2024 STOCK STATUS UPDATE OF EASTERN SCOTIAN SHELF NORTHERN SHRIMP (*PANDALUS BOREALIS*) IN SFAS 13-15)

CONTEXT

Advice on the status of the Eastern Scotian Shelf (ESS) Northern Shrimp (*Pandalus borealis*) stock is requested annually by Fisheries and Oceans Canada (DFO) Resource Management to help determine a total allowable catch (TAC) that is consistent with its management plan (DFO 2013).

This Science Response is from the regional peer review of December 12, 2024, on the Stock Status Update of Northern Shrimp on the Eastern Scotian Shelf.

SCIENCE ADVICE

Status

- The spawning stock biomass (SSB) index is above the limit reference point (LRP) and below the upper stock reference (USR), placing the stock in the cautious zone.

Trends

- In 2024, a 39% (2,653 mt) increase in the SSB index was observed from 2023 (6,884 mt to 9,537 mt) after three years of continuous decline. Two tows from stratum 17 account for 61% of this increase.
- In 2024, a 59% (6,114 mt) increase in total biomass was observed from 2023 (10,327 mt to 16,441 mt) after three years of continuous decline. Like the SSB, the same two tows in stratum 17 accounted for approximately half of this increase.
- The TAC and subsequent landings have been decreasing since 2015, with 2024 having the lowest landings and TAC (500 mt) since before the introduction of the Nordmøre grate in 1991. This has also resulted in the lowest exploitation rates (both total and on the female population) since 1990.
- The belly-bag index, a proxy for recruitment, was low in 2022 and 2023, but in 2024 reached its highest point since 2009 and is the fourth largest value on record.
- The length frequencies indicate the population length structure has not changed between 2023 and 2024, showing little to no recruitment to the fishery in 2024.

Ecosystem and Climate Change Considerations

- Bottom temperature has been high (> 3°C) since 2012, which is anticipated to have negatively affected the shrimp stock. Bottom temperature has been trending downwards for

3 years and in 2024 dropped to the lowest value since 2010 but remains in the red. The SST remains variable and maintains a high value in 2024.

- The predation index decreased from 2023. The cod recruitment index, an index of predation on shrimp, decreased but remains high.
- Snow Crab and Turbot recruits, which have been positively correlated with Northern Shrimp in the past, remains stable at high and historically low levels, respectively.

Stock Advice

- The ESS Northern Shrimp stock remains in the cautious zone but has seen its first increase in both overall biomass and SSB since 2019. This coincides with the lowest fishing effort and TAC in over 30 years. The high belly-bag index align with the lowest bottom temperatures in over a decade, after a two-year decrease. Cold conditions will likely need to persist for the stock to improve and move into the healthy zone.

BASIS FOR ASSESSMENT

Assessment Details

Year Assessment Approach was Approved

2015 (Hardie et. al. 2018)

Assessment Type

Interim Year Update

Most Recent Assessment Date

1. Last Full Assessment: 2021 (DFO 2022)
2. Last Interim-Year Update: 2023 (DFO 2024)

Stock Assessment Approach

1. Index-based (including fishery-dependent and fishery-independent indices).
2. A traffic light analysis (TLA) incorporating 24 indicators is used to provide additional context for the stock status of the ESS Shrimp Stock (Koeller et. al. 2000, DFO 2022). The limit reference point (LRP) is set on the SSB indicator and the maximum removal reference is set on female exploitation.

Ecosystem and Climate Change Assessment Approach

Indices that are examined as part of the TLA assessment include survey bottom temperature, sea surface temperature, predation, cod recruitment, snow crab recruitment, and turbot recruitment abundance.

Stock, Ecosystem and Fishery Overview Information

The TLA incorporates information on all three of these categories through indicators (see last full assessment for details, DFO 2022).

Stock Structure Assumption

The Northern Shrimp stock (SFAs 13-15) is a management-based stock unit and does not represent a biological unit. The survey focuses on the core shrimp habitat and is closer to a biological unit.

