

Cod in Division 3M

Advice June 2022 for 2023










Recommendation for 2023

Yield corresponding to F less than or equal to $3/4 F_{lim}$ in 2023 results in a very low probability ($\leq 10\%$) of SSB being below B_{lim} in 2024 and a very low probability ($\leq 10\%$) of exceeding F_{lim} .

However, given the present level of the SSB and projected decline of total biomass under any fishing scenario, in order to promote growth in SSB with more than 60% probability, SC advises scenarios with F no more than F_{sq} .

Management objectives

No explicit management plan or management objectives have been defined by the Commission. Convention General Principles are applied (NAFO GC Doc. 07-04).

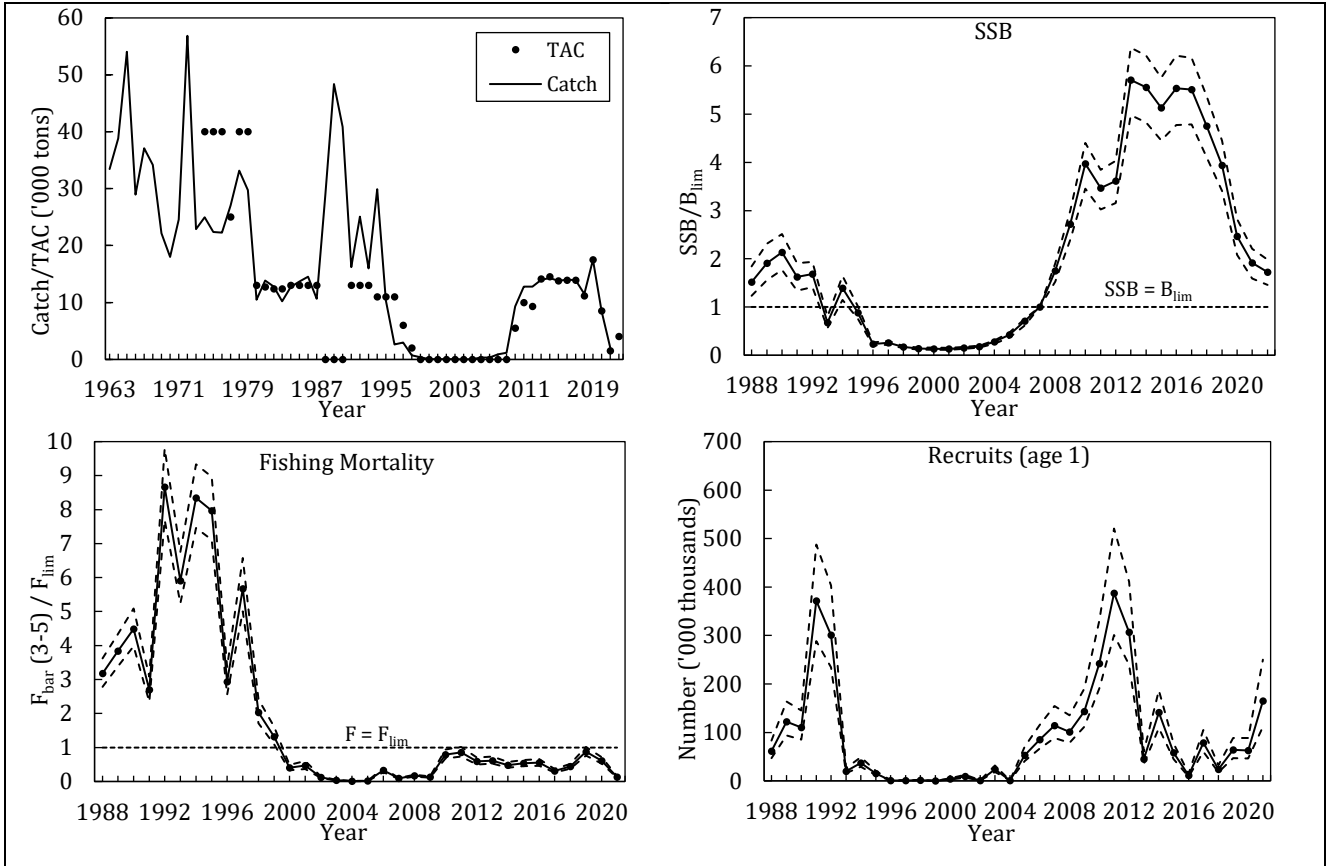
| <i>Convention objectives</i> | <i>Status</i> | <i>Comment/consideration</i> | |
|--------------------------------------------------------------------|-------------------------------------------------------------------------------------|-----------------------------------------------------|------------------------------------------------------------------------------------------------------|
| Restore to or maintain at B_{MSY} |  | Stock above B_{lim} in 2022. B_{MSY} is unknown |  OK |
| Eliminate overfishing |  | $F < F_{lim}$ in 2021 |  Intermediate |
| Apply Precautionary Approach |  | F_{lim} and B_{lim} defined |  Not accomplished |
| Minimise harmful impacts on living marine resources and ecosystems |  | VME closures in effect, no specific measures |  Unknown |
| Preserve marine biodiversity |  | Cannot be evaluated | |

