



# NORTHERN GULF OF ST. LAWRENCE (3PN, 4RS) ATLANTIC COD (*GADUS MORHUA*) STOCK ASSESSMENT IN 2024

## CONTEX

Fisheries and Oceans Canada's (DFO) Fisheries Management Branch has requested an assessment of the status of the northern Gulf of St. Lawrence Atlantic cod (*Gadus morhua*) stock (nGSL, NAFO Subdivision 3Pn and Divisions 4R and 4S) to guide its decisions for the next management cycle of this stock. Since 2022, no commercial fishing directed at the 3Pn4RS cod has been permitted. A [rebuilding plan](#) for the stock was completed in 2024.

This Science Advisory Report is from the regional peer review of February 18-19, 2025 on the Northern Gulf of St. Lawrence (3Pn, 4RS) Atlantic Cod (*Gadus morhua*) Stock Assessment in 2024. 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 spawning stock biomass (SSB) of the northern Gulf of St. Lawrence Atlantic cod, estimated in 2024 at 15,793 t, is below the limit reference point (LRP) with a very high probability, placing this stock in the critical zone of the Precautionary Approach (PA) since 1990.

### Trends

- Since 2017, SSB followed a downward trend, reaching in 2024 the lowest value in the series starting in 1973.
- Recruitment for cohorts born in 2019 to 2022 was below the average of the recent series. This contrasts with the recruitment of the 2018 cohort, which was estimated to be the largest since 1990. However, a high mortality rate in this cohort has considerably reduced its importance.
- Natural mortality ( $M$ ) followed an increasing trend since 2005, while fishing mortality ( $F$ ) is currently very low and negligible compared to natural mortality.

### Ecosystem and Climate Change Considerations

- Links between feeding intensity, condition and total mortality suggest that recent bottom-up effects of the environment may be important drivers of the low stock productivity.

**Stock Advice**

- The estimated SSB in 2024 is 22% of the PA limit reference point (LRP). According to the harvest control rule in the rebuilding plan, annual removals from all sources should not exceed 500 t.
- SSB projections based on reported catch scenarios ranging from 0 to 1,000 t show very low probabilities of SSB growth over the next four years. These results can be explained principally by high recent natural mortality, along with low recruitment.

**BASIS FOR ASSESSMENT****Assessment Details****Year Assessment Approach was Approved**

This assessment follows the framework developed during the [2021](#) and [2022](#) review of the 3Pn4RS cod stock assessment framework.

**Assessment Type**

Full Assessment

**Most Recent Assessment Date**

1. Last Full Assessment: February 2023 (DFO 2023a)
2. Last Interim-Year Update: January 2024 (DFO 2024a)

**Stock Assessment Approach**

1. Broad category: Single stock assessment model
2. Specific category: Statistical catch-at-age model (state-space model)

**Stock Structure Assumption**

Results from a genomic population study show that cod in the Gulf of St. Lawrence (GSL) are partially distinct from adjacent populations on the Scotian Shelf and Newfoundland/Labrador/Arctic (Puncher et al. 2021). These results suggest reduced genetic connectivity, or little reproduction, between GSL cod and those outside. However, these results do not show a distinction between 3Pn4RS cod and those from the southern GSL (4T + 4Vn stock [November to April]).

The results of several tagging studies show that the 3Pn4RS stock is fairly well isolated from the peripheral stocks. Except for subdivision 3Ps, in which recaptures of cod tagged in 3Pn4RS are relatively frequent, recaptures elsewhere outside of 3Pn4RS are rare (Bérubé and Fréchet 2001).

**Reference Points**

- Limit Reference Point (LRP): 71,970 t of SSB (DFO 2023a)
- Proposed Upper Stock Reference (USR): 143,939 t of SSB (DFO 2023a)
- Proposed Target Reference Point (TRP): 179,924 t of SSB (DFO 2023a)
- Proposed Removal Reference (Flim): 0.49 (DFO 2023a)

## Harvest Control Rule

The rebuilding plan for this stock (DFO 2024b) includes a harvest control rule (HCR) intended to promote stock growth towards the rebuilding target, set at a SSB of 81,961 t. The HCR recommends the total harvest level for 3Pn4RS cod from all fishery-related sources based on the value of SSB relative to the LRP (Table 1).

