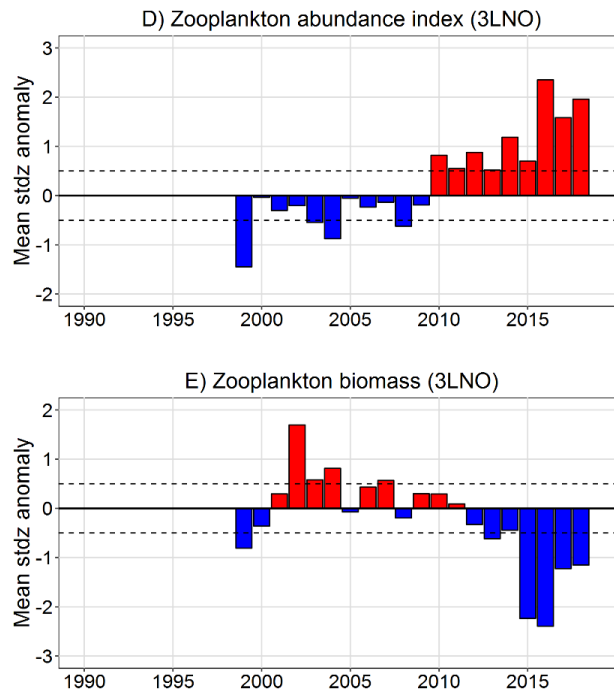


Figure 2.1. Environmental indices for NAFO Divisions 3LNO during 1990-2018. The ocean climate index (A) is the average of 12 individual time series of standardized ocean temperature anomalies: sea surface temperatures (SSTs) for Avalon Channel, Hibernia and Flemish Pass, vertically average ocean temperature (0-176 m) at Station 27, mean temperature and CIL volumes over standard hydrographic sections Seal Island, Bonavista and inshore Flemish Cap (FC-01 to FC-20), and mean bottom temperature in 3LNO for spring and fall. All these variables are presented in Cyr et al. (2019). Phytoplankton spring bloom magnitude (B) and duration (C) indices for the 1998-2018 period are derived from three satellite Ocean Colour boxes (Avalon Channel, Hibernia, and Southeast Shoal) distributed across NAFO Div. 3LNO. Zooplankton abundance (D) and biomass (E) indices for the 1999-2018 period are derived from two standard cross-shelf oceanographic sections (Flemish Cap and Southeastern Grand Banks) and one high-frequency coastal sampling station (Station 27) distributed across NAFO Div. 3LNO. The Zooplankton abundance index includes total copepod and non-copepod abundances. Positive/negative anomalies indicate conditions above/below (or late/early initiation) the long-term average for the reference period. All anomalies are mean standardized anomaly calculated using the following reference periods: ocean climate index, 1981-2010; phytoplankton indices (magnitude and peak timing): 1998-2015; zooplankton indices (abundance and biomass): 1999-2015. Anomalies within ± 0.5 SD (horizontal dashed lines) are considered normal conditions.

Environmental Overview

The water mass characteristic of the Grand Bank are typical cold intermediate layer (CIL) sub-polar waters which extend to the bottom in northern areas with average bottom temperatures generally $<0^{\circ}\text{C}$ during winter and through to autumn. The winter-formed CIL water mass is a reliable index of ocean climate conditions in this area. Bottom temperatures are higher in southern regions of Divs. 3NO reaching $1 - 4^{\circ}\text{C}$, 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 $4 - 8^{\circ}\text{C}$ due to the influence of warm slope water from the south. 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.

b) 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. The TAC was then reduced annually until no directed fishing (ndf) was implemented in 2015 to 2019 (Fig. 2.1). The TAC entries in the table below include autonomous TACs from Denmark (in respect of the Faroe Islands and Greenland) and STATLANT 21 entries.

Recent catches and TACs (t) for shrimp in Div. 3LNO (total) are as follows:

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|--------------------|-------|-------|-------|------|------|------|------|------|------|------|
| TAC ¹ | 32767 | 20971 | 13108 | 9393 | 4697 | ndf | ndf | ndf | ndf | ndf |
| STATLANT 21 | 19745 | 13013 | 10099 | 7919 | 2282 | 0 | 0 | 0 | 0 | |
| NIPAG ² | 20536 | 12900 | 10108 | 8647 | 2289 | 0 | 0 | 0 | 0 | |

¹ Includes autonomous TAC as set by Denmark (in respect of the Faroe Islands and Greenland).