Management unit

The cod stock in Flemish Cap (NAFO Div. 3M) is considered to be a separate population.

Stock status

SSB has been declining rapidly since 2017 but is still estimated to be above B_{lim} (median 15 037 t). The 2021 estimated recruitment showed a positive signal after a period of lower recruitment. Fishing mortality has remained below F_{lim} (median 0.166) since the fishery reopened in 2010.



Reference points

B_{lim} = SSB₂₀₀₇: Median = 15 037 tonnes of spawning biomass (Scientific Council, 2022).
 F_{lim} = $F_{30\%SPR}$: Median = 0.166 (Scientific Council, 2022).



Projections

Although advice is given only for 2023, projection results are shown to 2025 to illustrate the medium-term implications. F_{bar} is the mean of the F at ages 3-5 and used as the indicator of overall fishing mortality; F_{sq} is the status quo F , calculated as the mean of the last three years F_{bar} (2019-2021).

Table 1.

| | B | | SSB | | Yield |
|-----------------------------------------------------|-------|-----------------|-------|-----------------|-------|
| Median and 80% CI | | | | | |
| $F_{\text{bar}} = F_{\text{sq}}$ (median = 0.089) | | | | | |
| 2022 | 50511 | (45475 - 56297) | 25994 | (23085 - 28992) | 4000 |
| 2023 | 48942 | (43410 - 55808) | 22651 | (19983 - 25601) | 5791 |
| 2024 | 47441 | (41115 - 55572) | 23797 | (20536 - 27170) | 6987 |
| 2025 | 43101 | (35439 - 52003) | 27046 | (22345 - 32507) | |
| $F_{\text{bar}} = 0$ | | | | | |
| 2022 | 50511 | (45475 - 56297) | 25994 | (23085 - 28992) | 4000 |
| 2023 | 48942 | (43410 - 55808) | 22651 | (19983 - 25601) | 0 |
| 2024 | 53489 | (47131 - 61613) | 29062 | (25841 - 32474) | 0 |
| 2025 | 55443 | (47659 - 64531) | 37876 | (33038 - 43336) | |
| $F_{\text{bar}} = F_{2021}$ (median = 0.022) | | | | | |
| 2022 | 50511 | (45475 - 56297) | 25994 | (23085 - 28992) | 4000 |
| 2023 | 48942 | (43410 - 55808) | 22651 | (19983 - 25601) | 3425 |
| 2024 | 49900 | (43564 - 58037) | 25929 | (22708 - 29370) | 4429 |
| 2025 | 47858 | (40184 - 56840) | 31201 | (26375 - 36582) | |
| $F_{\text{bar}} = 1/2F_{\text{m}}$ (median = 0.083) | | | | | |
| 2022 | 50511 | (45475 - 56297) | 25994 | (23085 - 28992) | 4000 |
| 2023 | 48942 | (43410 - 55808) | 22651 | (19983 - 25601) | 5446 |
| 2024 | 47801 | (41467 - 55931) | 24123 | (20900 - 27453) | 6610 |
| 2025 | 43807 | (36133 - 52710) | 27667 | (22940 - 33046) | |
| $F_{\text{bar}} = 2/3F_{\text{m}}$ (median = 0.111) | | | | | |
| 2022 | 50511 | (45475 - 56297) | 25994 | (23085 - 28992) | 4000 |
| 2023 | 48942 | (43410 - 55808) | 22651 | (19983 - 25601) | 7032 |