Reference Points

- Limit reference point (LRP): 5,459 mt (average SSB in low productivity period before 1990)
- Upper stock reference (USR): 14,558 mt (80% of average SSB in high productivity period 2000-2010)
- Removal reference (RR): Maximum of 20% of SSB in Healthy Zone
- Target reference point (TRP): Not Applicable

Data

- DFO-Industry Cooperative Trawl Survey (main trawl, 1995-2024)
- DFO-Industry Cooperative Trawl Survey (belly-bag, 2002-2024)
- Commercial Logbook Data (1979-2024)
- DFO Ecosystem Survey (1980-2024)
- Snow Crab Survey (1997-2024)
- Commercial Port Sampling (1994-2024)
- Sea Surface Temperatures from GHRSST NOAA/STAR ACSPO v2.80 0.02 degree L3S Dataset from Afternoon LEO Satellites (GDS v2) (1983-2024)

ASSESSMENT

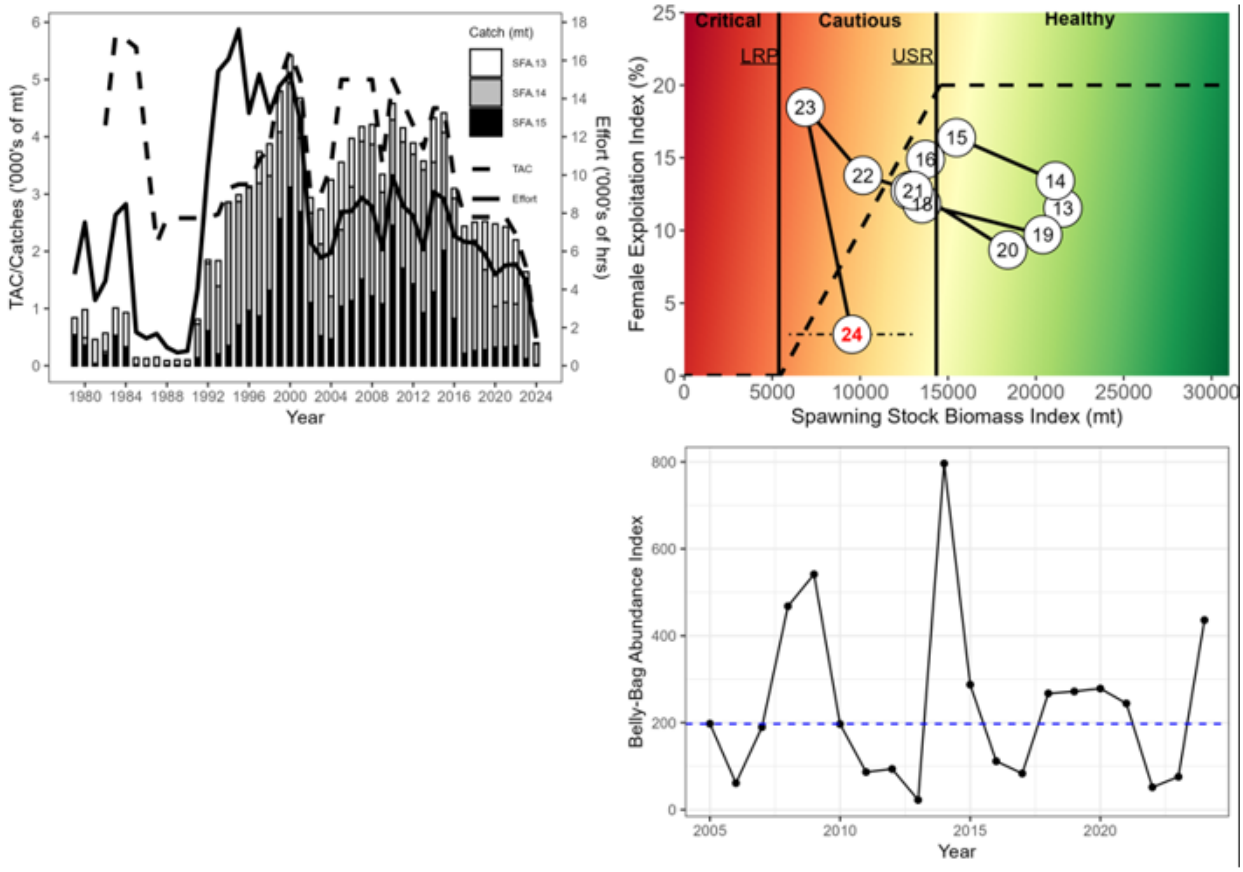

Figure 1. Top left panel : History of Eastern Scotian Shrimp Northern Shrimp catches per Shrimp Fishing Area (SFA; 13, 14, 15), total allowable catch (TAC) (thousands of mt), and effort (thousands of hours), from 1979-2023. Effort and catches for 2024 represent data available as of November 28, 2024. Top right panel: spawning stock biomass (SSB) index against female exploitation rate index between 2012 and 2024, with the 2024 confidence interval for SSB denoted by dashed lines, with the color gradient representing the healthy zone (green), separated by the upper stock reference (USR) from the cautious zone (yellow), itself separated by the limit reference point (LRP) from the critical zone (red). Bottom left: Since female exploitation rate index is shown in the previous figure, it is not repeated here. Bottom right: Belly bag abundance index, a proxy for recruitment, between 2002 and 2024 with blue dashed line representing long-term median.