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

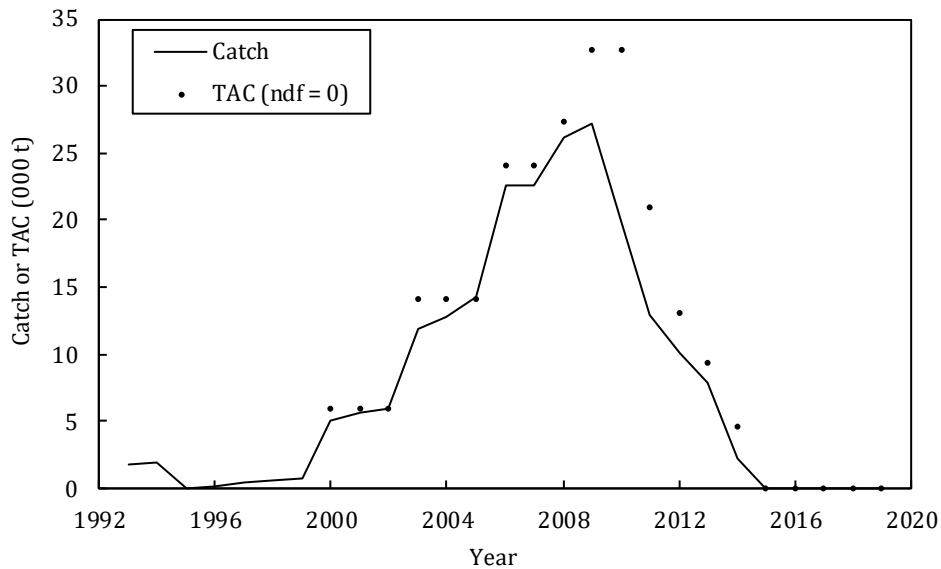


Figure 2.2. Shrimp in Div. 3LNO: Catches and TAC. The TAC illustrated includes the autonomous quotas set by Denmark (in respect of the Faroe Islands and Greenland). No directed fishing is plotted as zero TAC.

c) Input data

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 multi-species trawl survey. Canada has conducted stratified-random surveys in Div. 3LNO, using a Campelen 1800 shrimp trawl for spring (1999–2019) and autumn (1996–2018). The autumn survey in 2004, and the spring surveys in 2015, 2017 and 2018 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.

Spanish multi-species trawl survey. 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. Data are collected with a Campelen 1800 trawl. There was no EU-Spain Div. 3L survey in 2005.

d) Assessment results

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 level in the autumn time-series in 2018 and the second lowest level in the spring time-series in 2019 (Figure 2.3).