*Table 1. Total removals prescribed under the recovery plan according to the SSB relative to the LRP (% of LRP).*

| SSB relative to LRP (% LRP) | Total removals (t) |
|-----------------------------|--------------------|
| < 25                        | 500                |
| 26-49                       | 500                |
| 50-59                       | 500                |
| 60-69                       | 500                |
| 70-79                       | 500                |
| 80-89                       | 1,000              |
| 90-99                       | 1,500              |
| 100-113                     | 2,000              |

## Data

- Fishery catches (commercial landings and commercial fisheries discards, assumed or inferred recreational landings) and estimated age composition of catches: 1973-2024
- Six Abundance indices:
  - Ecosystemic survey in the Estuary and northern Gulf of St. Lawrence (hereinafter the nGSL survey, 1985-2024, ages 2-11+)
  - Sentinel bottom trawl survey (1995-2024, ages 2-11+)
  - Sentinel gillnet survey (1995-2024, ages 4-11+)
  - Summer longline sentinel survey (1995-2024, ages 3-11+)
  - Fall Longline sentinel survey (1995-2020, ages 3-11+)
  - Minet (1978) bottom trawl surveys (1973-1976, ages 3-11+)

Data changes: Use of a modified maturity ogive for SSB estimation.

## ASSESSMENT

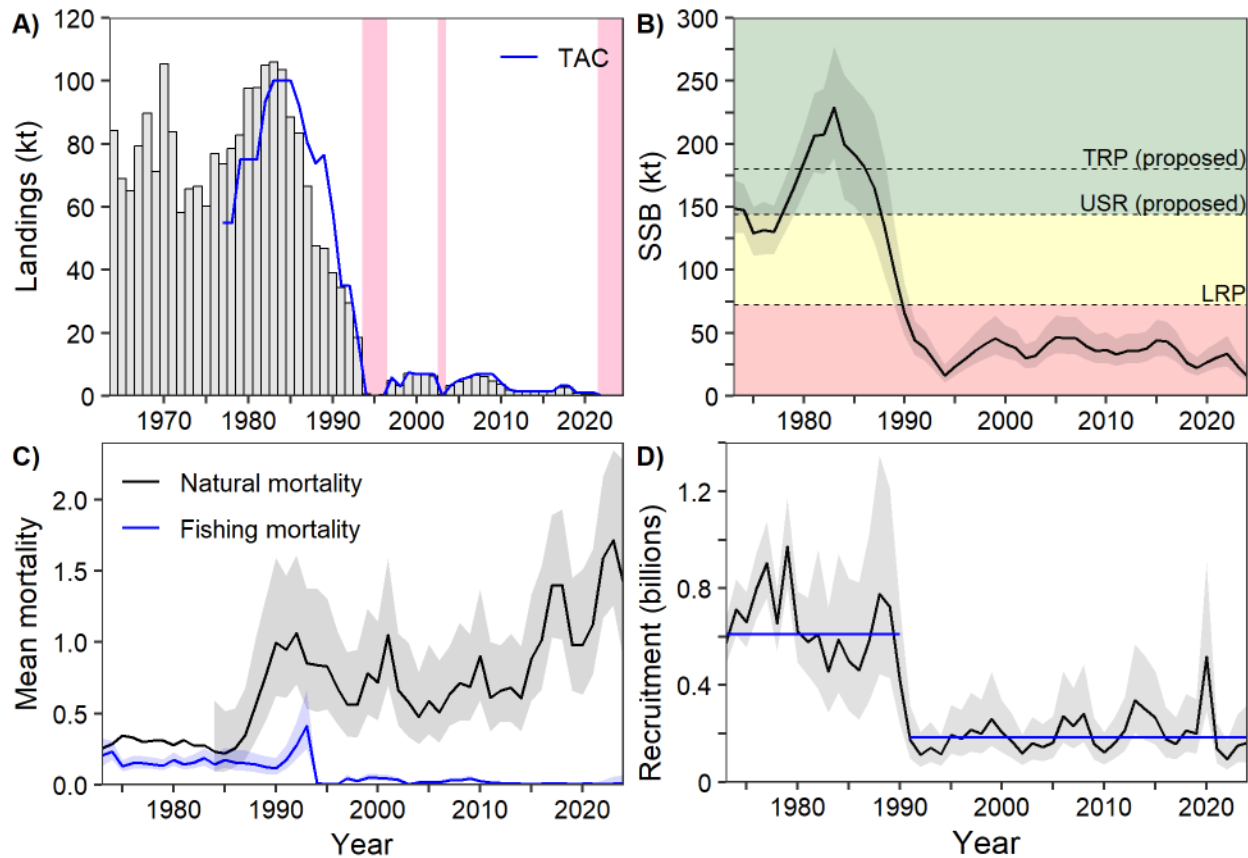


Figure 1. (A) Reported landings and total allowable catch (TAC) by management year (moratorium years shaded in pink), (B) estimated spawning stock biomass (SSB, black line) with 95% confidence intervals (CI), (C) estimated mean natural mortality (M) and fishing mortality (F) at ages 4-6 with 95% CI, (D) recruitment at age 2 with 95% CI and means for years  $\leq 1990$  and  $> 1990$  (blue lines).