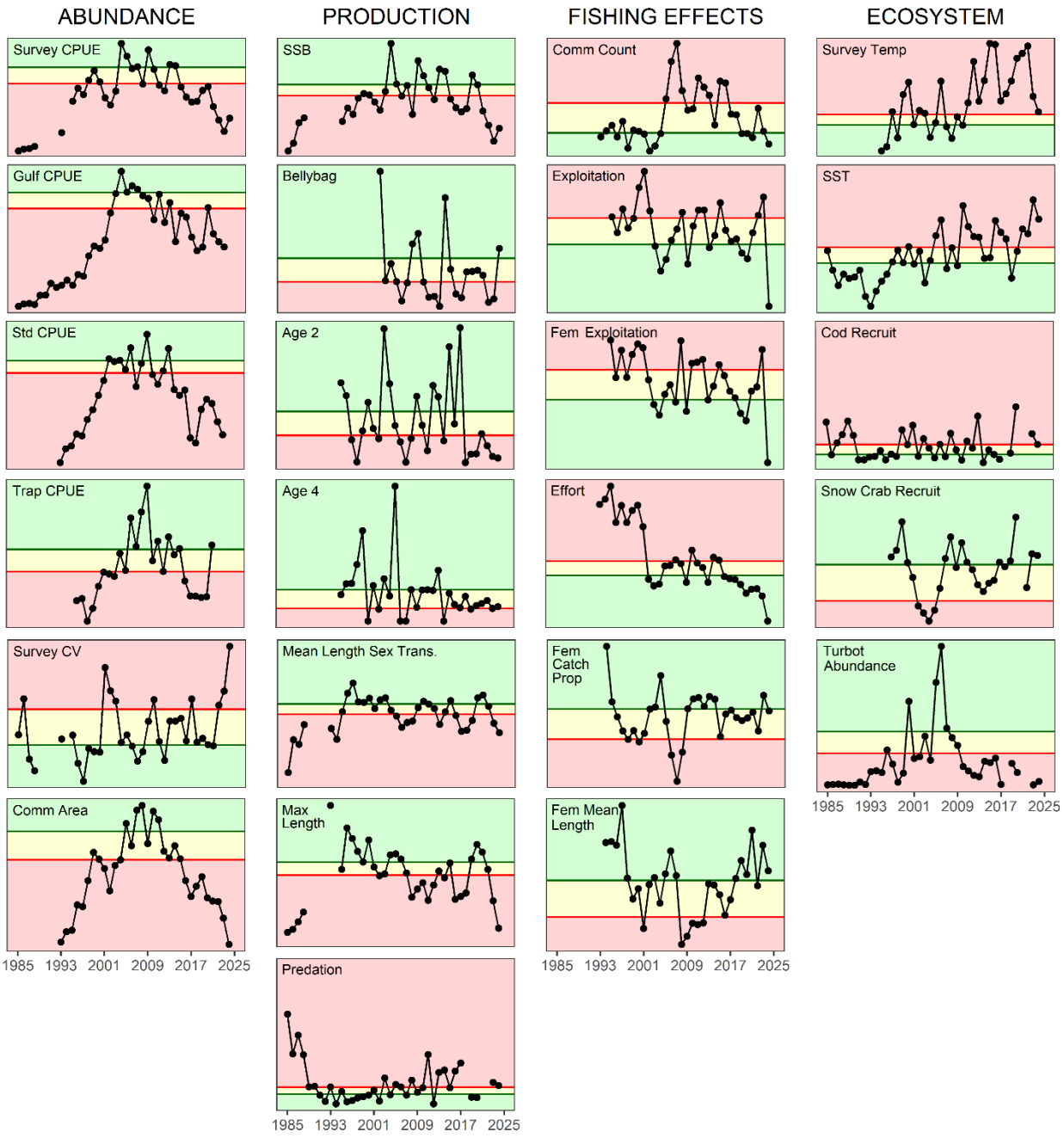

Figure 2. Time series of individual Eastern Scotian Shelf Northern Shrimp indicators. Refer to past Canadian Science Advisory Secretariat Research Documents for detailed description of indicators (e.g., Hardie et. al. 2018). Due to the limited number of active licenses and guidelines associated with the Privacy Act, the three commercial catch per unit effort (CPUE) indicators (Gulf CPUE, Std CPUE, Trap CPUE) are not updated in 2024. SST = Sea Surface Temperature, Std CPUE = Maritimes mobile fleet standardized catch per unit effort index, Comm count = commercial counts of shrimp per pound.