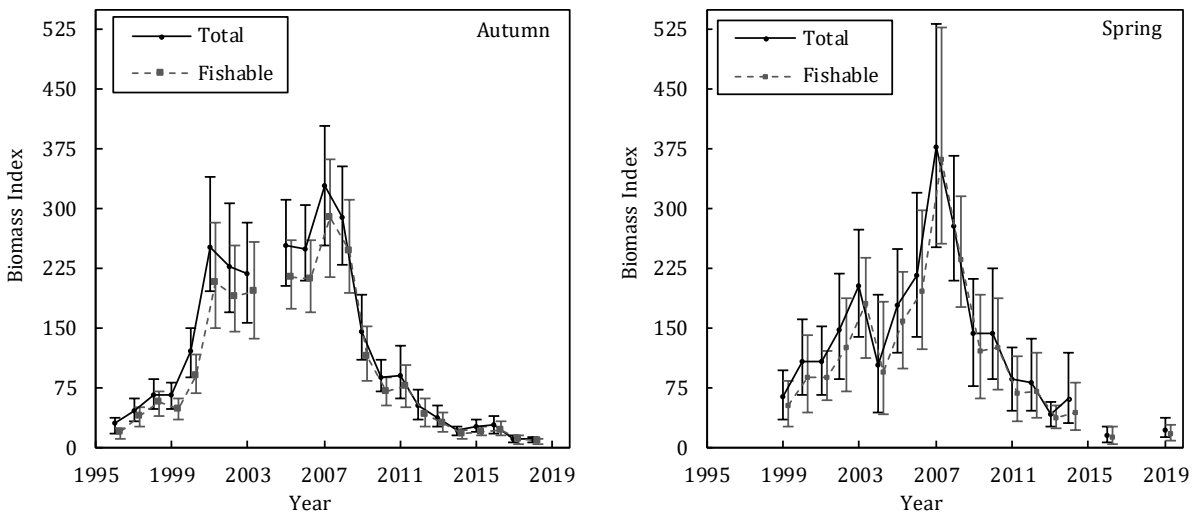


Figure 2.3. Shrimp in Div. 3LNO: Total and fishable biomass index estimates from Canadian autumn and spring multi-species surveys (with 95% confidence intervals). The 2014 autumn index is for Div. 3L only. There are no available biomass index estimates for spring 2015, 2017 or 2018.

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 2.4).

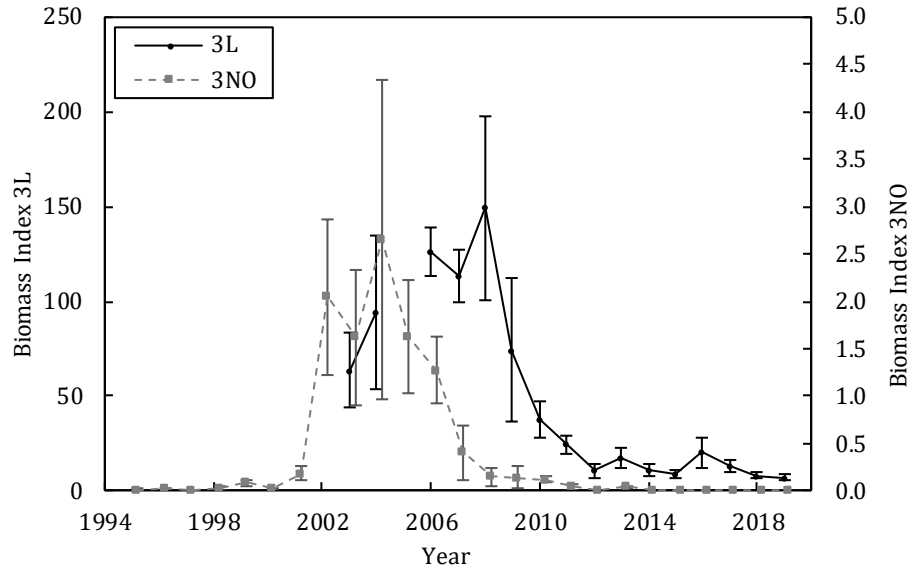


Figure 2.4. Shrimp in Div. 3LNO: Total biomass index estimates from EU - Spain multi-species surveys (± 1 SE) in the NAFO Regulatory Area (NRA) of Div. 3LNO.

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 2.5).

