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Newfoundland and Labrador

Canadian Science Advisory Secretariat
Science Advisory Report 2025/034

ASSESSMENT OF DIVISIONS 2J+3KL CAPELIN TO 2024

CONTEXT

Fisheries and Oceans Canada (DFO) Fisheries Management has requested Science Advice on the status of 2J3KL Capelin (*Mallotus villosus*) stock (Capelin Newfoundland & Labrador [NL] Region Divisions 2+3 [Capelin Fishing Areas 1–11]). This species was last fully assessed in 2024 (DFO 2024). Full assessments are carried out annually and the next full assessment is scheduled for 2026. This Science Advisory Report is from the regional peer review of March 4–6, 2025, for the Stock Assessment of Capelin in Divisions 2J+3KL. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

SCIENCE ADVICE

Status

- The 2024 Capelin acoustic biomass index was 647 kt (90% CI: 444–1,111 kt), and above the Limit Reference Point (155 kt) with greater than 95% probability.

Trends

- The 2024 Capelin acoustic biomass index was higher than the recent time period (2018–23: median 286 kt) and similar to the post-collapse time series highs in 2013 and 2014.
- Since 1991 the Capelin acoustic biomass index has remained well below the pre-collapse level (1982–90: median 3,697 kt).
- Spawning timing and the larval abundance index in 2024 suggest production of an average year-class relative to the post-collapse period.

Ecosystem and Climate Change Considerations

- The warm phase in ocean climate that started around 2020 along with recent zooplankton biomass levels are currently favourable for Capelin productivity and condition, however long term impacts of increasing temperatures due to climate change on Capelin are unknown.
- Total biomass levels of the fish community are at or near post-collapse highs, with increases being driven by groundfish. Estimates of Capelin consumed by fish predators and predictions of Capelin biomass from Atlantic Cod diet.
- Evidence from environmental, fish diets, and fish community analyses suggest a generally positive outlook for Capelin in 2025, but uncertainty remains high.

Stock Advice

- In 2025 the Capelin forecast model projects the acoustic biomass index to be above the Limit Reference Point with a 45 to 76% probability, depending on the timing of sea ice

retreat. This forecasted index predicts a decline from the 2024 level to near post collapse average.

BASIS FOR ASSESSMENT

Assessment Details

Year Assessment Approach was Approved

2019 (DFO 2021)

Assessment Type

Full Assessment: Full peer-reviewed stock assessment.

Most Recent Assessment Date

1. Last Full Assessment: March 5–8, 2024. (DFO 2024)
2. Last Interim Year Update: March 14–15, 2022. (DFO 2023)

Stock Assessment Approach

1. Broad category: Index-based (fishery-independent indices)
2. Specific category: Other (Capelin forecast model)

The Capelin forecast model (Lewis et al. 2019, Lewis et al. in prep[1]) is used to generate predictions of the Capelin acoustic biomass index for the current year incorporating information on timing of sea ice retreat, Capelin condition, Capelin larval and zooplankton abundances.

Ecosystem and Climate Change Assessment Approach

Ocean climate conditions and trends were evaluated with indicators including water temperature, ice condition, and the Newfoundland and Labrador Climate Index. Lower trophic levels were characterized using nutrients, chlorophyll, and zooplankton indicators from Atlantic Zonal Monitoring Program surveys and remote sensing. Of these, the timing of sea-ice retreat and zooplankton (*Pseudocalanus* spp.) abundance were incorporated into the Capelin forecast model. Further, fish community status and trends, including fish diets, consumption, predation mortality, ecosystem overfishing risk and marine mammals' role were evaluated using ecological indicators and modeling.

Stock Structure Assumption

Since 1992, as a result of accumulated biological evidence (Nakashima 1992), it was recommended that Capelin in Northwest Atlantic Fisheries Organization (NAFO) Subarea (SA) 2 + Division 3K and Division 3L be considered one stock complex (hereafter referred to as 2J+3KL Capelin). The management unit for Capelin consists of NAFO subDivision 3Ps in addition to Divisions 2J+3KL.