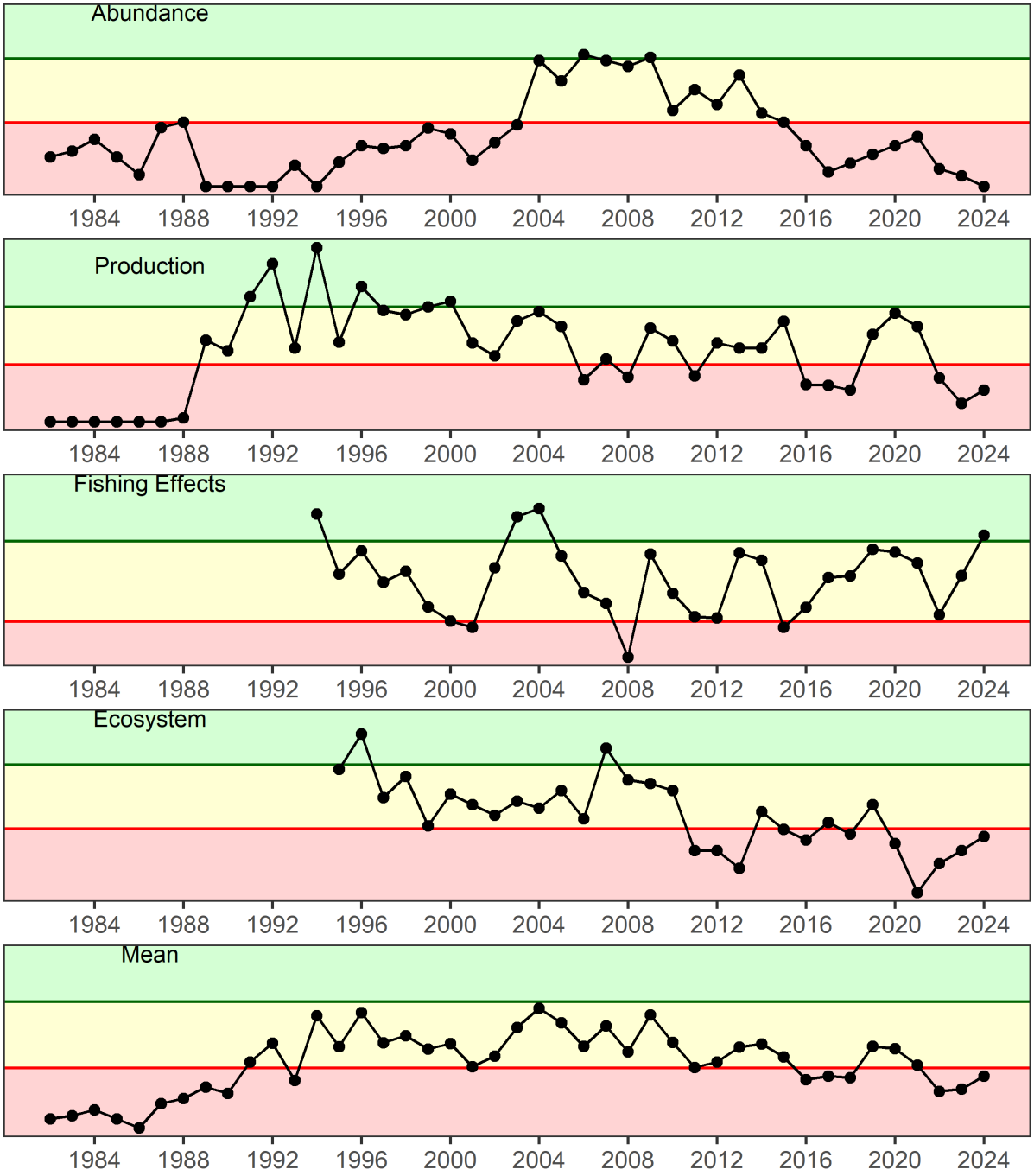

Figure 3. Time series (1982-2024) of all available Eastern Scotian Shelf Northern Shrimp indicators grouped into four characteristics (top four panels) and the mean (overall) indicator (bottom panel). Thresholds between red, yellow, and green are at the 33rd and 66th percentiles of the 2000-2010 data series for each indicator. Not all indicators in the summary above are discussed in the text. Only three indicators are included in the 2024 abundance mean indicator, as the three commercial CPUE could not be included due to guidelines associated with the Privacy Act. See Hardie et. al. (2018) for a detailed description of indicators.