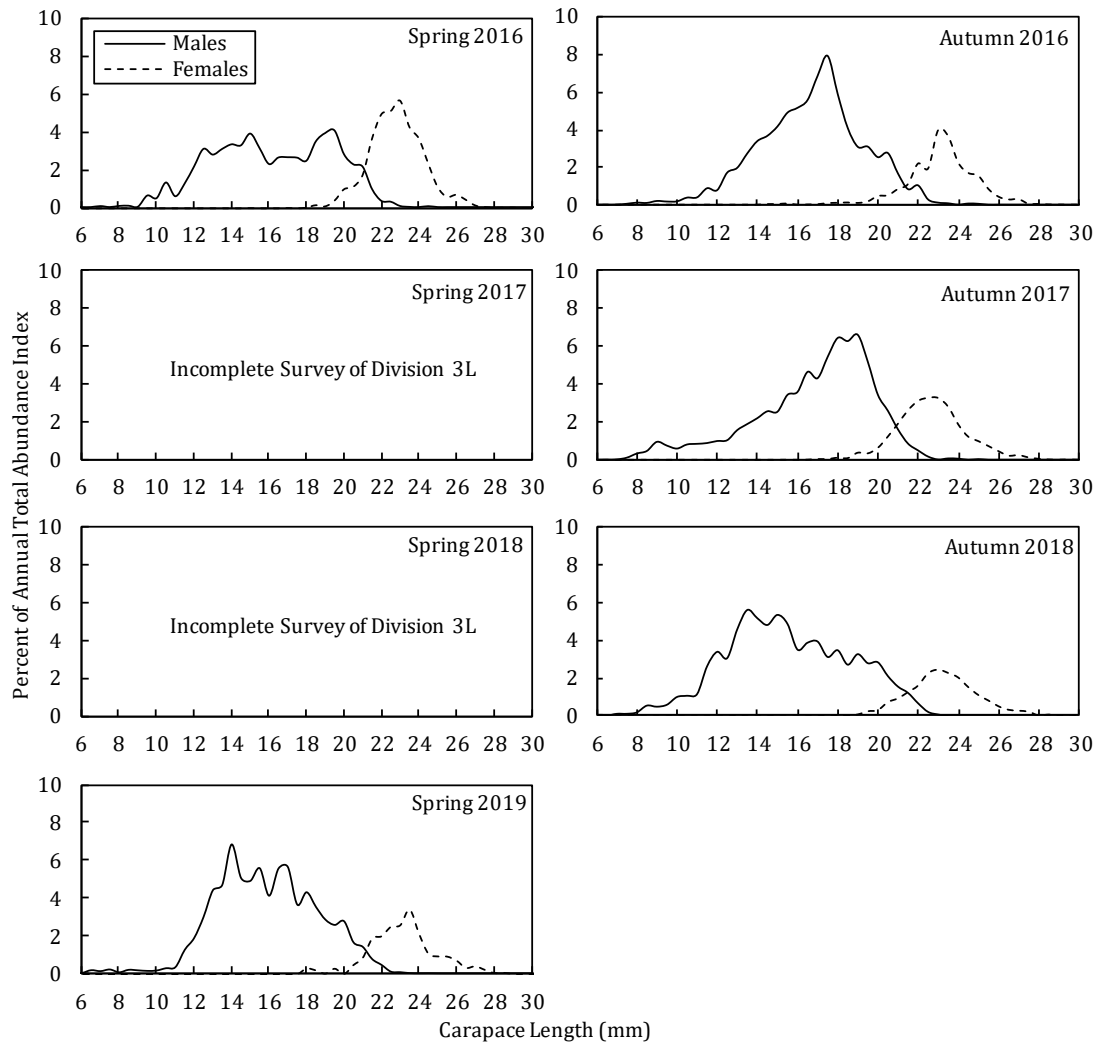


Figure 2.5. Shrimp in Div. 3LNO: Composition of survey catches (percentage at length) from Canadian spring and autumn multi-species survey data. No data for spring 2017 or 2018.

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 the lowest levels in the survey time series (Figure 2.6).

Research on transport of larval shrimp (Le Corre et al.) 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.

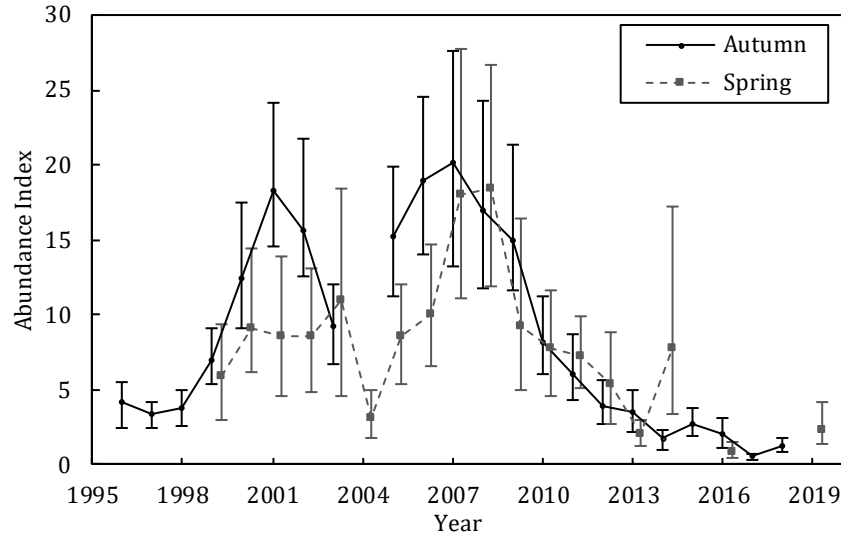


Figure 2.6. Shrimp in Div. 3LNO: Indices of recruitment-sized shrimp based on abundance of shrimp with 11.5 – 17 mm carapace lengths from Canadian spring and autumn multi-species surveys. Error bars represent 95% confidence intervals. The autumn index for 2014 is for Div. 3L only.