[1] Lewis, R.S., Murphy, H.M., Adamack, A.T., and Bourne C.M. In prep. Assessment of Capelin (*Mallotus villosus*) in NAFO Divisions 2J + 3KL to 2024. DFO Can. Sci. Advis. Sec. Res. Doc.

Reference Points

- Limit Reference Point (LRP): 155 kt in the Capelin spring acoustic biomass Index. The Capelin LRP is based upon the amount of Capelin required to maintain Northern cod at its LRP in the absence of fishing on Atlantic Cod (DFO 2024).
- Upper Stock Reference (USR): N/A
- Removal Reference (RR): N/A
- Target (TRP): N/A

Data

- Spring acoustic Capelin survey (1982–2024; no survey data 1983–84, 1993–95, 1997–98, 2006, 2016, 2020–21).
- Commercial landings (1978–2024; no fishery in 1994,1995 or 2022).
- Fall DFO-NL Research Vessel (RV) bottom trawl survey (1982–2024).
- Bellevue Beach (BB) larval survey (2001–24).
- Capelin spawning diary program (1991–2024).
- Day of year of the most southerly position of contiguous sea ice (sea ice retreat; t_{ice}) (1999–2024).
- DFO-NL Ecosystem Research Program Indicators (1960–2024).
- Atlantic Zone Monitoring Program Indicators (1950–2024).
- NASA Moderate Resolution Imaging Spectroradiometer Aqua Ocean Color observation (2003–24).