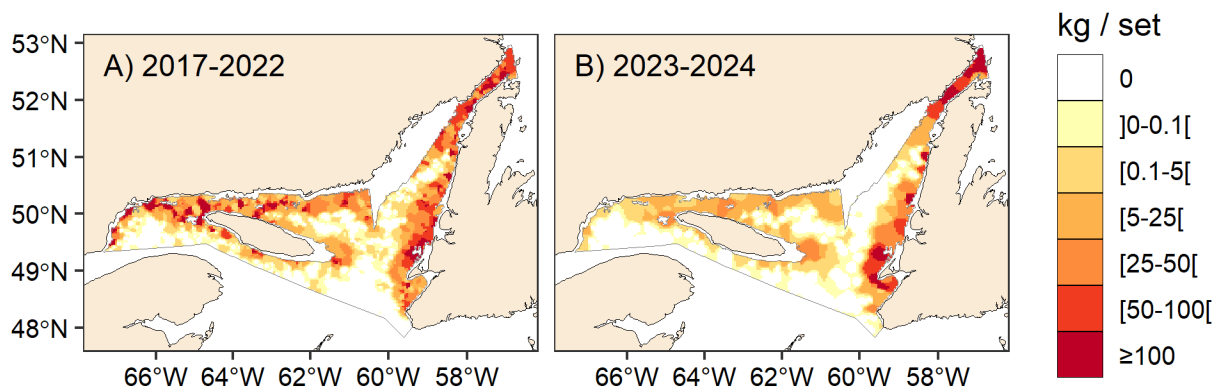


Figure 2. Distribution of cod catch rates (kg per 15 minutes tow) in NAFO divisions 4RS from the DFO August survey for A) 2017 to 2022 and B) 2023 to 2024. The study area is delimited by a grey line.

## Stock Status and Trends

### Biomass

SSB fluctuated without trend after the late 1990s, but since 2017, the trend has been downward (Figure 1B). The SSB estimate in 2024 (15,793 t) is the lowest of the series, followed by that of 1994 (16,256 t), during the first moratorium. The stock has been in the critical zone of the PA since 1990, SSB is now 22% of the LRP.

In recent years, catch rates have declined principally in NAFO Division 4S, in northwestern nGSL (Figure 2).

### Mortality

Estimates of natural mortality ( $M$ ) for ages 4 to 6 have increased significantly since 2015, reaching in 2022-2023 the highest values of the series starting in 1973 (Figure 1C). It is likely that part of this natural mortality is in fact made up of unaccounted fishing mortality.

Average fishing mortality ( $F$ ), for which the estimate is based on reported or inferred catches, has been very low for ages 4 to 6 years since the early 2010s and is considered low compared to natural mortality.

### Recruitment

Recruitment for this stock declined from a high average level (1973–1990) to a low level (1991–2024) in the early 1990s (Figure 1D). Recruitment of the last cohorts from 2019 to 2022, estimated at two years of age by the assessment model, is below the 1991–2024 average. This contrasts sharply with the recruitment of the 2018 cohort, which was estimated to be the largest since 1990. However, a high mortality rate in this cohort has considerably reduced its importance.

### Current Outlook

Despite the very low fishing mortality (from reported or inferred catches) over the past fifteen years, SSB has not increased and there has even been a recent downward trend. There is no indication that this situation will change in the medium term, principally due to the high natural mortality estimated recently, as well as low recruitment.

## History of Landings

Prior to 1977, annual landings ranged from 58,237 t (1972) to 105,465 t (1970, Figure 1A, Table 2). After the introduction of a first TAC of 55,000 t in 1977, landings and annual TACs increased until a maximum of 106,080 t was landed in 1983. The stock collapsed shortly thereafter and there have been three moratoria on directed commercial fishing: 1994-1996, 2003 and 2022 to present. Prior to the 2022 directed commercial fishery cod moratorium, the annual TAC for the previous three years was 1,000 t. Landings in 2023-2024 and 2024-2025, including bycatch from fisheries directed at other species and landed catches from sentinel surveys, were 156 and 120 t, respectively (preliminary data as of December 6, 2024).