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 2.7). Since there was no directed fishing in 2015-2019, the exploitation index is zero for that period of time. Mortality due to bycatch during other fisheries is unknown.

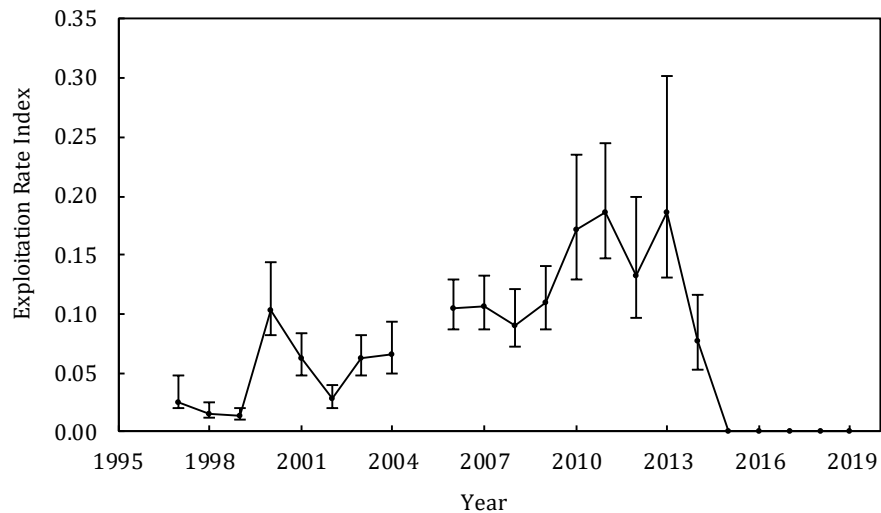


Figure 2.7. Shrimp in Div. 3LNO: Exploitation indices calculated as a year's catch divided by the previous year's autumn fishable biomass index. Error bars (calculated based on estimates of fishable biomass index) indicate 95% confidence intervals.

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 2019 the risk of being below B_{lim} was greater than 95% (Figure 2.8). A limit reference point for fishing mortality has not been defined.

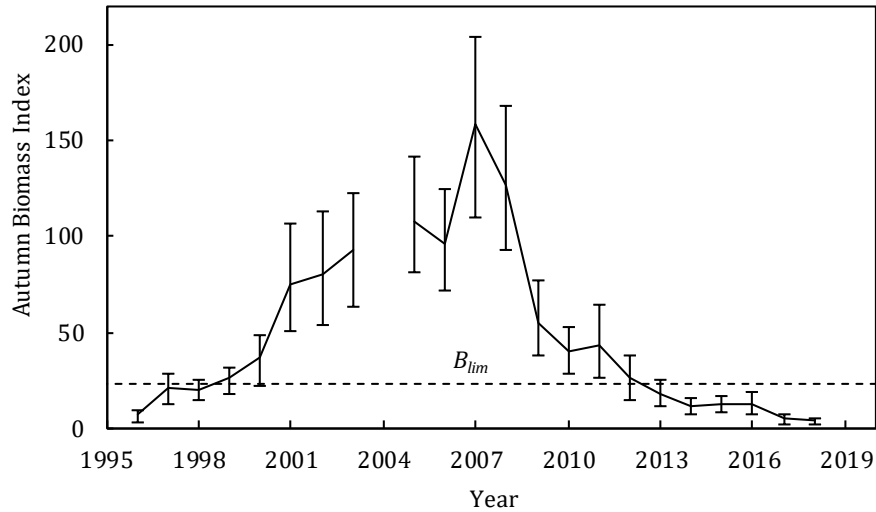


Figure 2.8. Shrimp in Div. 3LNO: Autumn female spawning stock biomass index (SSB) and B_{lim} . B_{lim} is defined as 15% of the maximum autumn female biomass over the time-series. Error bars indicate 95% confidence intervals. The autumn index for 2014 is for Div. 3L only.