ASSESSMENT

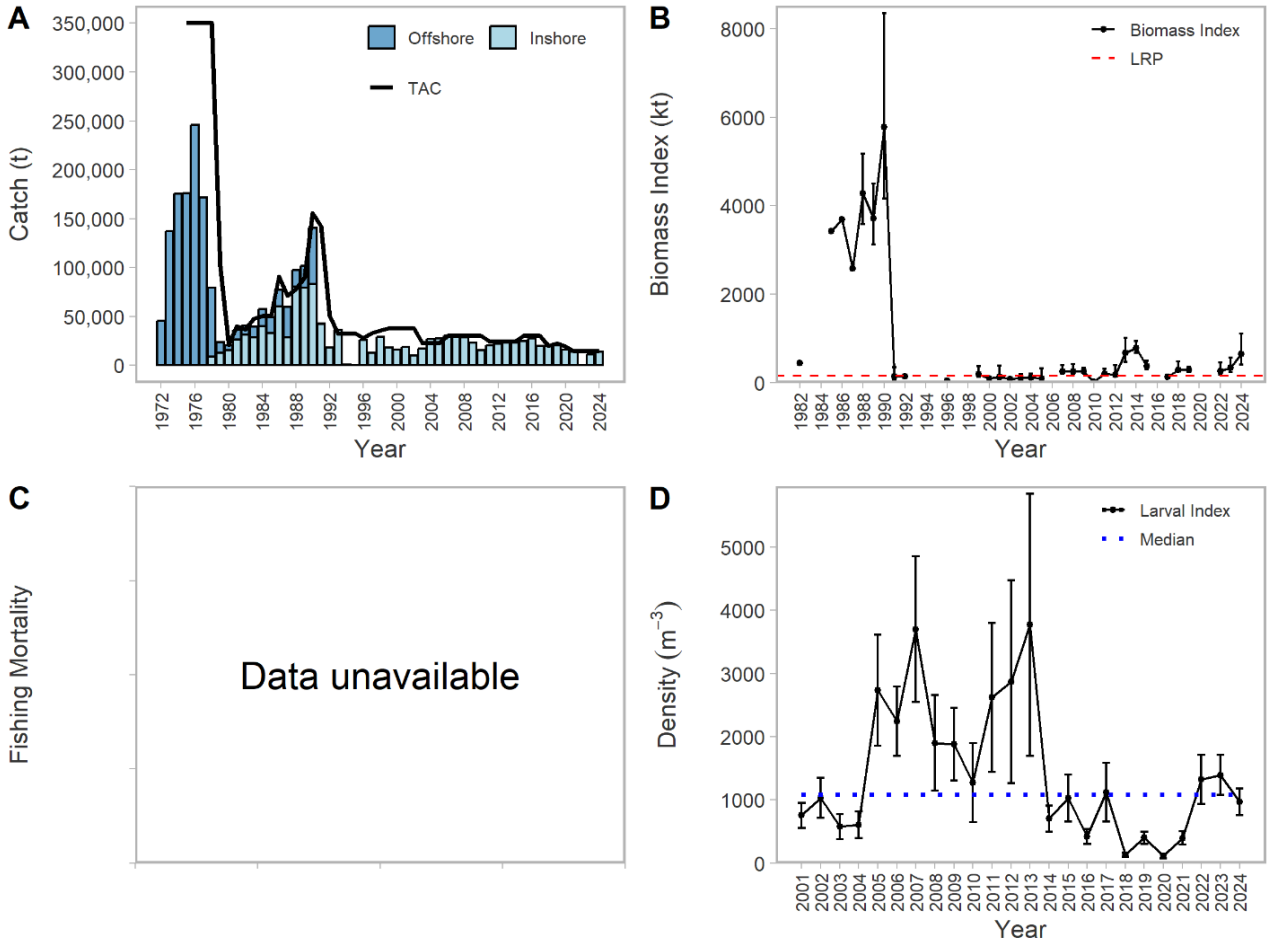

Figure 1: (A) Catch (t) and Total Allowable Catch (t); (B) Biomass Index (kt) in relation to the Limit Reference Point; (C) Fishing Mortality – not available for this stock; (D) Recruitment indicator for 2J3KL Capelin is based on the Bellevue Beach (BB) Larval Index (ind. m^{-3}).

Stock Status and Trends

Biomass Index

The Capelin acoustic biomass index in 2024 was 647 kt (90% confidence interval [CI]: 408–1,111 kt), which was higher than the 2018–23 time period (median: 286 kt) and similar to recent time series highs in 2013 (668 kt) and 2014 (779 kt) (Fig. 1B). Since the collapse of the stock in 1991, the median annual Capelin acoustic biomass index is 202 kt (1991–2023), well below the pre-collapse (1982–90) median of 3,697 kt.

Age Structure and Maturity

The age structure of the population is truncated in the post-collapse period with a very low proportion of age-4+ fish. In the 2024 spring acoustic survey, age-2 fish dominated the catch (~87%). The percentage of maturing age-2 female Capelin in the 2024 spring acoustic survey was one of the lowest in the post-collapse period; lower proportions of maturing age-2 females is indicative of higher stock biomass.

Recruitment

The BB larval index was 968.8 ± standard error (SE) 208.7 ind. m^{-3} in 2024 which was a slight decrease compared to 2023 and is similar to the time series median (1,119.0 ind. m^{-3}; 2001–23) (Fig. 1D). This suggests production of an average 2024 year-class relative to the post-collapse period. However, the earlier than average spawning time observed in 2024 may produce a stronger year class than expected (Murphy et al. 2021).

Current Outlook

The 2J+3KL Capelin stock collapsed in 1991 during a cold anomaly in the Newfoundland and Labrador ecosystem. The 2024 spring acoustic biomass index was above the LRP (>95% probability), remaining well below pre-collapse levels.

History of Management, Landings, TAC

The inshore commercial Capelin fishery occurs from June to August each year. Capelin fishery effort and landings can be negatively impacted by market factors. In 2024, the TAC for Capelin was 14,533 t and landings in 3KL were 14,109 t. There has been no fishery in 3Ps since 2011 or in 2J for at least 25 years. Typically, the allocated quota for 3Ps and 2J are transferred to 3KL.

Table 1: Inshore commercial Capelin fishery landings (tonnes) and combined TAC from two Capelin management areas (NAFO Divisions 2J+3KL and 3Ps) since 1980.