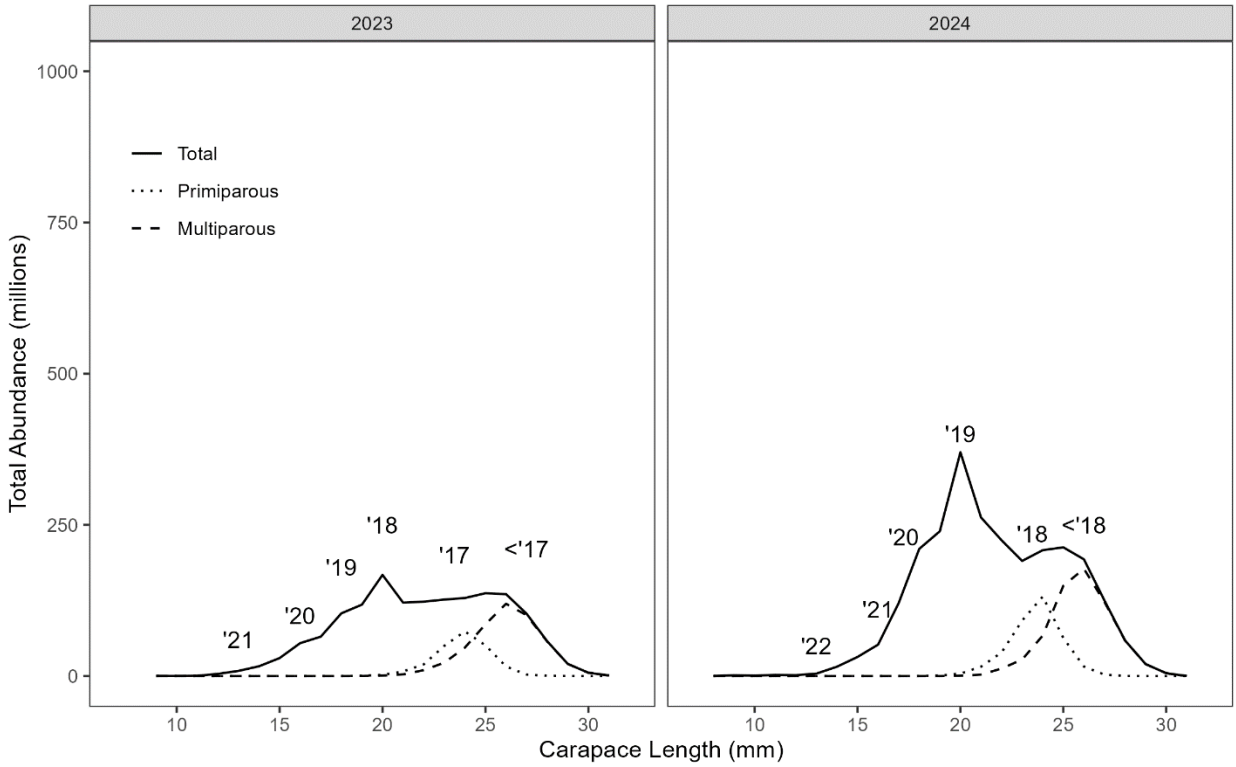

Figure 4. Population estimates of number of shrimp-at-length from the 2023 and 2024 DFO-Industry Cooperative trawl surveys (solid line). The dotted line in each figure represents transitional and primiparous Eastern Scotian Shelf (ESS) Northern Shrimp and the dash line represents multiparous