| 2024 | 46140 | (39833 - 54302) | 22661 | (19467 - 26010) | 8128 |
| 2025 | 40803 | (33146 - 49719) | 25127 | (20387 - 30497) | |
| $F_{\text{bar}} = 3/4F_{\text{m}}$ (median = 0.125) | | | | | |
| 2022 | 50511 | (45475 - 56297) | 25994 | (23085 - 28992) | 4000 |
| 2023 | 48942 | (43410 - 55808) | 22651 | (19983 - 25601) | 7787 |
| 2024 | 45350 | (39053 - 53527) | 21986 | (18790 - 25344) | 8790 |
| 2025 | 39437 | (31811 - 48396) | 23977 | (19350 - 29304) | |
| $F_{\text{bar}} = F_{\text{m}}$ (median = 0.166) | | | | | |
| 2022 | 50511 | (45475 - 56297) | 25994 | (23085 - 28992) | 4000 |
| 2023 | 48942 | (43410 - 55808) | 22651 | (19983 - 25601) | 9915 |
| 2024 | 43154 | (36866 - 51292) | 20065 | (16900 - 23469) | 10431 |
| 2025 | 35770 | (28221 - 44759) | 20928 | (16358 - 26280) | |
| Catch = 4000 tons | | | | | |
| 2022 | 50511 | (45475 - 56297) | 25994 | (23085 - 28992) | 4000 |
| 2023 | 48942 | (43410 - 55808) | 22651 | (19983 - 25601) | 4000 |
| 2024 | 49306 | (42971 - 57441) | 25399 | (22161 - 28803) | 4000 |
| 2025 | 47760 | (40074 - 56713) | 31052 | (26294 - 36499) | |
| Catch = 5000 tons | | | | | |
| 2022 | 50511 | (45475 - 56297) | 25994 | (23085 - 28992) | 4000 |
| 2023 | 48942 | (43410 - 55808) | 22651 | (19983 - 25601) | 5000 |
| 2024 | 48274 | (41931 - 56397) | 24492 | (21285 - 27869) | 5000 |
| 2025 | 45838 | (38143 - 54765) | 29349 | (24623 - 34867) | |

Table 2.

| | Yield | | | P(SSB < B _{lim}) | | | | P(F _{bar} > F _{lim}) | | | P(SSB ₂₅ > SSB ₂₂) |
|-----------------------------|-------|------|-------|----------------------------|------|------|------|-----------------------------------------|------|------|-------------------------------------------|
| | 2022 | 2023 | 2024 | 2022 | 2023 | 2024 | 2025 | 2022 | 2023 | 2024 | |
| F _{sq} = 0.089 | 4000 | 5791 | 6987 | <1% | <1% | <1% | <1% | <1% | <1% | <1% | 60% |
| F=0 | 4000 | 0 | 0 | <1% | <1% | <1% | <1% | <1% | <1% | <1% | 100% |
| F ₂₀₂₁ = 0.022 | 4000 | 3425 | 4429 | <1% | <1% | <1% | <1% | <1% | <1% | <1% | 95% |
| 1/2F _{lim} = 0.083 | 4000 | 5446 | 6610 | <1% | <1% | <1% | <1% | <1% | <1% | <1% | 67% |
| 2/3F _{lim} = 0.111 | 4000 | 7032 | 8128 | <1% | <1% | 1% | 1% | <1% | <1% | <1% | 39% |
| 3/4F _{lim} = 0.125 | 4000 | 7787 | 8790 | <1% | <1% | 1% | 1% | <1% | <1% | 3% | 27% |
| F _{lim} = 0.166 | 4000 | 9915 | 10431 | <1% | <1% | 3% | 6% | <1% | 50% | 50% | 9% |
| C = 4000t | 4000 | 4000 | 4000 | <1% | <1% | <1% | <1% | <1% | <1% | <1% | 94% |
| C = 5000t | 4000 | 5000 | 5000 | <1% | <1% | <1% | <1% | <1% | <1% | <1% | 86% |