Recreational cod fishing is still permitted with a 39-day fishing season spread from the end of June to the end of September. Although there is regulatory monitoring of compliance with the authorized daily quotas, no monitoring of catches and discards (e.g. length frequencies, landed weights) is carried out. With the closure of the directed commercial cod fishery since 2022, the assumed removals from the recreational fishery would now be higher than the reported catches.

Table 2. Reported landings (t) of 3Pn4RS Atlantic cod in the commercial fishery for the period 1964-2024, by management year or period and by NAFO Division. For periods, given values are annual means. TACs are also provided.

| Year                 | NAFO Division |        |        |        | TAC            |
|----------------------|---------------|--------|--------|--------|----------------|
|                      | 3Pn           | 4R     | 4S     | Total  |                |
| Mean 1964-1976       | 11,243        | 53,758 | 10,025 | 75,026 | No TAC         |
| Mean 1977-1993       | 11,417        | 44,389 | 14,746 | 70,551 | 18,000-100,000 |
| Mean 1994-1996       | 101           | 133    | 112    | 346    | 0              |
| Mean 1997-2002       | 1,497         | 3,578  | 802    | 5,876  | 3,000-7,500    |
| 2003/04              | 104           | 209    | 93     | 405    | 0              |
| Mean 2004/05-2018/19 | 604           | 2,023  | 554    | 3,181  | 1,500-7,000    |
| Mean 2019/20-2021/22 | 149           | 363    | 201    | 714    | 1,000          |
| 2022/23              | 30            | 29     | 104    | 162    | 0              |
| 2023/24              | 31            | 43     | 82     | 156    | 0              |
| 2024/25              | 2             | 16     | 102    | 120    | 0              |

### Ecosystem and Climate Change Considerations

Increasing water temperature in the nGSL (Galbraith et al. 2024) and decreasing dissolved oxygen concentration in deep waters (Blais et al. 2024) could affect the distribution and productivity of the 3Pn4RS cod stock.

Based on total fullness index, it is observed that cod from 4R had a higher feeding intensity than those from 4S during the last three years, during which the poor condition of cod in 4S was noted (Figure 3AB, DFO 2023a). A change in prey availability may have negatively affected the condition of 4S cod since 2022 (Figure 3B) which could have contributed to the increase in recent total mortality in 4S (Figure 3C). While the recent mortality in 4R is comparable to its historical average, the one achieved in 4S represents the maximum value of its series.

Links between feeding intensity, condition and total mortality suggest that recent bottom-up effects of the environment may be important drivers of the low stock productivity. Similar links have been put forward for neighboring Atlantic cod stocks of NAFO 3Ps (southern Newfoundland, DFO 2023b), 2J3KL (northeastern Newfoundland, Regular et al. 2022), and 3NO (southern Grand Banks, Cadigan et al. 2024). In particular, the study of Regular et al. (2022) showed that starvation-induced natural mortality, was linked to prey availability, and more specifically to those of capelin (*Mallotus villosus*) and northern shrimp (*Pandalus borealis*), two important preys of 3Pn4RS cod (Ouellette-Plante et al. 2020).