ESS Northern Shrimp. Year-classes associated with ESS Northern Shrimp at given carapace lengths are indicated.

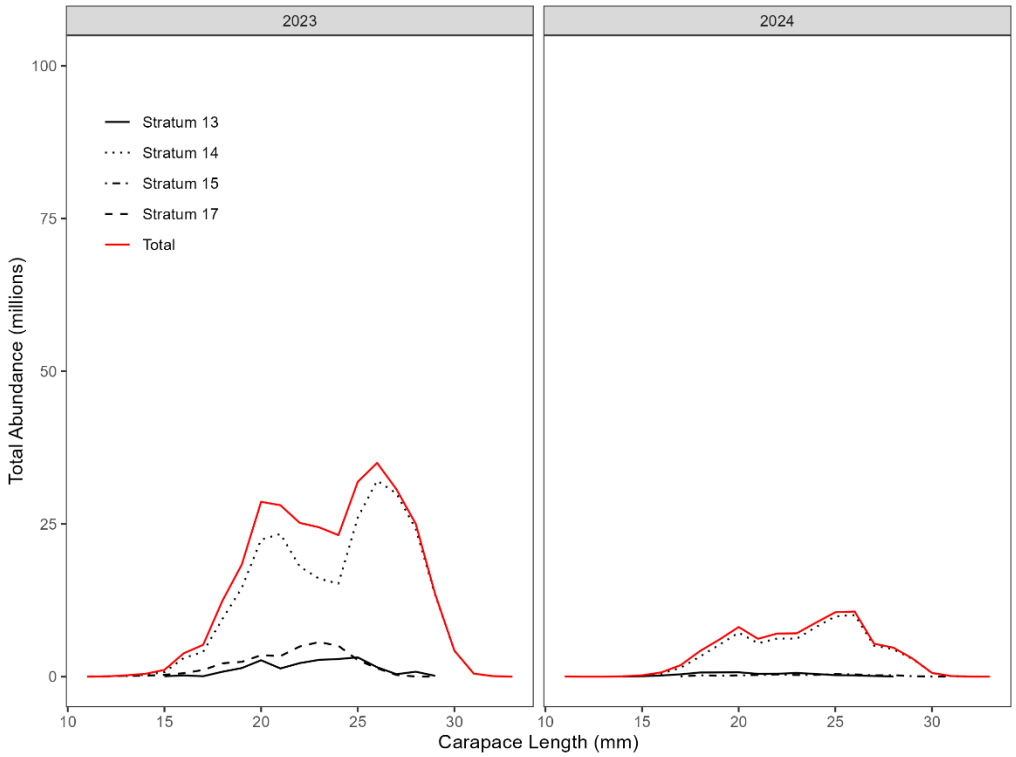

Figure 5. Catch-at-length from commercial sampling by stratum for 2023 and 2024. Sampling extent is usually based on 50 samples, but in 2024 only 20 samples were available.