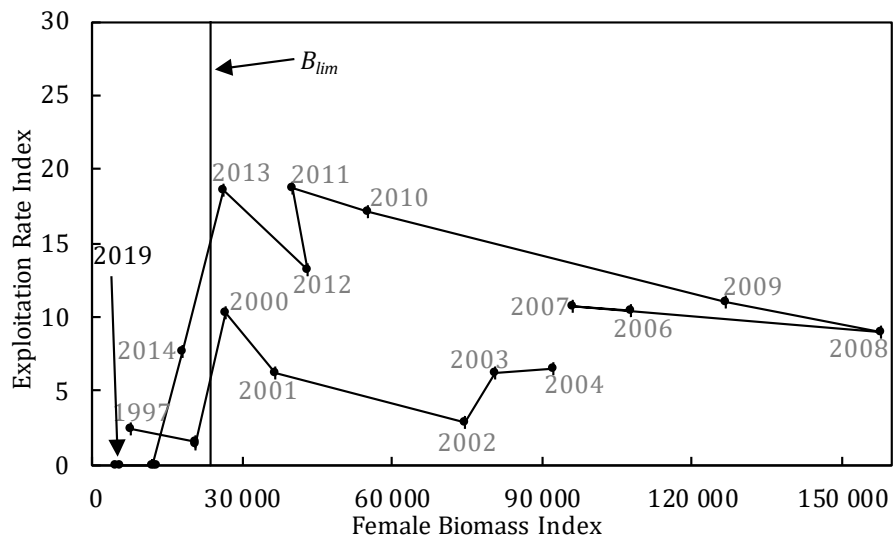


Figure 2.9. Shrimp in Div. 3LNO: Exploitation rate vs female SSB index from Canadian autumn survey. Vertical line denotes B_{lim} .

f) State of the stock

Biomass. Spring and autumn biomass indices have decreased considerably since 2007 and are among the lowest levels in the time series.

Recruitment. Recruitment indices have decreased since 2008 to the lowest levels in the time series.

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

State of the Stock. Currently the risk of the stock being below B_{lim} is greater than 95%. There is no indication of improved recruitment.

g) Ecosystem considerations

The Grand Bank (3LNO) EPU is currently experiencing low productivity conditions and biomass has declined across multiple trophic levels and stocks since 2014.

h) 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: While it was anticipated that a length based model would improve knowledge of a recruitment index for Div. 3LNO, that work has not been successfully completed. Hence 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.* 2018;00:1–20. <https://doi.org/10.1111/fog.12401> (in press).

APPENDIX II. PROVISIONAL AGENDAS**SCIENTIFIC COUNCIL MEETING, 10 September 2019 via WebEx**

1. Opening (Chair: Brian Healey)
 - a. Appointment of Rapporteur
 - b. Adoption of Agenda
 - c. Plan of Work
2. Review of Relevant Advice from 2018
3. Formulation of Advice
 - a. Northern shrimp in Divs. 3LNO
 - b. Northern shrimp in Div. 3M
4. Other Matters
 - a. Discussion of Reporting Formats
5. Adjournment

NAFO/ICES *PANDALUS* ASSESSMENT GROUP, 10 September 2019 via WebEx

1. Opening (Co-chairs Karen Dwyer and Ole Ritzau Eigaard)
 - a. Appointment of Rapporteur
 - b. Adoption of Agenda
2. General review
 - a. Review of Relevant Recommendations in 2018
 - b. Presentation of New Survey Data in 2019
3. Stock Assessments
 - a. Northern shrimp (Div. 3M)
 - b. Northern shrimp (Divs. 3LNO)
4. Other Business
5. Adjournment

APPENDIX III: EXPERTS FOR ASSESSMENT OF CERTAIN STOCKS

The following is the list of Designated Experts for 2019 assessments:

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

Northern shrimp in Divs. 3LNO Katherine Skanes katherine.skane@dfo-mpo.gc.ca

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

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

APPENDIX IV. LIST OF SCR AND SCS DOCUMENTS

| SCR Document | | | |
|---------------------|------------------|--------------------|--|
| Doc No. | Serial No | Author | Title |
| SCR Doc. 19/041 | N6969 | J.M. Casas Sánchez | Division 3M Northern shrimp (<i>Pandalus borealis</i>) - Interim Monitoring Update |

| SCS Document | | | |
|---------------------|------------------|---------------|---|
| Doc No. | Serial No | Author | Title |
| SCS Doc. 19/21 | N6970 | NAFO | Report of the Scientific Council (in conjunction with NIPAG), 10 September 2019 |

APPENDIX V. LIST OF PARTICIPANTS, 10 SEPTEMBER 2019

| CANADA | |
|---|--|
| Baker, Krista | Fisheries and Oceans Canada, Northwest Atlantic Fisheries Centre, P.O. Box 5667, St John's, NL A1C 5X1 Email:krista.baker@dfo-mpo.gc.ca |
| Dwyer, Karen <i>Chair of STACFIS & NIPAG co-Chair</i> | Fisheries and Oceans Canada, Northwest Atlantic Fisheries Centre, P.O. Box 5667, St John's, NL A1C 5X1 Email:karen.dwyer@dfo-mpo.gc.ca |
| Healey, Brian <i>Chair of Scientific Council</i> | Fisheries and Oceans Canada, Northwest Atlantic Fisheries Centre, P.O. Box 5667, St John's, NL A1C 5X1 Email:brian.healey@dfo-mpo.gc.ca |
| Skanes, Katherine | Fisheries and Oceans Canada, Northwest Atlantic Fisheries Centre, P.O. Box 5667, St John's, NL A1C 5X1 Email:katherine.skane@dfo-mpo.gc.ca |
| EUROPEAN UNION | |
| Casas Sanchez, José Miguel | Instituto Espanol de Oceanografia, Centro Oceanografio, De Vigo, Subida a Radiofaro, 50 P.O. Box 1552, E-36200 Vigo (Pontevedra), Spain Email: mikel.casas@ieo.es |
| Fernandez, Carmen <i>Vice-Chair of Scientific Council and Chair of STACREC</i> | Instituto Español de Oceanografía (IEO). Avenida Príncipe de Asturias, 70 bis. 33212 Gijón, Spain. Email: carmen.fernandez@ieo.es |
| Hubel, Kalvi | Estonian Marine Institute, University of Tartu, Estonia, Vanemuise 46a, Tartu, 51014 Email: kalvi.hubel@ut.ee |
| Plikšs, Māris | Institute of Food Safety, Animal Health and Environment "BIOR" Fishery Department, Daugavgrivas Str. 8, Riga, LV-1048, Latvia Email: Maris.Plikss@bior.lv |
| Ribeiro, Cristina | DG MARE, Rue Joseph II, 99, B-1049, Brussels, Belgium Email: Cristina-RIBEIRO@ec.europa.eu |
| Ritzau Eigaard, Ole <i>NIPAG co-Chair</i> | DTU-AQUA Technical University of Denmark, Charlottenlund Slot, DK-2920, Charlottenlund Email: ore@aqua.dtu.dk |
| Statkus, Romas | Fisheries service under the Ministry of Agriculture, Janonio str. 24, LT-92251 Klaipeda, Lithuania Email: romas.statkus@zuv.lt |
| Wieczorek, Renata | Email: Renata.Wieczorek@mgm.gov.pl |
| NORWAY | |
| Hvingel, Carsten | Institute of Marine Research, P.O. Box 1870, N-5817 Bergen, Norway E-mail: carsten.hvingel@imr.no |

| GREENLAND | | |
|---------------------------------|--|--------------------|
| Burmeister, AnnDorte | Greenland Institute of Natural Resources, P. O. Box 570. GL-3900, Nuuk Email: anndorte@natur.gl | |
| Rigét, Frank | Greenland Institute of Natural Resources, P. O. Box 570. GL-3900, Nuuk Email: frri@natur.gl | |
| UNITED STATES OF AMERICA | | |
| Sosebee, Katherine | National Marine Fisheries Service, NEFSC, 166 Water St., Woods Hole, MA 02543 E-mail: katherine.osebee@noaa.gov | |
| NAFO SECRETARIAT | | |
| Blasdale, Tom | Scientific Council Coordinator | tblasdale@nafo.int |
| Bell MacCallum, Dayna | Scientific Information Administrator | dbell@nafo.int |