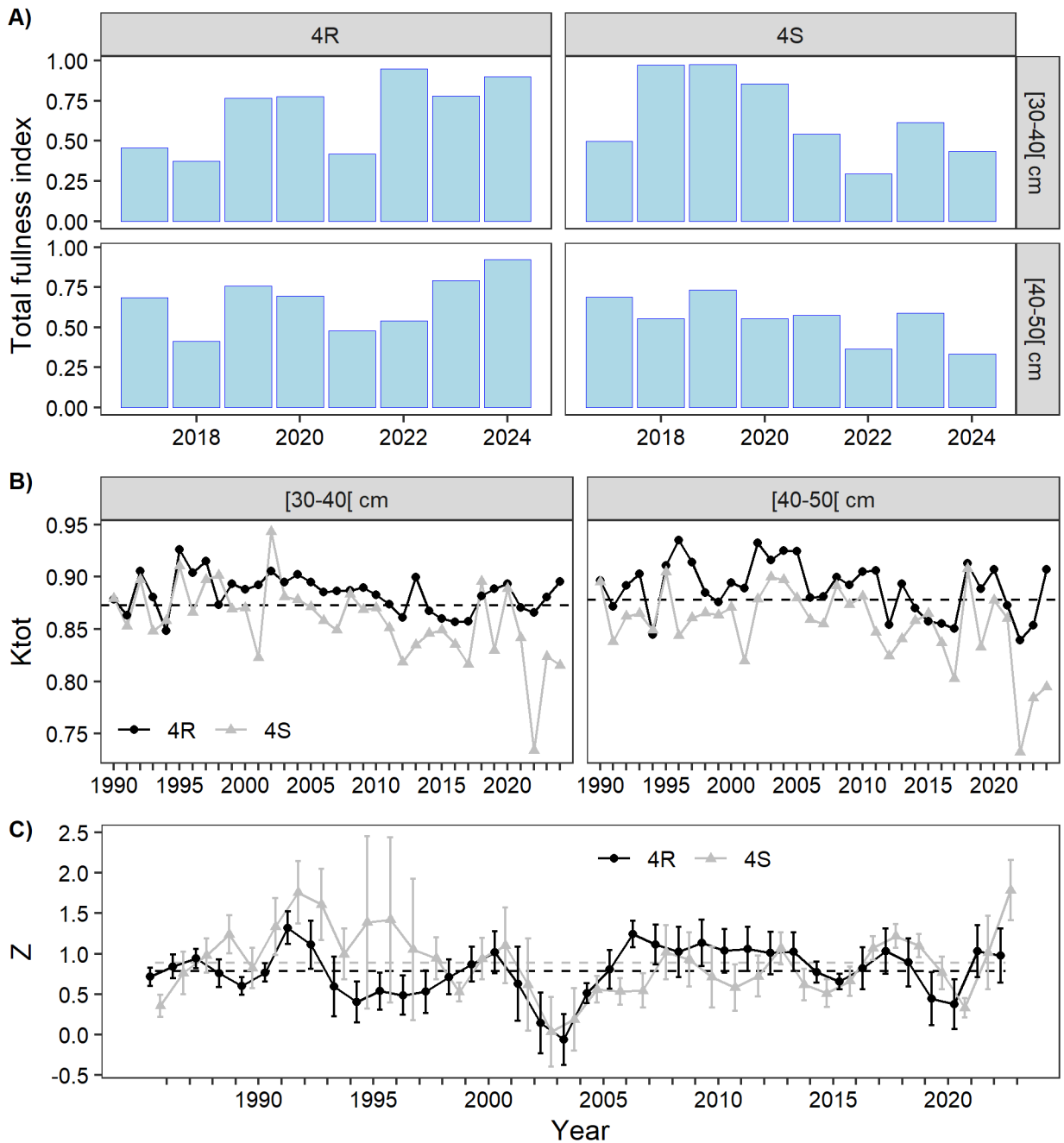


Figure 3. (A) Cod stomach total fullness index by NAFO Division, length class (cm) and year. (B) Fulton cod condition index ( $K_{tot}$ ) by NAFO Division and length class (cm). The horizontal hatched line represents the average of the 4RS 1990–2024 series. (C) Estimates of total mortality by NAFO Division ( $Z$ ,  $\pm$  95% CI) for ages 5 to 10. The dashed horizontal lines represent the average of each NAFO Division. Data source: DFO August survey.

### Stock Advice

Four-year projections (2025–2028) from the fitted assessment model were made for three catch scenarios (0, 500 and 1,000 t) requested by fisheries management. Under these scenarios, the

probability of an increase in SSB over four years ranges from 0.0396 (0 t) to 0.0128 (1,000 t, Table 3). The very low probabilities of an increase in the biomass and abundance of adult cod reflect the high estimated natural mortality and low recruitment observed in recent years.

*Table 3. Results of 4-year projections from the assessment model under different catch scenarios, based on 10,000 simulations.*

|   | Probability | 0 t    | 500 t  | 1000 t |
|---|-------------|--------|--------|--------|
| ... of any increase of SSB                  | 0.0396      | 0.0252 | 0.0128 |        |
| ... of a > 10% increase in SSB              | 0.0167      | 0.0114 | 0.0050 |        |
| ... of reaching or exceeding LRP            | 0.0000      | 0.0000 | 0.0000 |        |
| ... of any increase in age 5+ abundance     | 0.4774      | 0.4383 | 0.3789 |        |
| ... of a > 10% increase in age 5+ abundance | 0.3619      | 0.3232 | 0.2683 |        |

### Harvest Decision Rule

The estimated SSB in 2024 is 22% of the PA LRP. According to the harvest control rule in the rebuilding plan (Table 1), annual removals from all sources should not exceed 500 t.