The results indicate that under all scenarios with $F_{bar} > 0$, total biomass during the projected years will decrease, whereas the SSB is projected to increase slightly in 2025 except in all scenarios with $F \geq 2/3 F_{lim}$ (Table 1). The probability of SSB being below B_{lim} in 2024 is low ($\leq 3\%$) in all the scenarios (Table 2). The probability of SSB in 2025 being above that in 2022 ranges between 9% and 100%, depending on the scenario.

Under all scenarios, the probability of F_{bar} exceeding F_{lim} is less than or equal to 3% in 2023 and 2024 except for F_{lim} as expected.

SC notes that projected values of risk, in particular more than one year ahead (Table 2), will be inherently more uncertain than the projected median stock sizes (Table 1). The risks are typically derived from the tails of a probability distribution which are less precisely estimated compared to the median (centre) of the same distribution.

Assessment

A Bayesian SCAA model, introduced at the 2018 benchmark, was used as the basis for the assessment of this stock with data from 1988 to 2021.

The next full assessment for this stock will be in 2023.

Human impact

Mainly fishery related mortality. Other sources (e.g., pollution, shipping, oil-industry) are undocumented.

Biological and environmental interactions

Redfish, shrimp and smaller cod are important prey items for cod. Recent studies indicate strong trophic interactions between these species in the Flemish Cap.

A 2018 summary of the state of the fish community in the Flemish Cap (3M) EPU indicated that this ecosystem has not experienced sustained reductions in overall productivity observed in other EPU. With the exception of a short-lived increase in 2005-2009, total biomass has remained fairly stable over time despite the changes in individual stocks.

Fishery

Cod is caught in directed trawl and longline fisheries and as bycatch in the directed redfish fishery by trawlers. The fishery is regulated by quota. New technical regulations were introduced in 2021, in particular a closure of the directed fishery in the first quarter as well as sorting grids to protect juveniles.

Recent catch estimates and TACs ('000 tonnes) are as follows:

| | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|-------------|------|------|------|------|------|------|------|------|------|------|------|
| TAC | 9.3 | 14.1 | 14.5 | 13.8 | 13.9 | 13.9 | 11.1 | 17.5 | 8.5 | 1.5 | 4.0 |
| STATLANT 21 | 9.1 | 13.5 | 14.4 | 12.8 | 13.8 | 13.9 | 10.5 | 13.0 | 8.5 | 2.6 | |
| STACFIS | 12.8 | 14.0 | 14.3 | 13.8 | 14.0 | 13.9 | 11.5 | 17.5 | 8.5 | 2.1 | |

Effects of the fishery on the ecosystem

The impact of bottom fishing activities on major 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 fishing to protect VMEs.

Special comment

Despite the expected increases in SSB under most fishing scenarios, the total biomass will continue to decrease over the projected period under all fishing scenarios ($F > 0$).

Sources of information

SCS Doc. 22/06, 22/07, 22/08, 22/13 and SCR Doc. 22/04, 22/12 and 22/25.