Stock Status and Trends

After four years of steady increases, the Abundance characteristic has been decreasing since 2022 and continues the trend in 2024 (Figure 3). This characteristic remains in the red zone for 2024, as two of its three available indicators (three commercial CPUE values are excluded in 2024, due to guidelines related to the *Privacy Act*) are trending negatively from 2023 (Figure 2). Only survey CPUE showed a modest improvement in 2024, however a substantial portion of this increase (44%) was caused by two tows out of 60 which is reflected in the highest Survey Coefficient of Variation (CV) in the data series.

The Production characteristic declined in both 2022 and 2023 but has increased in 2024 (Figure 3). There have been no clear contributions from recruitment since 2020. While the SSB has increased by 39% in 2024, the majority of this increase stems from two tows which caught a large amount of shrimp in stratum 17 (as discussed above relative to the increase in CPUE). The belly bag index increased to its highest value since 2014, improving the productivity outlook for the shrimp stock (Figure 1 and 2). Despite this, in 2024 the Production characteristic remains in the red zone due to declines or relative stability in all other productivity indicators.

The survey length frequencies (Figure 4) indicates the length structure of the shrimp stock has not changed since 2023, and there was little to no recruitment to the fishery in 2024.

Current Outlook

The SSB (9,537 mt ± 3,574 mt) is estimated to be 74% above the LRP (5,459 mt), with the entirety of its confidence interval contained within the Cautious Zone (Figure 1). However, 61%

of this increase is caused by two tows in stratum 17. The Female Exploitation (2.9%) is at its lowest level on record and below the Maximum Removal Reference of 20%.

History of Landings, Harvest, Effort, and other Fishing Indicators

The 2024 fishing season saw the lowest amount of fishing effort due to the lowest TAC (500 mt, Figure 1) since the introduction of the Nordmøre grate in 1991. This has resulted in only 4 active licenses (all fleets combined) in 2024, which prevents the inclusion of the commercial CPUEs in the analysis. For the same reason, the port sampling resulted in only 20 samples instead of the target 50.

The Fishing Effects characteristic has been steadily improving since 2022 after declining sharply between 2021 and 2022 (Figure 3). In 2024, there is a continued overall improvement in the indicators. The large reduction in TAC in 2024 has resulted in the lowest landings, female exploitation, total exploitation, and effort on record (Figure 2). While the proportion of females in the catch has declined and the female mean length has also decreased, the commercial count has improved. This places the Fishing Effects characteristic in the green zone for the first time since 2004.

The commercial length frequencies (Figure 5) are harder to interpret due to the low sample size (20 instead of the target 50) in 2024 which are also the cause of the decrease in abundance, but the distribution remains similar with a higher proportion of larger female in the commercial landings than in the survey.

Ecosystem and Climate Change Considerations

In 2024, the Ecosystem characteristic has continued on the upward trend that has been occurring since 2021 (Figure 3). This is due to an improvement in all indicators between 2023 and 2024, with the exception of the Snow Crab indicator, which remained stable (Figure 2). However, these improvements were relatively minor with the exception of the Survey Bottom Temperature indicator, which saw a noticeable improvement and is at its lowest value (at less than 3°C) since 2011 (Figure 2). This still places the Ecosystem characteristic in the red zone for the fifth consecutive year.

Projections or Simulations

Projections or simulations have not been developed for this assessment as it is index-based and data driven.

SOURCES OF UNCERTAINTY

The largest Survey CV on record illustrates a larger uncertainty than usual in both the overall biomass index trend and the SSB trend, in part due to two tows in stratum 17, driving a large proportion of the increases seen in both indices.

The 2024 TAC reductions resulted in very low fishing effort; this in turn resulted in smaller port sample sizes, and greater uncertainty around the commercial indices. This has also resulted in the omission of 3 of our 6 commercially derived indicators, as they do not meet the guidelines related to the *Privacy Act*, leaving 21 of 24 indicators to be used in the 2024 TLA.

While there are promising signs in certain indicators (high belly bag index, lowest bottom temperature in 14 years, low exploitation rates, high female mean lengths), most others remain

poor (survey CPUE, SSB, both temperature indicators, commercial area, predation), introducing more uncertainty in the assessment.

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SOURCES OF INFORMATION

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