## PROCEDURE FOR INTERIM YEAR UPDATES

The rebuilding plan for the stock dictates that a full assessment will be undertaken every four years, with updates in interim years. The next full assessment is scheduled for winter 2029. In the meantime, annual updates will be completed, including the smoothed index of cod biomass  $\geq 43$  cm from the DFO August survey as an indicator of the SSB (Benoît and Ouellette-Plante 2023; DFO 2023a).

## SOURCES OF UNCERTAINTY

The magnitude of the recreational fishery, for which no monitoring of catches (quantities, sizes and weights) and discards is carried out, is uncertain (Ouellette-Plante et al. 2022). As the directed commercial fishery has been closed since 2022, it is likely that landings from recreational fishing currently constitute a significant portion of total 3Pn4RS cod landings. Unaccounted mortality resulting from the recreational fishery may contribute to high values of natural mortality estimated by the assessment model.

The link between cod condition and mortality should be further studied, in addition to elucidating the ecosystemic conditions that could be causing it. In particular, the effect of changing oceanographic and ecological conditions in the nGSL, particularly water temperature and dissolved oxygen content, as well as prey availability, represent research priorities.

## LIST OF MEETING PARTICIPANTS

| Name                        | Affiliation   | February 18 | February 19 |
|-----------------------------|---|-------------|-------------|
| Beaudry-Sylvestre, Manuelle | DFO – Science   | x           | x           |
| Belley, Rénaud              | DFO – Science   | x           | -           |
| Benoît, Hugues              | DFO – Science   | x           | x           |
| Bois, Samantha              | Association des capitaines propriétaires de la Gaspésie | x           | x           |
| Bourdages, Hugo             | DFO – Science   | x           | x           |



## Quebec Region

## Northern Gulf of St. Lawrence (3Pn, 4RS) Cod Stock Assessment in 2024

| Name                     | Affiliation   | February<br>18 | February<br>19 |
|--------------------------|---|----------------|----------------|
| Breton, Jérôme           | Association des capitaines propriétaires de la Gaspésie                   | x              | x              |
| Burridge, Angela         | Province of N.L.  | x              | x              |
| Byrne, Vanessa           | Atlantic Groundfish Council   | x              | x              |
| Cabrol, Jory             | DFO – Science   | x              | -              |
| Chamberland, Jean-Martin | DFO – Science   | x              | x              |
| Chlebak, Ryan            | DFO – Science   | x              | x              |
| Cormier, Julien          | DFO – Resource Management   | x              | -              |
| Cyr, Charley             | DFO – Science   | x              | x              |
| Dubé, Sonia              | DFO – Science   | x              | x              |
| Duplisea, Daniel         | DFO – Science   | x              | -              |
| Emond, Kim               | DFO – Science   | x              | x              |
| Griffin, Jeff            | Fish, Food and Allied Workers-Unifor                                      | x              | x              |
| Hardy, Magalie           | DFO – Resource Management   | x              | x              |
| Hardy, Troy              | Fish, Food and Allied Workers-Unifor                                      | x              | x              |
| Klvana, Ilya             | Regroupement des pêcheurs professionnels de la Haute et Moyenne Côte-Nord | x              | x              |
| Labbe-Giguère, Stéphanie | DFO – Resource Management   | x              | x              |
| Mello, Luiz              | DFO – Science   | x              | x              |
| Monger, Julie            | Association des pêcheurs de la Basse-Côte-Nord                            | x              | x              |
| Ouellette-Plante, Jordan | DFO – Science   | x              | x              |
| Parent, Geneviève        | DFO – Science   | x              | -              |
| Pond, Nancy              | DFO – Resource Management   | x              | x              |
| Rayner, Gemma            | Oceans North  | x              | x              |
| Riggs, Alexander         | DFO – Resource Management   | x              | x              |
| Rousseau, Shani          | DFO – Science   | x              | x              |
| Santo, Mélanie           | DFO – Science   | x              | -              |
| Senay, Caroline          | DFO – Science   | x              | x              |
| Smith, Andrew            | DFO – Science   | x              | x              |
| Taillefer, Emmanuelle    | DFO – Science   | x              | x              |
| Théberge, Elisabeth      | DFO – Resource Management   | x              | -              |
| Tucker, Jane             | Fish, Food and Allied Workers-Unifor                                      | x              | x              |
| Turcotte, François       | DFO – Science   | x              | x              |
| Van Beveren, Elisabeth   | DFO – Science   | x              | x              |
| Vanier, Caroline         | DFO – Science   | x              | -              |

## SOURCES OF INFORMATION

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