Management Year	1980–89 Avg.	1990–99 Avg.	2000–09 Avg.	2010–19 Avg.	2020	2021	2022	2023	2024
TAC (t)	57,815	58,132	30,496	26,219	19,377	14,533	14,533	14,533	14,533
Landings (t)	42,370	26,704	22,834	21,750	16,109	13,945	0	11,392	14,109

Ecosystem and Climate Change Considerations

The ocean climate in the NL bioregion shows multi-year to decadal scale cold and warm phases. The warm phase that started around 2020 continues, with record high sea surface temperatures in 2024. The ongoing warm phase indicates generally favorable conditions for Capelin recruitment and productivity strength (analogous to recruits per spawner) in 2025; however, the long-term impacts of continued warming and changes in ocean climate related to climate change on Capelin are unknown. Recent phytoplankton blooms have been early, which favours recruitment of the copepod *Calanus finmarchicus*, a key food item for many fish, including Capelin. In 2024, the timing of sea ice retreat, which is related to the timing of the annual spring plankton bloom, is on track to be similar to recent years. Total zooplankton biomass has been improving since the lows in the early-mid 2010s. These changes suggest improved foraging conditions for Capelin and have been reflected in Capelin body condition which has been above average since 2017.

Newfoundland and Labrador marine ecosystems collapsed in the late 1980s and early 1990s associated with extreme cold ocean conditions and ecosystem overfishing. Declines in biomass of groundfish and Capelin were not offset by increases in shellfish, with total biomass remaining below pre-collapse levels. Some rebuilding of total biomass, also linked to increases in Capelin, was observed between the mid-2000s and early 2010s, after which declines occurred.

While these ecosystems continue experiencing overall low productivity compared to the pre-collapse period, likely related to bottom-up processes (e.g., food limitation), improvements have been observed in recent years. The total biomass of the fish community has increased from the mid-late 2010s lows and has reached levels around the post-collapse highs in 2024. While these increases have been driven by groundfish, Capelin has also improved.

Predictions of Capelin biomass from Atlantic Cod stomachs, and estimates of Capelin consumption by fish predators, indicate that Capelin has shown improvements from the late 2010s biomass levels. The evidence from environmental, diet, and fish community analyses would suggest a generally positive outlook for Capelin in 2025, but uncertainty remains high.

Projections

The Capelin forecast modelling suite is used to predict the 2025 and 2026 acoustic biomass index. Eleven models were examined based on those developed in Lewis et al. (2019) and four formulations introduced in the 2025 assessment. The model selected from this suite in the current assessment includes timing of sea ice retreat, an index of Capelin larval abundance, the zooplankton index, and Capelin condition from the fall RV survey.

As timing of sea ice retreat for the current year is not known at the time of the assessment, prediction scenarios were run with weekly sea ice timing covering the period of recent sea ice retreat (Table 2).

With model inputs being largely near time series averages (2001–24) compared to highs seen in 2023 and 2024 (condition and zooplankton, respectively), the spring acoustic biomass index is predicted to decline (Figure 2). Predictions indicate a 45% to 76% probability of the acoustic biomass index being above the LRP in 2025 The median prediction for biomass in the 2025 spring acoustic survey is 214 kt (80% prediction interval: 98–462 kt) based on the timing of sea ice retreat occurring on March 3.

Table 2: Forecast model median biomass index and intervals, and probability above/below LRP for different dates of maximal sea ice retreat in 2025.

Sea ice retreat date	Median biomass (kt)	10th percentile	90th percentile	P(>LRP)	P(<LRP)
March 3, 2025	213.6	97.8	462.4	0.71	0.29
March 10, 2025	236.0	108.7	510.7	0.76	0.24
March 17, 2025	236.0	109.0	508.6	0.76	0.24
March 24, 2025	221.6	103.1	481.5	0.73	0.27
March 31, 2025	184.4	83.8	410.9	0.61	0.39
April 7, 2025	141.6	59.0	342.9	0.45	0.55

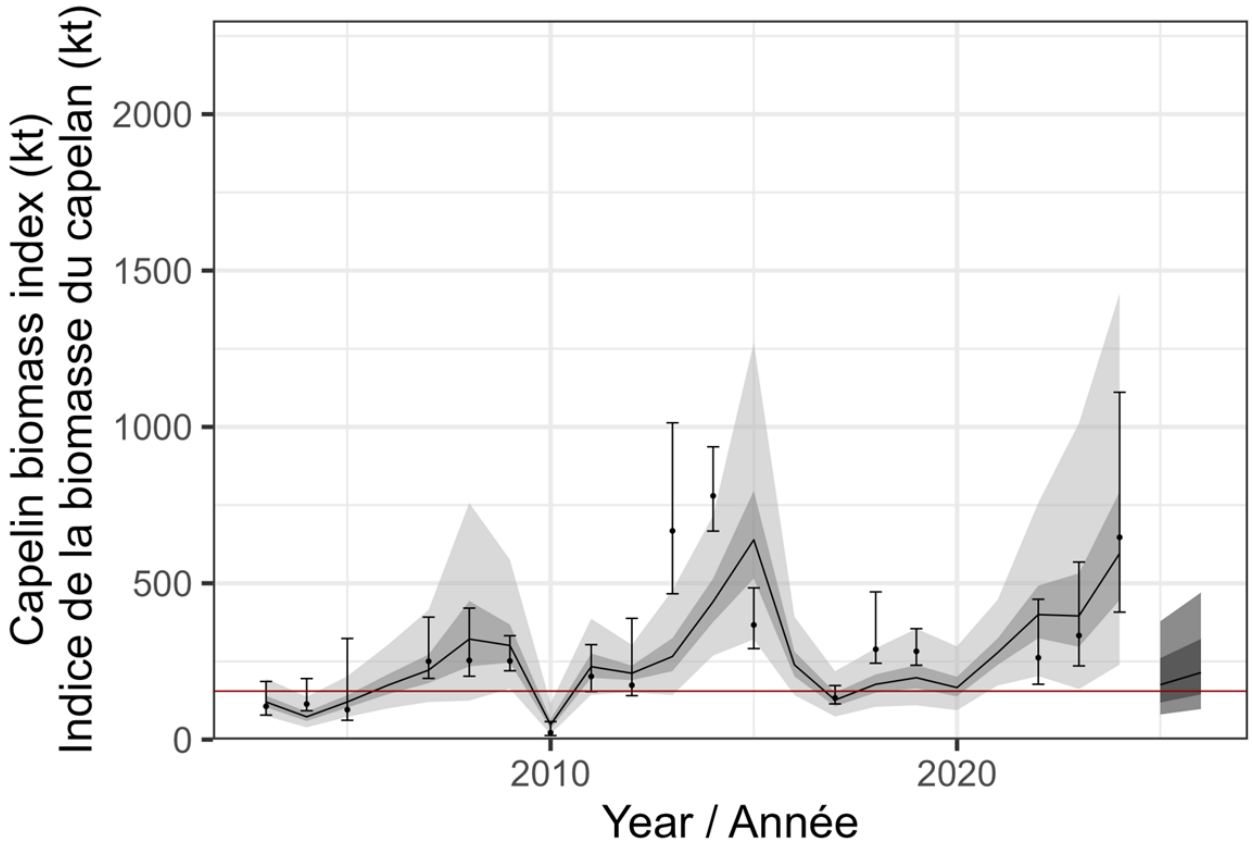

Figure 2: Forecast model credible intervals (2.5th to 97.5th percentiles) from 2003 to 2024, and prediction intervals (10th to 90th percentiles) from 2025 to 2026 using a March 3 timing of the sea ice retreat for the 2025 prediction. Solid lines show the median of the credible or prediction intervals. Observed biomass index values (black circles) with 90% confidence intervals (black lines with whiskers) and the LRP (red) are also shown.

SOURCES OF UNCERTAINTY

While the acoustic survey only covers a portion of the stock area (Division 3L and southern 3K), the index from this survey is considered representative of overall stock trends and status.

Fishes are the main consumers of Capelin although the estimates are variable and highly dependent on how well these species represent overall predation. Consumption of Capelin by marine mammals and seabirds remains an important source of uncertainty.

The impact of fishing mortality on the Capelin stock is not quantified and is generally poorly understood, particularly its targeted impact on pre-spawning, egg-bearing females.

At the time of the assessment the timing of sea ice retreat is unknown, so if the date included in the model changes the predicted biomass index for 2025 could also change (150 kt–250 kt, see Table 2). Alternate environmental variables are being investigated for inclusion in the model as sea ice is a proxy for the spring bloom and sea ice coverage is changing due to climate change.

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